

# **ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT**

| Applicant:            | LUMENUS LLC<br>800 Wilshire Blvd #200 Los Angeles, CA 90017 |
|-----------------------|---|
| Product Name:         | ioLight   |
| Brand Name:           | Lumenus   |
| Model No.:            | ioLight-1.0   |
| Model Difference:     | N/A   |
| Report Number:        | E2/2019/B0067   |
| FCC ID:               | 2AVGQ-IOLIGHT1  |
| FCC Rule Part:        | §15.247, Cat: DTS   |
| Issue Date:           | Feb. 18, 2020   |
| Date of Test:         | Nov. 29, 2019 ~Jan. 30, 2020                                |
| Date of EUT Received: | Nov. 29, 2019   |

#### We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Approved By: \_CHUN; CHIZEH, CHIEN

Chun Chieh Chen / Supervisor



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| Revision History |  |           |               |                         |  |  |
|------------------|--|-----------|---------------|-------------------------|--|--|
| Report Number    | Report Number     Revision     Description     Issue Date     Remark |           |               |                         |  |  |
| E2/2019/B0067    | Rev.00   | Original. | Feb. 18, 2020 | Revised By: Karen Huang |  |  |

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SGS Taiwan Ltd. No.134,WuKungRoad,NewTaipeiIndustrialPark,WukuDistrict,NewTaipeiCity,Taiwan24803/新北市五股區新北產業園區五工路 134號



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#### **GENERAL INFORMATION** 1

### **1.1 Product Description**

| Product Name:       | ioLight   |  |  |
|---------------------|---|--|--|
| Brand Name:         | Lumenus   |  |  |
| Model No.:          | ioLight-1.0   |  |  |
| Model Difference:   | N/A   |  |  |
| Product HW Version: | N/A   |  |  |
| Product SW Version: | N/A   |  |  |
| Micro-USB Cable:    | Model No.: 1Q1221191-SL, Supplier: SUNCA Co., Ltd.  |  |  |
|                     | 3.7Vdc from Rechargeable Li-polymer Battery<br>or 5 Vdc from Micro-USB Cable                              |  |  |
| Power Supply:       | Model No.: lipo 3.7V 2200mah 653585,Battery:Supplier: Shen Zhen Chuangxinjia Smart Technology<br>Co., Ltd |  |  |

| Radio Technology: | Bluetooth LE Single mode |
|-------------------|--------------------------|
| Frequency Range:  | 2402 – 2480MHz           |
| Channel number:   | 40 channels              |
| Modulation type:  | GFSK                     |
| Transmit Power:   | -5.59 dBm                |

### 1.2 Antenna Designation

| Antenna                      | Freq.  | Peak Antenna |
|------------------------------|--------|--------------|
| Type                         | (MHz)  | Gain (dBi)   |
| Meandered Inverted-F Antenna | 2.4GHz | 1.6          |

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### 1.3 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247 FCC KDB 558074 D01 DTS Meas. Guidance v05r02 ANSI C63.10:2013

### 1.4 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory (TAF code 0513) No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333

FCC Designation number: TW0002

### 1.5 Special Accessories

There are no special accessories used while test was conducted.

### 1.6 Equipment Modifications

There was no modification incorporated into the EUT.

### 1.7 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m\*9m\*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

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# 2 SYSTEM TEST CONFIGURATION

## 2.1 EUT Configuration

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

## 2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

### 2.3 Test Procedure

### 2.3.1 Conducted Emissions

The EUT is a placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed. The two LISNs provide 50uH/50 ohm of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

### 2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

### 2.3.3 Radiated Emissions

The EUT is a placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

## 2.4 Measurement Results Explanation Example

### For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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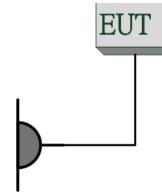
# 2.5 Configuration of Tested System Fig. 2-1 Conducted (Antenna Port) Emission Configuration



### Fig 2-2 Radiated Emission



Fig 2-3 Conduction (AC Power Line) Radiated Emission



| ltem | Equipment            | Mfr/Brand    | Model/Type No. | Series No. | Data Cable | Power<br>Cord |
|------|----------------------|--------------|----------------|------------|------------|---------------|
| 1    | BLE Test<br>Software | N/A          | N/A            | N/A        | N/A        | N/A           |
| 2    | Notebook             | Lenovo       | T470           | P0001293   | N/A        | N/A           |
| 3    | Adapter              | HSHONGAHAING | MUC-5K         | AC-USB012  | N/A        | N/A           |

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#### SUMMARY OF TEST RESULTS 3

| FCC Rules                        | Description Of Test                          | Result    |
|----------------------------------|--|-----------|
| §15.207(a)                       | AC Power Line Conducted Emission             | Compliant |
| §15.247(b) (3)                   | Peak Output Power                            | Compliant |
| §15.247(a)(2)                    | 6dB Bandwidth                                | Compliant |
| §15.205<br>§15.209<br>§15.247(d) | Conducted Band Edge<br>and Spurious Emission | Compliant |
| §15.205<br>§15.209<br>§15.247(d) | Radiated Band Edge<br>and Spurious Emission  | Compliant |
| §15.247(e)                       | Peak Power Density                           | Compliant |
| §15.203<br>§15.247(b)            | Antenna Requirement                          | Compliant |

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#### **DESCRIPTION OF TEST MODES** 4

#### 4.1 Operated in 2400 ~ 2483.5MHz Band

40 channels are provided for Bluetooth LE

| ITEM | FREQUENCY | ITEM | FREQUENCY | ITEM | FREQUENCY |
|------|-----------|------|-----------|------|-----------|
| 1    | 2402 MHz  | 15   | 2430 MHz  | 29   | 2458 MHz  |
| 2    | 2404 MHz  | 16   | 2432 MHz  | 30   | 2460 MHz  |
| 3    | 2406 MHz  | 17   | 2434 MHz  | 31   | 2462 MHz  |
| 4    | 2408 MHz  | 18   | 2436 MHz  | 32   | 2464 MHz  |
| 5    | 2410 MHz  | 19   | 2438 MHz  | 33   | 2466 MHz  |
| 6    | 2412 MHz  | 20   | 2440 MHz  | 34   | 2468 MHz  |
| 7    | 2414 MHz  | 21   | 2442 MHz  | 35   | 2470 MHz  |
| 8    | 2416MHz   | 22   | 2444 MHz  | 36   | 2472 MHz  |
| 9    | 2418 MHz  | 23   | 2446 MHz  | 37   | 2474 MHz  |
| 10   | 2420 MHz  | 24   | 2448 MHz  | 38   | 2476 MHz  |
| 11   | 2422 MHz  | 25   | 2450 MHz  | 39   | 2478 MHz  |
| 12   | 2424 MHz  | 26   | 2452 MHz  | 40   | 2480 MHz  |
| 13   | 2426 MHz  | 27   | 2454 MHz  |      |           |
| 14   | 2428 MHz  | 28   | 2456 MHz  |      |           |

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## 4.2 The Worst Test Modes and Channel Details

- 1. The EUT has been tested under operating condition.
- 2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
- 3. Investigation has been done on all the possible configurations for searching the worst case.

| AVAILABLE<br>FREQUENCY<br>(MHz)      | TESTED<br>FREQUENCY (MHz)                            | MODULATION   | DATA RATE<br>(Mbps)   |  |  |  |
|--------------------------------------|--|--|---|--|--|--|
| RADIATED EMISSION TEST (BELOW 1 GHz) |  |  |   |  |  |  |
| 2402 to 2480                         | 2442   | GFSK   | 1   |  |  |  |
| RADIATED EMISSION TEST (ABOVE 1 GHz) |  |  |   |  |  |  |
| 2402 to 2480                         | 2402, 2442, 2480                                     | GFSK   | 1   |  |  |  |
|                                      | FREQUENCY<br>(MHz)<br>RADIA<br>2402 to 2480<br>RADIA | FREQUENCY<br>(MHz) TESTED<br>FREQUENCY (MHz)   RADIATED EMISSION TEST (   2402 to 2480 2442   RADIATED EMISSION TEST ( | FREQUENCY<br>(MHz)TESTED<br>FREQUENCY (MHz)MODULATIONRADIATED EMISSION TEST (BELOW 1 GHz)2402 to 24802442GFSKRADIATED EMISSION TEST (ABOVE 1 GHz) |  |  |  |

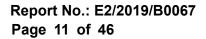
**Note:** The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth LE Transmitter for channel Low, Mid and High, the worst case E2 position was reported.

| ANTENNA PORT CONDUCTED MEASUREMENT |                                 |                           |            |                     |  |  |
|------------------------------------|---------------------------------|---------------------------|------------|---------------------|--|--|
| MODE                               | AVAILABLE<br>FREQUENCY<br>(MHz) | TESTED<br>FREQUENCY (MHz) | MODULATION | DATA RATE<br>(Mbps) |  |  |
| Bluetooth LE                       | 2402 to 2480                    | 2402, 2442, 2480          | GFSK       | 1                   |  |  |

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#### MEASUREMENT UNCERTAINTY 5

| Test Items                                   | Uncertainty                 |  |  |  |  |  |
|--|-----------------------------|--|--|--|--|--|
| AC Power Line Conducted Emission             | +/- 2.586 dB                |  |  |  |  |  |
| Peak Output Power                            | +/- 0.84 dB                 |  |  |  |  |  |
| 6dB Bandwidth                                | +/- 51.33 Hz                |  |  |  |  |  |
| 100 KHz Bandwidth Of<br>Frequency Band Edges | +/- 0.84 dB                 |  |  |  |  |  |
| Peak Power Density                           | +/- 1.3 dB                  |  |  |  |  |  |
| Temperature                                  | +/- 0.65 °C                 |  |  |  |  |  |
| Humidity                                     | +/- 4.6 %                   |  |  |  |  |  |
| DC / AC Power Source                         | DC= +/- 0.13%, AC= +/- 0.2% |  |  |  |  |  |

| Radiated Spurious Emission Measurement Uncertainty |                            |  |  |  |  |  |  |  |
|--|----------------------------|--|--|--|--|--|--|--|
|  | 9kHz~30MHz: +-2.3dB        |  |  |  |  |  |  |  |
|  | 30MHz - 180MHz: +/- 3.37dB |  |  |  |  |  |  |  |
| Polarization: Vertical                             | 180MHz -417MHz: +/- 3.19dB |  |  |  |  |  |  |  |
|  | 0.417GHz-1GHz: +/- 3.19dB  |  |  |  |  |  |  |  |
|  | 1GHz - 18GHz: +/- 4.04dB   |  |  |  |  |  |  |  |
|  | 18GHz - 40GHz: +/- 4.04dB  |  |  |  |  |  |  |  |
|  | 9kHz~30MHz: +-2.3dB        |  |  |  |  |  |  |  |
|  | 30MHz - 167MHz: +/- 4.22dB |  |  |  |  |  |  |  |
| Polarization: Horizontal                           | 167MHz -500MHz: +/- 3.44dB |  |  |  |  |  |  |  |
| Polarization. Horizontai                           | 0.5GHz-1GHz: +/- 3.39dB    |  |  |  |  |  |  |  |
|  | 1GHz - 18GHz: +/- 4.08dB   |  |  |  |  |  |  |  |
|  | 18GHz - 40GHz: +/- 4.08dB  |  |  |  |  |  |  |  |

#### Note:

- 1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
- 2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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# 6 CONDUCTED EMISSION TEST

### 6.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

|                 | Limits     |          |  |  |  |  |  |  |  |  |
|-----------------|------------|----------|--|--|--|--|--|--|--|--|
| Frequency range | dB( μV)    |          |  |  |  |  |  |  |  |  |
| MHz             | Quasi-peak | Average  |  |  |  |  |  |  |  |  |
| 0.15 to 0.50    | 66 to 56   | 56 to 46 |  |  |  |  |  |  |  |  |
| 0.50 to 5       | 56         | 46       |  |  |  |  |  |  |  |  |
| 5 to 30         | 60 50      |          |  |  |  |  |  |  |  |  |

Note

1. The lower limit shall apply at the transition frequencies

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

### 6.2 Measurement Equipment Used:

|                   | Conducted Emission Test Site |        |        |            |            |  |  |  |  |  |  |
|-------------------|------------------------------|--------|--------|------------|------------|--|--|--|--|--|--|
| EQUIPMENT         | MENT MFR MODEL SERIAL LAST   |        |        |            |            |  |  |  |  |  |  |
| TYPE              |                              | NUMBER | NUMBER | CAL.       |            |  |  |  |  |  |  |
| LISN              | TESEQ                        | NNB 51 | 36076  | 02/13/2019 | 02/12/2020 |  |  |  |  |  |  |
| EMI Test Receiver | R&S                          | ESCI   | 101300 | 11/14/2019 | 11/13/2020 |  |  |  |  |  |  |

### 6.3 EUT Setup:

- 1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
- 2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
- 3. The LISN was connected with 120Vac/60Hz power source.

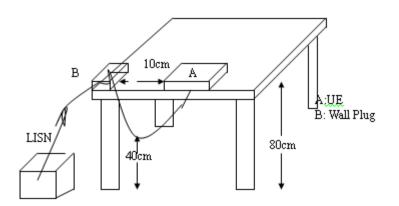
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## 6.4 Test SET-UP (Block Diagram of Configuration)



### 6.5 Measurement Procedure:

- 1. The EUT was placed on a table which is 0.8m above ground plan.
- 2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 3. Repeat above procedures until all phases of power being supplied by given UE are completed

### 6.6 Measurement Result:

Note: Refer to next page for measurement data and plots. Note2: The \* reveals the worst-case results that closet to the limit.

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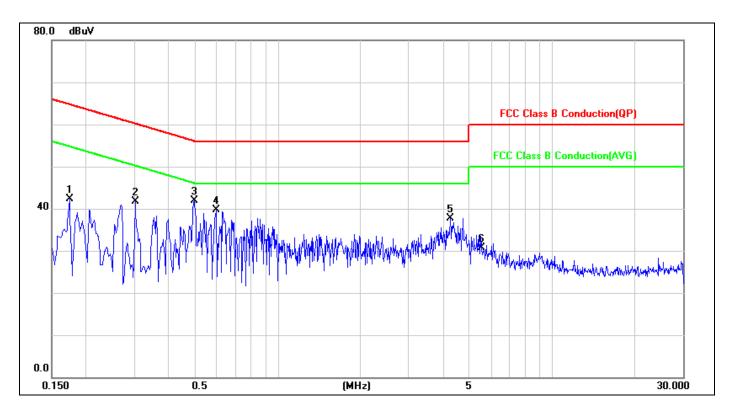
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### AC POWER LINE CONDUCTED EMISSION TEST DATA

| Description:  | Operation     | Date:              | 2020/01/17    |
|---------------|---------------|--------------------|---------------|
| Line:         | L1            | Temp.(°C)/Hum.(%): | 20.1 (°C)/62% |
| Test Voltage: | AC 120V/60Hz  | Test By:           | Ashton        |
| Report:       | E2/2019/B0067 | -                  |               |



|     |     | Freq.  | Reading | Factor | Measure- | Limit  | Over   |          |         |
|-----|-----|--------|---------|--------|----------|--------|--------|----------|---------|
| No. | Mk. |        |         |        | ment     |        |        | Detector | Comment |
|     |     | (MHz)  | (dBuV)  | (dB)   | (dBuV)   | (dBuV) | (dB)   |          |         |
| 1   |     | 0.1740 | 22.84   | 19.51  | 42.35    | 64.77  | -22.42 | peak     |         |
| 2   |     | 0.3020 | 22.07   | 19.63  | 41.70    | 60.19  | -18.49 | peak     |         |
| 3   | *   | 0.4980 | 22.06   | 19.76  | 41.82    | 56.03  | -14.21 | peak     |         |
| 4   |     | 0.5980 | 19.85   | 19.76  | 39.61    | 56.00  | -16.39 | peak     |         |
| 5   |     | 4.2580 | 17.83   | 19.92  | 37.75    | 56.00  | -18.25 | peak     |         |
| 6   |     | 5.5580 | 10.81   | 19.92  | 30.73    | 60.00  | -29.27 | peak     |         |

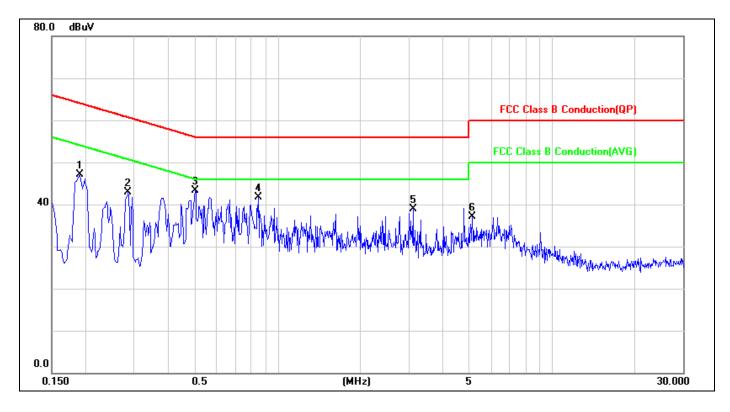
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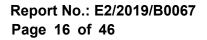
| Description:  | Operation     | Date:              | 2020/01/17    |
|---------------|---------------|--------------------|---------------|
| Line:         | Ν             | Temp.(°C)/Hum.(%): | 20.1 (°C)/62% |
| Test Voltage: | AC 120V/60Hz  | Test By:           | Ashton        |
| Report:       | E2/2019/B0067 |                    |               |



|     |     | Freq.  | Reading | Factor | Measure-       | Limit  | Over   | _        |         |
|-----|-----|--------|---------|--------|----------------|--------|--------|----------|---------|
| No. | Mk. | (MHz)  | (dBuV)  | (dB)   | ment<br>(dBuV) | (dBuV) | (dB)   | Detector | Comment |
|     |     | 1 /    |         |        |                |        |        |          |         |
| 1   |     | 0.1900 | 27.41   | 19.76  | 47.17          | 64.04  | -16.87 | peak     |         |
| 2   |     | 0.2860 | 23.14   | 19.84  | 42.98          | 60.64  | -17.66 | peak     |         |
| 3   | *   | 0.5020 | 23.39   | 19.97  | 43.36          | 56.00  | -12.64 | peak     |         |
| 4   |     | 0.8500 | 21.72   | 19.98  | 41.70          | 56.00  | -14.30 | peak     |         |
| 5   |     | 3.1180 | 18.74   | 20.17  | 38.91          | 56.00  | -17.09 | peak     |         |
| 6   |     | 5.1380 | 16.92   | 20.14  | 37.06          | 60.00  | -22.94 | peak     |         |

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# 7 PEAK OUTPUT POWER MEASUREMENT

## 7.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

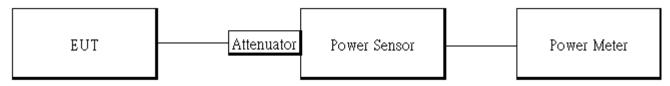
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

### 7.2 Measurement Equipment Used:

| Conducted Emission Test Site |           |                 |                  |              |            |  |  |  |  |  |
|------------------------------|-----------|-----------------|------------------|--------------|------------|--|--|--|--|--|
| EQUIPMENT<br>TYPE            | MFR       | MODEL<br>NUMBER | SERIAL<br>NUMBER | LAST<br>CAL. | CAL DUE.   |  |  |  |  |  |
| Power Meter                  | Anritsu   | ML2496A         | 1326001          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |
| Power Sensor                 | Anritsu   | MA2411B         | 1315048          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |
| Power Sensor                 | Anritsu   | MA2411B         | 1315049          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |
| Attenuator                   | Marvelous | MVE2213-10      | RF80             | 11/20/2019   | 11/19/2020 |  |  |  |  |  |

### 7.3 Test Set-up:



## 7.4 Measurement Procedure:

- 1. Place the EUT on the table and set it in transmitting mode.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.
- 4. Record the max. Reading as observed from Power Meter.
- 5. Repeat above procedures until all test default channel measured was complete.

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### 7.5 Duty Factor:

|     | Duty Cycle (%)<br>= Ton / (Ton+Toff) | Duty Factor (dB)<br>=10*log ( 1/Duty<br>Cycle ) | 1/T<br>(kHz) | VBW<br>setting<br>(kHz) |  |
|-----|--------------------------------------|---|--------------|-------------------------|--|
| BLE | 61.60                                | 2.10  | 2.60         | 3.00                    |  |

### Duty Cycle\_BLE\_1M\_MidCH20-2442

|                            |              | Spect |             | Analyzer - S        |     |         |                       |                                      |  |       |                                |               |     |        |       |                      |     |         |          |                |          |    |   |
|----------------------------|--------------|-------|-------------|---------------------|-----|---------|-----------------------|--------------------------------------|--|-------|--------------------------------|---------------|-----|--------|-------|----------------------|-----|---------|----------|----------------|----------|----|---|
|                            | R            | Erc   | RF          | 50<br>2.442         | Ω   |         | <u><u></u><u></u></u> |                                      |  |       | SEN                            | SE:INT        |     | A      | g Typ | IN AUTO              |     | 05:22:0 |          | Dec 09,        |          | -  | Frequency                                 |
|                            | nter         | FIE   | ، p         | 2.4420              | 000 | 000     | PN                    | IZ<br>NO: Fas<br>Sain:Lo             | st ↔<br>ow                             |       | : Free<br>en: 30               | e Run<br>0 dB |     | ~      | 9119  | <br>9.0              |     |         | DET      | E WWW<br>P N N | NNN      | Γ  | Auto Tune                                 |
|                            | dB/div       |       |             | f Offset<br>f 20.00 |     |         |                       |                                      |  |       |                                |               |     |        |       |                      | ΔΙ  | Mkr3    | 6:<br>-0 | 25.0<br>).05   | μs<br>dB | L  |   |
| Log<br>10.<br>0.0          |              |       | Ŷ           | ∆ <u>2</u> 3∆4      | 4   |         |                       |                                      |  |       |                                |               |     |        |       |                      |     |         |          |                | 1        |    | Center Fred<br>2.442000000 GHz            |
| -20.1<br>-30.1<br>-40.1    | 0            |       |             |                     |     | in the  |                       |                                      | 17m                                    |       | ava                            |               |     | Wester |       | elyger. <sup>g</sup> |     |         |          |                |          |    | Start Fred<br>2.442000000 GH2             |
| -50.1<br>-60.1<br>-70.1    | 0            |       | яr<br>—     | чид.<br>            |     | vyn yd  |                       |                                      | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ |       | - All-Sold                     |               | 4   |        |       |                      |     | ALANA . | r.       |                | 4~*!     |    | <b>Stop Fred</b><br>2.442000000 GH2       |
| Re                         | nter<br>s BW | 81    | мн          | _                   | Gł  | lz<br>× |                       | #                                    | VBW                                    | 8.0 N | ИНz                            |               | FUN | CTION  | FU    | <u> </u>             |     | 00 ms   | s (1     | oan 0<br>001   | pts)     | Αι | CF Step<br>8.000000 MH:<br><u>Ito</u> Mar |
| 1<br>2<br>3<br>4<br>5<br>6 | ∆4<br>F      | 1111  | t<br>t<br>t | (Δ)<br>(Δ)          |     |         | 50.<br>62             | 5.0 µs<br>.00 µs<br>5.0 µs<br>.00 µs | s<br>(Δ)                               | -5.   | 0.27<br>52 dE<br>0.05<br>52 dE | 3m<br>dB      |     |        |       | <br>                 |     |         |          |                |          |    | Freq Offse<br>0 Hz                        |
| 7<br>8<br>9<br>10<br>11    |              |       |             |                     |     |         |                       |                                      |  |       |                                |               |     |        |       |                      |     |         |          |                |          |    |   |
| MSG                        |              |       |             |                     |     |         |                       |                                      |  |       |                                |               |     |        |       | STAT                 | rus |         |          |                |          |    |   |

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### 7.6 Output Power:

#### 7.6.1 Peak & Avg

| СН   | Frequency<br>(MHz) | Peak Power Output<br>(dBm)                                   | Required Limit  |
|------|--------------------|--|-----------------|
| Low  | 2402               | -5.93  | 1 Watt = 30 dBm |
| Mid  | 2442               | -5.99  | 1 Watt = 30 dBm |
| High | 2480               | -5.59  | 1 Watt = 30 dBm |
| СН   | Frequency<br>(MHz) | Max. Avg. Output include<br>tune up tolerance Power<br>(dBm) | Required Limit  |
| Low  | 2402               | -6.25  | 1 Watt = 30 dBm |
| Mid  | 2442               | -6.31  | 1 Watt = 30 dBm |
| High | 2480               | -5.77  | 1 Watt = 30 dBm |

\*Note: Measured by power meter, cable loss as 1 dB that offsets on the power meter in Peak \*Note: Measured by power meter, as cable loss+ Duty cycle factor that offsets on the power meter \*Note: Max. Output include tune up tolerance Power is average power

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# 8 6DB BANDWIDTH MEASUREMENT

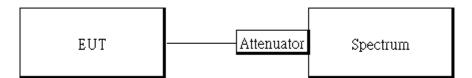
### 8.1 Standard Applicable

The minimum 6 dB bandwidth shall be at least 500 kHz .

### 8.2 Measurement Equipment Used

|                   | Conducted Emission Test Site |                 |                  |              |            |  |  |  |  |  |  |  |
|-------------------|------------------------------|-----------------|------------------|--------------|------------|--|--|--|--|--|--|--|
| EQUIPMENT<br>TYPE | MFR                          | MODEL<br>NUMBER | SERIAL<br>NUMBER | LAST<br>CAL. | CAL DUE.   |  |  |  |  |  |  |  |
|                   |                              |                 | _                |              |            |  |  |  |  |  |  |  |
| Power Meter       | Anritsu                      | ML2496A         | 1326001          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |  |  |
| Power Sensor      | Anritsu                      | MA2411B         | 1315048          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |  |  |
| Power Sensor      | Anritsu                      | MA2411B         | 1315049          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |  |  |
| Attenuator        | Marvelous                    | MVE2213-10      | RF80             | 11/20/2019   | 11/19/2020 |  |  |  |  |  |  |  |
| Spectrum Analyzer | KEYSIGHT                     | N9010A          | MY57120200       | 03/06/2019   | 03/05/2020 |  |  |  |  |  |  |  |
| DC Block          | PASTERNACK                   | PE8210          | RF256            | 11/20/2019   | 11/19/2020 |  |  |  |  |  |  |  |

### 8.3 Test Set-up:



### 8.4 Measurement Procedure:

- 1. Place the EUT on the table and set it in transmitting mode.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- 4. For 6dB Bandwidth:

Set the spectrum analyzer as RBW=100 kHz, VBW= 3\*RBW, Span = 5MHz, Detector=Peak, Sweep=auto.

- 5. Mark the peak frequency and –6dB (upper and lower) frequency.
- 6. For 99% Bandwidth:

Set the spectrum analyzer as RBW=1%, VBW=3\*RBW, Span = 2MHz, Detector=Sample, Sweep=auto.

- 7. Turn on the 99% bandwidth function, max reading.
- 8. Repeat above procedures until all test default channel is completed

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#### 8.5 **Measurement Result:**

6dB

| Frequency<br>(MHz) | 6dB<br>BW<br>(MHz) | Required<br>BW<br>(MHz) | Result |  |
|--------------------|--------------------|-------------------------|--------|--|
| 2402               | 0.7133             | > 0.5                   | PASS   |  |
| 2442               | 0.705              | > 0.5                   | PASS   |  |
| 2480               | 0.7042             | > 0.5                   | PASS   |  |

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#### OBW 6dB\_BLE\_1M\_LowCH00-2402

| 🚺 Keysight Spec | trum Analyzer - Occupied Bi      | v            |                                      |                     |                                   | - 6 -                          |
|-----------------|----------------------------------|--------------|--------------------------------------|---------------------|-----------------------------------|--------------------------------|
| Center Fr       | eq 2.402000000                   | GHz Cente    | SENSE:INT<br>r Freq: 2.402000000 GHz | Radio               | 8:32 PM Dec 10, 2019<br>Std: None | Frequency                      |
|                 |                                  | Trig: I      | FreeRun Avg Hold<br>1: 30 dB         | i: 100/100<br>Radio | Device: BTS                       |                                |
|                 |                                  | in Galicon   |                                      |                     |                                   |                                |
| 10 dB/div       | Ref Offset 1 dB<br>Ref 20.00 dBn | n            |                                      |                     |                                   |                                |
| Log<br>10.0     |                                  |              |                                      |                     |                                   |                                |
| 0.00            |                                  |              |                                      |                     |                                   | Center Freq<br>2.402000000 GHz |
| -10.0           |                                  |              |                                      |                     |                                   | 2.40200000 GH2                 |
| -20.0           |                                  |              |                                      |                     |                                   |                                |
| -30.0           |                                  |              |                                      |                     |                                   |                                |
| -40.0           |                                  |              |                                      |                     |                                   |                                |
| -50.0           |                                  |              |                                      | -                   |                                   |                                |
| -60.0           |                                  |              |                                      |                     |                                   |                                |
| -70.0           |                                  |              |                                      |                     | _                                 |                                |
| Center 2.4      | 102 CH2                          |              |                                      |                     | Span 5 MHz                        | <u> </u>                       |
| #Res BW         |                                  | #            | VBW 300 kHz                          |                     | Sweep 1 ms                        | CF Step<br>500.000 kHz         |
| Occup           | ied Bandwidt                     | 'n           | Total Power                          | 0.25 dBn            | <u>ו</u>                          | <u>Auto</u> Man                |
| occup           |                                  | <br>1126 MHz |                                      |                     |                                   |                                |
|                 |                                  |              |                                      |                     |                                   | Freq Offset<br>0 Hz            |
| Transm          | nit Freq Error                   | -19.797 kHz  | OBW Power                            | 99.00 %             | 6                                 | 0 H2                           |
| x dB Ba         | andwidth                         | 713.3 kHz    | x dB                                 | -6.00 dE            | 3                                 |                                |
|                 |                                  |              |                                      |                     |                                   |                                |
|                 |                                  |              |                                      |                     |                                   |                                |
|                 |                                  |              |                                      |                     |                                   |                                |
| MSG             |                                  |              |                                      | STATUS              |                                   |                                |

#### OBW 6dB BLE 1M MidCH20-2442

| equency              |            |                                |                       |            |   |                        |           |   |                       | ectrum Analyzer | Keysight Sp |  |  |  |  |  |
|----------------------|------------|--------------------------------|-----------------------|------------|---|------------------------|-----------|---|-----------------------|-----------------|-------------|--|--|--|--|--|
|                      | Fi         | 55 PMDec 10, 2019<br>Std: None |                       | ALIGN AUTO | 000 GHz   | SE:INT<br>eq: 2.442000 | Center Fr | Hz  | 2000000 G             |                 | Renter F    |  |  |  |  |  |
|                      | s          | Device: BTS                    | Radio De              | 100/100    | Trig: Free Run Avg Hold: 100/100<br>#Atten: 30 dB |                        |           | -+  | #IFGain:Low           |                 |             |  |  |  |  |  |
|                      |            |                                |                       |            |   |                        |           |   | fset 1 dB<br>0.00 dBm |                 | ) dB/div    |  |  |  |  |  |
| enter Fro            |            |                                |                       |            |   |                        |           |   |                       |                 | 0.0         |  |  |  |  |  |
| 2000000 Gi           |            | _                              |                       |            |   |                        |           |   |                       | _               | .00         |  |  |  |  |  |
|                      |            |                                |                       |            |   | $\sim$                 | $\sim$    | ++  |                       |                 | 0.0         |  |  |  |  |  |
|                      |            |                                |                       |            |   |                        | r         | + /   |                       |                 | 0.0         |  |  |  |  |  |
|                      |            |                                |                       |            |   |                        |           |   |                       |                 | 0.0         |  |  |  |  |  |
|                      | ~~~~       |                                |                       |            |   |                        |           |   |                       |                 | 0.0         |  |  |  |  |  |
|                      |            |                                |                       |            |   |                        |           |   |                       |                 | 0.0         |  |  |  |  |  |
|                      |            |                                |                       |            |   |                        |           |   |                       |                 | 2.0         |  |  |  |  |  |
|                      |            |                                |                       |            |   |                        |           |   |                       |                 |             |  |  |  |  |  |
| CF Ste<br>500.000 ki |            | weep 1 ms                      |                       |            | łz  | W 300 ki               | #VE       |   |                       |                 |             |  |  |  |  |  |
| Ma                   | Auto       |                                | ) dBm                 | 0.40       | wer   | Total Po               |           |   | ndwidth               | pied Ba         | Occu        |  |  |  |  |  |
| Freq Offs            |            |                                |                       |            |   |                        | Ηz        | 111 MI  | 1.1                   |                 |             |  |  |  |  |  |
| 01                   |            |                                | 9.00 %                | 99         | wer   | OBW Po                 | kHz       | -12.140   | Error                 | mit Freq        | Trans       |  |  |  |  |  |
|                      |            |                                | 00 dB                 | -6.        |   | x dB                   | kHz       | 705.0   | h                     | Bandwidt        | x dB B      |  |  |  |  |  |
|                      | ms<br>Auto |                                | Sw<br>0 dBm<br>9.00 % | 99         | #VBW 300 kHz<br>Total Power<br>OBW Power          |                        |           | zenter 2.442 GHz<br>Res BW 100 kHz<br>Occupied Bandwidth<br>1.1111 MHz<br>Transmit Freq Error -12.140 kHz<br>x dB Bandwidth 705.0 kHz |                       |                 |             |  |  |  |  |  |

#### OBW 6dB BLE 1M HighCH39-2480

| Keysight Spectrum Analyzer - Oco |                |  |   | • • • • •                   |
|----------------------------------|----------------|--|---|-----------------------------|
| R № 50 Ω<br>Center Freq 2.48000  | 00000 GHz Ce   | SENSE:INT<br>Inter Freq: 2.480000000 GHz<br>Ig: Free Run Avg Hold<br>tten: 30 dB | ALIGN AUTO 06:55:49 PM Dec 10, 20<br>Radio Std: None<br>I: 100/100<br>Radio Device: BTS | Frequency                   |
| Ref Offset<br>0 dB/div Ref 20.0  |                |  |   |                             |
| 0 9 10.0                         |                |  |   | Center Fre<br>2.48000000 GH |
| 0.0                              |                |  |   |                             |
| 40.0                             |                |  |   | -                           |
| 0.0                              |                |  |   |                             |
| enter 2.48 GHz<br>Res BW 100 kHz |                | #VBW 300 kHz   | Span 5 Mi<br>Sweep 1 n  | ns 500.000 kH               |
| Occupied Band                    |                | Total Power  | 1.14 dBm  | Auto Ma                     |
|                                  | 1.1093 MHz     |  |   | Freq Offse                  |
| Transmit Freq Err                | or -29.809 kHz | OBW Power  | 99.00 %   | он                          |
| x dB Bandwidth                   | 704.2 kHz      | x dB   | -6.00 dB  |                             |
| 30                               |                |  | STATUS  |                             |

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# 9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

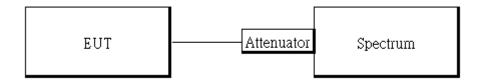
### 9.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

|                   | Conducted Emission Test Site |                 |                  |              |            |  |  |  |  |  |  |
|-------------------|------------------------------|-----------------|------------------|--------------|------------|--|--|--|--|--|--|
| EQUIPMENT<br>TYPE | MFR                          | MODEL<br>NUMBER | SERIAL<br>NUMBER | LAST<br>CAL. | CAL DUE.   |  |  |  |  |  |  |
| Power Meter       | Anritsu                      | ML2496A         | 1326001          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |  |
| Power Sensor      | Anritsu                      | MA2411B         | 1315048          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |  |
| Power Sensor      | Anritsu                      | MA2411B         | 1315049          | 08/05/2019   | 08/04/2020 |  |  |  |  |  |  |
| Attenuator        | Marvelous                    | MVE2213-10      | RF80             | 11/20/2019   | 11/19/2020 |  |  |  |  |  |  |
| Spectrum Analyzer | KEYSIGHT                     | N9010A          | MY57120200       | 03/06/2019   | 03/05/2020 |  |  |  |  |  |  |
| DC Block          | PASTERNACK                   | PE8210          | RF256            | 11/20/2019   | 11/19/2020 |  |  |  |  |  |  |

### 9.2 Measurement Equipment Used:

### 9.3 Test SET-UP:



### 9.4 Measurement Procedure

### 9.4.1 Reference Level of Emission Limit:

- 1. Set analyzer center frequency to DTS channel center frequency.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Set the span to 1.5 times the DTS channel bandwidth.
- 4. Set the RBW = 100kHz & VBW = 300 kHz.
- 5. Detector = peak.
- 6. Sweep time = auto couple.

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- 7. Trace mode = max hold.
- 8. Allow trace to fully stabilize.
- 9. Use the peak marker function to determine the maximum amplitude level.

## 9.4.2 Conducted Band Edge:

- **1.** To connect Antenna Port of EUT to Spectrum.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- **3.** Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- **4.** Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
- 5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
- 6. Mark the highest reading of the emission as the reference level measurement.
- **7.** Marker on frequency, 2.3999GHz and 2.4836GHz, and examine shall 100 kHz immediately outside the authorized (2400~2483.5MHz) be attenuated by 20dB at least relative to the maximum emission of power.
- 8. Repeat above procedures until all default test channel (low, middle, and high) was complete.

## 9.4.3 Conducted Spurious Emission:

- 1. To connect Antenna Port of EUT to Spectrum.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
- 4. Allow trace to fully stabilize.
- 5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
- 6. Repeat above procedures until all default test channel measured were complete.

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#### 9.5 Measurement Result

#### **Reference Level of Limit**

| Frequency<br>(MHz) | RF Power<br>Density (dBm) | Reference Level of Limit<br>= PSD - 20dB<br>(dBm) |
|--------------------|---------------------------|---|
| 2402               | -7.14                     | -27.14  |
| 2442               | -6.98                     | -26.98  |
| 2480               | -6.21                     | -26.21  |

NOTE: cable loss as 1dB that offsets in the spectrum NOTE: Refer to next page for plots.

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Frequency

Auto Tu

**Center Fre** 

Start Fre

2.310000000 G Stop Fre 10000000 G

CF Step 10.000000 MH

Freq Offset 0 H

Freque

Auto Tu

Center Fre

Start Fre 50000

Stop Fre 2.50000000 G

CF Step 2.500000 MHz

Freq Offse 0 H2

M

NNNN

1

-27.14 2

MDec 10, 2019 ≈ 1 2 3 4 5 6

DET P NNNN Mkr3 2.483 600 GHz -48.49 dBm

Span 25.00 MH

Sweep 2.400 ms (1001 pts)

Mkr3 2.390 0 GHz -56.99 dBm

Span 100.0 MHz Sweep 9.600 ms (1001 pts)

Band Edge\_BLE\_1M\_LowCH00-2402

2.399 9 GHz 2.390 0 GHz

hter Freq 2.487500000 GHz PNO: Fast ↔ #ff:faiht.ow #Atten: 30 dB

¢3

2.479 975 GHz 2.483 500 GHz 2.483 600 GHz

#VBW 300 kHz

-5.91 dB 48.09 dB 48.49 dB

Ref Offset 1 dB Ref 20.00 dBm

Center 2.48750 GHz

Res BW 100 kHz

1 N 2 N 3 N

#VBW 300 kHz

-42.76 dBn -56.99 dBn

Band Edge\_BLE\_1M\_HighCH39-2480

ALIGN AUTO Avg Type: Log-Pwr

Ref Offset 1 dB Ref 20.00 dB

enter 2.36000 GHz

Res BW 100 kH

SI MATRI N 1 N 1 f 2 N 1 f 3 N 1 f



#### Reference Level BLE 1M LowCH00-2402

|                | um Analyzer - Swept SA           |            |               |         |            |           |                   |                              |
|----------------|----------------------------------|------------|---------------|---------|------------|-----------|-------------------|------------------------------|
| R<br>enter Fre | q 2.4020000                      |            | SENSE:INT     | Avg Typ | e: Log-Pwr | TRACI     | E 1 2 3 4 5 6     | Frequency                    |
| dB/div         | Ref Offset 1 dB<br>Ref 20.00 dBn | IFGain:Low | #Atten: 30 dB |         | Mkr1 2     | .401 973  | 3 0 GHz<br>14 dBm | Auto Tur                     |
| 0.0            |                                  |            |               |         |            |           |                   | Center Fr<br>2.402000000 G   |
| 00             |                                  |            | •             | -       |            |           |                   | Start Fr<br>2.401250000 G    |
| 1.0            |                                  |            |               |         |            |           |                   | Stop Fr<br>2.402750000 G     |
|                |                                  |            |               |         |            |           | ~                 | CF St<br>150.000 k<br>Auto M |
|                |                                  |            |               |         |            |           |                   | Freq Offs<br>0               |
| enter 2.40     | 20000 GHz                        |            |               |         |            | Span 1.   | .500 MHz          |                              |
| Res BW 10      | 00 kHz                           | #VE        | W 300 kHz     |         | Sweep 1    | .000 ms ( |                   |                              |

#### Reference Level\_BLE\_1M\_MidCH20-2442

|           | ectrum Analyzer - Swept         |         |                 |           |      |   |           |          |  |                                 |
|-----------|---------------------------------|---------|-----------------|-----------|------|---|-----------|----------|--|---------------------------------|
| Center F  | req 2.442000                    | 0000 GH | Z<br>O: Wide -+ |           | Run  |   | LIGN AUTO | TRAC     | M Dec 10, 2019<br>E 1 2 3 4 5 6<br>P NNNNN | Frequency                       |
| 10 dB/div | Ref Offset 1 dB<br>Ref 20.00 dE | IFG     | ain:Low         | #Atten: 3 | 0 dB |   | Mkr1 2    | 2.441 97 | 6 0 GHz<br>98 dBm                          | Auto Tune                       |
| 10.0      |                                 |         |                 |           |      |   |           |          |  | Center Fred<br>2.442000000 GH:  |
| -10.0     |                                 |         | ~               | •         |      | - |           |          |  | Start Free<br>2.441250000 GH    |
| -20.0     |                                 |         |                 |           |      |   |           |          |  | Stop Fre<br>2.442750000 GH      |
| -40.0     |                                 |         |                 |           |      |   |           |          | ~  | CF Ste<br>150.000 kH<br>Auto Ma |
| -60.0     |                                 |         |                 |           |      |   |           |          |  | Freq Offse<br>0 H               |
|           | 4420000 GHz                     |         |                 |           |      |   |           |          | .500 MHz                                   |                                 |
| #Res BW   | 100 KHŻ                         |         | #VBW            | 300 kHz   |      |   | Sweep /   | -        | 1001 pts)                                  |                                 |

#### Reference Level BLE 1M HighCH39-2480

| Keysight Sp<br>R | ectrum Analyzer - Swept SA       |                         |               |                                 |   |                            |
|------------------|----------------------------------|-------------------------|---------------|---------------------------------|---|----------------------------|
|                  | req 2.48000000                   | 0 GHz<br>PNO: Wide      | SENSE:INT     | ALIGN AUTO<br>Avg Type: Log-Pwr | 06:56:24 PM Dec 10, 2019<br>TRACE 1 2 3 4 5 6<br>TYPE MWWWW | Frequency                  |
| 0 dB/div         | Ref Offset 1 dB<br>Ref 20.00 dBm | PNO: Wide<br>IFGain:Low | #Atten: 30 dB | Mkr1                            | 2.479 961 0 GHz<br>-6.21 dBm                                | Auto Tu                    |
| 10.0             |                                  |                         |               |                                 |   | Center Fr<br>2.480000000 G |
| 0.0              |                                  |                         | •1            |                                 |   | Start Fr<br>2.479250000 G  |
| 0.0              |                                  |                         |               |                                 |   | Stop Fr<br>2.480750000 G   |
| 0.0              |                                  |                         |               |                                 |   | CF St<br>150.000 M         |
|                  |                                  |                         |               |                                 |   | Freq Off                   |
| 0.0              |                                  |                         |               |                                 |   |                            |
|                  | 4800000 GHz<br>100 kHz           | #VBW                    | 300 kHz       | Sweep                           | Span 1.500 MHz<br>1.000 ms (1001 pts)                       |                            |
| sa               |                                  |                         |               | STAT                            | JS  |                            |

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#### Spurious Emission\_BLE\_1M\_LowCH00-2402

| 🊺 Keysight Sp                           | ectrum Analyzer - Sv      |  |   |          |           |            |                                       | - ¢ 💌                               |
|---|---------------------------|--|---|----------|-----------|------------|---------------------------------------|-------------------------------------|
| Center F                                | req 13.015                | 000000 GHz   | SENSI   | A        | Lign Auto | TRAC       | MDec 10, 2019<br>2 1 2 3 4 5 6<br>2 M | Frequency                           |
| 10 dB/div                               | Ref Offset 1<br>Ref 20.00 | IFGain:Low   |   |          | <br>Mk    | r4 2.39    | 3 GHz<br>28 dBm                       | Auto Tune                           |
| 10.0<br>0.00                            | 1                         |  |   |          |           |            |                                       | Center Free<br>13.015000000 GH      |
| -20.0                                   | 4                         |  |   |          |           |            | -27.14 dBn                            | Start Fre<br>30.000000 MH           |
| -50.0<br>-60.0<br>-70.0                 | -                         | 2  |   |          |           |            |                                       | Stop Fre<br>26.00000000 GH          |
| Center 13<br>#Res BW                    | 100 kHz                   | #V   | BW 300 kHz  | FUNCTION | Sweep 2   | 2.482 s (3 | 5.97 GHz<br>0001 pts)                 | CF Ste<br>2.597000000 GH<br>Auto Ma |
| 1 N<br>2 N<br>3 N<br>4 N<br>5<br>6<br>7 |                           | 2.401 9 GHz<br>4.804 0 GHz<br>7.206 0 GHz<br>2.399 3 GHz | -8,98 dBr<br>-58,62 dBn<br>-58,66 dBn<br>-47,28 dBn | n<br>n   |           |            |                                       | Freq Offse<br>0 H                   |
| 7<br>8<br>9<br>10<br>11                 |                           |  |   |          |           |            |                                       |                                     |
| ISG                                     |                           |  |   |          | STATUS    |            |                                       |                                     |

#### Spurious Emission\_BLE\_1M\_MidCH20-2442

| Keysight Spi                               | ectrum Analyzer - Sw      |   |   |            |            |              |                       | - 6 ×                               |
|--|---------------------------|---|---|------------|------------|--------------|-----------------------|-------------------------------------|
| Center F                                   | req 13.0150               | 000000 GHz  | SENSE   |            | ALIGN AUTO | TRAC         | E 1 2 3 4 5 6         | Frequency                           |
| 10 dB/div                                  | Ref Offset 1<br>Ref 20.00 |   | #Atten: 30 c  |            | <br>Mkr    | ہ<br>4 25.95 | 5 0 GHz<br>32 dBm     | Auto Tune                           |
| 10.0<br>0.00<br>-10.0                      | 1                         |   |   |            |            |              |                       | Center Fre<br>13.015000000 GH       |
| -20.0<br>-30.0<br>-40.0                    |                           |   |   |            |            |              | -26.98 dBn            | Start Fre<br>30.000000 MH           |
| 60.0<br>60.0<br>-70.0                      |                           | × 3   |   | , <b>1</b> | a dia araa |              |                       | Stop Fre<br>26.000000000 GH         |
| Center 13<br>#Res BW                       | 100 kHz                   | x   | BW 300 kHz  |            | Sweep 2    | 2.482 s (3   | 5.97 GHz<br>0001 pts) | CF Ste<br>2.597000000 GH<br>Auto Ma |
| 1 N 1<br>2 N 1<br>3 N 1<br>4 N 1<br>5<br>6 | †<br>†                    | 2.441 7 GHz<br>4.884 0 GHz<br>7.326 0 GHz<br>25.955 0 GHz | -7,77 dBn<br>-54.02 dBn<br>-60.06 dBn<br>-49.82 dBn | n<br>n     |            |              |                       | Freq Offse<br>0 ⊦                   |
| 7<br>8<br>9<br>10<br>11                    |                           |   |   |            |            |              | ≣.                    |                                     |
| e 📄 👘                                      |                           |   |   |            | STATUS     | 1            | •                     |                                     |

### Spurious Emission\_BLE\_1M\_HighCH39-2480

| Keysight Spei<br>R | ctrum Analyzer | r - Swept SA<br>50 Ω DC |                      | SENS                     | E:INT |           | ALIGN AUTO  | 07:01:54 P     | M Dec 10, 2019 |                |
|--------------------|----------------|-------------------------|----------------------|--------------------------|-------|-----------|-------------|----------------|----------------|----------------|
| nter Fr            |                | 15000000                | GHz<br>PNO: Fast     |                          |       | Avg Type  | e: Log-Pwr  | TRAC           | ET P NNNN      | Frequency      |
|                    | Ref Offse      | et 1 dB                 | IFGain:Low           | #Atten: 30               |       |           | Mkr         | 4 25.98        | 0 1 GHz        | Auto Tu        |
| dB/div             | Ref 20.        |                         |                      |                          |       |           |             | -49.           | 61 dBm         |                |
| .0                 | _              |                         |                      |                          |       |           |             |                |                | Center Fr      |
|                    | 1              |                         |                      | ++                       |       |           |             |                |                | 13.015000000 0 |
| .0                 | 1              | _                       |                      |                          |       |           |             |                |                |                |
| 0                  |                |                         | -                    |                          |       |           |             |                | -26.21 dBm     | Start F        |
| 0                  |                |                         |                      |                          |       |           |             |                |                | 30.000000 M    |
| 0                  |                | ୍ର <sup>2</sup>         |                      |                          |       |           |             |                | 4              |                |
| 0                  |                | and a syles             | () <sup>1</sup>      |                          |       |           | A Martine   | distributed in |                | Stop F         |
| 0                  |                |                         | -                    |                          |       |           |             |                |                | 26.000000000   |
| ntor 12            | .02 GHz        |                         |                      |                          |       |           |             | Enan 2         | 5.97 GHz       | CF S           |
|                    | 100 kHz        |                         | #VB                  | W 300 kHz                |       |           | Sweep       |                | 0001 pts)      | 2.597000000    |
| MODE TR            |                | ×                       |                      | Y                        |       | CTION FUI | NCTION WOTH | FUNCTI         | ON VALUE       | Auto 1         |
| N 1                | 1              | 4.9                     | 79 8 GHz<br>60 0 GHz | -7.43 dB                 | m     |           |             |                | _              | Freq Off       |
| N 1<br>N 1         | 1              |                         | 40 0 GHz<br>80 1 GHz | -61.09 dBr<br>-49.61 dBr |       |           |             |                | _              | Frequin        |
|                    |                |                         |                      |                          |       |           |             |                |                |                |
|                    |                |                         |                      |                          |       |           |             |                | _              |                |
|                    |                |                         |                      |                          |       |           |             |                |                |                |
|                    |                |                         |                      |                          |       |           |             |                |                |                |
|                    |                |                         |                      |                          |       |           | STATU       | s              |                |                |

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| 台灣檢驗科技股份有限公司 |
|--------------|
|--------------|



## **10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT**

### 10.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 limit as below.

And according to §15.33(a) (1) for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

| Frequency<br>(MHz) | Field strength<br>(microvolts/meter) | Distance<br>(meters) |
|--------------------|--------------------------------------|----------------------|
| 0.009-0.490        | 2400/F(kHz)                          | 300                  |
| 0.490-1.705        | 24000/F(kHz)                         | 30                   |
| 1.705-30           | 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 ( $dB\mu V/m$ ) = 20 log Emission level ( $dB\mu V/m$ )

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### **10.2 Measurement Equipment Used**

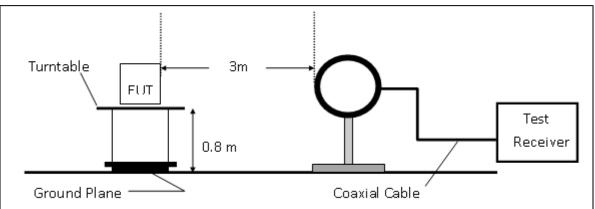
| 966 Chamber       |                        |                 |                  |              |            |  |  |
|-------------------|------------------------|-----------------|------------------|--------------|------------|--|--|
| EQUIPMENT<br>TYPE | MFR                    | MODEL<br>NUMBER | SERIAL<br>NUMBER | LAST<br>CAL. | CAL DUE.   |  |  |
| Broadband Antenna | TESEQ                  | CBL 6112D       | 35240            | 09/09/2019   | 09/08/2020 |  |  |
| Horn Antenna      | Schwarzbeck            | BBHA9170        | 184              | 12/27/2018   | 12/26/2019 |  |  |
| Horn Antenna      | Schwarzbeck            | BBHA9120D       | 1187             | 01/09/2019   | 01/08/2020 |  |  |
| Loop Antenna      | ETS.LINDGREN           | 6502            | 143303           | 04/25/2019   | 04/24/2020 |  |  |
| EMI Test Receiver | R&S                    | ESU 40          | 100363           | 04/15/2019   | 04/14/2020 |  |  |
| Pre-Amplifier     | <b>EMC</b> Instruments | EMC330          | 980096           | 11/20/2019   | 11/19/2020 |  |  |
| Pre-Amplifier     | EMC Instruments        | EMC0011830      | 980199           | 11/20/2019   | 11/19/2020 |  |  |
| Pre-Amplifier     | EMC Instruments        | EMC184045B      | 980135           | 11/20/2019   | 11/19/2020 |  |  |
| Attenuator        | Woken                  | WATT-218FS-10   | RF25             | 11/20/2019   | 11/19/2020 |  |  |
| Highpass Filter   | Micro Tronics          | BRM50701-01     | G008             | 11/20/2019   | 11/19/2020 |  |  |
| Coaxial Cable     | Huber Suhner           | SUCOFLEX 104    | MY17388/4        | 11/20/2019   | 11/19/2020 |  |  |
| Coaxial Cable     | Huber Suhner           | RG 214/U        | W22.03           | 11/20/2019   | 11/19/2020 |  |  |

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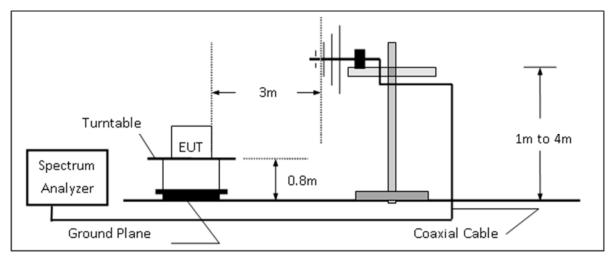
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### 10.3 Test SET-UP

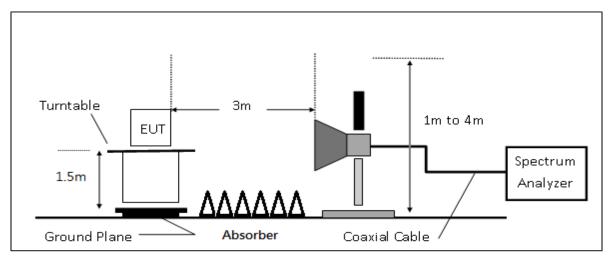




(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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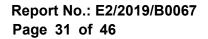
### **10.4 Measurement Procedure**

- 1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plan.
- 3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
- 4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
- 5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
- 6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
- Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.</li>
- 8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.
- 9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
- 11.Repeat above procedures until all default test channel measured were complete.

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### 10.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

*Where* FS = Field StrengthRA = Reading AmplitudeAF = Antenna Factor CL = Cable Attenuation Factor (Cable Loss) AG = Amplifier Gain

The limit of the emission level is expressed in dBuV/m, which converts 20\*log(uV/m)

Actual FS( $dB\mu V/m$ ) = SPA. Reading level( $dB\mu V$ ) + Factor(dB) Factor(dB) = Antenna Factor( $dB\mu V/m$ ) + Cable Loss(dB) – Pre\_Amplifier Gain(dB)

### 10.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

### 10.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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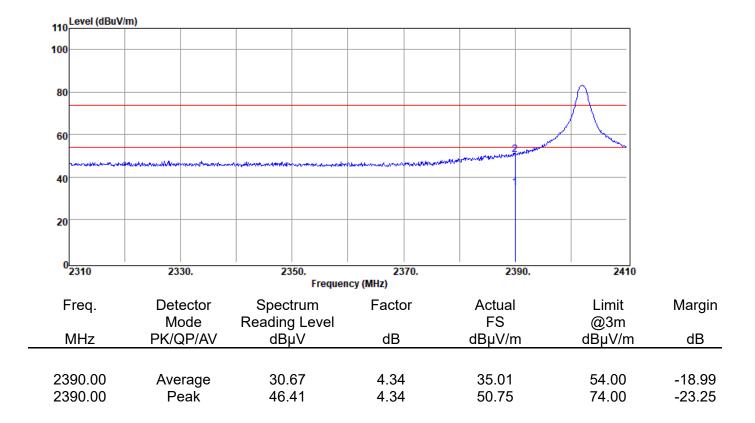
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### 10.7.1 Radiated Band Edge Measurement Result

| Report Number  | :E2/2019/B0067 | Test Date    | :2019-12-13 |
|----------------|----------------|--------------|-------------|
| Operation Mode | :BLE 1M        | Temp./Humi.  | :23.3/56    |
| Test Channel   | :2402 MHz      | Antenna Pol. | :VERTICAL   |
| Test Mode      | :BE CH LOW     | Engineer     | :Ashton     |
| EUT Pol        | :E2 Plan       |              |             |



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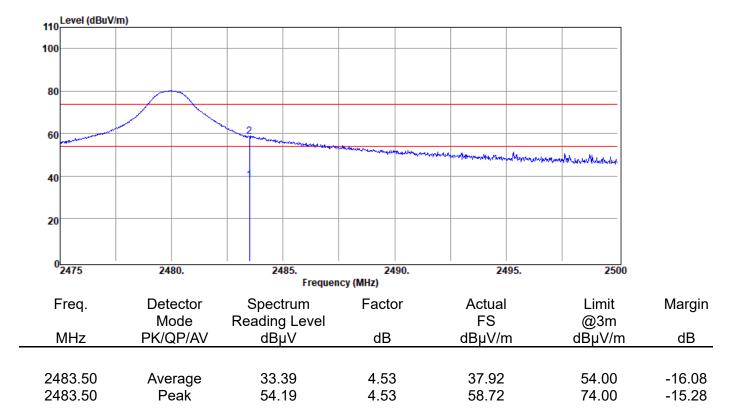


| Report Number<br>Operation Mode | :E2/2019/E<br>:BLE 1M  | 30067  |                                | Test Date<br>Temp./Humi.   | :2019-12-13<br>:23.3/56 |                  |
|---------------------------------|--|--|--------------------------------|--|-------------------------|------------------|
| Test Channel                    | :2402 MHz  | 7  |                                | Antenna Pol.   | :HORIZONT/              | 1                |
| Test Mode                       | :BE CH LC  |  |                                |  | :Ashton                 |                  |
|                                 |  | JVV  |                                | Engineer   | ASITION                 |                  |
| EUT Pol                         | :E2 Plan   |  |                                |  |                         |                  |
|                                 |  |  |                                |  |                         |                  |
| 110                             | )  |  |                                |  |                         |                  |
| 100                             |  |  |                                |  |                         |                  |
|                                 |  |  |                                |  |                         |                  |
| 80                              |  |  |                                |  |                         |                  |
|                                 |  |  |                                |  | +                       |                  |
| 60                              |  |  |                                | 2  |                         |                  |
|                                 |  |  | have and a start of the second | and an and a start of the start |                         |                  |
| 40                              | and a second | And the second |                                |  |                         |                  |
|                                 |  |  |                                |  |                         |                  |
| 20                              |  |  |                                |  |                         |                  |
|                                 |  |  |                                |  |                         |                  |
| 0                               | 2220   | 2250   | 2270                           | 2200   |                         |                  |
| 0<br>2310                       | 2330.  | 2350.<br>Frequen   | 2370.<br>Icy (MHz)             | 2390.  | 2410                    |                  |
| Freq.                           | Detector   | Spectrum   | Factor                         | Actual   | Limit                   | Margin           |
|                                 | Mode   | Reading Level  |                                | FS   | @3m                     |                  |
| MHz                             | PK/QP/AV   | dBµV   | dB                             | dBµV/m   | dBµV/m                  | dB               |
| 2200.00                         | Average  | 20.47  | 4.24                           | 34.51  | F4 00                   | 10.40            |
| 2390.00<br>2390.00              | Average<br>Peak  | 30.17<br>54.45   | 4.34<br>4.34                   | 34.51<br>58.79   | 54.00<br>74.00          | -19.49<br>-15.21 |
| 2000.00                         | reak   | 01.10  | 1.01                           | 00:10  | 14.00                   | 10.21            |

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| Report Number  | :E2/2019/B0067 | Test Date    | :2019-12-13 |
|----------------|----------------|--------------|-------------|
| Operation Mode | :BLE 1M        | Temp./Humi.  | :23.4/56    |
| Test Channel   | :2480 MHz      | Antenna Pol. | :VERTICAL   |
| Test Mode      | :BE CH HIGH    | Engineer     | :Ashton     |
| EUT Pol        | :E2 Plan       |              |             |
|                |                |              |             |



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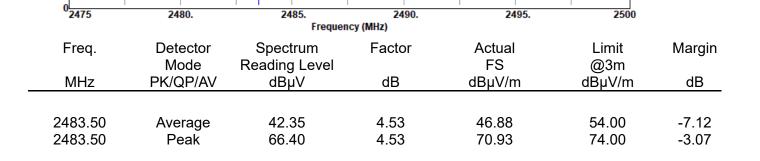


60

40

20

| Report Number      | :E2/2019/B0067                          | Т | lest Date    | :2019-12-13 |
|--------------------|---|---|--------------|-------------|
| Operation Mode     | :BLE 1M                                 | Т | ſemp./Humi.  | :23.4/56    |
| Test Channel       | :2480 MHz                               | A | Antenna Pol. | :HORIZONTAL |
| Test Mode          | :BE CH HIGH                             | E | Engineer     | :Ashton     |
| EUT Pol            | :E2 Plan                                |   |              |             |
|                    |   |   |              |             |
| 110 Level (dBuV/m) |   |   |              |             |
| 100                |   |   |              |             |
|                    | $\wedge$                                |   |              |             |
| 80                 |   |   |              |             |
|                    | ~ |   |              |             |



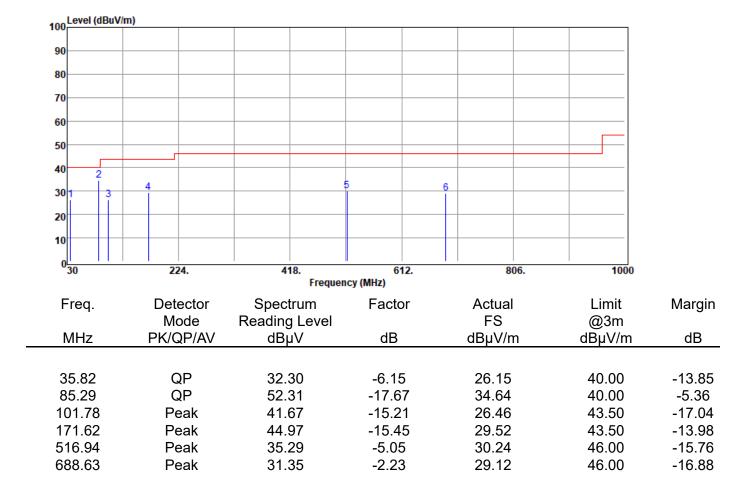
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### 10.7.2 Radiated Spurious Emission from 30MHz to 1000MHz

| Report Number  | :E2/2019/B0067 | Test Date    | :2019-12-13 |
|----------------|----------------|--------------|-------------|
| Operation Mode | :BLE 1M        | Temp./Humi.  | :23.3/55    |
| Test Channel   | :2442 MHz      | Antenna Pol. | :VERTICAL   |
| Test Mode      | :TX CH MID     | Engineer     | :Ashton     |
| EUT Pol        | :E2 Plan       |              |             |



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1000



30 20 10

0 30

5

224.

| Report Number      | :E2/2019/B0067 |         |  | Test Dat | te                   | :2019-12- | .13      |  |
|--------------------|----------------|---------|--|----------|----------------------|-----------|----------|--|
| Operation Mode     | :BLE 1M        | :BLE 1M |  |          | Temp./Humi. :23.3/55 |           | :23.3/55 |  |
| Test Channel       | :2442 MHz      |         |  | Antenna  | a Pol.               | :HORIZO   | NTAL     |  |
| Test Mode          | :TX CH MID     |         |  |          | Enginee              | er        | :Ashton  |  |
| EUT Pol            | :E2 Plan       |         |  |          |                      |           |          |  |
|                    |                |         |  |          |                      |           |          |  |
| 100 Level (dBuV/m) |                |         |  |          |                      |           |          |  |
| 90                 |                |         |  |          |                      |           |          |  |
|                    |                |         |  |          |                      |           |          |  |
| 80                 |                |         |  |          |                      |           |          |  |

Frequency (MHz) Freq. Detector Spectrum Factor Actual Limit Margin FS Mode Reading Level @3m PK/QP/AV MHz dBµV dB dBµV/m dBµV/m dB 74.62 Peak 53.20 -18.26 34.94 40.00 -5.06 85.29 QP 54.10 -17.67 36.43 40.00 -3.57 171.62 QP 52.39 -15.45 36.94 43.50 -6.56 177.44 53.53 -15.52 -5.49 Peak 38.01 43.50 257.95 Peak 44.73 -10.59 34.14 46.00 -11.86 516.94 33.19 46.00 -12.81 Peak 38.24 -5.05

612.

806.

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418.

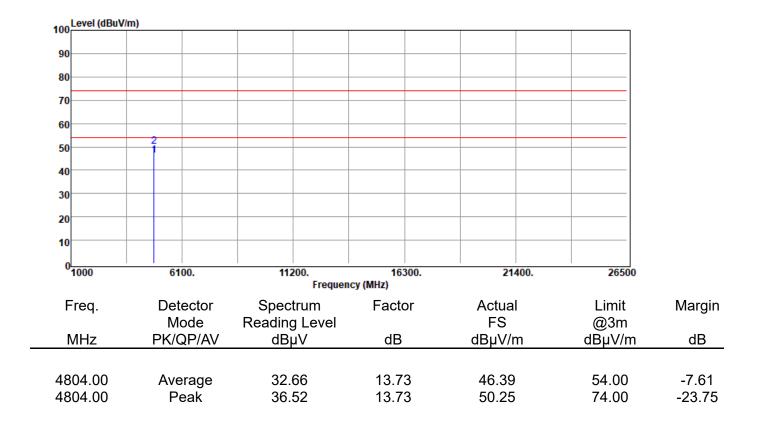
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### 10.7.3 Radiated Spurious Emission above 1GHz

| Report Number  | :E2/2019/B0067 | Test Date    | :2019-12-13 |
|----------------|----------------|--------------|-------------|
| Operation Mode | :BLE 1M        | Temp./Humi.  | :23.4/56    |
| Test Channel   | :2402 MHz      | Antenna Pol. | :VERTICAL   |
| Test Mode      | :TX CH LOW     | Engineer     | :Ashton     |
| EUT Pol        | :E2 Plan       |              |             |



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Test Date



:E2/2019/B0067

**Report Number** 

|                   | ,_0,0,1   |               |        | leer Bute    | .2010 12 10 |        |
|-------------------|-----------|---------------|--------|--------------|-------------|--------|
| Operation Mode    | e :BLE 1M |               |        | Temp./Humi.  | :23.4/56    |        |
| Test Channel      | :2402 MHz | 2             |        | Antenna Pol. | :HORIZONT   | AL     |
| Test Mode         | :TX CH LC | )W            |        | Engineer     | :Ashton     |        |
| EUT Pol           | :E2 Plan  |               |        | 9            |             |        |
| EUTFO             | .EZ FIAII |               |        |              |             |        |
|                   |           |               |        |              |             |        |
| 100 Level (dBuV/n | n)        |               |        |              |             |        |
|                   |           |               |        |              |             |        |
| 90                |           |               |        |              |             |        |
| 80                |           |               |        |              |             |        |
| 70                |           |               |        |              |             |        |
| 60                |           |               |        |              |             |        |
| 50                | 1         |               |        |              |             |        |
| 40                |           |               |        |              |             |        |
|                   |           |               |        |              |             |        |
| 30                |           |               |        |              |             |        |
| 20                |           |               |        |              |             |        |
| 10                |           |               |        |              |             |        |
| 0                 | 6100.     | 11200.        | 16300. | 21400.       | 26500       |        |
|                   |           | Frequen       |        |              |             |        |
| Freq.             | Detector  | Spectrum      | Factor | Actual       | Limit       | Margin |
|                   | Mode      | Reading Level |        | FS           | @3m         |        |
| MHz               | PK/QP/AV  | dBµV          | dB     | dBµV/m       | dBµV/m      | dB     |
|                   |           |               |        |              | = 1 00      | o 46   |
| 4804.00           | Average   | 33.79         | 13.73  | 47.52        | 54.00       | -6.48  |
| 4804.00           | Peak      | 37.23         | 13.73  | 50.96        | 74.00       | -23.04 |

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Test Date



:E2/2019/B0067

**Report Number** 

| t Channel<br>t Mode     | :2442 MHz<br>:TX CH MII |                  |                     | Antenna Pol.<br>Engineer | ol. :VERTICAL<br>:Ashton |  |  |
|-------------------------|-------------------------|------------------|---------------------|--------------------------|--------------------------|--|--|
| T Pol                   | :E2 Plan                |                  |                     |                          |                          |  |  |
| 100 Level (dBuV/m)      |                         |                  |                     |                          |                          |  |  |
| 90                      |                         |                  |                     |                          |                          |  |  |
| 80                      |                         |                  |                     |                          |                          |  |  |
| 70                      |                         |                  |                     |                          |                          |  |  |
| 60                      |                         |                  |                     |                          |                          |  |  |
| 50                      | 2                       |                  |                     |                          |                          |  |  |
| 40                      |                         |                  |                     |                          |                          |  |  |
| 30                      |                         |                  |                     |                          |                          |  |  |
| 20                      |                         |                  |                     |                          |                          |  |  |
| 10                      |                         |                  |                     |                          |                          |  |  |
| 0 <mark></mark><br>1000 | 6100.                   | 11200.<br>Freque | 16300.<br>ncy (MHz) | 21400.                   | 26500                    |  |  |
| Freq.                   | Detector                | Spectrum         | Factor              | Actual                   | Limit                    |  |  |

| Detector<br>Mode | Spectrum<br>Reading Level   | Factor   | Actual<br>FS                                   | Limit<br>@3m  | Margin  |
|------------------|-----------------------------|--|--|---|---|
| PK/QP/AV         | dBµV                        | dB   | dBµV/m   | dBµV/m  | dB  |
|                  |                             |  |  |   |   |
| Average          | 28.23                       | 13.75  | 41.98  | 54.00   | -12.02  |
| Peak             | 33.49                       | 13.75  | 47.24  | 74.00   | -26.76  |
|                  | Mode<br>PK/QP/AV<br>Average | Mode Reading Level<br>PK/QP/AV dBµV<br>Average 28.23 | ModeReading LevelPK/QP/AVdBµVAverage28.2313.75 | ModeReading LevelFSPK/QP/AVdBµVdBdBµV/mAverage28.2313.7541.98 | Mode<br>PK/QP/AVReading Level<br>dBµVFS<br>dB@3m<br>dBµV/mAverage28.2313.7541.9854.00 |

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Test Date



:E2/2019/B0067

**Report Number** 

4884.00

| Operation Mode<br>Test Channel<br>Test Mode<br>EUT Pol | :BLE 1M<br>:2442 MHz<br>:TX CH MI<br>:E2 Plan |                           | Te<br>Ai<br>Ei |              | :23.4/56<br>:HORIZONT/<br>:Ashton | AL     |
|--|---|---------------------------|----------------|--------------|-----------------------------------|--------|
| 100 Level (dBuV/m)                                     |   |                           |                |              |                                   |        |
| 90   |   |                           |                |              |                                   |        |
| 80   |   |                           |                |              |                                   |        |
| 70   |   |                           |                |              |                                   |        |
| 60   |   |                           |                |              |                                   |        |
| 50   | 1   |                           |                |              |                                   |        |
| 40   |   |                           |                |              |                                   |        |
| 30   |   |                           |                |              |                                   |        |
| 20   |   |                           |                |              |                                   |        |
| 10   |   |                           |                |              |                                   |        |
| 0  | 6100.   | 11200.                    | 16300.         | 21400.       | 26500                             |        |
| 1000   | 0100.   |                           | icy (MHz)      | 21400.       | 20500                             |        |
| Freq.  | Detector<br>Mode                              | Spectrum<br>Reading Level | Factor         | Actual<br>FS | Limit<br>@3m                      | Margin |
| MHz  | PK/QP/AV                                      | dBµV                      | dB             | dBµV/m       | dBµV/m                            | dB     |
| 4884.00  | Average                                       | 33.54                     | 13.75          | 47.29        | 54.00                             | -6.71  |

13.75

51.19

37.44

Peak

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74.00

-22.81



| Report Number<br>Operation Mode<br>Test Channel<br>Test Mode<br>EUT Pol | :E2/2019/B0067<br>:BLE 1M<br>:2480 MHz<br>:TX CH HIGH<br>:E2 Plan |       |   | Test Da<br>Temp./<br>Antenn<br>Engine | Humi.<br>a Pol. | :2019-12<br>:23.4/56<br>:VERTIC<br>:Ashton |  |
|---|---|-------|---|---------------------------------------|-----------------|--|--|
| 100 Level (dBuV/m)  |   | <br>1 | 1 |                                       |                 | · · · · · · · · · · · · · · · · · · ·      |  |
| 90  |   |       |   |                                       |                 |  |  |
| 80  |   |       |   |                                       |                 |  |  |
| 70  |   |       |   |                                       |                 |  |  |
| 60  | 2   |       |   |                                       |                 |  |  |
| 50  | 1   |       |   |                                       |                 |  |  |

| 0                  |                  |                           |                    |                |                |                 |  |
|--------------------|------------------|---------------------------|--------------------|----------------|----------------|-----------------|--|
| °1000              | 6100.            | 11200.<br>Frequenc        | 16300.<br>cy (MHz) | 21400.         | 26500          | 0               |  |
| Freq.              | Detector<br>Mode | Spectrum<br>Reading Level | Factor             | Actual<br>FS   | Limit<br>@3m   | Margin          |  |
| MHz                | PK/QP/AV         | dBµV                      | dB                 | dBµV/m         | dBµV/m         | dB              |  |
| 4960.00<br>4960.00 | Average<br>Peak  | 34.32<br>38.72            | 13.74<br>13.74     | 48.06<br>52.46 | 54.00<br>74.00 | -5.94<br>-21.54 |  |

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Test Date



:E2/2019/B0067

**Report Number** 

4960.00

Peak

| Operation<br>Test Char<br>Test Mode<br>EUT Pol | nnel     | :24<br>:TX | .E 1M<br>80 MHz<br>( CH HIC<br>2 Plan |                  |                 | Temp./Humi.<br>Antenna Pol.<br>Engineer |      | :23.4/56<br>:HORIZC<br>:Ashton | NTAL        |              |        |
|--|----------|------------|---------------------------------------|------------------|-----------------|---|------|--------------------------------|-------------|--------------|--------|
| 100  | (dBuV/m) |            |                                       |                  |                 | 1                                       |      |                                |             |              |        |
| 90   |          |            |                                       |                  |                 |   |      |                                |             |              |        |
| 80   |          |            |                                       |                  |                 |   |      |                                |             |              |        |
| 70   |          |            |                                       |                  |                 |   |      |                                |             |              |        |
| 60   |          | 2          |                                       |                  |                 |   |      |                                |             |              |        |
| 50   |          | 1          |                                       |                  |                 |   |      |                                |             |              |        |
| 40   |          |            |                                       |                  |                 |   |      |                                |             |              |        |
| 30   |          |            |                                       |                  |                 |   |      |                                |             |              |        |
| 20   |          |            |                                       |                  |                 |   |      |                                |             |              |        |
| 10   |          |            |                                       |                  |                 |   |      |                                |             |              |        |
| 0 <mark>0</mark> 0                             |          | 61         | <b>00.</b>                            | 112              | 200.<br>Frequei | 16:<br>ncy (MHz)                        | 300. | 21                             | <b>400.</b> | 2650         | 0      |
| Freq   |          |            | ector<br>ode                          | Spect<br>Reading |                 | Facto                                   | or   | Actua<br>FS                    | I           | Limit<br>@3m | Margin |
| MHz  | <u> </u> |            | QP/AV                                 | dB               |                 | dB                                      |      | dBµV/i                         | m           | dBµV/m       | n dB   |
| 4960.0   | 00       | Ave        | erage                                 | 37.3             | 39              | 13.7                                    | 4    | 51.13                          | }           | 54.00        | -2.87  |

13.74

54.34

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

40.60

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74.00

-19.66



# **11 POWER SPECTRAL DENSITY**

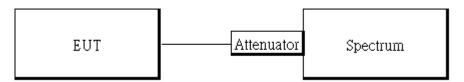
## 11.1 Standard Applicable:

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

## 11.2 Measurement Equipment Used:

| Conducted Emission Test Site |            |            |            |            |            |  |  |  |  |  |
|------------------------------|------------|------------|------------|------------|------------|--|--|--|--|--|
| EQUIPMENT                    | MFR        | MODEL      | SERIAL     | LAST       | CAL DUE.   |  |  |  |  |  |
| TYPE                         |            | NUMBER     | NUMBER     | CAL.       |            |  |  |  |  |  |
| Power Meter                  | Anritsu    | ML2496A    | 1326001    | 08/05/2019 | 08/04/2020 |  |  |  |  |  |
| Power Sensor                 | Anritsu    | MA2411B    | 1315048    | 08/05/2019 | 08/04/2020 |  |  |  |  |  |
| Power Sensor                 | Anritsu    | MA2411B    | 1315049    | 08/05/2019 | 08/04/2020 |  |  |  |  |  |
| Attenuator                   | Marvelous  | MVE2213-10 | RF80       | 11/20/2019 | 11/19/2020 |  |  |  |  |  |
| Spectrum Analyzer            | KEYSIGHT   | N9010A     | MY57120200 | 03/06/2019 | 03/05/2020 |  |  |  |  |  |
| DC Block                     | PASTERNACK | PE8210     | RF256      | 11/20/2019 | 11/19/2020 |  |  |  |  |  |

### 11.3 Test Set-up:



## **11.4 Measurement Procedure:**

- 1. Set analyzer center frequency to DTS channel center frequency.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Set the span to 1.5 times the DTS channel bandwidth.
- 4. Set the RBW = 3 kHz. & the VBW = 10 kHz
- For defining Restricted Band Edge Limit: Set the RBW = 100kHz & VBW = 300 kHz.
- 6. Detector = peak.
- 7. Sweep time = auto couple.
- 8. Trace mode = max hold.
- 9. Allow trace to fully stabilize.
- 10. Use the peak marker function to determine the maximum amplitude level.

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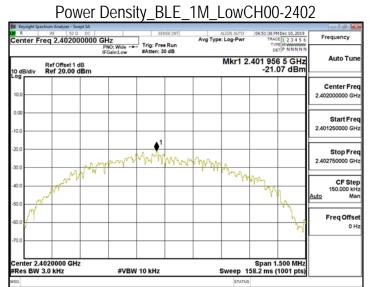
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### **11.5 Measurement Result:**

| Frequency<br>(MHz) | RF Power<br>Density (dBm) | Maximum Limit<br>(dBm) | Result |
|--------------------|---------------------------|------------------------|--------|
| 2402               | -21.07                    | 8                      | PASS   |
| 2442               | -20.67                    | 8                      | PASS   |
| 2480               | -19.91                    | 8                      | PASS   |

NOTE: cable loss as 1dB that offsets in the spectrum



### Power Density\_BLE\_1M\_MidCH20-2442

| Keysight Spectrum Analyzer                    |             |                |           |     |    |                    |                       |                      |                                   |
|---|-------------|----------------|-----------|-----|----|--------------------|-----------------------|----------------------|-----------------------------------|
| Center Freq 2.442                             |             | IZ<br>Ю:Wide ↔ |           | Run |    | ALIGN AUTO         | TRACE                 | Dec 10, 2019         | Frequency                         |
| Ref Offse                                     | IFC<br>t1dB | Sain:Low       | #Atten: 3 |     |    | Mkr1 2             | .441 965              | 5 5 GHz<br>7 dBm     | Auto Tune                         |
| - <b>og</b><br>10.0                           |             |                |           |     |    |                    |                       |                      | Center Fred<br>2.442000000 GH2    |
| 10.00   |             |                |           |     |    |                    |                       |                      | Start Free<br>2.441250000 GH:     |
| 30.0  | - Ary       | m              | nynh      | mm  | mm | Maria              |                       |                      | Stop Free<br>2.442750000 GHz      |
| 40.0 MM                                       | WAY I I     |                |           |     |    | , . <sub>4</sub> J | W BW                  | h                    | CF Step<br>150.000 kH<br>Auto Mar |
| 60.0  |             |                |           |     |    |                    |                       | )<br>M               | Freq Offse                        |
| 70.0<br>Center 2.4420000 0<br>#Res BW 3.0 kHz | 3Hz         | #VBW           | 10 kHz    |     |    | Sweep 1            | Span 1.<br>58.2 ms (7 | 500 MHz<br>1001 pts) |                                   |
| ISG   |             |                |           |     |    | STATUS             | 5                     |                      |                                   |

### Power Density\_BLE\_1M\_HighCH39-2480



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# **12 ANTENNA REQUIREMENT**

### 12.1 Standard Applicable:

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

In case of point-to-point operation, the power shall be reduced by the one dB for every 3 dB that the directional gain of antenna exceeds 6dBi.

### 12.2 Antenna Connected Construction:

The antenna is designed as permanently attached and no consideration of replacement. Please see EUT photo for details.

~ End of Report ~

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