

RADIO TEST REPORT

Product : VS Tracker

Model Name : VS Tracker 100

FCC ID : 2AFB3-VSTRACKER100

Test Regulation : FCC 47 CFR Part 15 Subpart C (Section 15.247)

Received Date : 2023/7/26

Test Date : 2023/8/18 ~ 2023/11/7

Issued Date : 2023/11/7

Applicant : Medimaging Integrated Solution Inc.
3F., No.24-2, Industry E. Rd. IV, Hsinchu Science Park,
Hsinchu, Taiwan 30077, R.O.C.

Issued By : Underwriters Laboratories Taiwan Co., Ltd.
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd.,
Zhudong Township, Hsinchu County, Taiwan



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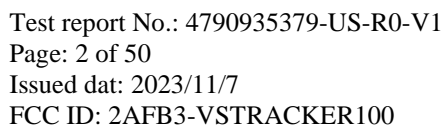
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Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1



Original Test Report No.: 4790935379-US-R0-V1

Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

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1. Attestation of Test Results

APPLICANT: Medimaging Integrated Solution Inc.
3F., No.24-2, Industry E. Rd. IV, Hsinchu Science Park,
Hsinchu, Taiwan 30077, R.O.C.

MANUFACTURER: Medimaging Integrated Solution Inc.
3F., No.24-2, Industry E. Rd. IV, Hsinchu Science Park,
Hsinchu, Taiwan 30077, R.O.C.

EUT DESCRIPTION: VS Tracker

BRAND: 

MODEL: VS Tracker 100

SAMPLE STAGE: Pilot-run Verification Test sample

DATE of TESTED: 2023/8/18 ~ 2023/11/7

APPLICABLE STANDARDS

| STANDARD | Test Results |
|---|--------------|
| FCC 47 CFR PART 15 Subpart C (Section 15.247) | PASS |

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:



Sally Lu
Project Handler

Date : 2023/11/7

Approved and Authorized By:



Eric Lee
Senior Laboratory Engineer

Date : 2023/11/7

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2. Summary of Test Results

| Summary of Test Results | | |
|--------------------------------|---|--------|
| FCC Clause | Test Items | Result |
| 15.247(a)(2) | 6dB Bandwidth | PASS |
| 15.247(b) | Conducted Output Power | PASS |
| 15.247(e) | Power Spectral Density | PASS |
| 15.247(d) | Antenna Port Emission | PASS |
| 15.205 / 15.209 / 15.247(d) | Radiated Emissions and Band Edge Measurement | PASS |
| 15.207 | AC Power Conducted Emission | PASS |
| 15.203 | Antenna Requirement | PASS |

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3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB558074 D01 Meas Guidance v05r02, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013.

4. Facilities and Accreditation

| | |
|----------------------------------|---|
| Test Location | Underwriters Laboratories Taiwan Co., Ltd. |
| Address | Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan |
| Accreditation Certificate | Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398. |

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5. Measurement Uncertainty

For statement of conformity, Simple acceptance (Section 4.3.4 of ISO Guide 115) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k=2$.

Determining compliance based on the results of the compliance measurement, not considering measurement instrumentation uncertainty.

| Measurement | Frequency | Uncertainty |
|--|----------------|-------------|
| Conducted disturbance at mains terminals ports | 150kHz ~ 30MHz | 3.1 dB |
| RF Conducted | 9 kHz - 40GHz | 2.3 dB |
| Radiated disturbance below 30MHz | 9 kHz - 30 MHz | 3.2 dB |
| Radiated disturbance below 1 GHz | 30MHz ~ 1GHz | 6.1 dB |
| Radiated disturbance above 1 GHz | 1GHz ~ 40GHz | 5.1 dB |

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6. Equipment under Test

6.1. Description of EUT

| | |
|-----------------------------|---|
| Product | VS Tracker |
| Brand Name |  |
| Model Name | VS Tracker 100 |
| Operating Frequency | 2402MHz ~ 2480MHz |
| Modulation | GFSK |
| Transfer Rate | Up to 1 Mbps |
| Number of Channel | 40 |
| Maximum Output Power | 3.92 dBm |
| Normal Voltage | 3.7Vdc from battery 5Vdc from adapter 5Vdc from host |
| Sample ID | 6288950 |

Note:

- The EUT contains following accessory devices:

| Product | Manufacturer | Model | Description |
|---------|-------------------------------------|-------------------------|--|
| Collar | Medimaging Integrated Solution Inc. | VS Tracker 100 Collar A | Datachable collars for various bottles |
| Collar | Medimaging Integrated Solution Inc. | VS Tracker 100 Collar B | Datachable collars for various bottles |
| Collar | Medimaging Integrated Solution Inc. | VS Tracker 100 Collar C | Datachable collars for various bottles |
| Collar | Medimaging Integrated Solution Inc. | VS Tracker 100 Collar D | Datachable collars for various bottles |

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2. The EUT could be supplied with rechargeable battery as the following table:

| Product | Manufacturer | Model | Description |
|--|--|-----------|---------------|
| Internal Rechargeable Lithium Battery | GUANGDONG ZHAONENG TECHNOLOGY CO., LTD. | ZN 502630 | 3.7V / 350mAh |

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual, the laboratory shall not be held responsible.

6.2. Channel List

40 channels are provided to this EUT:

| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---------|-----------------|---------|-----------------|---------|-----------------|---------|-----------------|
| 0 | 2402 | 10 | 2422 | 20 | 2442 | 30 | 2462 |
| 1 | 2404 | 11 | 2424 | 21 | 2444 | 31 | 2464 |
| 2 | 2406 | 12 | 2426 | 22 | 2446 | 32 | 2466 |
| 3 | 2408 | 13 | 2428 | 23 | 2448 | 33 | 2468 |
| 4 | 2410 | 14 | 2430 | 24 | 2450 | 34 | 2470 |
| 5 | 2412 | 15 | 2432 | 25 | 2452 | 35 | 2472 |
| 6 | 2414 | 16 | 2434 | 26 | 2454 | 36 | 2474 |
| 7 | 2416 | 17 | 2436 | 27 | 2456 | 37 | 2476 |
| 8 | 2418 | 18 | 2438 | 28 | 2458 | 38 | 2478 |
| 9 | 2420 | 19 | 2440 | 29 | 2460 | 39 | 2480 |

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6.3. Test Condition

| Test Item | Test Site No. | Environmental Condition | Input Power | Test Date | Tested by |
|------------------------------------|---------------|-------------------------|-------------------|---------------------------|-----------|
| Antenna Port Conducted Measurement | SR4 | 21~28°C/ 51~69%RH | 5Vdc from adapter | 2023/08/23~ 2023/11/07 | Rex Chen |
| Radiated Spurious Emission | 966-2 | 21~28°C/ 51~69%RH | 5Vdc from adapter | 2023/08/18~ 2023/08/22 | Rex Chen |
| AC power Line Conducted Emission | SR1 | 21~28°C/ 51~69%RH | 5Vdc from adapter | 2023/08/23~ 2023/08/25 | Rex Chen |

FCC Test Firm Registration Number: 498077

Sample Calculation:

Antenna Port Conducted Measurement:

- Where relevant, the follow sample calculation is provided:
 $\text{Result Value (dBm)} = \text{Reading Value (dBm)} + \text{Attenuator Factor (dB)} + \text{Cable Loss (dB)}.$
Example: $\text{Result Value (10dBm)} = \text{Reading Value (-2dBm)} + \text{Attenuator Factor (10dB)} + \text{Cable Loss(2dB)}.$
*Test plot only shown the “Result Value”.

Radiated Spurious Emission:

- Where relevant, the follow sample calculation is provided:
 $\text{Result Value (dBuV/m)} = \text{Reading Value (dBuV)} + \text{Correction Factor (dB/m)}.$
 $\text{Correction Factor (dB/m)} = \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Preamp Factor (dB)}.$
Example: $\text{Result Value (34.5dBuV/m)} = \text{Reading Value (40.1dBuV)} + \text{Antenna Factor (18.7dB/m)} + \text{Cable Loss (4.2dB)} - \text{Preamp Factor (28.5dB)}.$

AC power Line Conducted Emission:

- Where relevant, the follow sample calculation is provided:
 $\text{Result Value (dBuV)} = \text{Reading Value (dBuV)} + \text{Correction Factor (dB)}.$
 $\text{Correction Factor (dB)} = \text{Insertion loss(dB)} + \text{Cable loss(dB)}.$
Example: $\text{Result Value (53.7dBuV)} = \text{Reading Value (35.1dBuV)} + \text{Insertion loss(18.1dB)} + \text{Cable loss(0.5dB)}.$

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6.4. Description of Available Antennas

| Ant. No. | Transmitter Circuit | Brand Name | Model Name | Ant. Type | Maximum Gain (dBi) |
|----------|---------------------|------------------|------------|-----------|--------------------|
| 1 | Chain (0) | Würth Elektronik | NA | PCB | -1.6 |

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual, the laboratory shall not be held responsible.

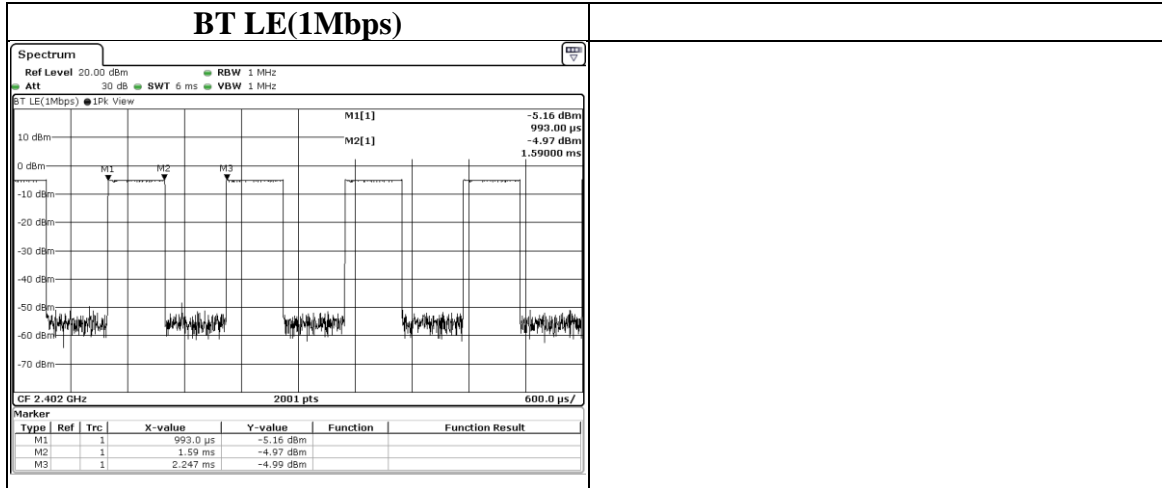
6.5. Test Mode Applicability and Tested Channel Detail

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- The fundamental of the EUT was investigated in three orthogonal axes X-Y/Y-Z/X-Z, it was determined that X-Z plane was worst-case. Therefore, all final radiated testing was performed with the EUT in X-Z plane.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- The EUT with three types of power sources: 3.7Vdc from the battery, 5Vdc from the adapter and 5Vdc from the host, above three types were pre-tested, and the worst case was found in the 5Vdc from the adapter. Therefore only the test data of the 5Vdc from the adapter was recorded in this report.
- The evaluated radiated emission(below 1GHz) and AC power line conducted emission when the EUT is in the charging mode.

| Test item | Modulation Type | Available Channel | Test Channel | Data Rate |
|------------------------------------|-----------------|-------------------|--------------|-----------|
| Radiated Emissions (Above 1GHz) | GFSK | 0 to 39 | 0,19,39 | 1 Mbps |
| Radiated Emissions (Below 1GHz) | GFSK | 0 to 39 | 19 | 1 Mbps |
| AC Power Line Conducted Emission | GFSK | 0 to 39 | 19 | 1 Mbps |
| Antenna Port Conducted Measurement | GFSK | 0 to 39 | 0,19,39 | 1 Mbps |

6.6. Duty cycle

| Mode | On Time (ms) | On+Off Time (ms) | Duty Cycle | Duty Factor (dB) | VBW Set (above 1GHz) |
|--------------|--------------|------------------|------------|------------------|----------------------|
| BT LE(1Mbps) | 0.597 | 1.254 | 0.4761 | 3.22 | 2kHz |



7. Test Equipment

| Test Equipment List | | | | | |
|--|--------------------|-------------------------|---------------------|------------|--------------|
| Equipment | Manufacturer | Model No. | Serial No. | Cal. Date | Expired date |
| Radiated Spurious Emission | | | | | |
| Spectrum Analyzer | Keysight | N9010A | MY56070827 | 2023/4/7 | 2024/4/6 |
| EMI Test Receiver | Rohde & Schwarz | ESR7 | 101754 | 2022/12/13 | 2023/12/12 |
| Loop Antenna | ETS lindgren | 6502 | 00213440 | 2023/1/4 | 2024/1/3 |
| Trilog-Broadband Antenna with 5dB Attenuator | Schwarzbeck & EMCI | VULB 9168 & N-6-05 | 774 & AT-N0538 | 2023/2/13 | 2024/2/12 |
| Horn Antenna (1-18 GHz) | Schwarzbeck | BBHA 9120 D | 01690 | 2022/12/21 | 2023/12/20 |
| Horn Antenna (18-40 GHz) | Schwarzbeck | BBHA 9170 | 781 | 2022/12/30 | 2023/12/29 |
| Preamplifier (30-1000 MHz) | EMCI | EMC330E | 980405 | 2023/6/7 | 2024/6/6 |
| Preamplifier (1-18 GHz) | EMCI | EMC051835BE | 980406 | 2023/2/17 | 2024/2/16 |
| Preamplifier (18-40GHz) | EMCI | EMC184040SEE | 980426 | 2023/5/9 | 2024/5/8 |
| Cables | Hanyitek | K1K50-UP0264-K1K50-2500 | 170214-4 & 170425-2 | 2022/12/1 | 2023/11/30 |
| Cables | Hanyitek | K1K50-UP0264-K1K50-2500 | 170214-1 & 170214-2 | 2022/12/1 | 2023/11/30 |

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| Test Equipment List | | | | | |
|------------------------------------|-----------------|---------------|--------------------------|------------|--------------|
| Equipment | Manufacturer | Model No. | Serial No. | Cal. Date | Expired date |
| Antenna Port Conducted Measurement | | | | | |
| Spectrum Analyzer | Rohde & Schwarz | FSVA3044 | 101281 | 2023/3/21 | 2024/3/20 |
| Attenuator | EMCI | EMC-40ATK2W10 | 17002 | 2022/12/9 | 2023/12/8 |
| Pulse Power Sensor | Anritsu | MA2411B | 1531202 | 2023/1/4 | 2024/1/3 |
| Power Meter | Anritsu | ML2495A | 1645002 | 2023/1/4 | 2024/1/3 |
| AC power Line Conducted Emission | | | | | |
| EMI Test Receiver | Rohde & Schwarz | ESR7 | 101753 | 2022/11/10 | 2023/11/9 |
| Two-Line V-Network | Rohde & Schwarz | ENV216 | 102136 | 2023/5/24 | 2024/5/23 |
| Impuls-Begrenzer Pulse Limiter | Rohde & Schwarz | ESH3-Z2 | 102219-Qt | 2022/8/30 | 2023/8/29 |
| Cables | TITAN | CFD200 | T0732ACFD200 20A300-2 | 2023/5/23 | 2024/5/22 |

| UL Software | | |
|----------------------------------|------------------------|---------------|
| Description | Name | Version |
| Radiated measurement | e3 | 6.191211 (V6) |
| Conducted measurement | RF-Conducted-FCC 15247 | ver 1.0 |
| AC power Line Conducted Emission | EZ EMC | UL-3A1.2 |

8. Description of Test Setup

Support Equipment

| ID | Equipment | Brand Name | Model Name | S/N | Remark |
|----|---------------------------------------|--|----------------------------------|---------|--------------------|
| A | AC Adapter | UNIFIVE | UM305-0512 | NA | Supplied by Client |
| B | Laptop | DELL | Latitude E6430 | 4MMN3X1 | Provide by Lab |
| C | Test Tool | Wurth elektronik | Proteus-III Bluetooth 5.1 EV-kit | NA | Supplied by Client |
| D | Internal Rechargeable Lithium Battery | GUANGDONG ZHAONENG TECHNOLOGY CO., LTD | ZN 502630 | NA | Supplied by Client |

I/O Cables

| ID | Equipment | Brand Name | Model Name | Length (m) | Remark |
|----|-------------------------------|------------------|----------------------------------|------------|--------------------|
| 1 | Type C Cable | assmann | AK-300127-010-S | 1 | Supplied by Client |
| 2 | Flexible Cable with test tool | Wurth elektronik | Proteus-III Bluetooth 5.1 EV-kit | 0.3 | Supplied by Client |

Controlled using a bespoke application (Smart Commander Version 1.3.0.0) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

```

graph LR
    Adapter["(A) Adapter"] --- EUT
    subgraph EUT ["EUT"]
        Battery["(D) Internal Rechargeable Lithium Battery"]
        Port["Type C USB Port"]
    end
    EUT --- 2["(2)"] --- TestTool["(C) Test Tool"]
    Laptop["(B) Laptop"] --- 1["(1)"] --- TestTool

```

Remote Site

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9. Test Results

9.1. 6dB Bandwidth

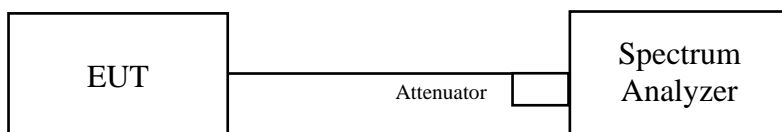
Requirements

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

Test procedure

- Set resolution bandwidth (RBW) = 100kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

| Mode | CH | Freq (MHz) | 6dB BW (MHz) | Limit (MHz) | Result |
|-----------------|----|---------------|-----------------|----------------|--------|
| BT LE(1Mbps) | 0 | 2402 | 0.691 | 0.5 | PASS |
| BT LE(1Mbps) | 19 | 2440 | 0.687 | 0.5 | PASS |
| BT LE(1Mbps) | 39 | 2480 | 0.687 | 0.5 | PASS |

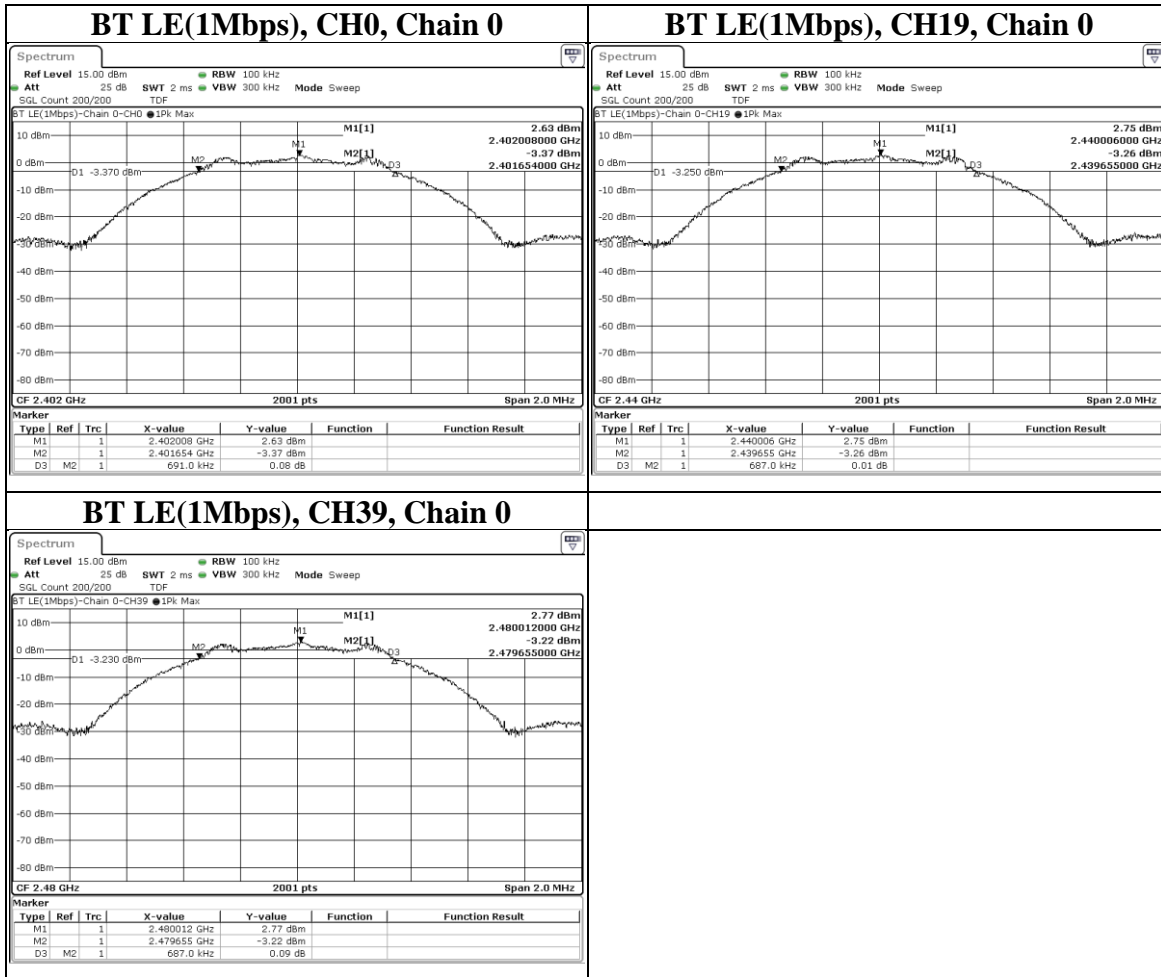
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9.2. Conducted Output Power

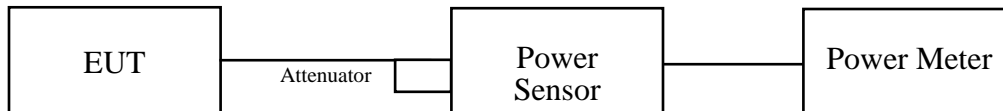
Requirements

For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

Test Setup



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.

Test Data**Peak Power****BT LE_1Mbps**

| Channel | Frequency (MHz) | Peak Power (mW) | Peak Power (dBm) | Limit (dBm) | Pass/Fail |
|---------|-----------------|-----------------|------------------|-------------|-----------|
| 0 | 2402 | 2.35 | 3.71 | 30 | PASS |
| 19 | 2440 | 2.466 | 3.92 | 30 | PASS |
| 39 | 2480 | 2.432 | 3.86 | 30 | PASS |

Average Power (Reference Only)**BT LE_1Mbps**

| Channel | Frequency (MHz) | Average Power (mW) | Average Power (dBm) |
|---------|-----------------|--------------------|---------------------|
| 0 | 2402 | 2.333 | 3.68 |
| 19 | 2440 | 2.443 | 3.88 |
| 39 | 2480 | 2.41 | 3.82 |

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9.3. Power Spectral Density

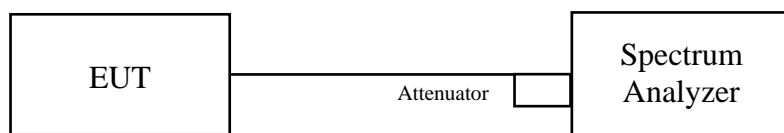
Requirements

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

Test procedure

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- Set the VBW $\geq 3 \times \text{RBW}$.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

| Mode | CH | Freq (MHz) | PSD (dBm/3kHz) | Limit (dBm/3kHz) | Result |
|-----------------|----|---------------|-------------------|---------------------|--------|
| BT LE(1Mbps) | 0 | 2402 | -13.39 | 8 | PASS |
| BT LE(1Mbps) | 19 | 2440 | -13.37 | 8 | PASS |
| BT LE(1Mbps) | 39 | 2480 | -13.08 | 8 | PASS |

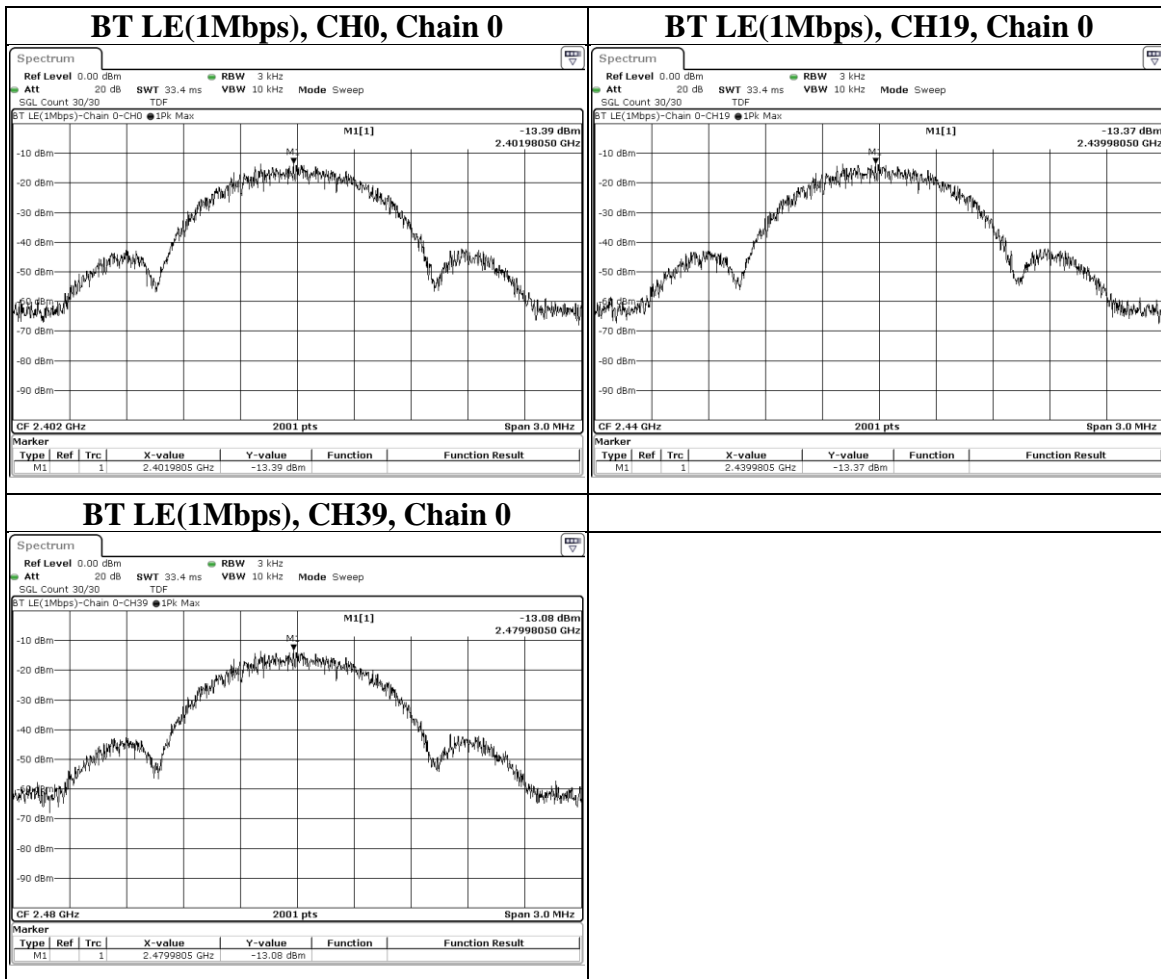
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9.4. Conducted Out of Band Emission

Requirements

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

Test procedure

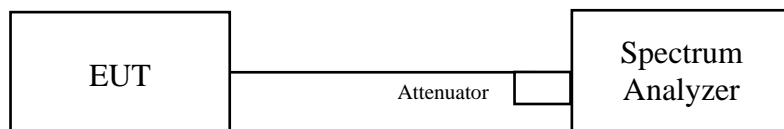
Measurement Procedure REF

- Set the RBW = 100 kHz.
- Set the VBW \geq 300 kHz.
- Set the span to 1.5 times the DTS bandwidth.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement Procedure OOBE

- Set RBW = 100 kHz.
- Set VBW \geq 300 kHz.
- Detector = peak.
- Sweep = auto couple.
- Trace Mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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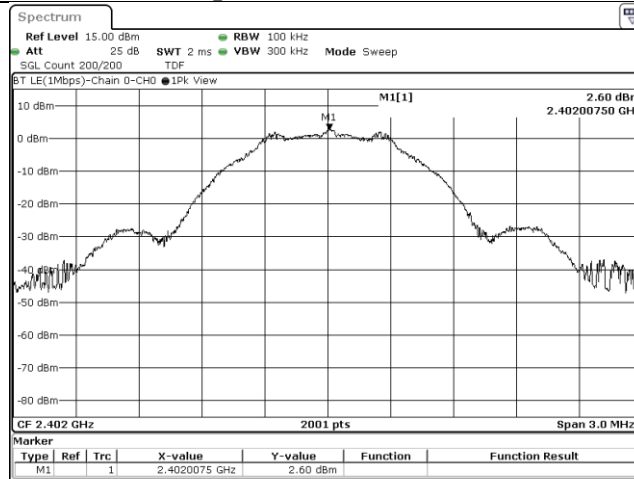
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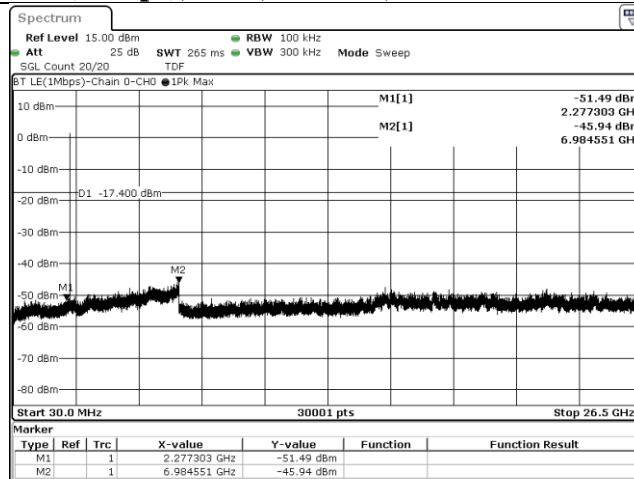
Doc No: Form-ULID-004737 (DCS:17-EM-F0876) / 6.1

Test Data

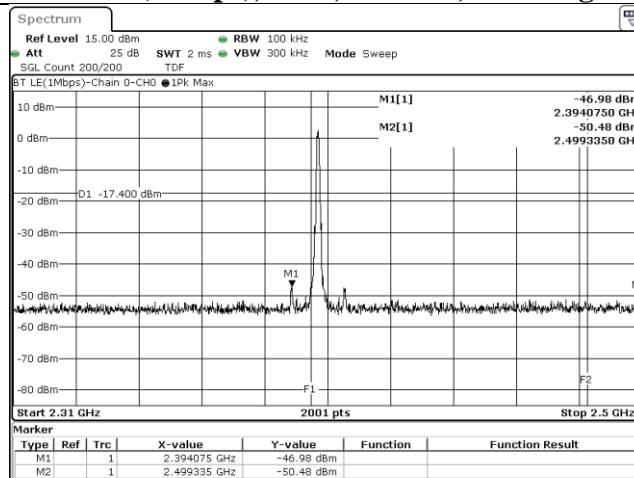
BT LE(1Mbps), CH0, Chain 0, Reference



BT LE(1Mbps), CH0, Chain 0, Conducted Emission



BT LE(1Mbps), CH0, Chain 0, Bandedge



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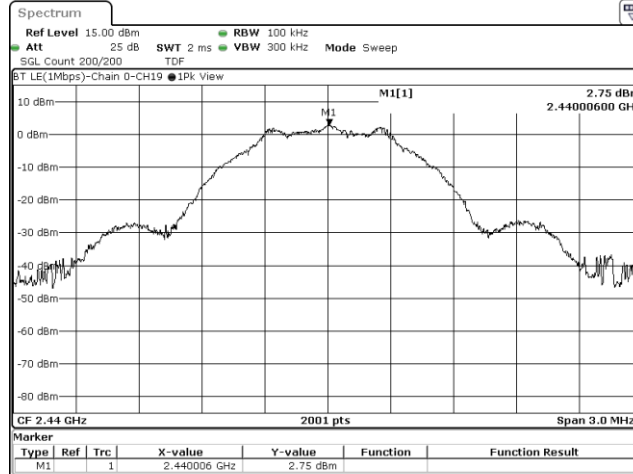
Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

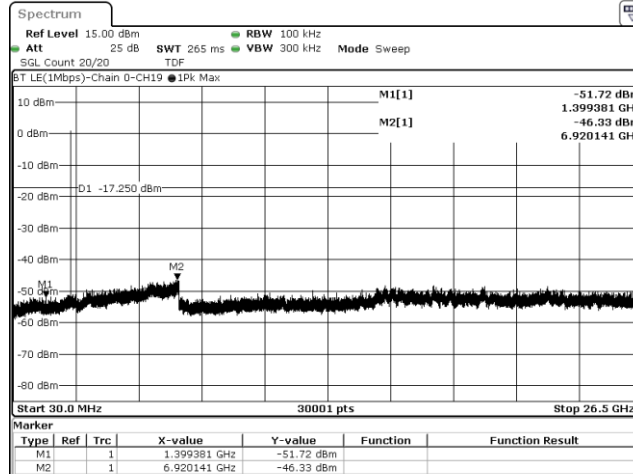
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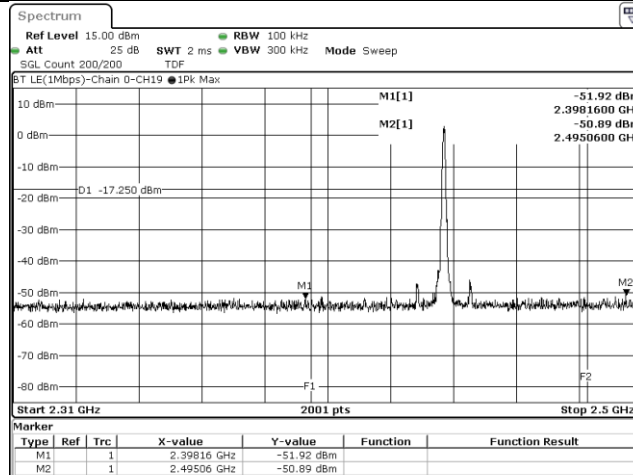
BT LE(1Mbps), CH19, Chain 0, Reference



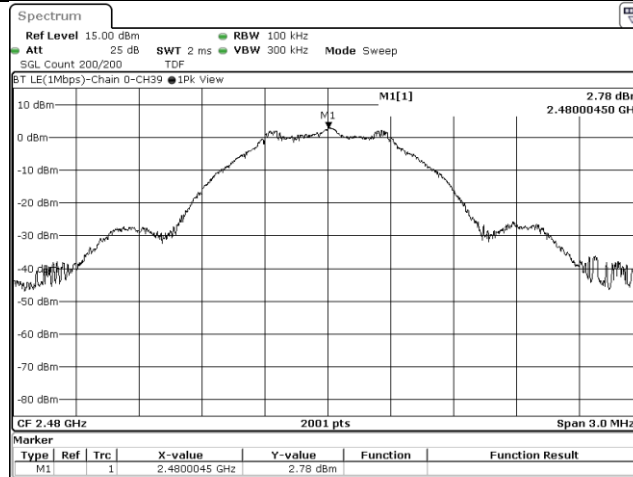
BT LE(1Mbps), CH19, Chain 0, Conducted Emission



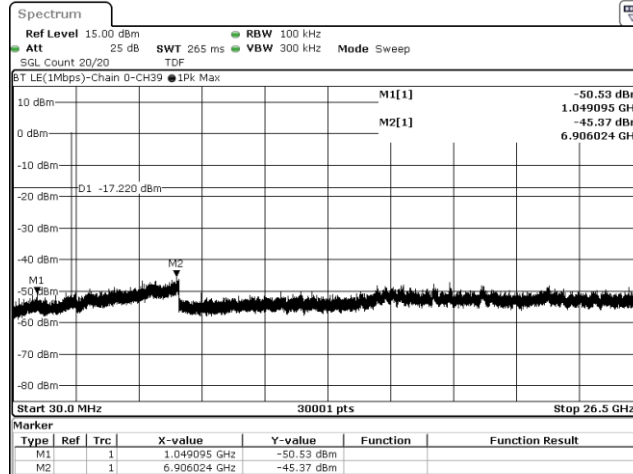
BT LE(1Mbps), CH19, Chain 0, Bandedge



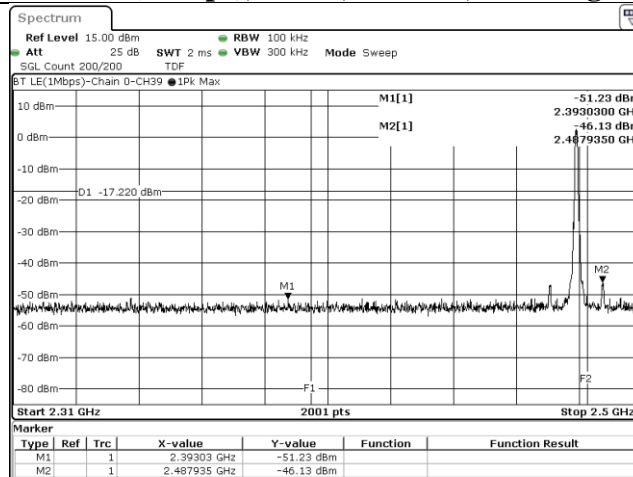
BT LE(1Mbps), CH39, Chain 0, Reference



BT LE(1Mbps), CH39, Chain 0, Conducted Emission



BT LE(1Mbps), CH39, Chain 0, Bandedge



9.5. Radiated Spurious Emission

Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

| Frequency(MHz) | Field strength (microvolts/meter) | Measurement distance (meters) |
|----------------|--------------------------------------|----------------------------------|
| 0.009-0.490 | 2400/F(kHz) | 300 |
| 0.490-1.705 | 24000/F(kHz) | 30 |
| 1.705-30.0 | 30 | 30 |
| 30-88 | 100 | 3 |
| 88-216 | 150 | 3 |
| 216-960 | 200 | 3 |
| Above 960 | 500 | 3 |

NOTE:

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

Test Procedures

[For 9 kHz ~ 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:

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

[For above 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
- f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

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Note:

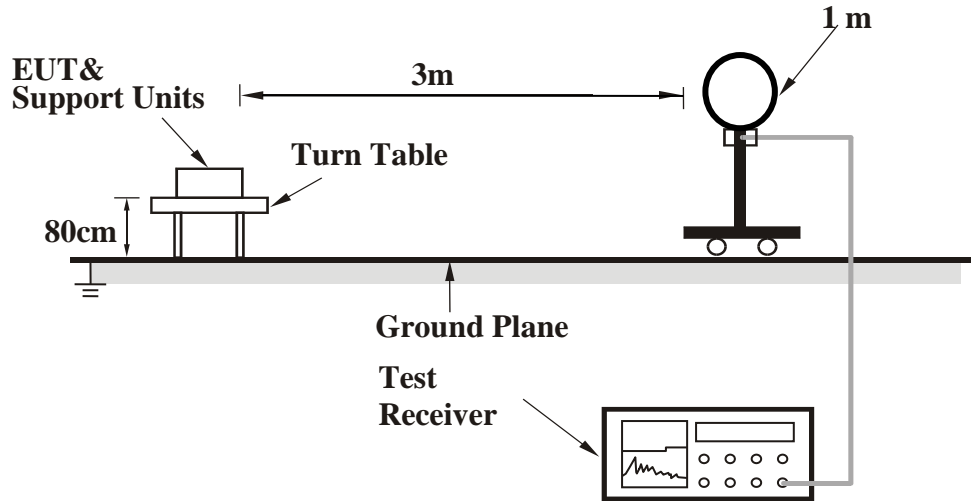
- a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
- b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
- c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle $< 98\%$) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.

| Configuration | Average | |
|---------------|---------|--------------------------------------|
| | RBW | VBW |
| Bluetooth LE | 1MHz | Refer to section 6.6 for duty cycle. |

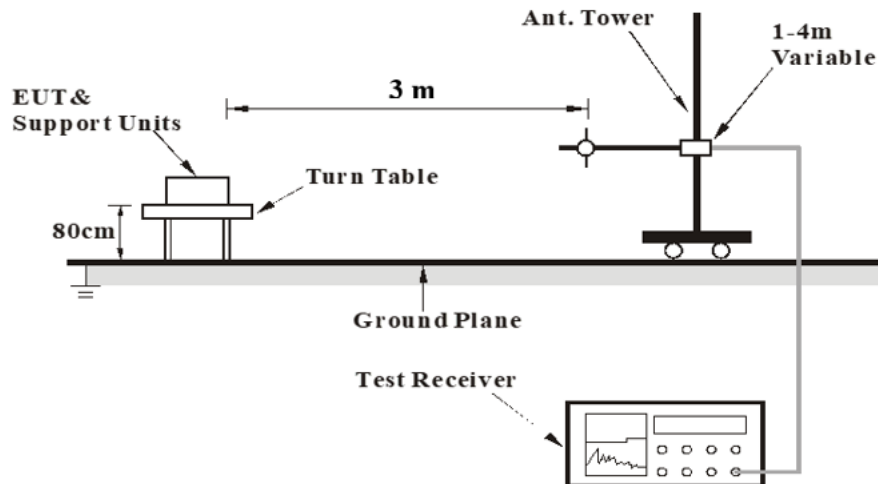
- d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
- e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
- f. Test data of Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
- g. Test data of Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Preamp Factor (dB).
- h. Test data of Notation "@" = Fundamental Frequency
- i. Test data of Notation "*" = The peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.

Test Setup

<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



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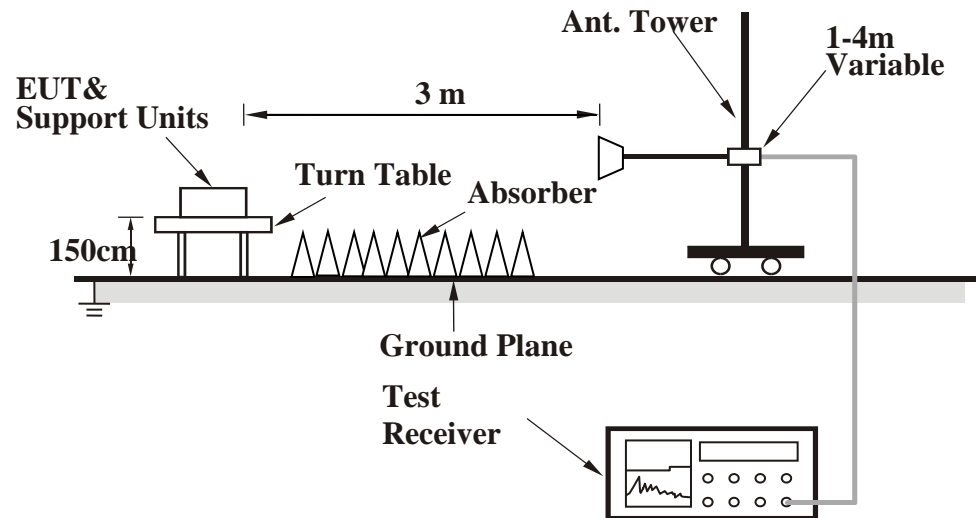
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<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations.

Test Data

Above 1 GHz

| | | | |
|------|-------------|---------|---|
| Mode | BT-LE-1Mbps | Channel | 0 |
|------|-------------|---------|---|

| Polarization | Notation | Frequency (MHz) | Reading (dBuV) | Correct (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|--------------|----------|--------------------|-------------------|-------------------|--------------------|-------------------|----------------|--------|
| Horizontal | | 2364.15 | 41.39 | 11.91 | 53.3 | 74 | -20.7 | PK |
| | | 2381.63 | 30.2 | 11.88 | 42.08 | 54 | -11.92 | AVG |
| | @ | 2402 | 76.98 | 11.85 | 88.83 | N/A | N/A | PK |
| | @ | 2402 | 76.3 | 11.85 | 88.15 | N/A | N/A | AVG |
| | * | 4804 | 44.09 | 2.14 | 46.23 | 74 | -27.77 | PK |
| Vertical | | 2341.54 | 41.49 | 11.96 | 53.45 | 74 | -20.55 | PK |
| | | 2342.87 | 29.99 | 11.95 | 41.94 | 54 | -12.06 | AVG |
| | @ | 2402 | 72.53 | 11.85 | 84.38 | N/A | N/A | PK |
| | @ | 2402 | 71.99 | 11.85 | 83.84 | N/A | N/A | AVG |
| | * | 4804 | 43.74 | 2.14 | 45.88 | 74 | -28.12 | PK |

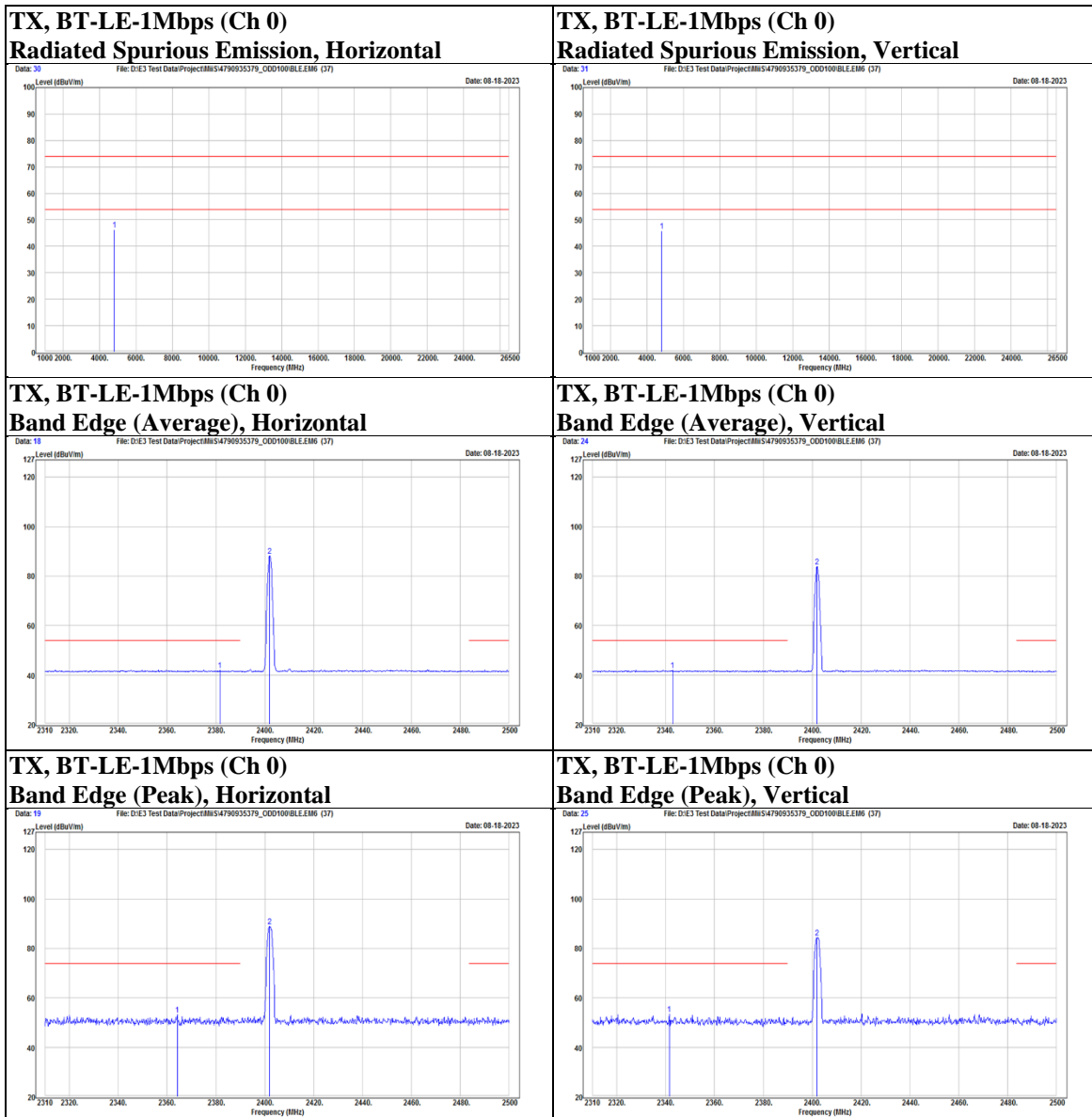
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| | | | |
|------|-------------|---------|----|
| Mode | BT-LE-1Mbps | Channel | 19 |
|------|-------------|---------|----|

| Polarization | Notation | Frequency (MHz) | Reading (dBuV) | Correct (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|--------------|----------|--------------------|-------------------|-------------------|--------------------|-------------------|----------------|--------|
| Horizontal | | 2370.99 | 29.95 | 11.91 | 41.86 | 54 | -12.14 | AVG |
| | | 2379.54 | 41.23 | 11.88 | 53.11 | 74 | -20.89 | PK |
| | @ | 2440 | 76.52 | 11.99 | 88.51 | N/A | N/A | PK |
| | @ | 2440 | 75.95 | 11.99 | 87.94 | N/A | N/A | AVG |
| | | 2488.22 | 40.33 | 11.78 | 52.11 | 74 | -21.89 | PK |
| | | 2496.01 | 29.96 | 11.73 | 41.69 | 54 | -12.31 | AVG |
| | * | 4880 | 42.81 | 2.21 | 45.02 | 74 | -28.98 | PK |
| | | 7320 | 44.96 | 10.25 | 55.21 | 74 | -18.79 | PK |
| | | 7320 | 41.9 | 10.25 | 52.15 | 54 | -1.85 | AVG |
| Vertical | | 2319.88 | 30.01 | 11.95 | 41.96 | 54 | -12.04 | AVG |
| | | 2389.99 | 41.86 | 11.86 | 53.72 | 74 | -20.28 | PK |
| | @ | 2440 | 74.78 | 11.99 | 86.77 | N/A | N/A | PK |
| | @ | 2440 | 73.98 | 11.99 | 85.97 | N/A | N/A | AVG |
| | | 2489.55 | 40.39 | 11.77 | 52.16 | 74 | -21.84 | PK |
| | | 2497.91 | 30.06 | 11.73 | 41.79 | 54 | -12.21 | AVG |
| | * | 4880 | 36.45 | 2.21 | 38.66 | 74 | -35.34 | PK |
| | | 7320 | 46.17 | 10.25 | 56.42 | 74 | -17.58 | PK |
| | | 7320 | 42.55 | 10.25 | 52.8 | 54 | -1.2 | AVG |

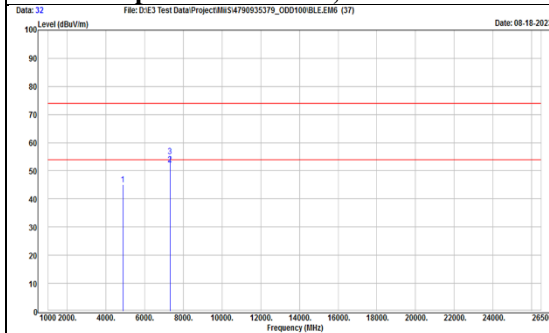
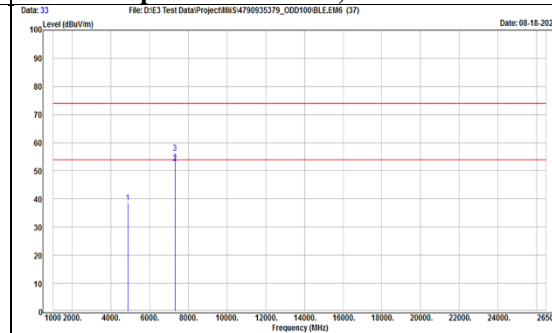
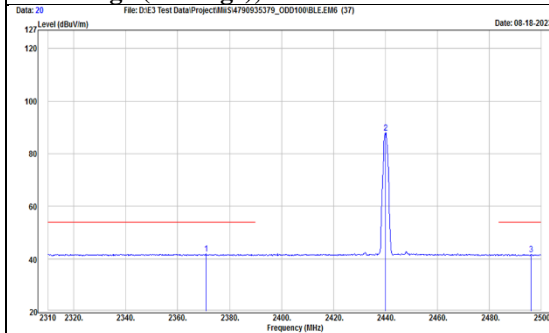
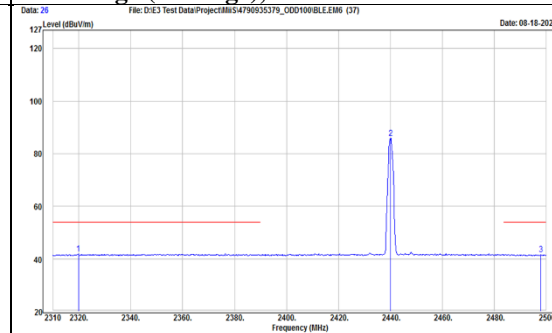
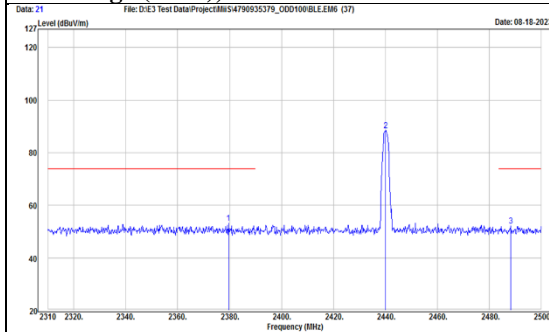
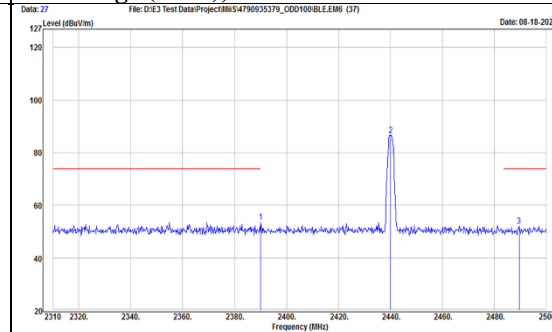
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TX, BT-LE-1Mbps (Ch 19)
Radiated Spurious Emission, Horizontal

TX, BT-LE-1Mbps (Ch 19)
Radiated Spurious Emission, Vertical

TX, BT-LE-1Mbps (Ch 19)
Band Edge (Average), Horizontal

TX, BT-LE-1Mbps (Ch 19)
Band Edge (Average), Vertical

TX, BT-LE-1Mbps (Ch 19)
Band Edge (Peak), Horizontal

TX, BT-LE-1Mbps (Ch 19)
Band Edge (Peak), Vertical


| | | | |
|------|-------------|---------|----|
| Mode | BT-LE-1Mbps | Channel | 39 |
|------|-------------|---------|----|

| Polarization | Notation | Frequency (MHz) | Reading (dBuV) | Correct (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|--------------|----------|--------------------|-------------------|-------------------|--------------------|-------------------|----------------|--------|
| Horizontal | @ | 2480 | 76.06 | 11.83 | 87.89 | N/A | N/A | PK |
| | @ | 2480 | 75.64 | 11.83 | 87.47 | N/A | N/A | AVG |
| | | 2487.84 | 30.48 | 11.79 | 42.27 | 54 | -11.73 | AVG |
| | | 2496.77 | 41.09 | 11.73 | 52.82 | 74 | -21.18 | PK |
| | * | 4960 | 38.2 | 2.3 | 40.5 | 74 | -33.5 | PK |
| | | 7440 | 44.61 | 10.69 | 55.3 | 74 | -18.7 | PK |
| | | 7440 | 42.75 | 10.69 | 53.44 | 54 | -0.56 | AVG |
| Vertical | @ | 2480 | 75.11 | 11.83 | 86.94 | N/A | N/A | PK |
| | @ | 2480 | 74.71 | 11.83 | 86.54 | N/A | N/A | AVG |
| | | 2484.99 | 41.35 | 11.8 | 53.15 | 74 | -20.85 | PK |
| | | 2488.22 | 30.35 | 11.78 | 42.13 | 54 | -11.87 | AVG |
| | * | 4960 | 39.02 | 2.3 | 41.32 | 74 | -32.68 | PK |
| | * | 7440 | 40.6 | 10.69 | 51.29 | 74 | -22.71 | PK |
| | | | | | | | | |

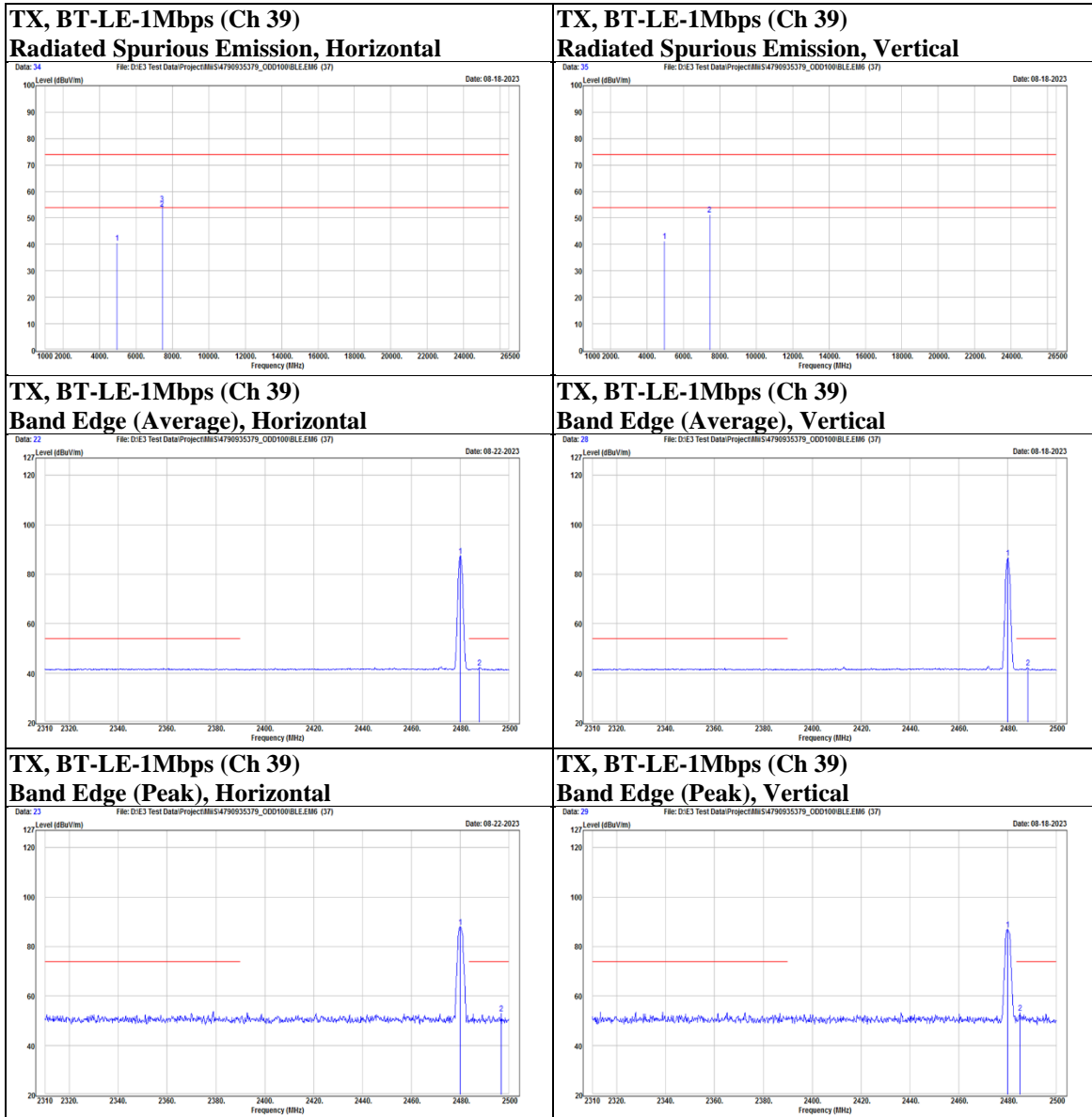
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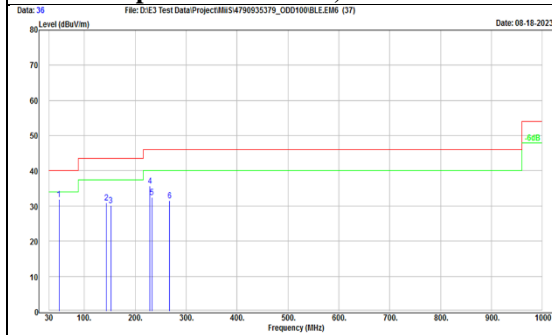
Below 1 GHz

| | | | |
|------|-------------|---------|----|
| Mode | BT-LE-1Mbps | Channel | 19 |
|------|-------------|---------|----|

| Polarization | Notation | Frequency (MHz) | Reading (dBuV) | Correct (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|--------------|----------|--------------------|-------------------|-------------------|--------------------|-------------------|----------------|--------|
| Horizontal | | 50.37 | 43.86 | -11.92 | 31.94 | 40 | -8.06 | PK |
| | | 143.49 | 43.21 | -12.31 | 30.9 | 43.5 | -12.6 | PK |
| | | 152.22 | 42.03 | -11.88 | 30.15 | 43.5 | -13.35 | PK |
| | | 228.85 | 49.64 | -13.94 | 35.7 | 46 | -10.3 | PK |
| | | 232.73 | 46.03 | -13.5 | 32.53 | 46 | -13.47 | PK |
| | | 267.65 | 43.16 | -11.67 | 31.49 | 46 | -14.51 | PK |
| Vertical | | 58.13 | 45.91 | -12.11 | 33.8 | 40 | -6.2 | PK |
| | | 68.8 | 45.71 | -13.62 | 32.09 | 40 | -7.91 | PK |
| | | 152.22 | 43.75 | -11.88 | 31.87 | 43.5 | -11.63 | PK |
| | | 227.88 | 45.35 | -14 | 31.35 | 46 | -14.65 | PK |
| | | 266.68 | 42.21 | -11.72 | 30.49 | 46 | -15.51 | PK |
| | | 304.51 | 40.4 | -10.54 | 29.86 | 46 | -16.14 | PK |

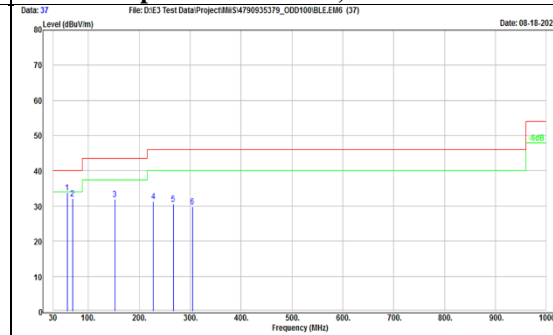
TX, BT-LE-1Mbps (Ch 19)

Radiated Spurious Emission, Horizontal



TX, BT-LE-1Mbps (Ch 19)

Radiated Spurious Emission, Vertical



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Charging Mode

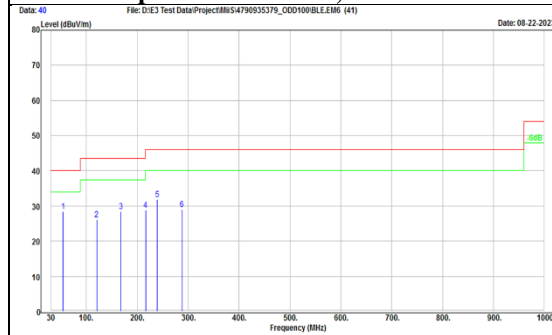
Below 1 GHz

| Mode | Charging Mode | Channel | N/A |
|------|---------------|---------|-----|
|------|---------------|---------|-----|

| Polarization | Notation @ | Frequency (MHz) | Reading (dBuV) | Correct (dB/m) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark |
|--------------|------------|-----------------|----------------|----------------|-----------------|----------------|-------------|--------|
| Horizontal | | 54.25 | 40.24 | -11.72 | 28.52 | 40 | -11.48 | PK |
| | | 120.21 | 40.53 | -14.36 | 26.17 | 43.5 | -17.33 | PK |
| | | 167.74 | 40.21 | -11.85 | 28.36 | 43.5 | -15.14 | PK |
| | | 216.24 | 43.27 | -14.44 | 28.83 | 46 | -17.17 | PK |
| | | 239.52 | 44.65 | -12.83 | 31.82 | 46 | -14.18 | PK |
| | | 288.02 | 39.91 | -10.87 | 29.04 | 46 | -16.96 | PK |
| Vertical | | 62.98 | 39.01 | -12.58 | 26.43 | 40 | -13.57 | PK |
| | | 71.71 | 45.18 | -14.08 | 31.1 | 40 | -8.9 | PK |
| | | 143.49 | 35.12 | -12.31 | 22.81 | 43.5 | -20.69 | PK |
| | | 232.73 | 42.74 | -13.5 | 29.24 | 46 | -16.76 | PK |
| | | 272.5 | 38.76 | -11.44 | 27.32 | 46 | -18.68 | PK |
| | | 289.96 | 38.33 | -10.82 | 27.51 | 46 | -18.49 | PK |

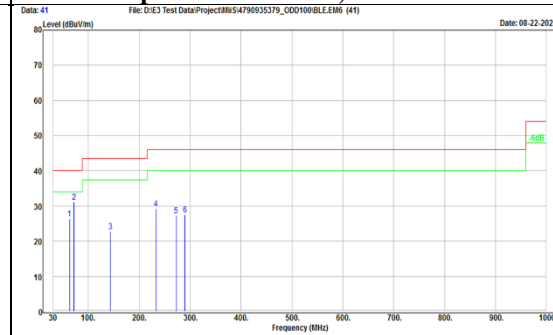
TX, Charging Mode (N/A)

Radiated Spurious Emission, Horizontal



TX, Charging Mode (N/A)

Radiated Spurious Emission, Vertical



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9 kHz ~ 30 MHz Data:

For 9 kHz to 30 MHz radiated emission have performed all modes of operation were investigated. The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

No non-compliance noted:

KDB 414788 D01 OATS and Chamber Correlation Justification

- Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

- OATs and chamber correlation testing had been performed and chamber measured test results is the worst case test result.

Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30m open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

9.6. AC Power Line Conducted Emission

Requirements

| Frequency (MHz) | Conducted limit (dBμV) | |
|-----------------|------------------------|---------|
| | Quasi-peak | Average |
| 0.15 - 0.5 | 66 - 56 | 56 - 46 |
| 0.50 - 5.0 | 56 | 46 |
| 5.0 - 30 | 60 | 50 |

Note:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

Test Procedures

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

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.
2. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
3. Test data of Result value (dBuV) = Reading value (dBuV) + Correction Factor (dB).
4. Test data of Margin(dB) = Result value (dBuV) - Limit value (dBuV).
5. Test data of Correction Factor (dB) = Insertion loss(dB) + Cable loss(dB).

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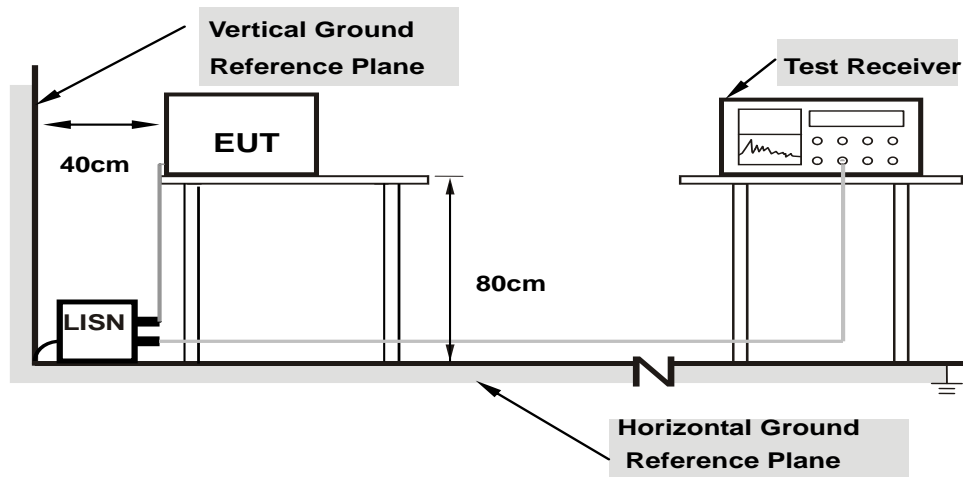
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Test Setup

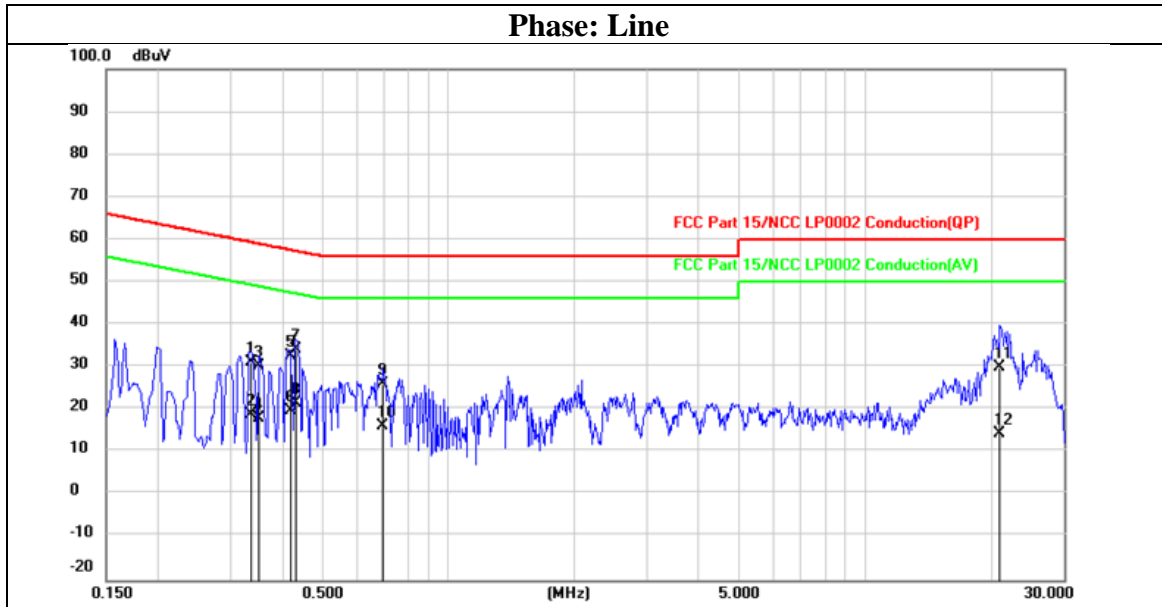


Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the Setup Configurations.

Test Data

| | | | |
|------|----------------|---------|----|
| Mode | BLE(1M)_TX2440 | Channel | 19 |
|------|----------------|---------|----|



| No. | Frequency (MHz) | Reading (dBuV) | Correct (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Remark |
|-----|--------------------|-------------------|-----------------|------------------|-----------------|----------------|--------|
| 1 | 0.3339 | 21.07 | 9.96 | 31.03 | 59.35 | -28.32 | QP |
| 2 | 0.3339 | 8.82 | 9.96 | 18.78 | 49.35 | -30.57 | AVG |
| 3 | 0.3466 | 20.16 | 9.96 | 30.12 | 59.04 | -28.92 | QP |
| 4 | 0.3466 | 7.84 | 9.96 | 17.80 | 49.04 | -31.24 | AVG |
| 5 | 0.4187 | 22.69 | 9.96 | 32.65 | 57.47 | -24.82 | QP |
| 6 | 0.4187 | 9.76 | 9.96 | 19.72 | 47.47 | -27.75 | AVG |
| 7 | 0.4299 | 24.30 | 9.96 | 34.26 | 57.25 | -22.99 | QP |
| 8 | 0.4299 | 11.63 | 9.96 | 21.59 | 47.25 | -25.66 | AVG |
| 9 | 0.6951 | 16.02 | 9.96 | 25.98 | 56.00 | -30.02 | QP |
| 10 | 0.6951 | 6.24 | 9.96 | 16.20 | 46.00 | -29.80 | AVG |
| 11 | 21.0770 | 19.58 | 10.49 | 30.07 | 60.00 | -29.93 | QP |
| 12 | 21.0770 | 3.79 | 10.49 | 14.28 | 50.00 | -35.72 | AVG |

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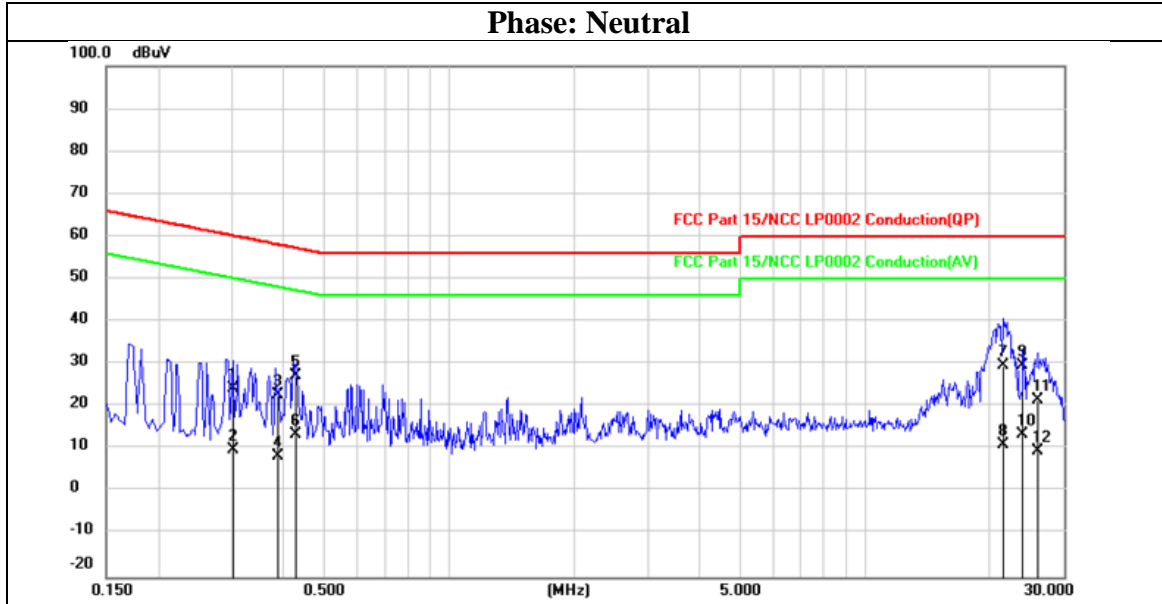
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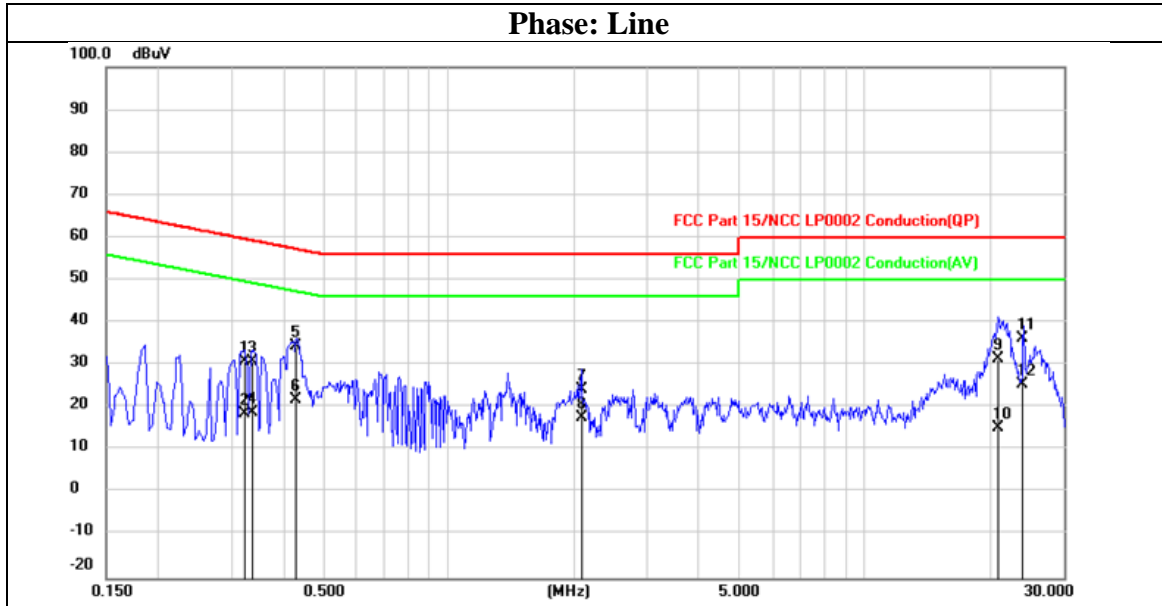
| | | | |
|------|----------------|---------|----|
| Mode | BLE(1M)_TX2440 | Channel | 19 |
|------|----------------|---------|----|



| No. | Frequency (MHz) | Reading (dBuV) | Correct (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Remark |
|-----|--------------------|-------------------|-----------------|------------------|-----------------|----------------|--------|
| 1 | 0.3006 | 14.38 | 9.94 | 24.32 | 60.23 | -35.91 | QP |
| 2 | 0.3006 | -0.23 | 9.94 | 9.71 | 50.23 | -40.52 | AVG |
| 3 | 0.3868 | 12.85 | 9.95 | 22.80 | 58.13 | -35.33 | QP |
| 4 | 0.3868 | -1.45 | 9.95 | 8.50 | 48.13 | -39.63 | AVG |
| 5 | 0.4260 | 17.43 | 9.95 | 27.38 | 57.33 | -29.95 | QP |
| 6 | 0.4260 | 3.42 | 9.95 | 13.37 | 47.33 | -33.96 | AVG |
| 7 | 21.5723 | 19.13 | 10.54 | 29.67 | 60.00 | -30.33 | QP |
| 8 | 21.5723 | 0.43 | 10.54 | 10.97 | 50.00 | -39.03 | AVG |
| 9 | 23.9907 | 18.93 | 10.60 | 29.53 | 60.00 | -30.47 | QP |
| 10 | 23.9907 | 2.86 | 10.60 | 13.46 | 50.00 | -36.54 | AVG |
| 11 | 25.9841 | 11.02 | 10.64 | 21.66 | 60.00 | -38.34 | QP |
| 12 | 25.9841 | -0.95 | 10.64 | 9.69 | 50.00 | -40.31 | AVG |

Charging Mode

| | | | |
|------|---------------|---------|-----|
| Mode | Charging Mode | Channel | N/A |
|------|---------------|---------|-----|



| No. | Frequency (MHz) | Reading (dBuV) | Correct (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Remark |
|-----|--------------------|-------------------|-----------------|------------------|-----------------|----------------|--------|
| 1 | 0.3223 | 20.79 | 9.96 | 30.75 | 59.65 | -28.90 | QP |
| 2 | 0.3223 | 8.59 | 9.96 | 18.55 | 49.65 | -31.10 | AVG |
| 3 | 0.3370 | 20.98 | 9.96 | 30.94 | 59.28 | -28.34 | QP |
| 4 | 0.3370 | 8.77 | 9.96 | 18.73 | 49.28 | -30.55 | AVG |
| 5 | 0.4290 | 24.40 | 9.96 | 34.36 | 57.27 | -22.91 | QP |
| 6 | 0.4290 | 11.87 | 9.96 | 21.83 | 47.27 | -25.44 | AVG |
| 7 | 2.0805 | 14.14 | 10.02 | 24.16 | 56.00 | -31.84 | QP |
| 8 | 2.0805 | 7.61 | 10.02 | 17.63 | 46.00 | -28.37 | AVG |
| 9 | 20.8252 | 20.93 | 10.48 | 31.41 | 60.00 | -28.59 | QP |
| 10 | 20.8252 | 4.86 | 10.48 | 15.34 | 50.00 | -34.66 | AVG |
| 11 | 23.9994 | 25.79 | 10.54 | 36.33 | 60.00 | -23.67 | QP |
| 12 | 23.9994 | 14.88 | 10.54 | 25.42 | 50.00 | -24.58 | AVG |

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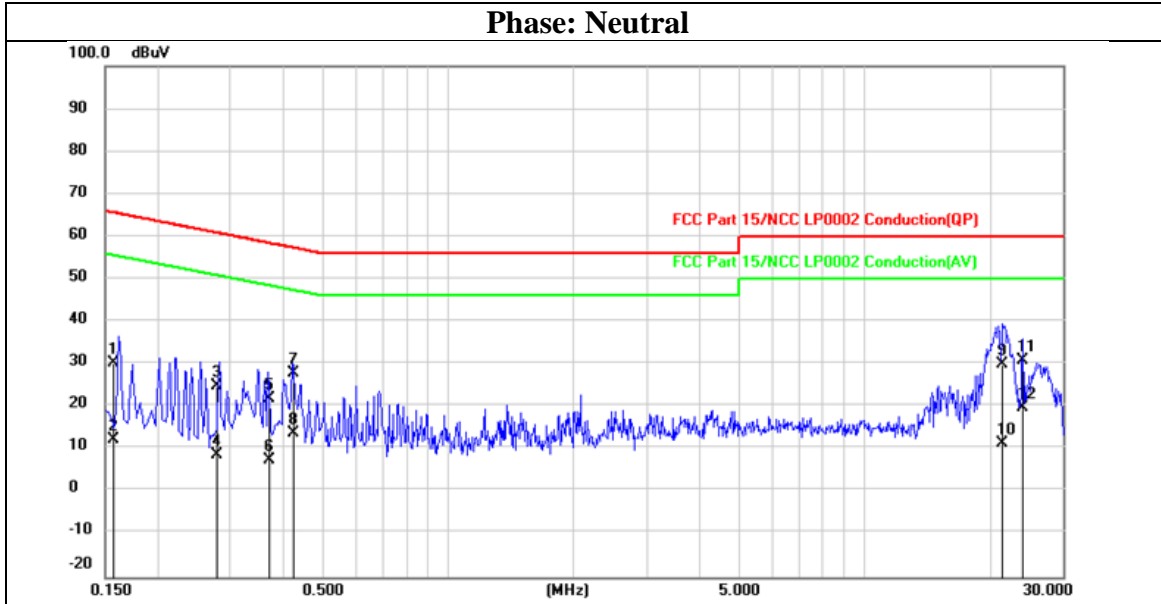
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| | | | |
|------|---------------|---------|-----|
| Mode | Charging Mode | Channel | N/A |
|------|---------------|---------|-----|



| No. | Frequency (MHz) | Reading (dBuV) | Correct (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Remark |
|-----|--------------------|-------------------|-----------------|------------------|-----------------|----------------|--------|
| 1 | 0.1573 | 20.31 | 9.95 | 30.26 | 65.61 | -35.35 | QP |
| 2 | 0.1573 | 2.29 | 9.95 | 12.24 | 55.61 | -43.37 | AVG |
| 3 | 0.2788 | 14.93 | 9.94 | 24.87 | 60.85 | -35.98 | QP |
| 4 | 0.2788 | -1.41 | 9.94 | 8.53 | 50.85 | -42.32 | AVG |
| 5 | 0.3730 | 11.76 | 9.95 | 21.71 | 58.43 | -36.72 | QP |
| 6 | 0.3730 | -2.40 | 9.95 | 7.55 | 48.43 | -40.88 | AVG |
| 7 | 0.4268 | 17.77 | 9.95 | 27.72 | 57.31 | -29.59 | QP |
| 8 | 0.4268 | 3.77 | 9.95 | 13.72 | 47.31 | -33.59 | AVG |
| 9 | 21.4765 | 19.53 | 10.54 | 30.07 | 60.00 | -29.93 | QP |
| 10 | 21.4765 | 0.67 | 10.54 | 11.21 | 50.00 | -38.79 | AVG |
| 11 | 24.0009 | 20.25 | 10.60 | 30.85 | 60.00 | -29.15 | QP |
| 12 | 24.0009 | 9.28 | 10.60 | 19.88 | 50.00 | -30.12 | AVG |

END OF REPORT

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