

Test Report No:  
23C0817R-RFUSV14S-A

## TEST REPORT

### FCC Rules&Regulations

|                                 |                                                                                     |
|---------------------------------|-------------------------------------------------------------------------------------|
| Product Name                    | zūmo R1 Radar                                                                       |
| Brand Name                      | GARMIN                                                                              |
| Model No.                       | A04811                                                                              |
| FCC ID                          | IPH-04811                                                                           |
| Applicant's Name / Address      | Garmin International Inc.<br>1200 E. 151st. Street, Olathe, KS 66062, United States |
| Manufacturer's Name             | GARMIN Corporation                                                                  |
| Test Method Requested, Standard | FCC CFR Title 47 Part 95 Subpart M<br>ANSI C63.10-2013                              |
| Verdict Summary                 | IN COMPLIANCE                                                                       |
| Documented by Jinn Chen         |  |
| Tested by Ivan Chuang           |  |
| Approved by Alan Chen           |  |
| Date of Receipt                 | 2023/12/26                                                                          |
| Date of Issue                   | 2024/07/09                                                                          |
| Report Version                  | V1.0                                                                                |

## INDEX

|                                                           | page |
|-----------------------------------------------------------|------|
| Competences and Guarantees.....                           | 4    |
| General Conditions.....                                   | 4    |
| Revision History.....                                     | 5    |
| Summary of Test Result.....                               | 6    |
| 1. General Information.....                               | 7    |
| 1.1. EUT Description.....                                 | 7    |
| 1.2. EUT Information.....                                 | 7    |
| 1.3. Testing Location Information.....                    | 8    |
| 1.4. Measurement Uncertainty.....                         | 9    |
| 1.5. List of Test Equipment.....                          | 10   |
| 2. Test Configuration of EUT.....                         | 12   |
| 2.1. Test Condition.....                                  | 12   |
| 2.2. Test Software.....                                   | 12   |
| 2.3. Duty Cycle.....                                      | 13   |
| 2.4. The Worst Case Measurement Configuration.....        | 14   |
| 2.5. Tested System Details.....                           | 15   |
| 2.6. Configuration of tested System.....                  | 15   |
| 3. AC Power Line Conducted Emission.....                  | 16   |
| 3.1. Test Setup.....                                      | 16   |
| 3.2. Test Limit.....                                      | 16   |
| 3.3. Test Procedure.....                                  | 16   |
| 3.4. Test Result of AC Power Line Conducted Emission..... | 16   |
| 4. Occupied Bandwidth.....                                | 17   |
| 4.1. Test Setup.....                                      | 17   |
| 4.2. Test Limit.....                                      | 17   |
| 4.3. Test Procedures.....                                 | 17   |
| 4.4. Test Result of Occupied Bandwidth.....               | 17   |
| 5. Maximum output power (EIRP).....                       | 18   |
| 5.1. Test Setup.....                                      | 18   |
| 5.2. Test Limit.....                                      | 18   |
| 5.3. Test Procedures.....                                 | 19   |
| 5.4. Test Result of Maximum output power (EIRP).....      | 19   |
| 6. Radiated Emission.....                                 | 20   |
| 6.1. Test Setup.....                                      | 20   |
| 6.2. Test Limit.....                                      | 21   |
| 6.3. Test Procedure.....                                  | 22   |

6.4. Test Result of Radiated Emissions.....22

7. Frequency Stability .....23

7.1. Test Setup .....23

7.2. Limit.....23

7.3. Test Procedure .....24

7.4. Test Result of Frequency Stability .....24

Appendix A. Test Result of AC Power Line Conducted Emission

Appendix B. Test Result of Occupied Bandwidth

Appendix C. Test Result of Maximum output power (EIRP)

Appendix D. Test Result of Radiated Emissions

Appendix E. Test Result of Frequency Stability

Appendix F. Test Setup Photograph

## Competences and Guarantees

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DEKRA is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA has a calibration and maintenance program for its measurement equipment.

DEKRA guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated in the report and it is based on the knowledge and technical facilities available at DEKRA at the time of performance of the test.

DEKRA is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

**IMPORTANT:** No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA.

## General Conditions

---

1. The test results relate only to the samples tested.
2. The test results shown in the test report are traceable to the national/international standard through the calibration report of the equipment and evaluated measurement uncertainty herein.
3. This report must not be used to claim product endorsement by TAF or any agency of the government.
4. The test report shall not be reproduced without the written approval of DEKRA Testing and Certification Co., Ltd.
5. Measurement uncertainties evaluated for each testing system and associated connections are given here to provide the system information for reference. Compliance determinations do not take into account measurement uncertainties for each testing system, but are based on the results of the compliance measurement.

Revision History

| Version | Description             | Issued Date |
|---------|-------------------------|-------------|
| V1.0    | Initial issue of report | 2024/07/09  |

## Summary of Test Result

| Report Clause | Test Items                       | Result (PASS/FAIL) | Remark |
|---------------|----------------------------------|--------------------|--------|
| 3             | AC Power Line Conducted Emission | N/A                | -      |
| 4             | Occupied Bandwidth               | PASS               | -      |
| 5             | Maximum output power (EIRP)      | PASS               | -      |
| 6             | Radiated Emission                | PASS               | -      |
| 7             | Frequency Stability              | PASS               | -      |

### Comments and Explanations

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

## 1. General Information

### 1.1. EUT Description

|                                      |                                                |
|--------------------------------------|------------------------------------------------|
| Frequency Band                       | 76.00 ~ 81.00 GHz                              |
| Operating Frequency / Channel Number | 78.11 GHz, 78.957 GHz, 79.805 GHz / 3 Channels |
| Type of Modulation                   | FMCW                                           |

| Accessories Information |                |                  |
|-------------------------|----------------|------------------|
| No.                     | Equipment Name | Description      |
| 1                       | TTL FTDI Cable | Non-shielded, 3m |

| Antenna Information |                   |            |                     |            |
|---------------------|-------------------|------------|---------------------|------------|
| Item                | Brand Name        | Part No.   | Type                | Gain (dBi) |
| 1                   | Texas Instruments | IWR1843AOP | Patch array on chip | 5          |

| Working Frequency of Each Channel |           |         |            |         |            |
|-----------------------------------|-----------|---------|------------|---------|------------|
| Channel                           | Frequency | Channel | Frequency  | Channel | Frequency  |
| 01                                | 78.11 GHz | 02      | 78.957 GHz | 03      | 79.805 GHz |

### 1.2. EUT Information

|                |              |
|----------------|--------------|
| EUT Power Type | From Battery |
|----------------|--------------|

### 1.3. Testing Location Information

|        |                                                       |
|--------|-------------------------------------------------------|
| USA    | FCC Designation Number: TW0033                        |
| Canada | CAB Identifier Number: TW3023 / Company Number: 26930 |

|                  |                         |
|------------------|-------------------------|
| Site Description | Accredited by TAF       |
|                  | Accredited Number: 3023 |

|                    |                                                                             |
|--------------------|-----------------------------------------------------------------------------|
| Test Laboratory    | DEKRA Testing and Certification Co., Ltd.                                   |
|                    | Linkou Laboratory                                                           |
| Address            | No.5-22, Ruishukeng Linkou District, New Taipei City, 24451, Taiwan, R.O.C. |
| Performed Location | No. 26, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan, R.O.C.   |
| Phone Number       | +886-3-275-7255                                                             |
| Fax Number         | +886-3-327-8031                                                             |

Ambient conditions in the laboratory:

| Performed Item        | Items            | Required | Actual  | Test Date             |
|-----------------------|------------------|----------|---------|-----------------------|
| Radiated Emission     | Temperature (°C) | 10~40 °C | 24.8 °C | 2024/01/15~2024/02/23 |
|                       | Humidity (%RH)   | 10~90 %  | 65.0 %  |                       |
| RF Conducted Emission | Temperature (°C) | 10~40 °C | 24.6 °C | 2024/02/23~2023/03/01 |
|                       | Humidity (%RH)   | 10~90 %  | 66.2 %  |                       |

#### 1.4. Measurement Uncertainty

Uncertainties have been calculated according to the DEKRA internal document with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ( $k=2$ )).

| Test item                        | Uncertainty                                                                                                                                                                    |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AC Power Line Conducted Emission | $\pm 3.50$ dB                                                                                                                                                                  |
| Occupied Bandwidth               | $\pm 1580.61$ Hz                                                                                                                                                               |
| Maximum output power (EIRP)      | $\pm 4.02$ dB                                                                                                                                                                  |
| Radiated Emission                | 9kHz~30MHz: $\pm 3.88$ dB<br>30MHz~1GHz: $\pm 4.42$ dB<br>1GHz~18GHz: $\pm 4.28$ dB<br>18GHz~40GHz: $\pm 3.90$ dB<br>40GHz~50GHz: $\pm 5.06$ dB<br>50GHz~325GHz: $\pm 5.71$ dB |
| Frequency Stability              | $\pm 1580.61$ Hz                                                                                                                                                               |

## 1.5. List of Test Equipment

For Test Site number: HY-SR03

|   | Equipment           | Manufacturer | Model No.              | Serial No. | Cal. Date  | Due Date   |
|---|---------------------|--------------|------------------------|------------|------------|------------|
| V | Temperature Chamber | KSON         | THS-D4T-100            | A0606      | 2023/08/10 | 2024/08/09 |
| V | DC Power Supply     | GW Instek    | SPD-3606               | GEQ820915  | 2023/07/07 | 2024/07/06 |
| V | Spectrum Analyzer   | Keysight     | N9030B                 | MY56320509 | 2023/07/20 | 2024/07/19 |
| V | Horn Antenna        | VDI          | RCH012RL<br>(60-90GHz) | N/A        | 2022/03/10 | 2025/03/09 |

Note:

1. The mm-Wave VDI equipment (above 50GHz) is calibrated every three years, the other equipments are calibrated every one year.
2. The test instruments marked with “V” are used to measure the final test results.

## For Radiated Measurements / HY-CB02

|   | Equipment              | Manufacturer | Model No.             | Serial No.   | Cal. Date  | Due Date   |
|---|------------------------|--------------|-----------------------|--------------|------------|------------|
| V | Signal Analyzer        | R&S          | FSV3044               | 101113       | 2024/02/05 | 2025/02/04 |
| V | Spectrum Analyzer      | Keysight     | N9030B                | MY56320509   | 2023/07/20 | 2024/07/19 |
| V | Horn Antenna           | VDI          | RCH015RL (50-75GHz)   | --           | 2022/03/10 | 2025/03/09 |
| V | Horn Antenna           | VDI          | RCH012RL(60-90GHz)    | --           | 2022/03/10 | 2025/03/09 |
| V | Horn Antenna           | VDI          | RCH08RL(90-140GHz)    | --           | 2022/03/10 | 2025/03/09 |
| V | Horn Antenna           | VDI          | RCH05RL(140-220GHz)   | --           | 2022/03/10 | 2025/03/09 |
|   | Horn Antenna           | VDI          | 2-43/2-44(220-330GHz) | --           | 2022/03/10 | 2025/03/09 |
| V | Down Converter(SAX405) | VDI          | N9029AV15(AT0-55847)  | US54250164   | 2022/03/10 | 2025/03/09 |
| V | Down Converter(SAX404) | VDI          | N9029AV12(AT0-59570)  | US54250170   | 2022/03/10 | 2025/03/09 |
| V | Down Converter(SAX403) | VDI          | N9029AV08(AT0-59571)  | US53250012   | 2022/03/10 | 2025/03/09 |
| V | Down Converter(SAX402) | VDI          | N9029AV05(AT0-60029)  | US53250019   | 2022/03/10 | 2025/03/09 |
|   | Down Converter(SAX401) | VDI          | N9029AV03(AT0-57775)  | US53250021   | 2022/03/10 | 2025/03/09 |
| V | Loop Antenna           | AMETEK       | HLA6121               | 56736        | 2023/05/23 | 2024/05/22 |
| V | Bi-Log Antenna         | SCHWARZBECK  | VULB9168              | 9168-0675    | 2023/08/09 | 2025/08/08 |
| V | Horn Antenna           | RF SPIN      | DRH18-E               | 210802A18ES  | 2023/03/23 | 2024/03/22 |
| V | Horn Antenna           | Com-Power    | AH-840                | 101100       | 2023/10/02 | 2025/10/01 |
| V | Pre-Amplifier          | SGH          | SGH0301-9             | 20211007-8   | 2024/01/10 | 2025/01/09 |
| V | Pre-Amplifier          | SGH          | SGH118-HS             | 20211102-2   | 2024/01/10 | 2025/01/09 |
| V | Pre-Amplifier          | EMCI         | EMC05820SE            | 980285       | 2024/01/10 | 2025/01/09 |
| V | Pre-Amplifier          | EMCI         | EMC184045SE           | 980369       | 2024/01/10 | 2025/01/09 |
| V | Coaxial Cable          | EMCI         | EMC102-KM-KM-600      | 1160314      | 2024/01/10 | 2025/01/09 |
| V | Coaxial Cable          | EMCI         | EMC102-KM-KM-7000     | 170242       | 2024/01/10 | 2025/01/09 |
| V | EMI Test Receiver      | R&S          | ESR3                  | 102792       | 2024/01/05 | 2025/01/04 |
| V | Coaxial Cable          | SGH          | HA800                 | GD20110223-2 | 2024/01/10 | 2025/01/09 |
| V | Coaxial Cable          | SGH          | HA800                 | GD20110222-4 | 2024/01/10 | 2025/01/09 |
| V | Coaxial Cable          | SGH          | SGH18                 | 202108-5     | 2024/01/10 | 2025/01/09 |
| V | Coaxial Cable          | SGH          | SGH18                 | 2021005-2    | 2023/11/27 | 2024/11/26 |

## Note:

1. Bi-Log Antenna and Horn Antenna(AH-840) is calibrated every two years, VDI and Millitech equipments is calibrated every three years, the other equipments are calibrated every one year.
2. The test instruments marked with "V" are used to measure the final test results.
3. Test Software version: e3 230303 dekra V9.

## 2. Test Configuration of EUT

### 2.1. Test Condition

| EUT Operational Condition |        |
|---------------------------|--------|
| Testing Voltage           | DC 12V |

### 2.2. Test Software

|                       |                                     |
|-----------------------|-------------------------------------|
| Test Software Version | iMonitor Properties Version 1.0.0.0 |
|-----------------------|-------------------------------------|

| Modulation | Frequency (GHz) | Power Setting |
|------------|-----------------|---------------|
| FMCW       | 78.11           | N/A           |
|            | 78.957          | N/A           |
|            | 79.805          | N/A           |

2.3. Duty Cycle

| Modulation | On Times (ms) | On+Off Times (ms) | Duty Cycle (%) |
|------------|---------------|-------------------|----------------|
| FMCW       | 5.1           | 24.9              | 20.48          |



## 2.4. The Worst Case Measurement Configuration

|           |                     |
|-----------|---------------------|
| Test Mode | Mode 1: Transmit    |
|           | Mode 2: Receive     |
|           | Mode 3: Co-location |

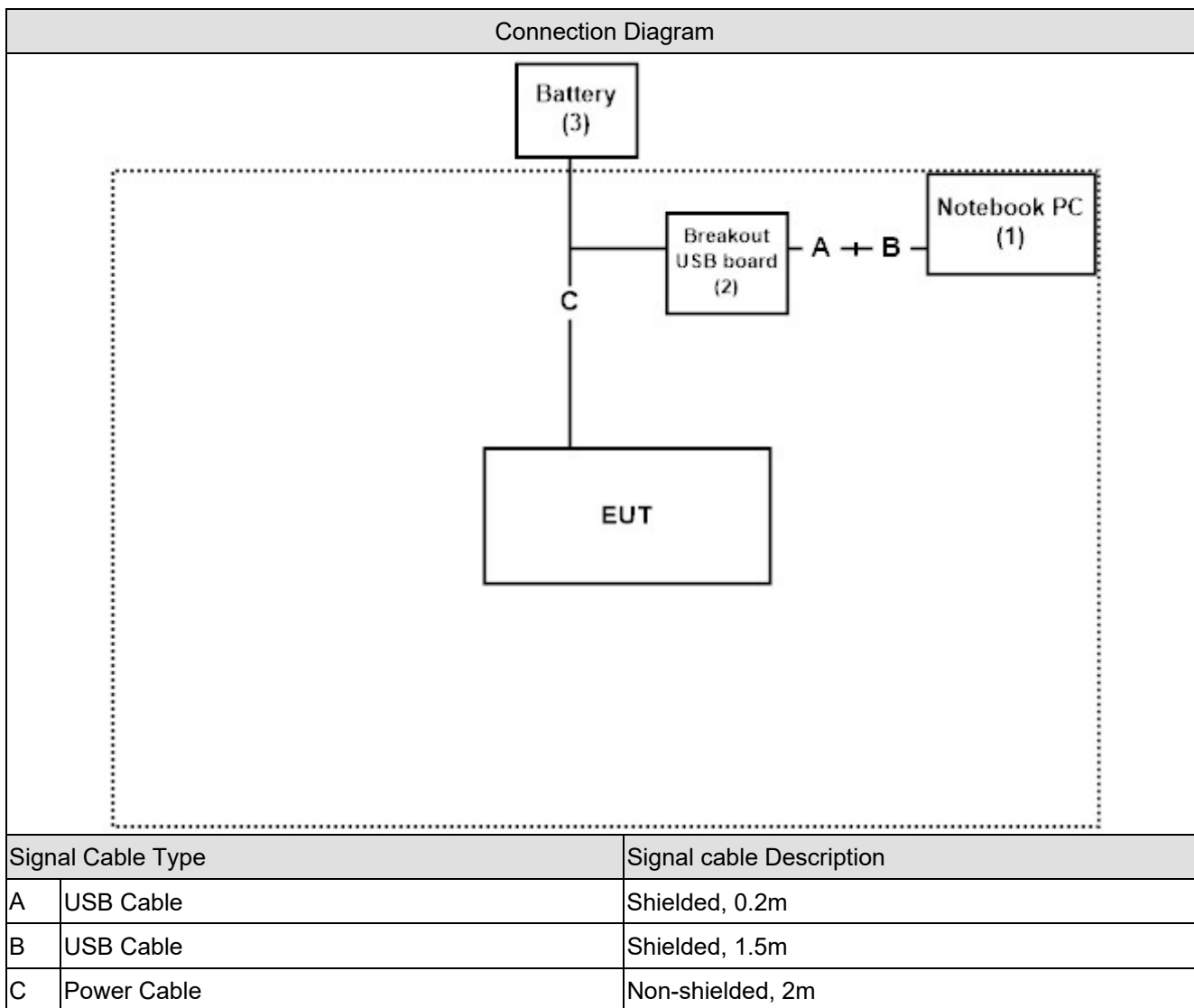
**Note:**

1. Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.
2. For radiated emission below 1 GHz and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
3. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case is shown in the report.

## 2.5. Tested System Details

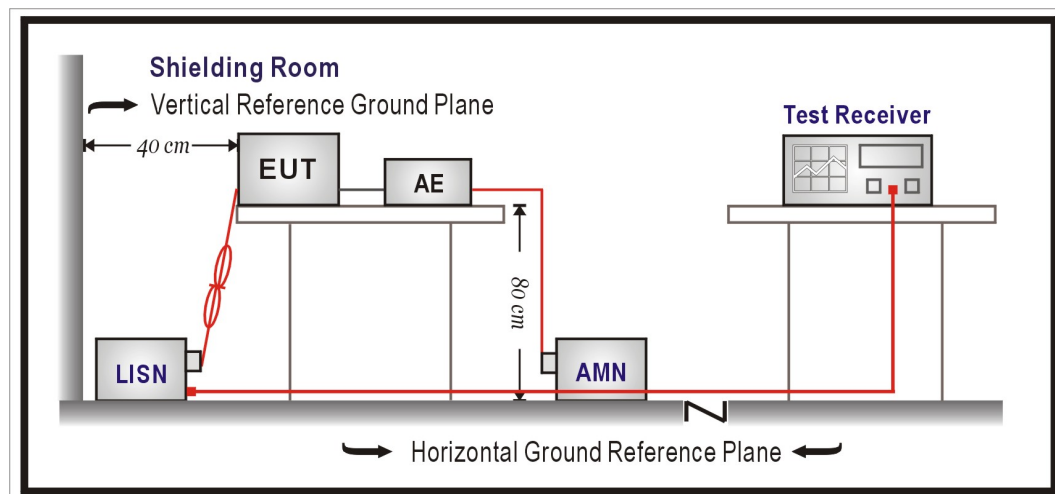
| No. | Equipment          | Brand Name | Model No. | Serial No. | Power Cord |
|-----|--------------------|------------|-----------|------------|------------|
| 1   | Notebook PC        | Lenovo     | TP00135A  | RF-3ZD0E9  | N/A        |
| 2   | Breakout USB board | N/A        | N/A       | N/A        | N/A        |
| 3   | Battery            | BOSCH      | 60044     | N/A        | N/A        |

## 2.6. Configuration of tested System



### 3. AC Power Line Conducted Emission

#### 3.1. Test Setup



#### 3.2. Test Limit

| Frequency (MHz) | QP (dBuV) | AV (dBuV) |
|-----------------|-----------|-----------|
| 0.15 - 0.50     | 66 - 56   | 56 - 46   |
| 0.50 - 5.0      | 56        | 46        |
| 5.0 - 30        | 60        | 50        |

Remarks: In the above table, the tighter limit applies at the band edges.

#### 3.3. Test Procedure

The EUT and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50 ohm /50 uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50 ohm /50 uH coupling impedance with 50ohm termination. (Please refer to the block diagram of the test setup and photographs.) Both sides of A.C. line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.

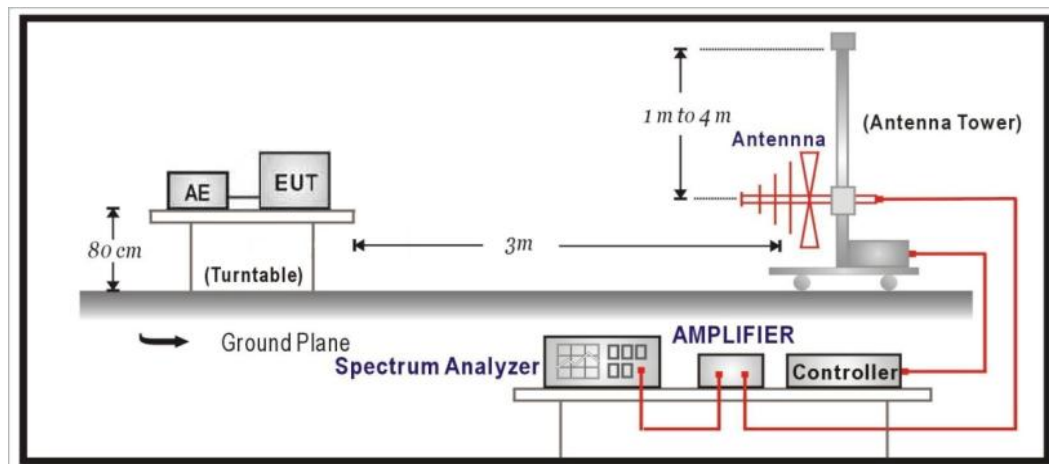
Conducted emissions were investigated over the frequency range from 0.15 MHz to 30 MHz using a receiver bandwidth of 9 kHz.

#### 3.4. Test Result of AC Power Line Conducted Emission

Refer as Appendix A

## 4. Occupied Bandwidth

### 4.1. Test Setup



### 4.2. Test Limit

Within the designated 76~81GHz frequency band.

### 4.3. Test Procedures

1. The signal analyzer's automatic bandwidth measurement capability was used to perform the 99 % occupied bandwidth and the 26 dB bandwidth. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2.  $RBW = 1 \sim 5 \%$  of the expected OBW &  $VBW \geq 3 \times RBW$ .
3. Detector = Peak.
4. Trance mode = Max hold.
5. Sweep = Auto couple.
6. The trace was allowed to stabilize.
7. If necessary, step 2 ~ 6 were repeated after changing the RBW such that it would be within 1 ~ 5 % of the 99 % occupied bandwidth observed in step 6.

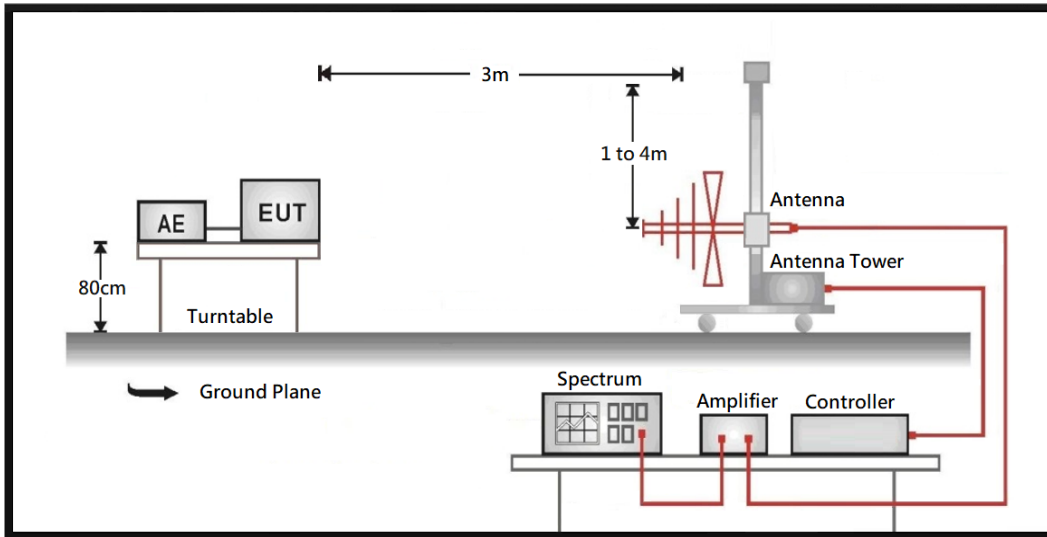
Note: The RBW and VBW were setting up to the limitations of the test equipment.

### 4.4. Test Result of Occupied Bandwidth

Refer as Appendix B

## 5. Maximum output power (EIRP)

### 5.1. Test Setup



### 5.2. Test Limit

76-81 GHz Band Radar Service radiated power limits.

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

- (a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).
- (b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

### 5.3. Test Procedures

Maximum power(EIRP) –Averaging detector

Note: The maximum power(averaging detector) measurements are performed using the “channel power” measurement capability and integrated over the 99% OBW to obtain the result.

1. Measurement capability of instrument = channel power
2. Set RBW = 1MHz
3. Set VBW  $\geq 3 \times$  RBW
4. span to 2 x to 3 x the OBW
5. Channel bandwidth setting of instrument  $\geq$ OBW
6. Detector = power averaging (rms)
7. Set number of points in sweep  $\geq 2 \times$  span / RBW
8. Sweep time=auto-couple
9. Trace = averaging

Maximum peak power(EIRP) –Peak detector

1. Set RBW = 1MHz
2. Set VBW  $\geq 3 \times$  RBW
3. span to 2 x to 3 x the OBW
4. Detector = Peak
5. Set number of points in sweep  $\geq 2 \times$  span / RBW
6. Sweep time=auto-couple
7. Trace = max-hold

Measuring the frequency range above 1GHz, the EUT is placed on a turn table which is 1.5 meter above ground.

The turn table is rotated 360 degrees to determine the position of the maximum emission level.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned between 1 meter and 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.26: 2015-Section 5.5 on radiated measurement.

The resolution bandwidth below 30MHz setting on the field strength meter is above 1GHz is 1MHz.

Radiated emission measurements above 1GHz are made using Horn Antennas.

The measurement is divided into the Preliminary Measurement and the Final Measurement.

The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna.

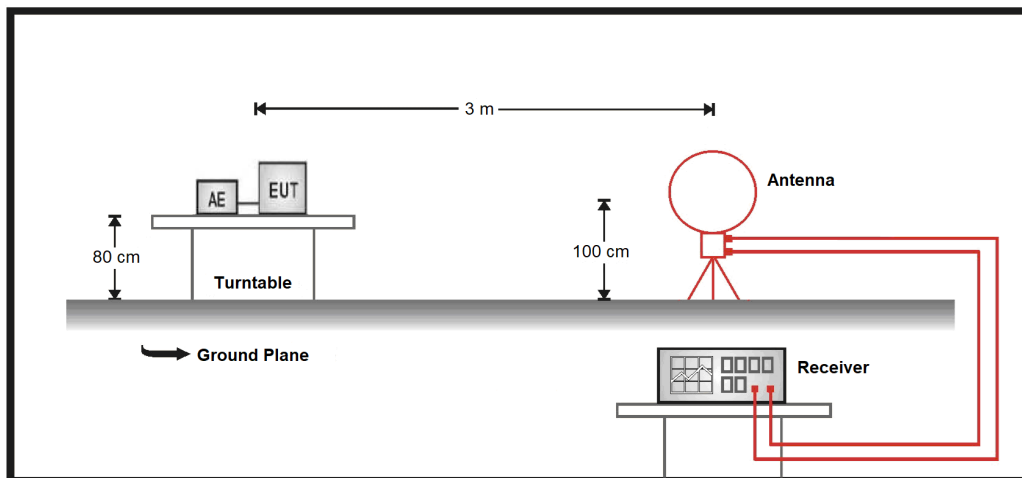
### 5.4. Test Result of Maximum output power (EIRP)

Refer as Appendix C

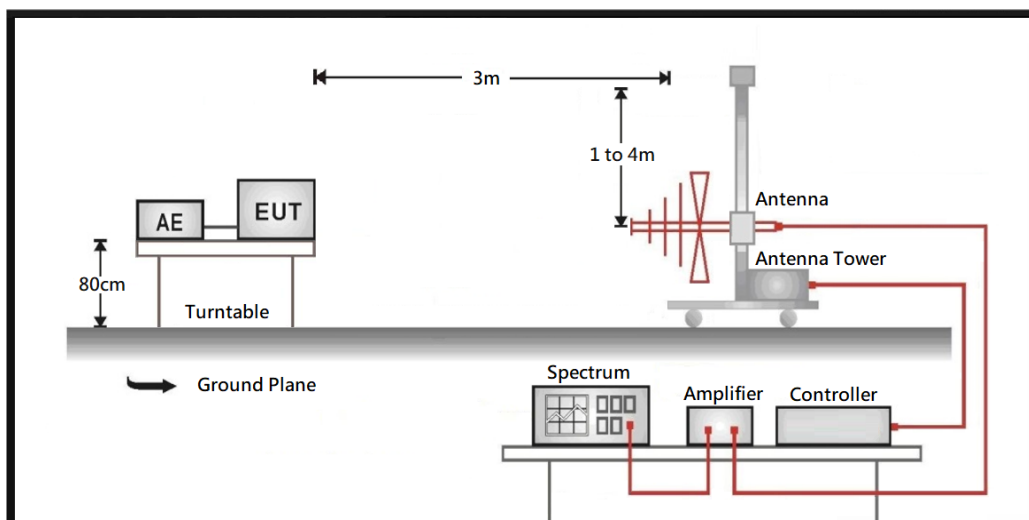
## 6. Radiated Emission

### 6.1. Test Setup

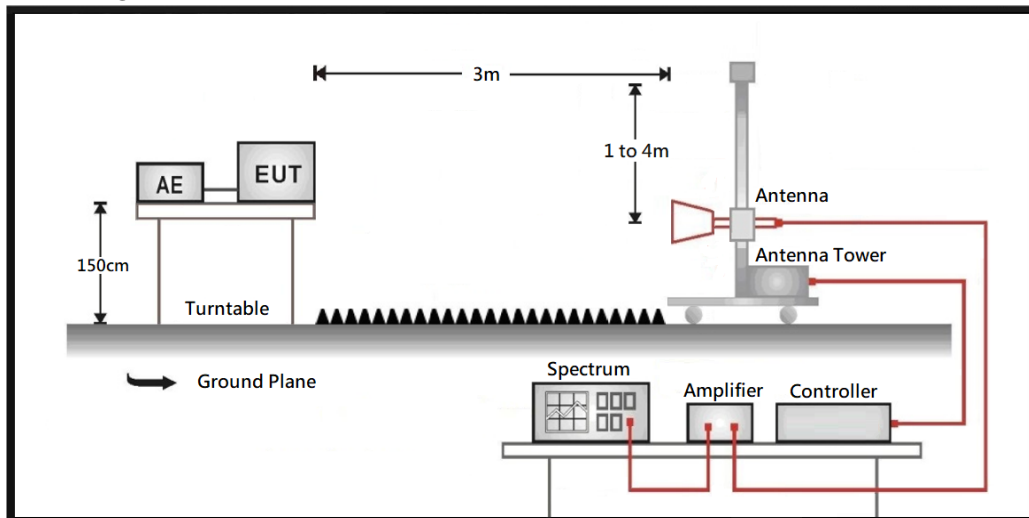
9 kHz ~ 30 MHz



30 MHz ~ 1 GHz



Above 1 GHz



## 6.2. Test Limit

| Frequency (MHz) | Field strength (uV/m) | Field strength (dBuV/m) | Measurement distance (m) |
|-----------------|-----------------------|-------------------------|--------------------------|
| 0.009 – 0.490   | 2400/F(kHz)           | 20 log (2400/F(kHz))    | 300                      |
| 0.490 – 1.705   | 24000/F(kHz)          | 20 log (24000/F(kHz))   | 30                       |
| 1.705 - 30      | 30                    | 29.5                    | 30                       |
| 30 - 88         | 100                   | 40                      | 3                        |
| 88 - 216        | 150                   | 43.5                    | 3                        |
| 216 - 960       | 200                   | 46                      | 3                        |
| Above 960       | 500                   | 54                      | 3                        |

Remarks:

1. Field strength (dBuV/m) = 20 log Field strength (uV/m)
2. In the Above Table, the tighter limit applies at the band edges.
3. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

- (i) In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.
  - (ii) The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
  - (iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.
- (2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:
- (i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm<sup>2</sup> at a distance of 3 meters from the exterior surface of the radiating structure.
  - (ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm<sup>2</sup> at a distance of 3 meters from the exterior surface of the radiating structure.
- (3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

### 6.3. Test Procedure

Measuring the frequency range below 1GHz, the EUT is placed on a turn table which is 0.8 meter above ground, when measuring the frequency range above 1GHz, the EUT is placed on a turn table which is 1.5 meter above ground.

The turn table is rotated 360 degrees to determine the position of the maximum emission level.

The EUT was positioned such that the distance from antenna to the EUT was 3 meters.

The antenna is scanned between 1 meter and 4 meters to find out the maximum emission level. This is repeated for both horizontal and vertical polarization of the antenna. In order to find the maximum emission, all of the interface cables were manipulated according to ANSI C63.10: 2013 on radiated measurement.

The resolution bandwidth below 30MHz setting on the field strength meter is 9kHz and 30MHz~1GHz is 120kHz and above 1GHz is 1MHz.

Radiated emission measurements below 30MHz are made using Loop Antenna and 30MHz~1GHz are made using broadband Bilog antenna and above 1GHz are made using Horn Antennas.

The measurement is divided into the Preliminary Measurement and the Final Measurement.

The suspected frequencies are searched for in Preliminary Measurement with the measurement antenna kept pointed at the source of the emission both in azimuth and elevation, with the polarization of the antenna oriented for maximum response. The antenna is pointed at an angle towards the source of the emission, and the EUT is rotated in both height and polarization to maximize the measured emission. The emission is kept within the illumination area of the 3 dB bandwidth of the antenna.

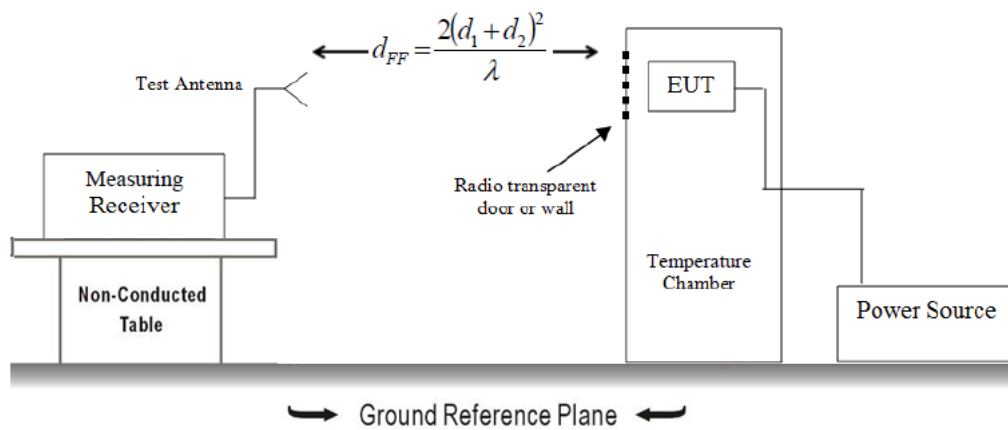
The measurement frequency range from 9kHz – 231GHz was investigated.

### 6.4. Test Result of Radiated Emissions

Refer as Appendix D

## 7. Frequency Stability

### 7.1. Test Setup



### 7.2. Limit

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation.

### **7.3. Test Procedure**

The carrier frequency of the transmitter is measured at room temperature. (20°C to provide a reference)

At 10 °C intervals of temperatures between –30 °C and +50 °C at the manufacturer's rated supply voltage, and At +20 °C temperature and  $\pm 15\%$  supply voltage variations. If a product is specified to operate over a range of input voltage then the –15% variation is applied to the lowermost voltage and the +15% is applied to the uppermost voltage.

Measurement data showing variation in transmitter output frequency from a cold start and the elapsed time necessary for the frequency to stabilize within the applicable tolerance. Tests shall be made after temperature stabilization at each of the ambient temperature levels; the lower temperature limit, 0° centigrade and + 30° centigrade with no primary power applied.

Beginning at each temperature level , the frequency shall be measured within one minute after application of primary power to the transmitter and at intervals of no more than one minute thereafter until ten minutes have elapsed or until sufficient measurements are obtained to indicate clearly that the frequency has stabilized within the applicable tolerance, whichever time period is greater. During each test, the ambient temperature shall not be allowed to rise more than 10° centigrade above the respective beginning ambient temperature level.

### **7.4. Test Result of Frequency Stability**

Refer as Appendix E