Testing Laboratory 3787

# RADIO TEST REPORT

| | | |
|---|---|---|
| FCC ID | : | 2AHXD-5301478 |
| Equipment | : | CarBack Radar |
| Brand Name | : | TREK |
| Model Name | : | 5301478 |
| Applicant | : | Trek Bicycle Corporation<br>801 W Madison St, Waterloo, WI 53594 |
| Manufacturer | : | Universal Microelectronics co.,LTD<br>3,27TH RD.,Taichung Industrial Park.Taichung, Taiwan |
| Standard | : | 47 CFR FCC Part 95M |

**The product was received on Jun. 19, 2023, and testing was started from Aug. 11, 2023 and completed on Nov. 01, 2023. We, Sporton International Inc. Hsinchu Laboratory, would like to declare that the tested sample has been evaluated in accordance with the procedures given in ANSI C63.10-2013 and shown compliance with the applicable technical standards.**

**The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. Hsinchu Laboratory, the test report shall not be reproduced except in full.**

**Approved by: Sam Chen**

***Sporton International Inc. Hsinchu Laboratory***
*No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)*

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# History of this test report

| Report No. | Version | Description | Issued Date |
|---|---|---|---|
| FR360116AA | 01 | Initial issue of report | Nov. 22, 2023 |
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# Summary of Test Result

| Report Clause | Ref Std. Clause | Test Items | Result (PASS/FAIL) | Remark |
|---|---|---|---|---|
| 3.1 | 95.303 | Occupied Bandwidth | PASS | - |
| 3.2 | 95.3367 | Radiated E.I.R.P Power | PASS | - |
| 3.3 | 95.3379 | Transmitter Radiated Unwanted Emissions | PASS | - |
| 3.4 | 95.3379 | Frequency Stability | PASS | - |

**Conformity Assessment Condition:**

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the chapter "Measurement Uncertainty".

**Disclaimer:**

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

**Reviewed by: Sam Chen**
**Report Producer: Sophia Shiung**

# 1 General Description

## 1.1 Information

### 1.1.1 RF General Information

| RF General Information | | | |
|---|---|---|---|
| **Frequency Range (GHz)** | **Operating Frequency Range (GHz)** | **Test Frequency (GHz)** | **Modulation** |
| 76-81 | 76.15-76.31 | 76.2315 | FMCW |

### 1.1.2 Antenna Information

| Ant. | Port | | | Brand | Model Name | Antenna Type | Connector | Gain (dBi) |
|---|---|---|---|---|---|---|---|---|
| | Bluetooth / ANT plus | 76~81GHz | | | | | | |
| | | TX | RX | | | | | |
| 1 | - | 1~3 | 1~6 | UMEC | S78* | Patch | N/A | 11.2 |
| 2 | 1 | - | - | JOHANSON | 2450AT18D0100E | Chip | N/A | 1.5 |

Note 1: The above information was declared by manufacturer.

Note 2: The Bluetooth and ANT plus cannot function at the same time.

Note 3: **For Bluetooth function (1TX/1RX):**

Only Port 1 can be used as transmitting/receiving antenna.

**For ANT plus function (1TX/1RX):**

Only Port 1 can be used as transmitting/receiving antenna.

**For 76~81GHz function (3TX/6RX):**

Port 1~3 can be used as transmitting antenna.

Port 1~3 could transmit simultaneously.

Port 1~6 can be used as receiving antenna.

Port 1~6 could receive simultaneously.

### 1.1.3 EUT Operational Condition

| | | | | |
|---|---|---|---|---|
| **EUT Power Type** | From Battery or Host system | | | |
| **Supply Voltage** | ☐ | AC | State AC voltage | - |
| **Supply Voltage** | ☒ | DC | State DC voltage | 5 |

### 1.1.4 Test Signal Duty Cycle

| Test Signal Duty Cycle |
|---|
| ☒ Continuous transmission – 0.6% |
| ☐ Transmissions occur regularly in time - …% |

## 1.2 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR FCC Part 95M
- ANSI C63.10 - Testing Unlicensed Wireless Devices
- KDB653005 D01 76-81 GHz Radars v01r02

The following reference test guidance is not within the scope of accreditation of TAF.

- FCC KDB 414788 D01 v01r01

## 1.3 Testing Location Information

| Testing Location Information | |
|---|---|
| Test Lab.：Sporton International Inc. Hsinchu Laboratory | |
| Hsinchu (TAF: 3787) | ADD: No.8, Ln. 724, Bo'ai St., Zhubei City, Hsinchu County 302010, Taiwan (R.O.C.)<br>TEL: 886-3-656-9065 FAX: 886-3-656-9085<br>Test site Designation No. TW3787 with FCC.<br>Conformity Assessment Body Identifier (CABID) TW3787 with ISED. |

| Test Condition | Test Site No. | Test Engineer | Test Environment (°C / %) | Test Date |
|---|---|---|---|---|
| Radiated – Frequency Stability | TH03-CB | Gino Huang | 23.7~24.3 / 58~63 | Aug. 11, 2023 |
| Radiated < 1GHz – Other tests | 03CH04-CB | Gordon Hong | 22.4~23.5 / 55~58 | Aug. 11, 2023~ Nov. 01, 2023 |
| Radiated > 1GHz – Other tests | 03CH01-CB | Chris Lee | 21.7~22.9 / 58~62 | Aug. 11, 2023~ Oct. 13, 2023 |
| | 03CH03-CB | | 22~22.9 / 59~61 | |

## 1.4 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated 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 Items | Uncertainty | Remark |
|---|---|---|
| Radiated Emission (9kHz ~ 30MHz) | 3.7 dB | Confidence levels of 95% |
| Radiated Emission (30MHz ~ 1,000MHz) | 5.1 dB | Confidence levels of 95% |
| Radiated Emission (1GHz ~ 18GHz) | 4.1 dB | Confidence levels of 95% |
| Radiated Emission (18GHz ~ 40GHz) | 4.2 dB | Confidence levels of 95% |
| Radiated Emission (40GHz ~ 60GHz) | 3.0 dB | Confidence levels of 95% |
| Radiated Emission (60GHz ~ 90GHz) | 3.0 dB | Confidence levels of 95% |
| Radiated Emission (90GHz ~ 200GHz) | 4.3 dB | Confidence levels of 95% |
| Radiated Emission (200GHz ~ 280GHz) | 5.0 dB | Confidence levels of 95% |
| Temperature | 1.3°C | Confidence levels of 95% |

# 2 Test Configuration of EUT

## 2.1 Test Channel Frequencies Configuration

| Test Software Version | nRF Connect Version 4.26. |
|---|---|
| Test Frequencies (GHz) | 76.2315 |
| Software Setting | Default |

## 2.2 Conformance Tests and Related Test Frequencies

| Test Item | Test Frequencies (GHz) |
|---|---|
| Occupied Bandwidth | 76.2315 |
| Radiated E.I.R.P Power | 76.2315 |
| Transmitter Spurious Emissions (below 1 GHz) | Random |
| Transmitter Spurious Emissions (1 GHz-40 GHz) | 76.2315 |
| Transmitter Spurious Emissions (above 40 GHz) | 76.2315 |
| Frequency Stability | 76.2315 |

## 2.3 The Worst Case Measurement Configuration

| The Worst Case Mode for Following Conformance Tests | |
|---|---|
| **Tests Item** | Occupied Bandwidth<br>Radiated E.I.R.P Power<br>Frequency Stability |
| **Test Condition** | Radiated measurement |
| **Operating Mode** | CTX |
| | After evaluating, EUT in Y axis was the worst case, so the measurement will follow this same test configuration. |
| 1 | EUT in Y axis |

| The Worst Case Mode for Following Conformance Tests | |
|---|---|
| **Tests Item** | Transmitter Radiated Unwanted Emissions |
| **Test Condition** | Radiated measurement |
| **Operating Mode < 1GHz** | Normal link |
| | After evaluating, EUT in Y axis was the worst case, so the measurement will follow this same test configuration. |
| 1 | EUT in Y axis_76~81GHz + ANT plus (Powered by Host system) |
| 2 | EUT in Y axis_76~81GHz + ANT plus (Powered by Adapter) |
| 3 | EUT in Y axis_76~81GHz + ANT plus (Powered by Battery) |

| | |
|---|---|
| Mode 1 has been evaluated to be the worst case among Mode 1~3, thus measurement for Mode 4 will follow this same test mode. | |
| 4 | EUT in Y axis_76~81GHz + Bluetooth (Powered by Host system) |
| For operating, mode 4 is the worst case and it was record in this test report. | |
| **Operating Mode > 1GHz** | CTX |
| | After evaluating, EUT in Y axis was the worst case, so the measurement will follow this same test configuration. |
| 1 | EUT in Y axis |

| **The Worst Case Mode for Following Conformance Tests** | |
|---|---|
| **Tests Item** | Simultaneous Transmission Analysis - Co-location RF Exposure Evaluation |
| **Operating Mode** | |
| 1 | 76~81GHz + Bluetooth |
| 2 | 76~81GHz + ANT plus |
| Refer to Sporton Test Report No.: FA360116 for Co-location RF Exposure Evaluation. | |

Note: The adapter was for measurement only and would not be marketed. Its information is shown as below:

| Equipment | Brand Name | Model Name |
|---|---|---|
| Adapter | XIAOMI | MDY-09-EA |

## 2.4 EUT Operation during Test

**For CTX Mode:**

The EUT was programmed to be in continuously transmitting mode.

**For Normal Link Mode:**

During the test, the EUT operation to normal function.

## 2.5 Accessories

| **Accessories** |
|---|
| USB cable*1: Shielded, 1.5m |
| Lithium-ion battery*1 |

## 2.6 Support Equipment

**For Radiated < 1GHz (Other tests):**

| Support Equipment | | | | |
|---|---|---|---|---|
| **No.** | **Equipment** | **Brand Name** | **Model Name** | **FCC ID** |
| A | NB | DELL | E4300 | N/A |
| B | Smart phone | Nokia | TA-1062 | N/A |
| C | Earphone | SHYARO CHI | MIC-04 | N/A |
| D | Mouse | Logitech | M-U0026 | N/A |

**For Radiated (Frequency Stability) and Radiated > 1GHz (Other tests):**

| Support Equipment | | | | |
|---|---|---|---|---|
| **No.** | **Equipment** | **Brand Name** | **Model Name** | **FCC ID** |
| A | Notebook | DELL | E4300 | N/A |

## 2.7 Far Field Boundary Calculations

The far-field boundary is given as:

far field = (2 * L^2) /λ

where:

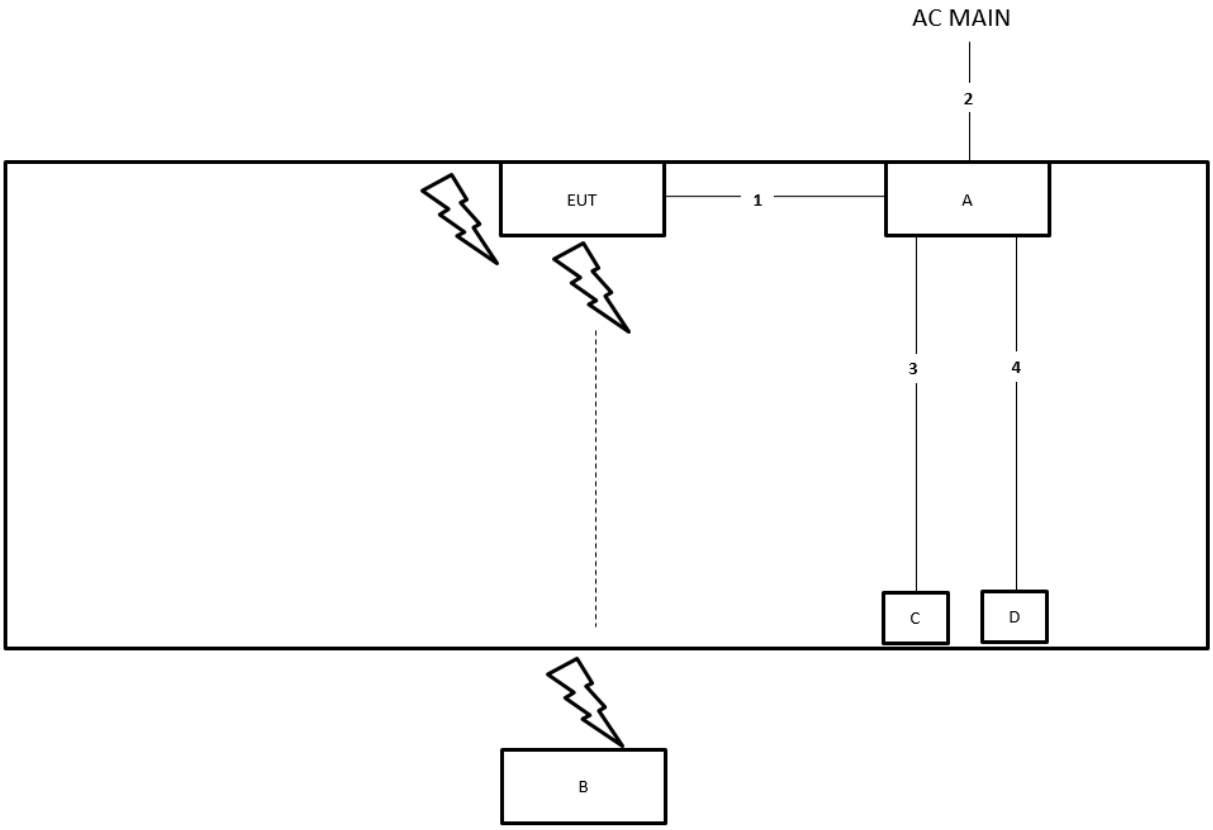
L = Largest Antenna Dimension, including the reflector, in meters

λ= wavelength in meters

| Far Field (m) | | | | |
|---|---|---|---|---|
| **Frequency (GHz)** | **L (m)** | **Lambda (m)** | **d(Far Field) (m)** | **d(Far Field) (cm)** |
| 76.2315 | 0.01314 | 0.0039354 | 0.088 | 8.77 |

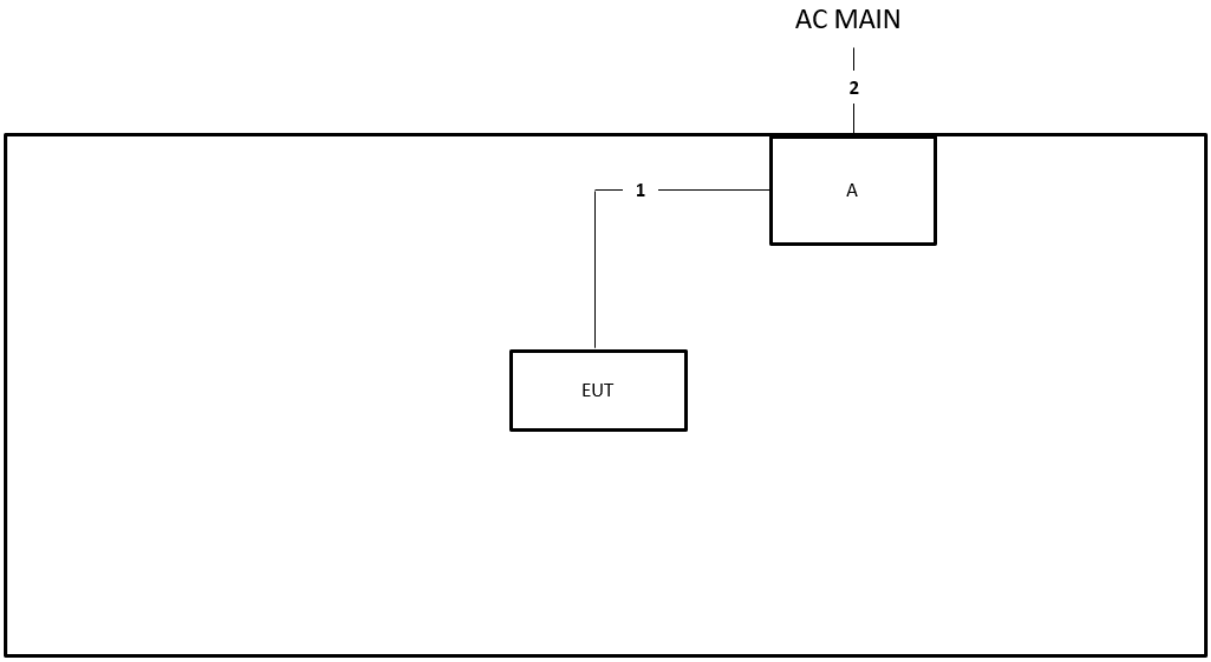
## 2.8 Test Setup Diagram

**Test Setup Diagram - Radiated Test < 1GHz**
**Operating Mode: Normal link**




| Item | Connection | Shielded | Length |
|---|---|---|---|
| 1 | USB cable | Yes | 1.5m |
| 2 | Power cable | No | 1.2m |
| 3 | Audio cable | No | 1.2m |
| 4 | USB cable | Yes | 1m |

**Test Setup Diagram - Radiated Test**
**Operating Mode: CTX**




| Item | Connection | Shielded | Length |
|---|---|---|---|
| 1 | USB cable | Yes | 1.5m |
| 2 | Power cable | No | 1.2m |

# 3 Transmitter Test Result

## 3.1 Occupied Bandwidth

### 3.1.1 Occupied Bandwidth (OBW) Limit

| Occupied Bandwidth (EBW) Limit |
|---|
| Information only |

### 3.1.2 Measuring Instruments

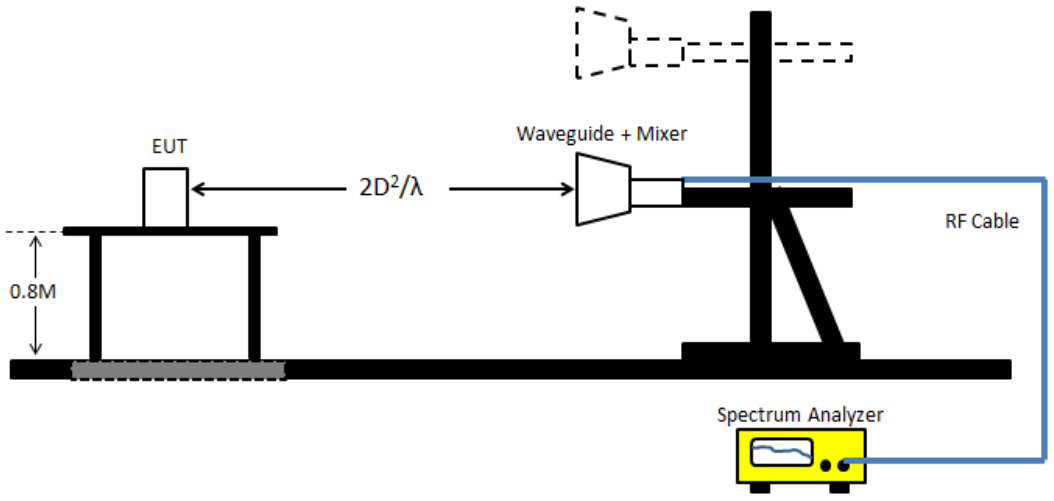
Refer a test equipment and calibration data table in this test report.

### 3.1.3 Test Procedures

| Test Method | |
|---|---|
| ☒ | For the Occupied bandwidth shall be measured using one of the options below: |
| | ☒ Refer as ANSI C63.10, clause 7.8.7 for EBW measurement. |
| | ☐ Refer as ANSI C63.10, clause 6.9.2 for occupied bandwidth testing. |
| ☒ | Refer as ANSI C63.10, clause 9 for radiated measurement. |
| | ☒ Radiated test was conducted at far-field distance. the distance from the radiating element of the EUT to the edge of the far field may be calculated from [$r \geq 2D^2/\lambda$]<br>r is the distance from the radiating element of the EUT to the edge of the far field, in m<br>D is the largest dimension of both the radiating element and the test antenna (horn), in m<br>λ is the wavelength of the emission under investigation [300/f (MHz)], in m |

### 3.1.4 Test Setup

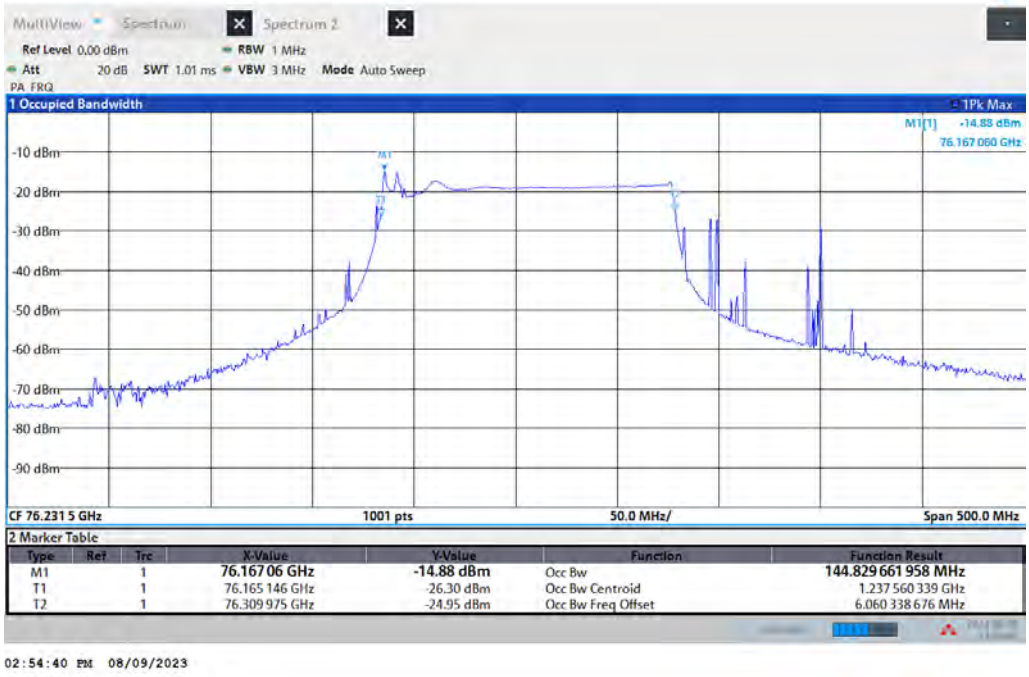
**Occupied Bandwidth**



### 3.1.5 Test Result of Occupied Bandwidth

| Test Results | | |
|---|---|---|
| **Test Freq. (GHz)** | **99% Occupied Bandwidth (MHz)** | **Limit (MHz)** |
| 76.2315 | 144.83 | N/A |

| Occupied Bandwidth Plots |
|---|
| **Test Frequency: 76.2315 GHz** |



# 3.2 Radiated E.I.R.P Power

## 3.2.1 Radiated E.I.R.P Power

| Radiated E.I.R.P Power | |
|---|---|
| ☒ | 76-81 GHz Band: |
| | ☒ Peak: EIRP 55 dBm [279uW/cm$^2$ at 3m]<br>Average: EIRP 50 dBm [88uW/cm$^2$ at 3m] |

## 3.2.2 Measuring Instruments

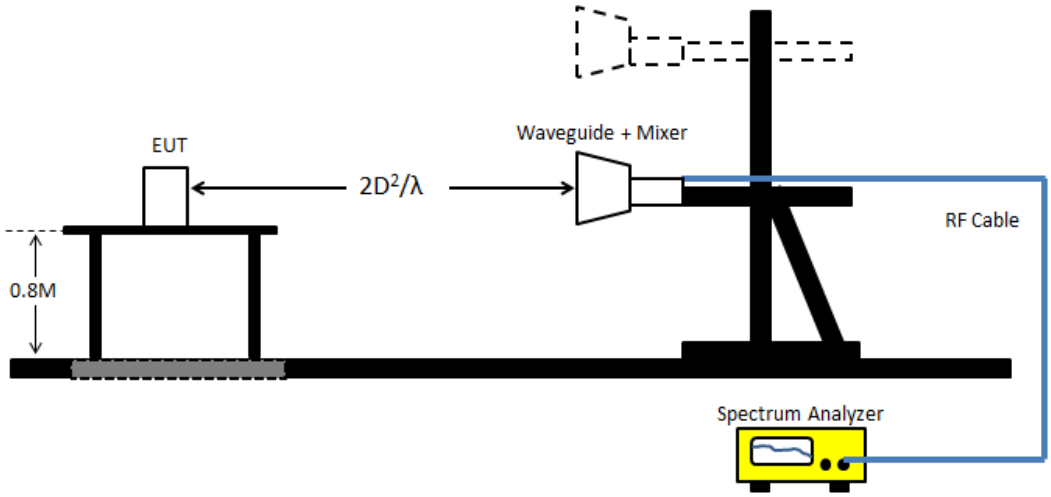
Refer a test equipment and calibration data table in this test report.

## 3.2.3 Test Procedures

| Test Method | |
|---|---|
| ☒ | For the Occupied bandwidth shall be measured using one of the options below: |
| ☒ | Refer as ANSI C63.10, clause 9 for radiated measurement. |
| | ☒ Radiated test was conducted at far-field distance. the distance from the radiating element of the EUT to the edge of the far field may be calculated from [$r \geq 2D^2/\lambda$]<br>r is the distance from the radiating element of the EUT to the edge of the far field, in m<br>D is the largest dimension of both the radiating element and the test antenna (horn), in m<br>λ is the wavelength of the emission under investigation [300/f (MHz)], in m |
| | ☒ The measured power level is converted to EIRP using the Friis equation:<br>E Meas = 126.8 - 20log(λ) + P – G<br><br>where<br>E is the field strength of the emission at the measurement distance, in dBμV/m<br>P is the power measured at the output of the test antenna, in dBm<br>λ is the wavelength of the emission under investigation [300/fMHz], in m<br>G is the gain of the test antenna, in dBi<br><br>EIRP = E Meas + 20 log(d Meas) – 104.7<br><br>where<br>EIRP : is the equivalent isotropically radiated power, in dBm.<br>E Meas : is the field strength of the emission at the measurement distance, in dBμV/m.<br>d Meas : is the measurement distance, in m. |

### 3.2.4 Test Setup

**Radiated E.I.R.P Power**




### 3.2.5 Measurement Results Calculation

The measured Level is calculated using:
EIRP = Read Level - Rx Gain +20*LOG(4*3.14159* Distance / (300/(Test Freq.*1000))).

### 3.2.6 Test Result of Radiated E.I.R.P Power

| Freq. (GHz) | Rx Gain (dBi) | P-Peak (dBm) | P-Average (dBm) | E-Meas-Peak (dBuV/m) | E-Meas-Average (dBuV/m) | Distance (m) | EIRP-Peak (dBm) | EIRP-Average (dBm) |
|---|---|---|---|---|---|---|---|---|
| 76.2315 | 23.9 | -14.4 | -38.87 | 136.60 | 112.13 | 0.50 | 25.78 | 1.31 |
| **EIRP Limit** | | | | | | | **55** | **50** |

# 3.3 Transmitter Radiated Unwanted Emissions

## 3.3.1 Transmitter Radiated Unwanted Emissions Limit

| Transmitter Radiated Unwanted Emissions Limit (Below 40 GHz) | | | |
|---|---|---|---|
| **Frequency Range (MHz)** | **Field Strength (uV/m)** | **Field Strength (dBuV/m)** | **Measure Distance (m)** |
| 0.009~0.490 | 2400/F(kHz) | 48.5 - 13.8 | 300 |
| 0.490~1.705 | 24000/F(kHz) | 33.8 - 23 | 30 |
| 1.705~30.0 | 30 | 29 | 30 |
| 30~88 | 100 | 40 | 3 |
| 88~216 | 150 | 43.5 | 3 |
| 216~960 | 200 | 46 | 3 |
| Above 960 - 40000 | 500 | 54 | 3 |

| Frequency Range (GHz) | EIRP (dBm) | Power Density ($pW/cm^2$ @ 3m) |
|---|---|---|
| 40 - 200 | -1.7 | 600 |
| 200 - 231 | 0.5 | 1000 |

## 3.3.2 Measuring Instruments

Refer a test equipment and calibration data table in this test report.

## 3.3.3 Test Procedures

| Test Method – General Information | | | |
|---|---|---|---|
| ☒ | For the transmitter unwanted emissions shall be measured using following options below: | | |
| | ☒ | Refer as ANSI C63.10, clause 6.3 for unwanted emissions into non-restricted bands. | |
| | ☒ | For unwanted emissions below 40GHz bands. | |
| | | ☒ | Radiated emissions below 40 GHz shall not exceed the general limits in LP0002 Section 2.8 |
| | | ☒ | Refer as ANSI C63.10, clause 4.1.4.2.3 (Video Averaging) average measurements using spectrum reduced video bandwidth (VBW≥10Hz) - [duty cycle ≥ 98 or external power trigger]. |
| | | ☐ | Refer as ANSI C63.10, clause 4.1.4.2.4 average value of pulsed emissions. |
| | | ☐ | Refer as ANSI C63.10, clause 4.1.4.2.2 measurement procedure peak limit. |

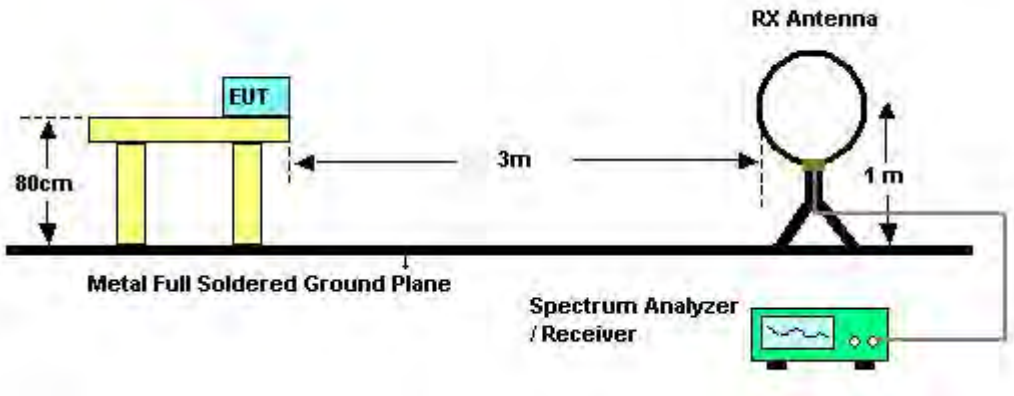
| Test Method | | |
|---|---|---|
| ☒ | For radiated measurement below 40GHz. | |
| | ☒ | Refer as ANSI C63.10, clause 6.3 through 6.6 for radiated emissions from below 40 GHz. |
| ☒ | For radiated measurement above 40GHz. Refer as ANSI C63.10, clause 9.12 for radiated measurement. | |
| | ☒ | Radiated test was conducted at far-field distance. the distance from the radiating element of the |

| Test Method | | |
|---|---|---|
| | | EUT to the edge of the far field may be calculated from [$r \geq 2D^2/\lambda$]<br>r is the distance from the radiating element of the EUT to the edge of the far field, in m<br>D is the largest dimension of both the radiating element and the test antenna (horn), in m<br>λ is the wavelength of the emission under investigation [300/f (MHz)], in m |
| | ☒ | The measured power level is converted to EIRP using the Friis equation:<br>E Meas = 126.8 - 20log(λ) + P – G<br><br>where<br>E is the field strength of the emission at the measurement distance, in dBμV/m<br>P is the power measured at the output of the test antenna, in dBm<br>λ is the wavelength of the emission under investigation [300/fMHz], in m<br>G is the gain of the test antenna, in dBi |
| | | EIRP = E Meas + 20 log(d Meas) – 104.7<br><br>where<br>EIRP : is the equivalent isotropically radiated power, in dBm.<br>E Meas : is the field strength of the emission at the measurement distance, in dBμV/m.<br>d Meas : is the measurement distance, in m. |
| | | Equations to calculate power density<br>Calculate the power density at the distance specified by the limit from the EIRP in watts using Equation:<br>$PD = \frac{EIRP_{Linear}}{4\pi d^2}$<br>where<br>PD is the power density at the distance specified by the limit, in W/m2<br>EIRPLinear is the equivalent isotropically radiated power, in watts<br>d is the distance at which the power density limit is specified, in m. |

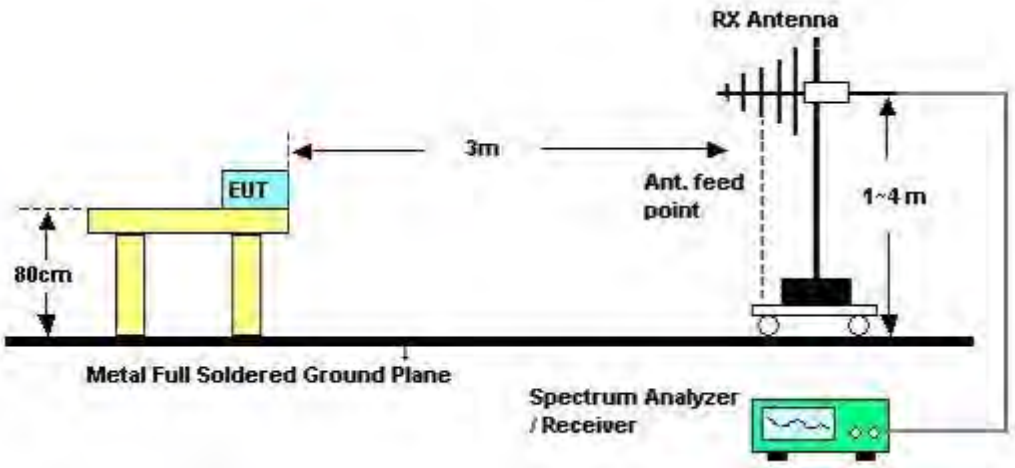
## 3.3.4 Test Setup

**Transmitter Radiated Unwanted Emissions**

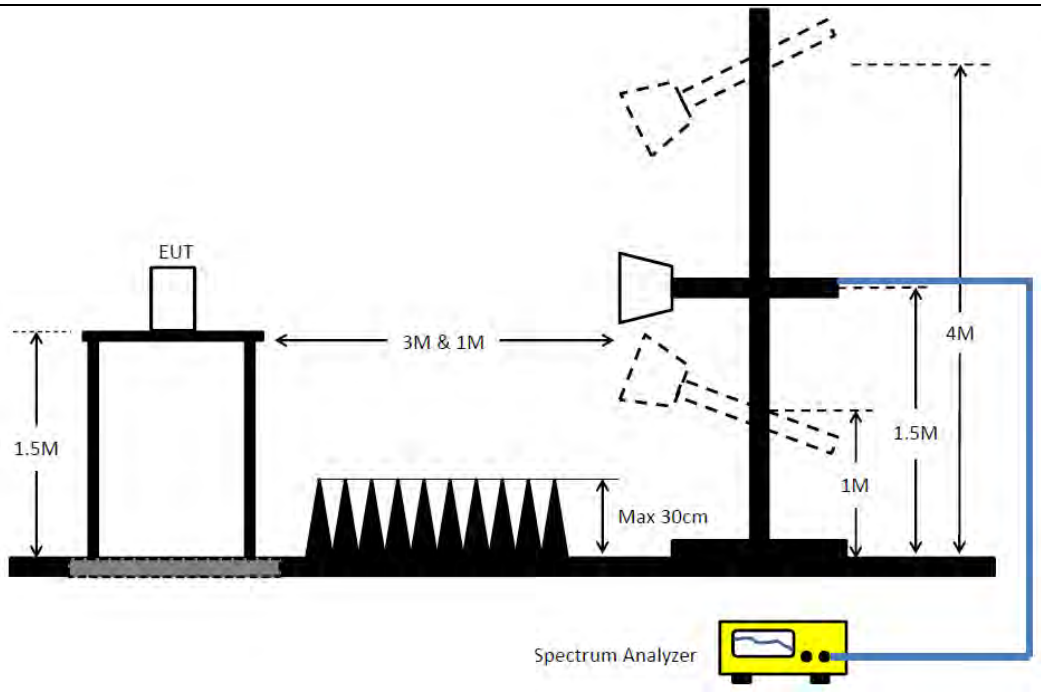
**9kHz ~30MHz**



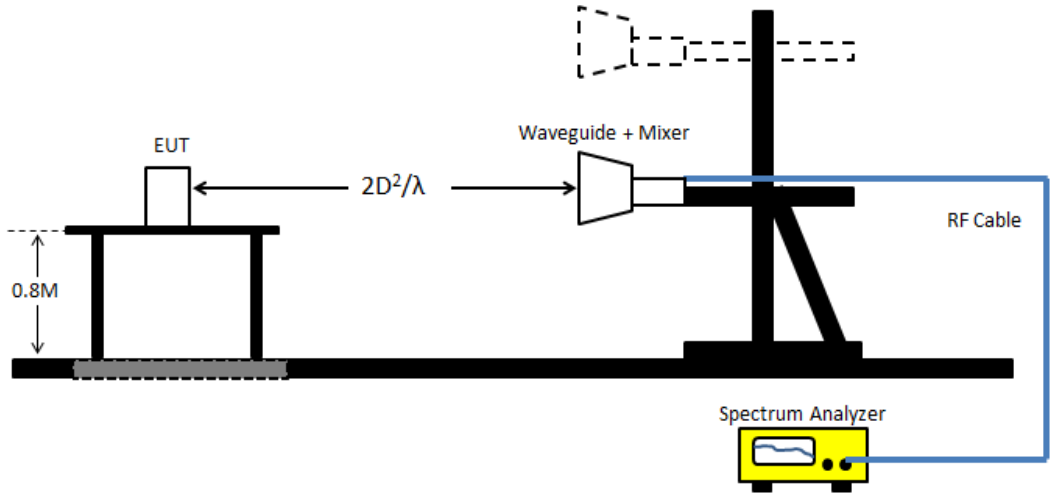
**30MHz~1GHz**




**1GHz ~40GHz**



**Above 40GHz**




### 3.3.5 Measurement Results Calculation

The measured Level is calculated using:
For below 40GHz
Corrected Reading: Antenna factor (AF) + Cable loss (CL) + Read level (Raw) - Preamp factor (PA)(if applicable) = Level.
For above 40GHz
EIRP = Read Level - Rx Gain +20*LOG(4*3.14159* Distance / (300/(Test Freq.*1000))).
Power Density = ((10^(EIRP/10)/1000)/(4*3.14159*(Specification Distance *100)^2))*1000000000000.

### 3.3.6 Test Result of Transmitter Radiated Unwanted Emissions (Below 30MHz)

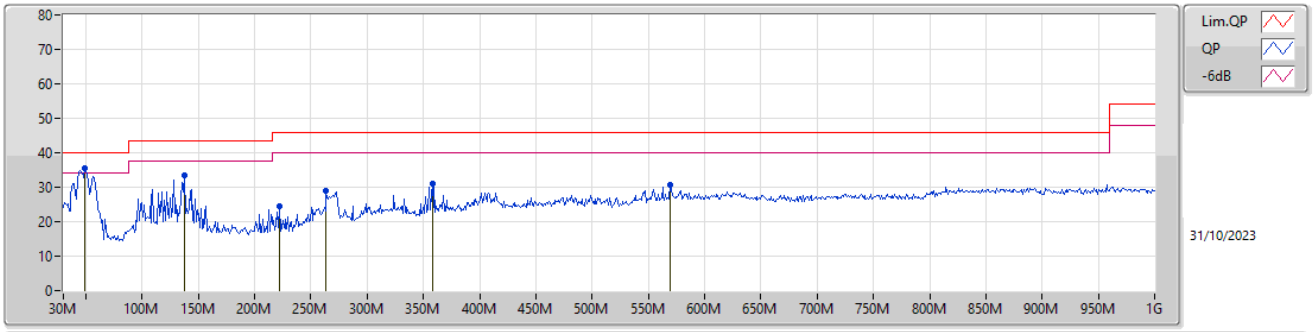
There is a comparison data of both open-field test site and alternative test site - semi-Anechoic chamber according to KDB414788 Radiated Test Site, and the result came out very similar.
All amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.
The radiated emissions were investigated from 9 kHz or the lowest frequency generated within the device, up to the 10 harmonic or 40 GHz, whichever is appropriate.

### 3.3.7 Test Result of Transmitter Radiated Unwanted Emissions (30MHz ~ 1GHz)

| Test Range | 30 MHz – 1 GHz |
|---|---|

***Vertical***

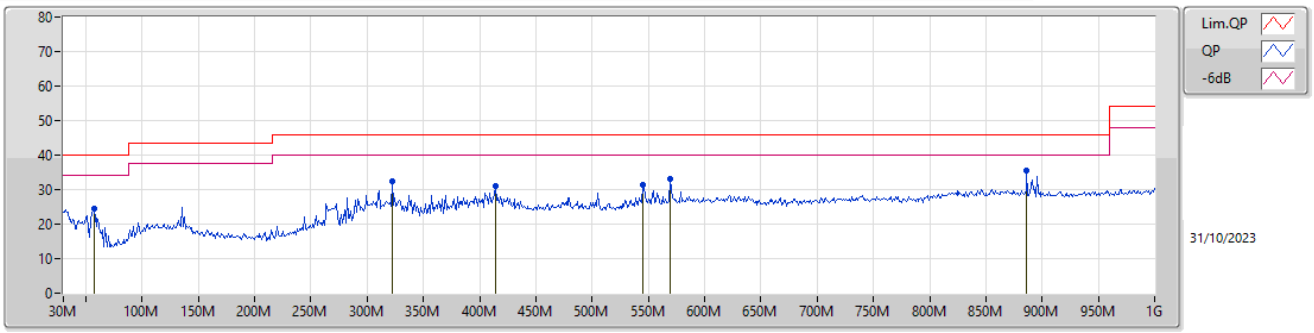
**Mode 4**




| Type | Freq | Level | Limit | Margin | Factor | Dist | Condition | Azimuth | Height | Comment | Raw | AF | CL | PA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Hz) | (dBuV/m) | (dBuV/m) | (dB) | (dB/m) | (m) | | (°) | (m) | | (dBuV/m) | (dB/m) | (dB) | (dB) |
| PK | 49.4M | 35.50 | 40.00 | -4.50 | -16.86 | 3 | Vertical | 299 | 1.00 | "Worst" | 52.36 | 14.16 | 0.53 | 31.55 |
| PK | 137.67M | 33.58 | 43.50 | -9.92 | -12.74 | 3 | Vertical | 6 | 1.25 | - | 46.32 | 18.00 | 1.07 | 31.81 |
| PK | 222.06M | 24.32 | 46.00 | -21.68 | -14.95 | 3 | Vertical | 130 | 1.00 | - | 39.27 | 15.49 | 1.35 | 31.79 |
| PK | 263.77M | 28.80 | 46.00 | -17.20 | -11.26 | 3 | Vertical | 164 | 2.00 | - | 40.06 | 19.03 | 1.52 | 31.81 |
| PK | 357.86M | 31.04 | 46.00 | -14.96 | -9.50 | 3 | Vertical | 3 | 2.00 | - | 40.54 | 20.51 | 1.81 | 31.82 |
| PK | 569.32M | 30.62 | 46.00 | -15.38 | -5.20 | 3 | Vertical | 31 | 2.90 | - | 35.82 | 24.58 | 2.36 | 32.14 |

***Horizontal***

**Mode 4**




| Type | Freq | Level | Limit | Margin | Factor | Dist | Condition | Azimuth | Height | Comment | Raw | AF | CL | PA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Hz) | (dBuV/m) | (dBuV/m) | (dB) | (dB/m) | (m) | | (°) | (m) | | (dBuV/m) | (dB/m) | (dB) | (dB) |
| PK | 57.16M | 24.43 | 40.00 | -15.57 | -18.25 | 3 | Horizontal | 334 | 3.00 | - | 42.68 | 12.89 | 0.57 | 31.71 |
| PK | 321.97M | 32.33 | 46.00 | -13.67 | -10.66 | 3 | Horizontal | 154 | 1.00 | - | 42.99 | 19.44 | 1.72 | 31.82 |
| PK | 414.12M | 31.08 | 46.00 | -14.92 | -7.74 | 3 | Horizontal | 115 | 1.00 | - | 38.82 | 22.27 | 2.00 | 32.01 |
| PK | 545.07M | 31.39 | 46.00 | -14.61 | -4.95 | 3 | Horizontal | 225 | 2.00 | - | 36.34 | 24.87 | 2.31 | 32.13 |
| PK | 569.32M | 33.19 | 46.00 | -12.81 | -5.20 | 3 | Horizontal | 3 | 1.00 | - | 38.39 | 24.58 | 2.36 | 32.14 |
| PK | 886.51M | 35.62 | 46.00 | -10.38 | -2.70 | 3 | Horizontal | 95 | 1.00 | "Worst" | 38.32 | 26.50 | 3.03 | 32.23 |

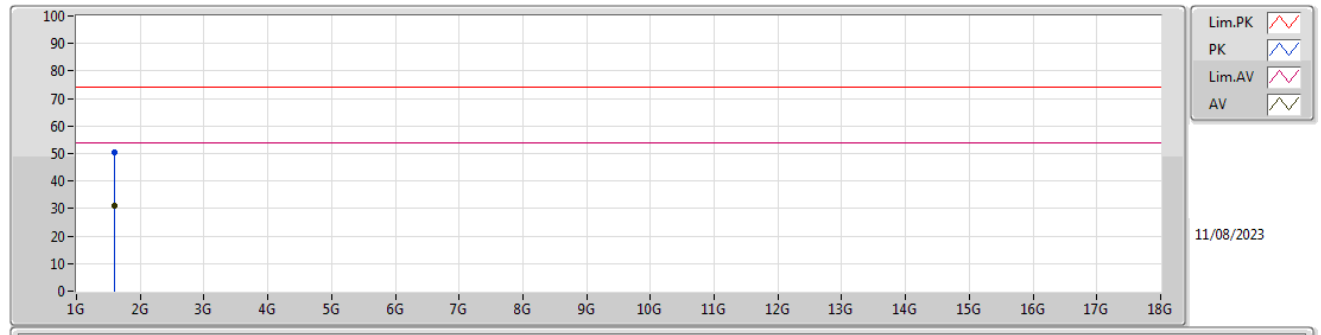
Note 1: “>20dB” means spurious emission levels that exceed the level of 20 dB below the applicable limit.
Note 2: “N/F” means Nothing Found spurious emissions (No spurious emissions were detected.)

### 3.3.8 Test Result of Transmitter Radiated Unwanted Emissions (1GHz – 40GHz)

| Test Range | 1 GHz – 18 GHz |
|---|---|

***Vertical***

**Mode 1**

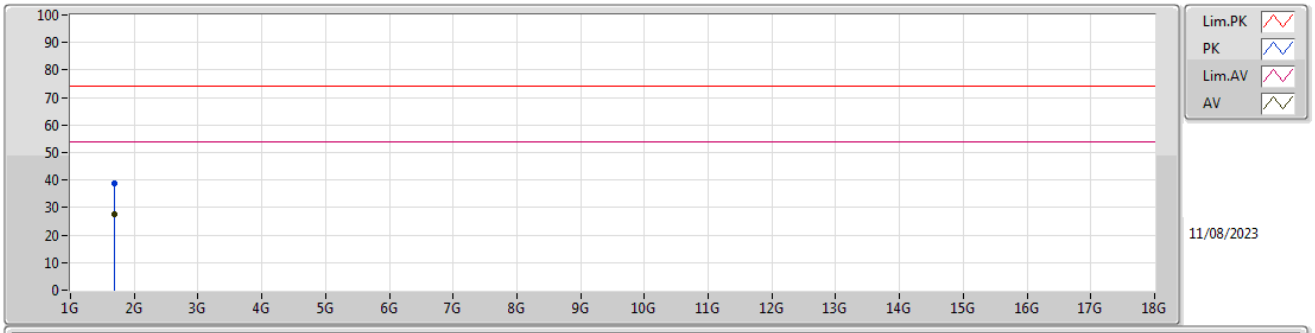



EUT Y_1TX
Setting Default
03-I-W-4

| Type | Freq | Level | Limit | Margin | Factor | Dist | Condition | Azimuth | Height | Comment | Raw | AF | CL | PA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Hz) | (dBuV/m) | (dBuV/m) | (dB) | (dB/m) | (m) | | (°) | (m) | | (dBuV/m) | (dB/m) | (dB) | (dB) |
| PK | 1.59855G | 50.51 | 74.00 | -23.49 | -5.43 | 3 | Vertical | 212 | 2.30 | - | 55.94 | 25.49 | 3.70 | 34.62 |
| AV | 1.59715G | 30.91 | 54.00 | -23.09 | -5.45 | 3 | Vertical | 212 | 2.30 | "Worst" | 36.36 | 25.47 | 3.70 | 34.62 |

***Horizontal***

**Mode 1**



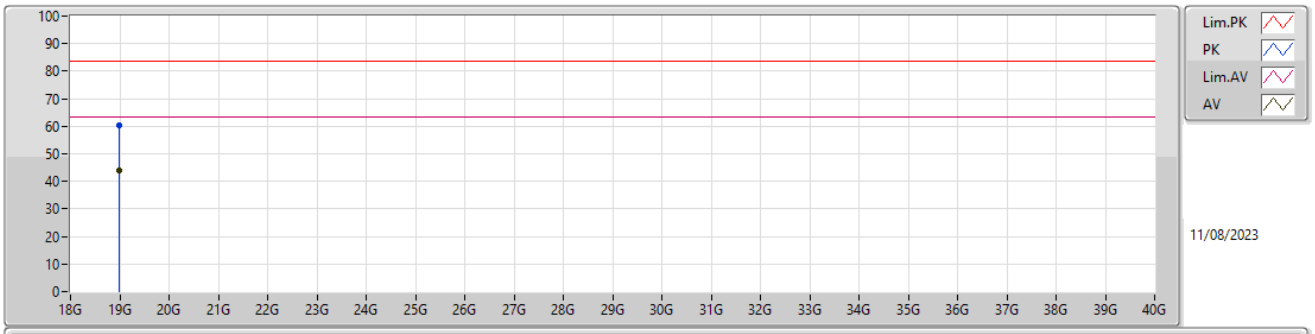

EUT Y_1TX
Setting Default
03-I-W-4

| Type | Freq | Level | Limit | Margin | Factor | Dist | Condition | Azimuth | Height | Comment | Raw | AF | CL | PA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Hz) | (dBuV/m) | (dBuV/m) | (dB) | (dB/m) | (m) | | (°) | (m) | | (dBuV/m) | (dB/m) | (dB) | (dB) |
| PK | 1.69675G | 38.59 | 74.00 | -35.41 | -4.58 | 3 | Horizontal | 45 | 2.47 | - | 43.17 | 26.27 | 3.80 | 34.65 |
| AV | 1.6948G | 27.41 | 54.00 | -26.59 | -4.59 | 3 | Horizontal | 45 | 2.47 | "Worst" | 32.00 | 26.26 | 3.79 | 34.64 |

| Test Range | 18 GHz – 40 GHz |
|---|---|

***Vertical***

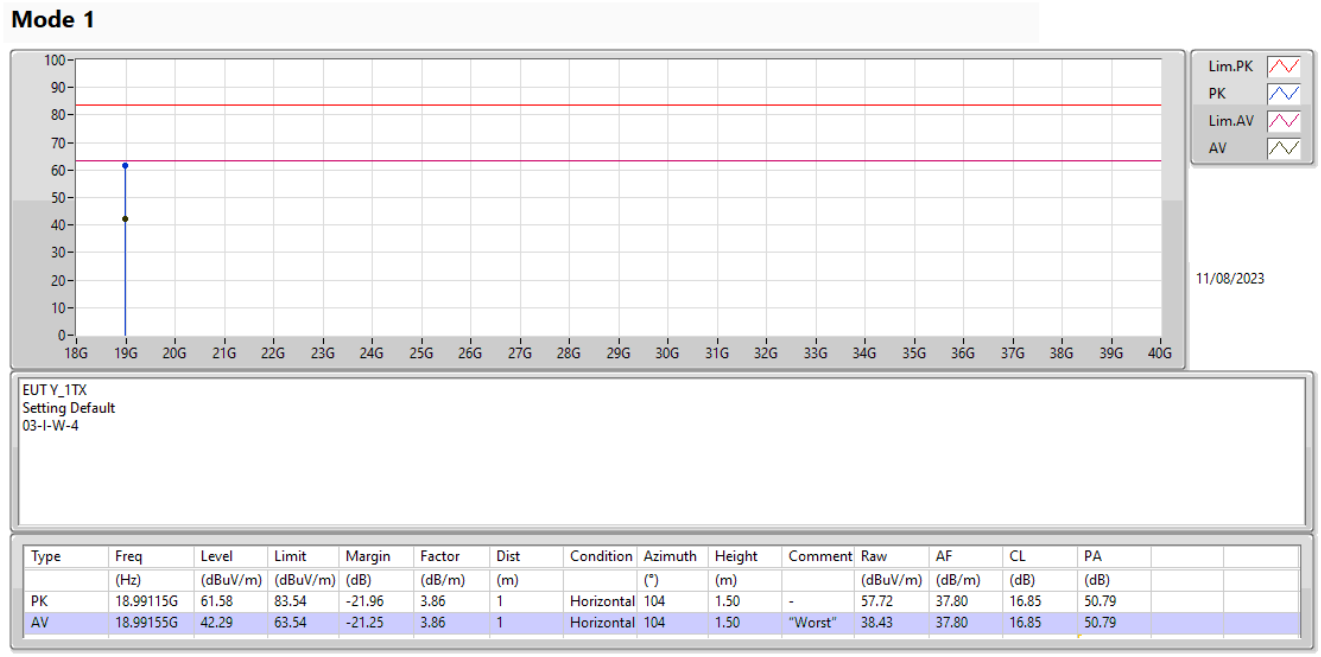
**Mode 1**




EUT Y_1TX
Setting Default
03-I-W-4

| Type | Freq | Level | Limit | Margin | Factor | Dist | Condition | Azimuth | Height | Comment | Raw | AF | CL | PA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Hz) | (dBuV/m) | (dBuV/m) | (dB) | (dB/m) | (m) | | (°) | (m) | | (dBuV/m) | (dB/m) | (dB) | (dB) |
| PK | 18.98225G | 60.51 | 83.54 | -23.03 | 3.85 | 1 | Vertical | -0 | 1.50 | - | 56.66 | 37.79 | 16.84 | 50.78 |
| AV | 18.98022G | 43.95 | 63.54 | -19.59 | 3.85 | 1 | Vertical | -0 | 1.50 | "Worst" | 40.10 | 37.79 | 16.84 | 50.78 |

***Horizontal***




| Type | Freq | Level | Limit | Margin | Factor | Dist | Condition | Azimuth | Height | Comment | Raw | AF | CL | PA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (Hz) | (dBuV/m) | (dBuV/m) | (dB) | (dB/m) | (m) | | (°) | (m) | | (dBuV/m) | (dB/m) | (dB) | (dB) |
| PK | 18.99115G | 61.58 | 83.54 | -21.96 | 3.86 | 1 | Horizontal | 104 | 1.50 | - | 57.72 | 37.80 | 16.85 | 50.79 |
| AV | 18.99155G | 42.29 | 63.54 | -21.25 | 3.86 | 1 | Horizontal | 104 | 1.50 | "Worst" | 38.43 | 37.80 | 16.85 | 50.79 |

Note 1: “>20dB” means spurious emission levels that exceed the level of 20 dB below the applicable limit.
Note 2: “N/F” means Nothing Found spurious emissions (No spurious emissions were detected.)

### 3.3.9 Test Result of Transmitter Radiated Unwanted Emissions (40GHz – 200GHz)

| Test Freq. (GHz) | Rx Gain (dBi) | Distance (m) | Read Worse Frequency (GHz) | Read Level (dBm) | EIRP (dBm) | Specification Distance (m) | Power Density (pW/cm^2) | Test Result |
|---|---|---|---|---|---|---|---|---|
| 76.2315 | 23.2 | 0.50 | 61.35 | -84 | -45.02 | 3 | 0.0278 | PASS |
| **Limit** | | | | | | | **600** | - |

### 3.3.10 Test Result of Transmitter Radiated Unwanted Emissions (200GHz – 231GHz)

| Test Freq. (GHz) | Rx Gain (dBi) | Distance (m) | Read Worse Frequency (GHz) | Read Level (dBm) | EIRP (dBm) | Specification Distance (m) | Power Density (pW/cm^2) | Test Result |
|---|---|---|---|---|---|---|---|---|
| 76.2315 | 24.2 | 0.50 | 219.36 | -99.21 | -50.17 | 3 | 0.0085 | PASS |
| **Limit** | | | | | | | **1000** | - |

# 3.4 Frequency Stability

## 3.4.1 Frequency Stability Limit

| Frequency Stability Limit |
|---|
| Fundamental emissions must be contained within the frequency bands specified in this 76-81GHz band during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage. |

## 3.4.2 Measuring Instruments

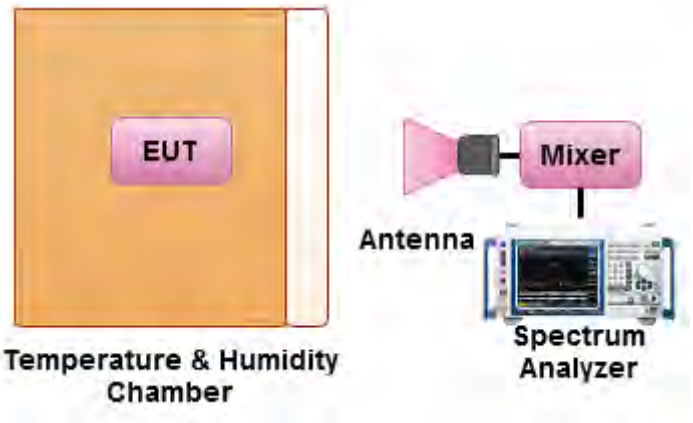
Refer a test equipment and calibration data table in this test report.

## 3.4.3 Test Procedures

| Test Method | |
|---|---|
| ☒ | For the frequency stability shall be measured using one of the options below: |
| | ☒ Refer as ANSI C63.10, clause 9.14 for frequency stability measurement. |
| ☒ | Refer as ANSI C63.10, clause 9 for radiated measurement. |
| | ☒ Radiated test was conducted at far-field distance. the distance from the radiating element of the EUT to the edge of the far field may be calculated from [$r \geq 2D^2/\lambda$]<br>r is the distance from the radiating element of the EUT to the edge of the far field, in m<br>D is the largest dimension of both the radiating element and the test antenna (horn), in m<br>λ is the wavelength of the emission under investigation [300/f (MHz)], in m |
| | ☒ The mixer may be placed outside the chamber in front of the temperature chamber door, and the chamber door opened for each reading. |

## 3.4.4 Test Setup

**Frequency Stability**



### 3.4.5 Test Result of Frequency Stability

**Test Freq. (GHz): 76.2315**

| Test Temperature: (°C) | Measured Frequency (MHz) | Delta Frequency (kHz) | Limit (±kHz) |
|---|---|---|---|
| -20 | 76238.254 | 166 | Within band |
| -10 | 76238.463 | 374 | Within band |
| 0 | 76238.538 | 450 | Within band |
| 10 | 76238.591 | 503 | Within band |
| 20 | 76238.089 | Reference | Within band |
| 30 | 76238.207 | 118 | Within band |
| 40 | 76238.387 | 298 | Within band |
| 50 | 76238.422 | 215 | Within band |
| **Test Voltage: (Vdc)** | **Measured Frequency (MHz)** | **Delta Frequency (kHz)** | **Limit (±kHz)** |
| 4.25 | 76238.581 | 493 | Within band |
| 5 | 76238.089 | Reference | Within band |
| 5.75 | 76238.204 | 115 | Within band |

# 4 Test Equipment and Calibration Data

| Instrument | Brand | Model No. | Serial No. | Characteristics | Calibration Date | Calibration Due Date | Remark |
|---|---|---|---|---|---|---|---|
| Loop Antenna | Teseq | HLA 6120 | 31244 | 9kHz - 30 MHz | Mar. 23, 2023 | Mar. 22, 2024 | Radiation (03CH04-CB) |
| 3m Semi Anechoic Chamber NSA | TDK | SAC-3M | 03CH04-CB | 30 MHz ~ 1 GHz | Aug. 01, 2023 | Jul. 31, 2024 | Radiation (03CH04-CB) |
| BILOG ANTENNA with 6 dB attenuator | Schaffner & EMCI | CBL6112B & N-6-06 | 22021&AT-N0607 | 30MHz ~ 1GHz | Oct. 08, 2022 | Oct. 07, 2023 | Radiation (03CH04-CB) |
| BILOG ANTENNA with 6 dB attenuator | Schaffner & EMCI | CBL6112B & N-6-06 | 22021&AT-N0607 | 30MHz ~ 1GHz | Oct. 07, 2023 | Oct. 06, 2024 | Radiation (03CH04-CB) |
| Pre-Amplifier | EMCI | EMC330N | 980391 | 20MHz ~ 3GHz | May 23, 2023 | May 22, 2024 | Radiation (03CH04-CB) |
| Spectrum Analyzer | R&S | FSP40 | 100142 | 9kHz~40GHz | Mar. 21, 2023 | Mar. 20, 2024 | Radiation (03CH04-CB |
| EMI Test Receiver | R&S | ESCS | 826547/017 | 9kHz ~ 2.75GHz | Jun. 13, 2023 | Jun. 12, 2024 | Radiation (03CH04-CB) |
| RF Cable-low | Woken | RG402 | Low Cable-03+67 | 30MHz – 1GHz | Oct. 03, 2022 | Oct. 02, 2023 | Radiation (03CH04-CB) |
| RF Cable-low | Woken | RG402 | Low Cable-03+67 | 30MHz – 1GHz | Oct. 02, 2023 | Oct. 01, 2024 | Radiation (03CH04-CB) |
| Test Software | SPORTON | SENSE | V5.10 | - | N.C.R. | N.C.R. | Radiation (03CH04-CB) |
| 3m Semi Anechoic Chamber VSWR | TDK | SAC-3M | 03CH01-CB | 1GHz ~18GHz 3m | May 05, 2023 | May 04, 2024 | Radiation (03CH01-CB) |
| Horn Antenna | ETS-LINDGREN | 3115 | 00075790 | 750MHz ~ 18GHz | Nov. 04, 2022 | Nov. 03, 2023 | Radiation (03CH01-CB) |
| Horn Antenna | SCHWARZBECK | BBHA 9170 | BBHA9170507 | 15GHz ~ 40GHz | Jun. 28, 2023 | Jun. 27, 2024 | Radiation (03CH01-CB) |
| Pre-Amplifier | Agilent | 8449B | 3008A02121 | 1GHz ~ 26.5GHz | May 18, 2023 | May 17, 2024 | Radiation (03CH01-CB) |
| Pre-Amplifier | SGH | SGH184 | 20221107-3 | 18GHz ~ 40GHz | Nov. 16, 2022 | Nov. 15, 2023 | Radiation (03CH01-CB) |
| Signal Analyzer | R&S | FSV3044 | 101437 | 10kHz ~ 44GHz | Nov. 29, 2022 | Nov. 29, 2023 | Radiation (03CH01-CB) |
| RF Cable-high | Woken | RG402 | High Cable-16 | 1 GHz ~ 18 GHz | Oct. 03, 2022 | Oct. 02, 2023 | Radiation (03CH01-CB) |
| RF Cable-high | Woken | RG402 | High Cable-16 | 1 GHz ~ 18 GHz | Oct. 02, 2023 | Oct. 01, 2024 | Radiation (03CH01-CB) |
| RF Cable-high | Woken | RG402 | High Cable-16+17 | 1 GHz ~ 18 GHz | Oct. 03, 2022 | Oct. 02, 2023 | Radiation (03CH01-CB) |

| Instrument | Brand | Model No. | Serial No. | Characteristics | Calibration Date | Calibration Due Date | Remark |
|---|---|---|---|---|---|---|---|
| RF Cable-high | Woken | RG402 | High Cable-16+17 | 1 GHz ~ 18 GHz | Oct. 02, 2023 | Oct. 01, 2024 | Radiation (03CH01-CB) |
| High Cable | Woken | WCA0929M | 40G#5+6 | 1GHz ~ 40 GHz | Dec. 07, 2022 | Dec. 06, 2023 | Radiation (03CH01-CB) |
| High Cable | Woken | WCA0929M | 40G#5 | 1GHz ~ 40 GHz | Dec. 07, 2022 | Dec. 06, 2023 | Radiation (03CH01-CB) |
| High Cable | Woken | WCA0929M | 40G#6 | 1GHz ~ 40 GHz | Dec. 07, 2022 | Dec. 06, 2023 | Radiation (03CH01-CB) |
| Test Software | SPORTON | SENSE | V5.10 | - | N.C.R. | N.C.R. | Radiation (03CH01-CB) |
| *Mixer | OML | M19HWA | U91113-1 | 40 ~ 60 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH01-CB) |
| *Mixer | OML | M15HWA | V91113-1 | 50 ~ 75 GHz | Oct. 22, 2022 | Oct. 21, 2024 | Radiation (03CH01-CB) |
| *Mixer | OML | M12HWA | E91113-1 | 60 ~ 90 GHz | Oct. 22, 2022 | Oct. 21, 2024 | Radiation (03CH01-CB) |
| *Mixer | OML | M08HWA | F91113-1 | 90 ~ 140 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH01-CB) |
| *Mixer | OML | M05HW/A | G91113-1 | 140 ~ 220 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH01-CB) |
| *Mixer | OML | M03HWD | 120320-1 | 220 ~ 325 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH01-CB) |
| Standard Horn Antenna | Custom Microwave | M19RH | U91113-A | 40 ~ 60 GHz | N.C.R | N.C.R | Radiation (03CH01-CB) |
| Standard Horn Antenna | Custom Microwave | M15RH | V91113-A | 50 ~ 75 GHz | N.C.R | N.C.R | Radiation (03CH01-CB) |
| Standard Horn Antenna | Custom Microwave | M12RH | E91113-A | 60 ~ 90 GHz | N.C.R | N.C.R | Radiation (03CH01-CB) |
| Standard Horn Antenna | Custom Microwave | M08RH | F91113-A | 90 ~ 140 GHz | N.C.R | N.C.R | Radiation (03CH01-CB) |
| Standard Horn Antenna | Custom Microwave | M05RH | G91113-A | 140 ~ 220 GHz | N.C.R | N.C.R | Radiation (03CH01-CB) |
| Standard Horn Antenna | Custom Microwave | M03RH | 120320-A | 220 ~ 325 GHz | N.C.R | N.C.R | Radiation (03CH01-CB) |
| 3m Semi Anechoic Chamber VSWR | TDK | SAC-3M | 03CH03-CB | 1GHz ~18GHz 3m | May 04, 2023 | May 03, 2024 | Radiation (03CH03-CB) |
| Horn Antenna | ETS・Lindgren | 3115 | 6821 | 750MHz~18GHz | Feb. 03, 2023 | Feb. 02, 2024 | Radiation (03CH03-CB) |
| Horn Antenna | SCHWARZBECK | BBHA 9170 | BBHA9170507 | 15GHz ~ 40GHz | Jun. 28, 2023 | Jun. 27, 2024 | Radiation (03CH03-CB) |
| Pre-Amplifier | Agilent | 8449B | 3008A02097 | 1GHz ~ 26.5GHz | Jun. 30, 2023 | Jun. 29, 2024 | Radiation (03CH03-CB) |
| Pre-Amplifier | SGH | SGH184 | 20221107-3 | 18GHz ~ 40GHz | Nov. 16, 2022 | Nov. 15, 2023 | Radiation (03CH03-CB) |

| Instrument | Brand | Model No. | Serial No. | Characteristics | Calibration Date | Calibration Due Date | Remark |
|---|---|---|---|---|---|---|---|
| Spectrum Analyzer | R&S | FSP40 | 100019 | 9kHz ~ 40GHz | Jun. 12, 2023 | Jun. 11, 2024 | Radiation (03CH03-CB) |
| RF Cable-high | Woken | RG402 | High Cable-20+29 | 1GHz ~ 18GHz | Oct. 03, 2022 | Oct. 02, 2023 | Radiation (03CH03-CB) |
| RF Cable-high | Woken | RG402 | High Cable-20+29 | 1GHz ~ 18GHz | Oct. 02, 2023 | Oct. 01, 2024 | Radiation (03CH03-CB) |
| RF Cable-high | Woken | RG402 | High Cable-29 | 1GHz ~ 18GHz | Oct. 03, 2022 | Oct. 02, 2023 | Radiation (03CH03-CB) |
| RF Cable-high | Woken | RG402 | High Cable-29 | 1GHz ~ 18GHz | Oct. 02, 2023 | Oct. 01, 2024 | Radiation (03CH03-CB) |
| High Cable | Woken | WCA0929M | 40G#5+6 | 1GHz ~ 40 GHz | Dec. 07, 2022 | Dec. 06, 2023 | Radiation (03CH03-CB) |
| High Cable | Woken | WCA0929M | 40G#5 | 1GHz ~ 40 GHz | Dec. 07, 2022 | Dec. 06, 2023 | Radiation (03CH03-CB) |
| High Cable | Woken | WCA0929M | 40G#6 | 1GHz ~ 40 GHz | Dec. 07, 2022 | Dec. 06, 2023 | Radiation (03CH03-CB) |
| Test Software | SPORTON | SENSE | V5.10 | - | N.C.R. | N.C.R. | Radiation (03CH03-CB) |
| *Mixer | OML | M19HWA | U91113-1 | 40 ~ 60 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH03-CB) |
| *Mixer | OML | M15HWA | V91113-1 | 50 ~ 75 GHz | Oct. 22, 2022 | Oct. 21, 2024 | Radiation (03CH03-CB) |
| *Mixer | OML | M12HWA | E91113-1 | 60 ~ 90 GHz | Oct. 22, 2022 | Oct. 21, 2024 | Radiation (03CH03-CB) |
| *Mixer | OML | M08HWA | F91113-1 | 90 ~ 140 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH03-CB) |
| *Mixer | OML | M05HW/A | G91113-1 | 140 ~ 220 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH03-CB) |
| *Mixer | OML | M03HWD | 120320-1 | 220 ~ 325 GHz | Mar. 10, 2022 | Mar. 09, 2024 | Radiation (03CH03-CB) |
| Standard Horn Antenna | Custom Microwave | M19RH | U91113-A | 40 ~ 60 GHz | N.C.R | N.C.R | Radiation (03CH03-CB) |
| Standard Horn Antenna | Custom Microwave | M15RH | V91113-A | 50 ~ 75 GHz | N.C.R | N.C.R | Radiation (03CH03-CB) |
| Standard Horn Antenna | Custom Microwave | M12RH | E91113-A | 60 ~ 90 GHz | N.C.R | N.C.R | Radiation (03CH03-CB) |
| Standard Horn Antenna | Custom Microwave | M08RH | F91113-A | 90 ~ 140 GHz | N.C.R | N.C.R | Radiation (03CH03-CB) |
| Standard Horn Antenna | Custom Microwave | M05RH | G91113-A | 140 ~ 220 GHz | N.C.R | N.C.R | Radiation (03CH03-CB) |
| Standard Horn Antenna | Custom Microwave | M03RH | 120320-A | 220 ~ 325 GHz | N.C.R | N.C.R | Radiation (03CH03-CB) |
| Spectrum analyzer | R&S | FSV40 | 101028 | 9kHz~40GHz | Dec. 30, 2022 | Dec. 29, 2023 | Radiation (TH03-CB) |

| Instrument | Brand | Model No. | Serial No. | Characteristics | Calibration Date | Calibration Due Date | Remark |
|---|---|---|---|---|---|---|---|
| Temp. and Humidity Chamber | Gaint Force | GTH-408-40-CP-AR | MAA1410-011 | -40~100 degree | Sep. 02, 2022 | Sep. 01, 2023 | Radiation (TH03-CB) |
| RF Cable | Woken | RG402 | High Cable-11 | 30MHz –18 GHz | Feb. 14, 2023 | Feb. 13, 2024 | Radiation (TH03-CB) |
| RF Cable | Woken | RG402 | High Cable-12 | 30MHz –18 GHz | Feb. 14, 2023 | Feb. 13, 2024 | Radiation (TH03-CB) |
| RF Cable | Woken | RG402 | High Cable-13 | 30MHz –18 GHz | Feb. 14, 2023 | Feb. 13, 2024 | Radiation (TH03-CB) |
| RF Cable-high | Woken | RG402 | High Cable-14 | 1 GHz –18 GHz | Oct. 03, 2022 | Oct. 02, 2023 | Radiation (TH03-CB) |
| RF Cable-high | Woken | RG402 | High Cable-15 | 1 GHz –18 GHz | Oct. 03, 2022 | Oct. 02, 2023 | Radiation (TH03-CB) |

Note: Calibration Interval of instruments listed above is one year.

"*" Calibration Interval of instruments listed above is two years.

N.C.R. means Non-Calibration required.