# RF MEASUREMENT REPORT

| | |
|---|---|
| **FCC ID:** | 2BLND-FR552 |
| **Applicant:** | Indigo Technologies, Inc. |
| **Product:** | Millimeter wave radar |
| **Model No.:** | FR552 |
| **FCC Classification:** | Part 95 Vehicular Radar Systems (VRD) |
| **FCC Rule Part(s):** | FCC Part 95, Subpart M |
| **Received Date:** | 2024-10-12 |
| **Test Date:** | 2024-10-17 ~ 2024-12-12 |

**Reviewed By:** Yuri Li

**Approved By:** Robin Wu


The test results relate only to the samples tested.

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2020. Test results reported herein relate only to the item(s) tested.

## Revision History

| Report No. | Version | Description | Issue Date | Note |
|---|---|---|---|---|
| 2409RSU036-U1 | V01 | Initial Report | 2025-01-15 | Invalid |
| 2409RSU036-U1 | V02 | Update Antenna Information | 2025-02-28 | Invalid |
| 2409RSU036-U1 | V03 | Update Radio Specification | 2025-03-05 | Valid |
| | | | | |

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# 1. General Information

## 1.1. Applicant

Indigo Technologies, Inc.

73 Holton St. Woburn, MA 01801

## 1.2. Manufacturer

Indigo Technologies, Inc.

73 Holton St. Woburn, MA 01801

## 1.3. Testing Facility

| | | | | | |
|---|---|---|---|---|---|
| ☒ | **Test Site – MRT Suzhou Laboratory** | | | | |
| | **Laboratory Location (Suzhou - Wuzhong)**<br>D8 Building, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China<br>**Laboratory Location (Suzhou - SIP)**<br>4b Building, Liando U Valley, No.200 Xingpu Rd., Shengpu Town, Suzhou Industrial Park, China<br>**Laboratory Location (Suzhou - Wujiang)**<br>Building 1, No.1 Xingdong Road, Wujiang, Suzhou, Jiangsu, People's Republic of China | | | | |
| | **Laboratory Accreditations** | | | | |
| | A2LA: 3628.01 | | CNAS: L10551 | | |
| | FCC: CN1166 | | ISED: CN0001 | | |
| | VCCI: | ☐R-20025 | ☐G-20034 | ☐C-20020 | ☐T-20020 |
| | | ☐R-20141 | ☐G-20134 | ☐C-20103 | ☐T-20104 |
| ☐ | **Test Site – MRT Shenzhen Laboratory** | | | | |
| | **Laboratory Location (Shenzhen)**<br>1G, Building A, Junxiangda Building, Zhongshanyuan Road West, Nanshan District, Shenzhen, China | | | | |
| | **Laboratory Accreditations** | | | | |
| | A2LA: 3628.02 | | CNAS: L10551 | | |
| | FCC: CN1284 | | ISED: CN0105 | | |
| ☐ | **Test Site – MRT Taiwan Laboratory** | | | | |
| | **Laboratory Location (Taiwan)**<br>No. 38, Fuxing 2nd Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) | | | | |
| | **Laboratory Accreditations** | | | | |
| | TAF: 3261 | | | | |
| | FCC: 291082, TW3261 | | ISED: TW3261 | | |

### 1.4. Product Information

| | |
|---|---|
| Product Name | Millimeter wave radar |
| Model No. | FR552 |
| EUT Identification No. | 20241128Sample#03 |
| RF Specification | 76 ~ 77GHz Radar |
| Product Voltage | 9 ~ 16V DC (normal 12V) |
| Working Temperature Rang | -40 ~ 85°C |
| Remark:<br>The information of EUT was provided by the manufacturer, and the accuracy of the information shall be the responsibility of the manufacturer. | |

### 1.5. Radio Specification under Test

| | |
|---|---|
| Working Frequency Range | 76 ~ 77GHz |
| Radar Type | Non-pulsed Radar (FMCW) |
| Modulation Type | Sawtooth wave |
| FMCW Sweep Bandwidth | Long Range: 200MHz<br>Short Range: 600MHz |
| FMCW Sweep Rate | Long Range: 9.765625MHz/μs<br>Short Range: 29.296875MHz/μs |
| FMCW Sweep Time | Long Range: 28.48μs<br>Short Range: 24.48μs |
| Antenna Type | Planar Antenna |
| Antenna Gain | Long Range: 18dBi<br>Short Range: 13dBi |

# 2. Test Configuration

## 2.1. Test Mode

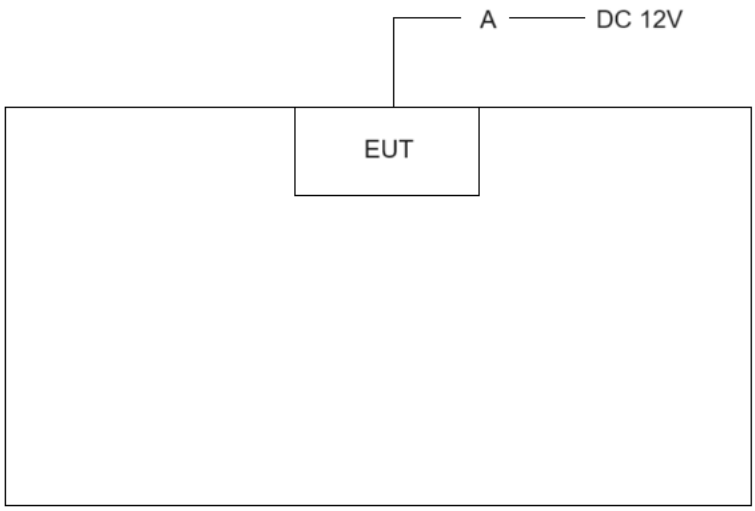
| Mode 1: Collocated $T_X$ / $R_X$ mode by DC 12V |
|---|

Note: The test sample was provided by the manufacturer, which was configured into Collocated $T_X$ / $R_X$ mode after power on.

## 2.2. Test System Connection Diagram

The device was tested per the guidance ANSI C63.10: 2020 was used to reference the appropriate EUT setup for radiated emissions testing.

| Connection Diagram |
|---|




| Cable Type | | Cable Description | Length |
|---|---|---|---|
| A | DC Cable | Non shielded | 2.0m |

### 2.3. Applied Standards

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

- FCC Part 95, Subpart M
- KDB 653005 D01v01r02
- ANSI C63.10-2020
- ANSI C63.26-2015

### 2.4. Test Environment Condition

| | |
|---|---|
| Ambient Temperature | 15 ~ 35°C |
| Relative Humidity | 20% ~ 75%RH |

## 3. Measuring Instrument

| Instrument | Manufacturer | Model No. | Asset No. | Cali. Interval | Cali. Due Date | Test Site |
|---|---|---|---|---|---|---|
| EMI Test Receiver | R&S | ESR3 | MRTSUE06185 | 1 year | 2024-12-17 | SIP-AC3 |
| Signal Analyzer | Keysight | N9010B | MRTSUE06559 | 1 year | 2025-05-08 | SIP-AC3 |
| Horn Antenna | Schwarzbeck | BBHA 9170 | MRTSUE06599 | 1 year | 2025-09-08 | SIP-AC3 |
| Preamplifier | EMCI | EMC184045SE | MRTSUE06602 | 1 year | 2025-10-08 | SIP-AC3 |
| Horn Antenna | R&S | HF907 | MRTSUE06611 | 1 year | 2025-07-07 | SIP-AC3 |
| Thermohygrometer | testo | 608-H1 | MRTSUE06619 | 1 year | 2025-10-16 | SIP-AC3 |
| Preamplifier | EMCI | EMC012645SE | MRTSUE06642 | 1 year | 2025-01-11 | SIP-AC3 |
| TRILOG Antenna | Schwarzbeck | VULB 9168 | MRTSUE06646 | 1 year | 2025-07-29 | SIP-AC3 |
| Anechoic Chamber | RIKEN | SIP-AC3 | MRTSUE06782 | 1 year | 2024-12-21 | SIP-AC3 |
| Loop Antenna | Schwarzbeck | FMZB 1519 B | MRTSUE06937 | 1 year | 2025-01-27 | SIP-AC3 |
| Waveguide Harmonic Mixer | Keysight | M1970V | MRTSUE06271 | 3 years | 2025-09-22 | SIP-TR2 |
| Waveguide Harmonic Mixer | Keysight | M1970W | MRTSUE06272 | 3 years | 2025-09-29 | SIP-TR1/SIP-TR2 |
| mmWave Antenna | MI-WWAVE | 261U-25/383 | MRTSUE06273 | N/A | N/A | SIP-TR2 |
| mmWave Antenna | MI-WWAVE | 261G/387 | MRTSUE06274 | N/A | N/A | SIP-TR2 |
| mmWave Antenna | MI-WWAVE | 261F/387 | MRTSUE06275 | N/A | N/A | SIP-TR2 |
| mmWave Antenna | VDI | WR3/4 | MRTSUE06277 | N/A | N/A | SIP-TR2 |
| mmWave Extension Module | Keysight | N9029AV03 | MRTSUE06366 | N/A | N/A | SIP-TR2 |
| mmWave Extension Module | Keysight | N9029AV05 | MRTSUE06367 | N/A | N/A | SIP-TR2 |
| mmWave Extension Module | Keysight | N9029AV06 | MRTSUE06368 | N/A | N/A | SIP-TR2 |
| mmWave Antenna | A-INFO | LB-15-25-A | MRTSUE06409 | N/A | N/A | SIP-TR2 |
| mmWave Antenna | A-INFO | LB-10-25-A | MRTSUE06410 | N/A | N/A | SIP-TR1/SIP-TR2 |
| Thermohygrometer | testo | 608-H1 | MRTSUE11109 | 1 year | 2025-03-05 | SIP-TR2 |
| Signal Analyzer | Keysight | N9030B | MRTSUE06395 | 1 year | 2025-06-21 | SIP-TR1/SIP-TR2 |
| Temperature Chamber | BAOYT | BYG-408CS | MRTSUE06847 | 1 year | 2025-02-03 | SIP-TR1 |
| Thermohygrometer | testo | 608-H1 | MRTSUE11022 | 1 year | 2025-10-16 | SIP-TR1 |

Note: Standard gain horns need not be periodically calibrated. Antenna appearance and connector were checked and no damage.

| Software | Version | Function |
|---|---|---|
| e3 | 230711 | EMI Test Software |
| Controller_MF 7802BS | 1.02 | RE Antenna & Turntable |
| MotorContor | V 2 | mmw |

# 4. Decision Rules and Measurement Uncertainty

## 4.1. Decision Rules

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4: 2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

## 4.2. Measurement Uncertainty

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k = 2.

| Radiated Emission Measurement | |
|---|---|
| Measurement Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): | |
| Coaxial: | 9kHz~30MHz: 2.59dB |
| Coplanar: | 9kHz~30MHz: 2.60dB |
| Horizontal: | 30MHz~200MHz: 3.85dB |
| | 200MHz~1GHz: 4.36dB |
| | 1GHz~40GHz: 4.98dB |
| | 40GHz~50GHz: 3.96dB |
| | 50GHz~75GHz: 4.01dB |
| | 75GHz~110GHz: 3.99dB |
| | 110GHz~140GHz: 4.11dB |
| | 140GHz~220GHz: 4.20dB |
| | 220GHz~231GHz: 4.29dB |
| Vertical: | 30MHz~200MHz: 4.06dB |
| | 200MHz~1GHz: 5.28dB |
| | 1GHz~40GHz: 4.91dB |
| | 40GHz~50GHz: 3.86dB |
| | 50GHz~75GHz: 3.89dB |
| | 75GHz~110GHz: 3.87Db |
| | 110GHz~140GHz: 4.13dB |
| | 140GHz~220GHz: 4.24dB |
| | 220GHz~231GHz: 4.28dB |

# 5. Test Result

## 5.1. Summary

| FCC Part Section(s) | Test Description | Test Condition | Verdict |
|---|---|---|---|
| 95.3367 | EIRP | Radiated | Pass |
| 2.1049 | Occupied bandwidth | | Pass |
| 95.3379(a) | Unwanted Emissions | | Pass |
| 95.3379(b) | Frequency stability | | Pass |

Note: The radiation measurements are performed in X, Y, Z axis positioning. Only the worst-case data are shown in the report.

## 5.2. Equivalent Isotropically Radiated Power (EIRP)

### 5.2.1. Test Limit

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.

### 5.2.2. Test Procedure

ANSI C63.26 Section 4.6.2

KDB 653005 D01v01r02 Section 4.b) & 4.c)

Note: Far-field boundary calculation as below.

According to ANSI C63.10-2020, Clause 9.1.4, the far-field boundary for mm-wave antennas is $2D^2/\lambda$. For fundamental or out-of-band emissions the far-field boundary distance of the EUT antenna or measurement antenna, whichever is largest, shall be used.

- D is the largest dimension of the antenna aperture in meters.
- λ is the wavelength in m

| Far-field boundary calculation | | | |
|---|---|---|---|
| Frequency Range (GHz) | λ (m) | D (m) | $R_{(Far\ Field)}$ (m) |
| 76 ~ 81 | 0.0037 | 0.026 | 0.365 |

The measurement is performed at a minimum distance of 0.75m > $R_{(Far\ Field)}$

### 5.2.3. Test Setting

**For the maximum power (EIRP)**

1. Span = approximately 2 × the OBW, centered on the carrier frequency
2. Set the RBW = 1MHz
3. Set the VBW ≥ 3 × RBW
4. Detector function = Average
5. Sweep time ≥ (span / RBW) × (transmission symbol period).
6. Trace mode = Average
7. Allow the trace to stabilize
8. Use the integrated band/channel power analyzer function to determine the average power.

**For the maximum peak power (EIRP)**

1. Span = approximately 2 × the OBW, centered on the carrier frequency
2. Set the RBW = 1MHz
3. Set the VBW ≥ 3 × RBW
4. Detector function = Peak
5. Sweep time ≥ (span / RBW) × (transmission symbol period).
6. Trace mode = max hold
7. Allow the trace to stabilize
8. Use the peak search function to mark the max value of the emission.
9. For FMCW emissions, the Desensitization for peak detection needs to be considered. The desensitization when the above signal passes through a Gaussian RBW filter is calculated by following Equation

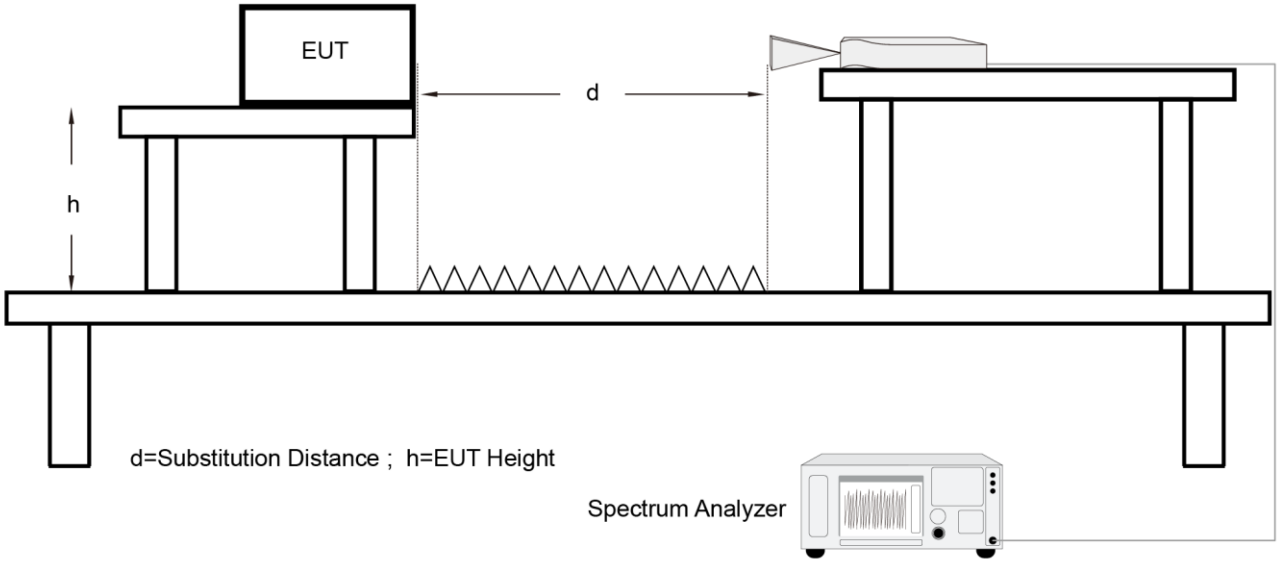
$$\text{Desensitization Factor} = -10 * \log(\alpha)$$

$$\alpha = \{[1 + (2 * \ln(2) / \pi)^2 * [BW_{Chirp} / (T_{Chirp} * B^2)]^2\}^{0.5}$$

Where

| | |
|---|---|
| $\alpha$ | is the reduction in amplitude |
| $BW_{Chirp}$ | is the FMCW Chirp Bandwidth, in MHz |
| $T_{Chirp}$ | is the FMCW Chirp Time, in μs |
| B | is the 3 dB IF Bandwidth = RBW, in MHz |

### 5.2.4. Test Setup




### 5.2.5. Test Result

Refer to Appendix A.1.

## 5.3. Occupied bandwidth

### 5.3.1. Test Limit

The occupied bandwidth of the radar device shall be shown to be fully contained within the designated 76-81 GHz frequency band.

### 5.3.2. Test Procedure

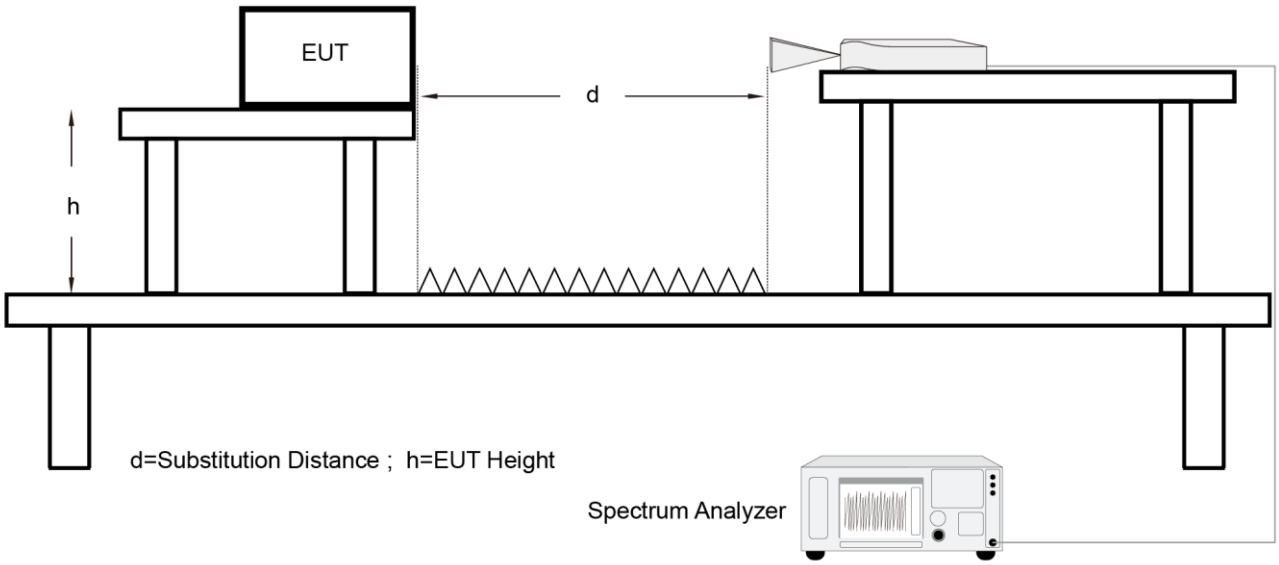
ANSI C63.26 Section 5.4.4

KDB 653005 D01v01r02 Section 4.d)

### 5.3.3. Test Setting

1. Span = 1.5 × OBW, centered on the carrier frequency
2. RBW = 1% to 5% of the anticipated OBW
3. Set the VBW ≥ 3 × RBW
4. Detector function = Peak
5. Trace mode = max hold.
6. Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

### 5.3.4. Test Setup



### 5.3.5. Test Result

Refer to Appendix A.2.

## 5.4. Unwanted Emissions

### 5.4.1. Test Limit

The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

| Frequency (MHz) | Field Strength (uV/m) | Measurement Distance (m) |
|---|---|---|
| 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 |

(i) The tighter limit applies at the band edges.

(ii) The limits in the table 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 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 between 40 GHz and 200 GHz: 600 pW/cm$^2$ at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz: 1000 pW/cm$^2$ 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.

### 5.4.2. Test Procedure

ANSI C63.10 Section 4.1.5.2.2 & 4.1.5.2.8

ANSI C63.26 Section 4.6.3

KDB 653005 D01v01r02 Section 4.e)

Note: Far-field boundary calculation as below.

According to ANSI C63.10-2020, Clause 9.1.4, the far-field boundary for mm-wave antennas is $2D^2/\lambda$. For spurious and harmonic emissions the far-field boundary distance shall be based on the measurement antenna.

- D is the largest dimension of the antenna aperture in meters.
- λ is the wavelength in m

| Far-field boundary calculation | | | |
|---|---|---|---|
| Frequency Range (GHz) | λ (m) | D (m) | $R_{(Far\ Field)}$ (m) |
| 40.00 ~ 50.00 | 0.006 | 0.046 | 0.705 |
| 50.00 ~ 75.00 | 0.004 | 0.036 | 0.648 |
| 75.00 ~ 110.00 | 0.0027 | 0.026 | 0.501 |
| 110.00 ~ 140.00 | 0.0021 | 0.020 | 0.381 |
| 140.00 ~ 220.00 | 0.0014 | 0.014 | 0.280 |
| 220.00 ~ 231.00 | 0.0013 | 0.0055 | 0.047 |

For 40.00 ~ 231.00GHz, Our measurement is performed at a minimum distance of 0.75m > $R_{(Far\ Field)}$.

### 5.4.3. Test Setting

**Measurement of harmonic and spurious emissions above 40 GHz**

1. Connect the test antenna covering the appropriate frequency range to a spectrum analyzer via an external mixer.
2. Set spectrum analyzer RBW = 1MHz, VBW = 3MHz, average detector.
3. Maximize all observed emissions. Note the maximum power indicated on the spectrum analyzer. Adjust this reading, if necessary, by the conversion loss of the external mixer used at the frequency under investigation and the external mixer IF cable loss.
4. Calculate the maximum field strength of the emission at the measurement distance.
5. Calculate the power density at the distance specified by the limit from the field strength at the distance specified by the limit.
6. Repeat the preceding sequence for every emission observed in the frequency band under investigation.

**Measurement of harmonic and spurious emissions below 40 GHz**

**Quasi-Peak Strength Measurements**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. Span was set greater than 1MHz
3. RBW = as specified in Table 1
4. Detector = CISPR quasi-peak
5. Sweep time = auto couple
6. Trace was allowed to stabilize

**Peak Field Strength Measurements**

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = as specified in Table 1
3. VBW = 3 x RBW
4. Detector = Peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

**Table 1 – RBW**

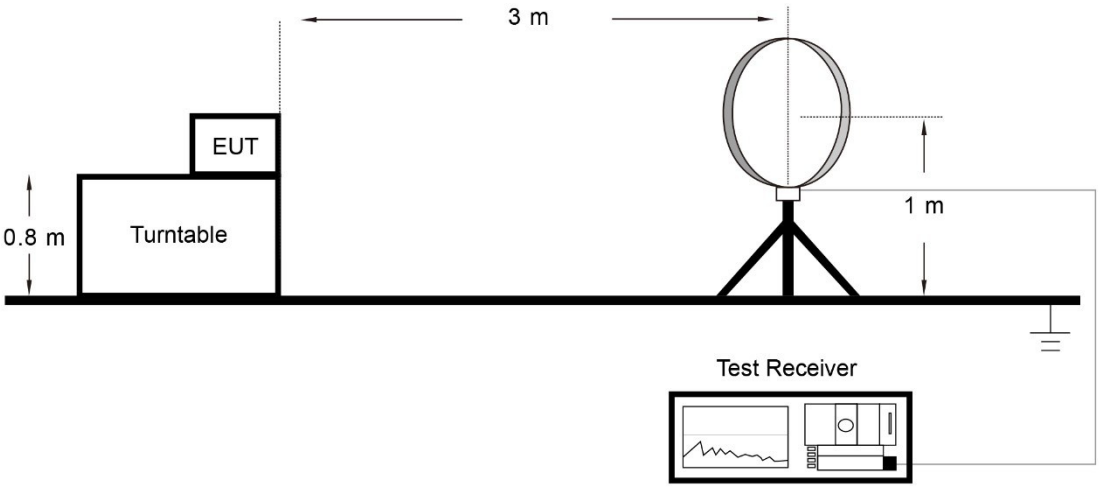
| Frequency | RBW |
|---|---|
| 9 ~ 90 kHz | 1 MHz |
| 90 ~ 110 kHz | 200 Hz |
| 110 ~ 490 kHz | 1 MHz |
| 0.49 ~ 30 MHz | 9 kHz |
| 30 ~ 1000 MHz | 120 kHz |
| > 1000 MHz | 1 MHz |

**Average Field Strength Measurements**

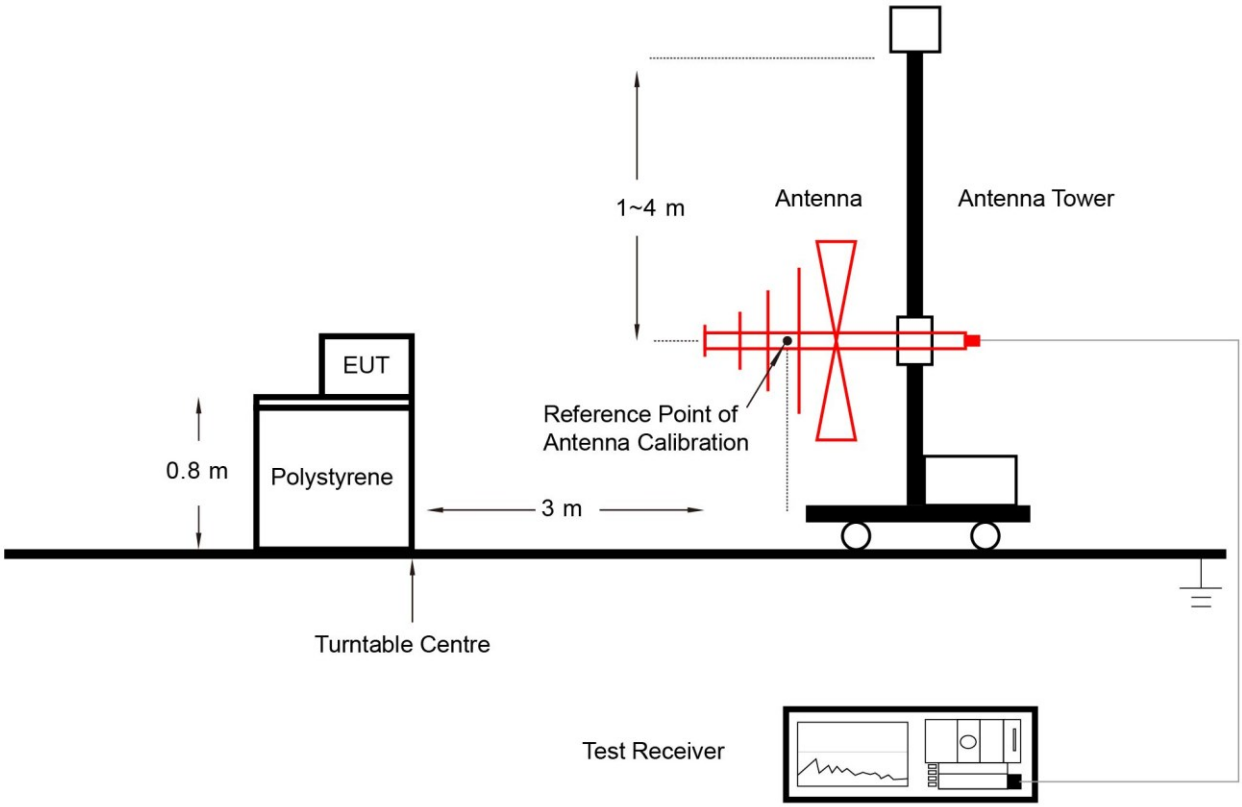
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3 x RBW
4. Detector = Average
5. Sweep time = auto couple
6. Trace mode = Average

### 5.4.4. Test Setup

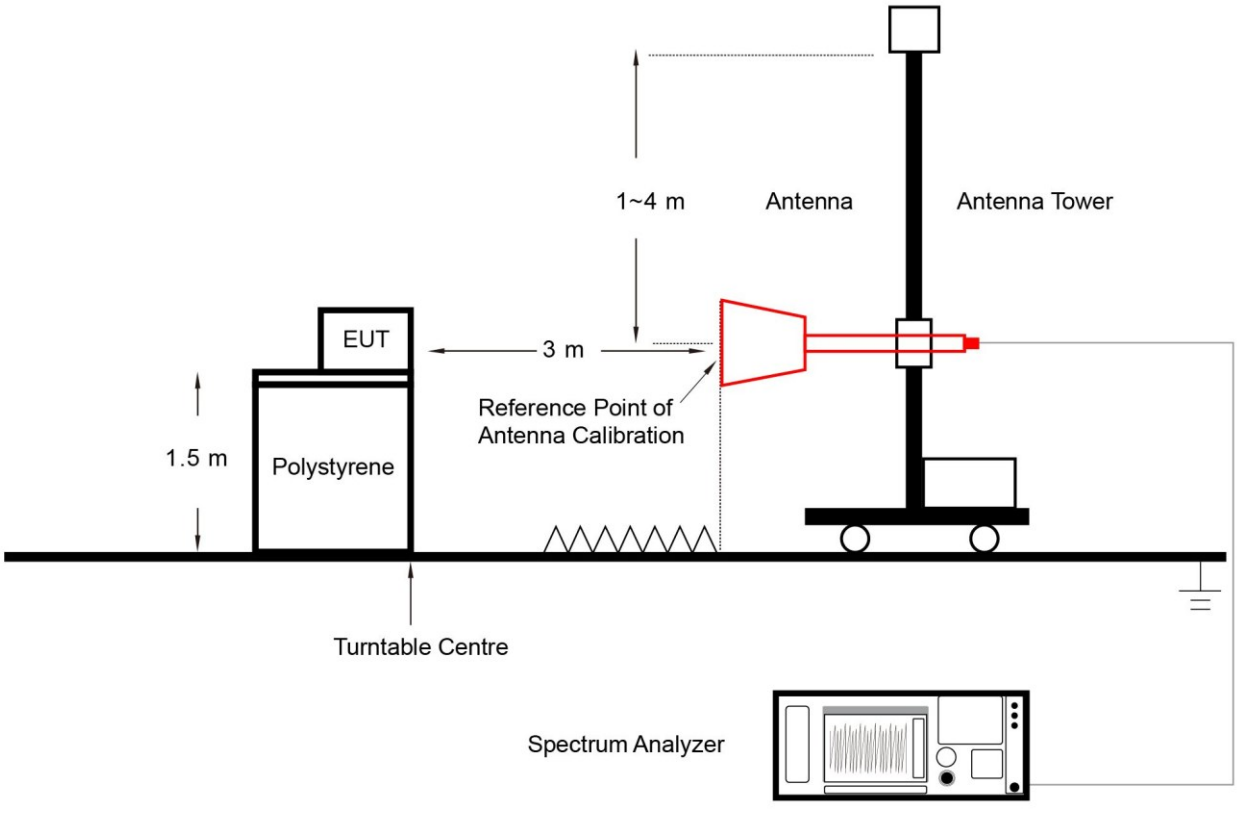
Below 30MHz Test Setup:



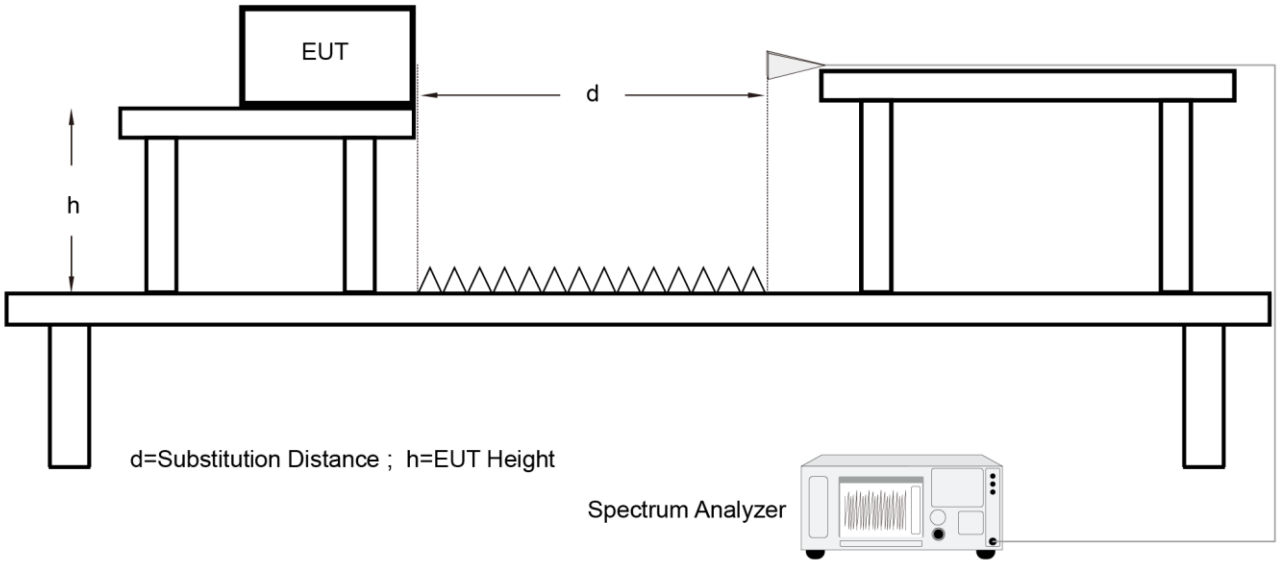
Below 1GHz Test Setup:



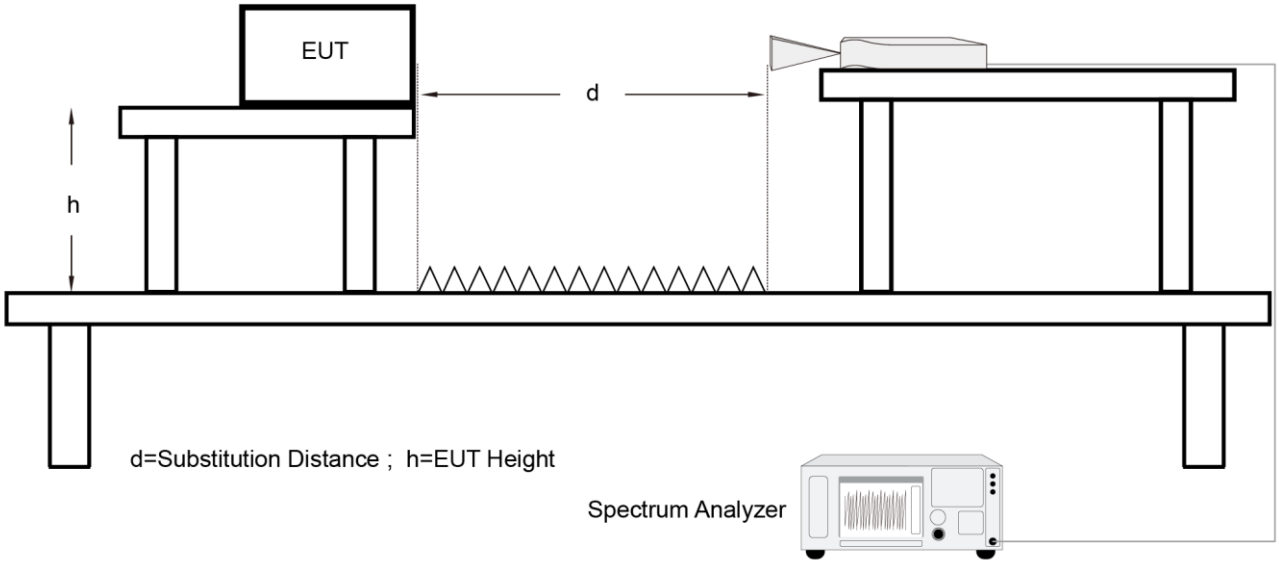

1GHz ~ 40GHz Test Setup:



40GHz ~ 50GHz Test Setup:




Above 50GHz Test Setup:




### 5.4.5. Test Results

Refer to Appendix A.3.

## 5.5. Frequency Stability

### 5.5.1. Test Limit

Fundamental emissions must be contained within the frequency bands 76 - 81GHz 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, unless justification is presented to demonstrate otherwise.

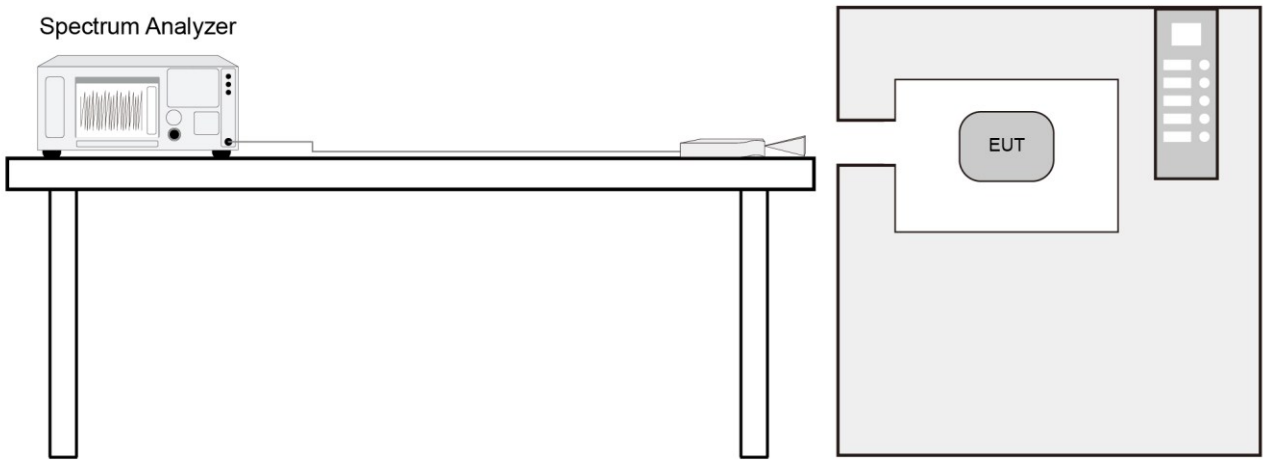
### 5.5.2. Test Procedure

ANSI C63.26 Section 5.4.4 & 5.6.3

### 5.5.3. Test Setting

1. Arrange EUT and test equipment according Section 5.5.4.
2. With the EUT at ambient temperature (20 °C) and voltage source set to the EUT nominal operating voltage
3. Use the 99% power bandwidth function of the instrument, record the Low and high frequencies ($f_L$ and $f_H$) of the fundamental frequency emission.
4. Vary EUT power supply between 85% and 115% of nominal Voltage, record the $f_L$ and $f_H$.
5. Set the power supply to 100% nominal setting, and raise EUT operating temperature to 50 °C.
6. Record the $f_L$ and $f_H$ of the fundamental frequency emission.
7. Repeat step 6 at each 10°C increment down to -20 °C.

### 5.5.4. Test Setup



### 5.5.5. Test Result

Refer to Appendix A.4.

# Appendix A – Test Result

## A.1 Equivalent Isotropically Radiated Power (EIRP) Test Result

| Test Site | SIP-TR2 | Test Engineer | Alisa Deng |
|---|---|---|---|
| Test Date | 2024-12-04 | | |

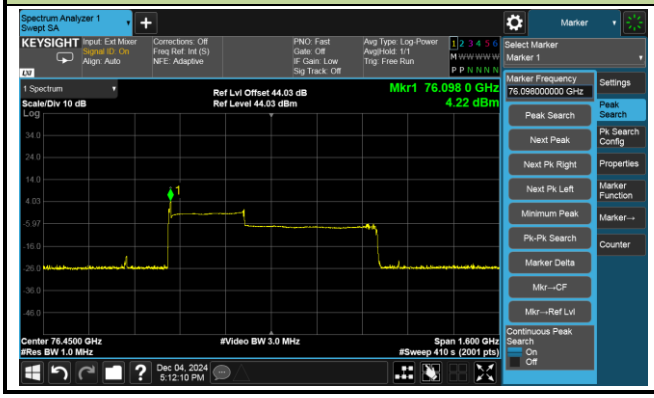
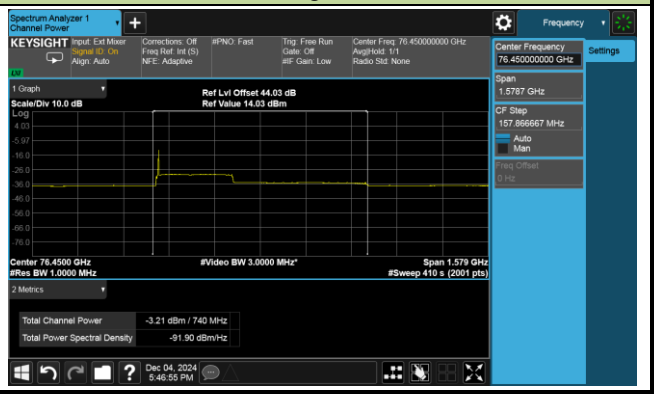
| FMCW Desensitization Factor | | | | | | |
|---|---|---|---|---|---|---|
| Frequency Band (GHz) | $BW_{Chirp}$ (MHz) | $T_{Chirp}$ (μs) | B (MHz) | Normalized Sweep Rate | α | Desensitization Factor (dB) |
| 76 ~ 77 | 800 | 52.96 | 1.00 | 15.11 | 0.15 | 8.29 |

Notes:

1. Normalized Sweep Rate = $BW_{Chirp}$ / ($T_{Chirp}$ *$B^2$)
2. Desensitization Factor = -10 *log(α)
3. α = {[1 + (2 *ln(2) / π)$^2$ *[$BW_{Chirp}$ / ($T_{Chirp}$ * $B^2$)]$^2$}$^{0.5}$
4. The information of EUT was provided by the manufacturer, and the accuracy of the information shall be the responsibility of the manufacturer.

| EIRP (dBm) | | EIRP Limit (dBm) | | Result |
|---|---|---|---|---|
| Peak | Average | Peak | Average | |
| 12.51 | -3.21 | ≤ 55 | ≤ 50 | Pass |

Note: Peak EIRP = Measure Peak EIRP + Desensitization Factor

| Peak EIRP | Average EIRP |
|---|---|
|  |  |

## A.2 Occupied bandwidth Test Result

| Test Site | SIP-TR2 | Test Engineer | Alisa Deng |
|---|---|---|---|
| Test Date | 2024-12-04 | | |

| 99% Bandwidth (MHz) | $f_L$ (MHz) | $f_L$ Limit (MHz) | $f_H$ (MHz) | $f_H$ Limit (MHz) | Result |
|---|---|---|---|---|---|
| 739.33 | 76085.18 | ≥ 76000 | 76824.51 | ≤ 81000 | Pass |

99% Occupied Bandwidth


Note: $f_L$ (MHz) = Center Frequency (MHz) + Lower Boundary Offset Frequency (MHz)

$f_H$ (MHz) = Center Frequency (MHz) + Upper Boundary Offset Frequency (MHz)

### A.3 Unwanted Emissions Test Result

| Test Site | SIP-AC3 | Test Engineer | Mero Zhou |
|---|---|---|---|
| Test Date | 2024-12-09 | Test Frequency Range | Below 1GHz |

| Frequency (MHz) | Reading Level (dBμV) | Factor (dB/m) | Measure Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|
| 61.2 | 3.2 | 17.8 | 21.0 | 40.0 | -19.0 | QP | Horizontal |
| 107.3 | 9.0 | 14.9 | 23.9 | 43.5 | -19.6 | QP | Horizontal |
| 178.5 | 5.3 | 16.9 | 22.2 | 43.5 | -21.3 | QP | Horizontal |
| 241.7 | 12.5 | 16.6 | 29.1 | 46.0 | -16.9 | QP | Horizontal |
| 247.3 | 8.3 | 16.8 | 25.1 | 46.0 | -20.9 | QP | Horizontal |
| 934.2 | -5.3 | 29.8 | 24.5 | 46.0 | -21.5 | QP | Horizontal |
| 43.8 | 4.3 | 18.3 | 22.6 | 40.0 | -17.4 | QP | Vertical |
| 56.0 | 9.0 | 18.4 | 27.4 | 40.0 | -12.6 | QP | Vertical |
| 61.5 | 7.0 | 17.8 | 24.8 | 40.0 | -15.2 | QP | Vertical |
| 67.0 | 5.6 | 16.8 | 22.4 | 40.0 | -17.6 | QP | Vertical |
| 106.9 | 6.2 | 14.8 | 21.0 | 43.5 | -22.5 | QP | Vertical |
| 241.7 | 10.5 | 16.6 | 27.1 | 46.0 | -18.9 | QP | Vertical |

Notes:

1. Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m)

   Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m)

2. The amplitude of radiated emissions (frequency range from 9KHz to 30MHz) is that proximity to ambient noise, which also are attenuated more than 20 dB below the permissible value. Therefore, the data is not presented in the report.

3. Test Distance “d” = 3m, Test height “h” = 0.8m

| Test Site | SIP-AC3 | Test Engineer | Mero Zhou |
|---|---|---|---|
| Test Date | 2024-11-29 ~ 2024-12-09 | Test Frequency Range | 1 ~ 40 GHz |

| Frequency (MHz) | Reading Level (dBμV) | Factor (dB/m) | Measure Level (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|
| 11574.0 | 48.7 | 0.4 | 49.1 | 74.0 | -24.9 | Peak | Horizontal |
| 15555.4 | 45.8 | 6.1 | 51.9 | 74.0 | -22.1 | Peak | Horizontal |
| 15555.4 | 38.6 | 6.1 | 44.7 | 54.0 | -9.3 | Average | Horizontal |
| 17733.1 | 46.0 | 8.2 | 54.2 | 74.0 | -19.8 | Peak | Horizontal |
| 17733.1 | 38.6 | 8.2 | 46.8 | 54.0 | -7.2 | Average | Horizontal |
| 11628.4 | 49.2 | 0.0 | 49.2 | 74.0 | -24.8 | Peak | Vertical |
| 15640.4 | 46.1 | 6.0 | 52.1 | 74.0 | -21.9 | Peak | Vertical |
| 15640.4 | 38.3 | 6.0 | 44.3 | 54.0 | -9.7 | Average | Vertical |
| 17850.4 | 45.7 | 9.5 | 55.2 | 74.0 | -18.8 | Peak | Vertical |
| 17850.4 | 37.6 | 9.5 | 47.1 | 54.0 | -6.9 | Average | Vertical |
| 19025.2 | 63.3 | -10.2 | 53.1 | 74.0 | -20.9 | Peak | Horizontal |
| 19025.2 | 58.9 | -10.2 | 48.7 | 54.0 | -5.3 | Average | Horizontal |
| 37762.6 | 56.4 | -1.9 | 54.5 | 74.0 | -19.5 | Peak | Horizontal |
| 37762.6 | 40.8 | -1.9 | 38.9 | 54.0 | -15.1 | Average | Horizontal |
| 38981.4 | 55.0 | 1.5 | 56.5 | 74.0 | -17.5 | Peak | Horizontal |
| 38981.4 | 41.4 | 1.5 | 42.9 | 54.0 | -11.1 | Average | Horizontal |
| 19025.2 | 59.6 | -10.2 | 49.4 | 74.0 | -24.6 | Peak | Vertical |
| 19025.2 | 54.6 | -10.2 | 44.4 | 54.0 | -9.6 | Average | Vertical |
| 27358.8 | 59.0 | -7.6 | 51.4 | 74.0 | -22.6 | Peak | Vertical |
| 27358.8 | 44.6 | -7.6 | 37.0 | 54.0 | -17.0 | Average | Vertical |
| 39300.4 | 53.7 | 2.3 | 56.0 | 74.0 | -18.0 | Peak | Vertical |
| 39300.4 | 41.1 | 2.3 | 43.4 | 54.0 | -10.6 | Average | Vertical |

Notes:

1. Measure Level (dBμV/m) = Reading Level (dBμV) + Factor (dB/m)

   Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m) - Pre_Amplifier Gain (dB)

2. Average measurement was not performed when the peak level lower than average limit

3. Test Distance “d” = 3m, Test height “h” = 1.5m

| Test Site | SIP-TR2 | Test Engineer | Alisa Deng |
|---|---|---|---|
| Test Date | 2024-10-17 ~ 2024-12-05 | Test Frequency Range | 40 ~ 231GHz |

| Frequency (GHz) | Reading Level @0.75m (dBμV) | Factor (dB/m) | Measure Level @0.75m (dBμV/m) | Measure Level @3m (dBμV/m) | Power Density ($pW/cm^2$) | Limit ($pW/cm^2$) | Margin (dB) | Detector | Polarization |
|---|---|---|---|---|---|---|---|---|---|
| 49.294 | 5.088 | 45.72 | 50.81 | 38.77 | 0.002 | 600 | -599.998 | Average | Horizontal |
| 49.144 | 6.884 | 45.78 | 52.66 | 40.62 | 0.003 | 600 | -599.997 | Average | Vertical |
| 60.452 | 23.090 | 41.51 | 64.60 | 52.56 | 0.048 | 600 | -599.952 | Average | Horizontal |
| 61.216 | 23.168 | 41.18 | 64.35 | 52.31 | 0.045 | 600 | -599.955 | Average | Vertical |
| 75.929 | 25.737 | 44.01 | 69.75 | 57.71 | 0.156 | 600 | -599.844 | Average | Horizontal |
| 75.943 | 27.037 | 44.01 | 71.05 | 59.01 | 0.211 | 600 | -599.789 | Average | Vertical |
| 83.081 | 26.708 | 44.20 | 70.91 | 58.87 | 0.204 | 600 | -599.796 | Average | Horizontal |
| 83.456 | 26.209 | 44.25 | 70.46 | 58.42 | 0.184 | 600 | -599.816 | Average | Vertical |
| 110.276 | 4.971 | 58.06 | 63.03 | 50.99 | 0.033 | 600 | -599.967 | Average | Horizontal |
| 110.368 | 5.024 | 58.06 | 63.08 | 51.04 | 0.034 | 600 | -599.966 | Average | Vertical |
| 141.386 | 5.363 | 61.25 | 66.61 | 54.57 | 0.076 | 600 | -599.924 | Average | Horizontal |
| 141.287 | 5.281 | 61.25 | 66.53 | 54.49 | 0.075 | 600 | -599.925 | Average | Vertical |
| 181.807 | 5.299 | 60.29 | 65.59 | 53.55 | 0.060 | 600 | -599.940 | Average | Horizontal |
| 189.185 | 5.414 | 61.33 | 66.74 | 54.70 | 0.078 | 600 | -599.922 | Average | Vertical |
| 228.989 | 5.409 | 60.05 | 65.46 | 53.42 | 0.058 | 1000 | -999.942 | Average | Horizontal |
| 228.482 | 5.375 | 60.05 | 65.43 | 53.38 | 0.058 | 1000 | -999.942 | Average | Vertical |

Notes:

1. Measure Level @0.75m ((dBμV/m)) = Reading Level @0.75m ((dBμV)) + Factor (dB/m)
   For below 110GHz: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m)
   For above 110GHz: Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m) + Mixer Conversion Loss (dB)
2. Measure Level @3m (dBμV/m) = Measure Level @0.75m (dBμV/m) + 20 * log(0.75m / 3m)
3. Power Density = $(10^8 / 377) * \{10^{[(\text{Measure Level @3m } -120) / 20]}\}^2$
4. Test Distance “d” = 0.75m, Test height “h” = 0.45m

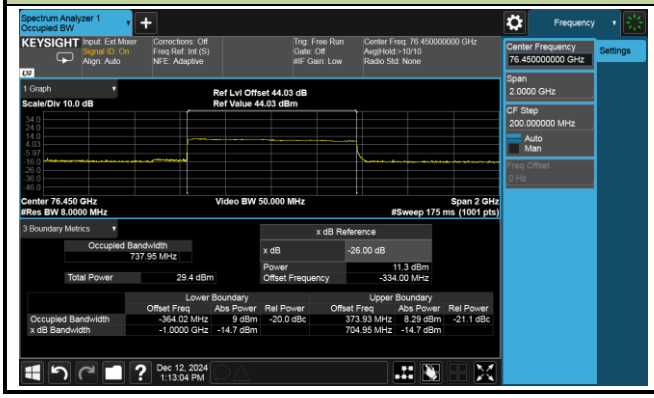
## A.4 Frequency Stability Test Result

| Test Site | SIP-TR1 | Test Engineer | Alisa Deng |
|---|---|---|---|
| Test Date | 2024-12-12 | | |

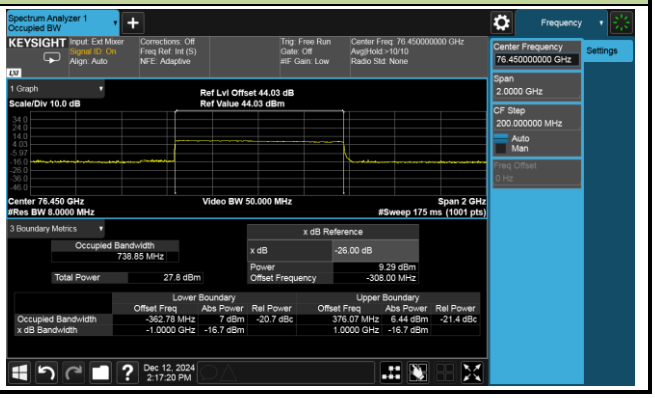
| Voltage (%) | Power (VDC) | Temp (°C) | $f_L$ (GHz) | $f_H$ (GHz) | Limit (GHz) | Result |
|---|---|---|---|---|---|---|
| 100 | 12.0 | - 20 | 76.08728 | 76.82354 | 76 ~ 81 | Pass |
| | | - 10 | 76.08722 | **76.82607** | 76 ~ 81 | Pass |
| | | 0 | 76.08623 | 76.82570 | 76 ~ 81 | Pass |
| | | + 10 | 76.08619 | 76.82481 | 76 ~ 81 | Pass |
| | | + 20 | **76.08598** | 76.82393 | 76 ~ 81 | Pass |
| | | + 30 | 76.81376 | 76.82378 | 76 ~ 81 | Pass |
| | | + 40 | 76.08599 | 76.82361 | 76 ~ 81 | Pass |
| | | + 50 | 76.08635 | 76.82301 | 76 ~ 81 | Pass |
| 115 | 13.8 | + 20 | 76.08628 | 76.82444 | 76 ~ 81 | Pass |
| 85 | 10.2 | + 20 | 76.08715 | 76.82383 | 76 ~ 81 | Pass |

Worse Case Test Data Plots

$f_L$




$f_H$



## Appendix B - Test Setup Photograph.

Refer to “2409RSU036-UT” file.

## Appendix C - EUT Photograph

Refer to “2409RSU036-UE” file.