# CE EMC Test Report

Issued date: Jun. 27, 2024

Project No.: 24Q030604

**Product :** Rugged Embedded System

**Model :** ECS-4700-PoE

**Series Model :** ECS-4700 Series, ECS-4XXXXXXXXXX ("X" can be 0-9, A-Z or blank for marketing purpose)

**Applicant :** Vecow Co., Ltd

**Address :** 3F, No. 10, Jiankang Rd., Zhonghe Dist., New Taipei City 23586, Taiwan

## Report No: WD-EE-R-240176-B0

## According to

| | |
|---|---|
| **EN 50121-1: 2017** | **BS EN 50121-1: 2017** |
| **EN 50121-3-2: 2016** | **BS EN 50121-3-2: 2016** |
| **EN 50155:2021, Clause 13.4.9** | **BS EN 50155:2021, Clause 13.4.9** |
| **EN 61000-3-2:2014, Class A** | **BS EN 61000-3-2:2014, Class A** |
| **EN IEC 61000-3-2:2019 + A1:2021, Class A** | **BS EN IEC 61000-3-2:2019 + A1:2021, Class A** |
| **EN 61000-3-3: 2013 + A1:2019 + A2:2021** | **BS EN 61000-3-3: 2013 + A1:2019 + A2:2021** |
| EN 61000-4-2: 2009 | BS EN 61000-4-2: 2009 |
| EN IEC 61000-4-3: 2020 | BS EN IEC 61000-4-3: 2020 |
| EN 61000-4-4: 2012 | BS EN 61000-4-4: 2012 |
| EN 61000-4-5: 2014 + A1: 2017 | BS EN 61000-4-5: 2014 + A1: 2017 |
| EN 61000-4-6: 2014 + AC: 2015 | BS EN 61000-4-6: 2014 + AC: 2015 |

**Authorized Signatory :** / Ken Huang

**Wendell Industrial Co., Ltd**
**Wendell EMC & RF Laboratory**
Add: 5F-1, No. 188, Baoqiao Road, Xindian District, New Taipei City 23145, Taiwan R.O.C.

Testing Laboratory 2965

# Table of Contents

# History of this test report

| Report No. | Issue date | Description |
|---|---|---|
| WD-EE-R-240176-B0 | Jun. 27, 2024 | Initial Issue |

**Declaration**

This report is for your exclusive use. Any copying or replication of this report to or for any other person or entity, or use of our name or trademark, is permitted only with our prior written permission. This report sets forth our findings solely with respect to the test samples identified herein. The results set forth in this report are not indicative or representative of the quality or characteristics of the lot from which a test sample was taken or any similar or identical product unless specifically and expressly noted. Our report includes all of the tests requested by you and the results thereof based upon the information that you provided to us.

# History of supplementary report

| Report No. | Issue date | Description |
|---|---|---|
| WD-EE-R-240176-B0 | Jun. 27, 2024 | Original report |

**Declaration**

This report is for your exclusive use. Any copying or replication of this report to or for any other person or entity, or use of our name or trademark, is permitted only with our prior written permission. This report sets forth our findings solely with respect to the test samples identified herein. The results set forth in this report are not indicative or representative of the quality or characteristics of the lot from which a test sample was taken or any similar or identical product unless specifically and expressly noted. Our report includes all of the tests requested by you and the results thereof based upon the information that you provided to us.

# 1 Certification

| | |
|---|---|
| **Product:** | Rugged Embedded System |
| **Model:** | ECS-4700-PoE |
| **Series Model:** | ECS-4700 Series, ECS-4XXXXXXXXXX ("X" can be 0-9, A-Z or blank for marketing purpose) |
| **Applicant:** | Vecow Co., Ltd |
| **Tested:** | Mar. 16 ~ Jun. 20, 2024 |
| **Standard:** | **EN 50121-1: 2017**<br>**EN 50121-3-2: 2016**<br>**EN 50155:2021, Clause 13.4.9**<br>**EN 61000-3-2:2014, Class A**<br>**EN IEC 61000-3-2:2019 + A1:2021, Class A**<br>**EN 61000-3-3: 2013 + A1:2019 + A2:2021**<br>EN 61000-4-2: 2009<br>EN IEC 61000-4-3: 2020<br>EN 61000-4-4: 2012<br>EN 61000-4-5: 2014 + A1: 2017<br>EN 61000-4-6: 2014 + AC: 2015<br>**BS EN 50121-1: 2017**<br>**BS EN 50121-3-2: 2016**<br>**BS EN 50155:2021, Clause 13.4.9**<br>**BS EN 61000-3-2:2014, Class A**<br>**BS EN IEC 61000-3-2:2019 + A1:2021, Class A**<br>**BS EN 61000-3-3: 2013 + A1:2019 + A2:2021**<br>BS EN 61000-4-2: 2009<br>BS EN IEC 61000-4-3: 2020<br>BS EN 61000-4-4: 2012<br>BS EN 61000-4-5: 2014 + A1: 2017<br>BS EN 61000-4-6: 2014 + AC: 2015 |

The above equipment (Model: ECS-4700-PoE) has been tested by **Wendell EMC & RF Laboratory**, and found compliance with the requirement of the above standards. The test record, data evaluation and Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Please note that the measurement uncertainty are provided for informational purpose only and are not used in determining the Pass/Fail results.

## 1.1 Summary of Test Result

The EUT has been tested according to the following specifications:

| Emission | | | |
|---|---|---|---|
| **Basic Standard** | **Test Item** | **Result** | **Remark** |
| EN 55016-2-1 | Conducted disturbance at mains terminals | Pass | Meets the requirements |
| EN IEC 61000-6-4 | Radiated disturbance | Pass | Meets the requirements |
| EN 61000-3-2 | Harmonic current emissions | Pass | The power consumption of EUT is less than 75W and no limits apply |
| EN 61000-3-3 | Voltage fluctuations and flicker | Pass | Meets the requirements |

| Immunity | | | |
|---|---|---|---|
| **Basic Standard** | **Test Item** | **Result** | **Remark** |
| EN 61000-4-2 | Electrostatic discharges (ESD) | Pass | Meets the requirements of Performance Criterion B |
| EN IEC 61000-4-3 | Radiated, Radio-frequency, Electromagnetic field immunity test (RS) | Pass | Meets the requirements of Performance Criterion A |
| EN 61000-4-4 | Electrical fast transient immunity test (EFT) | Pass | Meets the requirements of Performance Criterion A |
| EN 61000-4-5 | Surges immunity test | Pass | Meets the requirements of Performance Criterion A |
| EN 61000-4-6 | Radio-frequency common mode (CS) | Pass | Meets the requirements of Performance Criterion A |

**Note:** Test record contained in the referenced test report relate only to the EUT sample and test item.

# 2 Test Configuration of Equipment Under Test

## 2.1 Test Facility

**Conducted disturbance at mains terminals, Harmonics, Flicker, ESD, EFT, Surge and CS Tests**

W01: 5F-1, No.188, Baoqiao Rd., Xindian Dist., New Taipei City 23145, Taiwan R.O.C.

**RS Test**

W05: 1F-7, No.188, Baoqiao Rd., Xindian Dist., New Taipei City 23145, Taiwan R.O.C.

**Conducted disturbance at mains terminals and Radiated emission (9*6*6 Chamber) Tests**

W08: No.119, Wugong 3rd Rd., Wugu Dist., New Taipei City 248, Taiwan (R.O.C)

ACCREDITATIONS

The laboratories are accredited and approved by the TAF according to ISO/EN 17025.

## 2.2 Measurement Uncertainty

The measurement instrumentation uncertainty is evaluated according to CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Wendell EMC & RF Laboratory $U_{lab}$ is less than $U_{cispr}$, therefore compliance or non-compliance with a disturbance limit shall be determined in the following manner.

– compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit;

– non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.

Please note that the measurement uncertainty ($U_{lab}$) is provided for informational purpose only and is not used in determining the Pass/Fail results.

### 2.2.1 Conducted Emission test

| Test Site | Measurement Freq. Range | dB ($U_{lab}$) | Note |
|---|---|---|---|
| W01-CE | 150 kHz ~ 30 MHz | 2.75 | N/A |
| W08-CE | 150 kHz ~ 30 MHz | 2.76 | N/A |

### 2.2.2 Radiated Emission test

| Test Site | Measurement Freq. Range | Ant | dB ($U_{lab}$) | Note |
|---|---|---|---|---|
| W08-966-1 | 30 MHz ~ 200 MHz | V | 3.78 | N/A |
| | 30 MHz ~ 200 MHz | H | 2.69 | N/A |
| | 200 MHz ~ 1000 MHz | V | 4.91 | N/A |
| | 200 MHz ~ 1000 MHz | H | 3.40 | N/A |
| | 1 GHz ~ 6 GHz | V | 4.48 | N/A |
| | 1 GHz ~ 6 GHz | H | 4.33 | N/A |

# 3 General Information

## 3.1 Description of EUT

| | |
|---|---|
| **Product** | Rugged Embedded System |
| **Model** | ECS-4700-PoE |
| **Series Model** | ECS-4700 Series, ECS-4XXXXXXXXXX ("X" can be 0-9, A-Z or blank for marketing purpose) |
| **Applicant** | Vecow Co., Ltd |
| **Received Date** | Mar. 07, 2024 |
| **EUT Power Rating** | 24Vdc (from adapter) |
| **Model Differences** | The models are electrically identical, different models no. are for marketing purpose. The series model information is provided by client. |
| **Operating System** | WIN 11, Burnintest |
| **Data Cable Supplied** | N/A |
| **Accessory Device** | N/A |
| **I/O Port** | Please refer to the User's Manual |

**Note:**

1. The EUT uses the follow adapter:

| **Adapter (support unit only)** | |
|---|---|
| **Brand** | FSP |
| **Model** | FSP120-AAAN2 |
| **Input Power** | 100-240Vac, 1.8A, 50-60Hz |
| **Output Power** | 24Vdc, 5A |
| **Power line** | Input: 1.8m non-shielded cable<br>Output: 1.6m non-shielded cable with 1 core |

2. The EUT contains following components.

| **Item** | **Brand** | **Model** | **Spec.** | **Qty.** |
|---|---|---|---|---|
| Main Board | - | ECS-4700 | Rev. B | 1 |
| CPU | Intel | 13th Gen Intel® Core™ i7-1365UE | 1.70 GHz | 1 |
| RAM | innodisk | M5D0-BGS2Q5VP-H03 | 32GB DDR5 4800 W/T ECC SODIMM | 2 |
| SSD | innodisk | DGS25-C12M71EW3QF-H03 | 512GB 2.5" SATA SSD 3TG6-P | 2 |
| M.2 SSD | innodisk | DGM28-01TDP1KWAEF-H03 | M.2(P80) 4TG2-P 1TB | 1 |

3. The EUT's highest operating frequency is 1.7GHz. Therefore the radiated emission is tested up to 6GHz.

## 3.2 Description of Test Modes

Test results are presented in the report as below.

| Test Mode | Test Condition |
|---|---|
| **Conducted emission test** | |
| - | Adapter mode |
| **Radiated emission 30MHz ~ 1GHz test** | |
| - | Adapter mode |
| **Radiated emission above 1GHz test** | |
| - | Adapter mode |
| **Harmonics, Flicker and Immunity test** | |
| - | Adapter mode |

## 3.3 EUT Operating Condition

a. Placed the EUT on the test table.
b. Prepare PC to act as a communication partner and placed it outside of testing area.
c. The EUT was connected to the PC with LAN cable.
d. The communication partner sent data to EUT by command "ping" via LAN.
e. The IPCAM sent signal to EUT through PoE supply LAN cable.
f. The EUT read and write data with Internal HDD, External HDD & SSD.
g. The EUT run test program "BurnIN.exe" to enable all functions.
h. The EUT sent "Color Bar ITU-R.BT471-1" signal to monitor and displayed on screen.
i. The microphone sent voice signal to EUT.
j. The EUT sent voice signal to earphone.

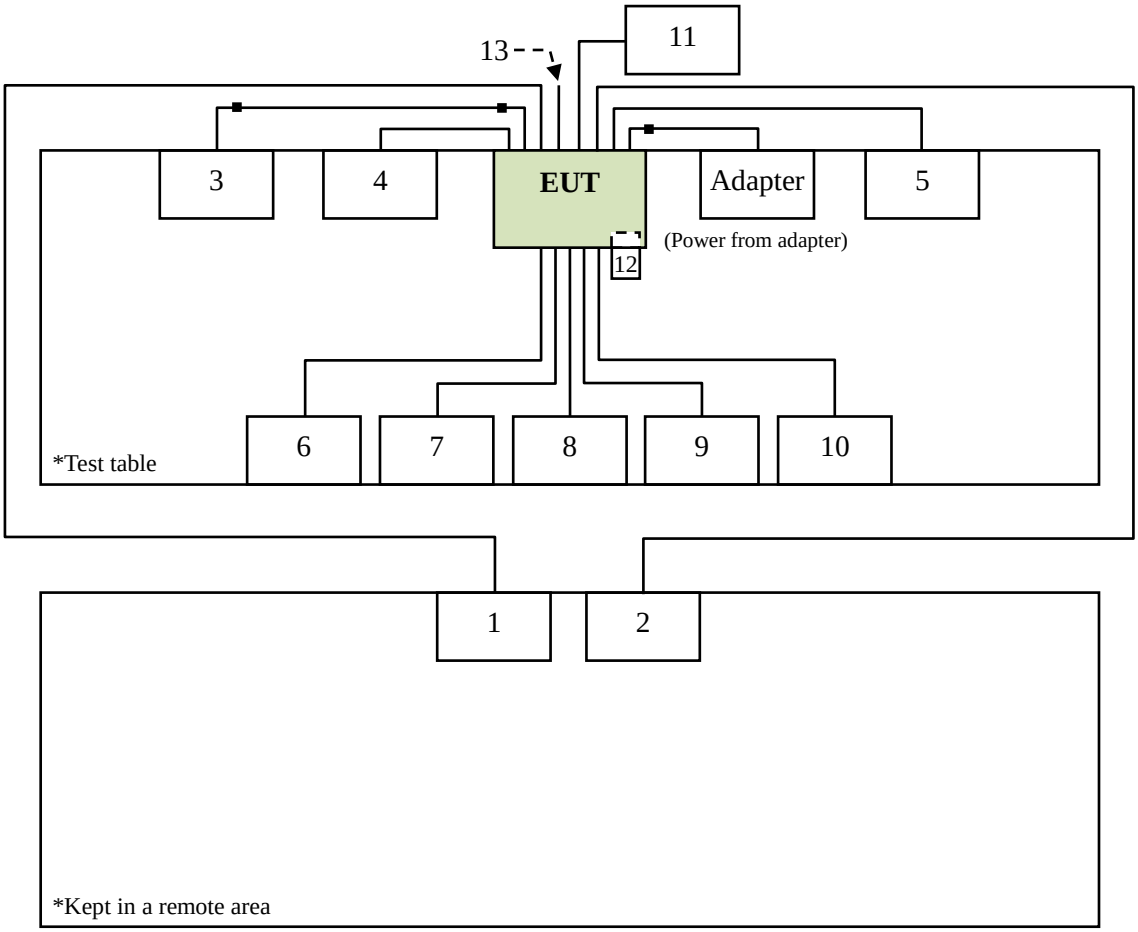
## 3.4 Description of Support Unit

The EUT has been conducted testing with other necessary accessories or support units.

| Item | Equipment | Brand | Model No. | Serial No. | FCC ID | Data Cable | Power Cable | Remark |
|---|---|---|---|---|---|---|---|---|
| 1 | Desktop PC | DELL | D19M | N/A | PPD-QCNFA335 | 20m CAT.5E non-shielded RJ45 cable | 1.8m non-shielded cable | - |
| 2 | Desktop PC | DELL | D13M | H6K10 A00 | FCC DoC Approved | 20m CAT.5E non-shielded RJ45 cable | 1.8m non-shielded cable | - |
| 3 | 4K monitor | PHILIPS | 276E8V | UKC1926000458 | FCC DoC Approved | 1.5m shielded HDMI cable with 2 cores | AC: 1.8m non-shielded cable DC: 1.4m non-shielded cable with 1 core | - |
| 4 | 4K monitor | HP | HP 27f 4k Display | 3CM01916TF | FCC DoC Approved | 1.7m shielded DP cable | AC: 1.8m non-shielded cable DC: 1.4m non-shielded cable with 1 core | - |
| 5 | 4K monitor | HP | HP 27f 4k Display | 3CM01935TF | FCC DoC Approved | 1.7m shielded DP cable | AC: 1.8m non-shielded cable DC: 1.4m non-shielded cable with 1 core | - |
| 6 | Keyboard | Logitech | Y-U0009 | 1710SC500LA8 | FCC DoC Approved | 1.5m non-shielded cable | N/A | |
| 7 | Mouse | Logitech | M-U0026 | HS726HB | FCC DoC Approved | 2m non-shielded cable | N/A | - |
| 8 | Earphone & microphone | E-books | E-EPA057 | N/A | N/A | 1.4m non-shielded cable | N/A | - |
| 9 | External hard drive (x2) | Transcend | TS1TSJ25C3N | D62397-0399 | FCC DoC Approved | 1m shielded cable | N/A | - |
| 10 | External portable SSD | Transcend | TS120GESD240C | F96474-0001 | FCC DoC Approved | 1m shielded cable | N/A | - |
| 11 | IP CAM (x4) | N/A | MBL030A-ORZ0310 | N/A | N/A | 1m CAT.5E non-shielded RJ45 cable | N/A | Use shielded cable only for ESD, RS, Surge and CS<br><br>Supplied by client |
| 12 | RS232 terminator (x4) | N/A | N/A | N/A | N/A | N/A | N/A | Supplied by client |
| 13 | Multi conductor cable | N/A | N/A | N/A | N/A | 1.2m non-shielded cable | N/A | - |

**Note:** 1. The core(s) is(are) originally attached to the cable(s).
2. Item 1-2 acted as communication partners to transfer data.

## 3.5 Configuration of System Under Test



# 4 Emission Test

## 4.1 Conducted Emission Measurement

### 4.1.1 Limit of Conducted Emission Measurement

| Frequency (MHz) | EN 50121-3-2 |
|---|---|
| | Quasi-peak (dBμV) |
| 0.15 to 0.5 | 99 |
| 0.5 to 30.0 | 93 |

**Note:** 1. The lower limit shall apply at the transition frequencies.
2. Detector function in the form: QP = Quasi Peak
3. The test result calculated as following:
Measurement Value = Reading Level + Correct Factor
Correction Factor = Insertion loss of LISN + Cable loss + Transient Limiter (If use)
Margin Level = Measurement Value –Limit Value

## 4.1.2 Test Instrument

| Test Site: W01-CE | | | | | |
|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model** | **Meter No.** | **Calibration Date** |
| 1 | TWO-LINE V-NETWORK | R&S | ENV216 | CT-1-025-1 | Jun. 05, 2024 |
| 2 | Pulse limiter | R&S | ESH3-Z2 | CT-2-015 | Jun. 06, 2024 |
| 3 | EMI Test Receiver | R&S | ESCI | CT-1-024 | Jun. 06, 2024 |
| 4 | Artificial Mains Network (AMN) | SCHWARZBECK | NSLK 8127 | CT-1-104-1 | Jun. 06, 2024 |
| 5 | RF Cable | MVE | 200200.400LL .500A | CT-9-101 | Jun. 06, 2024 |
| 6 | 50ohm Termination | N/A | N/A | CT-1-065-1 | May 30, 2024 |
| 7 | Measurement Software | EZ-EMC | Ver: EMC-CON 3A1 | CT-3-012 | No calibration request |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

| Test Site: W08-CE | | | | | |
|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model** | **Meter No.** | **Calibration Date** |
| 1 | TWO-LINE V-NETWORK | R&S | ENV216 | CT-1-025-2 | Jun. 16, 2023 |
| 2 | RF Cable | EMCI | EMCCFD300-BM-BM-5000 | CT-1-107-2 | Jun. 17, 2023 |
| 3 | EMI Test Receiver | R&S | ESR3 | CT-1-103 | Jun. 19, 2023 |
| 4 | Artificial Mains Network (AMN) | SCHWARZBECK | NSLK 8127 RC | CT-1-104-1RC | Jun. 16, 2023 |
| 5 | Transient Limiter | Electro-Metrics | EM-7600 | CT-1-026 | Jun. 17, 2023 |
| 6 | 50ohm Termination | N/A | N/A | CT-1-109-1 | Jun. 16, 2023 |
| 7 | Measurement Software | EZ-EMC | Ver: EMC-CON 3A1 | CT-3-012 | No calibration request |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

### 4.1.3 Test Procedure

a. The table-top EUT was placed 0.8 meter height wooden table from the horizontal ground plane with EUT being connected to power source through a line impedance stabilization network (LISN). The floor-standing EUT was placed insulation support unit from the horizontal ground plane. The LISN at least be 80 cm from nearest chassis of EUT.

b. The line impedance stabilization network (LISN) provides 50 ohm/50uH of coupling impedance for the measuring instrument. All other support equipments powered from additional LISN(s).

c. Interrelating cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle. All I/O cables were positioned to simulate typical usage.

d. All I/O cables that are not connected to a peripheral shall be bundle in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

e. The EMI test receiver connected to LISN powering the EUT. The actual test configuration, please refer to EUT test photos.

f. The receiver scanned from 150kHz to 30MHz for emissions in each of test modes. A scan was taken on both power lines, Line and Neutral, recording at least six highest emissions.

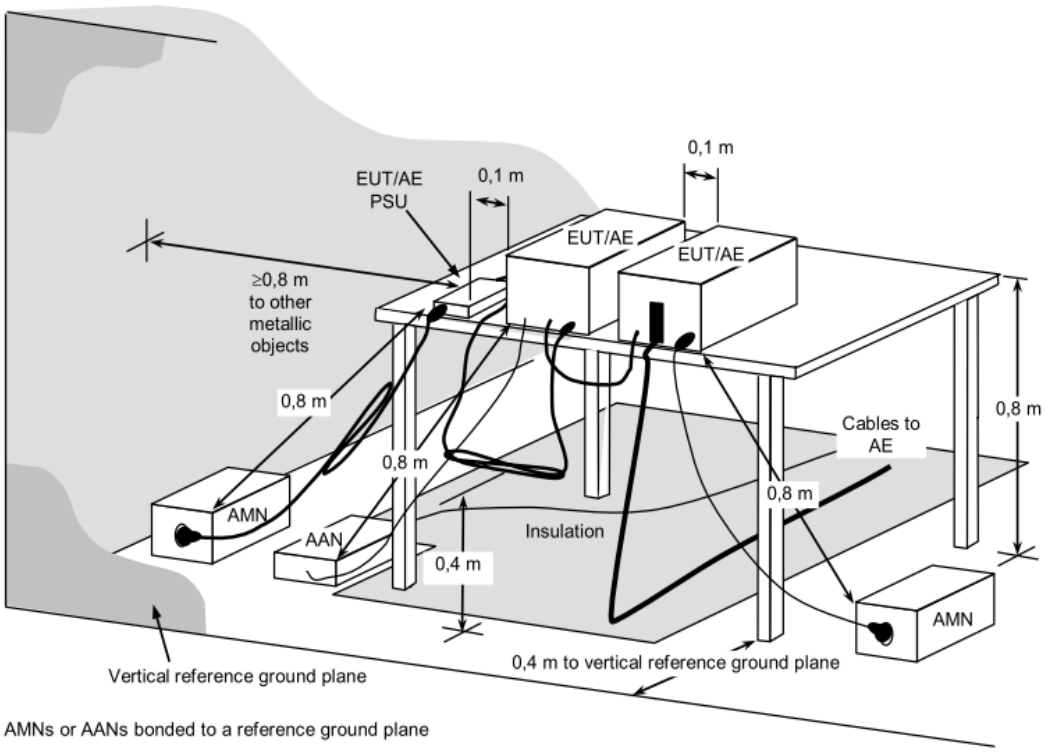
g. The EUT and cable configuration of the above highest emission levels were recorded. The test data of the worst case was recorded.

### 4.1.4 Deviation from Test Standard

No deviation

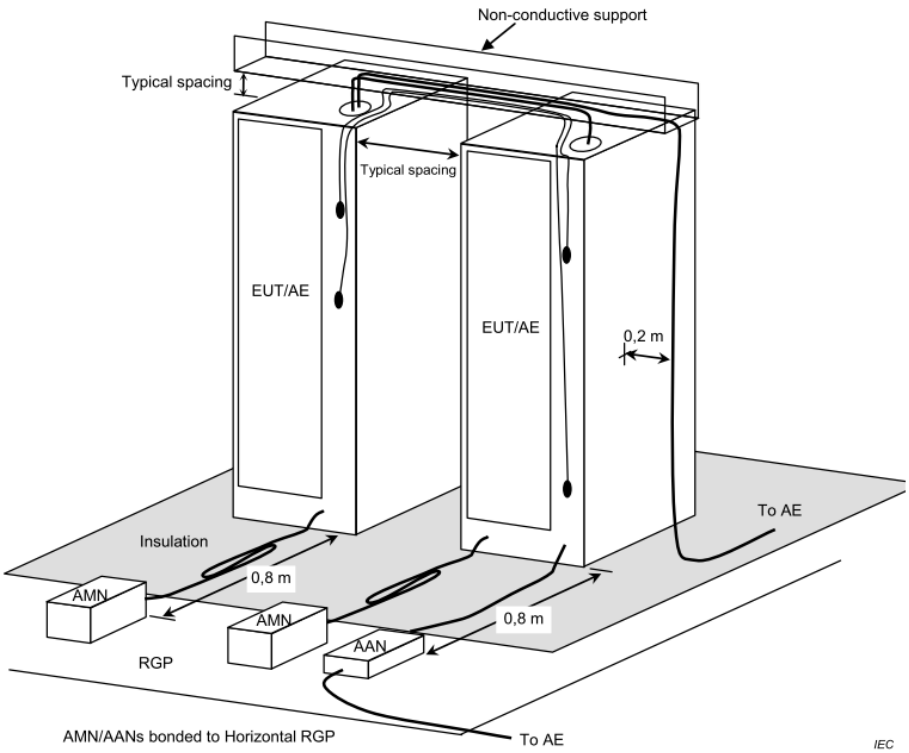
## 4.1.5 Test Setup

**< Table-Top equipment >**




AMNs or AANs bonded to a reference ground plane

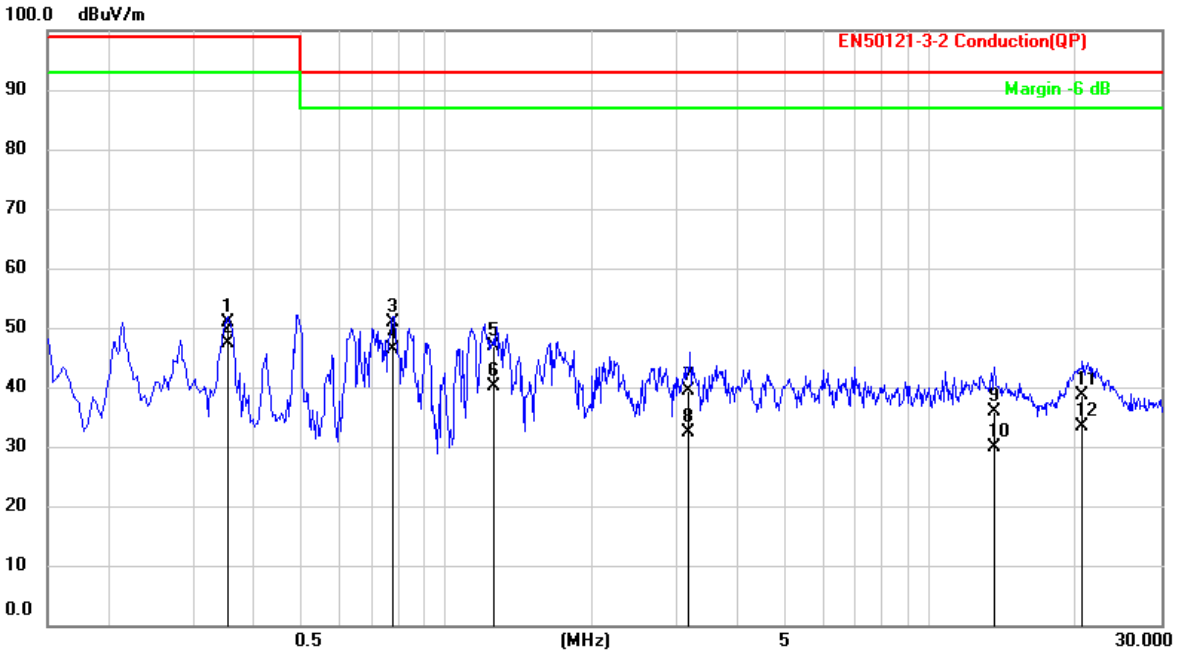
**< Floor-Standing equipment >**




**Note:** Please refer to 4.1.7 for the actual test configuration.

## 4.1.6 Test Result

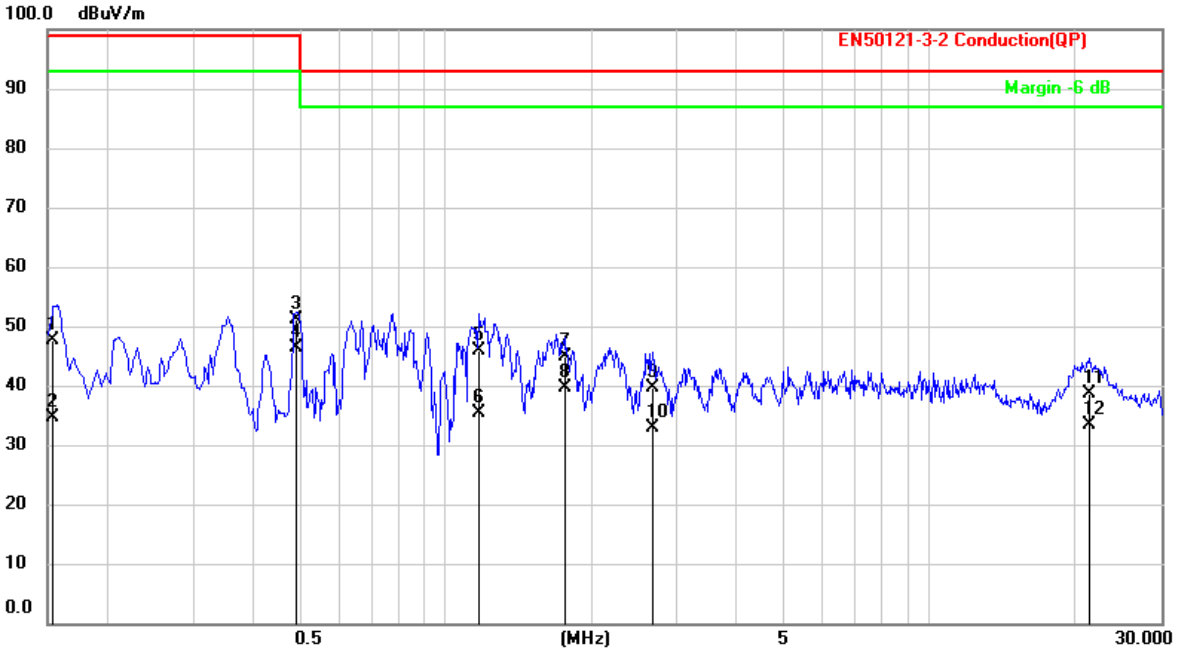
| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Frequency Range** | 0.15-30 MHz |
| **Environmental Conditions** | 21℃, 51% RH | **6dB Bandwidth** | 9 kHz |
| **Test Date** | 2024/03/22 | **Phase** | L |
| **Tested by** | Andy Li | **Test Site** | W01-CE |




| No. | Frequency (MHz) | Reading Level (dBµV) | Correct Factor (dB) | Measurement (dBµV) | Limit (dBµV) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 0.3537 | 40.83 | 9.95 | 50.78 | 99.00 | -48.22 | QP |
| 2 | 0.3537 | 37.40 | 9.95 | 47.35 | 99.00 | -51.65 | AVG |
| 3 | 0.7773 | 40.95 | 9.97 | 50.92 | 93.00 | -42.08 | QP |
| 4 | 0.7773 | 36.47 | 9.97 | 46.44 | 93.00 | -46.56 | AVG |
| 5 | 1.2574 | 36.88 | 9.98 | 46.86 | 93.00 | -46.14 | QP |
| 6 | 1.2574 | 30.12 | 9.98 | 40.10 | 93.00 | -52.90 | AVG |
| 7 | 3.1595 | 29.32 | 10.04 | 39.36 | 93.00 | -53.64 | QP |
| 8 | 3.1595 | 22.40 | 10.04 | 32.44 | 93.00 | -60.56 | AVG |
| 9 | 13.5630 | 25.70 | 10.25 | 35.95 | 93.00 | -57.05 | QP |
| 10 | 13.5630 | 19.75 | 10.25 | 30.00 | 93.00 | -63.00 | AVG |
| 11 | 20.6165 | 28.36 | 10.34 | 38.70 | 93.00 | -54.30 | QP |
| 12 | 20.6165 | 22.96 | 10.34 | 33.30 | 93.00 | -59.70 | AVG |

**Remark:** 1. QP = Quasi Peak, AVG = Average
2. Correction Factor = Insertion loss of LISN + Cable loss
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Measurement Value –Limit Value

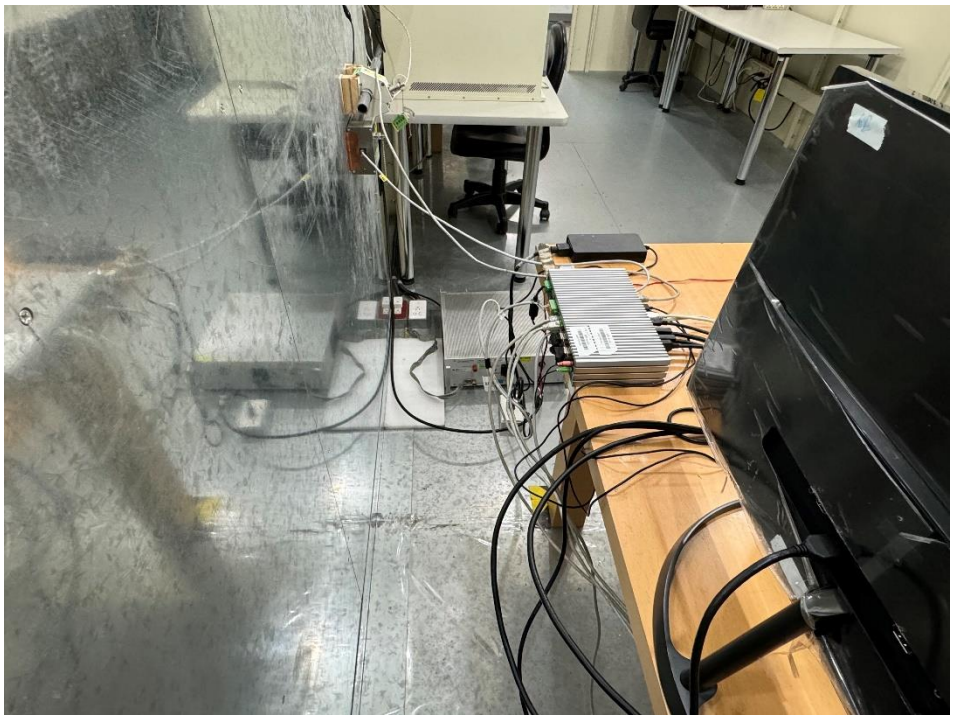
| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Frequency Range** | 0.15-30 MHz |
| **Environmental Conditions** | 21℃, 51% RH | **6dB Bandwidth** | 9 kHz |
| **Test Date** | 2024/03/22 | **Phase** | N |
| **Tested by** | Andy Li | **Test Site** | W01-CE |




| No. | Frequency (MHz) | Reading Level (dBµV) | Correct Factor (dB) | Measurement (dBµV) | Limit (dBµV) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|---|
| 1 | 0.1539 | 37.74 | 9.97 | 47.71 | 99.00 | -51.29 | QP |
| 2 | 0.1539 | 24.62 | 9.97 | 34.59 | 99.00 | -64.41 | AVG |
| 3 | 0.4899 | 41.18 | 9.97 | 51.15 | 99.00 | -47.85 | QP |
| 4 | 0.4899 | 36.52 | 9.97 | 46.49 | 99.00 | -52.51 | AVG |
| 5 | 1.1730 | 35.80 | 10.00 | 45.80 | 93.00 | -47.20 | QP |
| 6 | 1.1730 | 25.44 | 10.00 | 35.44 | 93.00 | -57.56 | AVG |
| 7 | 1.7592 | 34.93 | 10.03 | 44.96 | 93.00 | -48.04 | QP |
| 8 | 1.7592 | 29.48 | 10.03 | 39.51 | 93.00 | -53.49 | AVG |
| 9 | 2.6609 | 29.63 | 10.06 | 39.69 | 93.00 | -53.31 | QP |
| 10 | 2.6609 | 22.70 | 10.06 | 32.76 | 93.00 | -60.24 | AVG |
| 11 | 21.1961 | 28.30 | 10.42 | 38.72 | 93.00 | -54.28 | QP |
| 12 | 21.1961 | 22.99 | 10.42 | 33.41 | 93.00 | -59.59 | AVG |

**Remark:** 1. QP = Quasi Peak, AVG = Average
2. Correction Factor = Insertion loss of LISN + Cable loss
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Measurement Value –Limit Value

### 4.1.7 Photographs of Test Configuration



## 4.2 Radiated Emission Measurement

### 4.2.1 Limits of Radiated Emission Measurement

**Radiated Frequency range 30 MHz to 1000 MHz**

| Frequency (MHz) | EN 50121-3-2 (at 3m) |
|---|---|
| | Quasi Peak (dBµV/m) |
| 30 to 230 | 50 |
| 230 to 1000 | 57 |

**Note:** 1. The lower limit shall apply at the transition frequency.

**Radiated Frequency range above 1 GHz**

| Frequency (GHz) | EN 50121-3-2 (at 3m) | |
|---|---|---|
| | Average (dBµV/m) | Peak (dBµV/m) |
| 1 to 3 | 56 | 76 |
| 3 to 6 | 60 | 80 |

**Note:** 1. The lower limit shall apply at the transition frequency.
2. Detector function in the form: PK = Peak, QP = Quasi Peak, AV = Average
3. The test result calculated as following:
Measurement Value = Reading Level + Correct Factor
Correction Factor = Antenna factor + Cable loss (Antenna to preamplifier ) - preamplifier Gain + Cable loss (preamplifier to receiver )
Margin Level = Measurement Value - Limit Value
4. Maximum internal signal source is defined as the maximum frequency of the device under test, or EUT highest frequency tuning of the operation or in the production or use of the device under test.
5. If the highest internal frequency of the EUT is less than 108MHz, the measurement shall only be made up to 1GHz.
6. If the highest internal frequency of the EUT is between 108MHz and 500MHz, the measurement shall only be made up to 2GHz.
7. If the highest internal frequency of the EUT is between 500MHz and 1GHz, the measurement shall only be made up to 5GHz.
8. If the highest internal frequency of the EUT is above 1 GHz, the measurement shall be made up to 6 GHz. Where the highest internal frequency is not known, tests shall be performed up to 6GHz.

## 4.2.2 Test Instrument

| Test Site: W08-966-1 | | | | | |
|---|---|---|---|---|---|
| **Item** | **Equipment** | **Manufacturer** | **Model** | **Meter No.** | **Calibration Date** |
| 1 | Horn Antenna | Schwarzbeck | BBHA 9120D | CT-9-031 | Jul. 31, 2023 |
| 2 | Horn Antenna | Schwarzbeck | BBHA 9170 | CT-9-032 | Aug. 21, 2023 |
| 3 | TRILOG Broadband Antenna with 6 dB Attenuator | Schwarzbeck & MVE | VULB 9168 & MVE2251-06 | CT-1-096-1 | May 06, 2024 |
| 4 | Spectrum Analyzer | Agilent | E4407B | CT-1-003(1) | Aug. 02, 2023 |
| 5 | EXA Signal Analyzer | Keysight | N9010A | CT-1-093 | Aug. 18, 2023 |
| 6 | EMI Test Receiver | Keysight | N9038A | CT-9-007 | Aug. 02, 2023 |
| 7 | Preamplifier | EM | EM 330 | CT-9-024 | Aug. 03, 2023 |
| 8 | Preamplifier | SGH & MCL | SGH118 & BW-S15W2+ | CT-9-071 | Aug. 03, 2023 |
| 9 | Preamplifier | EMCI | EMC184045SE | CT-9-013 | Aug. 22, 2023 |
| 10 | Test Cable | EMCI | EMCCFD400-NM-NM-1000 | CT-1-132 | Aug. 03, 2023 |
| 11 | Test Cable | PEWC | CFD400NL-LW-NM-NM-3000 | CT-1-141 | Aug. 03, 2023 |
| 12 | Test Cable | EMCI | EMCCFD400-NM-NM-15000 | CT-1-133 | Aug. 03, 2023 |
| 13 | Test Cable | EMCI | EMC104-SM-35M-600 | CT-1-134 | Aug. 03, 2023 |
| 14 | Test Cable | MVE | 280280.LL266.1400 | CT-9-072 | Aug. 03, 2023 |
| 15 | Test Cable | EMCI | EMC102-KM-KM-600 | CT-1-136 | Aug. 22, 2023 |
| 16 | Measurement Software | EZ-EMC | Ver :WD-03A1-1 | CT-3-012 | No calibration request |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

## 4.2.3 Test Procedure

a. The table-top EUT was placed on the top of a turntable 0.8 meters above the ground at 3 m 966 chamber. The floor-standing EUT was placed insulation support unit from the horizontal ground plane. The table was rotated 360 degrees to determine the position of the high radiation emissions.

b. The height of the test antenna shall vary between 1 m to 4 m. Both vertical and horizontal polarizations of the antenna were set to make the measurement.

c. The EUT was set up as per the test configuration to simulate typical usage per the user's manual. All I/O cables were positioned to simulate typical usage. The actual test configuration, please refer to EUT test photos.

d. The initial step in collecting radiated emission data is a Spectrum Mode scanning the measurement frequency range.

**Below 1GHz:**

Reading in which marked as QP or Peak means measurements by using Spectrum Mode with detector RBW=120kHz.

If the Spectrum Mode measured peak value compliance with and lower than Quasi Peak Limit, the EUT shall be deemed to meet QP Limits.

**Above 1GHz:**

Reading in which marked as Peak & AVG means measurements by using Spectrum Mode with setting in RBW=1MHz.

If the Spectrum Mode measured value compliance with the Peak Limits and lower than AVG Limits, the EUT shall be deemed to meet both Peak and AVG Limits.

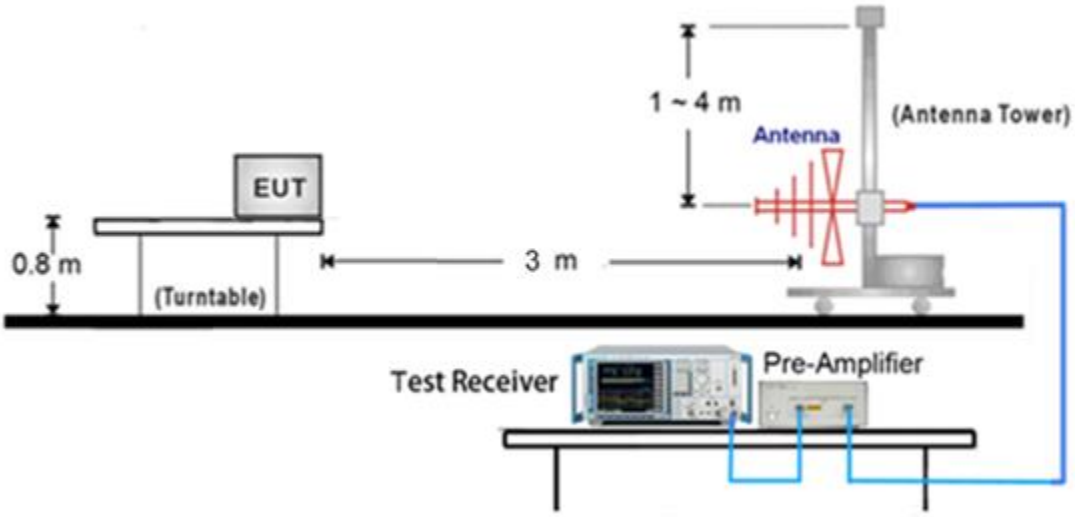
e. Emission frequency and amplitude were recorded, recording at least six highest emissions. The EUT and cable configuration of the above highest emission levels were recorded. The test data of the worst case was recorded.

## 4.2.4 Deviation from Test Standard

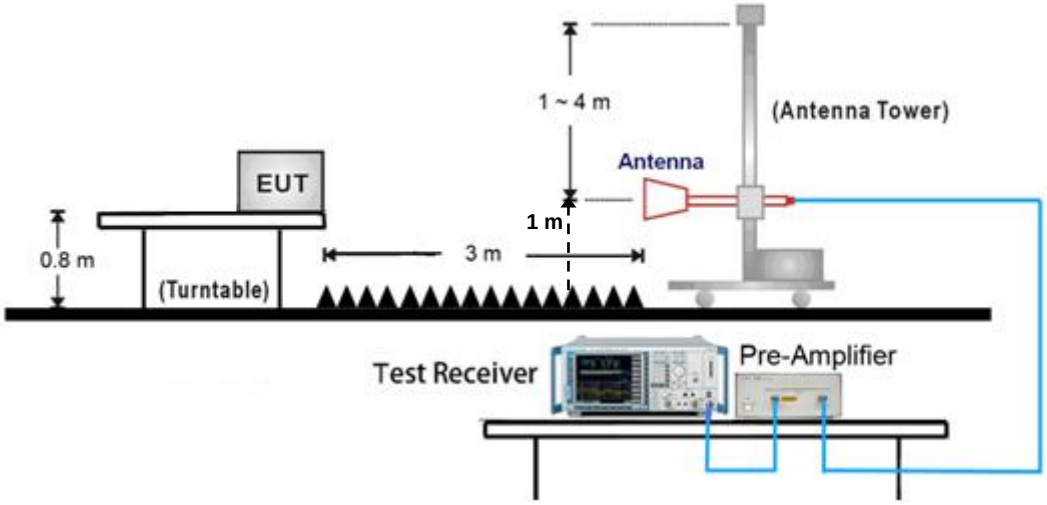
No deviation

## 4.2.5 Test Setup

**< Radiated Emissions Frequency: 30 MHz to 1000 MHz >**



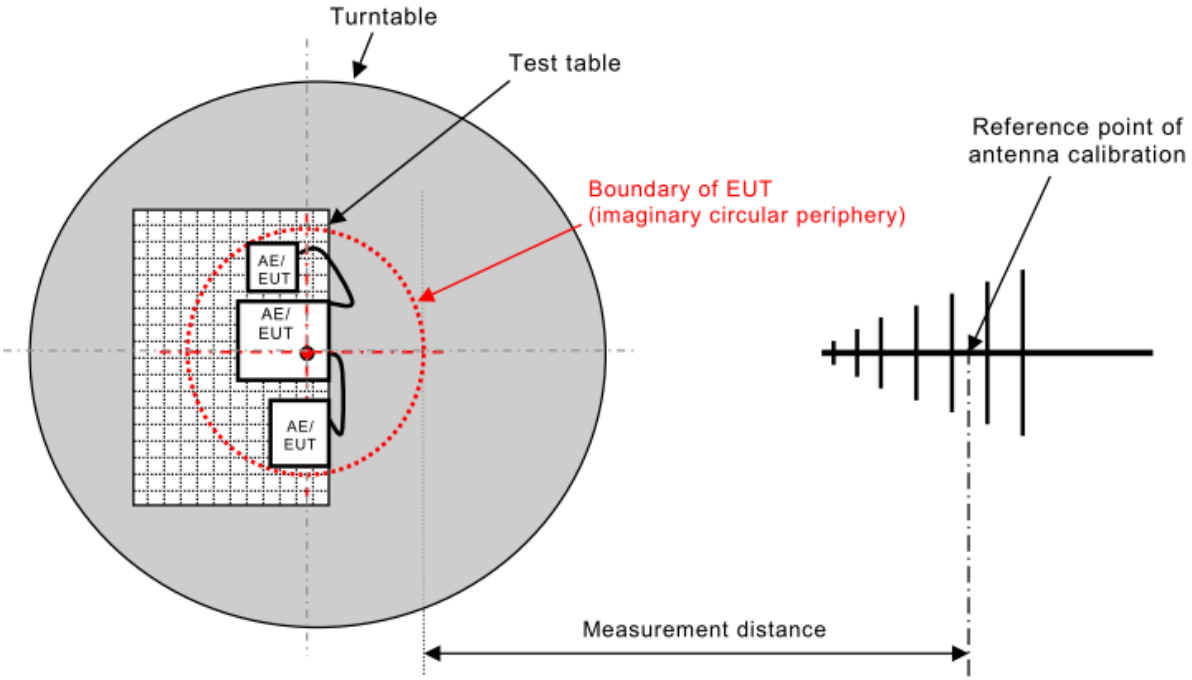

**< Radiated Emissions Frequency: above 1GHz >**



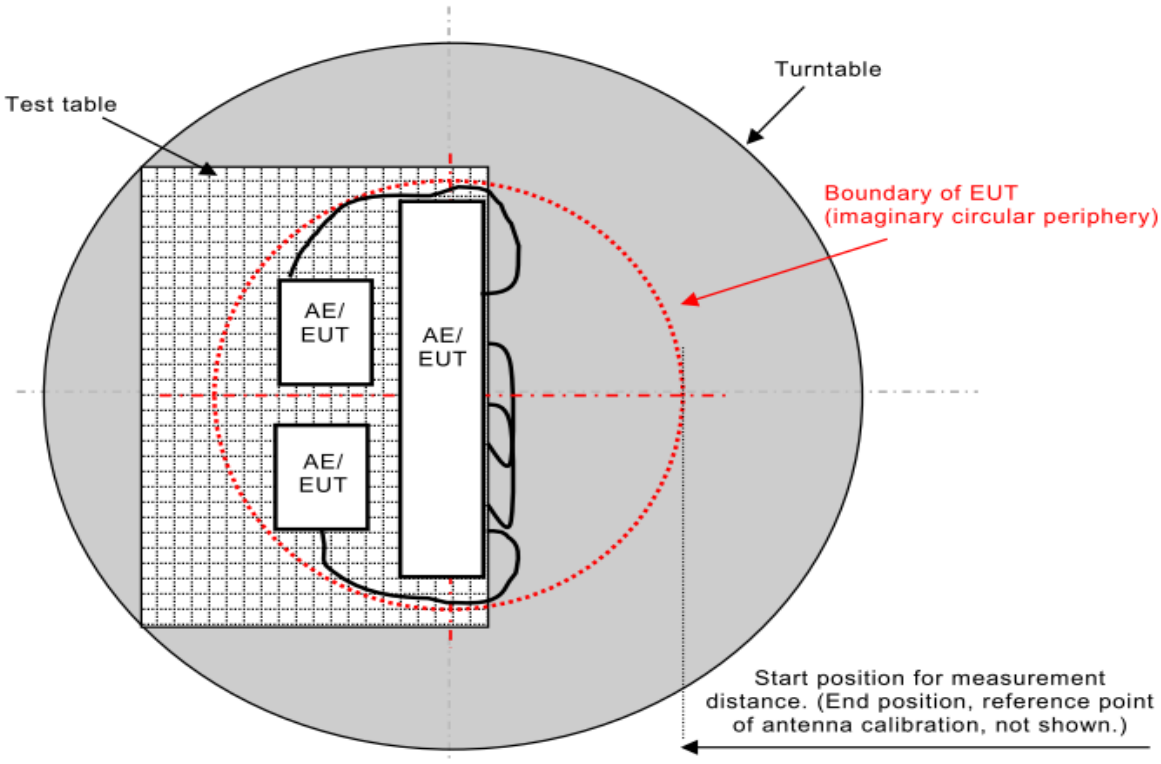

**Note:**

(1) Please refer to the 4.3.7 for the actual test configuration.
(2) The formula of measured value as: Test Result = Reading + Correction Factor
(3) Detector function in the form: PK = Peak, QP = Quasi Peak, AV = Average
(4) The test result calculated as following:
Measurement Value = Reading Level + Correct Factor
Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain (if use)
Margin Level = Measurement Value - Limit Value

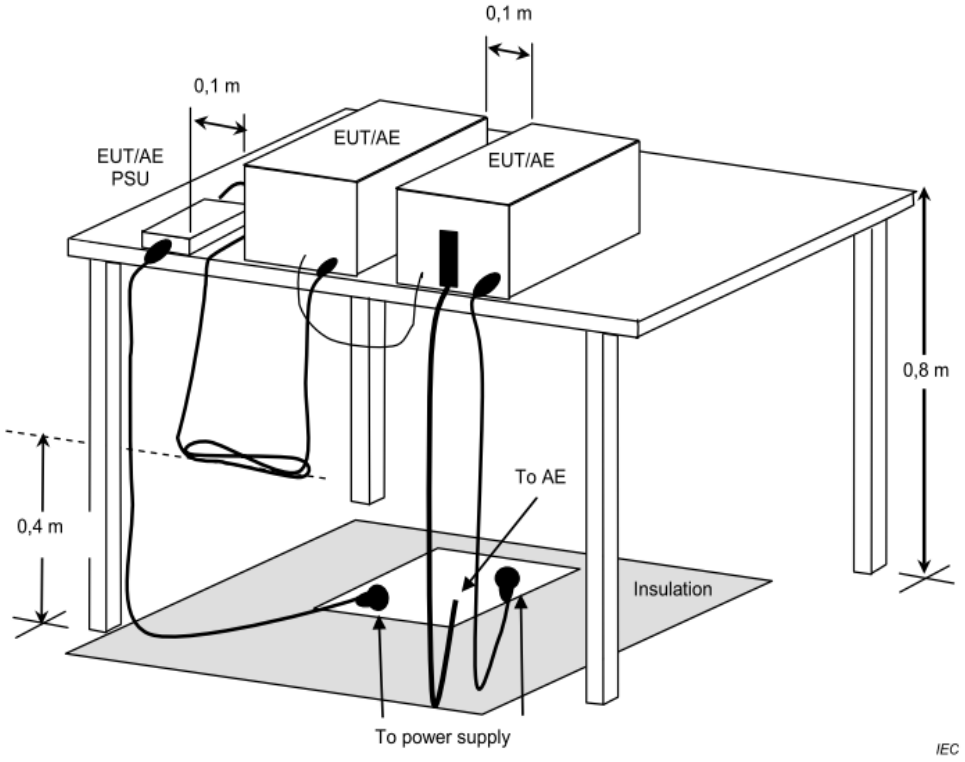
**< EUT placement top view and measurement distance >**



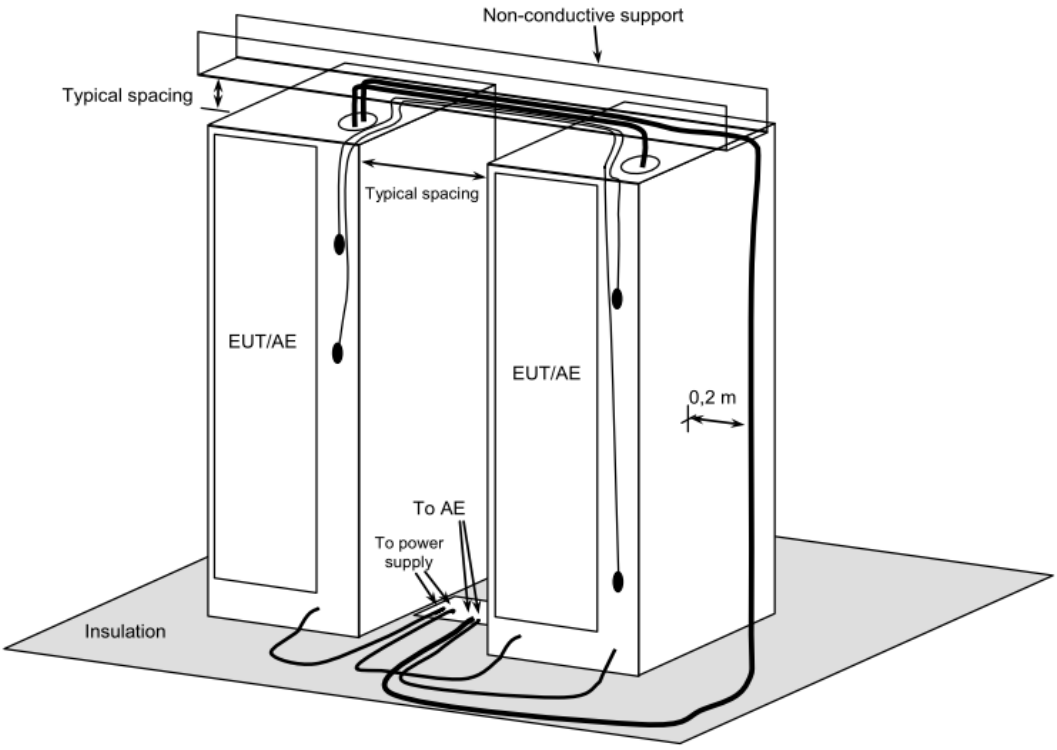

**< Boundary of EUT, Local AE and associated cabling >**



**< Table-Top equipment >**



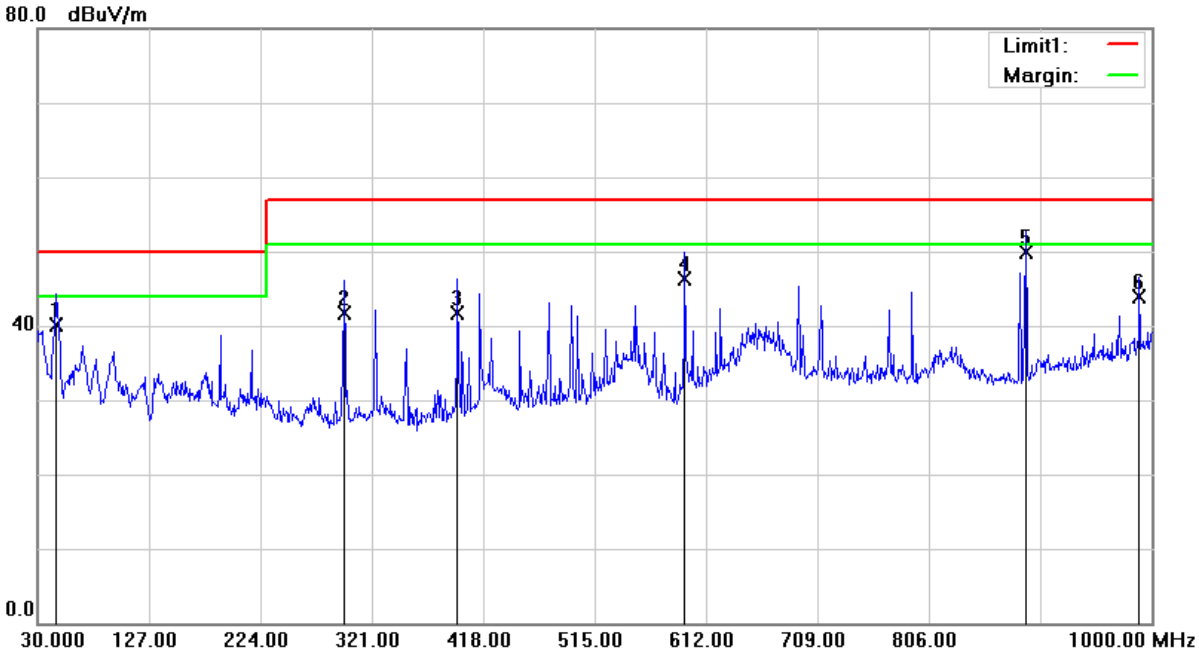

**< Floor-Standing equipment >**




**Note:** Please refer to the 4.3.7 for the actual test configuration.

## 4.2.6 Test Result

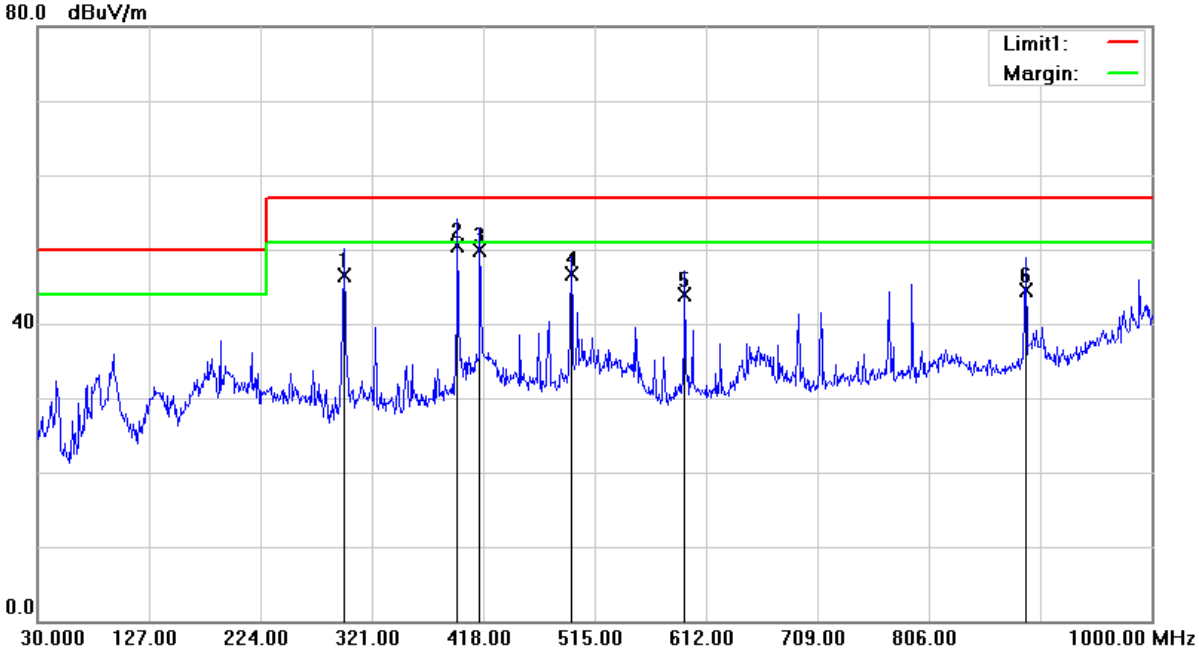
| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Frequency Range** | 30 – 1000 MHz |
| **Environmental Conditions** | 26℃, 46% RH | **6dB Bandwidth** | 120 kHz |
| **Test Date** | 2024/03/20 | **Test Distance** | 3m |
| **Tested by** | Rod Yu | **Polarization** | Vertical |
| **Test Site** | W08-966-1 | | |




| No. | Frequency (MHz) | Reading Level (dBµV) | Correct Factor (dB/m) | Measurement (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Table Degree (degree) | Antenna Height (cm) | Detector |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 46.4900 | 49.68 | -9.64 | 40.04 | 50.00 | -9.96 | 244 | 100 | QP |
| 2 | 296.7500 | 50.33 | -8.68 | 41.65 | 57.00 | -15.35 | 277 | 100 | QP |
| 3 | 395.6900 | 47.59 | -5.88 | 41.71 | 57.00 | -15.29 | 0 | 118 | QP |
| 4 | 593.5700 | 47.11 | -0.74 | 46.37 | 57.00 | -10.63 | 341 | 100 | QP |
| 5 | 890.3900 | 45.53 | 4.34 | 49.87 | 57.00 | -7.13 | 20 | 100 | QP |
| 6 | 989.3300 | 37.83 | 6.04 | 43.87 | 57.00 | -13.13 | 0 | 168 | QP |

**Remark:** 1. QP = Quasi Peak
2. Correction Factor = Antenna factor + Cable loss (Antenna to preamplifier ) - preamplifier Gain + Cable loss (preamplifier to receiver )
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Measurement Value - Limit Value

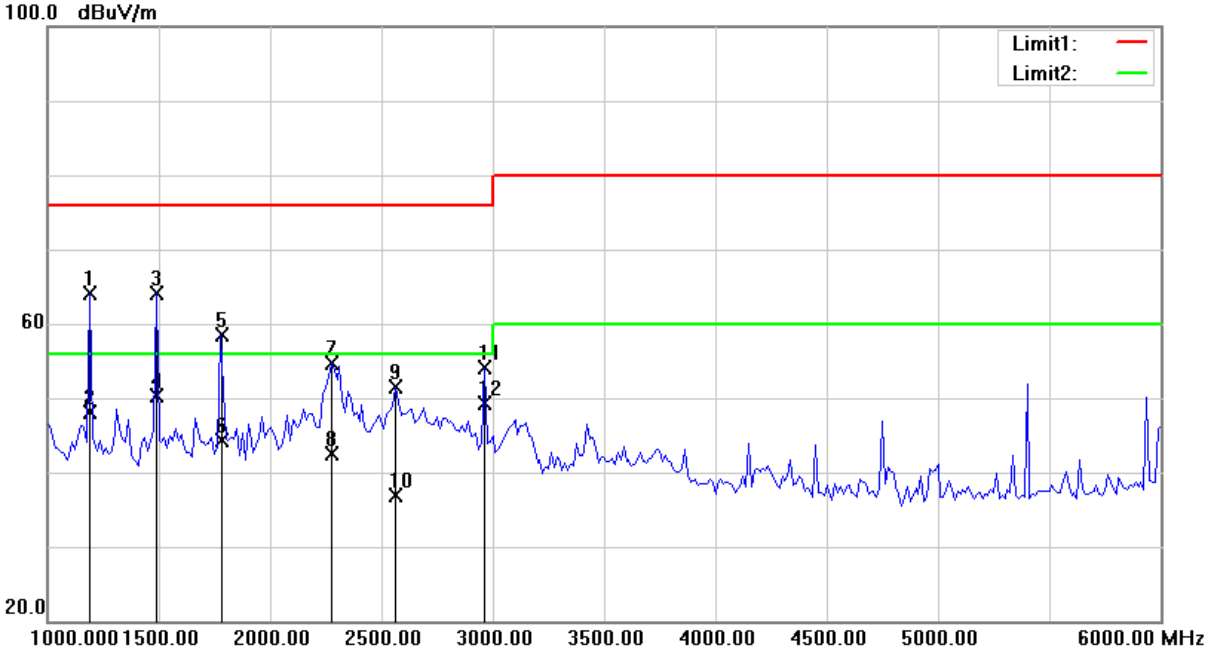
| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Frequency Range** | 30 – 1000 MHz |
| **Environmental Conditions** | 26℃, 46% RH | **6dB Bandwidth** | 120 kHz |
| **Test Date** | 2024/03/20 | **Test Distance** | 3m |
| **Tested by** | Rod Yu | **Polarization** | Horizontal |
| **Test Site** | W08-966-1 | | |




| No. | Frequency (MHz) | Reading Level (dBµV) | Correct Factor (dB/m) | Measurement (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Table Degree (degree) | Antenna Height (cm) | Detector |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 296.7500 | 55.19 | -8.68 | 46.51 | 57.00 | -10.49 | 188 | 100 | QP |
| 2 | 395.6900 | 56.29 | -5.88 | 50.41 | 57.00 | -6.59 | 144 | 100 | QP |
| 3 | 415.0900 | 55.33 | -5.36 | 49.97 | 57.00 | -7.03 | 151 | 100 | QP |
| 4 | 494.6300 | 49.87 | -3.26 | 46.61 | 57.00 | -10.39 | 154 | 100 | QP |
| 5 | 593.5700 | 44.67 | -0.74 | 43.93 | 57.00 | -13.07 | 312 | 200 | QP |
| 6 | 890.3900 | 40.23 | 4.34 | 44.57 | 57.00 | -12.43 | 185 | 200 | QP |

**Remark:** 1. QP = Quasi Peak
2. Correction Factor = Antenna factor + Cable loss (Antenna to preamplifier ) - preamplifier Gain + Cable loss (preamplifier to receiver )
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Measurement Value - Limit Value

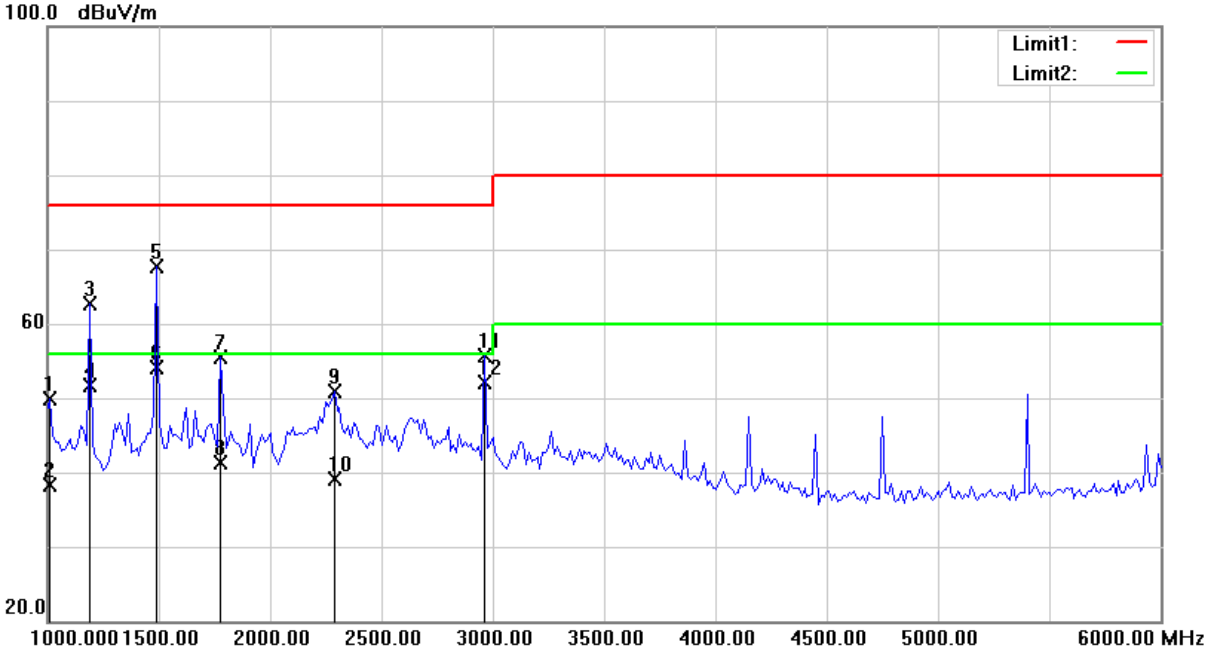
| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Frequency Range** | 1 – 6GHz |
| **Environmental Conditions** | 26°C, 46% RH | **6dB Bandwidth** | 1MHz |
| **Test Date** | 2024/03/20 | **Test Distance** | 3m |
| **Tested by** | Rod Yu | **Polarization** | Vertical |
| **Test Site** | W08-966-1 | | |




| No. | Frequency (MHz) | Reading Level (dBµV) | Correct Factor (dB/m) | Measurement (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Table Degree (degree) | Antenna Height (cm) | Detector |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1187.500 | 83.19 | -19.12 | 64.07 | 76.00 | -11.93 | 203 | 100 | peak |
| 2 | 1187.500 | 67.18 | -19.12 | 48.06 | 56.00 | -7.94 | 203 | 100 | AVG |
| 3 | 1487.500 | 82.40 | -18.34 | 64.06 | 76.00 | -11.94 | 224 | 100 | peak |
| 4 | 1487.500 | 68.74 | -18.34 | 50.40 | 56.00 | -5.60 | 224 | 100 | AVG |
| 5 | 1780.250 | 76.61 | -18.18 | 58.43 | 76.00 | -17.57 | 234 | 100 | peak |
| 6 | 1780.250 | 62.56 | -18.18 | 44.38 | 56.00 | -11.62 | 234 | 100 | AVG |
| 7 | 2275.000 | 69.26 | -14.61 | 54.65 | 76.00 | -21.35 | 140 | 100 | peak |
| 8 | 2275.000 | 57.11 | -14.61 | 42.50 | 56.00 | -13.50 | 140 | 100 | AVG |
| 9 | 2562.500 | 66.28 | -14.75 | 51.53 | 76.00 | -24.47 | 140 | 100 | peak |
| 10 | 2562.500 | 51.65 | -14.75 | 36.90 | 56.00 | -19.10 | 140 | 100 | AVG |
| 11 | 2962.500 | 67.23 | -13.05 | 54.18 | 76.00 | -21.82 | 356 | 100 | peak |
| 12 | 2962.500 | 62.29 | -13.05 | 49.24 | 56.00 | -6.76 | 356 | 100 | AVG |

**Remark:** 1. peak = Peak, AVG = Average
2. Correction Factor = Antenna factor + Cable loss (Antenna to preamplifier ) - preamplifier Gain + Cable loss (preamplifier to receiver )
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Measurement Value - Limit Value

| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Frequency Range** | 1 – 6GHz |
| **Environmental Conditions** | 26℃, 46% RH | **6dB Bandwidth** | 1MHz |
| **Test Date** | 2024/03/20 | **Test Distance** | 3m |
| **Tested by** | Rod Yu | **Polarization** | Horizontal |
| **Test Site** | W08-966-1 | | |




| No. | Frequency (MHz) | Reading Level (dBµV) | Correct Factor (dB/m) | Measurement (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Table Degree (degree) | Antenna Height (cm) | Detector |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1008.750 | 70.32 | -20.36 | 49.96 | 76.00 | -26.04 | 217 | 100 | peak |
| 2 | 1008.750 | 58.73 | -20.36 | 38.37 | 56.00 | -17.63 | 217 | 100 | AVG |
| 3 | 1186.900 | 81.82 | -19.13 | 62.69 | 76.00 | -13.31 | 195 | 100 | peak |
| 4 | 1186.900 | 70.87 | -19.13 | 51.74 | 56.00 | -4.26 | 195 | 100 | AVG |
| 5 | 1487.500 | 86.02 | -18.34 | 67.68 | 76.00 | -8.32 | 167 | 100 | peak |
| 6 | 1487.500 | 72.39 | -18.34 | 54.05 | 56.00 | -1.95 | 167 | 100 | AVG |
| 7 | 1775.000 | 73.64 | -18.20 | 55.44 | 76.00 | -20.56 | 50 | 100 | peak |
| 8 | 1775.000 | 59.44 | -18.20 | 41.24 | 56.00 | -14.76 | 50 | 100 | AVG |
| 9 | 2287.500 | 65.60 | -14.65 | 50.95 | 76.00 | -25.05 | 132 | 100 | peak |
| 10 | 2287.500 | 53.84 | -14.65 | 39.19 | 56.00 | -16.81 | 132 | 100 | AVG |
| 11 | 2962.500 | 68.82 | -13.05 | 55.77 | 76.00 | -20.23 | 311 | 100 | peak |
| 12 | 2962.500 | 65.14 | -13.05 | 52.09 | 56.00 | -3.91 | 311 | 100 | AVG |

**Remark:** 1. peak = Peak, AVG = Average
2. Correction Factor = Antenna factor + Cable loss (Antenna to preamplifier ) - preamplifier Gain + Cable loss (preamplifier to receiver )
3. Measurement Value = Reading Level + Correct Factor
4. Margin Level = Measurement Value - Limit Value

## 4.2.7 Photographs of Test Configuration

**Radiated Emission Test (30MHz~1GHz)**


**Radiated Emission Test (Above 1GHz)**


## 4.3 Harmonics Current Measurement

### 4.3.1 Limits of Harmonics Current Measurement

The limits ensure that harmonic disturbance levels do not exceed the compatibility levels defined in IEC 61000-3-2.

| Limits for Class A equipment | |
|---|---|
| Harmonics Order n | Max. permissible harmonics current A |
| Odd harmonics | |
| 3 | 2.30 |
| 5 | 1.14 |
| 7 | 0.77 |
| 9 | 0.40 |
| 11 | 0.33 |
| 13 | 0.21 |
| 15<=n<=39 | 0.15x15/n |
| Even harmonics | |
| 2 | 1.08 |
| 4 | 0.43 |
| 6 | 0.30 |
| 8<=n<=40 | 0.23x8/n |

| Limits for Class D equipment | | |
|---|---|---|
| Harmonics Order n | Max. permissible harmonics current per watt mA/W | Max. permissible harmonics current A |
| Odd Harmonics only | | |
| 3 | 3.4 | 2.30 |
| 5 | 1.9 | 1.14 |
| 7 | 1.0 | 0.77 |
| 9 | 0.5 | 0.40 |
| 11 | 0.35 | 0.33 |
| 13 | 0.30 | 0.21 |
| 15<=n<=39 | 3.85/n | 0.15x15/n |

**Note:** 1. Class A and Class D are classified according to item section 5 of EN 61000-3-2.
2. According to section 7 of EN 61000-3-2, the above limits for all equipment except for lighting equipment having an active input power > 75 W and no limits apply for equipment with an active input power up to and including 75 W.

### 4.3.2 Test Instrument

| Item | Equipment | Manufacturer | Model | Meter No. | Calibration Date |
|---|---|---|---|---|---|
| 1 | Harmonics & Flicker Analyser | EMC PARTNER | HAR-1000-1P | CT-1-090(1) | Oct. 19, 2023 |
| 2 | Power Source | EMC PARTNER | PS3-1 | CT-1-090a1 | Oct. 19, 2023 |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

### 4.3.3 Test Procedure

The table-top EUT was placed on the top of a wooden table 0.8 meter above the ground and operated to produce the maximum harmonic under normal operating conditions for each successive harmonic component in turn. The floor-standing EUT was placed insulation support unit from the horizontal ground plane.

The classification of EUT is according to section 5 of EN 61000-3-2.

The EUT classified as follows:

Class A:

- Balanced three-phase equipment;
- Household appliances excluding equipment identified as Class D;
- Tools excluding portable tools;
- Dimmers for incandescent lamps;
- Audio equipment.

Equipment not specified in one of the three other classes should be considered as Class A equipment.

Note 1: Equipment that can be shown to have a significant effect on the supply system may be reclassified in a future edition of the standard. Factors to be taken into account include:

- Number in use;
- Duration of use;
- Simultaneity of use;
- Power consumption;
- Harmonic spectrum, including phase.

Class B:

- Portable tools;
- Arc welding equipment, which is not professional equipment.

Class C:

- Lighting equipment;

Class D:

Equipment having a specified power according to 6.2.2 less than or equal to 600W, of the following types:

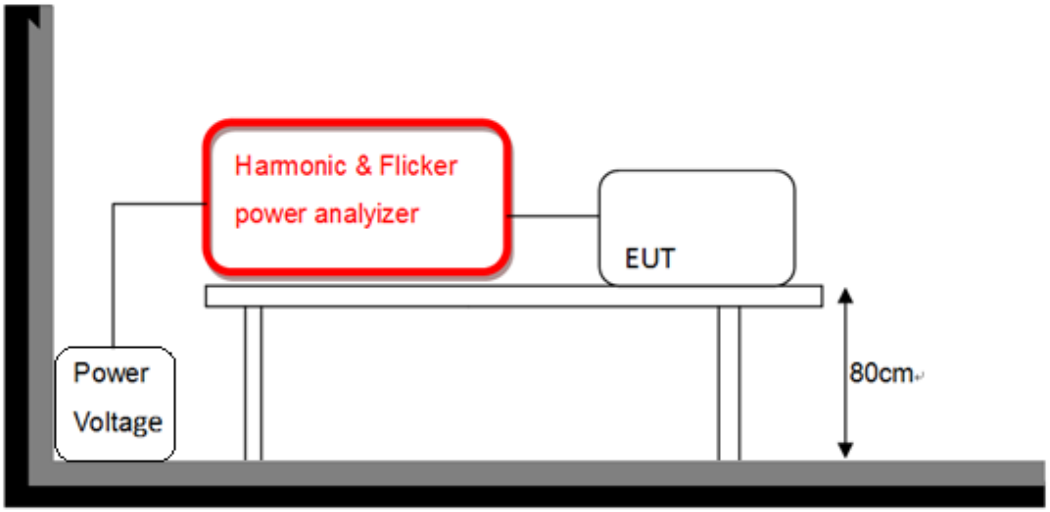
- Personal computers and personal computer monitors;
- Television receivers.
- Refrigerators and freezers having one or more variable-speed drives to control compressor motor(s).

## 4.3.4 Deviation from Test Standard

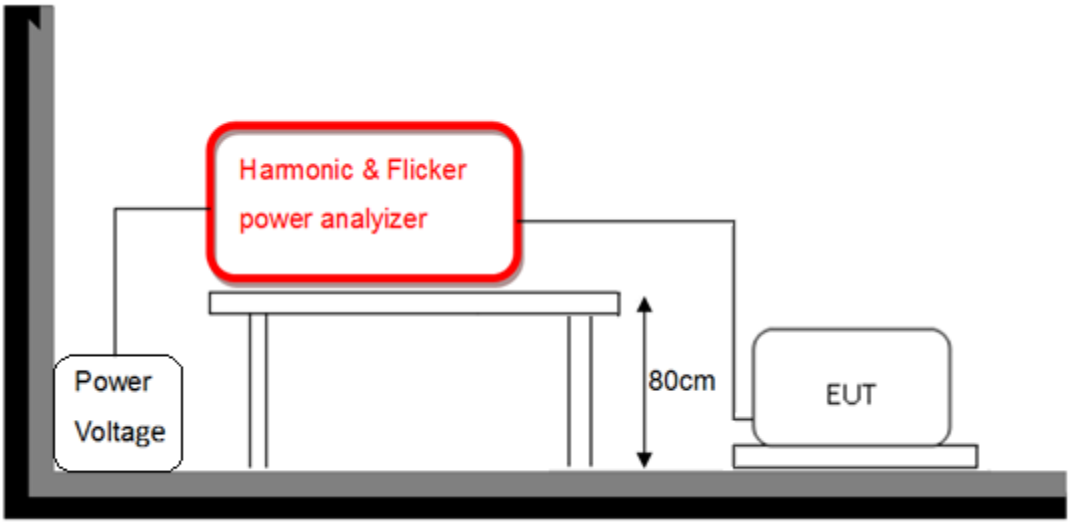
No deviation

## 4.3.5 Test Setup

**< Table-Top equipment >**




**< Floor-Standing equipment >**



## 4.3.6 Test Result

| | | | |
|---|---|---|---|
| **Supply Voltage / Ampere** | 229.7 Vrms / 0.352 Arms | **Test Date** | 2024/03/16 |
| **Test Duration** | 5 min | **Power Consumption** | 72.62W |
| **Power Frequency** | 49.922Hz | **Power Factor** | 0.898 |
| **Environmental Conditions** | 21℃, 49% RH | **Tested by** | Guanwei Liao |

**Note:**

1. Limits are not specified for equipment with a rated power of 75W or less (other than lighting equipment).
2. According to EN 61000-3-2 the manufacturer shall specify the power of the apparatus. This value shall be used for establishing limits. The specified power shall be within +/-10% of the measured power.

### 4.3.7 Photographs of Test Configuration

## 4.4 Voltage Fluctuation and Flicker Measurement

### 4.4.1 Limit for Voltage Function and Flicker Measurement

| Tests Item | Limits | Remark |
|---|---|---|
| | IEC/EN 61000-3-3 | |
| $P_{st}$ | 1.0, $T_p$= 10 min. | $P_{st}$ means short-term flicker |
| $P_{lt}$ | 0.65, $T_p$=2 hr. | $P_{lt}$ means long-term flicker |
| dc (%) | 3.3% | dc means relative steady-state voltage change |
| $d_{max}$ (%) | 4% | $d_{max}$ means maximum relative voltage change. |
| $T_{dt}$ | 3.3% / 500 ms | $T_{dt}$ means maximum time that dt exceeds 3.3 %. |

### 4.4.2 Test Instrument

| Item | Equipment | Manufacturer | Model | Meter No. | Calibration Date |
|---|---|---|---|---|---|
| 1 | Harmonics & Flicker Analyser | EMC PARTNER | HAR-1000-1P | CT-1-090(1) | Oct. 19, 2023 |
| 2 | Power Source | EMC PARTNER | PS3-1 | CT-1-090a1 | Oct. 19, 2023 |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

### 4.4.3 Test Procedure

The table-top EUT was placed on the top of a wooden table 0.8 meter above the ground and operated to produce the most unfavorable sequence of voltage changes under normal operating condition. The floor-standing EUT was placed insulation support unit from the horizontal ground plane.

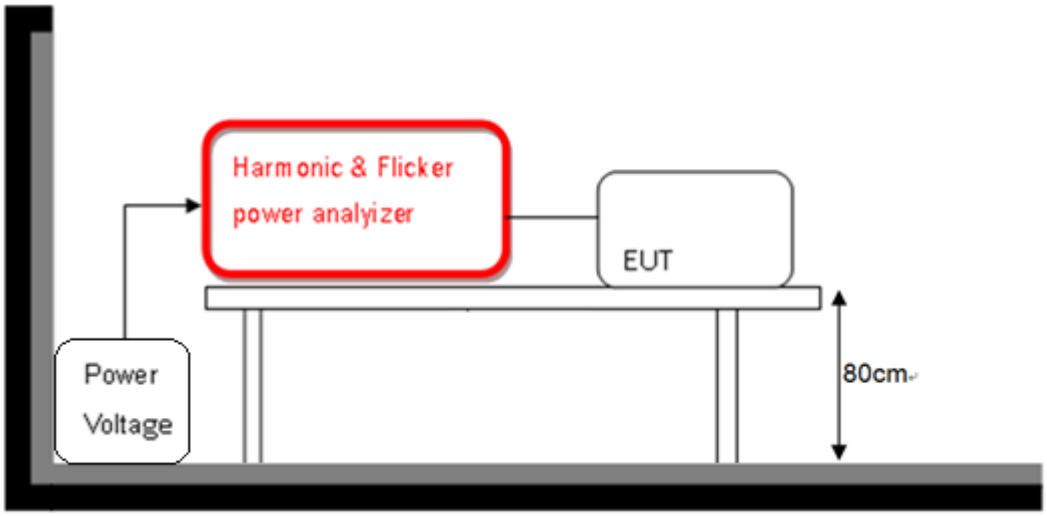
During the flick measurement, the measure time shall include that part of whole operation cycle in which the EUT produce the most unfavorable sequence of voltage changes. The observation period for short-term flicker indicator is 10 min and the observation period for long-term flicker indicator is 2 hours.

### 4.4.4 Deviation from Test Standard

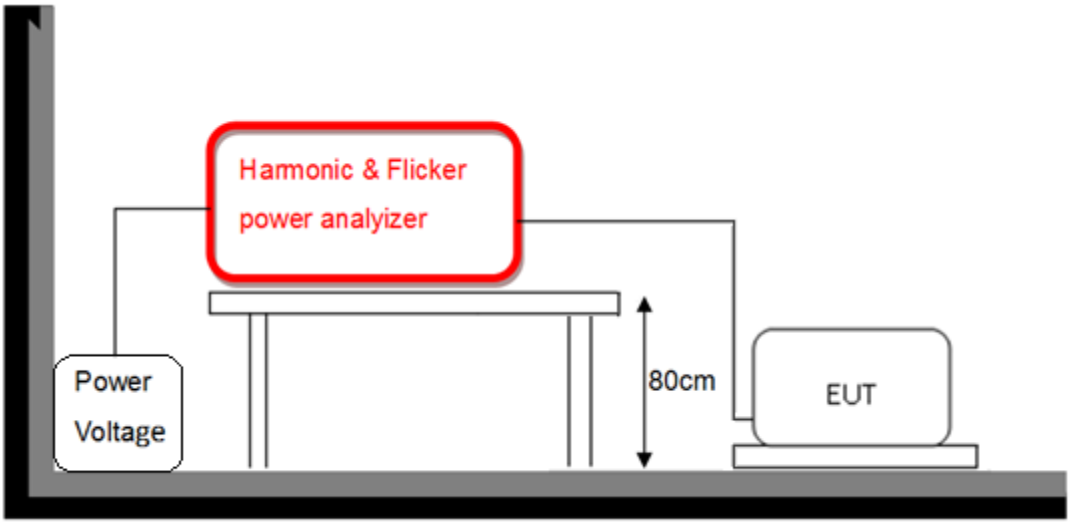
No deviation

## 4.4.5 Test Setup

**< Table-Top equipment >**




**< Floor-Standing equipment >**



## 4.4.6 Test Result

| | | | |
|---|---|---|---|
| **Supply Voltage / Ampere** | 229.5 Vrms / 0.345 Arms | **Test Date** | 2024/03/16 |
| **Observation (Tp)** | 30 min | **Environmental Conditions** | 21℃, 49% RH |
| **Power Frequency** | 49.922Hz | **Tested by** | Guanwei Liao |

| Test Parameter | Measurement Value | Test Limit | Remarks |
|---|---|---|---|
| $P_{st}$ | 0.07 | 1.00 | Pass |
| $P_{lt}$ | 0.07 | 0.65 | Pass |
| $T_{dt}$ (ms) | 0.00 | 500 | Pass |
| $d_{max}$ (%) | 0.00 | 4% | Pass |
| dc (%) | 0.01 | 3.3% | Pass |

**Note:** 1. $P_{st}$ means short-term flicker indicator.
2. $P_{lt}$ means long-term flicker indicator.
3. $T_{dt}$ means maximum time that dt exceeds 3.3 %.
4. $d_{max}$ means maximum relative voltage change.
5. dc means relative steady-state voltage change.

### 4.4.7 Photographs of Test Configuration

# 5 Immunity Test

## 5.1 Standard Description

| Product standard | EN 50121-3-2 | |
|---|---|---|
| Basic Standard and Performance Criterion required | EN 61000-4-2 (ESD) | ±8kV Air discharge<br>±6kV Contact discharge,<br>Performance Criterion B |
| | EN IEC 61000-4-3 (RS) | Radio-frequency electromagnetic field amplitude modulated (Note1)<br>80 ~ 800 MHz, 20 V/m(rms), 80% AM (1kHz)<br>Radio-frequency electromagnetic field (Note2)<br>800~ 1000 MHz, 20 V/m, 80% AM (1kHz)<br>1400 ~ 2000 MHz, 10 V/m, 80% AM (1kHz)<br>2000~ 2700 MHz, 5 V/m, 80% AM (1kHz)<br>5100~ 6000 MHz, 3 V/m, 80% AM (1kHz)<br>Performance Criterion A |
| | EN 61000-4-4 (EFT) | Power Port: ±2kV<br>Signal / Control Ports (cable length > 3m): ±2kV<br>Performance Criterion A |
| | EN 61000-4-5 (Surge) | Power Port: line to line ±1kV, 42Ω, 0.5μF<br>line to ground ±2kV, 42Ω, 0.5μF<br>Performance Criteria B |
| | EN 61000-4-6 (CS) | Power Port and Signal / Control Ports (cable length > 3m)<br>0.15 ~ 80 MHz, 10V, 80% AM (1kHz)<br>Performance Criterion A |

Note 1: This limit applies to equipment mounted in the passenger compartments, drivers cab or external to the rolling stock (roof, underframe). For equipment mounted in all other areas a severity level of 10V/m may be used.

Note 2: For large apparatus (e.g. traction drives, auxiliary converters) it is often not practical to perform the immunity test to radiated electromagnetic fields on the complete unit. In such cases the manufacturer should test susceptible sub-systems (e.g. control electronics). The test report should justify the selection or not of sub-systems and any assumptions made (e.g. reduction of field due to case shielding).

## 5.2 Performance Criteria

According to EN 50121-1 standard, the general performance criteria as following:

| | |
|---|---|
| **Criteria A** | The apparatus shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation, and from what the user may reasonably expect from the apparatus if used as intended. |
| **Criteria B** | The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation, and from what the user may reasonably expect from the apparatus if used as intended. |
| **Criteria C** | Temporary loss of function is allowed, provided the function is selfrecoverable or can be restored by the operation of the controls. |

## 5.3 Electrostatic Discharge (ESD)

### 5.3.1 Test Specification

| | |
|---|---|
| **Standard** | EN 61000-4-2 |
| **Discharge Impedance** | 330 ohm / 150 pF |
| **Discharge Voltage** | Air Discharge: ±2, ±4, ±8 kV (Direct)<br>Contact Discharge: ±6 kV (Direct) and HCP/VCP: ±6 kV (Indirect) |
| **Number of Discharge** | Air: Minimum 10 times at each polarity<br>Contact: Minimum 10 times at each polarity |
| **Discharge Mode** | Single Discharge |
| **Discharge Period** | 1 second minimum |

### 5.3.2 Test Instrument

| Item | Equipment | Manufacturer | Model | Meter No. | Calibration Date |
|---|---|---|---|---|---|
| 1 | ESD Generator | TESEQ | NSG 437 | CT-1-140 | Jun. 15, 2024 |
| 2 | ESD Generator | NoiseKen | ESS-B3011 | CT-1-089 | Aug. 04, 2023 |
| 3 | Digital Thermo-Hygro Meter | N/A | HTC-8 | CT-2-047 | Jun. 06, 2023 |
| 4 | Atmosphere pressure meter | TES | TES-1161 | CT-5-094 | Aug. 10, 2023 |

**Note:** 1. The calibration interval of the test instruments is 12 months.
2. The calibration interval of thermo hygrometer/ Atmosphere pressure meter is 24 months.

## 5.3.3 Test Procedure

The test generator necessary to perform direct and indirect application of discharge to the EUT in following methods:

a. Contact discharges to the conductive surface and coupling planes:

For table-top equipment one of the test points shall be the centre front edge of the horizontal coupling plane, which shall be subjected to at least 20 indirect discharges (10 of each polarity). All other test points shall each receive at least 20 direct contact discharges (10 of each polarity). All areas normally touched by the user should be tested. Test shall be performed at a maximum repetition rate of one discharge per second.

**Vertical Coupling Plane (VCP):**

The coupling plane, of dimensions 0.5 m × 0.5 m, is placed parallel to, and positioned at a distance 0.1 m from, the EUT, with the discharge electrode touching the coupling plane. The four faces of the EUT will be performed with electrostatic discharge.

**Horizontal Coupling Plane (HCP):**

The coupling plane, of dimensions 1.6 m × 0.8 m, is placed under the EUT. The generator shall be positioned vertically a distance of 0.1 m from the EUT, with the discharge electrode touching the coupling plane. The four faces of the EUT will be performed with electrostatic discharge.

b. Air discharge at apertures and slots and insulating surface:

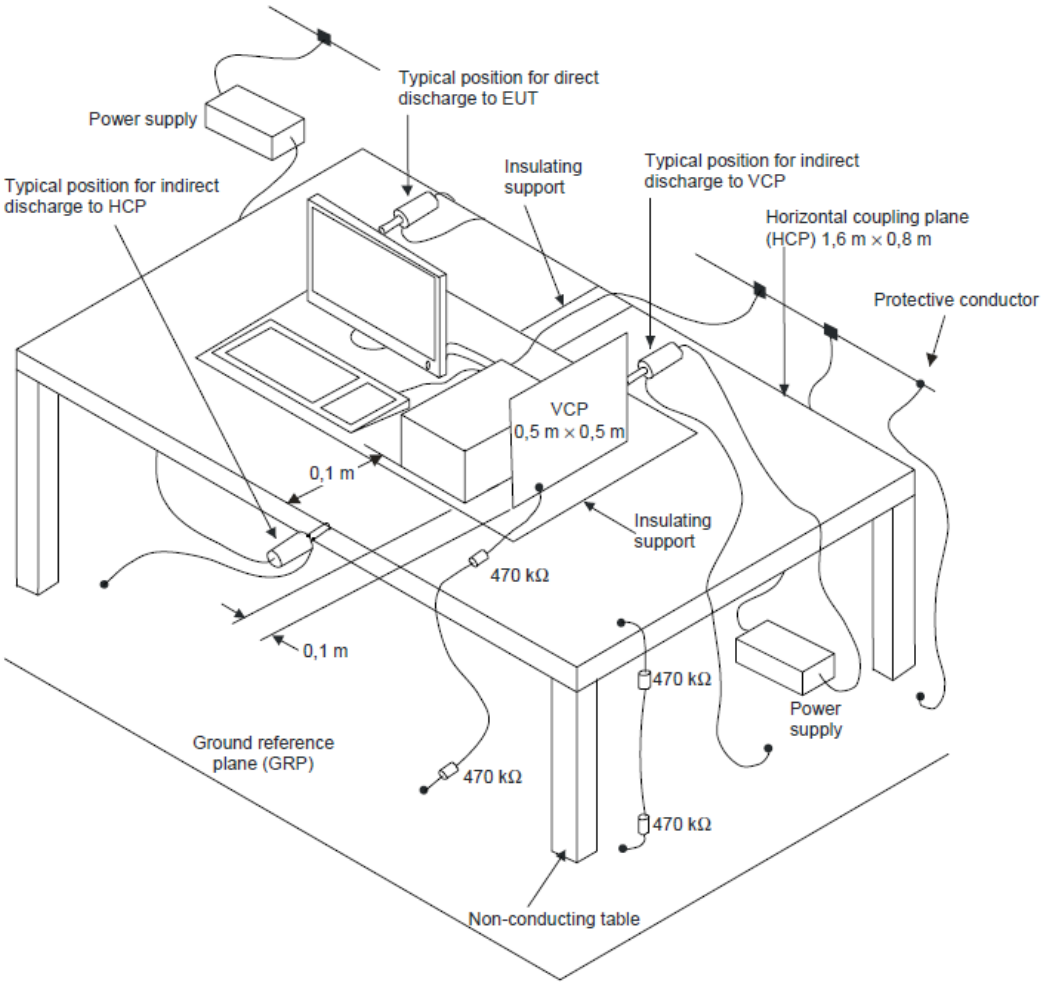
On those parts of the EUT where it is not possible to perform contact discharge testing, the equipment should be investigated to identify user accessible points where breakdown may occur. Such points are tested using the air discharge method. This investigation should be restricted to those area normally handled by the user. A minimum 10 single air discharges shall be applied to the selected test point for each such area.

## 5.3.4 Deviation from Test Standard

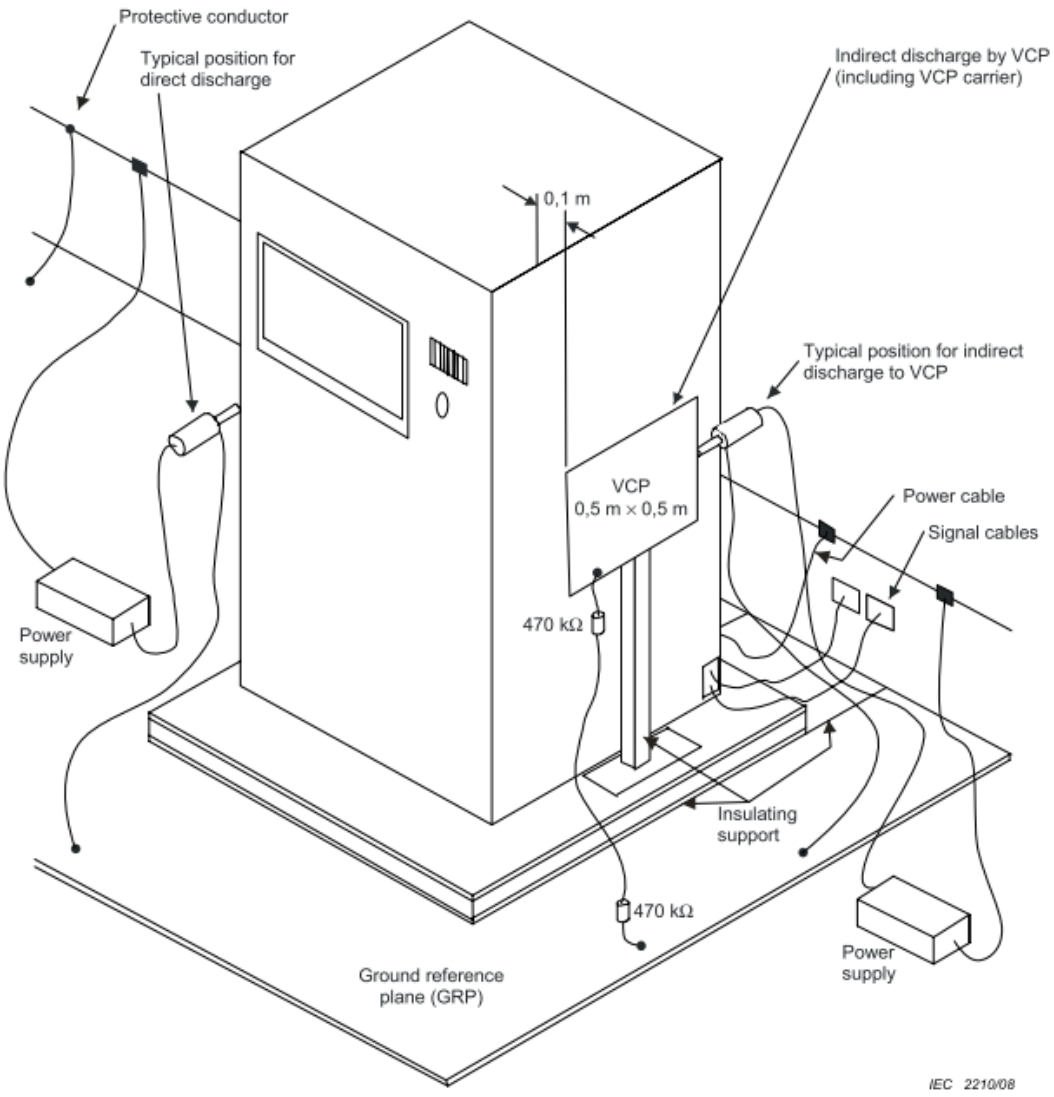
No deviation

## 5.3.5 Test Setup

**< Table-Top equipment >**



**< Floor-Standing equipment >**



## 5.3.6 Test Result

| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Test Date** | 2024/06/20 |
| **Environmental Conditions** | 24℃, 54% RH | **Pressure** | 1007 mbar |
| **Tested by** | Guanwei Liao | | |

**Test Results of Direct Application**

| Air Discharge | | | | |
|---|---|---|---|---|
| **Test Point** | **Discharge Level (kV)** | | | **Result** |
| | **±2** | **±4** | **±8** | |
| Front | A | A | A | A |
| Back | A | A | A | A |
| Left | N/A | N/A | N/A | N/A |
| Right | N/A | N/A | N/A | N/A |
| Top | N/A | N/A | N/A | N/A |
| Bottom | N/A | N/A | N/A | N/A |
| Other | N/A | N/A | N/A | N/A |

* Test location(s) in which discharge to be applied illustrated by photos shown in next page(s).

| Contact Discharge | | |
|---|---|---|
| **Test Point** | **Discharge Level (kV)** | **Result** |
| | **±6** | |
| Front | B (#1) | B |
| Back | A | A |
| Left | A | A |
| Right | A | A |
| Top | A | A |
| Bottom | A | A |
| Other | N/A | N/A |

* Test location(s) in which discharge to be applied illustrated by photos shown in next page(s).

**Test Results of Indirect Application**

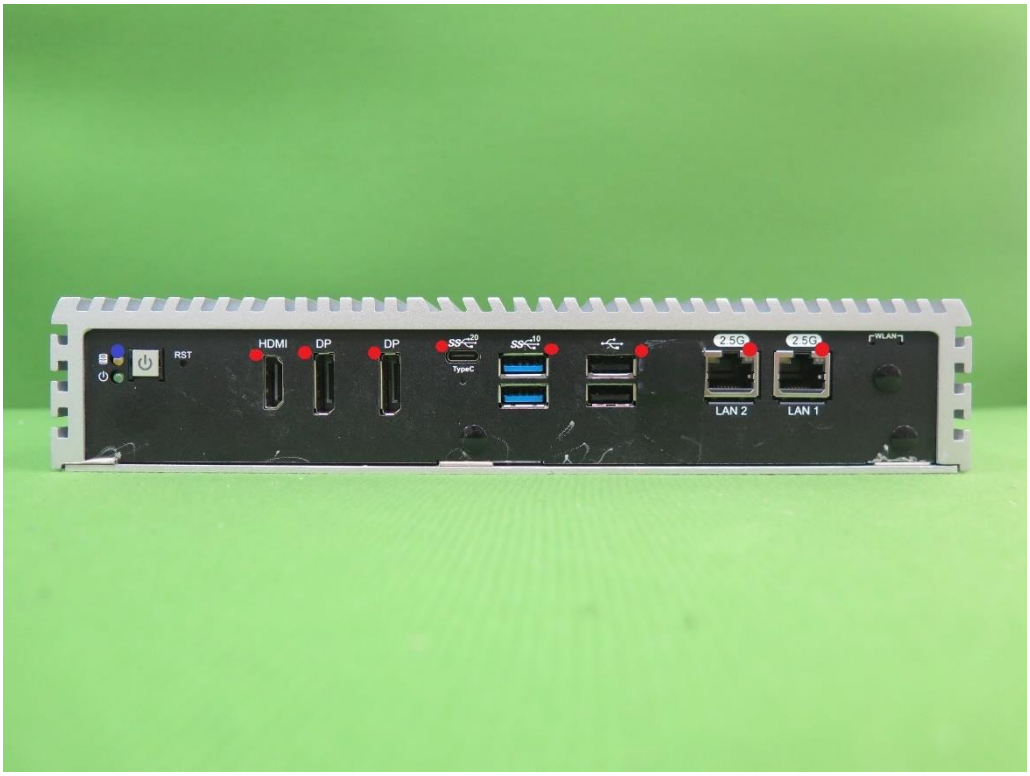
| HCP Discharge | | |
|---|---|---|
| **Test Point** | **Discharge Level (kV)** | **Result** |
| | **±6** | |
| Front | A | A |
| Back | A | A |
| Left | A | A |
| Right | A | A |

| VCP Discharge | | |
|---|---|---|
| **Test Point** | **Discharge Level (kV)** | **Result** |
| | **±6** | |
| Front | A | A |
| Back | A | A |
| Left | A | A |
| Right | A | A |

**Note:**
Criteria A: The EUT function was correct during the test.
Criteria A: (#1) No occur arcing.
Criteria B: (#1) The EUT was interrupted during the test, but could self-recover to the normal mode after the test.

**Description of Test Points**

Front




Back

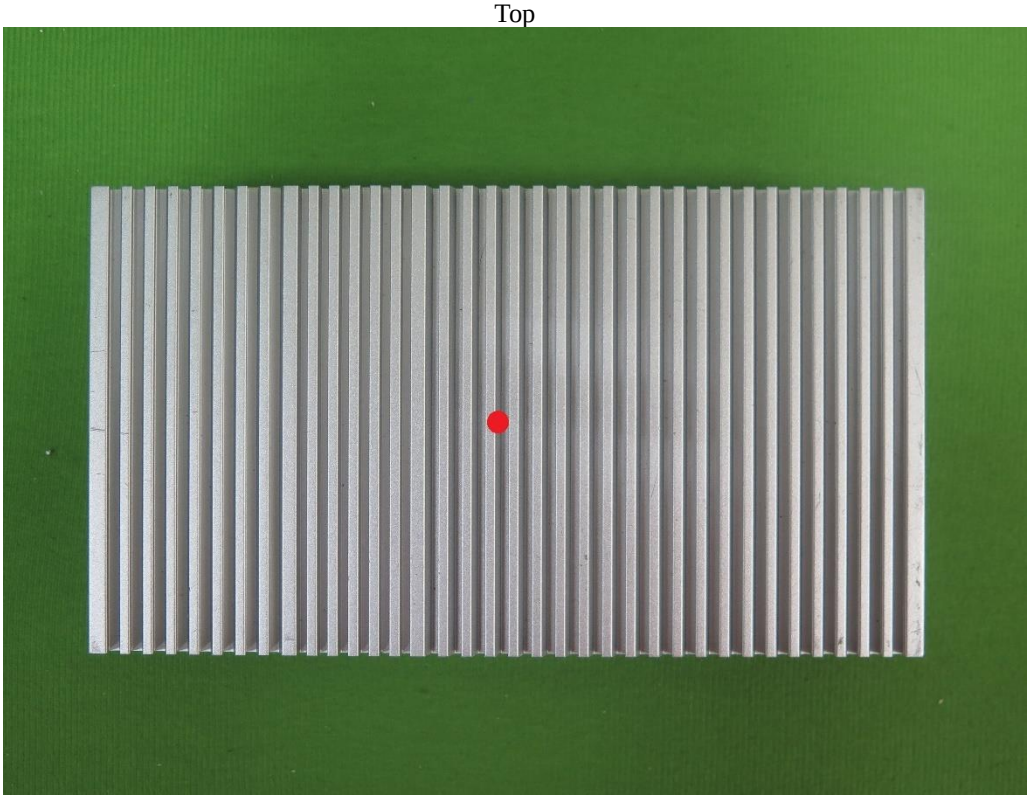

*Red Dot - Contact Discharged
Blue Dot - Air Discharged

Left

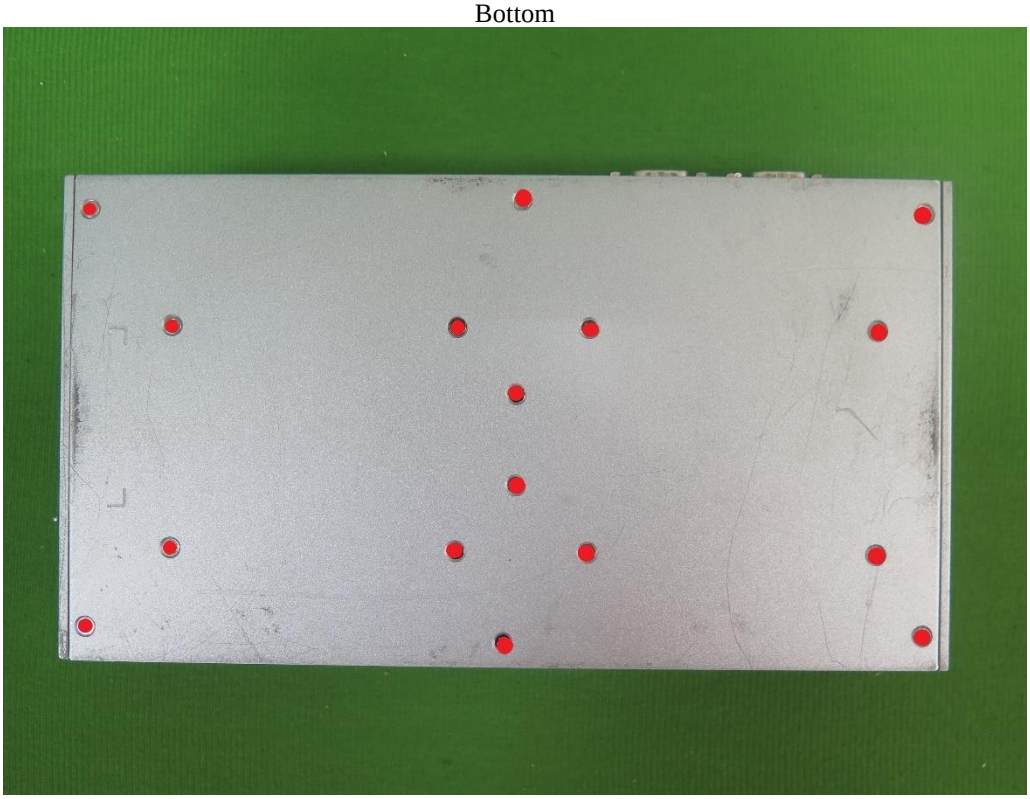
Right

*Red Dot - Contact Discharged
Blue Dot - Air Discharged

Top

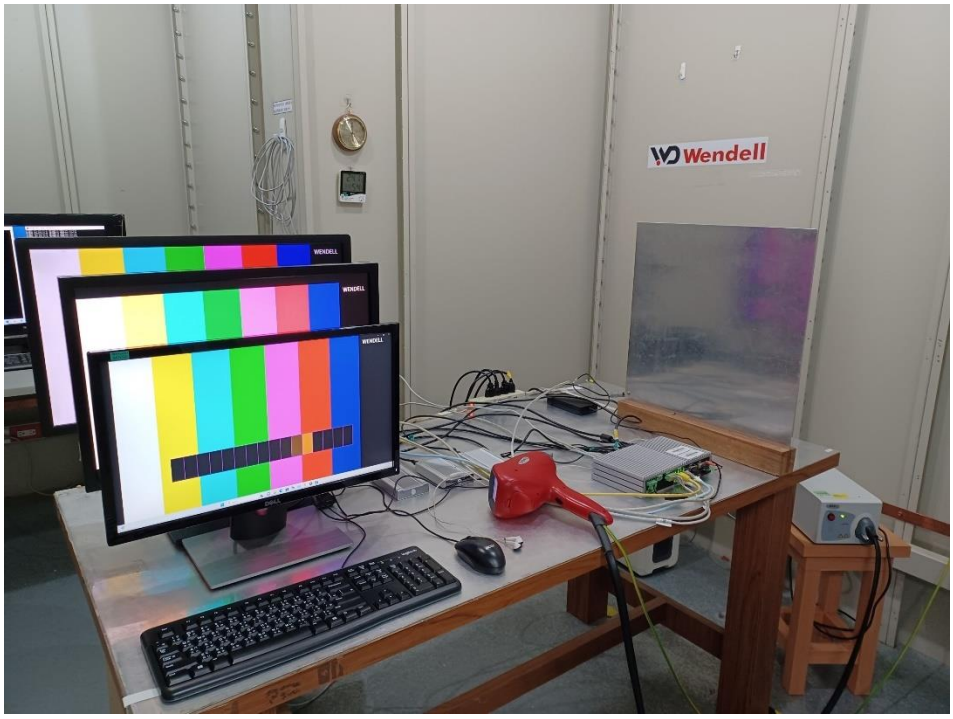


Bottom



*Red Dot - Contact Discharged
Blue Dot - Air Discharged

### 5.3.7 Photographs of Test Configuration



## 5.4 Radiated, Radio-frequency, Electromagnetic Field Immunity Test (RS)

### 5.4.1 Test Specification

| | |
|---|---|
| **Standard** | EN IEC 61000-4-3 |
| **Frequency Range/ Field Strength** | 80MHz - 800MHz: 20 V/m (note1)<br>800MHz - 1000MHz: 20 V/m<br>1400MHz - 2000MHz:10 V/m<br>2000MHz - 2700MHz: 5 V/m<br>5100MHz - 6000MHz: 3 V/m |
| **Modulation** | 80%, AM Modulation, 1 kHz Sine Wave |
| **Frequency Step** | 1% |
| **Polarity of Antenna** | Horizontal and Vertical |
| **Test Distance** | 2.15 m (80MHz - 1000MHz)<br>1 m (1GHz - 6GHz) |
| **Antenna Height** | 1.5 m (80MHz - 1000MHz)<br>1 m (1GHz - 6GHz) |
| **Dwell Time** | 3.0 seconds |

Note 1: This limit applies to equipment mounted in the passenger compartments, drivers cab or external to the rolling stock (roof, underframe). For equipment mounted in all other areas a severity level of 10 V/m may be used.

## 5.4.2 Test Instrument

| Item | Equipment | Manufacturer | Model | Meter No. | Calibration Date |
|---|---|---|---|---|---|
| 1 | RadiCentre ® Modular EMC Test Systems | DARE | CTR1004B | CT-1-080 | No calibration request |
| 2 | RF Signal Generator | DARE | RGN6000B | CT-1-080 | Aug. 06, 2023 |
| 3 | LINEAR POWER RF AMPLIFIER | TESEQ | CBA1G-300 D | CT-1-163 | Aug. 06, 2023 |
| 4 | LINEAR POWER RF AMPLIFIER | OPHIR | 5193 | CT-1-083 | Aug. 06, 2023 |
| 5 | LINEAR POWER RF AMPLIFIER | FRANKONIA | FLG-30C | CT-1-061 | Aug. 06, 2023 |
| 6 | Periodic Test-Antenna | Schwarzbeck Mess - Elektronik | STLP 9128 E | CT-1-085 | No calibration request |
| 7 | Stacked Microwave Log.-Per. Antenna | Schwarzbeck Mess - Elektronik | STLP 9149 | CT-1-086 | No calibration request |
| 8 | Electric Field Probe | FRANKONIA | EFS-10 | CT-1-060a1 | Sep. 29, 2023 |
| 9 | Measurement Software | EMC-RS | Ver: 2.0.1.3 | N/A | No calibration request |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

## 5.4.3 Test Procedure

The test procedure was in accordance with EN IEC 61000-4-3.

The table-top EUT and load, which are placed on a table that is 0.8 meter above ground, are placed with one coincident with the calibration plane such that the distance from antenna to the EUT was 2.15 meter at test frequency 80M - 1GHz. (The distance was 1 meter at test frequency 1G - 6GHz)

Both horizontal and vertical polarization of the antenna and four sides of the EUT are set on measurement.

The EUT shall be positioned so that the four sides of the EUT shall be exposed to the electromagnetic field in sequence. In each position the performance of the EUT will be investigated.

In the case where the most sensitive surface side of the EUT is known throughout the frequency range (for example, via preliminary tests), testing may be restricted to that surface side only. Where it is not possible to determine the most sensitive face with any certainty (for example where different faces are sensitive at different frequencies) all four faces shall be tested.

If the EUT is too large such that it cannot be fully illuminated by the radiating antenna, or exceeds the size of the Uniform Field Area (UFA) then partial illumination shall be used. The EUT can be repositioned so that the front surface remains within the UFA in order to illuminate those sections of the EUT that were previously outside the UFA.

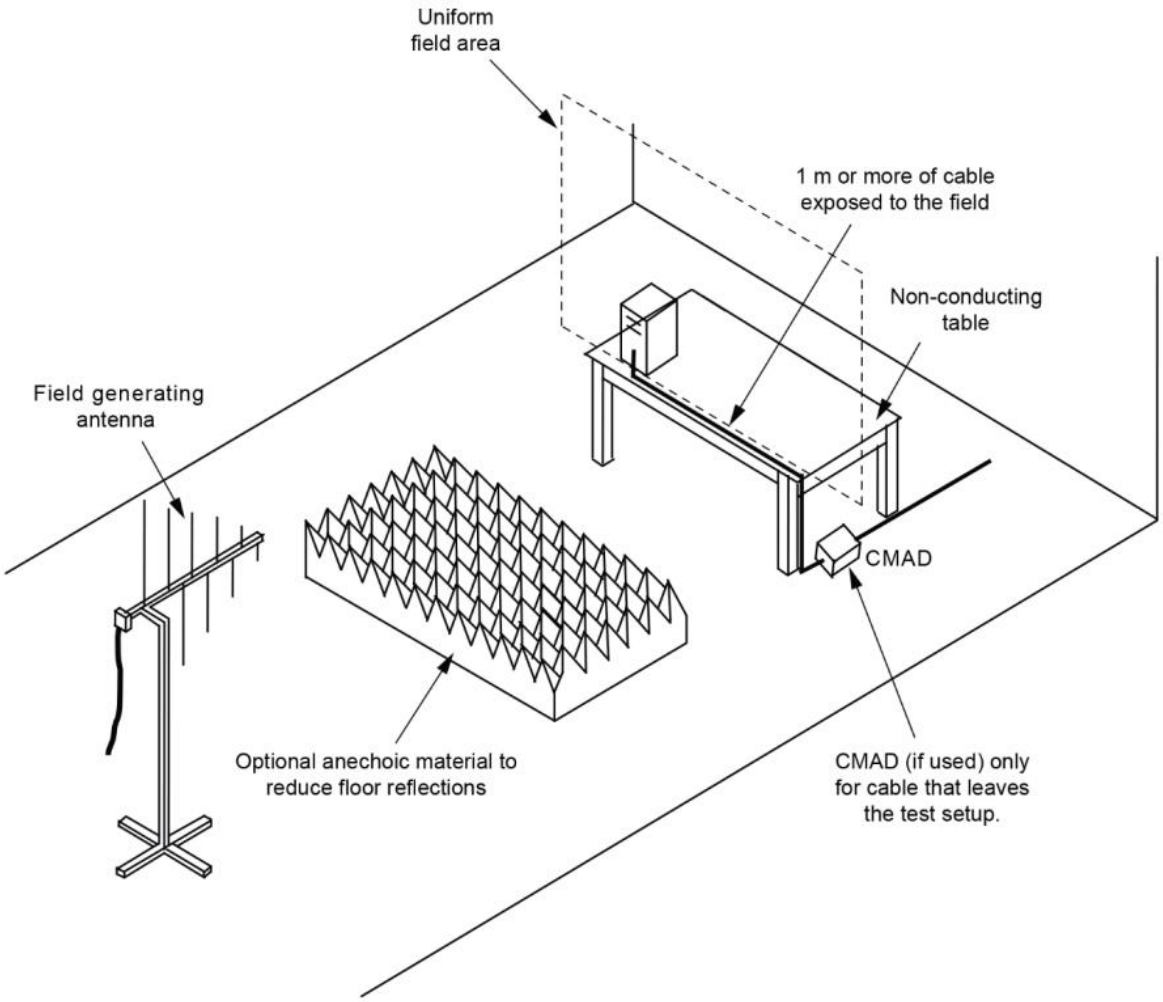
In order to judge the EUT performance, a CCD camera is used to monitor EUT screen.
All the scanning conditions are as follows:

| | Condition of Test | Remarks |
|---|---|---|
| 1 | Scanning Frequency and Field Strength | 80 MHz - 800 MHz: 20 V/m<br>800 MHz - 1000 MHz: 20 V/m<br>1400 MHz - 2000 MHz:10 V/m<br>2000 MHz - 2700 MHz: 5 V/m<br>5100 MHz - 6000 MHz: 3 V/m |
| 2 | Radiated Signal | AM 80% Modulated with 1kHz |
| 3 | Dwell Time | 3.0 Seconds |
| 4 | Frequency Step Size $\Delta f$ | 1% |

## 5.4.4 Deviation from Test Standard

No deviation

### 5.4.5 Test Setup



## 5.4.6 Test Result

| Test Voltage | 230Vac, 50Hz | Environmental Conditions | 22°C, 51% RH |
|---|---|---|---|
| Tested by | Eric Hsieh | Test Date | 2024/06/12 |

| Frequency Range (MHz) | Azimuth | Polarity | Field Strength (V/m) | Modulation | Result |
|---|---|---|---|---|---|
| 80-1000 | 0 | H/V | 20 | 80% AM (1kHz) | A |
| 80-1000 | 90 | H/V | 20 | 80% AM (1kHz) | A |
| 80-1000 | 180 | H/V | 20 | 80% AM (1kHz) | A |
| 80-1000 | 270 | H/V | 20 | 80% AM (1kHz) | A |

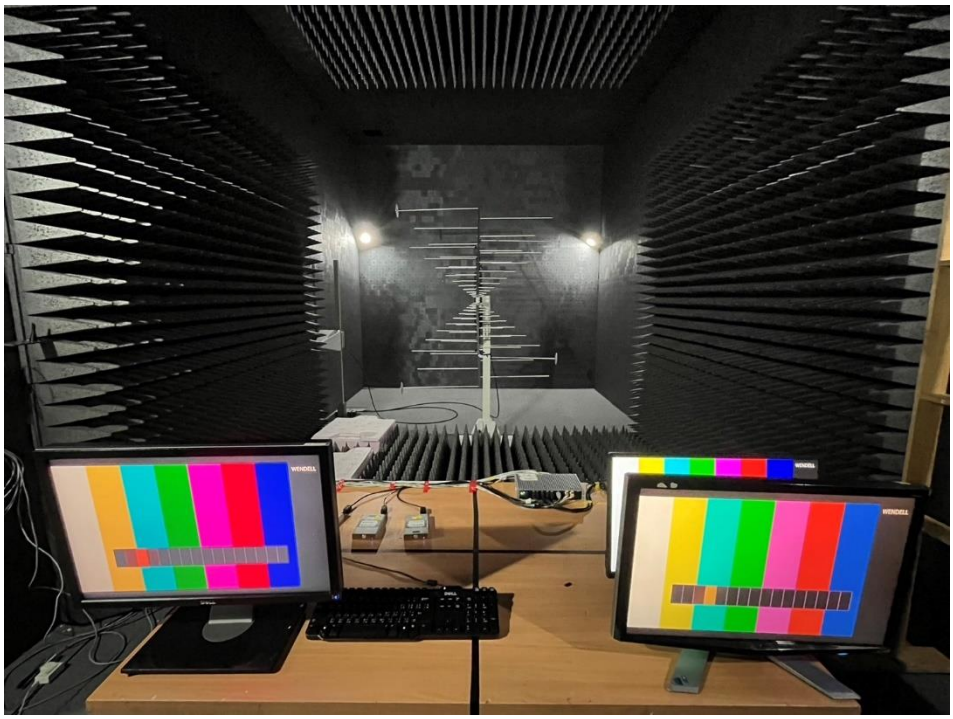
| Frequency Range (MHz) | Azimuth | Polarity | Field Strength (V/m) | Modulation | Result |
|---|---|---|---|---|---|
| 1400-2000 | 0 | H/V | 10 | 80% AM (1kHz) | A |
| 1400-2000 | 90 | H/V | 10 | 80% AM (1kHz) | A |
| 1400-2000 | 180 | H/V | 10 | 80% AM (1kHz) | A |
| 1400-2000 | 270 | H/V | 10 | 80% AM (1kHz) | A |

| Frequency Range (MHz) | Azimuth | Polarity | Field Strength (V/m) | Modulation | Result |
|---|---|---|---|---|---|
| 2000-2700 | 0 | H/V | 5 | 80% AM (1kHz) | A |
| 2000-2700 | 90 | H/V | 5 | 80% AM (1kHz) | A |
| 2000-2700 | 180 | H/V | 5 | 80% AM (1kHz) | A |
| 2000-2700 | 270 | H/V | 5 | 80% AM (1kHz) | A |

| Frequency Range (MHz) | Azimuth | Polarity | Field Strength (V/m) | Modulation | Result |
|---|---|---|---|---|---|
| 5100-6000 | 0 | H/V | 3 | 80% AM (1kHz) | A |
| 5100-6000 | 90 | H/V | 3 | 80% AM (1kHz) | A |
| 5100-6000 | 180 | H/V | 3 | 80% AM (1kHz) | A |
| 5100-6000 | 270 | H/V | 3 | 80% AM (1kHz) | A |

**Note:**
Criteria A: The EUT function was correct during the test.

## 5.4.7 Photographs of Test Configuration



## 5.5 Electrical Fast Transient Immunity Test (EFT)

### 5.5.1 Test Specification

| | |
|---|---|
| **Standard** | EN 61000-4-4 |
| **Test Voltage** | Power Port: ±2kV<br>Signal / Control Ports (cable length > 3m): ±2kV |
| **Polarity** | Positive & Negative |
| **Impulse Frequency** | 5kHz |
| **Impulse Wave** | 5/50 ns |
| **Burst Duration** | 15 ms |
| **Burst Period** | 300 ms |
| **Test Duration** | Not less than 1 min. |

### 5.5.2 Test Instrument

| Item | Equipment | Manufacturer | Model | Meter No. | Calibration Date |
|---|---|---|---|---|---|
| 1 | EFT Generator | 3ctest | EFT500S | CT-1-165 | Sep. 20, 2023 |
| 2 | Clamp | 3ctest | CCC100 | CT-1-166 | Sep. 20, 2023 |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

## 5.5.3 Test Procedure

The table-top EUT was placed on a table that is 0.8 meter height. A ground reference plane is placed on the table, and uses 0.1m insulation between the EUT and ground reference plane. The floor-standing EUT was placed on 0.1m insulation support unit between the EUT and ground reference plane.

The minimum area of the ground reference plane is 1m × 1m, and 0.65mm thick min, and projected beyond the EUT by at least 0.1m on all sides.

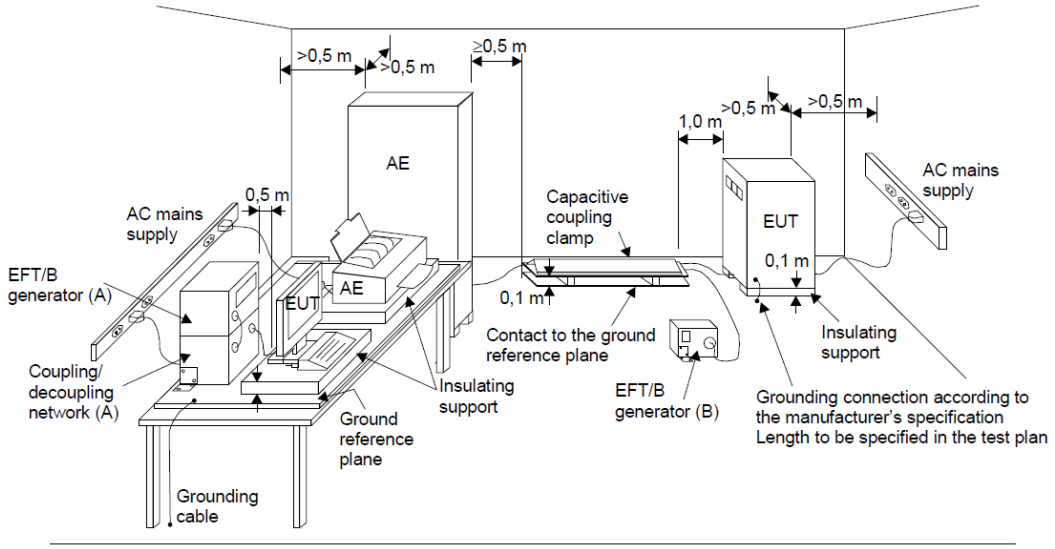
For input power ports:

The EUT is connected to the power ports through a coupling device that directly couples the EFT/B interference signal. Each of the line conductors is impressed with burst noise for 1 minute. The length of the power lines between the coupling device and the EUT is 0.5m.

## 5.5.4 Deviation from Test Standard

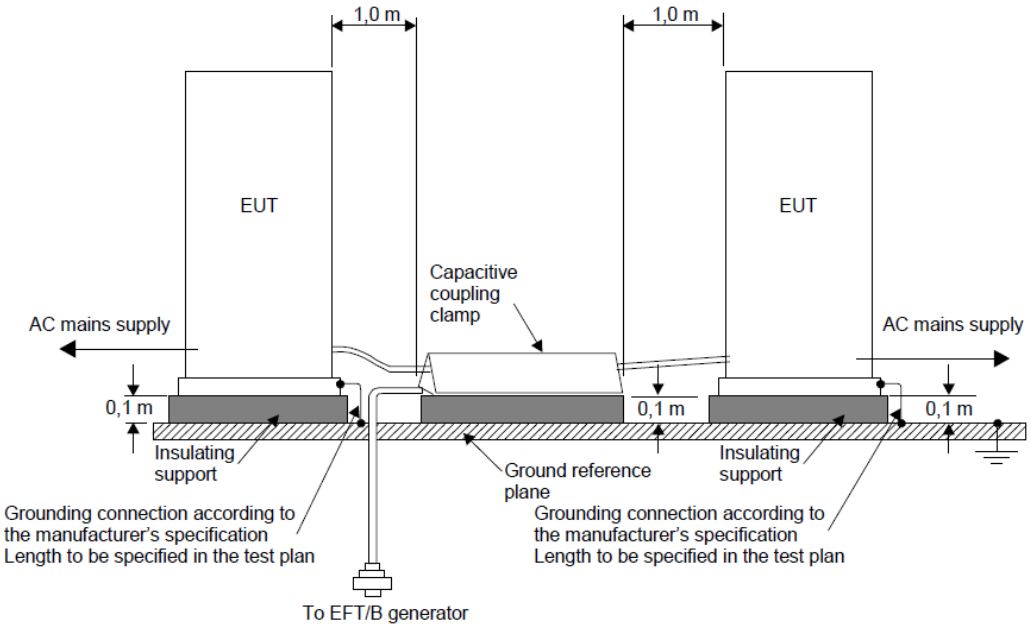
No deviation

## 5.5.5 Test Setup




(A) location for supply line coupling

(B) location for signal lines coupling



## 5.5.6 Test Result

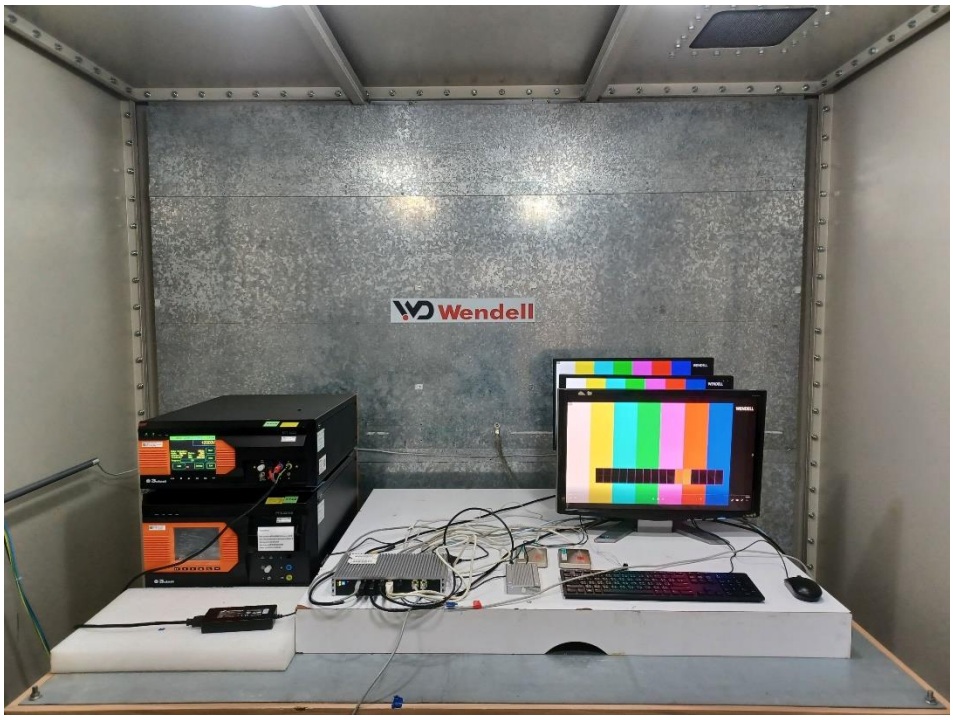
| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Environmental Conditions** | 22℃, 49% RH |
| **Tested by** | Guanwei Liao | **Test Date** | 2024/04/18 |

| **Test Point** | | **Test Level (kV)** | **Polarity (+/-)** | **Result** |
|---|---|---|---|---|
| AC Power Port | L | 2 | +/- | A |
| | N | 2 | +/- | A |
| | PE | 2 | +/- | A |
| | L + N | 2 | +/- | A |
| | L + PE | 2 | +/- | A |
| | N + PE | 2 | +/- | A |
| | L + N + PE | 2 | +/- | A |
| Signal and communication, process measurement and control ports | RJ45 | 2 | +/- | A |
| | PoE | 2 | +/- | A |

**Note:**
Criteria A: The EUT function was correct during the test.

## 5.5.7 Photographs of Test Configuration

Power




Signal

PoE

## 5.6 Surge Immunity Test

### 5.6.1 Test Specification

| | |
|---|---|
| **Standard** | EN 61000-4-5 |
| **Wave- Shape** | 1.2/50 μs Open Circuit Voltage<br>8/20 μs Short Circuit Current |
| **Test Voltage** | Power Port: line to line ±1kV, 42Ω, 0.5μF<br>line to ground ±2kV, 42Ω, 0.5μF |
| **Surge Input / Output** | L1-L2, L1-PE, L2-PE |
| **Polarity** | Positive/Negative |
| **Phase Angle** | 0˚/90˚/180˚/270˚ (For AC Power Port) |
| **Pulse Repetition Rate** | 1 time / min. (maximum) |
| **Times** | 5 positive and 5 negative at selected points |

### 5.6.2 Test Instrument

| Item | Equipment | Manufacturer | Model | Meter No. | Calibration Date |
|---|---|---|---|---|---|
| 1 | Surge Generator | HAEFELY | AXOS8 | CT-1-059(1) | Aug. 07, 2023 |
| 2 | Surge CDN | 3cTest | CDN-405T8A1 | CT-1-074(5) | May 27, 2024 |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

## 5.6.3 Test Procedure

The EUT is placed on a table that is 0.8 meter above a metal ground plane measured 1m × 1m minimum and 0.65mm thick minimum and projected beyond the EUT by at least 0.1m on all sides. The length of power cord between the coupling device and the EUT shall be 2m or less.

For input power ports:

The EUT is connected to the power mains through a coupling device that directly couples the surge interference signal.

The surge noise shall be applied synchronized to the peak value of the voltage wave. (Positive and negative)

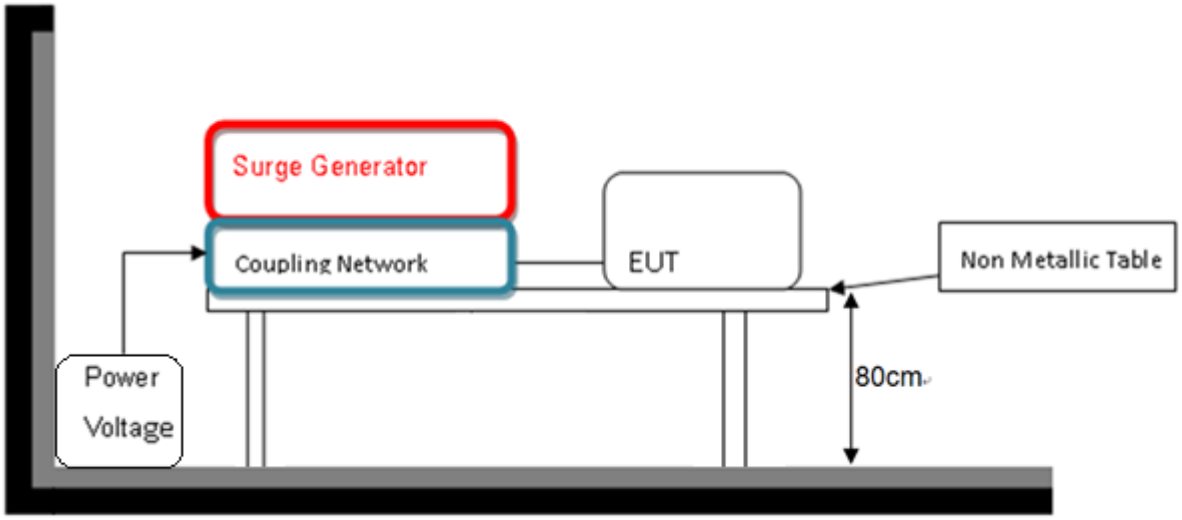
Each of Line to Earth and Line to Line is impressed with a sequence of five surge voltages with interval of 1 minute.

## 5.6.4 Deviation from Test Standard

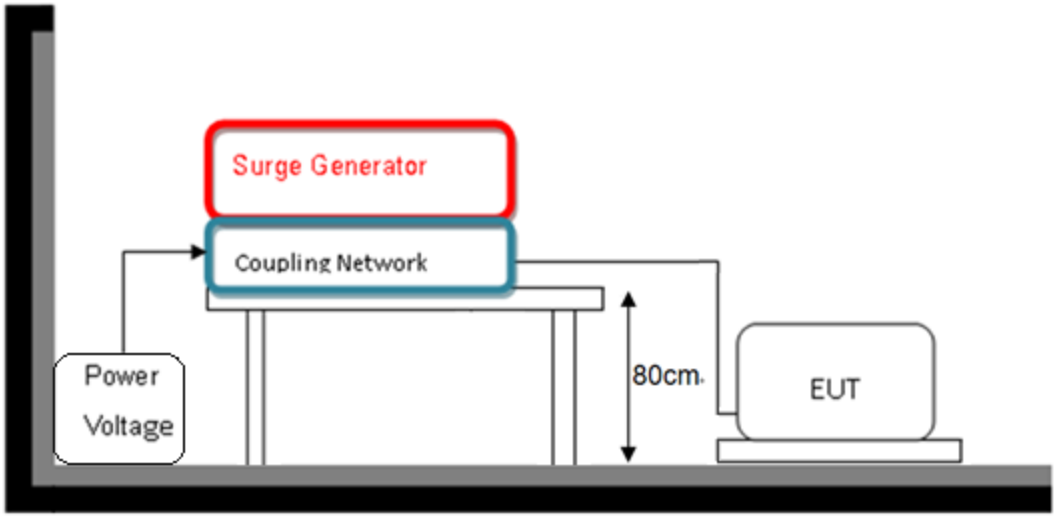
No deviation

## 5.6.5 Test Setup

**< Table-Top equipment >**




**< Floor-Standing equipment >**



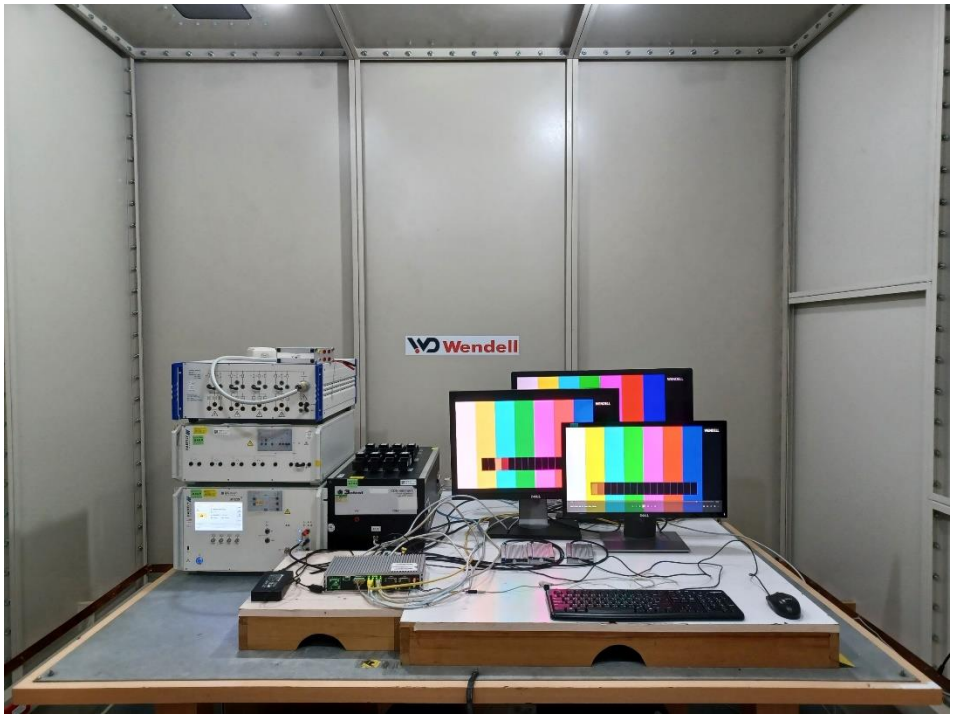
## 5.6.6 Test Result

| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Environmental Conditions** | 21℃, 49% RH |
| **Tested by** | Guanwei Liao | **Test Date** | 2024/06/20 |

| AC Power Port | | | | | | |
|---|---|---|---|---|---|---|
| **Test Point** | **Phase** | **Polarity (+/-)** | **Test Voltage (kV)** | | | **Result** |
| | | | **0.5** | **1** | **2** | |
| L to N | 0° | +/- | A | A | - | A |
| | 90° | +/- | A | A | - | |
| | 180° | +/- | A | A | - | |
| | 270° | +/- | A | A | - | |
| L to PE | 0° | +/- | A | A | A | A |
| | 90° | +/- | A | A | A | |
| | 180° | +/- | A | A | A | |
| | 270° | +/- | A | A | A | |
| N to PE | 0° | +/- | A | A | A | A |
| | 90° | +/- | A | A | A | |
| | 180° | +/- | A | A | A | |
| | 270° | +/- | A | A | A | |

**Note:**
Criteria A: The EUT function was correct during the test.

## 5.6.7 Photographs of Test Configuration



## 5.7 Radio-frequency common mode (CS)

### 5.7.1 Test Specification

| | |
|---|---|
| **Standard** | EN 61000-4-6 |
| **Frequency Range** | 0.15MHz - 80MHz |
| **Voltage Level** | 10 V(rms) |
| **Modulation** | AM Modulation, 80%, 1 kHz Sine Wave |
| **Frequency Step** | 1% of fundamental |
| **Dwell Time** | 3 seconds |

### 5.7.2 Test Instrument

| Item | Equipment | Manufacturer | Model | Meter No. | Calibration Date |
|---|---|---|---|---|---|
| 1 | Coupling clamp according to IEC 6100-4-6 | FRANKONIA | EMCL-20 | CT-1-049 | May 30, 2024 |
| 2 | CDN for power supply lines | FRANKONIA | CDN M2+M3 | CT-1-054 | May 30, 2024 |
| 3 | 6 dB Attenuator | BIRD | 75-A-FFN-06 | CT-1-056 | May 30, 2024 |
| 4 | Compact Immunity Test System acc | FRANKONIA | CIT-10/75 | CT-1-057 | May 30, 2024 |
| 5 | CDN for screened lines | FRANKONIA | RJ45S | CT-1-052 (1) | May 30, 2024 |
| 6 | 50ohm Termination | N/A | N/A | CT-1-065-1 | May 30, 2024 |
| 7 | Measurement Software | HUBERT | Ver: 1.1.2 | N/A | No calibration request |

**Note:** 1. The calibration interval of the above test instruments is 12 months.

### 5.7.3 Test Procedure

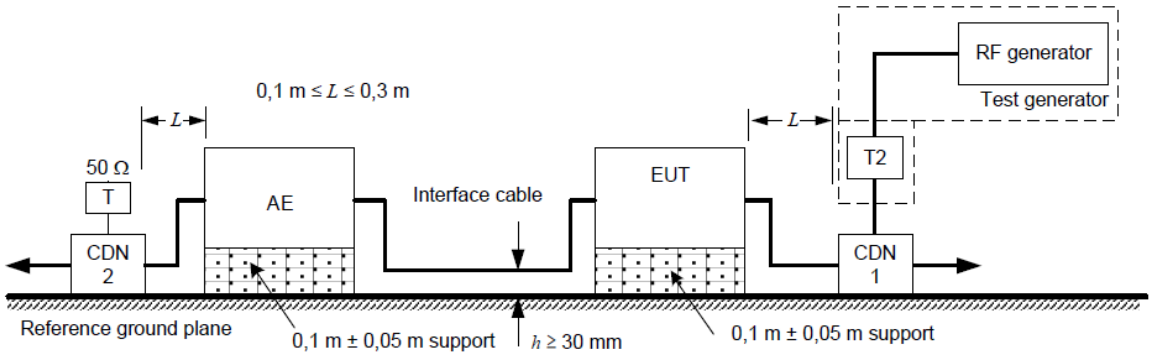
The EUT is placed on 0.1m insulation table between the EUT and ground reference plane.

For input power ports:
The EUT is connected to the power ports through a coupling and decoupling networks for power supply lines. And directly couples the disturbances signal into EUT.
Auxiliary equipment (AE) required for the defined operation of the EUT according to the specifications of the product committee.

## 5.7.4 Deviation from Test Standard

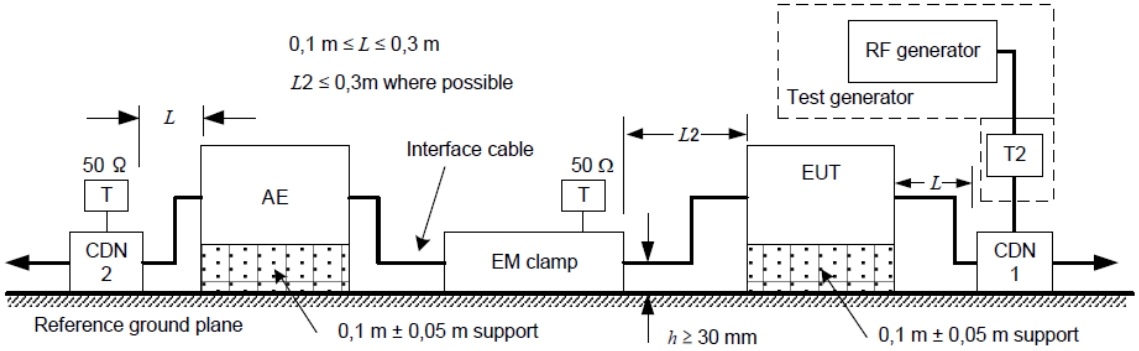
No deviation

## 5.7.5 Test Setup




The interface cable is set at 1 m if possible.

**a) Schematic setup for a 2-port EUT connected to only 1 CDN**




**Note:**

T: Termination 50 Ω

T2: Power attenuator (6 dB)

CDN: Coupling and decoupling network

Injection clamp: current clamp or EM clamp

## 5.7.6 Test Result

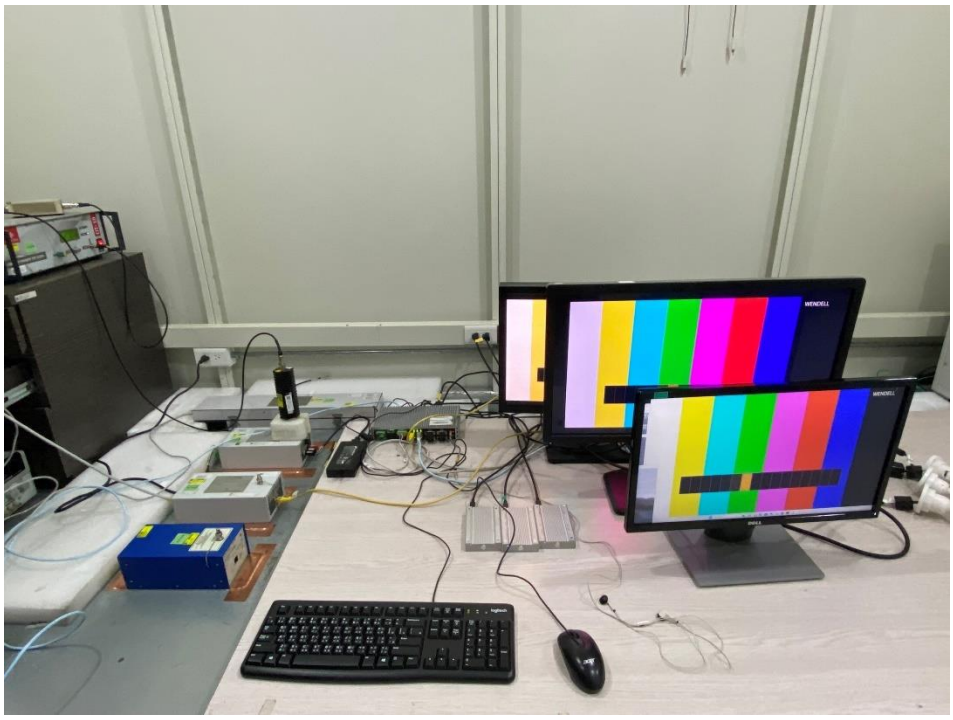
| | | | |
|---|---|---|---|
| **Test Voltage** | 230Vac, 50Hz | **Environmental Conditions** | 25℃, 50% RH |
| **Tested by** | Dennis Chen | **Test Date** | 2024/06/19 |

| Frequency Range (MHz) | Tested Port | Injection Method | Test Level ($V_{r.m.s.}$) | Modulation | Result |
|---|---|---|---|---|---|
| 0.15 - 80 | AC Power | CDN-M2 +M3(M3) | 10 | 80% AM, 1kHz | A |
| 0.15 - 80 | RJ45 | CLAMP | 10 | 80% AM, 1kHz | A |
| 0.15 - 80 | PoE | CDN RJ45S | 10 | 80% AM, 1kHz | A |

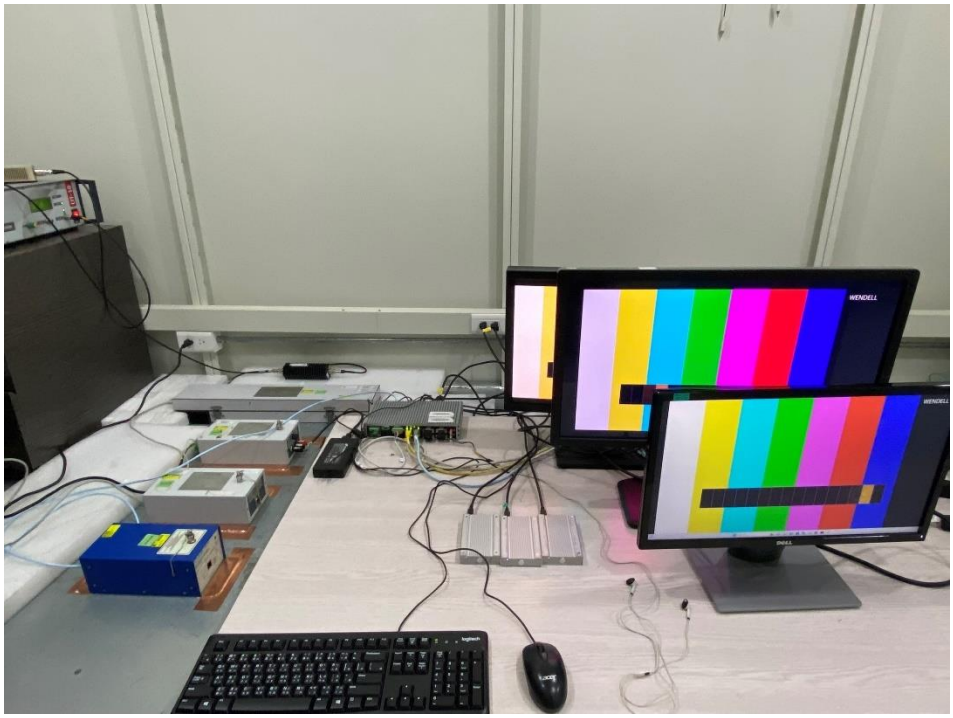
**Note:**
Criteria A: The EUT function was correct during the test.

### 5.7.7 Photographs of Test Configuration

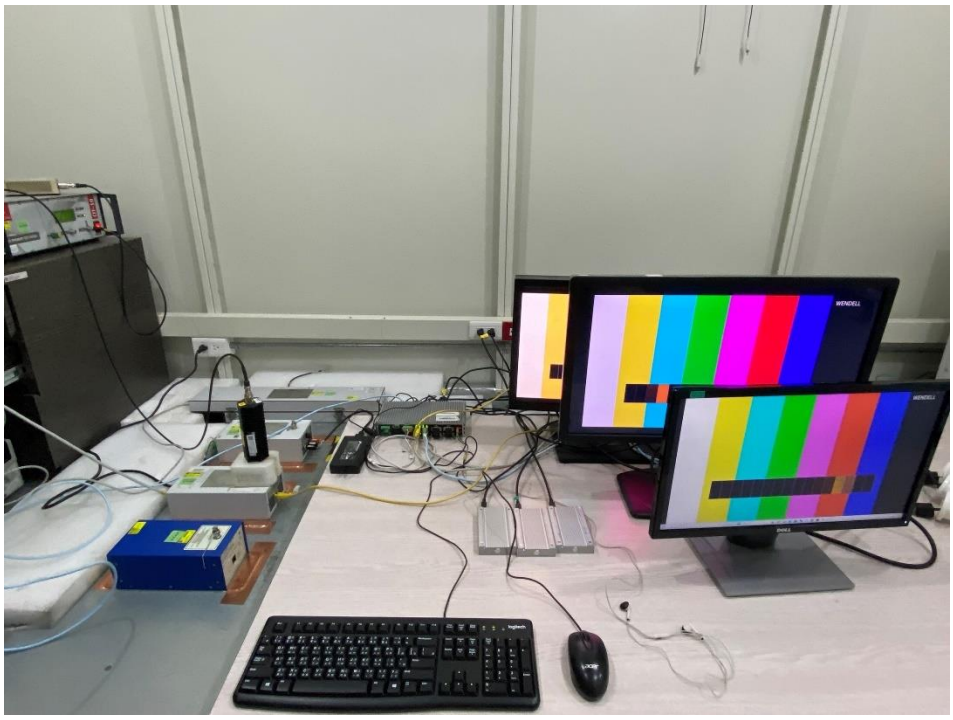
Power



Signal



PoE



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