# ARCOPLAST, INC.

# TEST REPORT

**SCOPE OF WORK**
ELECTROMAGNETIC COMPATIBILITY

**REPORT NUMBER**
105789756GRR-001 Rev. -

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ARCOPLAST, INC.
Report No.: 105789756GRR-001 Rev. -
Date: 7 JUN 2024
P.O.: 12870

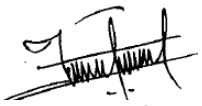
# Electromagnetic Compatibility Test Report

Project Number: G105789756
Test Date(s): 13 MAY 2024 through 16 MAY 2024

**Product Designations:** **Arcoplast Chamber**

**Applicable Documents:** Non-Standard Differential RF Attenuation

| Tested by: | Client: |
|---|---|
| Intertek Testing Services NA, Inc.<br>4700 Broadmoor SE Suite 200<br>Kentwood, MI 49512 | ARCOPLAST, INC.<br>106 Crafton Drive<br>O'Fallon, MO 63366 |

| Report prepared by | Report reviewed by |
|---|---|
|  <br>Hector Quiroz<br>Sr. EMC Project Engineer |  <br>James Vandenakker<br>EMC Project Engineer |

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# 1. EXECUTIVE SUMMARY

## 1.1 Scope

The purpose of the testing described herein was to perform an RF attenuation test on 5 samples of Arcoplast Inc Chambers based on a simplified differential test method. Prior to making the attenuations measurements, a baseline RF electric field was established with the probe outside of the cases. Continuous Wave (CW) was used for all testing. This method was discussed and approved by the client before testing. No standardized test method was used. The data within is to be used for engineering discovery purposes and does not indicate conformance with any known standardized test method or test certification.

The tests indicated in section 1.2 were performed on 3 sample configurations of the product constructed as described in section 3. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test method, test conditions, a list of the test equipment used, documentation photos, results, and raw data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

## 1.2 Test Summary

The product has no acceptance criteria or minimum requirements established by the client. Test results are for engineering investigation purposes only. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

The test summary is listed in Table 1. For detailed information including environmental conditions, equipment lists, pictures and additional test artifacts, see the applicable report section.

Table 1. Test Results Summary

| Section | Test Name | Test Date | Result |
|---|---|---|---|
| 3 | RF Electric Field Attenuation | 14 MAY 2024 – 16 MAY 2024 | Tested |

## 1.3 Acronym List

| Acronym | Definition |
|---|---|
| CW | Continuous Wave |
| DC | Direct Current |
| DUT | Device Under Test |
| ECU | Electronic Control Unit |
| EMC | Electromagnetic Compatibility |
| EUT | Equipment Under Test |
| RF | Radio Frequency |
| VBU | Verify Before Use |
| GFRP | Gelcoat Fiberglass Reinforce Polymer |
| GFRMC | Gelcoat Fiberglass Reinforced Matt Core |
| iPanel | Gelcoat Fiberglass Insulated Core |

## 2. DESCRIPTION OF SYSTEM UNDER TEST

### 2.1 Factual Data/EUT Description

The EUT under test is a Arcoplast Chamber as shown in Figure 1.

The interior dimension of the chamber is 39 3/8” wide x 39 3/8” long x 39 3/8” high = (1 $m^3$). The frame construction is based on 3 5/8” (92mm) 20 gauge (0.812mm) metallic steel stud erected 16” c/c and secured to a metallic floor and ceiling track using a UTWH (ultra-thin wafer head) #8 self-drilling screws. The test chamber panel to panel joint was sealed with Arcoplast A-1010 Bio-Seal and the wall to wall, wall to floor and wall to ceiling junctions were all coved with the A-1010 Bio-Seal.

- Arcoplast Chamber #1: Panels made of Acryloyl of 12.5 mm of thickness.
- Arcoplast Chamber #2: Panels made of Acryloyl of 9.5 mm of thickness.
- Arcoplast Chamber #3: Panels made of Gelcoat Fiberglass Reinforce Polymer (GFRP) of 9.5 mm of thickness.
- Arcoplast Chamber #4: Panels made of Gelcoat Fiberglass Reinforced Matt Core (GFRMC) of 5 mm of thickness.
- Arcoplast Chamber #5: Panels made of Gelcoat Fiberglass Insulated Core (iPanel) of 15 mm of thickness.

| Description | Manufacturer | Test Samples |
|---|---|---|
| Arcoplast Chamber | Arcoplast Inc | Arcoplast Chamber #1<br>Arcoplast Chamber #2<br>Arcoplast Chamber #3<br>Arcoplast Chamber #4<br>Arcoplast Chamber #5 |

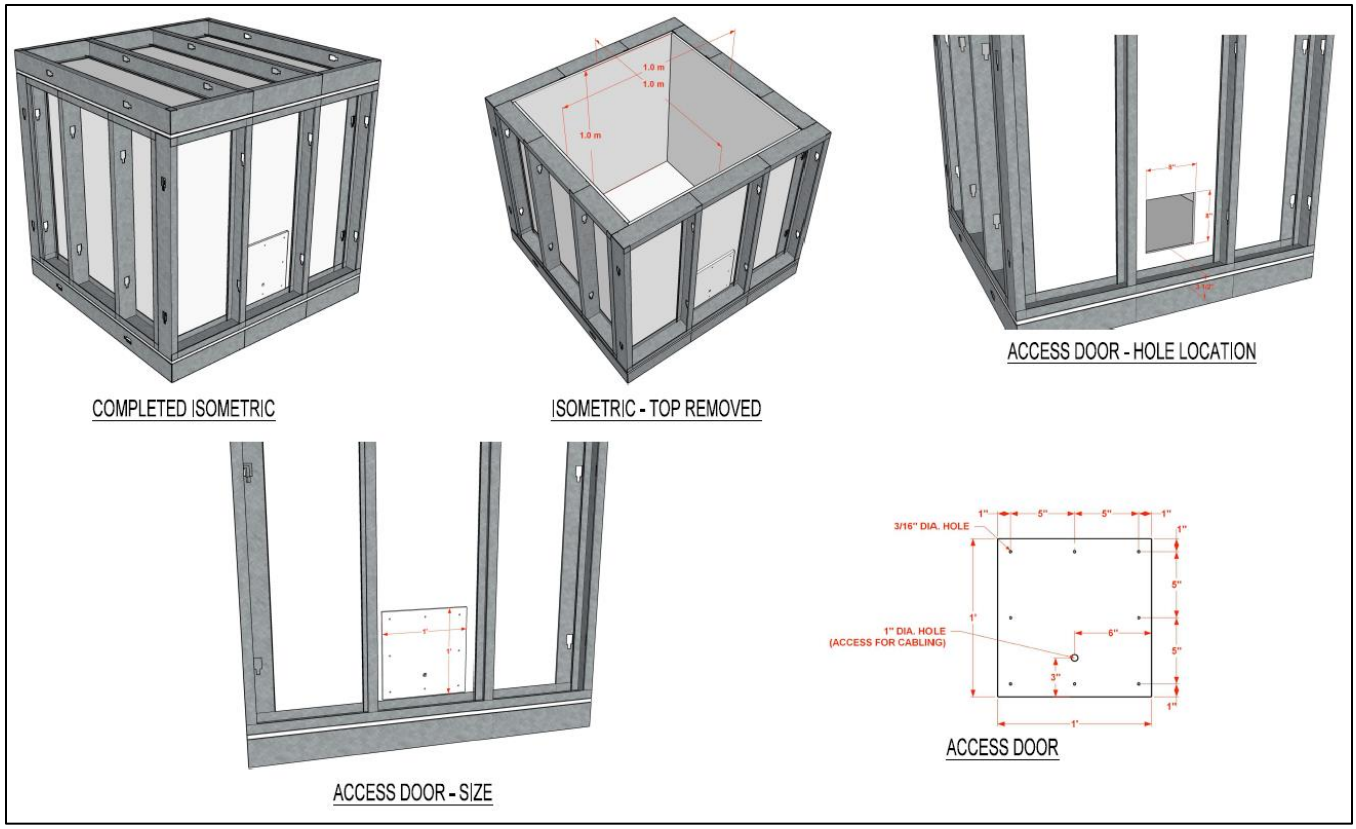


Figure 1. Arcoplast Chamber

## 2.2 **Product Disposition**

| | |
|---|---|
| EUT receive date | 16 APR 2024 |
| EUT receive condition | Good |
| Estimated EUT return date | TBD |

## 3. RF ELECTRIC FIELD ATTENUATION

Test Engineer: Hector Quiroz

### 3.1 Test Method

Testing was performed in accordance with the test procedure in section 3.6 of this report.

### 3.2 Test Conditions

#### 3.2.1 *Environmental Conditions*

Table 2. Environmental Conditions Table

| Date | Temperature (ºC) | Humidity (%RH) |
|---|---|---|
| 14 MAY 2024 | 25.4 | 45.2 |
| 15 MAY 2024 | 24.8 | 35.1 |
| 16 MAY 2024 | 24.7 | 35.2 |

### 3.3 Modes of Operation and Pass Criteria

The following modes and samples were tested:

Table 3. Modes of Operation and Pass Criteria Table

| Operating Mode | Test Samples | Acceptance Criteria |
|---|---|---|
| RF Attenuation | Arcoplast Chamber #1<br>Arcoplast Chamber #2<br>Arcoplast Chamber #3<br>Arcoplast Chamber #4<br>Arcoplast Chamber #5 | Test is conducted for informational purposes only. |

### 3.4 List of Test Equipment Used

The following table lists equipment used for this test. Equipment not requiring calibration are indicated with Verify Before Use (VBU) in the Calibration Date Column. The equipment is checked for functionality prior to the test.

Table 4. RF Electric Field Attenuation Test Equipment List

| Asset # | Description | Manufacturer | Model | Serial # | Last Cal | Next Due |
|---|---|---|---|---|---|---|
| 166439 | PROBE, FIELD, 3M - 18G | AMPLIFIER RESEARCH | FP7018 | 311648 | 9/6/2023 | 9/6/2024 |
| 166788 | TEMP/RH/PRESSURE RECORDER | OMEGA | OM-CP-PRHTEMP2000 | P71715 | 5/16/2023 | 5/16/2024 |
| 166392 | MONITOR, FIELD | AMPLIFIER RESEARCH | FM 7004 | 312962 | VBU | VBU |
| 166014 | POWER METER (10k - 8G) | BOONTON | 4232A | 60601 | 7/17/2023 | 7/17/2024 |
| 166923 | Power Sensor | BOONTON | 51011 | 32301 | 8/17/2023 | 8/17/2024 |
| 166418 | SIGNAL GENERATOR, 100k - 43.5G | RHODE & SCHWARZ | SMF100A | 101769 | 5/1/2023 | 6/1/2024 |
| 166898 | SSA 1.0-2.5GHZ, 500 WATTS | AMETEK | S251-500 | T2510-0619 | VBU | VBU |
| 166410 | ANTENNA; TRANSMIT 4G - 8G, 500W | AMPLIFIER RESEARCH | ATH4G8 | 0335168 | VBU | VBU |

| Asset # | Description | Manufacturer | Model | Serial # | Last Cal | Next Due |
|---|---|---|---|---|---|---|
| 166406 | ANTENNA, 0.8 - 5G, 1500 W | AMPLIFIER RESEARCH | ATH800M5GA | 0334151 | VBU | VBU |
| 166367 | AMPLIFIER, 2 - 8G, 250 W | CPI | VZS/C-6963J2 | J12935H0 | VBU | VBU |

## 3.5 Arrangement of EUT and Test Instrumentation

Figure 2. Calibration Setup – 900MHz, 2.437GHz, 5GHz

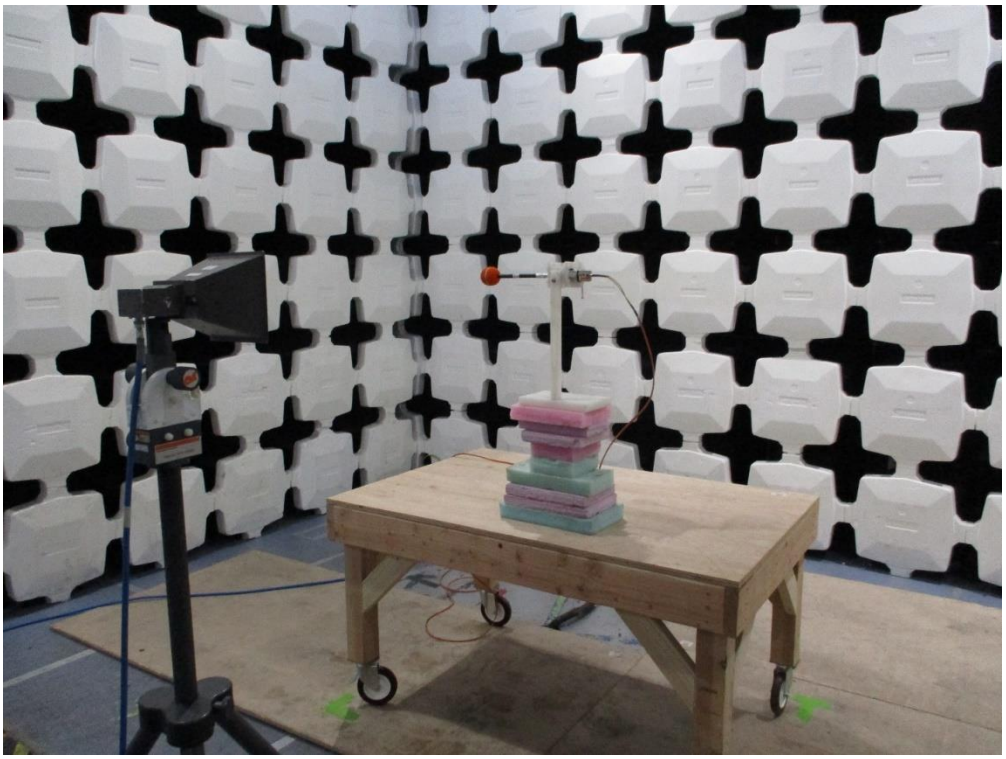

Figure 3. Calibration Setup - 6.515GHz

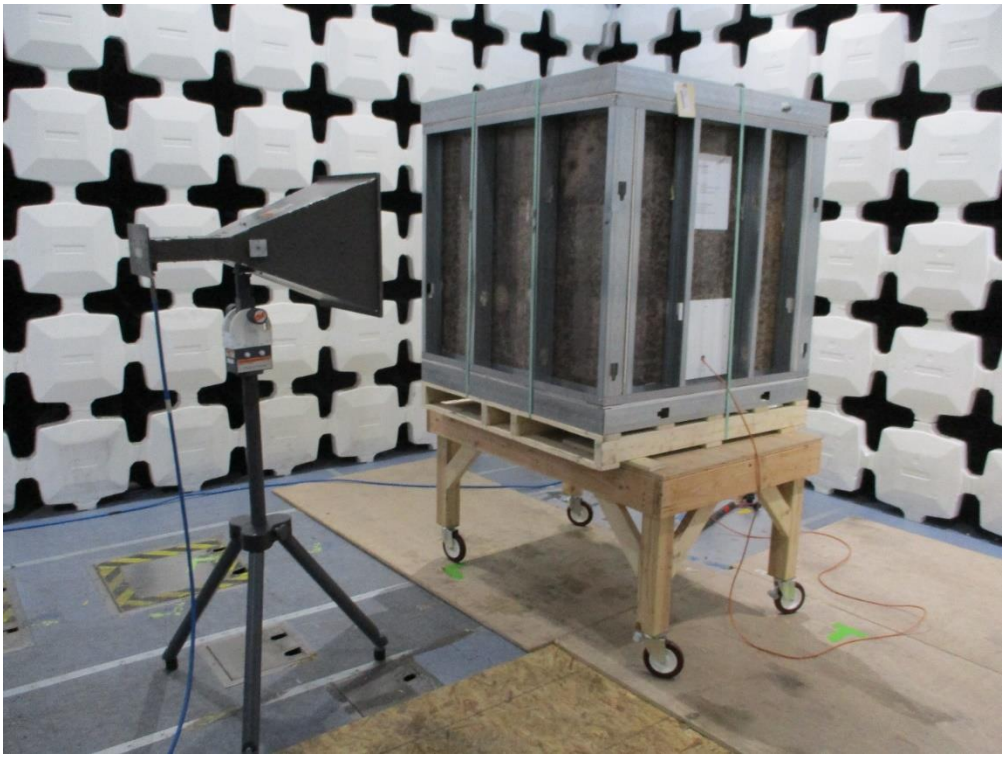

Figure 4. Right Face Test Setup – 900MHz, 2.437GHz, 5GHz

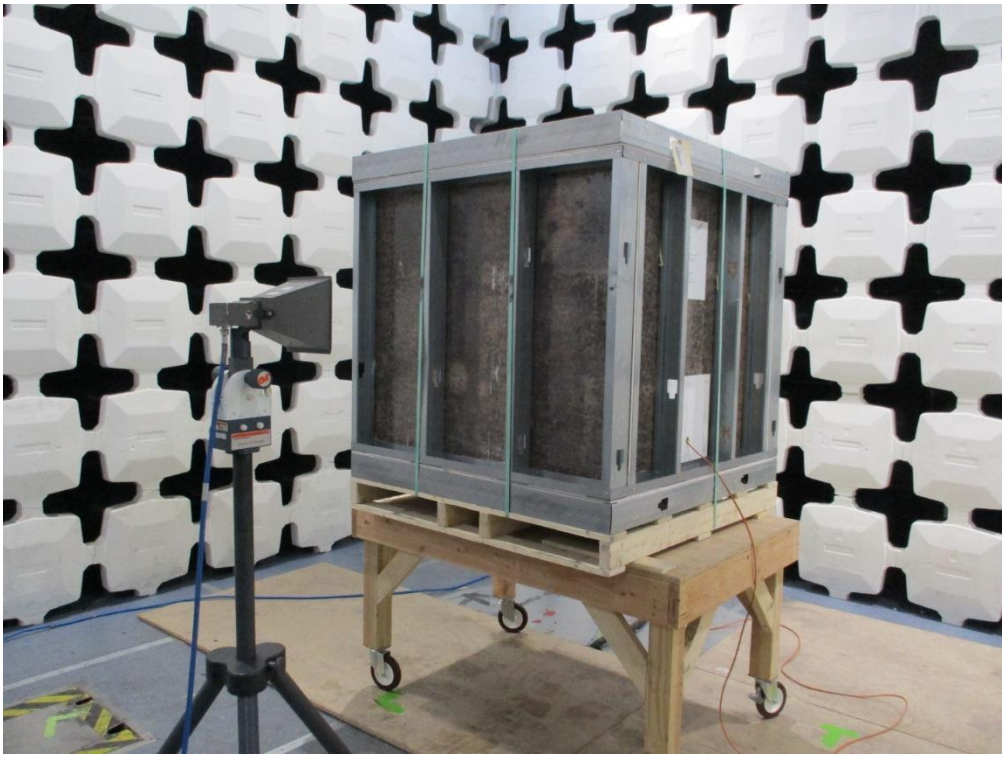

Figure 5. Right Face Test Setup – 6.515GHz

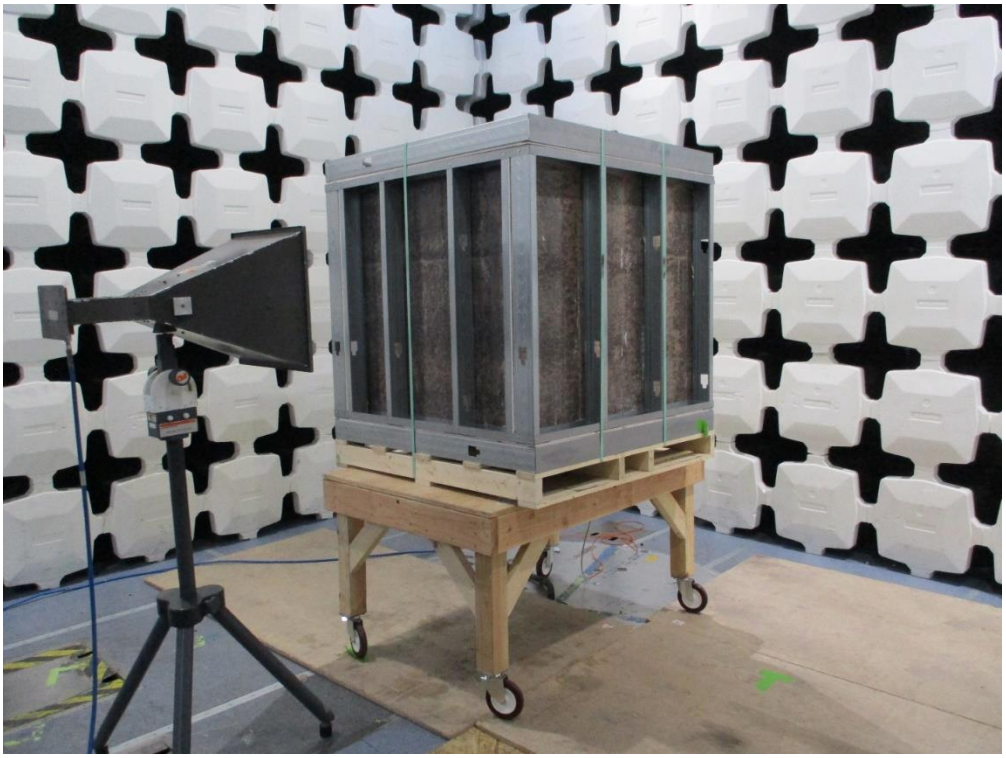

Figure 6. Front Face Test Setup – 900MHz, 2.437GHz, 5GHz

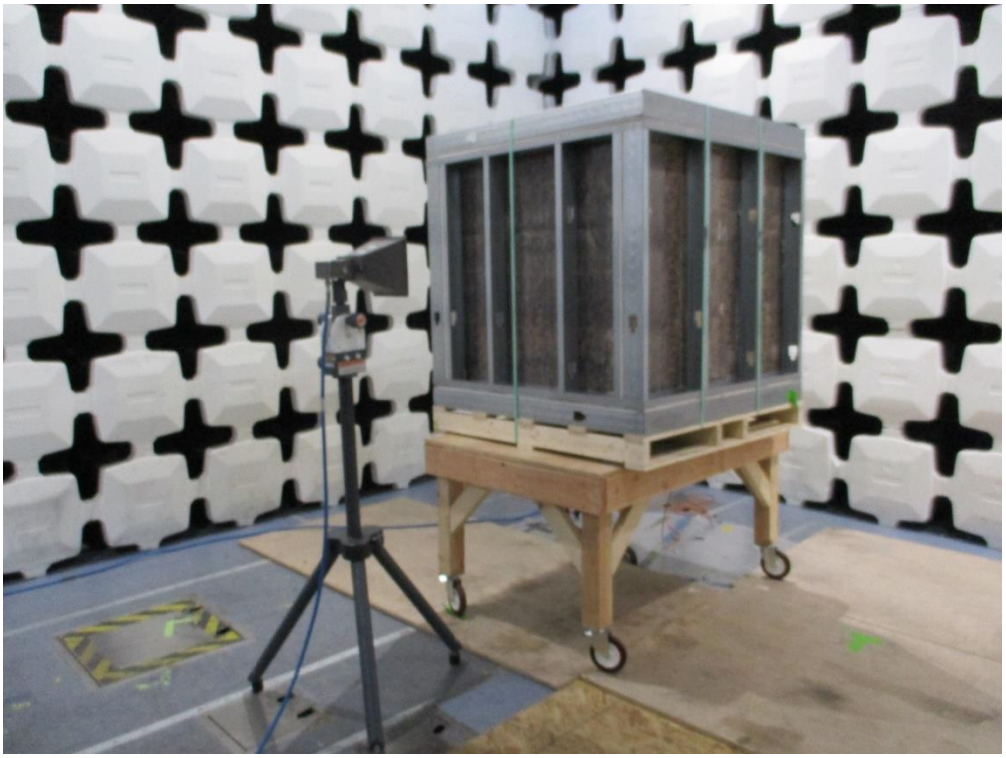

Figure 7. Front Face Test Setup – 6.515GHz

Figure 8. Field Probe Inside Chamber Setup

## 3.6 EUT Test Measurements

The following electric field levels were generated. In terms of dB of attenuation, the following conversion is used:

$$dBV = 20*Log\ (V_{in} / V_{out})$$

Where:
$V_{in}$: Calibrated level with field probe in open field
$V_{out}$: Measured level with field probe inside the enclosure

The Arcoplast Chamber unit was placed within an RF Shielded Enclosure with an Electric Field Sensor placed inside. An electric field was transmitted at the Chamber exterior. This radiation was sensed by the Electric Field Sensor inside the Arcoplast Chamber, and the level of radiation was measured and displayed via an electric field monitor. Negative attenuation measurement means that the electric field measured inside the Arcoplast Chamber is higher compared with the base electric field during calibration.

Table 5. Calibration Measurement Values

| Frequency (GHz) | E-Field Level | Forward Power |
|---|---|---|
| 0.9 | 200 | -4.03 |
| 2.437 | 200 | -7.63 |
| 5 | 200 | -6.17 |
| 6.515 | 200 | -7.06 |

### 3.6.1 *Arcoplast Chamber 1*

Table 6. Right Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 136.8 | 3.30 |
| 2.437 | 200 | 208.22 | -0.35 |
| 5 | 200 | 108.16 | 5.34 |
| 6.515 | 200 | 149.9 | 2.50 |

Table 7. Front Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 256.6 | -2.16 |
| 2.437 | 200 | 215.32 | -0.64 |
| 5 | 200 | 210.95 | -0.46 |
| 6.515 | 200 | 125.47 | 4.05 |

### 3.6.2 *Arcoplast Chamber 2*

Table 8. Right Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 96.9 | 6.29 |
| 2.437 | 200 | 87.65 | 7.17 |

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 5 | 200 | 245.8 | -1.79 |
| 6.515 | 200 | 143.9 | 2.86 |

Table 9. Front Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 187.22 | 0.57 |
| 2.437 | 200 | 130.65 | 3.70 |
| 5 | 200 | 104.39 | 5.65 |
| 6.515 | 200 | 85.74 | 7.36 |

### 3.6.3 *Arcoplast Chamber 3*

Table 10. Right Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 103.53 | 5.72 |
| 2.437 | 200 | 169.63 | 1.43 |
| 5 | 200 | 54.3 | 11.32 |
| 6.515 | 200 | 51.77 | 11.74 |

Table 11. Front Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 214.81 | -0.62 |
| 2.437 | 200 | 280.73 | -2.95 |
| 5 | 200 | 166.7 | 1.58 |
| 6.515 | 200 | 161.62 | 1.85 |

### 3.6.4 *Arcoplast Chamber 4*

Table 12. Right Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 306.3 | -3.70 |
| 2.437 | 200 | 277.5 | -2.84 |
| 5 | 200 | 119.7 | 4.46 |
| 6.515 | 200 | 166.5 | 1.59 |

Table 13. Front Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 143.5 | 2.88 |
| 2.437 | 200 | 245.43 | -1.78 |
| 5 | 200 | 188.8 | 0.50 |
| 6.515 | 200 | 225.5 | -1.04 |

### 3.6.5 *Arcoplast Chamber 5*

Table 14. Right Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 222.33 | -0.92 |
| 2.437 | 200 | 250.88 | -1.97 |
| 5 | 200 | 105.1 | 5.59 |
| 6.515 | 200 | 150.09 | 2.49 |

Table 15. Front Face Test Measurements – RF Attenuation

| Frequency (GHz) | Calibrated E-Field (V/m) | Measured E-Field (V/m) | Attenuation (dBV) |
|---|---|---|---|
| 0.9 | 200 | 242.45 | -1.67 |
| 2.437 | 200 | 301.26 | -3.56 |
| 5 | 200 | 159.52 | 1.96 |
| 6.515 | 200 | 152.45 | 2.36 |

## 4. REVISION HISTORY

| Revision Level | Date | Report Number | Prepared By | Reviewed By | Notes |
|---|---|---|---|---|---|
| - | 7 JUN 2024 | 105789756GRR-001 Rev. - | HQ | JV | Original Issue |
| | | | | | |