

# Antenna Report

FCC ID: A4RGUR25

4/3/2024

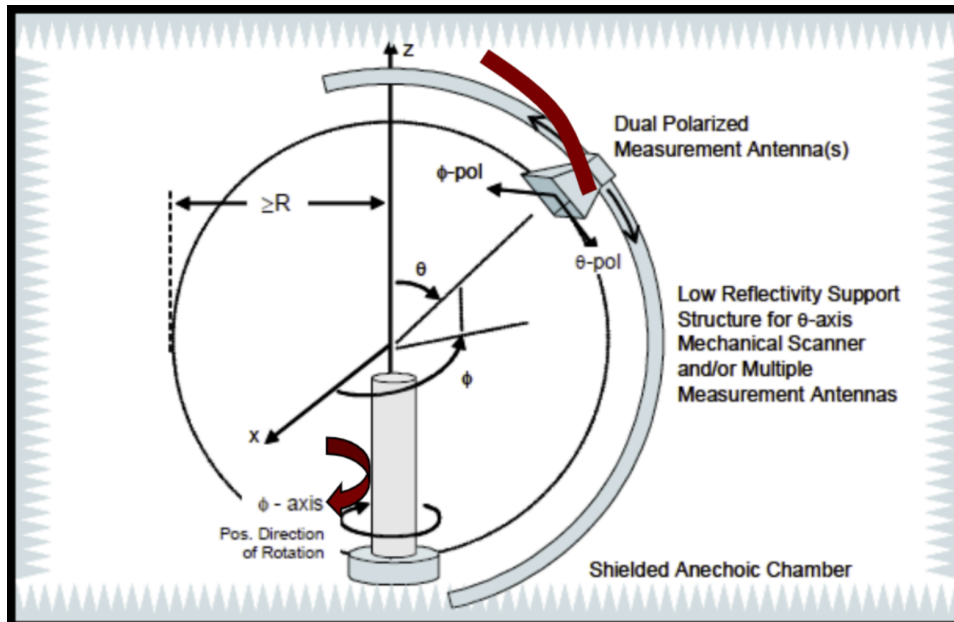
Google LLC

## 1. Test Method

The antenna gains are obtained through measurements in a fully anechoic OTA chamber with a 3D positioner.

Measurements are taken in discrete steps in theta and phi direction. Data is recorded for both theta and phi polarizations at each position using Network Analyzer (passive) or Signal Analyzer(active). Step size is 15 deg along both axes.

Gain is derived from peak EIRP and conducted power measurements or directly through spatial averaging of VNA S21 measurements



$R=1.02\text{m}$  for WPTC-S

## 2. Test Equipment and Calibration

Antenna gain measurements were divided into two chambers (2.4GHz and 5-6 GHz (UNII-1 to UNII-8))

### a. Chamber 1: 2.4 GHz

| Site Description                               | Chamber Manufacturer                        | Type     |
|------------------------------------------------|---------------------------------------------|----------|
| MVG SL<br>50GHz_50115-1014<br>Anechoic Chamber | MVG                                         | Anechoic |
| Site location:                                 | 1383 Shorebird Way, Mountain View, CA 94043 |          |

| Description      | Manufacturer | Model          |
|------------------|--------------|----------------|
| Network Analyzer | Keysight     | N5245B (PNA-X) |

|                              |                                                                             |
|------------------------------|-----------------------------------------------------------------------------|
| Equipment calibration status | - Calibration date: Sep.16, 2022<br>- Due of next calibration: Sep.16, 2024 |
| Test dates                   | - March. 11, 2024                                                           |
| Names of test personnel      | - Aobo Li                                                                   |

### b. Chamber 2: 5-6GHz (UNII-1 to UNII-8)

| Site Description              | Chamber Manufacturer                        | Type     |
|-------------------------------|---------------------------------------------|----------|
| TS8991 OTA system<br>(WPTC-S) | R&S                                         | Anechoic |
| Site location:                | 1383 Shorebird Way, Mountain View, CA 94043 |          |

| Description     | Manufacturer | Model |
|-----------------|--------------|-------|
| Signal Analyzer | R&S          | FSV   |

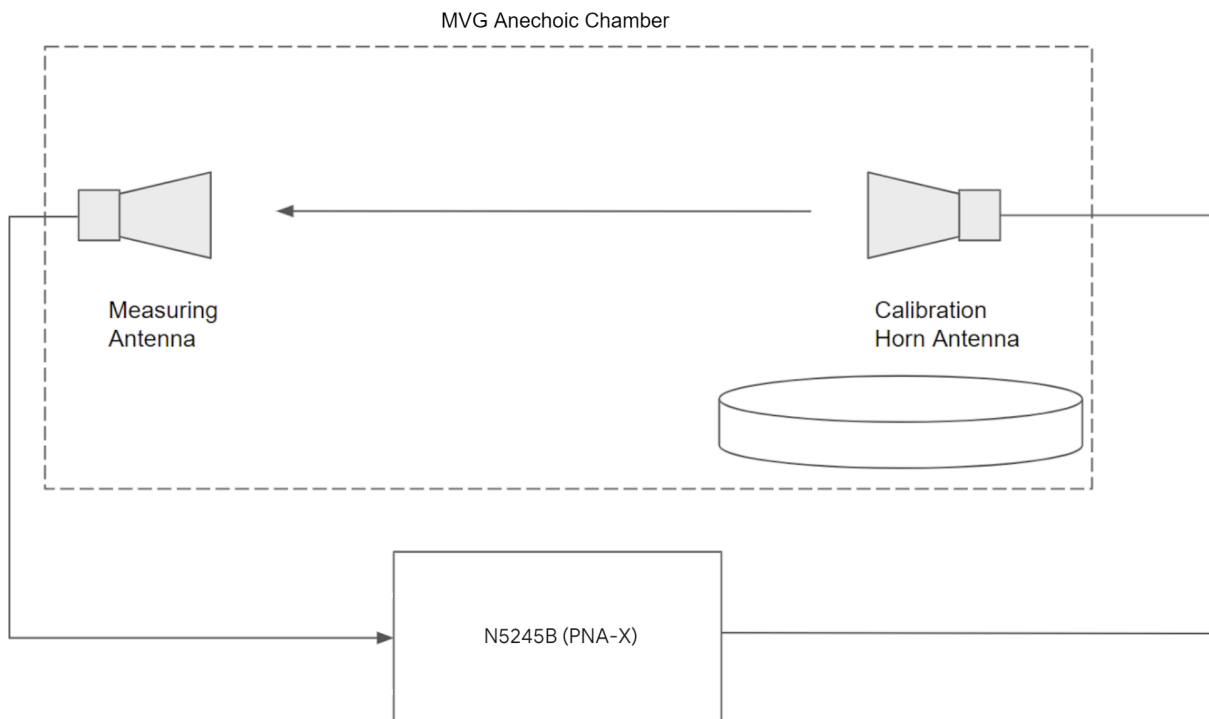
|                              |                                                                             |
|------------------------------|-----------------------------------------------------------------------------|
| Equipment calibration status | - Calibration date: Sep.18, 2022<br>- Due of next calibration: Sep.18, 2024 |
| Test dates                   | - January. 17, 2024                                                         |
| Names of test personnel      | - Patrick Choi                                                              |

### 3. Site Path Loss

To provide accurate antenna gain values, the chamber is calibrated with the measured path loss. The block diagram below represents the setup of the site path loss. Path loss is provided for both polarities for all WLAN frequency ranges. Path losses were divided into two chambers (2.4GHz and 5-6GHz (UNII-1 to UNII-8))

#### a. Chamber 1: 2.4 GHz

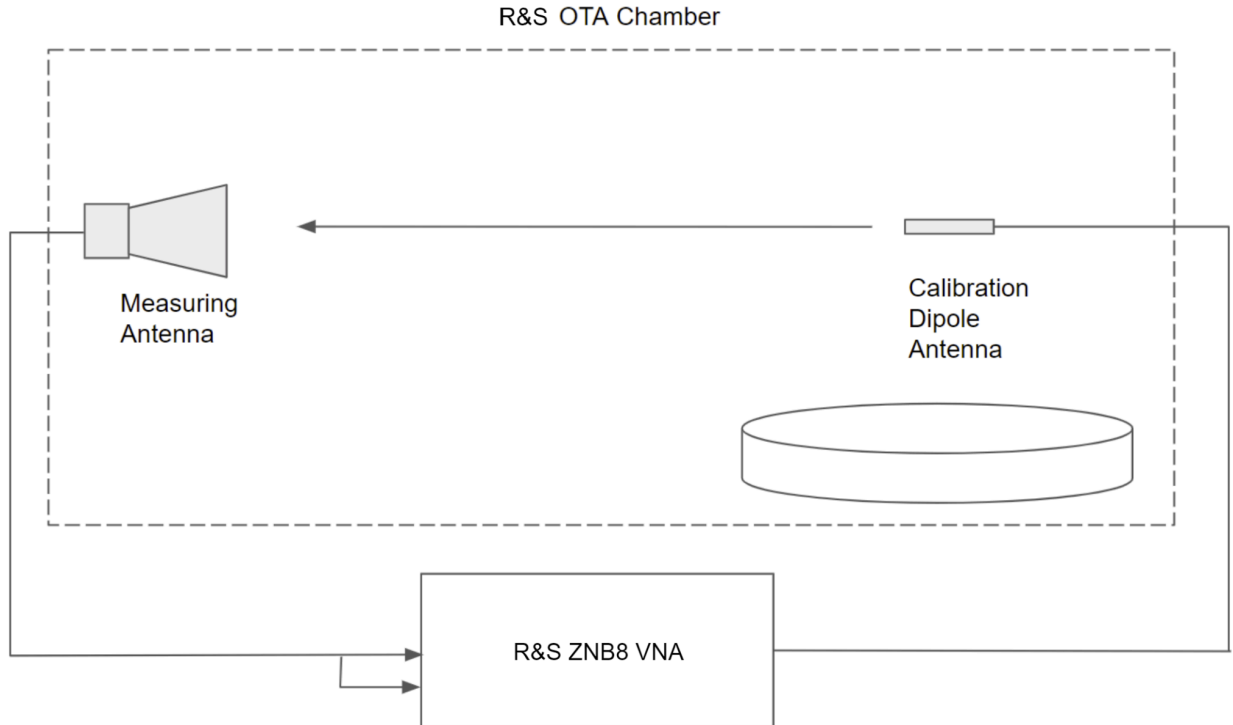
Figure: Chamber 1 Block Diagram of Path Loss



| Frequency (MHz) | Path Loss |
|-----------------|-----------|
| 2402            | -19.76    |
| 2412            | -19.82    |
| 2437            | -20.06    |
| 2462            | -20.33    |
| 2480            | -20.46    |

## b. Chamber 2: 5-6GHz (UNII-1 to UNII-8)

Figure: Chamber 2 Block Diagram of Path Loss



| Frequency (MHz) | H-Pol Path Loss | V-Pol Path Loss |
|-----------------|-----------------|-----------------|
| 5180            | -53.62          | -52.53          |
| 5280            | -53.47          | -52.79          |
| 5500            | -53.58          | -53.32          |
| 5820            | -54.47          | -54.74          |
| 5887            | -54.1           | -54.13          |
| 6175            | -54.94          | -55.28          |
| 6475            | -55.23          | -55.13          |
| 6700            | -55.6           | -55.47          |
| 7000            | -55.24          | -55.74          |

#### 4. Test Setup

See separate appendix document for pictures of the test setup in this filing.

#### 5. Antenna Type

See description of antenna type below.

| Antenna Name | Antenna Type |
|--------------|--------------|
| Ant3         | IFA          |
| Ant4         | ILA          |

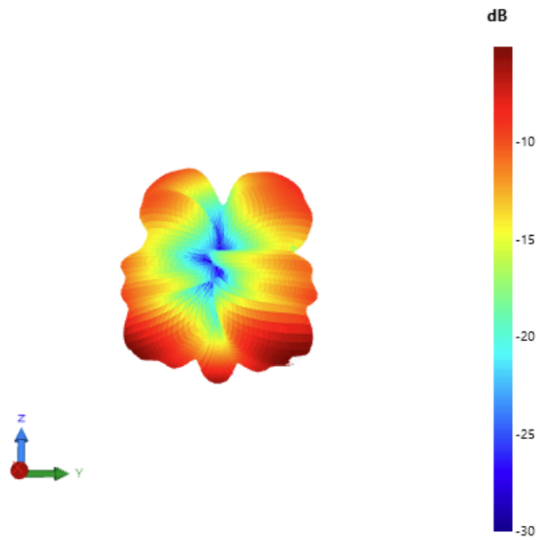
## 6. WLAN/BT Antennas

| Ant         | Band                   | Frequency Band    | Peak Gain(dBi) |
|-------------|------------------------|-------------------|----------------|
| <b>Ant4</b> | 2.4 GHz WiFi/BT/Thread | 2400 - 2483.5 MHz | -1.1           |
|             | UNII-1                 | 5180 MHz          | -6.3           |
|             | UNII-2A                | 5280 MHz          | -3.5           |
|             | UNII-2C                | 5500 MHz          | -3.2           |
|             | UNII-3                 | 5820 MHz          | -3.5           |
|             | UNII-4                 | 5887 MHz          | -3.5           |
|             | UNII-5                 | 6175 MHz          | -3.8           |
|             | UNII-6                 | 6475 MHz          | -5.2           |
|             | UNII-7                 | 6700 MHz          | -5.5           |
|             | UNII-8                 | 7000 MHz          | -6.9           |
| <b>Ant3</b> | 2.4 GH WiFi/BT/Thread  | 2400 - 2483.5 MHz | 0.9            |
|             | UNII-1                 | 5180 MHz          | -0.9           |
|             | UNII-2A                | 5280 MHz          | -0.9           |
|             | UNII-2C                | 5500 MHz          | -1.8           |
|             | UNII-3                 | 5820 MHz          | -1.1           |
|             | UNII-4                 | 5887 MHz          | -1.3           |
|             | UNII-5                 | 6175 MHz          | -2.2           |
|             | UNII-6                 | 6475 MHz          | -0.8           |
|             | UNII-7                 | 6700 MHz          | -1.5           |
|             | UNII-8                 | 7000 MHz          | -0.1           |

## 7. Radiation Plots

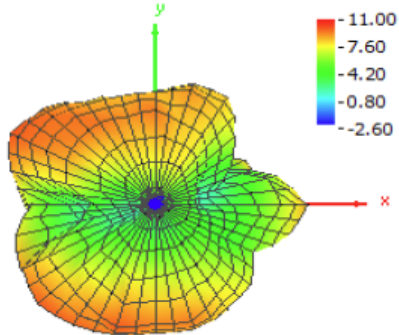
**Ant4:**

Ant4 Freq. 2.4GHz:



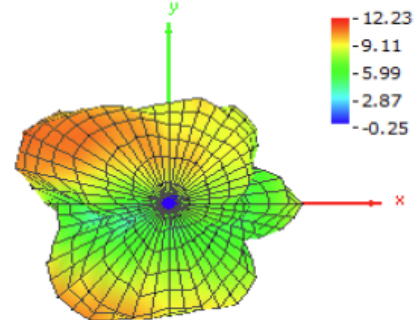
Ant4 Freq. 5180 MHz:

**Theta = 0, Phi = 0**



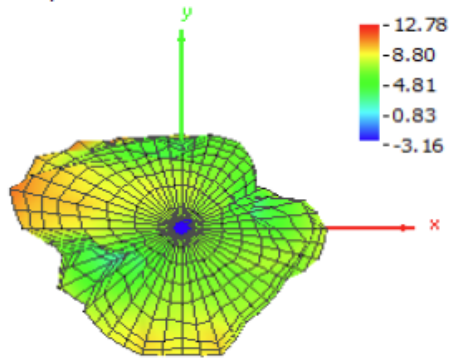
Ant4 Freq. 5280 MHz:

**Theta = 0, Phi = 0**



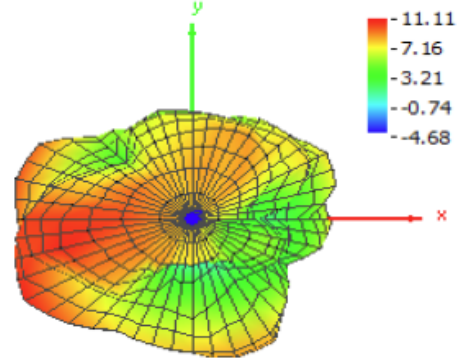
Ant4 Freq. 5500 MHz:

**Theta = 0, Phi = 0**



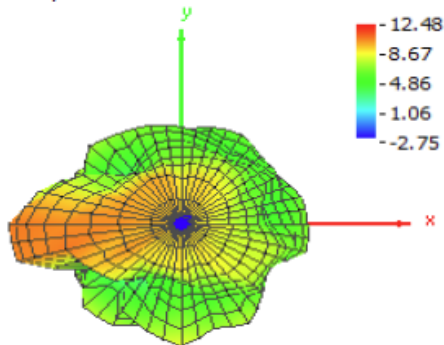
Ant4 Freq. 6175 MHz:

**Theta = 0, Phi = 0**



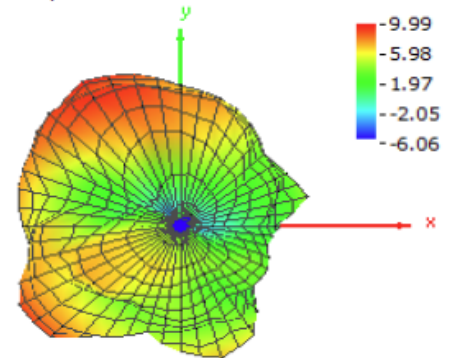
Ant4 Freq. 5820 MHz:

**Theta = 0, Phi = 0**



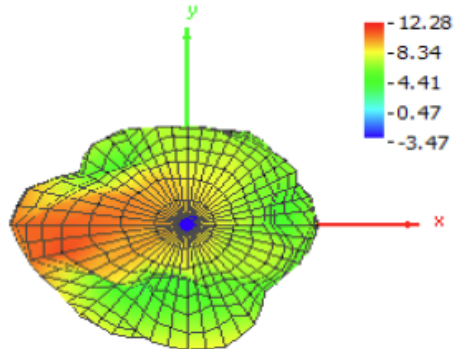
Ant4 Freq. 6475 MHz:

**Theta = 0, Phi = 0**



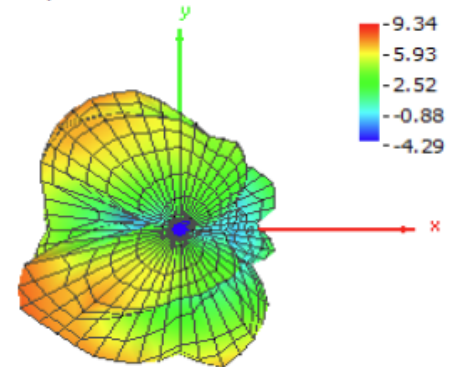
Ant4 Freq. 5887 MHz:

**Theta = 0, Phi = 0**



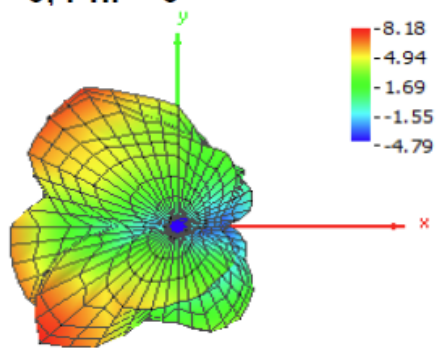
Ant4 Freq. 6700 MHz:

**Theta = 0, Phi = 0**



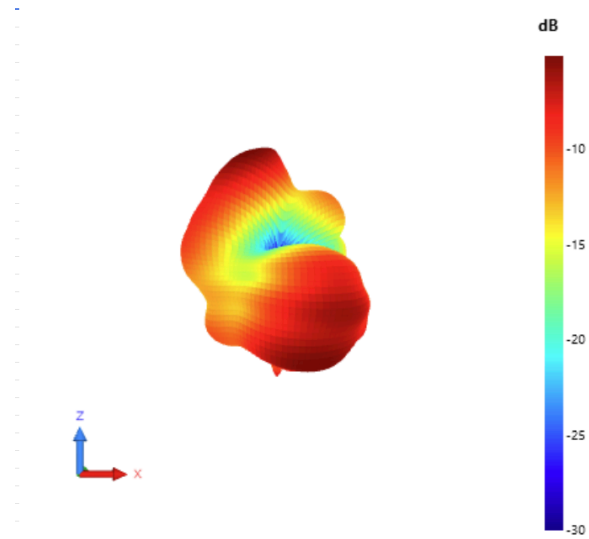
Ant4 Freq. 7000 MHz

**Theta = 0, Phi = 0**



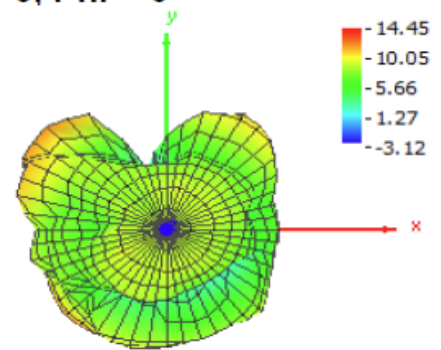
**Ant3:**

Ant3 Freq. 2.4GHz:



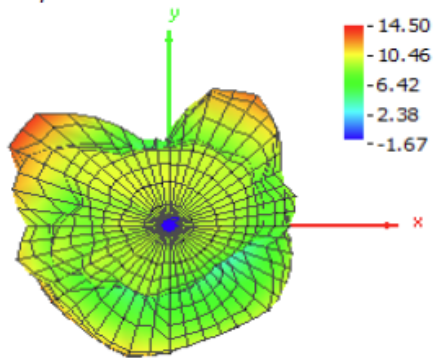
Ant3 Freq. 5180 MHz:

**Theta = 0, Phi = 0**



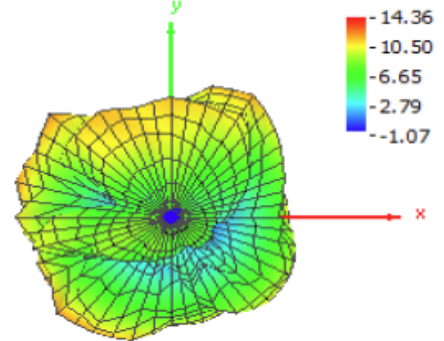
Ant3 Freq. 5280 MHz:

**Theta = 0, Phi = 0**



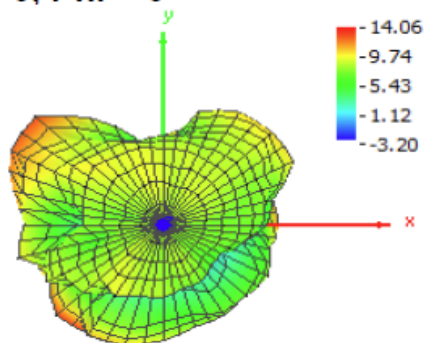
Ant3 Freq. 5887 MHz:

**Theta = 0, Phi = 0**



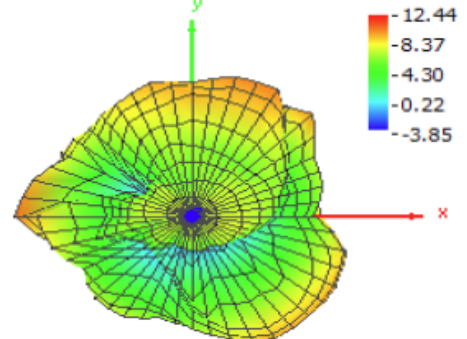
Ant3 Freq. 5500 MHz:

**Theta = 0, Phi = 0**



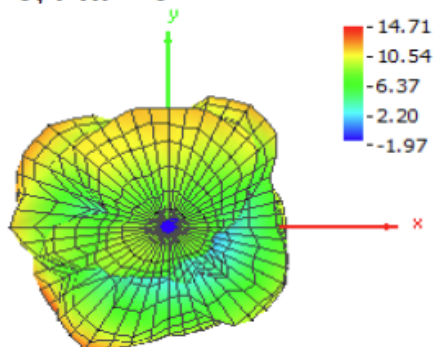
Ant3 Freq. 6175 MHz:

**Theta = 0, Phi = 0**



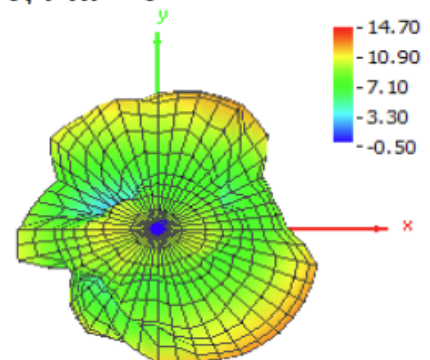
Ant3 Freq. 5820 MHz:

**Theta = 0, Phi = 0**



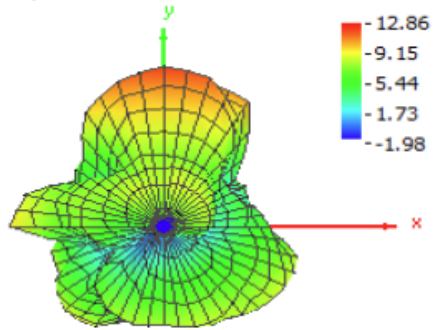
Ant3 Freq. 6475 MHz:

**Theta = 0, Phi = 0**



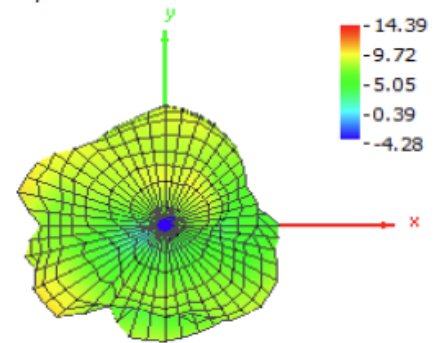
Ant3 Freq. 6700 MHz:

**Theta = 0, Phi = 0**



Ant3 Freq. 7000 MHz:

**Theta = 0, Phi = 0**



## 8. Report Signatory

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