# Antenna Report

**FCC ID: A4RGB62Z**

**12/6/2022**

**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 being recorded using the spectrum analyzer (active) or network analyzer (passive) for both theta and phi polarizations at each position resulting in a 3D gain pattern. Step size is <30 deg along both axes.

Gain is either derived directly through spatial averaging of VNA S21 measurements (passive measurement) or by the ratio of spatial averaging of 3D EIRP/TRP measurements vs the conducted power (active measurement)
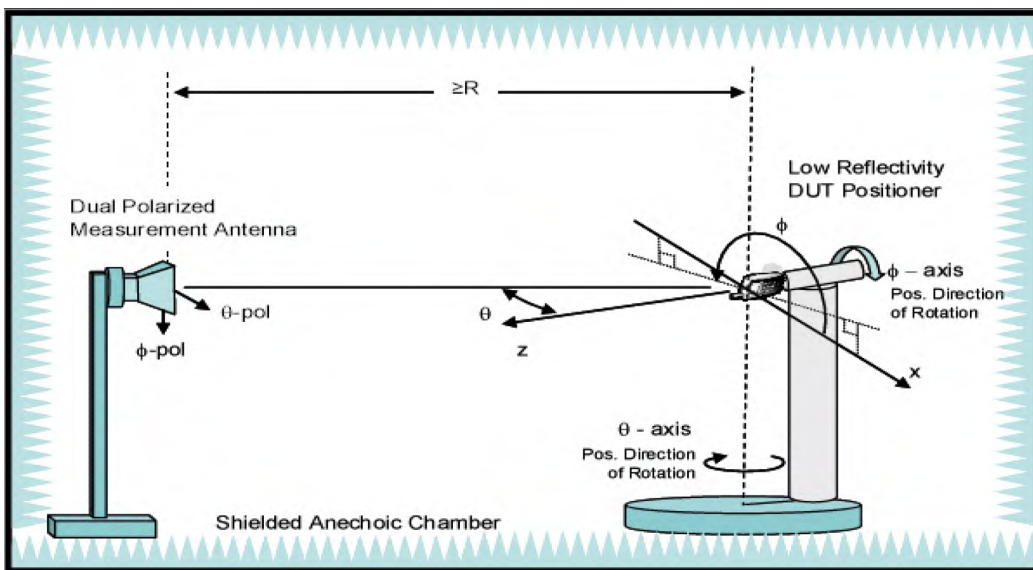


## 2. Test Equipment

| Site Description | Chamber Manufacturer | Type |
|---|---|---|
| AMS-8500 | ETS-Lindgren | Fully anechoic |
| Software Version | ETS-Lindgren | EMQuest V1.10 Bulid 4671 |
| Site location | No.23, Xinghua Road, Taoyuan District, Taoyuan City 33068, Taiwan | |
| Test Engineer | Jason Lin / Jason Cheng | |
| Date | Aug. 2022 | |

| Description | Manufacturer | Moder | Calibration Date | Due Date |
|---|---|---|---|---|
| Network Analyzer | Agilent | E5071C | Feb. 17, 2022 | Feb. 17, 2023 |
| Spectrum Analyzer | Rohde&Schwarz | FSVA3030 | May 16, 2022 | May 16, 2023 |

## 3. Test Setup

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

## 4. Antenna Information

| | Antenna Type |
|---|---|
| Ant3 | IFA |
| Ant4 | IFA |

| Ant | Band | Frequency Band | Peak Gain(dBi) |
|---|---|---|---|
| Ant4 | WiFi/BT 2.4 GHz | 2402 MHz | -3.7 |
| | | 2412 MHz | -3.7 |
| | | 2437 MHz | -3.9 |
| | | 2472 MHz | -2.7 |
| | | 2480 MHz | -2.7 |
| Ant3 | WiFi/BT 2.4 GHz | 2402 MHz | -3.0 |
| | | 2412 MHz | -2.8 |
| | | 2437 MHz | -1.1 |
| | | 2472 MHz | -0.3 |
| | | 2480 MHz | -0.2 |
| Ant4 | UNII-1 | 5180 MHz | -3.1 |
| | UNII-2A | 5280 MHz | -2.3 |
| | UNII-2C | 5500 MHz | -1.8 |
| | UNII-3 | 5820 MHz | -1.0 |
| | UNII-4 | 5887 MHz | -1.4 |
| | UNII-5 | 6175 MHz | -2.9 |
| | UNII-6 | 6475 MHz | -3.6 |
| | UNII-7 | 6700 MHz | -5.6 |
| | UNII-8 | 7000 MHz | -6.2 |
| Ant3 | UNII-1 | 5180 MHz | -4.3 |
| | UNII-2A | 5280 MHz | -4.1 |
| | UNII-2C | 5500 MHz | -2.2 |
| | UNII-3 | 5820 MHz | -2.5 |
| | UNII-4 | 5887 MHz | -2.6 |
| | UNII-5 | 6175 MHz | -2.1 |
| | UNII-6 | 6475 MHz | -2.5 |
| | UNII-7 | 6700 MHz | -5.7 |

| | UNII-8 | 7000 MHz | -6.5 |
|---|---|---|---|

Note: Antenna gain is measured at Google internal OTA anechoic chamber. The measurement antenna is fixed in position and the EUT is rotated in both the azimuth and the roll direction to achieve three-dimensional measurement. We use the vector network analyzer method for measurement. The signal from the output port of the vector network analyzer is connected by a cable to the measurement antenna and the input port is connected to the DUT. The vector network analyzer system splits the transmission signal from the output port and gets feedback as a reference signal to the input port for comparison with the measured signal to evaluate the antenna gain.

**Measurement Facilities:**
Measurement Chamber: ETS-Lindgren AMS-8500 3D fully anechoic test system
ETS-Lindgren positioner: EMCO-2090
RF Relay Switches: Agilent 3499B
Network Analyzer: Agilent E5071C

## 5. Radiation Plots for Max Gain Plane

### Ant3:

ANT3 Frequency 2402MHz
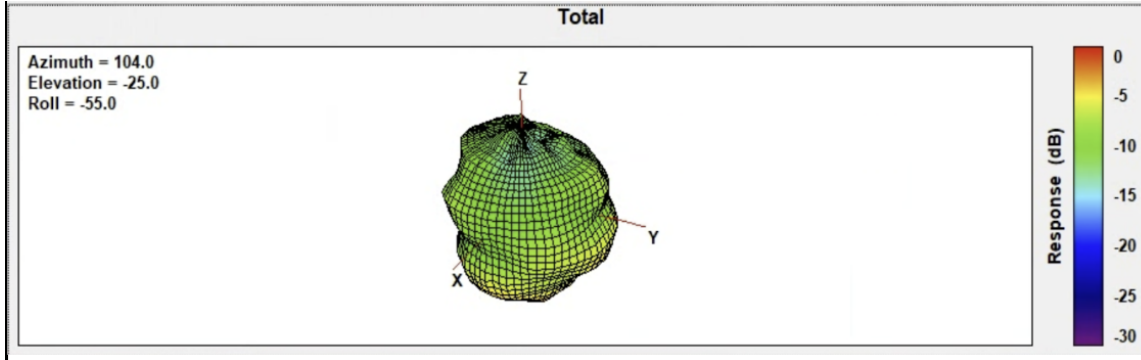


ANT3 Frequency 2412MHz
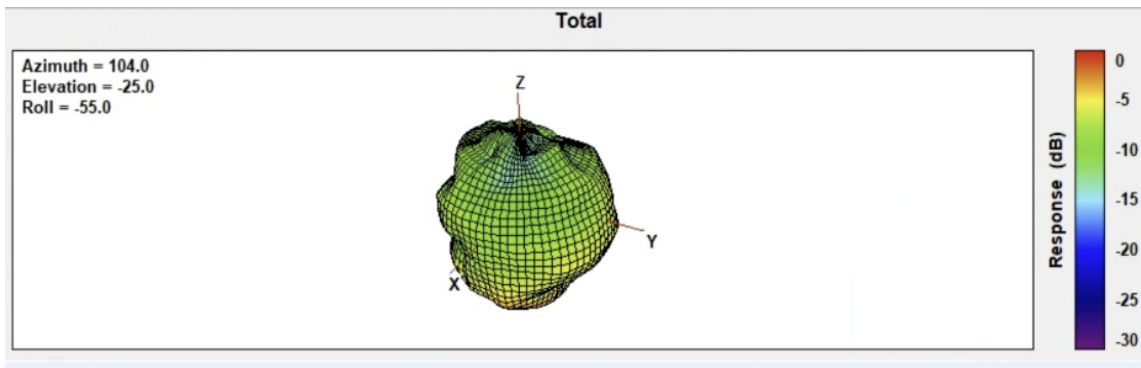
ANT3 Frequency 2437MHz
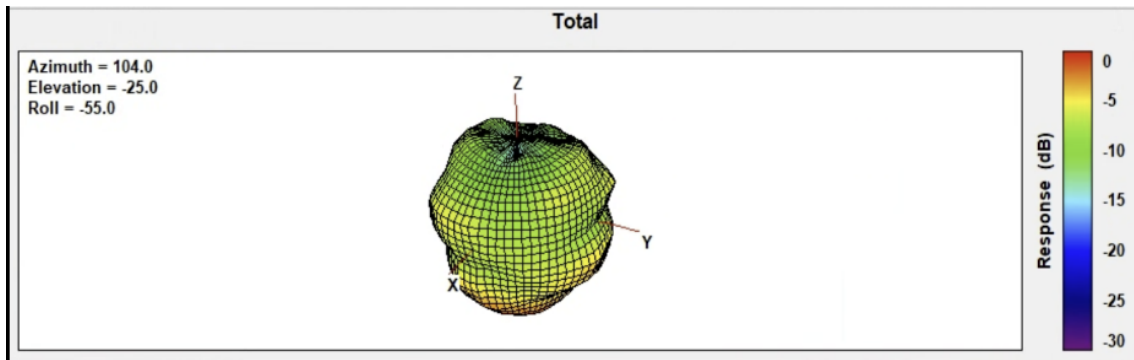


ANT3 Frequency 2472MHz
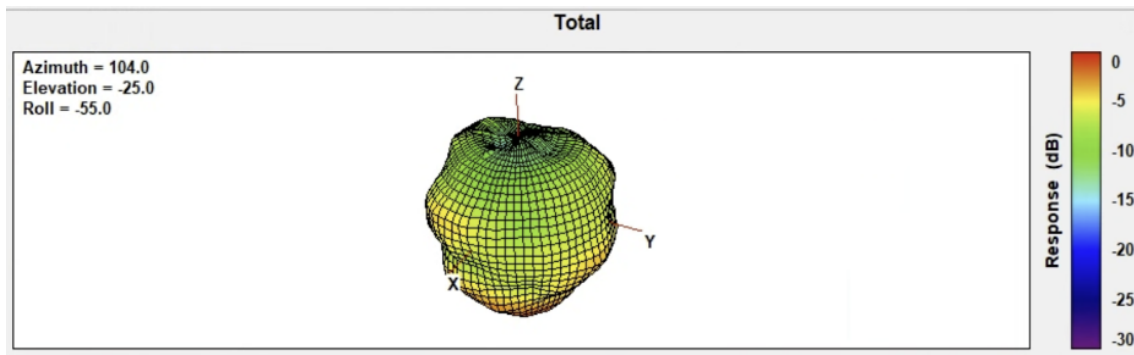


ANT3 Frequency 2480MHz
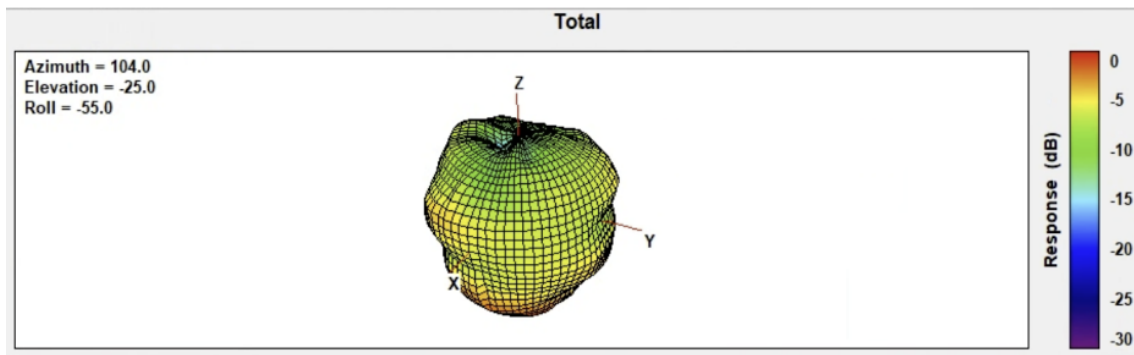


ANT3 Frequency 5180 MHz
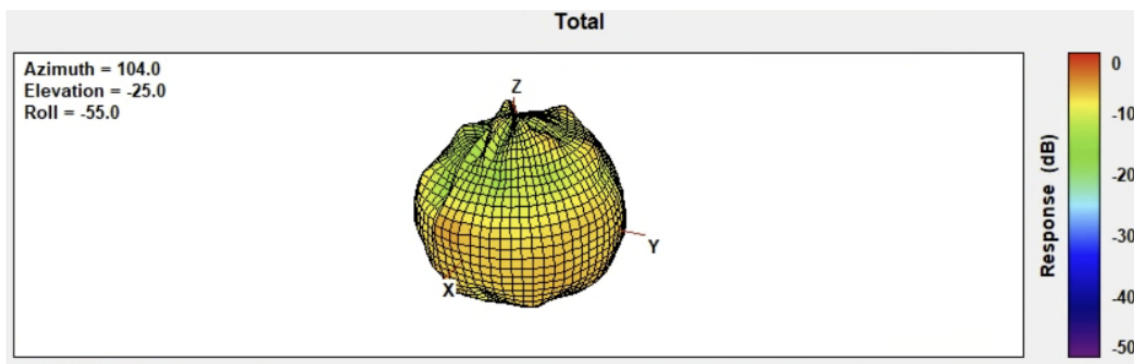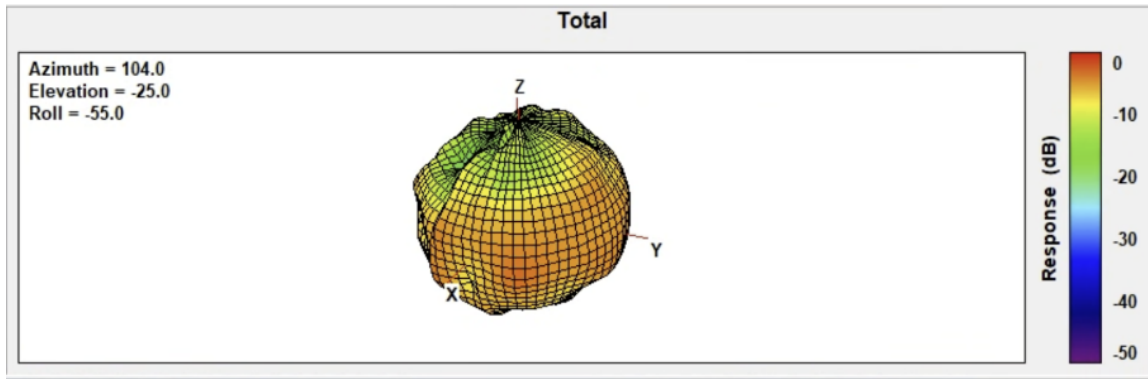
ANT3 Frequency 5280 MHz
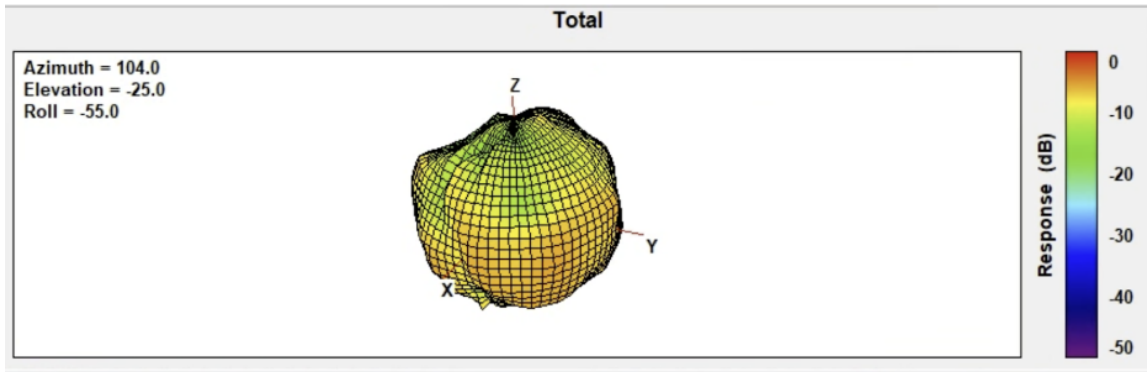


ANT3 Frequency 5500 MHz
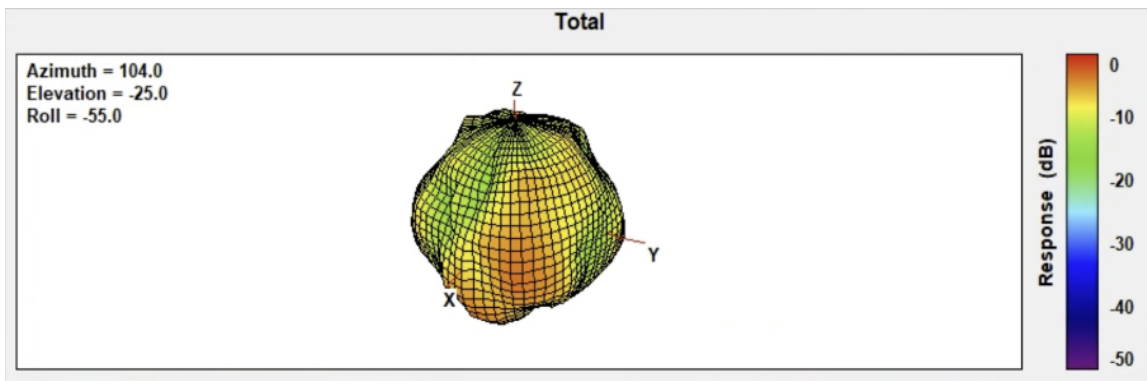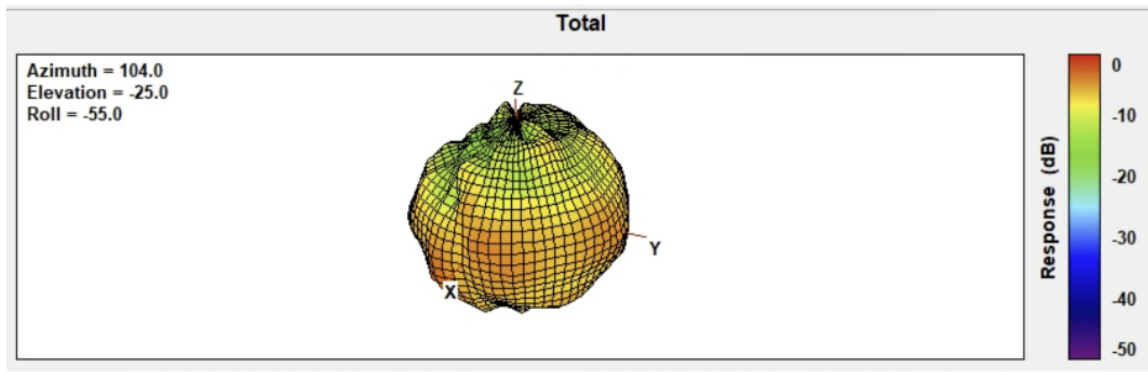


ANT3 Frequency 5820 MHz
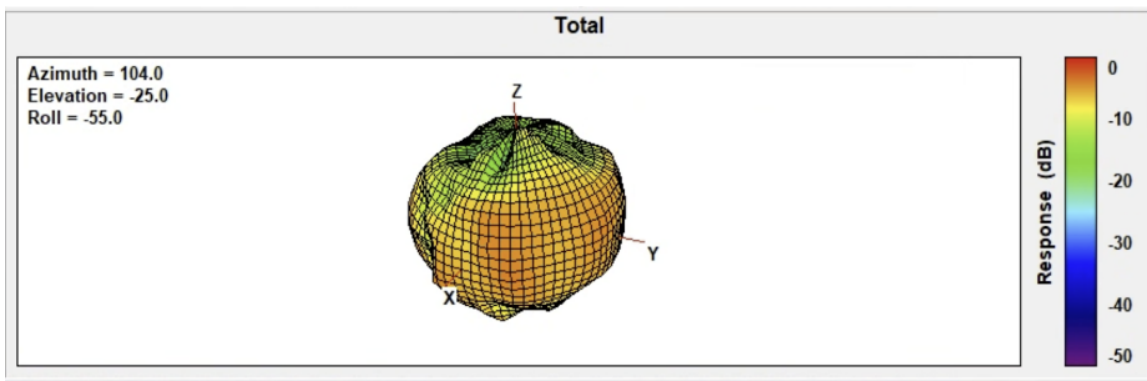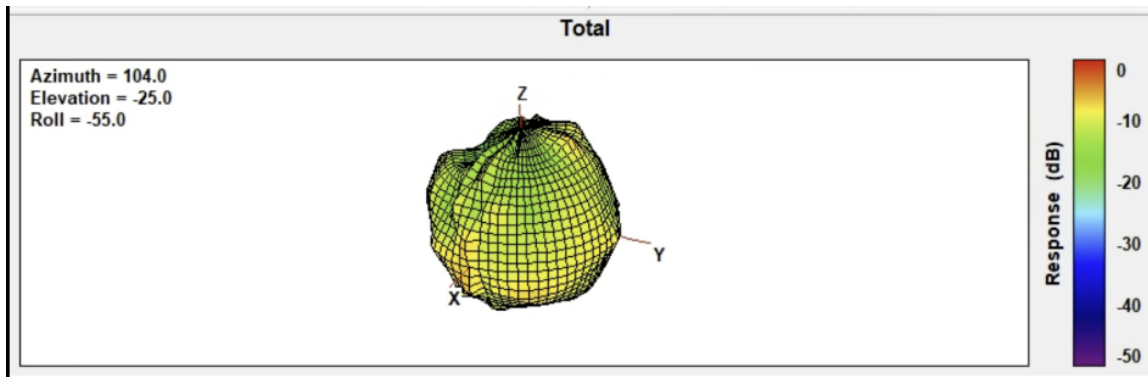


ANT3 Frequency 5887 MHz
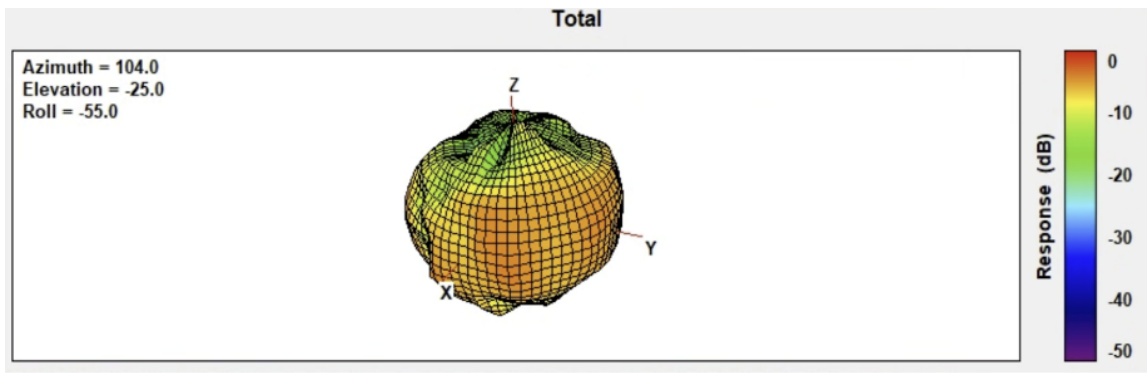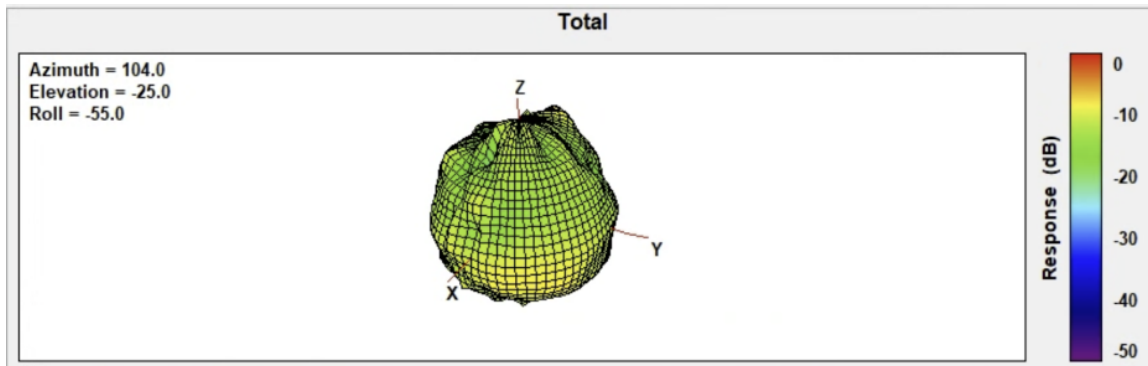
ANT3 Frequency 6175 MHz



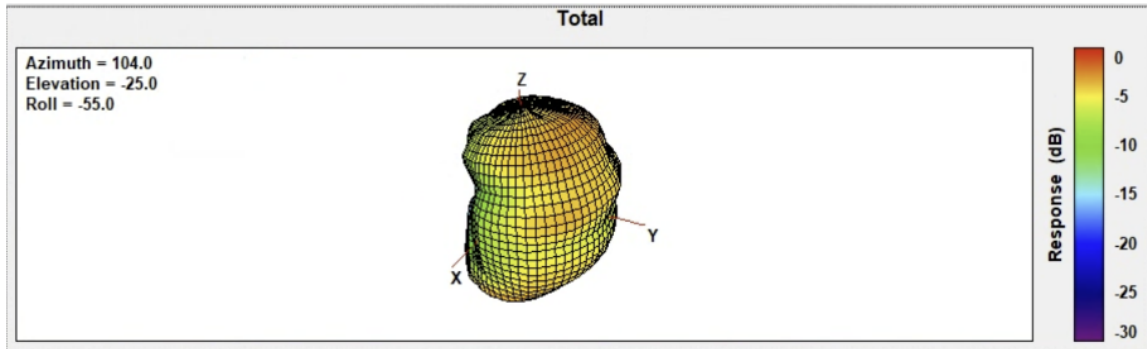ANT3 Frequency 6475 MHz



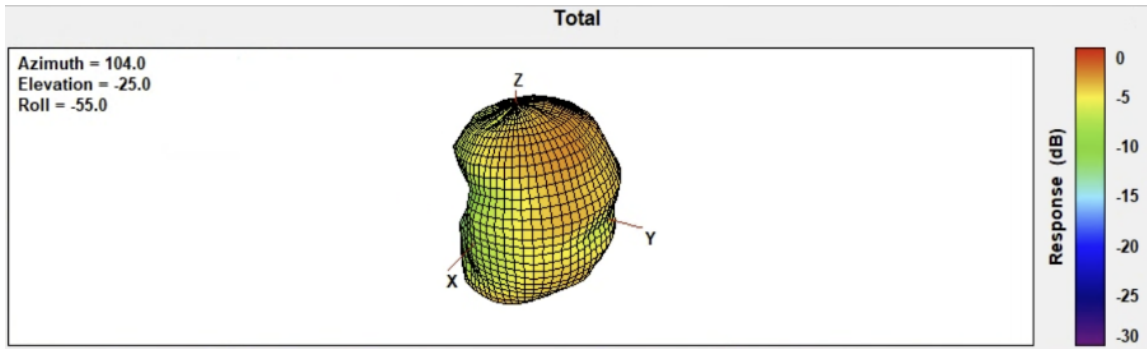ANT3 Frequency 6700 MHz



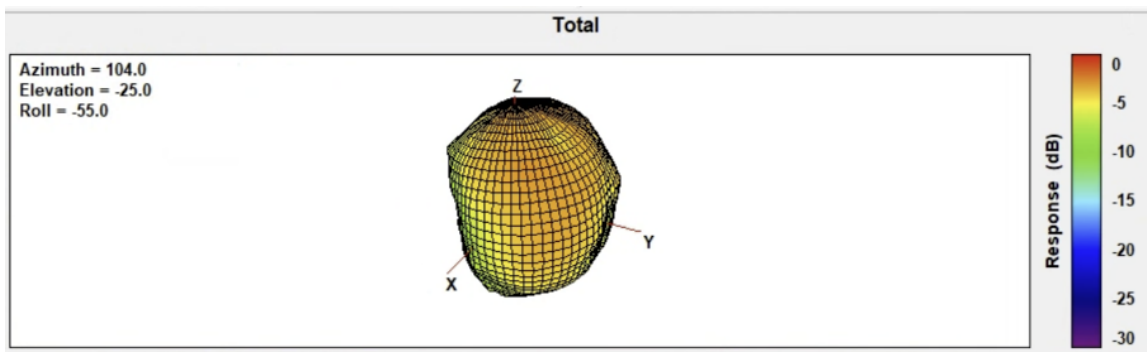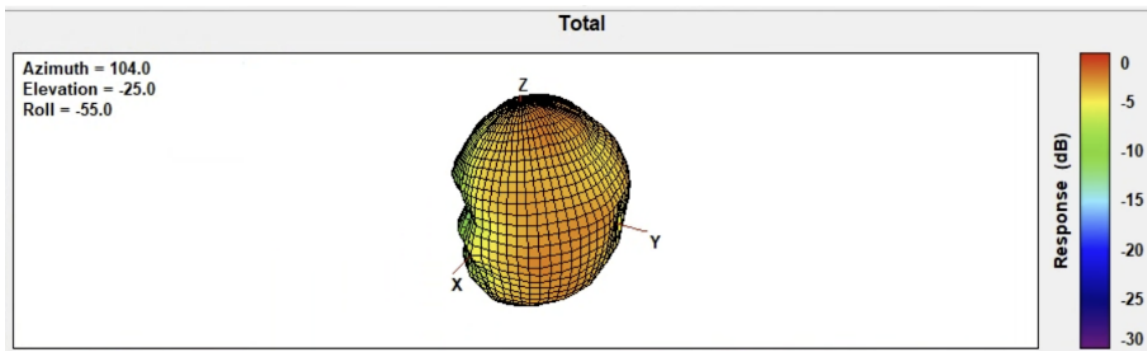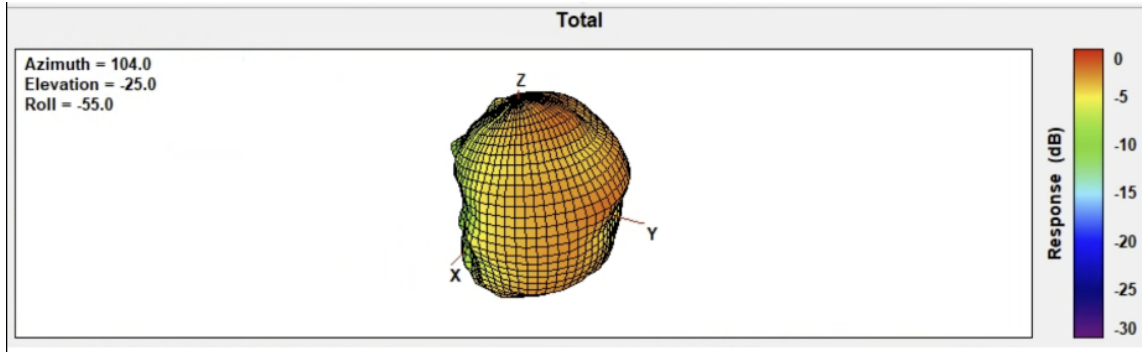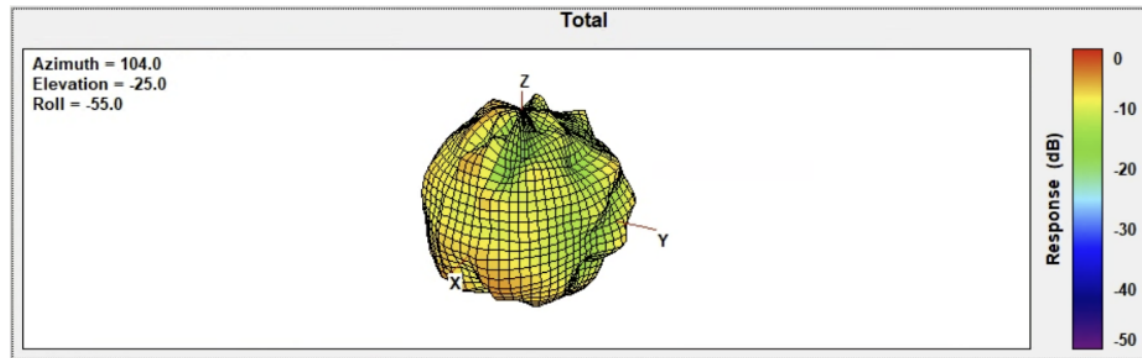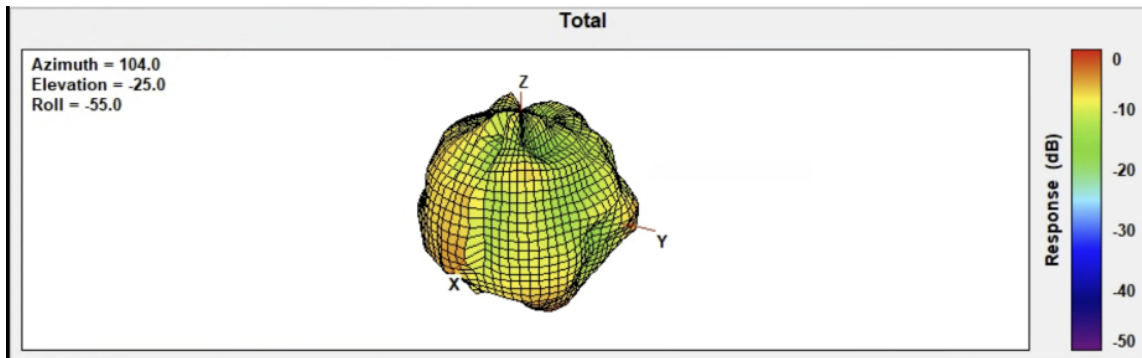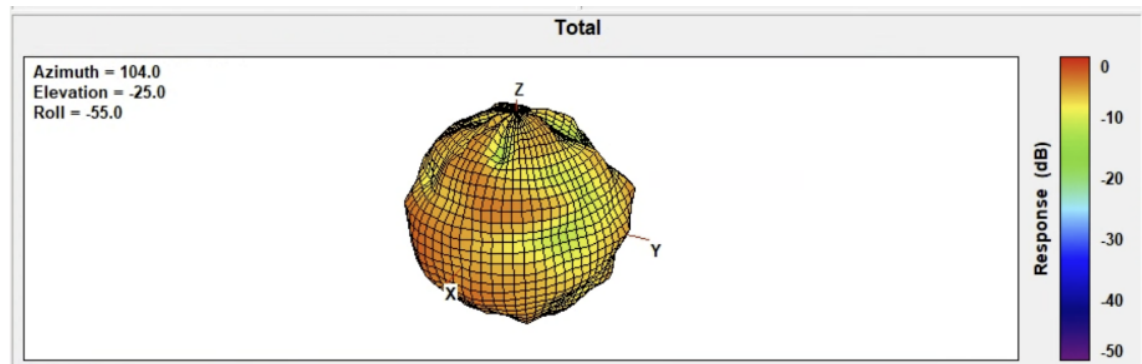ANT3 Frequency 7000 MHz

**Ant4:**

ANT4 Frequency 2402MHz



ANT4 Frequency 2412MHz



ANT4 Frequency 2437MHz



ANT4 Frequency 2472MHz
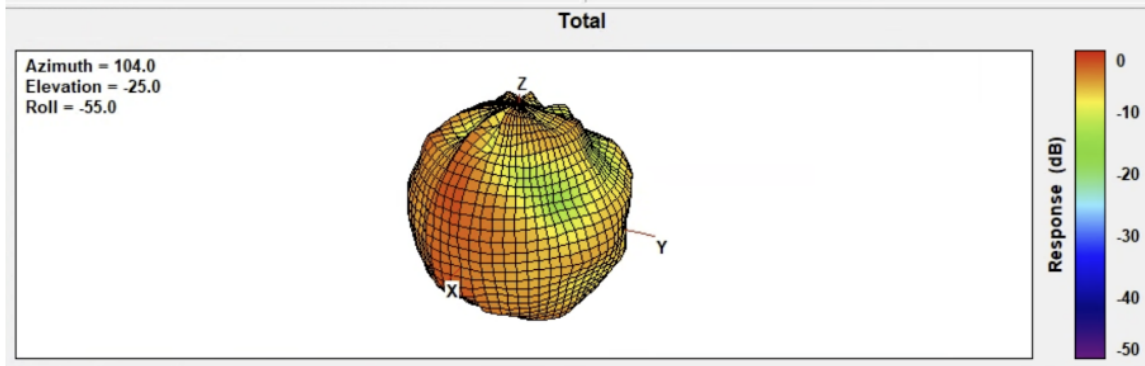
ANT4 Frequency 2480MHz
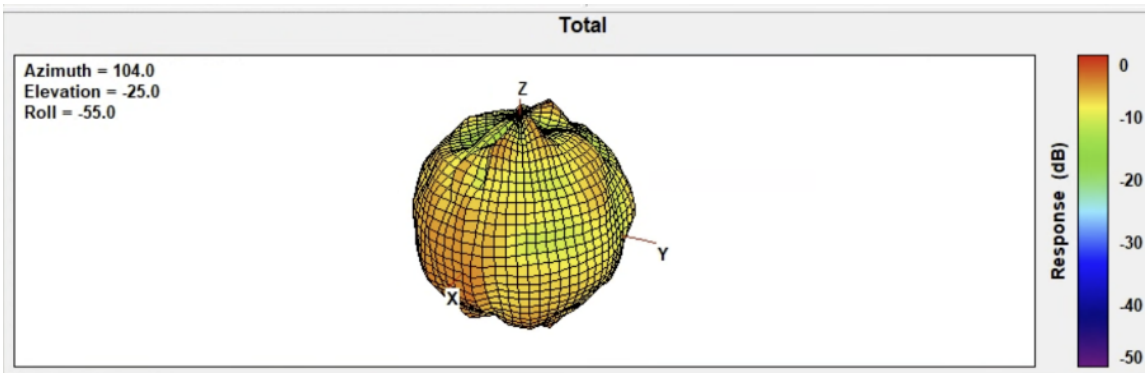


ANT4 Frequency 5180 MHz



ANT4 Frequency 5280 MHz



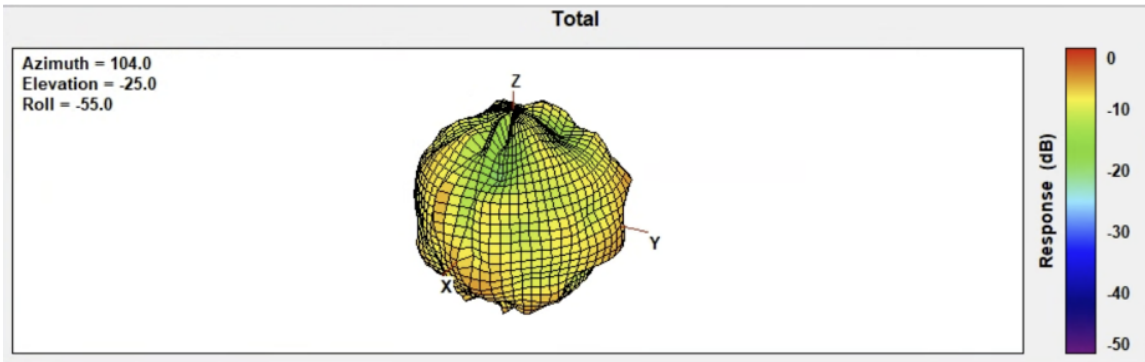ANT4 Frequency 5500 MHz

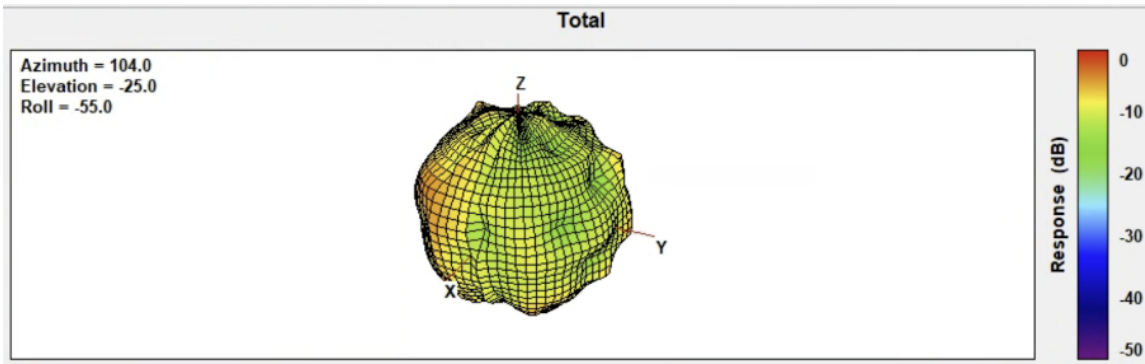ANT4 Frequency 5820 MHz
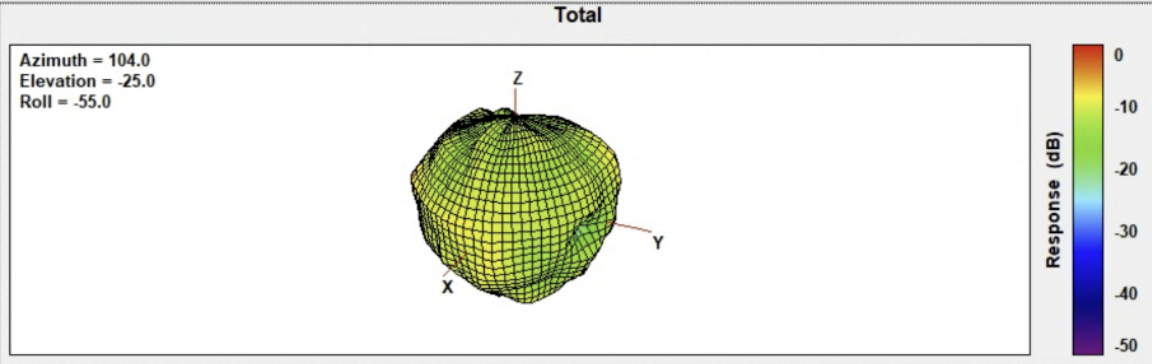


ANT4 Frequency 5887 MHz



ANT4 Frequency 6175 MHz



ANT4 Frequency 6475 MHz

ANT4 Frequency 6700 MHz



ANT4 Frequency 7000 MHz