Antenna Report

FCC ID: A4RGGH2X

May 16, 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 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)
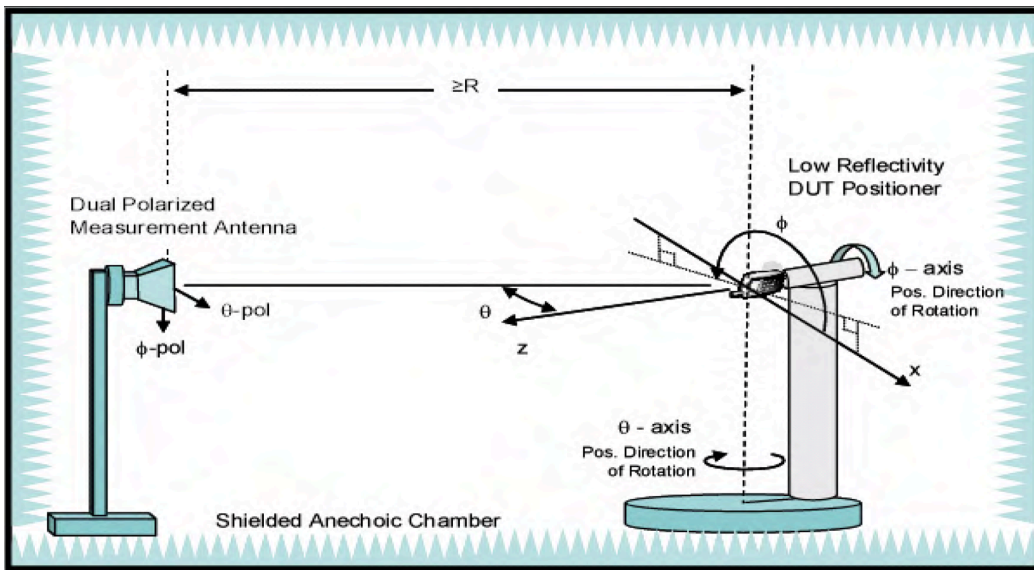
2. Test Equipment

Site Description	Chamber Manufacturer	Type
AMS-8500	ETS-Lindgren	Fully anechoic
Software Version	ETS-Lindgren	EMQuest V1.08 Bulid 142267
Site location	No.4, Minsheng St, Tucheng District, New Taipei City 23679, Taiwan	
Test Engineer	Eddie Chen (EddieWXChen@fih-foxconn.com)	
Date	Mar. 2024	

Description	Manufacturer	Moder	Calibration Date	Due Date
Network Analyzer	Agilent	E5071C	May. 11, 2023	May. 11, 2024
Spectrum Analyzer	Rohde&Schwarz	FSP7	Aug. 16, 2023	Aug 16, 2024

3. Test Setup

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

4. Antenna Information

Ant #	Antenna Type
Ant3	IFA
Ant4	ILA

Ant	Band	Frequency Band	Open mode Peak Gain(dBi)	Closed mode Peak Gain(dBi)
Ant3	WiFi/BT/Thread 2.4 GHz	2400 - 2483.5 MHz	-3.3	-4.3
Ant4	WiFi/BT 2.4 GHz	2400 - 2483.5 MHz	-3.5	-1.2
Ant3	UNII-1	5150-5250 MHz	-2.9	-5.9
	UNII-2A	5250-5350 MHz	-1.3	-7.2
	UNII-2C	5470-5725 MHz	-1.7	-5.7
	UNII-3	5725-5850 MHz	-3.2	-5.7
	UNII-4	5850-5895 MHz	-4.7	-6.3
	UNII-5	5925-6425 MHz	-6.6	-7.6
	UNII-6	6425-6525 MHz	-6.6	-12.4
	UNII-7	6525-6875 MHz	-9.3	-9.6
	UNII-8	6875-7125 MHz	-4.0	-4.8
Ant4	UNII-1	5150-5250 MHz	-4.2	-3.6
	UNII-2A	5250-5350 MHz	-4.5	-3.6
	UNII-2C	5470-5725 MHz	-3.1	-3.9
	UNII-3	5725-5850 MHz	-4.2	-3.7
	UNII-4	5850-5895 MHz	-4.0	-3.6
	UNII-5	5925-6425 MHz	-3.4	-3.4
	UNII-6	6425-6525 MHz	-4.7	-6.7
	UNII-7	6525-6875 MHz	-2.9	-5.2
	UNII-8	6875-7125 MHz	-2.2	-5.5

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.
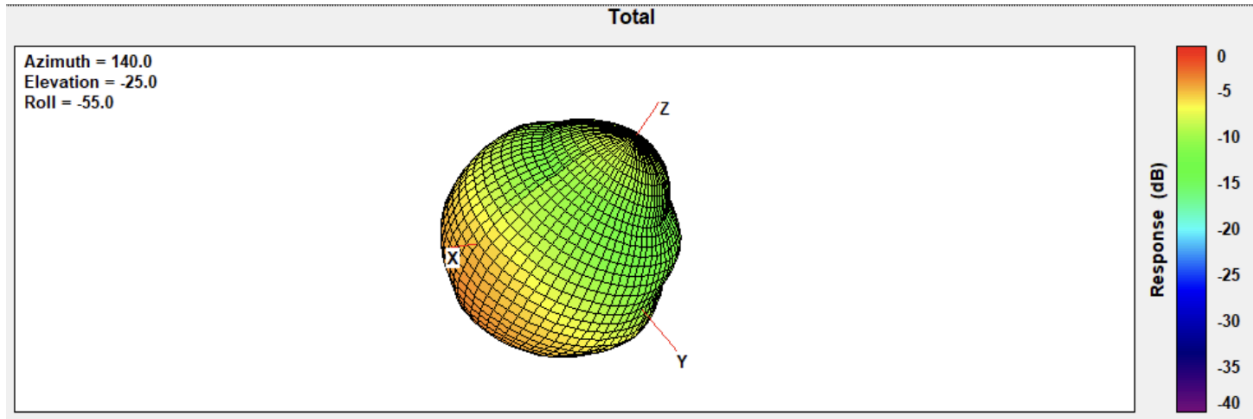
Measurement Facilities:
Measurement Chamber: ETS-Lindgren AMS-8500 3D fully anechoic test system
ETS-Lindgren positioner: EMCO-2090
RF Relay Switches: Agilent 3499B
Network Analyzer: Agilent E5071C
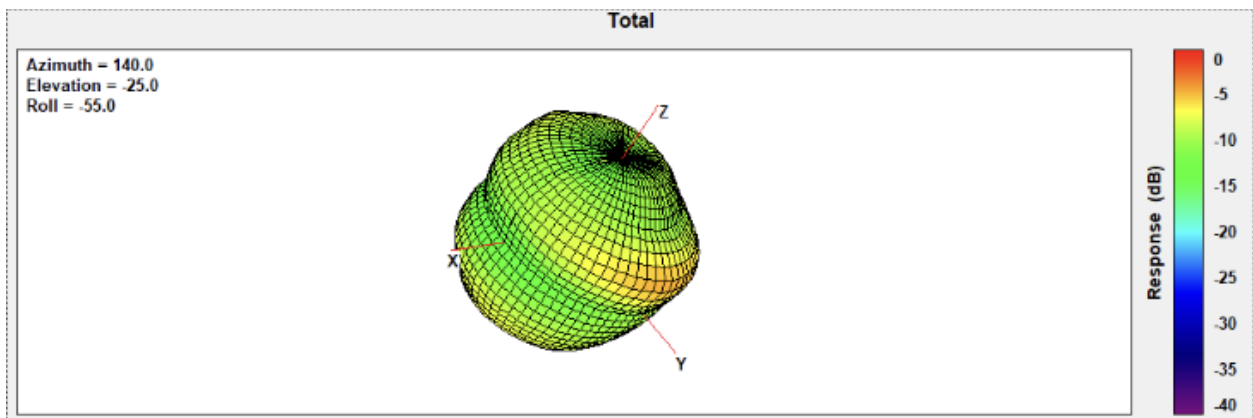
5. Radiation Plots for Max Gain Plane
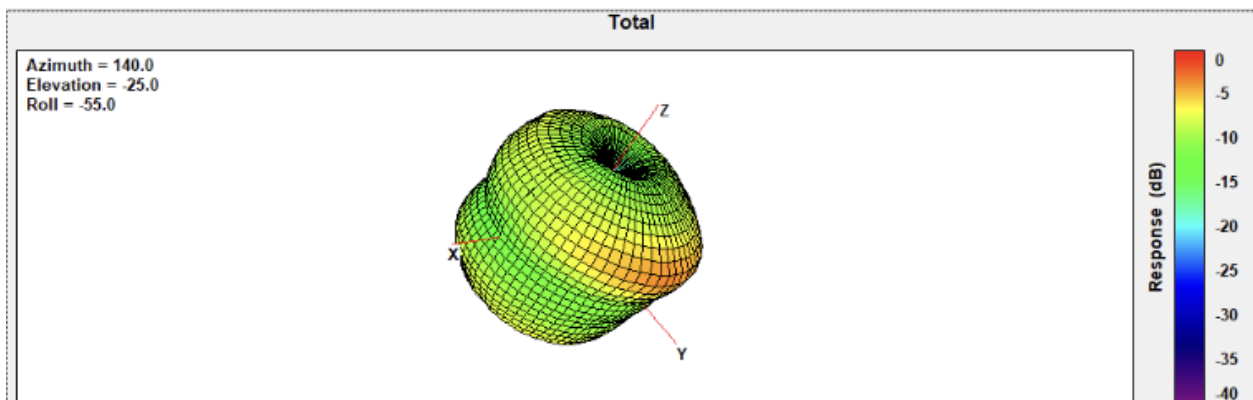
Open mode
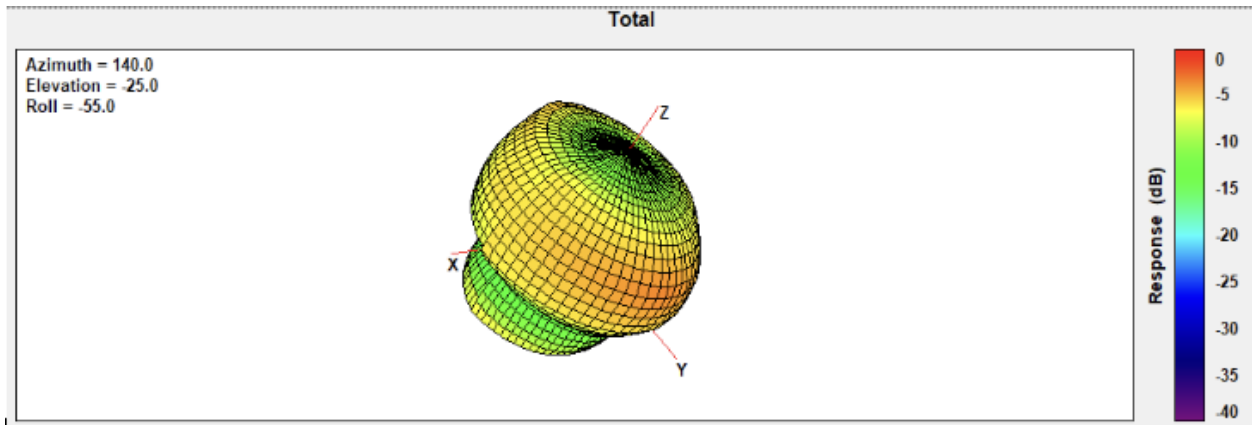
Ant3:

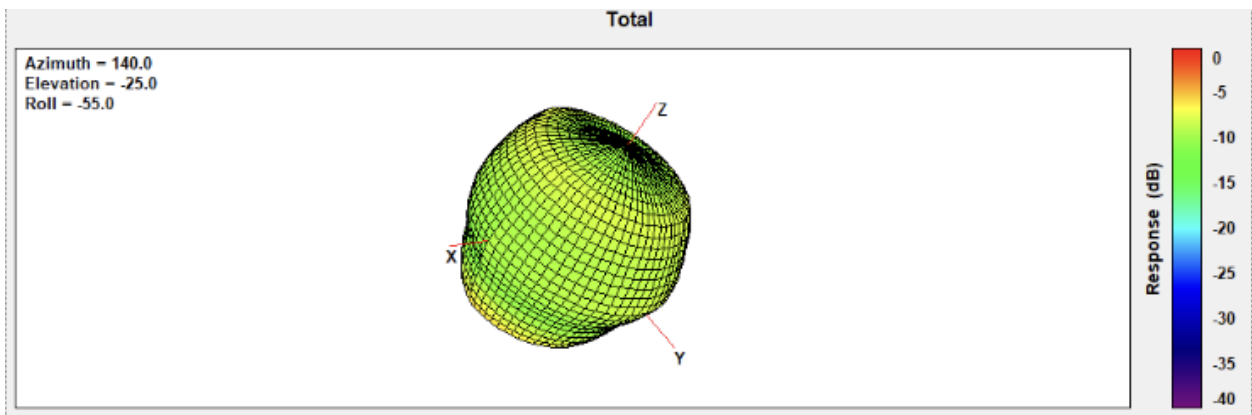ANT3 Frequency 2400-2483.5MHz

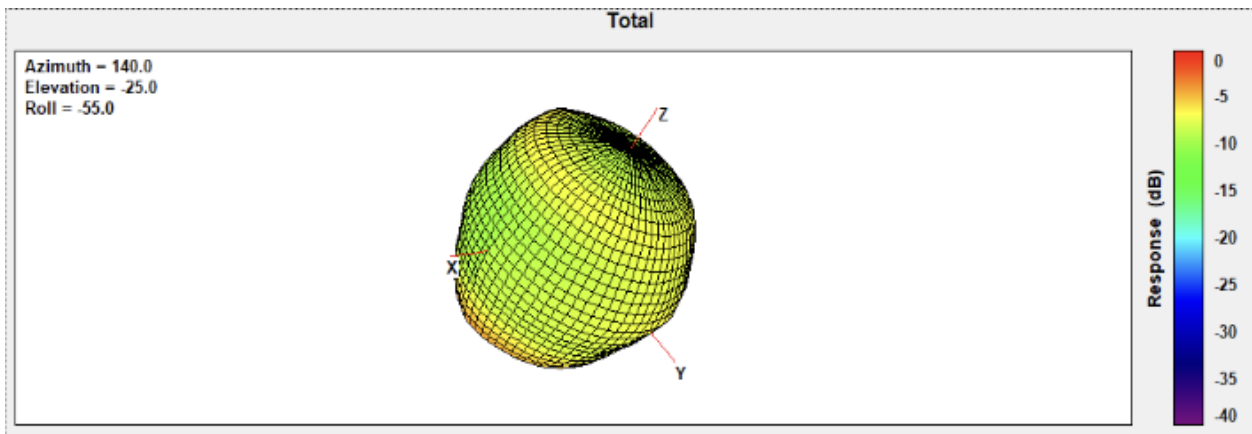ANT3 Frequency 5150-5250 MHz

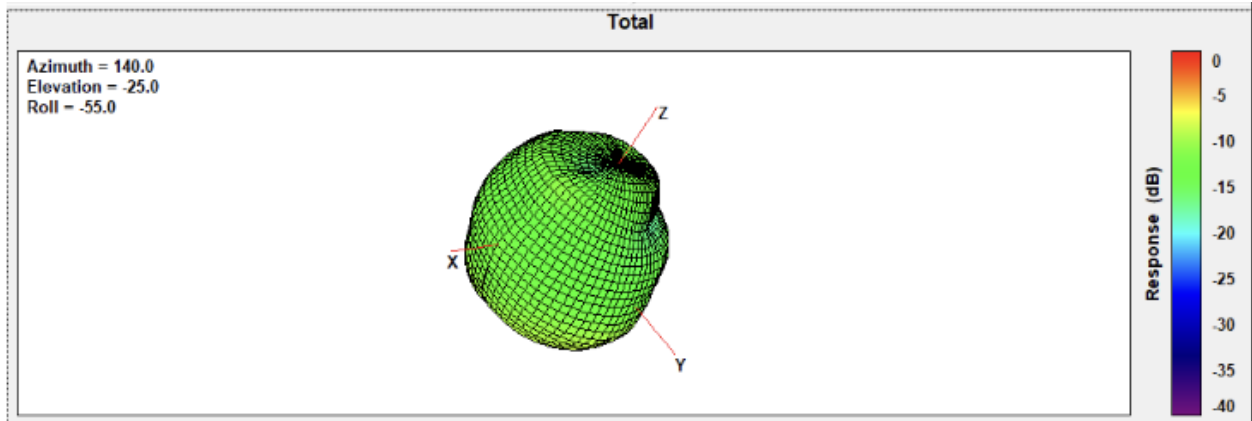ANT3 Frequency 5250-5350 MHz

ANT3 Frequency 5470-5725 MHz

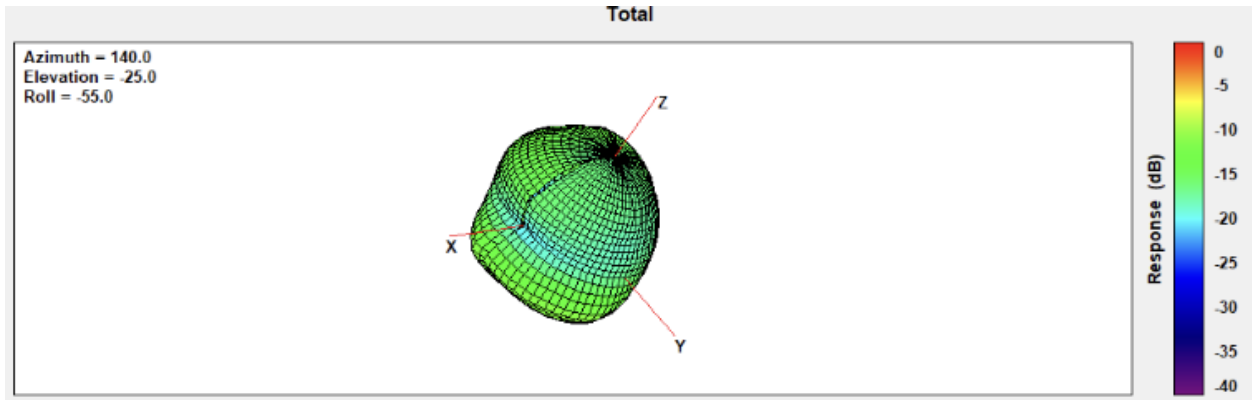ANT3 Frequency 5725-5850 MHz

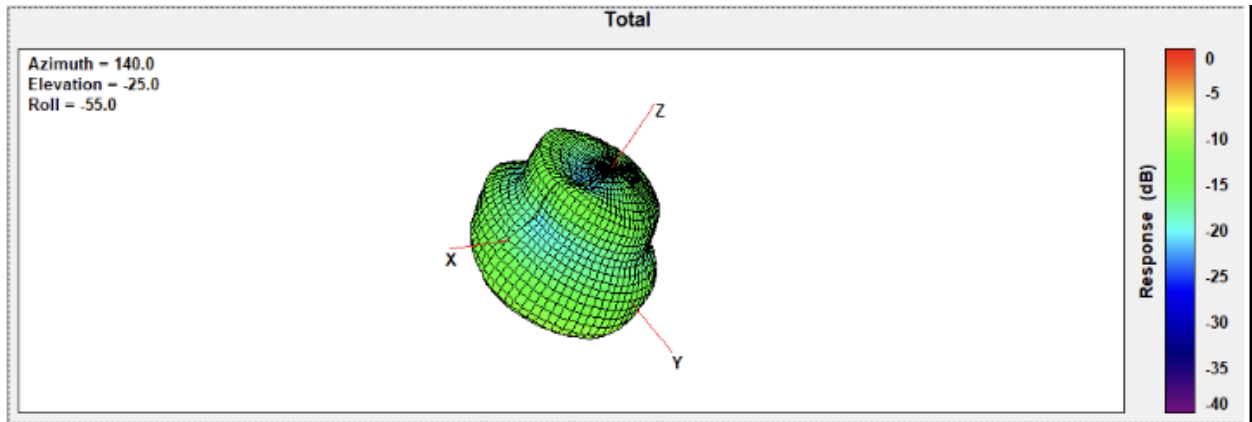ANT3 Frequency 5850-5895 MHz

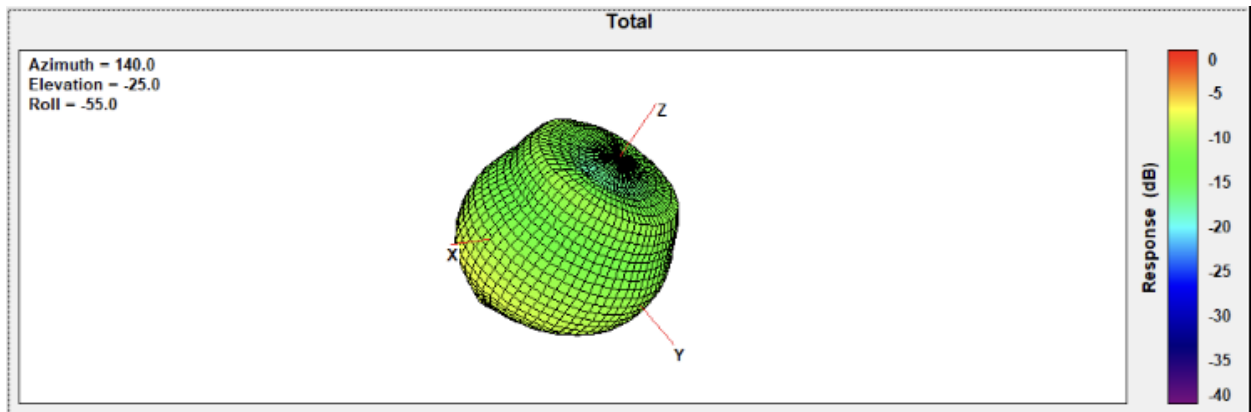ANT3 Frequency 5925-6425 MHz

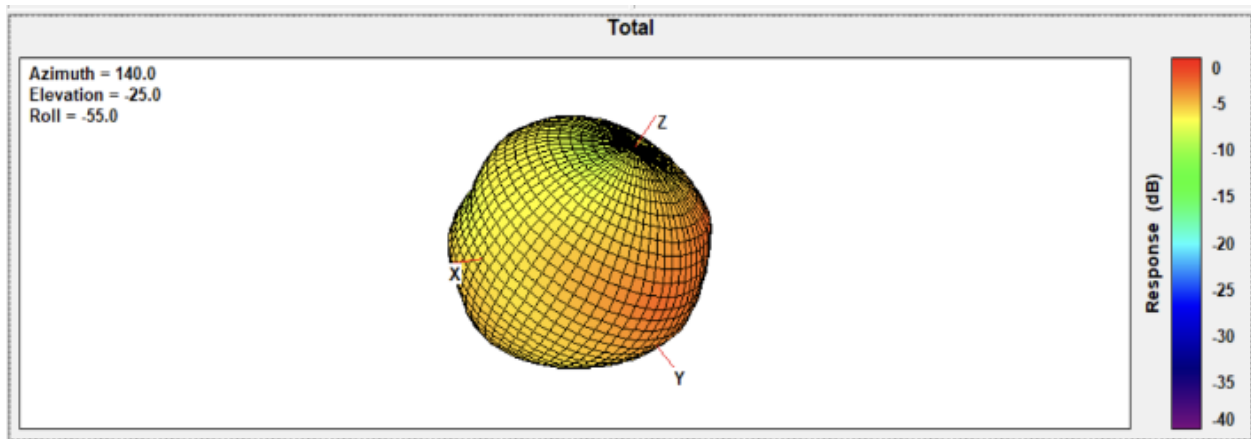ANT3 Frequency 6425-6525 MHz

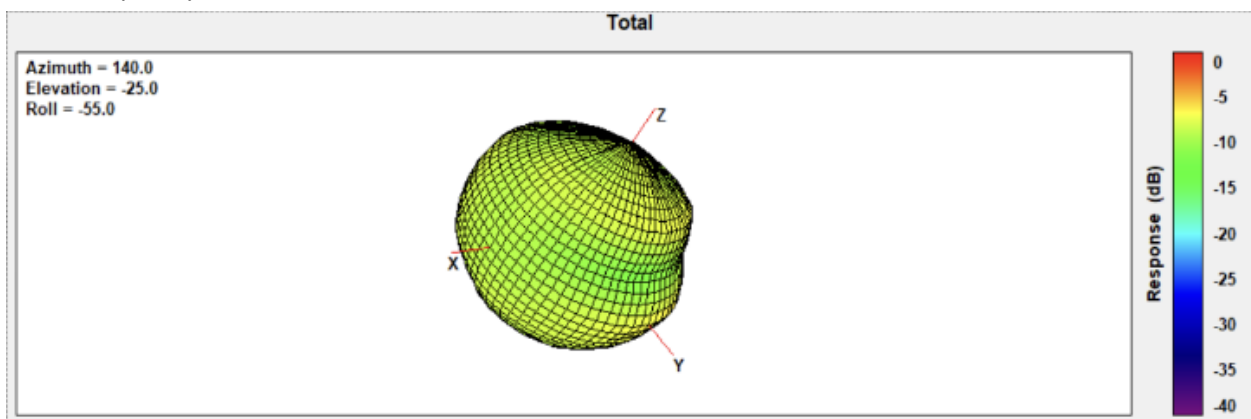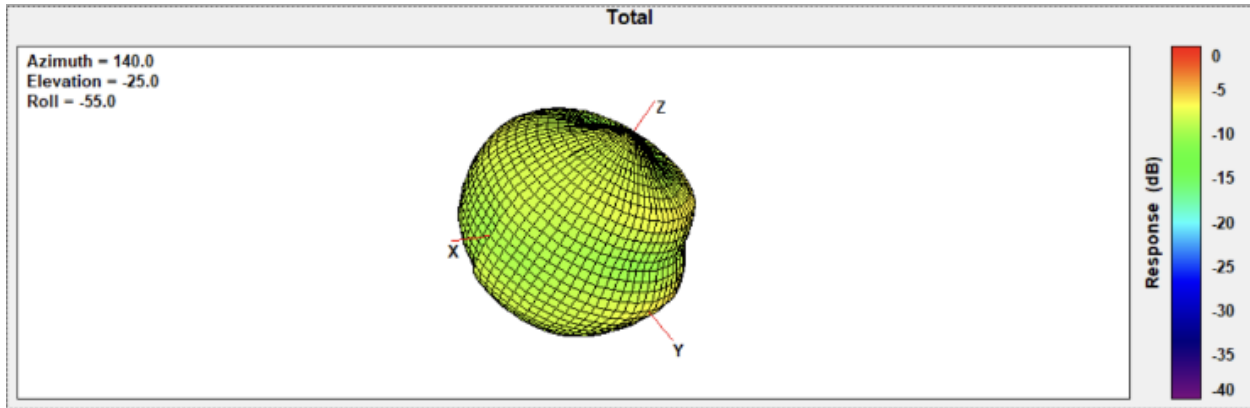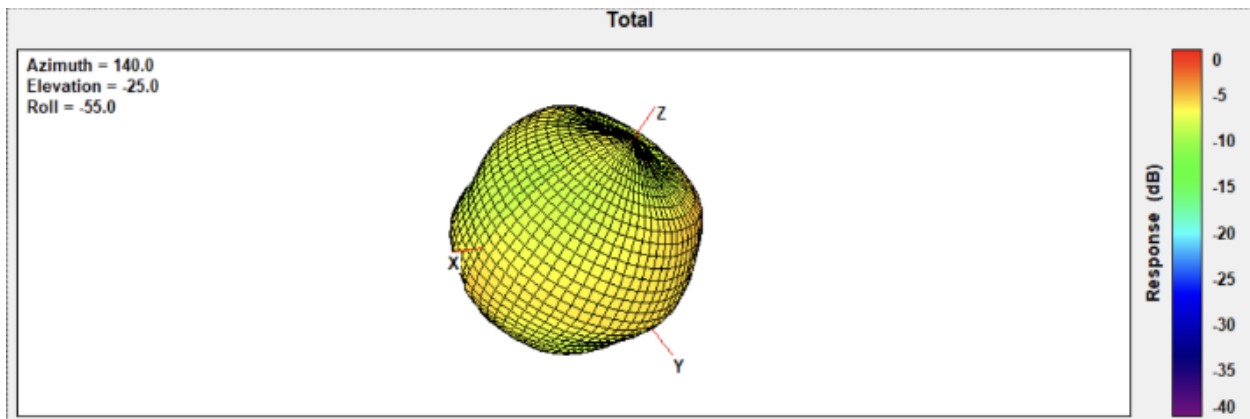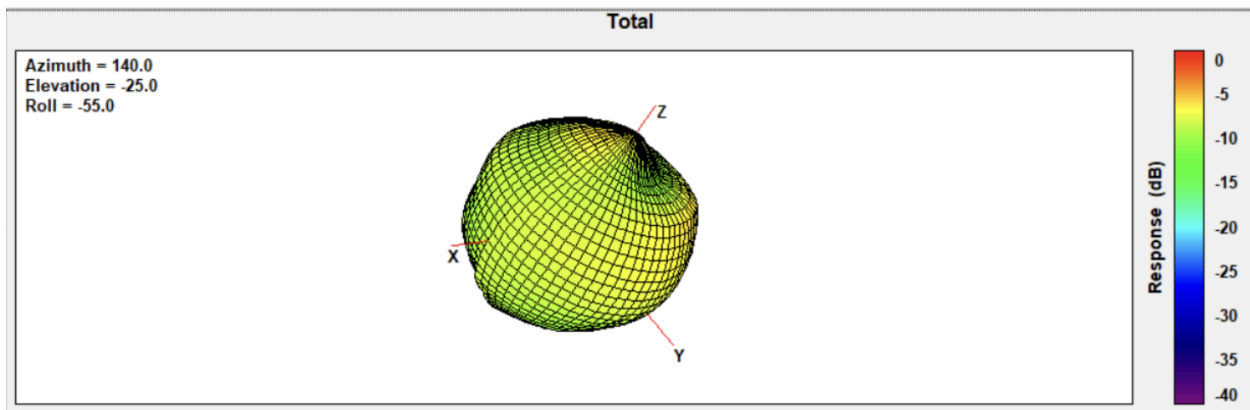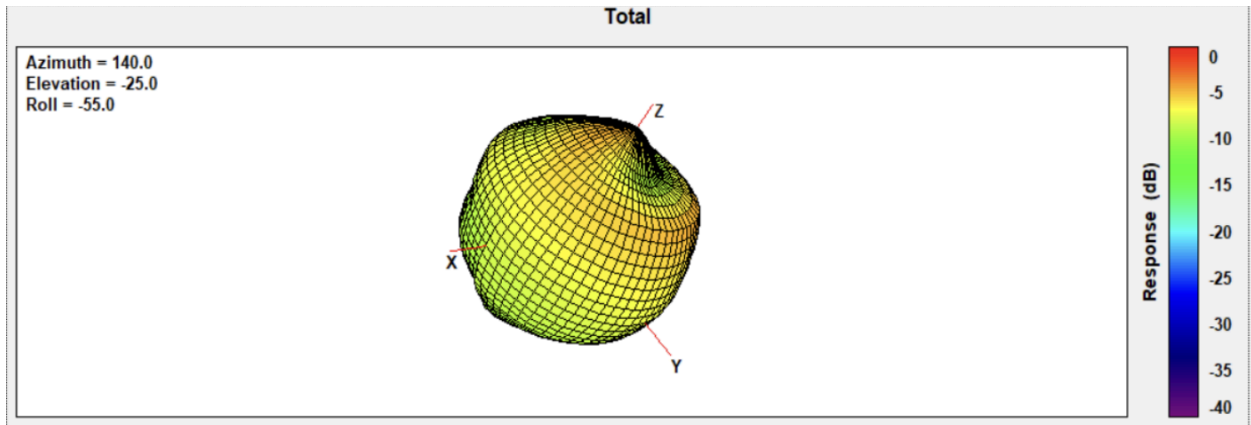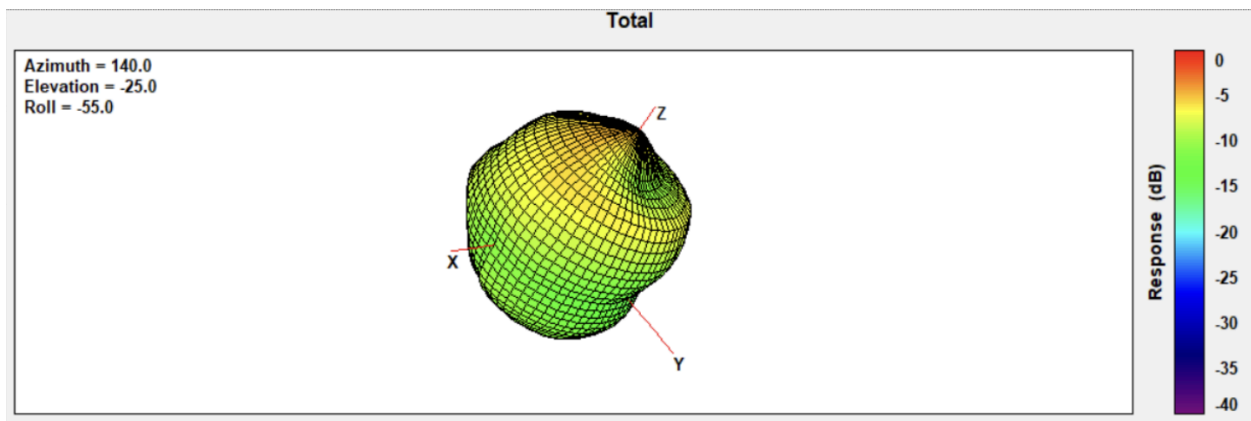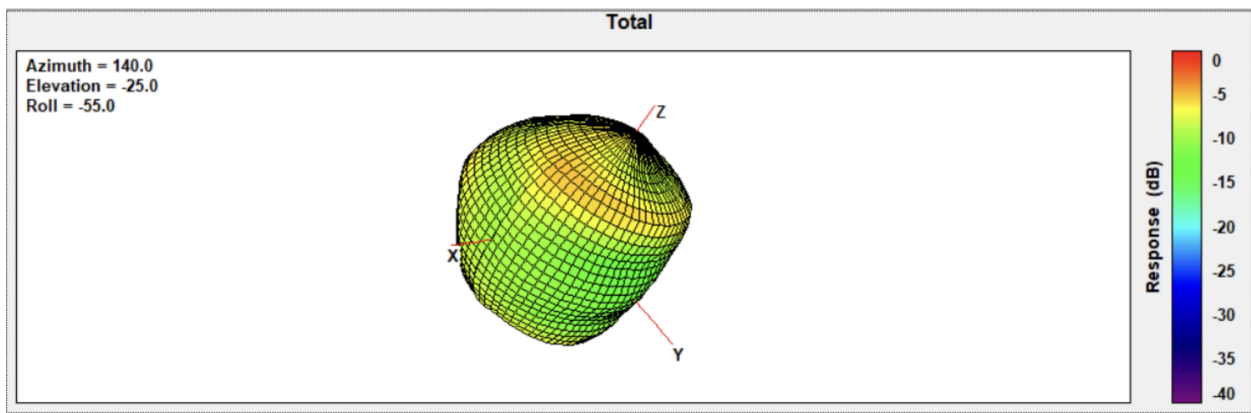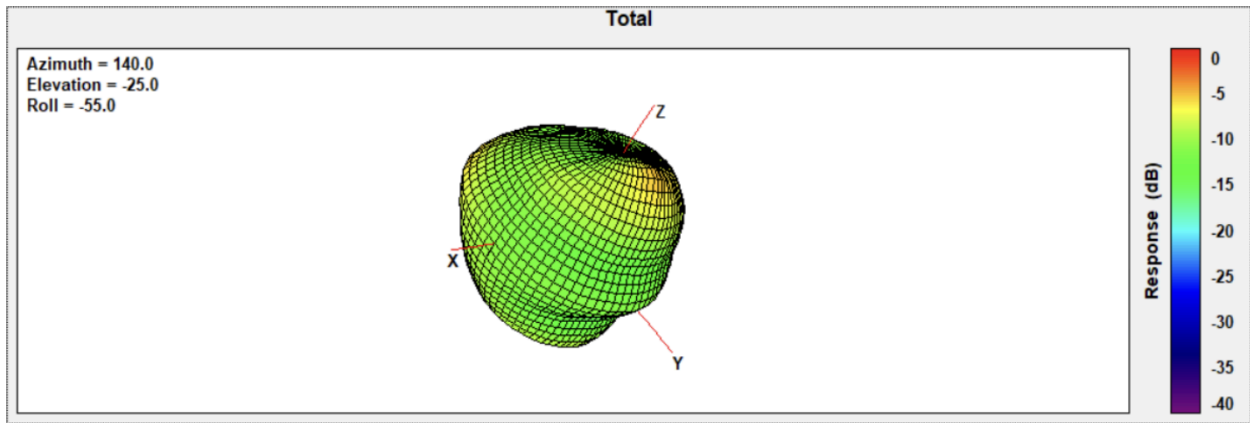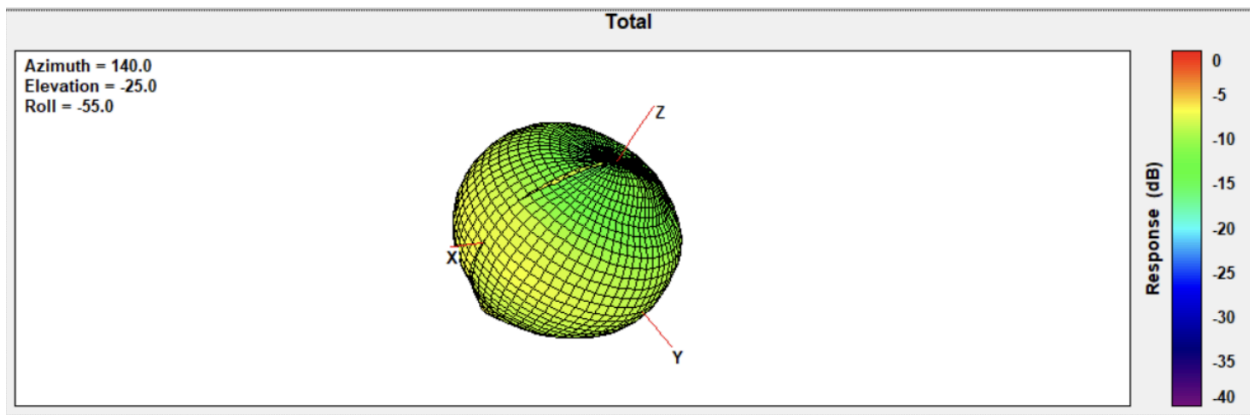ANT3 Frequency 6525-6875 MHz

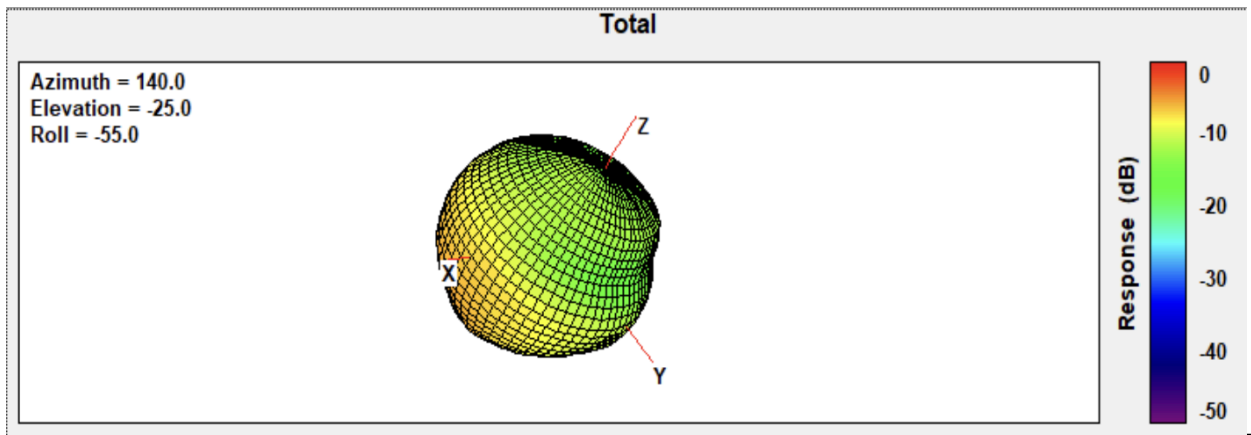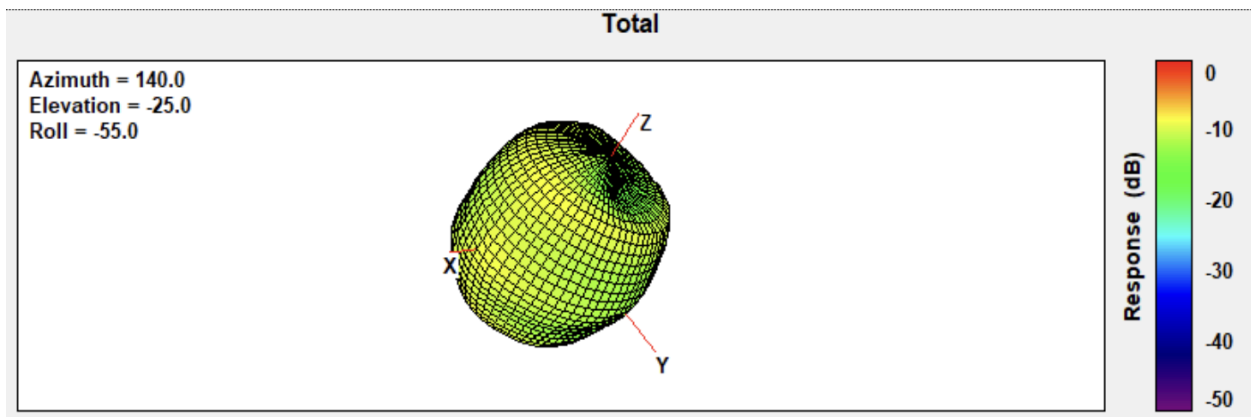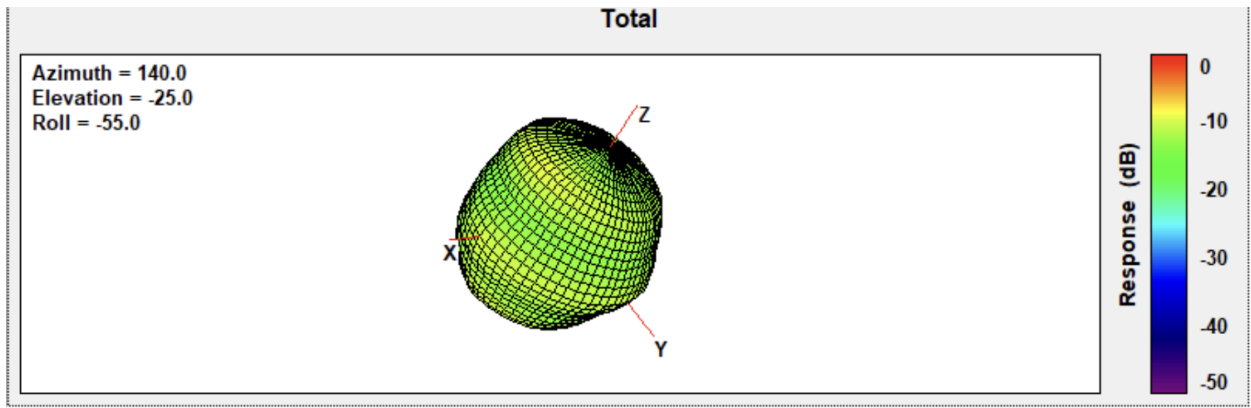ANT3 Frequency 6875-7125 MHz

Ant4:

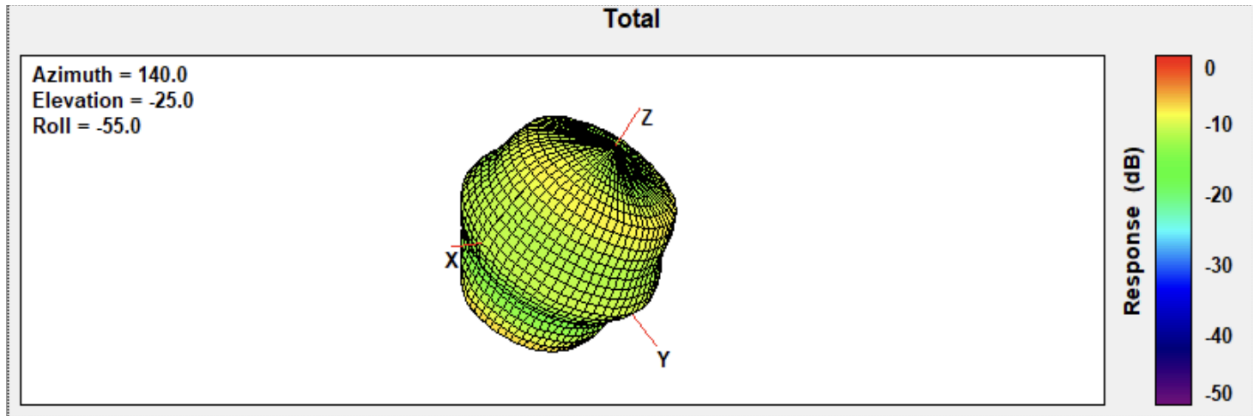ANT4 Frequency 2400-2483.5MHz

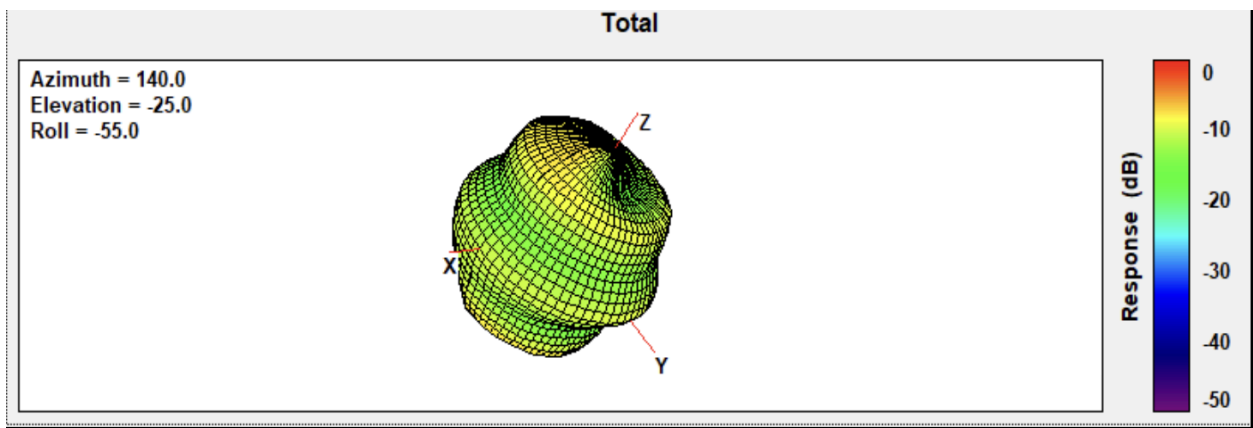ANT4 Frequency 5150-5250 MHz
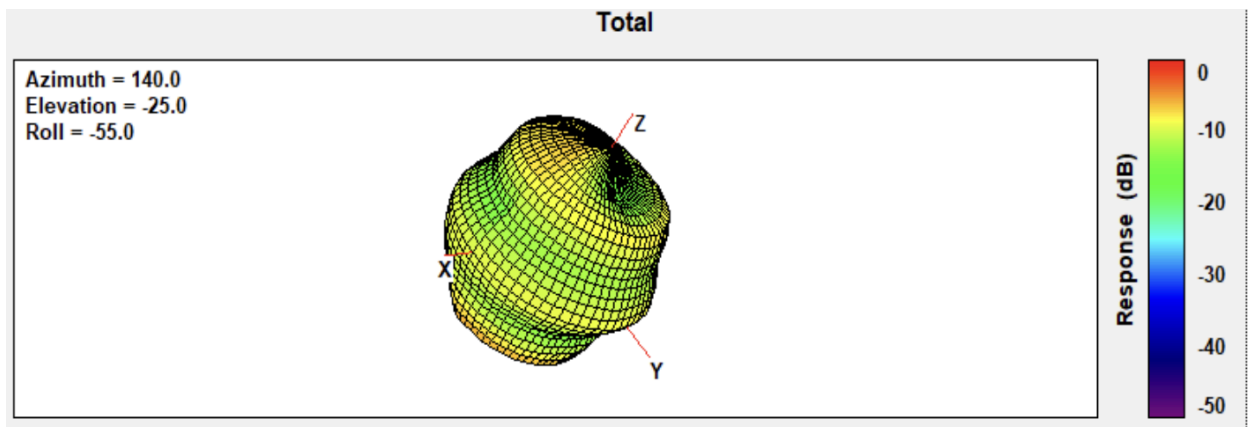
ANT4 Frequency 5250-5350 MHz
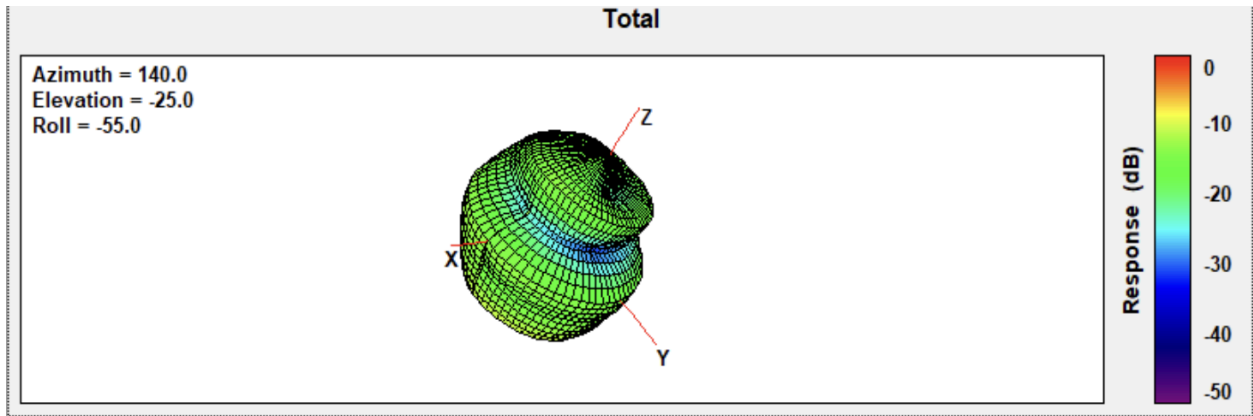

ANT4 Frequency 5470-5725 MHz
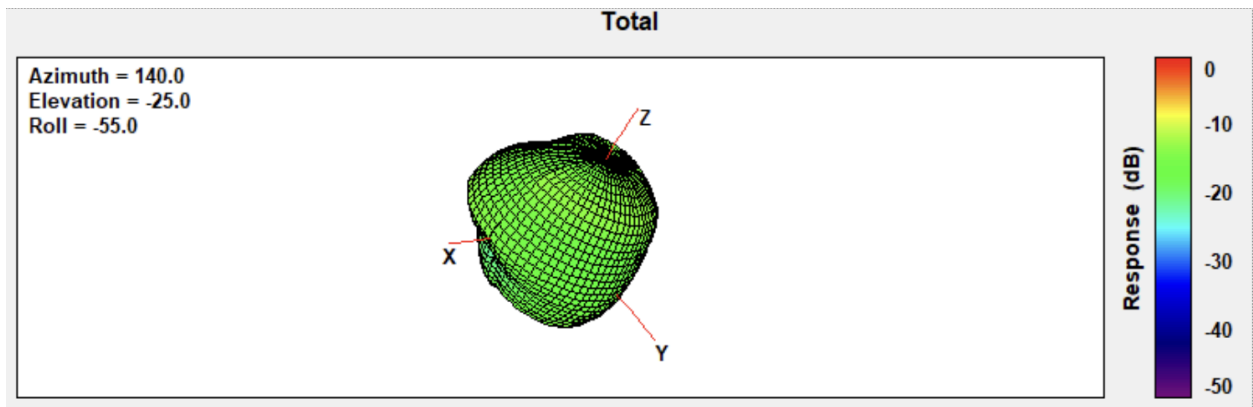

ANT4 Frequency 5725-5850 MHz
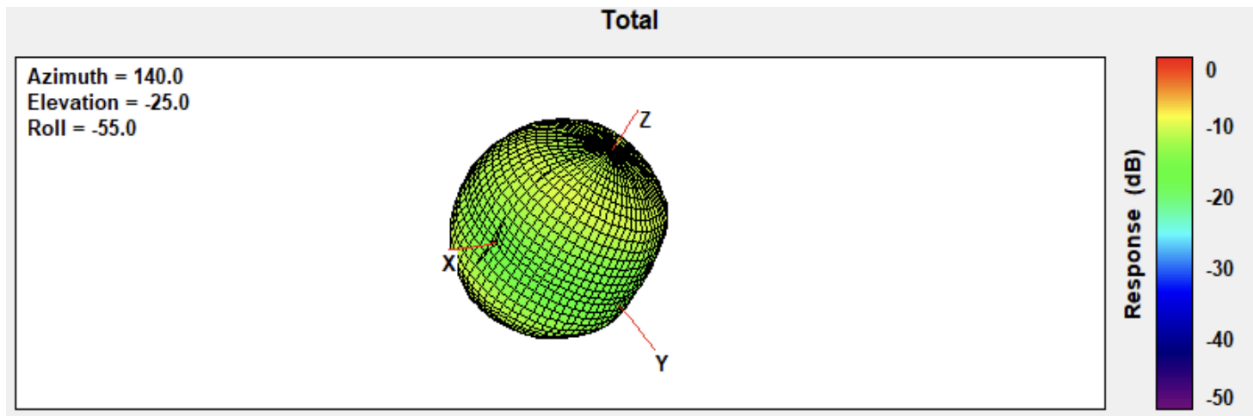
ANT4 Frequency 5850-5895 MHz

ANT4 Frequency 5925-6425 MHz

ANT4 Frequency 6425-6525 MHz

ANT4 Frequency 6525-6875 MHz

ANT4 Frequency 6875-7125 MHz

Closed mode

Ant3:

ANT3 Frequency 2400-2483.5MHz

ANT3 Frequency 5150-5250 MHz

ANT3 Frequency 5250-5350 MHz

ANT3 Frequency 5470-5725 MHz

ANT3 Frequency 5725-5850 MHz

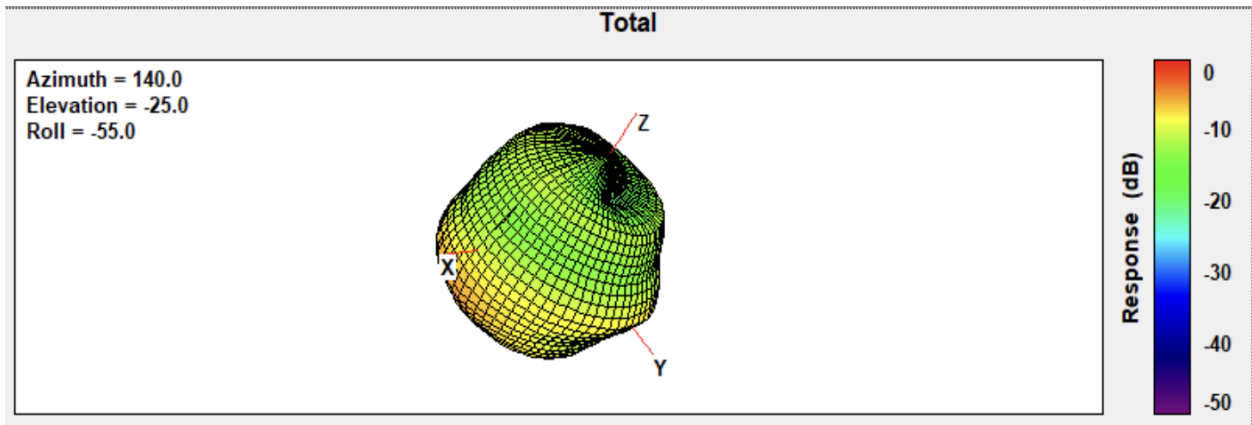ANT3 Frequency 5850-5895 MHz

ANT3 Frequency 5925-6425 MHz

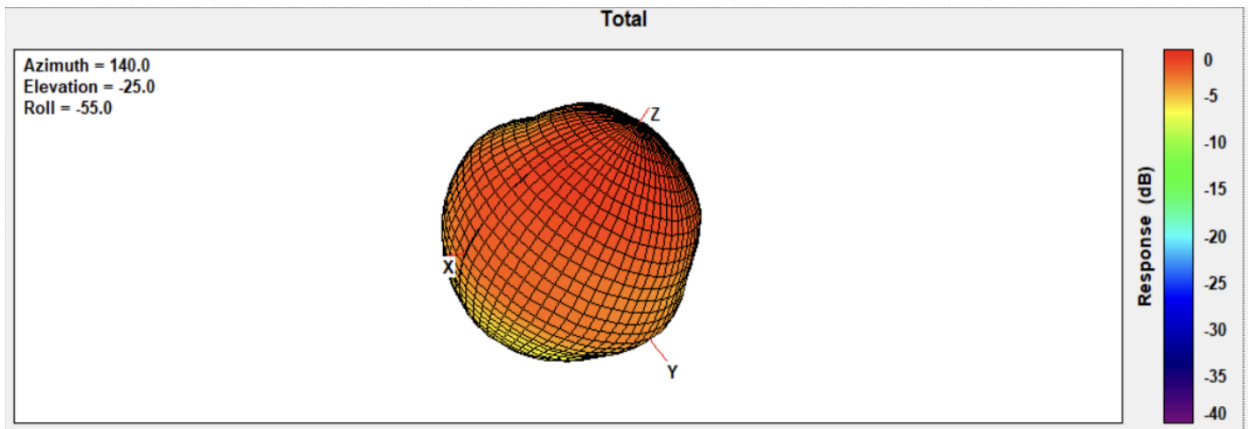ANT3 Frequency 6425-6525 MHz

ANT3 Frequency 6525-6875 MHz
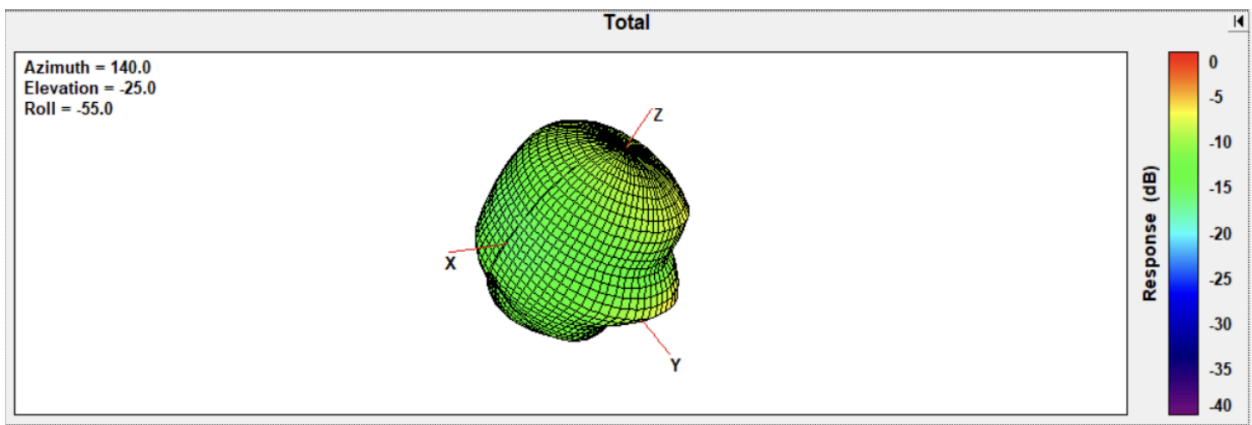
ANT3 Frequency 6875-7125 MHz
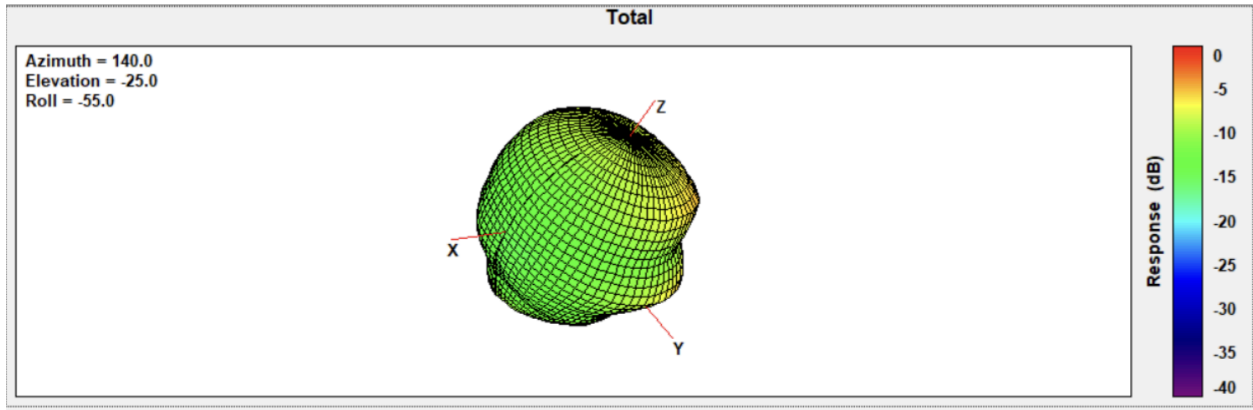

Ant4:

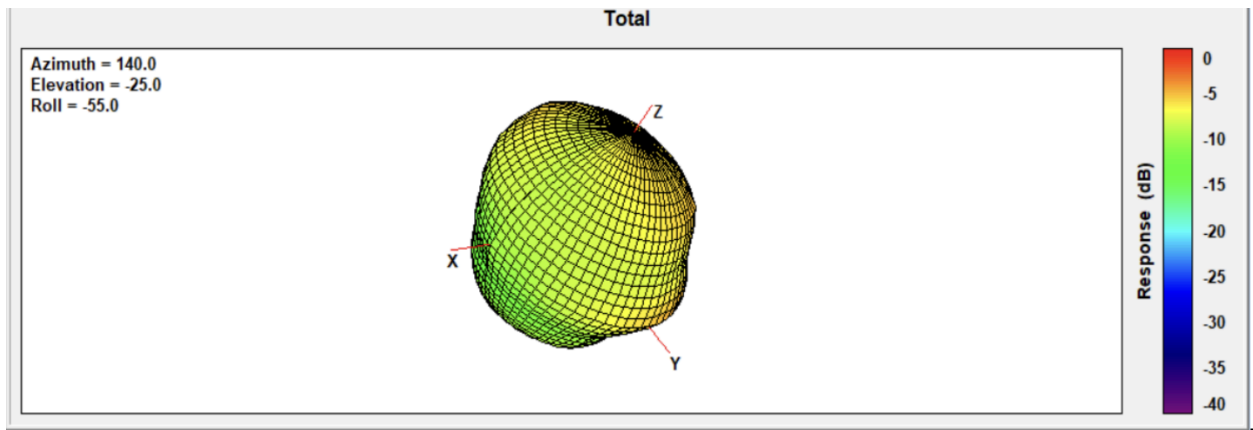ANT4 Frequency 2400-2483.5MHz

ANT4 Frequency 5150-5250 MHz

ANT4 Frequency 5250-5350 MHz

ANT4 Frequency 5470-5725 MHz

ANT4 Frequency 5725-5850 MHz