Passive Antenna Radiation Gain Pattern Test Report

Project No.	:	P239042
Applicant	:	SUNHENG TECHNOLOGY CO., LTD.
Applicant Address	:	No. 88, Ln. 211, Taiming Rd., Wuri Dist., Taichung City 414, Taiwan, R.O.C.
Product Type	:	PCB Antenna
Model Number	:	SH-05BT-ANT
Received Date	:	Sep. 06, 2023
Test Dates	:	Sep. 06, 2023
Test Engineer	:	Jason Tsai
Issued Date	:	Sep. 07, 2023

Issued by
Eurofins E&E Wireless Taiwan Co., Ltd.
No. 140-1, Changan Street,
Bade District, Taoyuan City
334025, Taiwan (R.O.C.)
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Approved By: Willson Lin
(Willson Lin)

Revision History

Rev.	Issued Date	Revisions	Revised By
00	Sep. 07, 2023	Initial Issue	Willson Lin

Contents

1. Overview

This report describes the test setups, test methods, and required test equipment used to perform test of the PCB Antenna, SH-05BT-ANT.

2. Equipment Configuration

2.1. Equipment Under Test (EUT) Information

Antenna Manufacturer:	SUNHENG TECHNOLOGY CO., LTD.
Antenna Manufacturer Address :	No. 88, Ln. 211, Taiming Rd., Wuri Dist., Taichung City 414, Taiwan, R.O.C.
Antenna Model:	SH-05BT-ANT
Device Type:	PCB Antenna
Environmental Test Conditions:	Temperature: 25 ±5° C
	Relative Humidity: 30-70%

2.2. Testing Location

All testing was performed in a limited access test laboratory facility located at Eurofins E&E Wireless Taiwan Co., Ltd.

Site Name: Eurofins E&E Wireless Taiwan
Site Address: ■ No. 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan (R.O.C.)
Site Address: □ No. 2, Wuquan 5th Rd., Wugu Dist., New Taipei City 248018, Taiwan (R.O.C.)

All testing performed at Eurofins E&E Wireless Taiwan Co., Ltd. was conducted in the Environmental Simulation Lab. All equipment used in making physical determinations is accurate and bears recent traceability to the National Standards and Technology.

2.3. Test Equipment Used During Testing

2.3.1. Test Equipment

Name / Description	Manufacturer	Model Number	Calibration Data[1]	Calibration Due Data
Anechoic Chamber	ETS-Lindgren	AMS 8500	N.C.R[2]	N.C.R[2]
Quad Ridge Horn	ETS-Lindgren	3164-08	N.C.R[2]	N.C.R[2]
Antenna Positioner Controller	ETS-Lindgren	EMCenter	N.C.R[2]	N.C.R[2]
MAPS Positioner	ETS-Lindgren	EMCenter	N.C.R[2]	N.C.R[2]
Network Analyzer	Keysight	E5080B	Feb. 18, 2023	Feb. 17, 2024

Note 1: The 'Customer Supplied Calibration Data' column will be marked as either not applicable, not available, or will contain the calibration date supplied by the customer.

Note 2: N.C.R. = No Calibration Request.

2.3.2. Measurement Software

Description	Manufacturer	Name	Version
OTA software	ETS-Lindgren	EMQuest	1.16

2.3.3. Reference Standard Objects

Name / Description	Manufacturer	Model Number	Calibration Data[1]	Calibration Due Data
Sleeve Dipole	ETS-Lindgren	3126-700	Oct. 26, 2021	Oct. 25, 2023
Sleeve Dipole	ETS-Lindgren	3126-800	Oct. 26, 2021	Oct. 25, 2023
Sleeve Dipole	ETS-Lindgren	3126-900	Oct. 21, 2021	Oct. 20, 2023
Sleeve Dipole	ETS-Lindgren	3126-1850	Sep. 14, 2021	Sep.13, 2023
Sleeve Dipole	ETS-Lindgren	3126-2150	Nov. 10, 2021	Nov. 9, 2023
Sleeve Dipole	ETS-Lindgren	3126-2500	Nov. 1, 2021	Oct. 31, 2023

3. Test Methodology

3.1. Test System Setup

The test system is an ETS-Lindgren AMS-8500 chamber which consists of:

Rectangular Fully Anechoic Chamber:
Shield Dimensions (L x W x H): 7.3 m x 3.7 m x 3.7 m; Path Length: 4.9 m

Open Boundary Quad-ridged Horn Antenna
Open boundary Quad-ridged Horn Antenna design is similar to two double-ridged waveguide antennas, placed orthogonally to each other, providing the ability to measure the two principal components of a radiating electric field.

Multi-Axis Positioner System (MAPS)
Multi-Axis Positioner System (MAPS) is designed with adjustment rails to position the Antenna Under Test (AUT) to the center of rotation axes (both in Theta and Phi axes) for accurate antenna measurements. The MAPS rotates the device under test (DUT) around two orthogonal axes for full spherical coverage.

Data Acquisition and Analysis Software
EMQuest Antenna Measurement Software supports data acquisition in either the great circle-cut or conical-cut test sequence to perform full spherical antenna measurements. Post-processing calculations include derivation of antenna half-power beam-width, directivity, gain, radiation efficiency, total radiated power, and total optional isotropic sensitivity. Advanced graphic capabilities allow acquired data to be displayed in a variety of 2D and 3D formats.

Instrumentation
The system is configured to perform generic antenna measurement by using a multi-channel Vector Network Analyzer (VNA).

3.2. Gain-transfer measurement

The gain-transfer method measures the unknown realized gain of an AUT by comparison with a gain standard.
The AUT is either radiating, or illuminated by, a polarization-matched plane wave. The received power into a matched load is measured. The AUT is replaced by a gain standard, leaving all other conditions the same. The received power into a matched load is again measured. Starting with the Friis transmission formula, Equation, and substituting the standard for the AUT and then taking the ratio, the AUT realized gain, G_{AUT}, is given in Equation.

$$G_{AUT}(dB) = G_S(dB) + 10\log_{10}(P_{AUT} / P_S)$$

where

G_S is the realized gain of the gain standard
P_{AUT} is the received power with the AUT mounted
P_S is the received power with the gain standard mounted

3.3. TRP measurement

A three-dimensional characterization of the radiated power of the AUT is pieced together by analyzing the data from the spatially distributed measurements. Data points taken every 15 degrees in the Theta (θ) and in the Phi (Φ) axes are sufficient to fully characterize the AUT's Far-Field radiation pattern and total radiated power. This accounts for a total of 264 measurements for each polarization since measurements at Theta = 0 and 180 degrees are not taken. All the measured power values will be integrated to give a single figure of merit referred to as Total Radiated Power (TRP).
Assuming that a complete sphere is measured with N theta intervals and M phi intervals, then the Total Radiated Power may be calculated as follows.

$$TRP \cong \frac{\pi}{2NM} \sum_{i=1}^{N-1} \sum_{j=0}^{M-1} \left[EiRP_\theta(\theta_i, \phi_j) + EiRP_\phi(\theta_i, \phi_j) \right] \sin(\theta_i)$$

3.4. Antenna Radiated Gain / Efficiency Calculation

As a VNA was used for the testing, Insertion Loss measurement (S21) was performed instead of power measurement at each test point. The input power level to the AUT can be considered as 0 dBm. Therefore, the EIRP (dBm) showed in the test data is equal to Gain (dBi); the TRP (dBm) is equal to Efficiency (dB).

4. Summation Test Report

4.1. Antenna A

Test / Position	3D Gain / Free Space										
Frequency (MHz)	2400	2405	2410	2415	2420	2425	2430	2435	2440	2445	2450
Tot. Rad. Pwr. (dBm) or Efficiency (dB)	-11.37	-11.43	-11.48	-11.54	-11.63	-11.71	-11.73	-11.78	-11.72	-11.63	-11.74
Peak Gain(dBi)	-5.30	-5.39	-5.32	-5.43	-5.36	-5.56	-5.50	-5.61	-5.51	-5.37	-5.52
Directivity (dBi)	6.06	6.05	6.16	6.12	6.27	6.15	6.23	6.17	6.21	6.25	6.22
Efficiency (%)	7.30	7.19	7.11	7.01	6.88	6.75	6.71	6.64	6.73	6.88	6.70

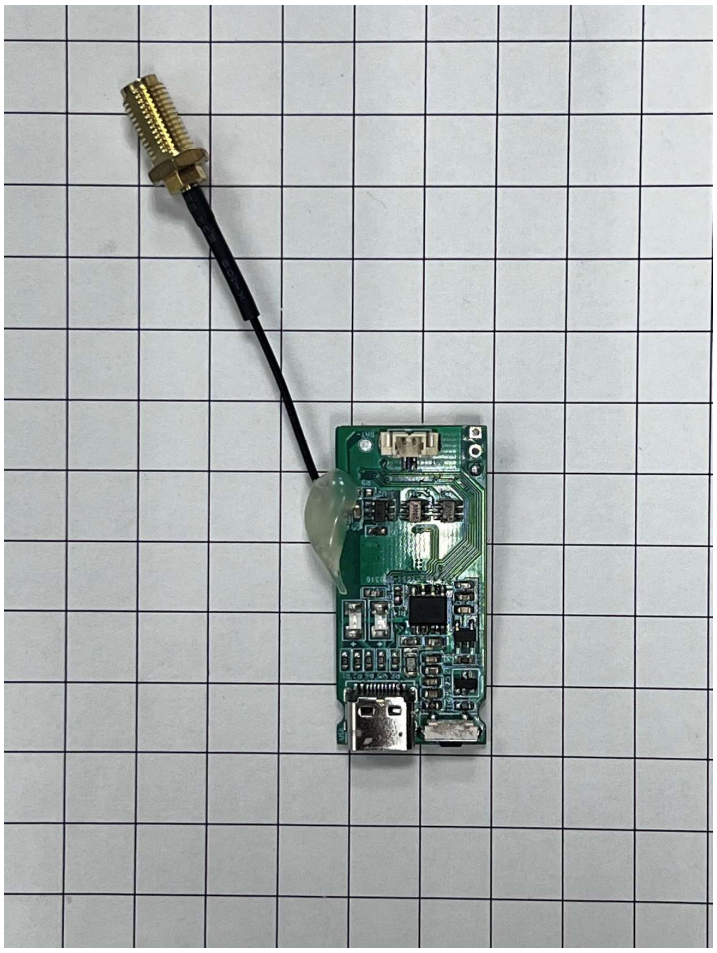
Test / Position	3D Gain / Free Space									
Frequency (MHz)	2455	2460	2465	2470	2475	2480	2485	2490	2495	-
Tot. Rad. Pwr. (dBm) or Efficiency (dB)	-11.77	-11.98	-12.07	-12.15	-12.17	-12.26	-12.25	-12.20	-12.15	-
Peak Gain(dBi)	-5.67	-5.96	-6.10	-6.17	-6.30	-6.46	-6.44	-6.31	-6.21	-
Directivity (dBi)	6.10	6.01	5.97	5.99	5.87	5.80	5.81	5.89	5.94	-
Efficiency (%)	6.65	6.34	6.21	6.09	6.07	5.95	5.96	6.03	6.09	-

5. Measurement Uncertainty

5.1. Measurement Uncertainty

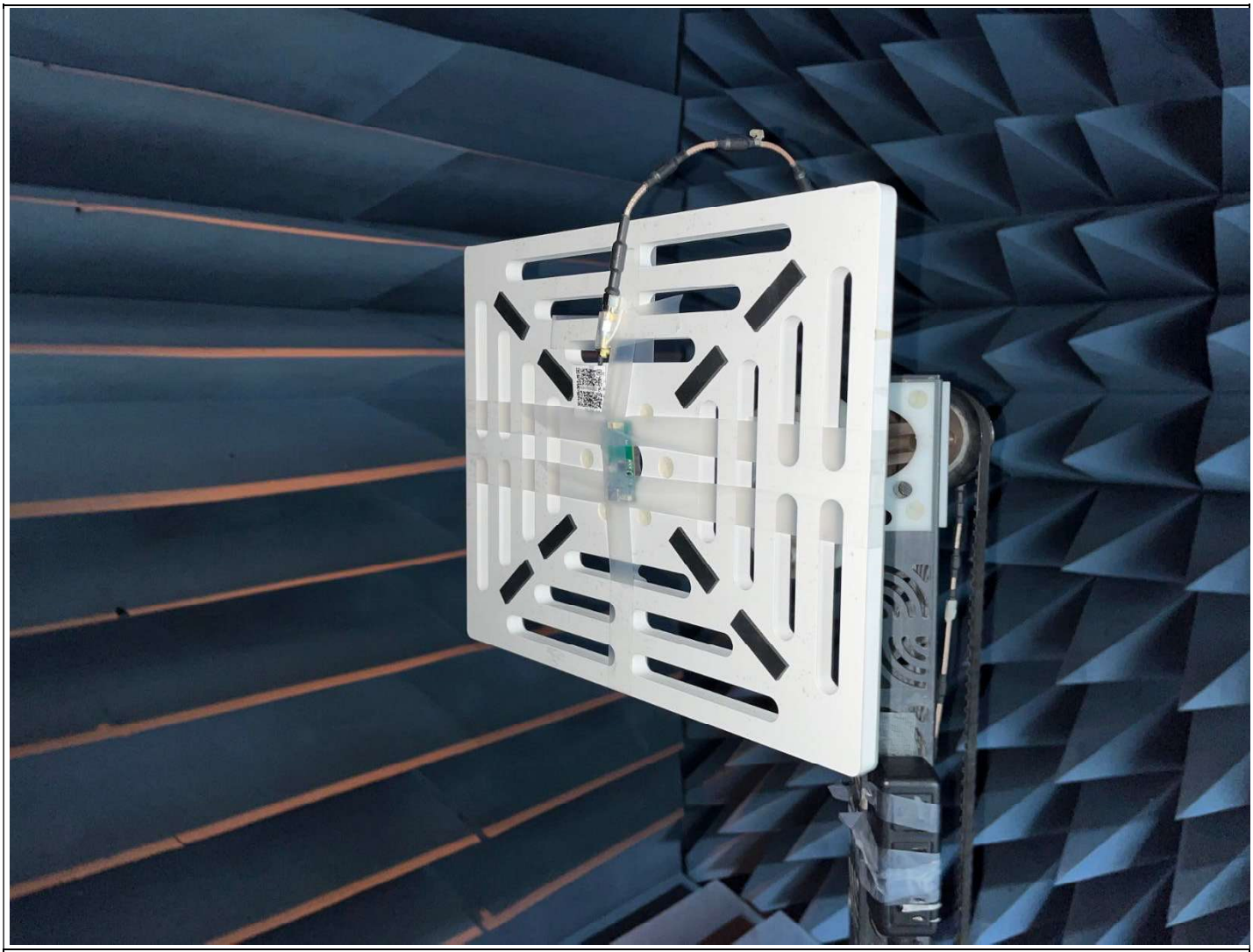
Band	TRP Expanded Uncertainty [dB]
617 - 698 MHz	1.21
699 - 798 MHz	1.42
814 - 894 MHz	1.11
1695 – 1780 MHz	1.33
1850 - 2020 MHz	1.41
2110 – 2180 MHz	1.46
2300 – 2800 MHz	1.41

ANNEX A. Antenna Photos



Antenna Front View

ANNEX B. SETUP Photos



Setup Free Space

ANNEX C. Radiation Pattern

2400MHz

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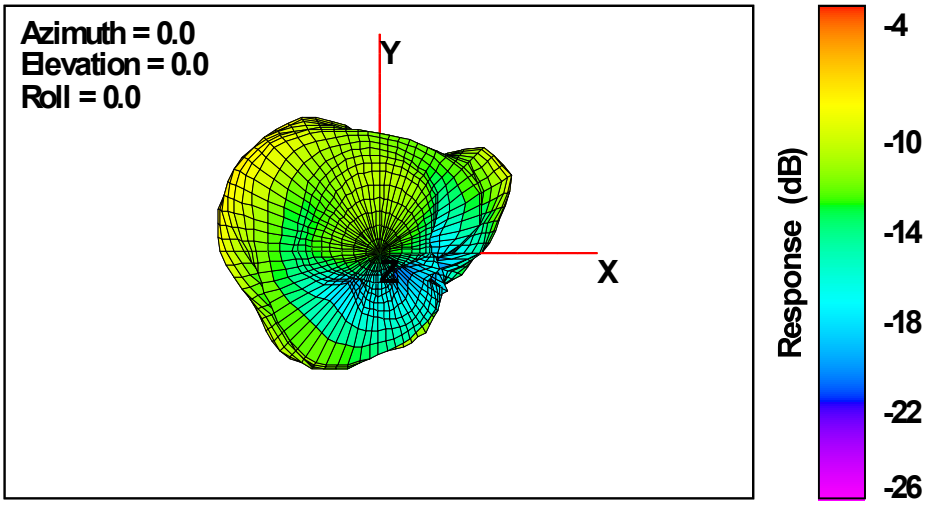

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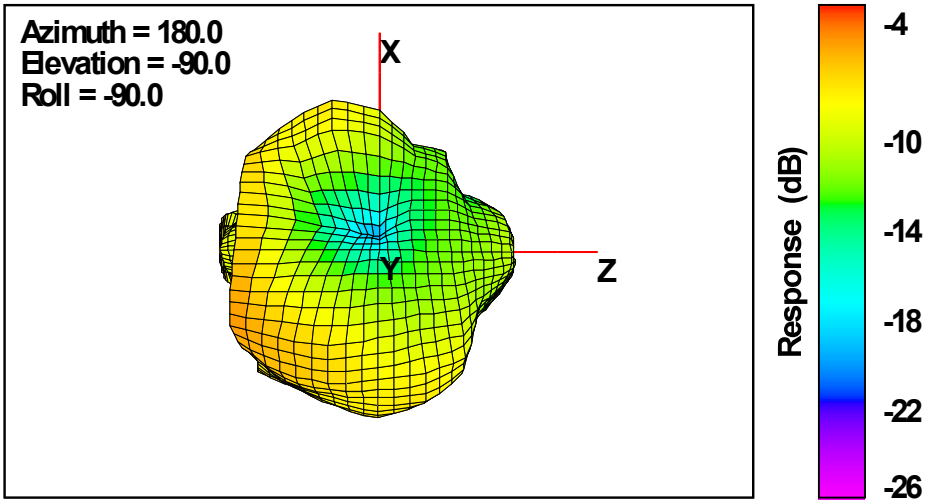

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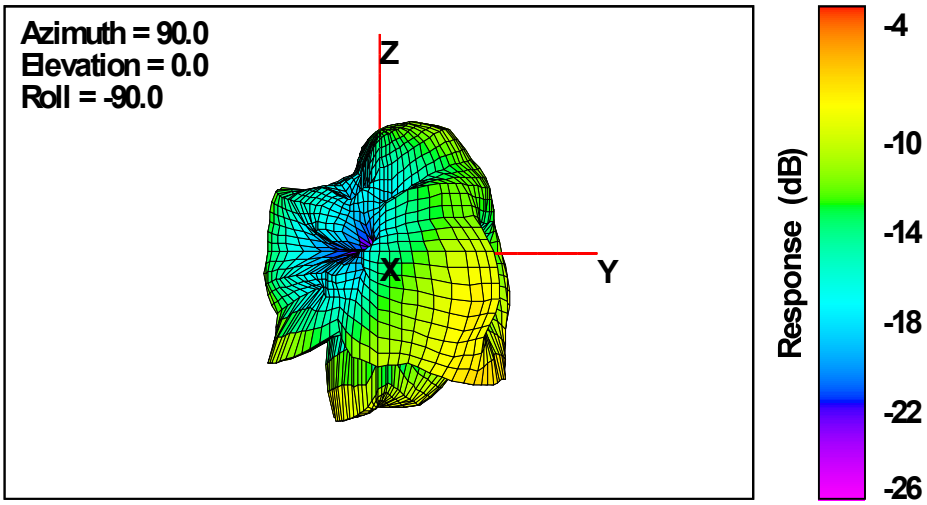

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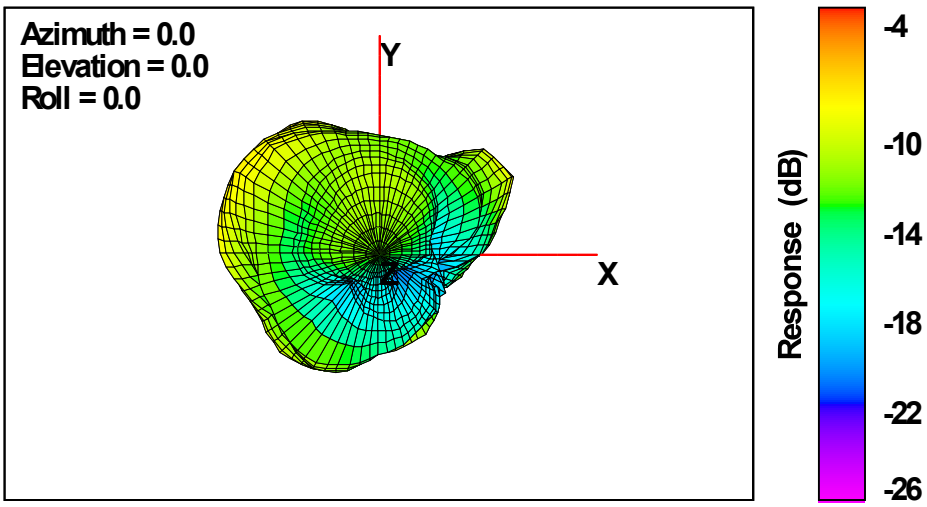

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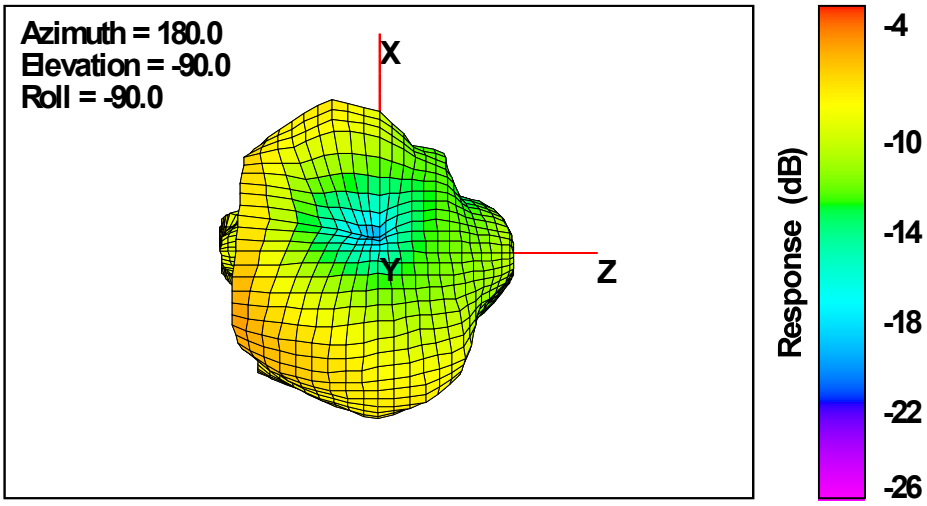

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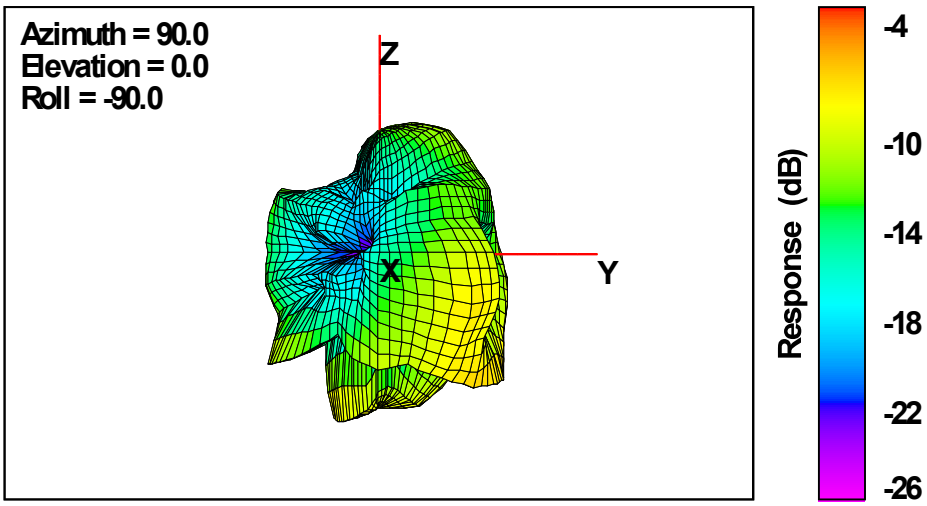

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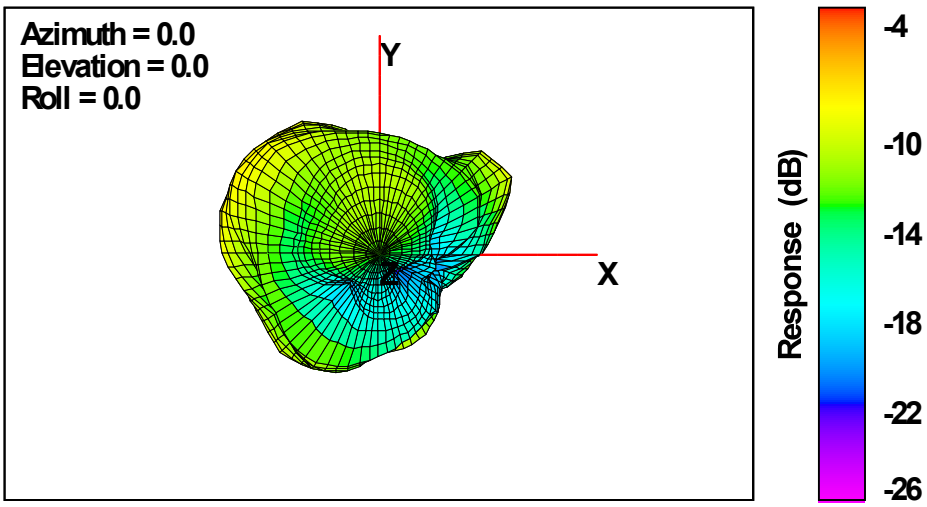

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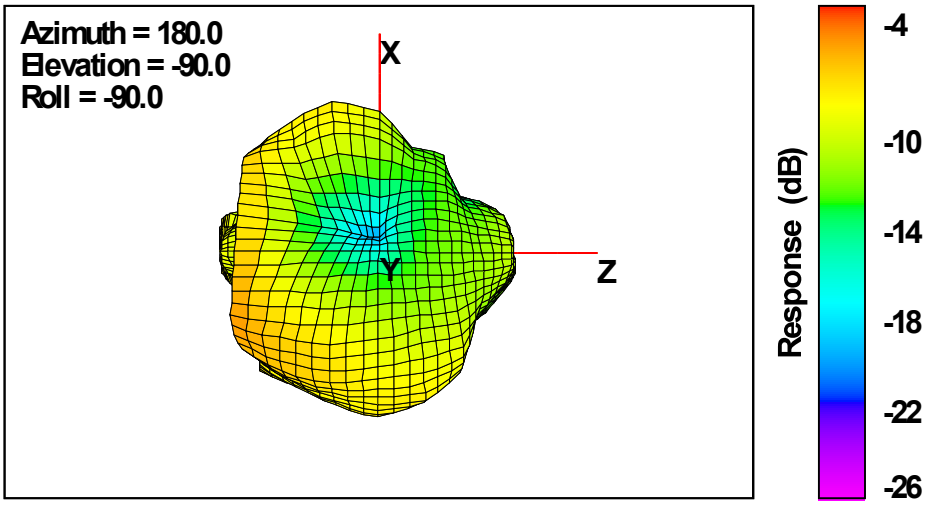

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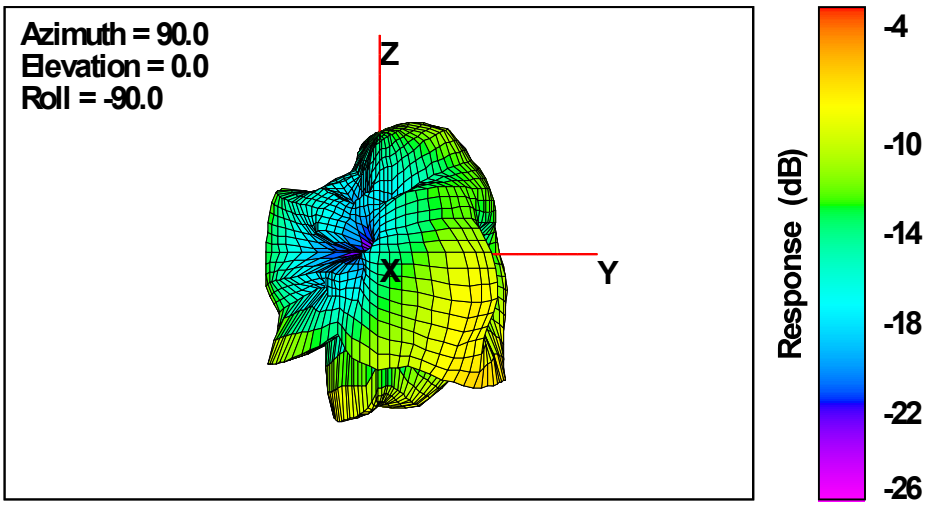

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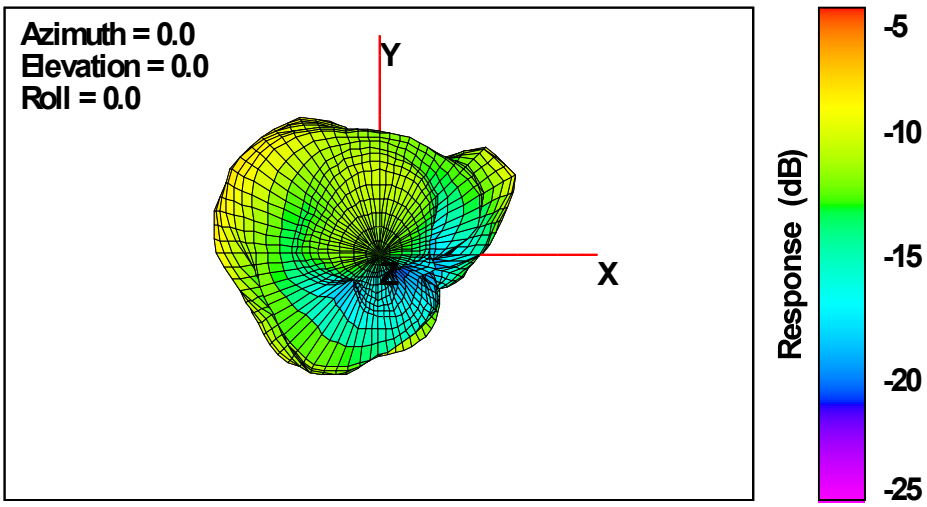

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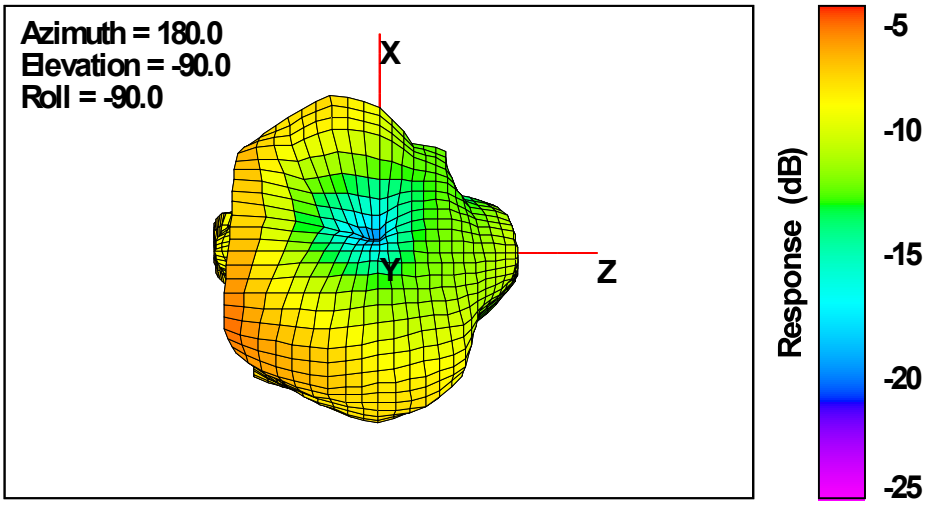

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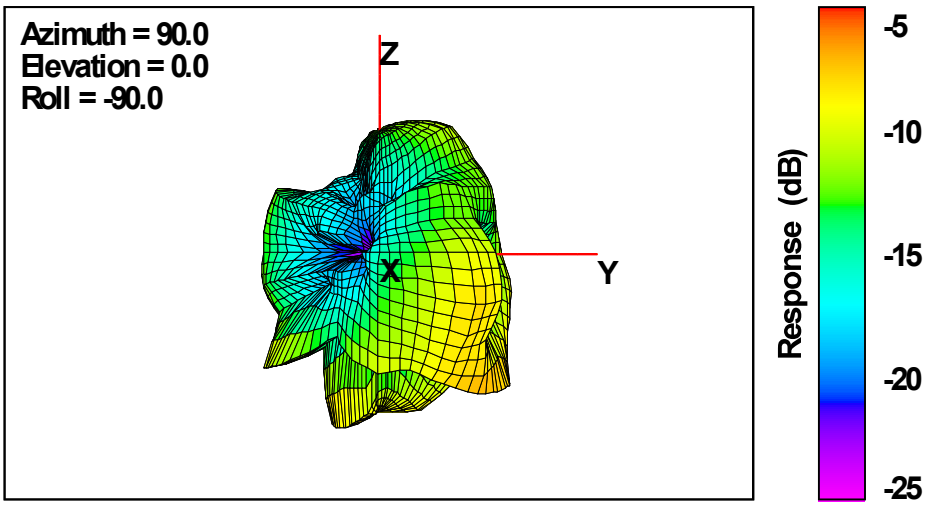

2420MHz

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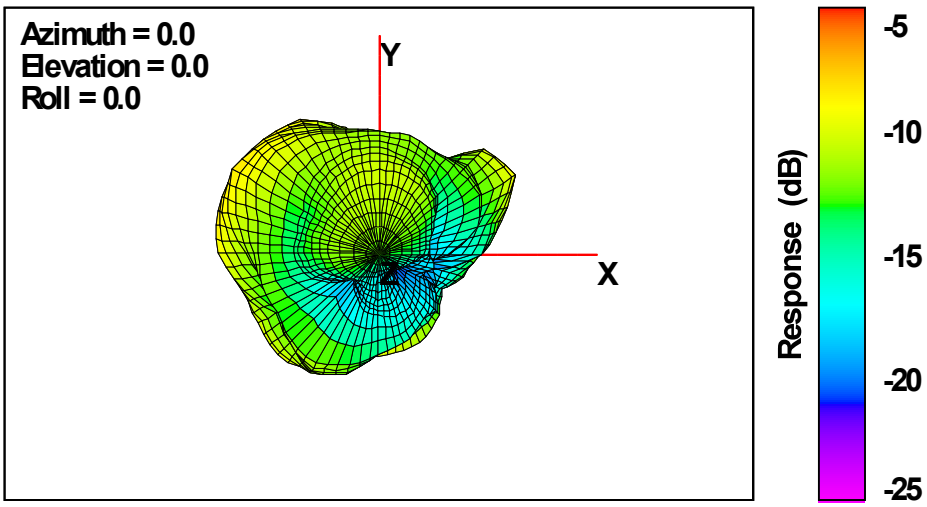

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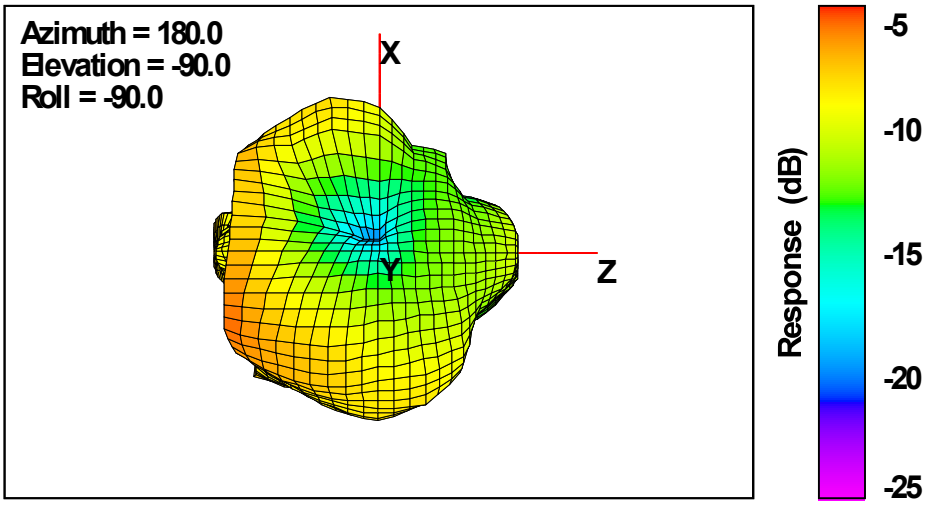

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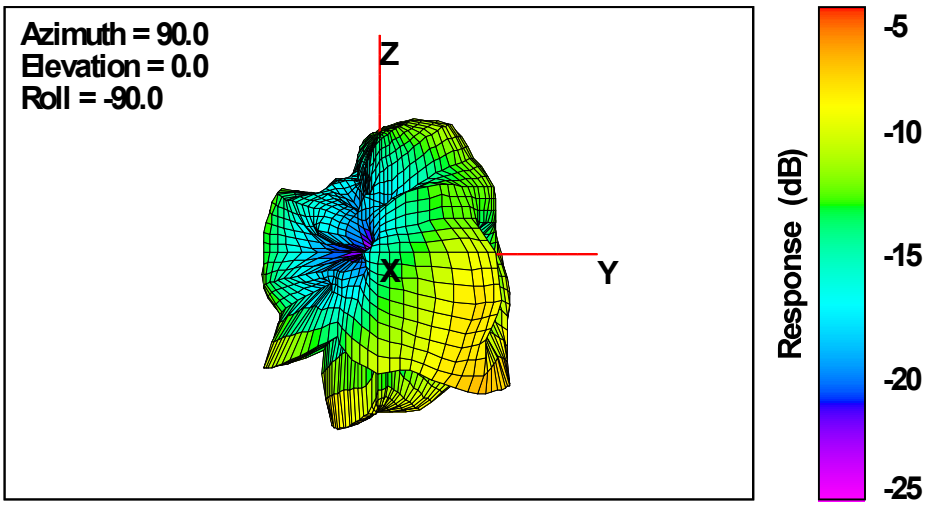

2425MHz

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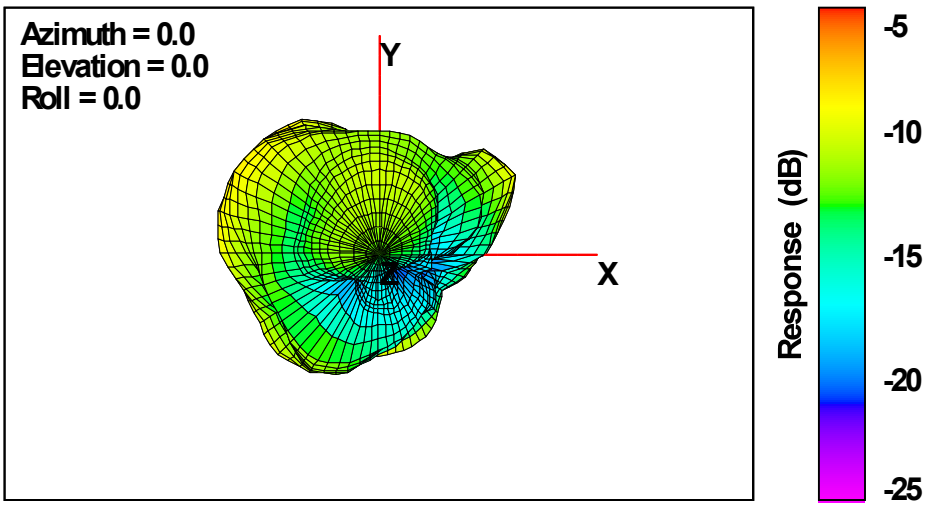

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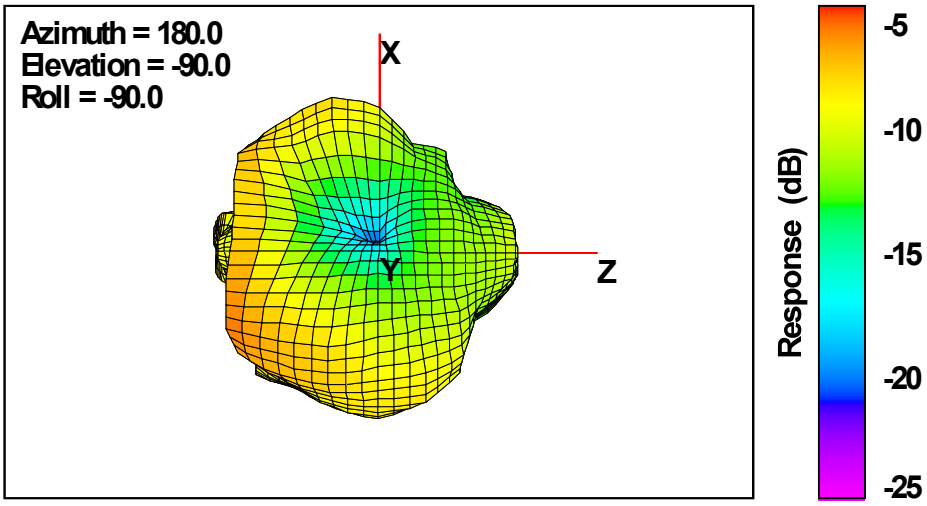

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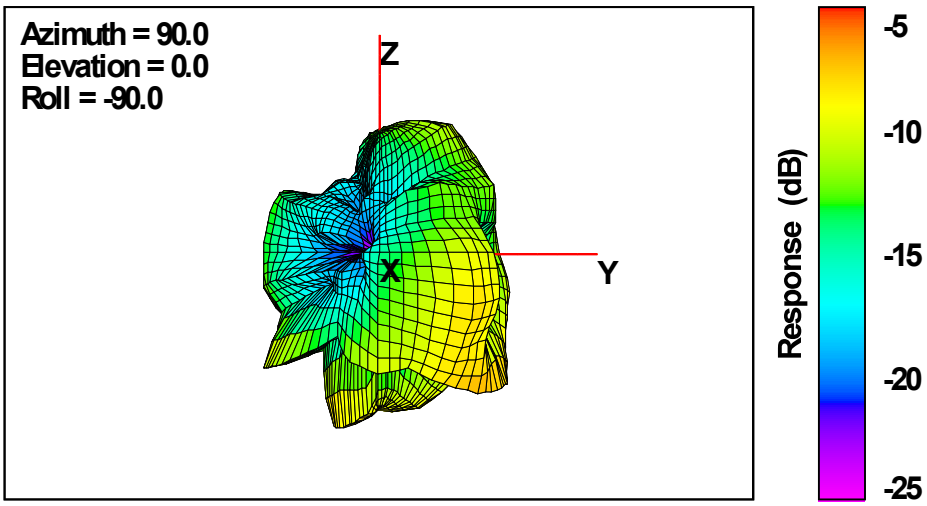

2430MHz

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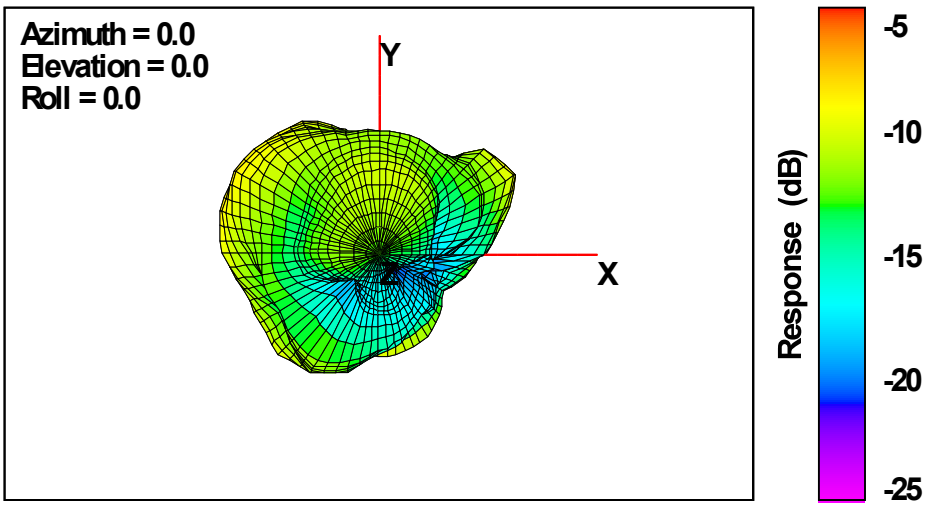

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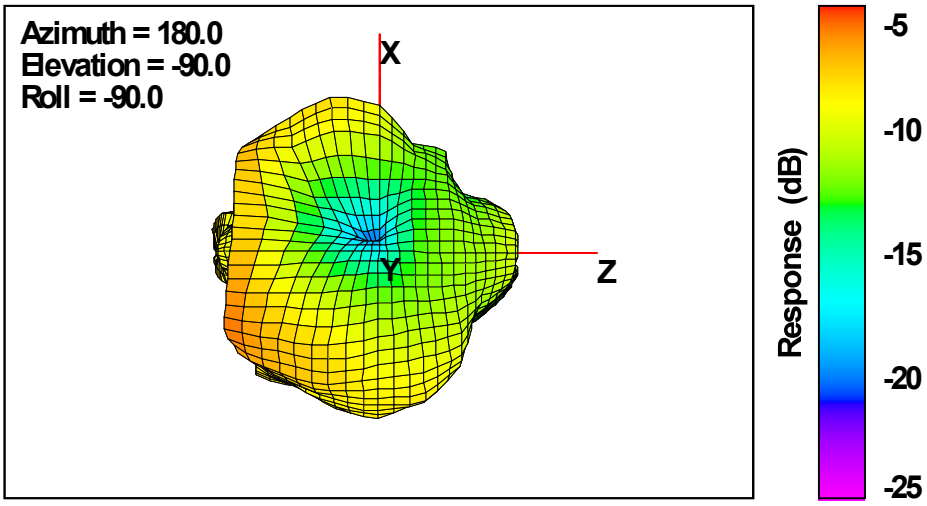

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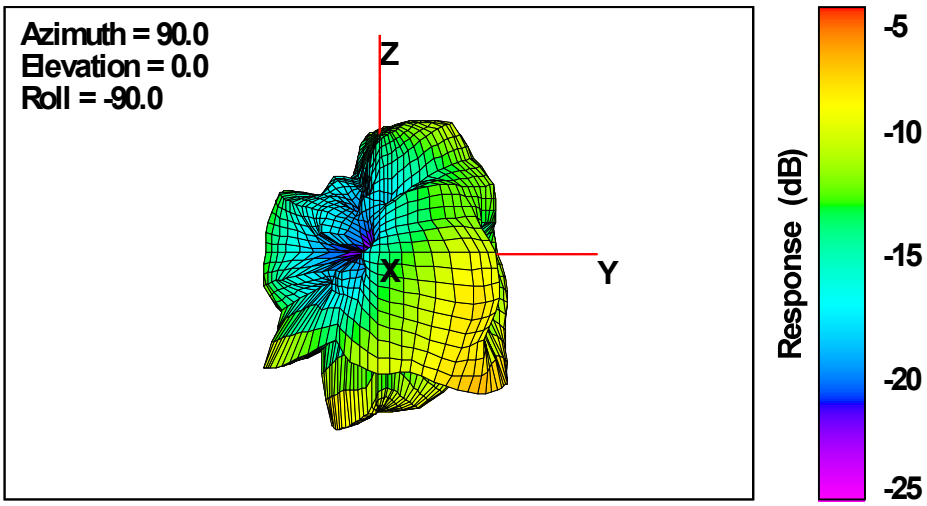

2435MHz

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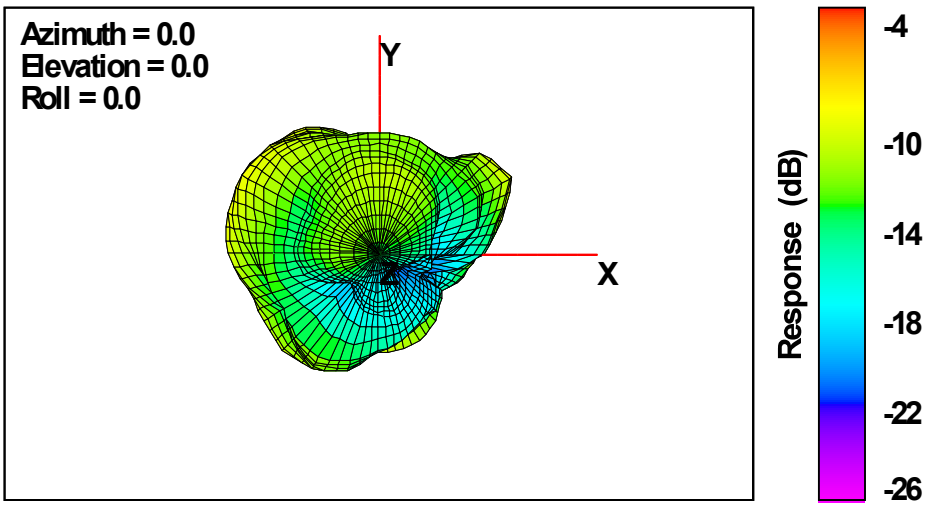

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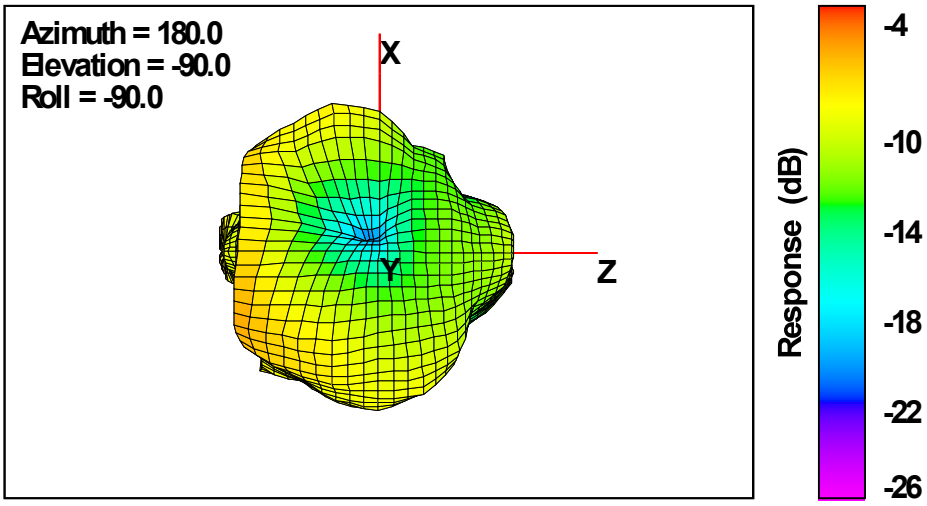

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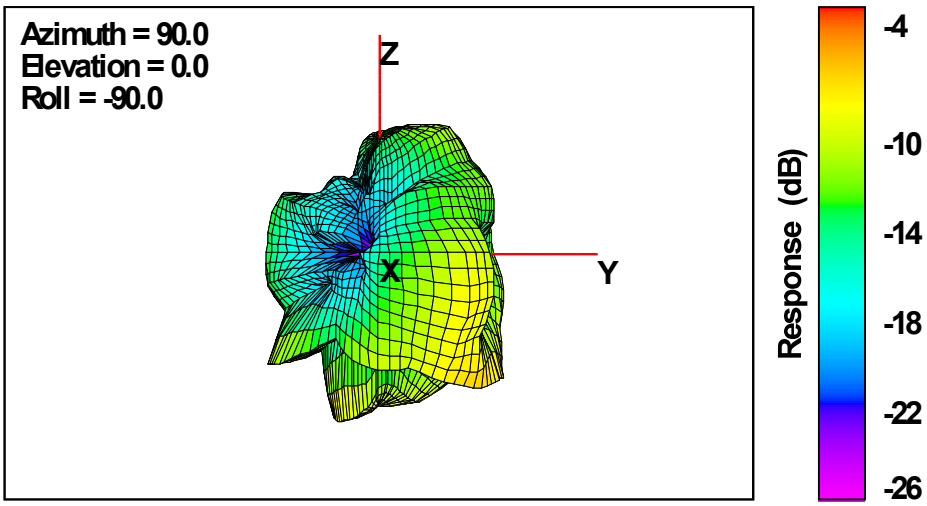

2440MHz

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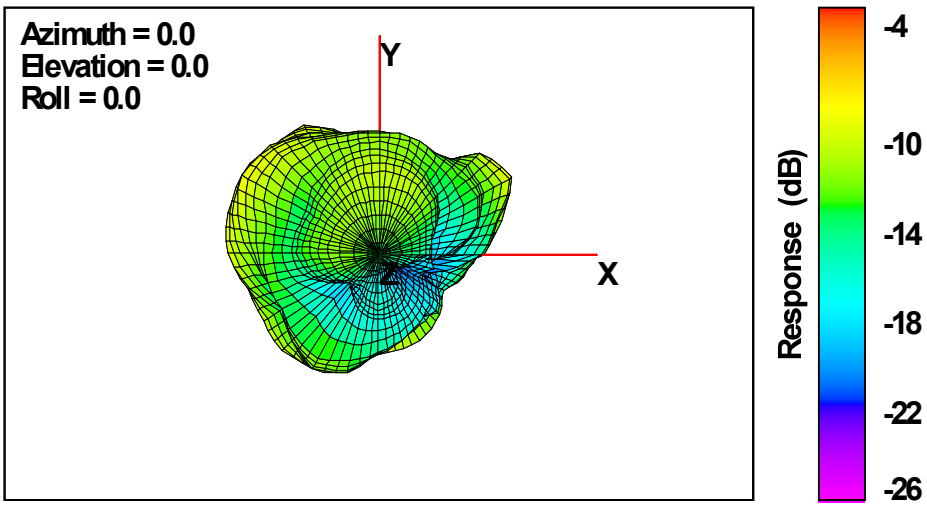

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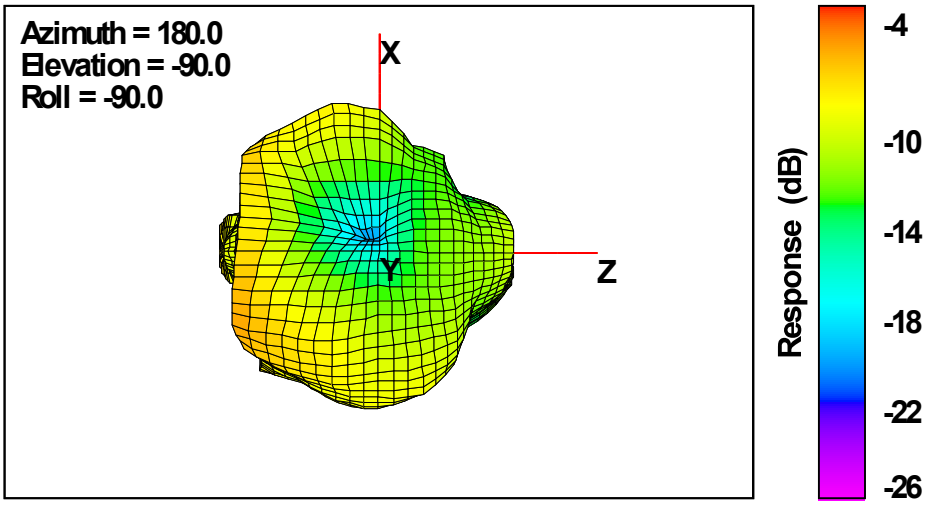

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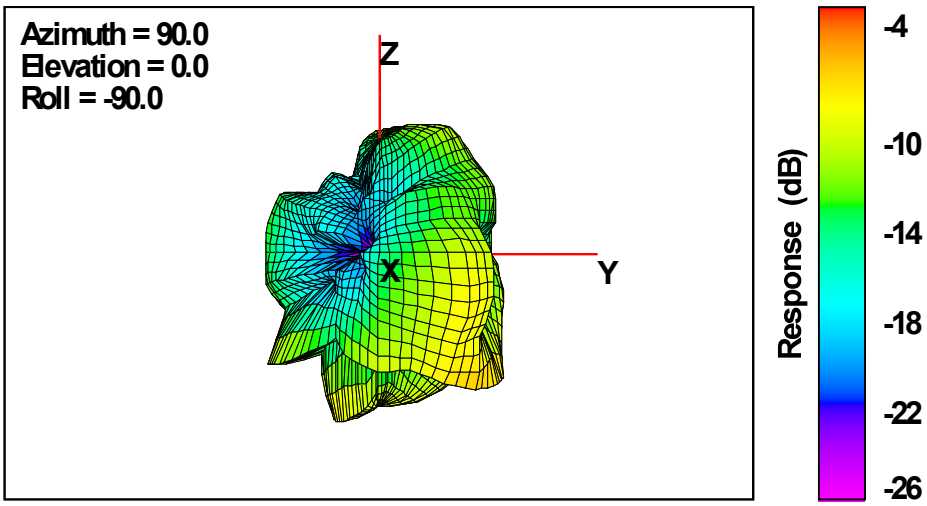

2445MHz

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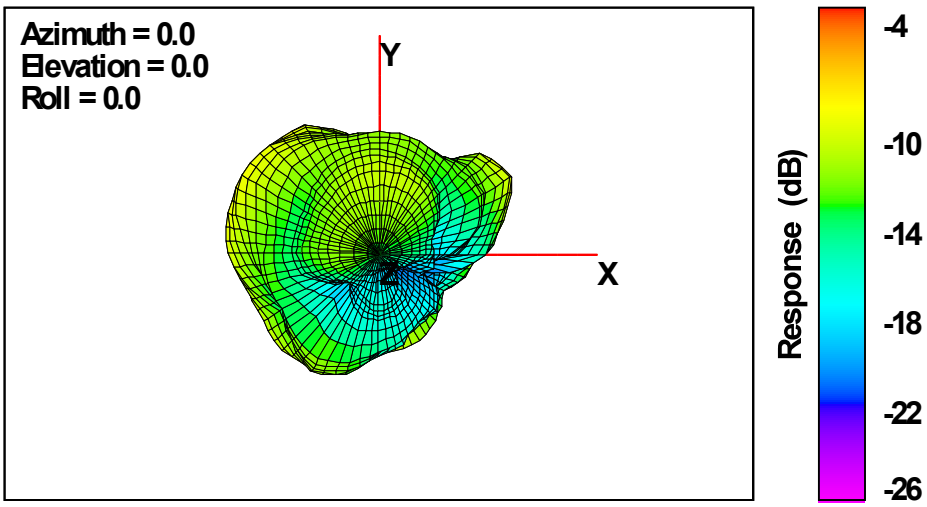

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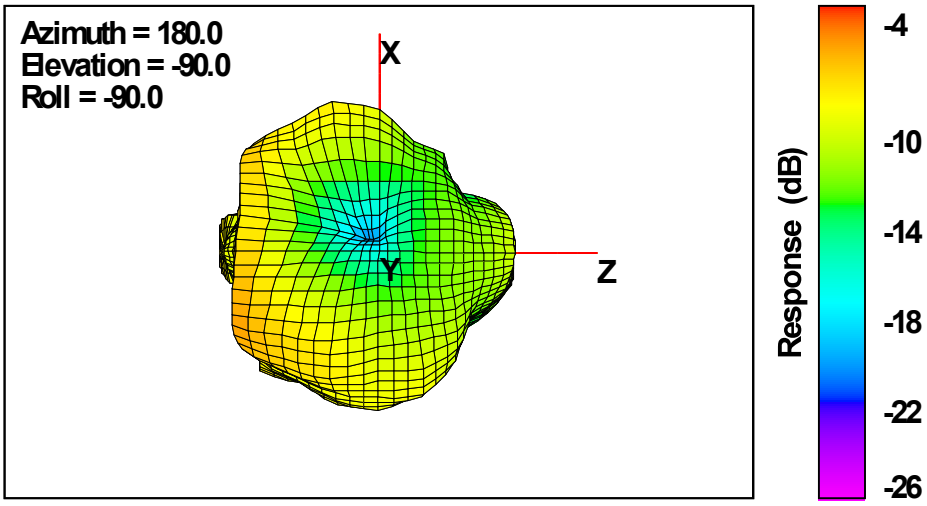

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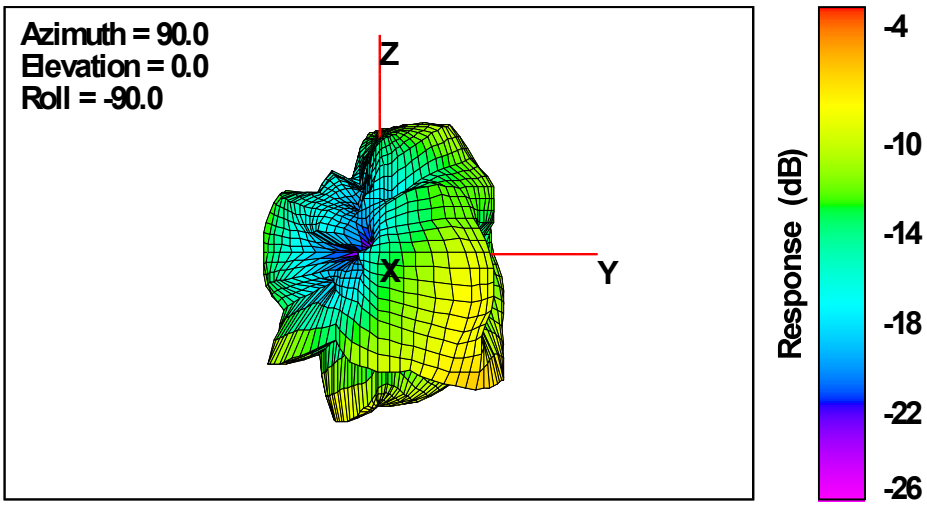

2450MHz

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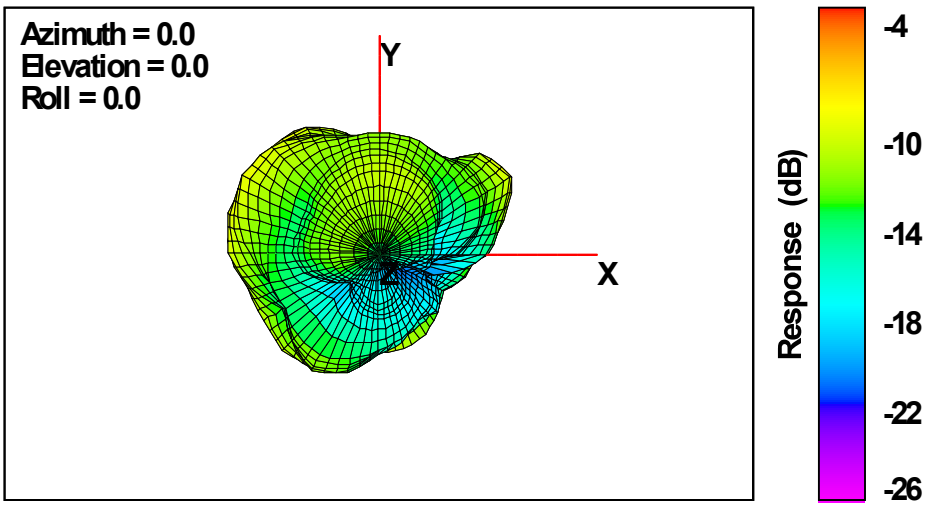

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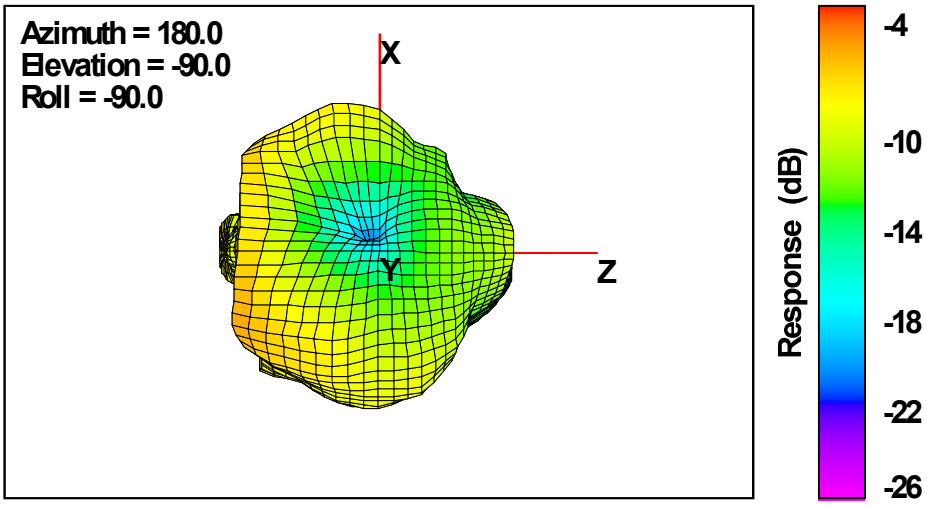

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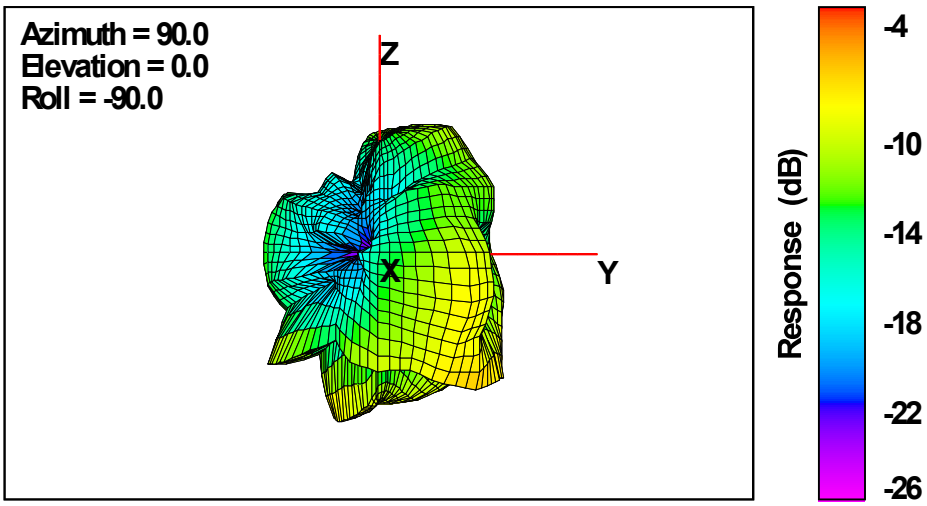

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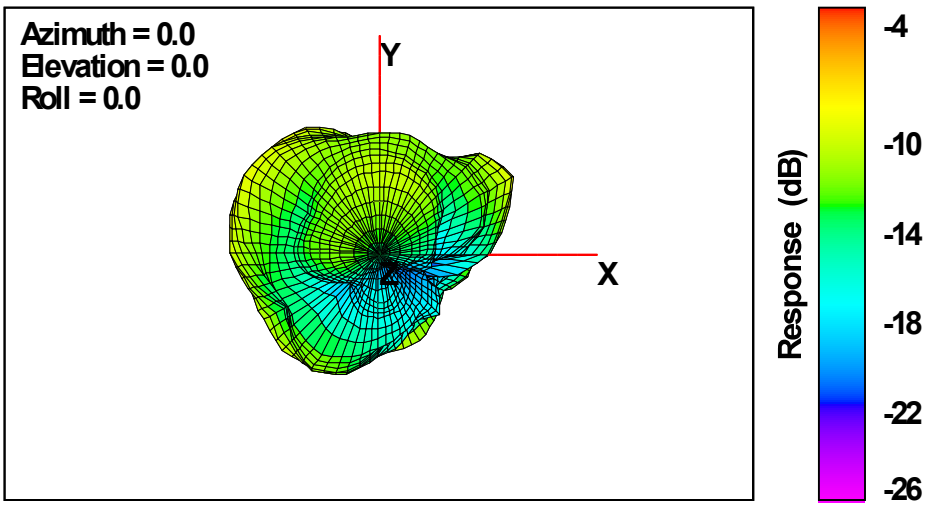

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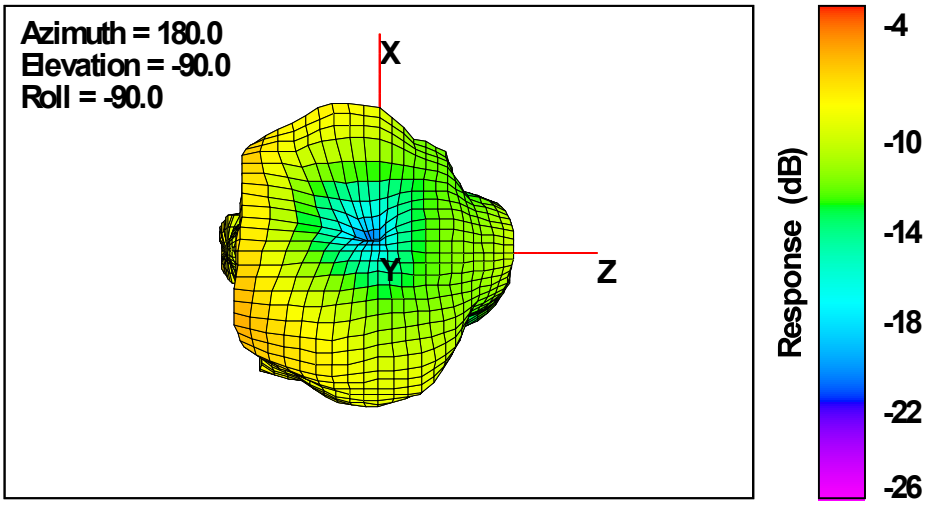

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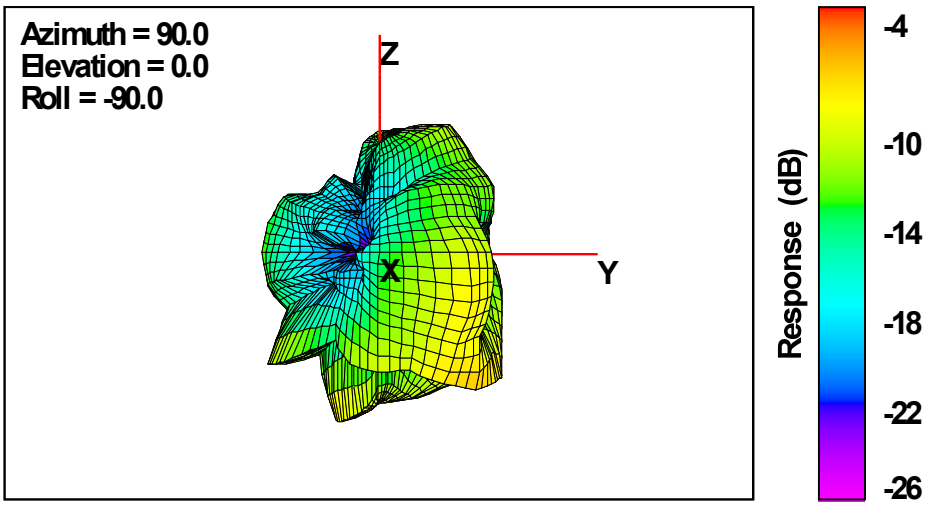

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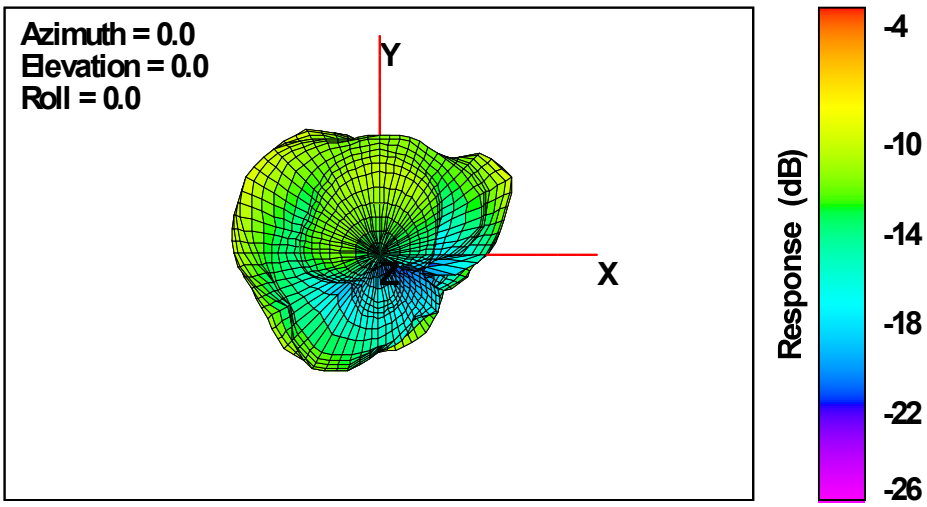

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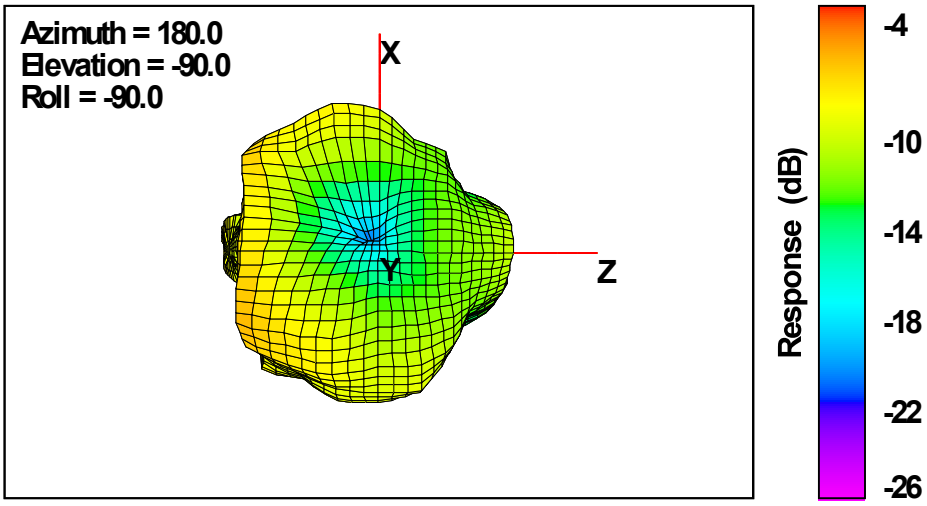

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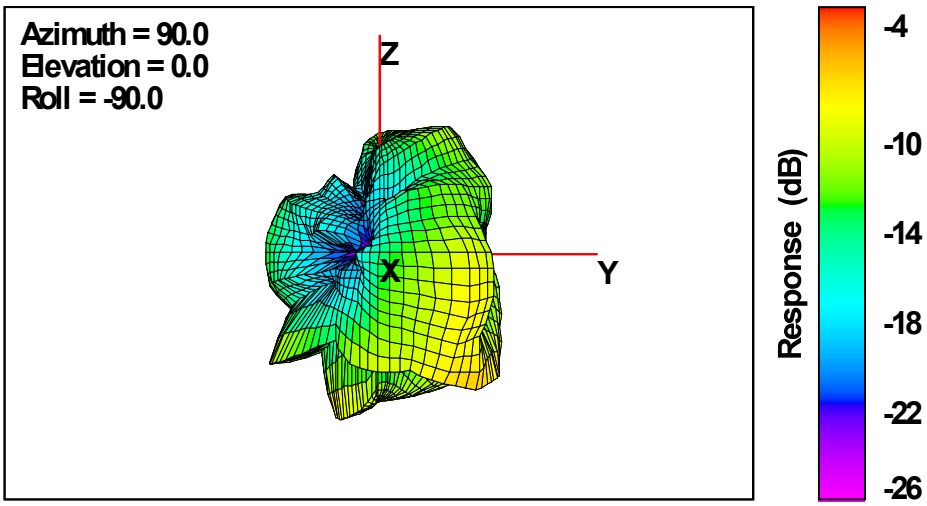

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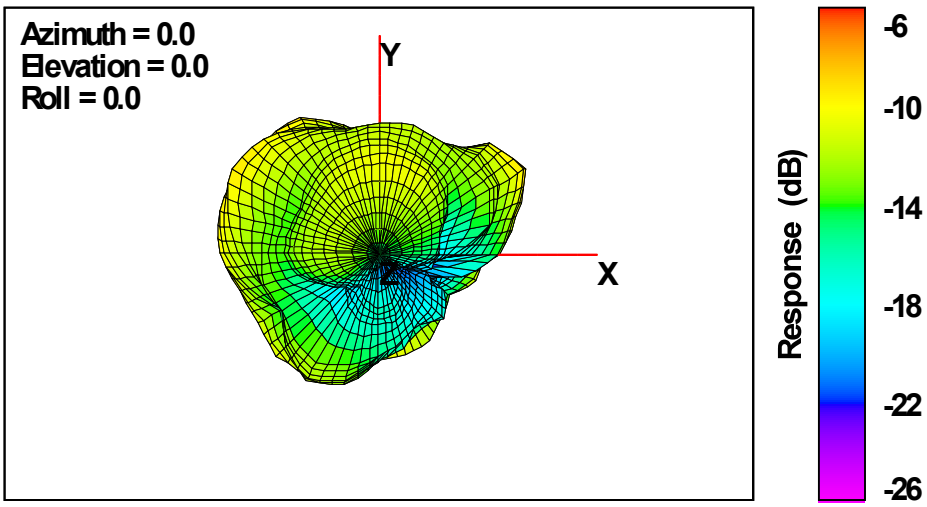

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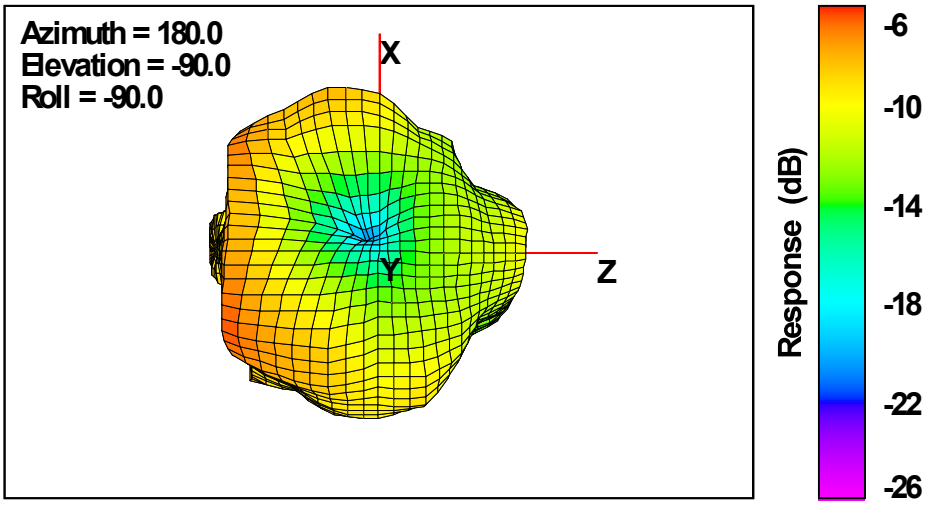

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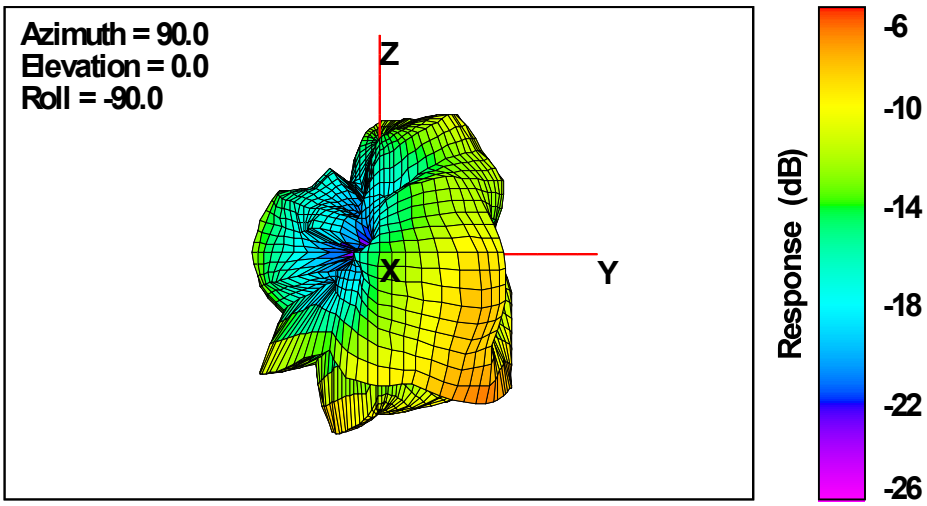

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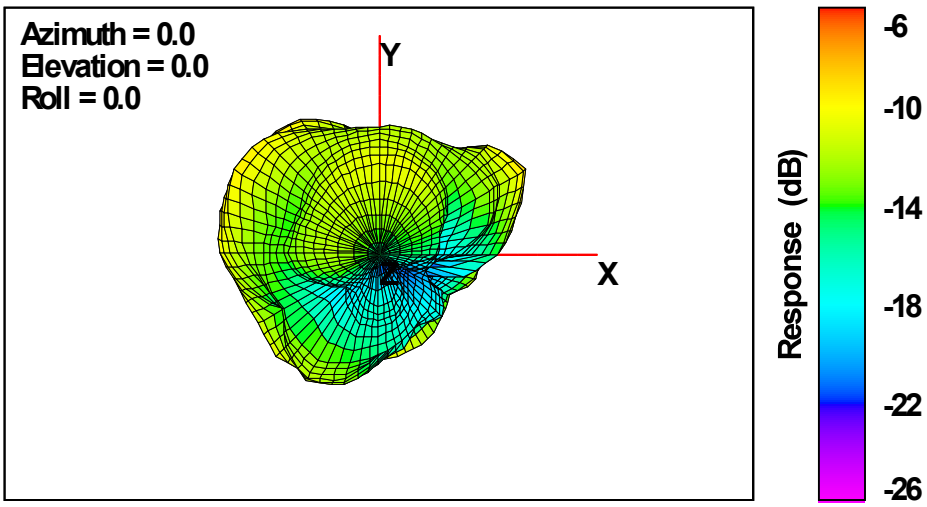

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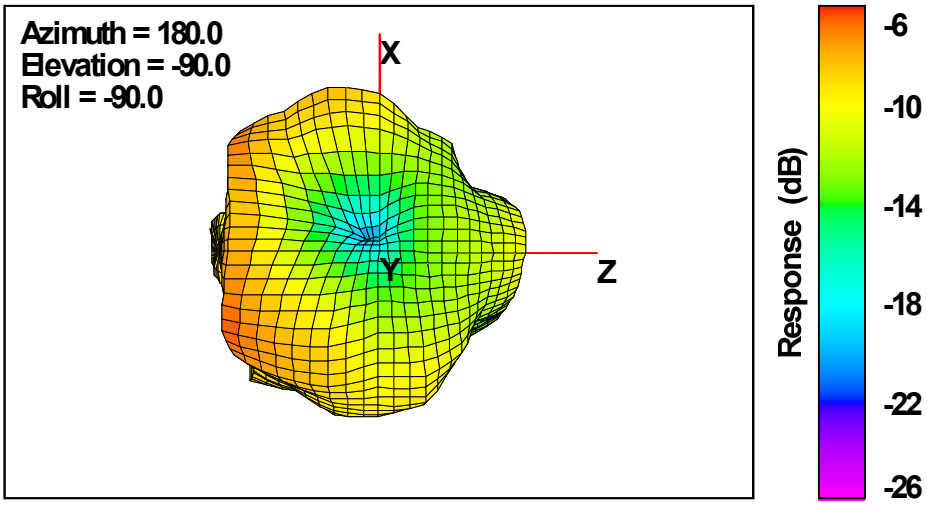

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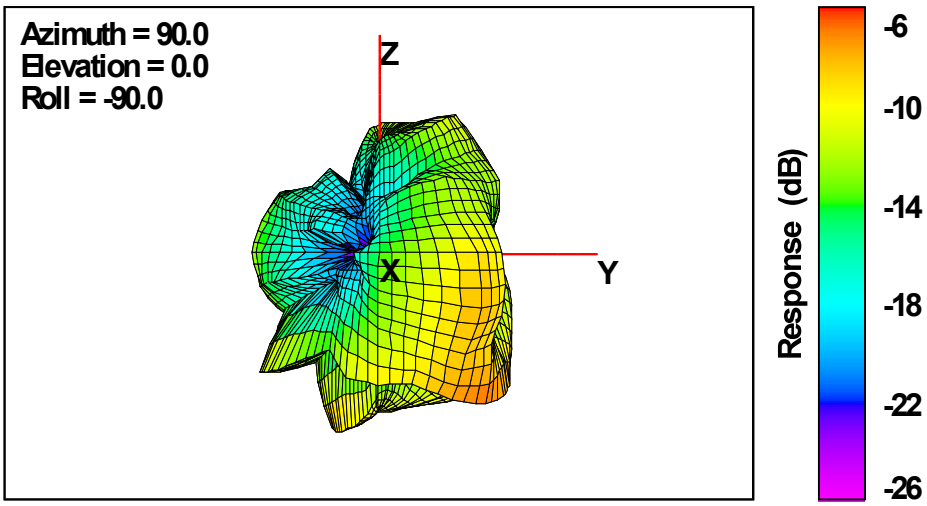

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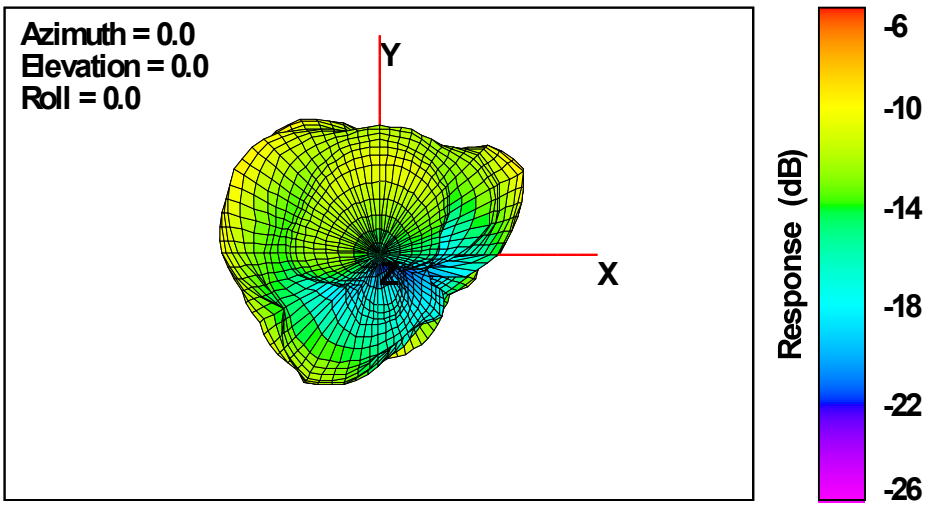

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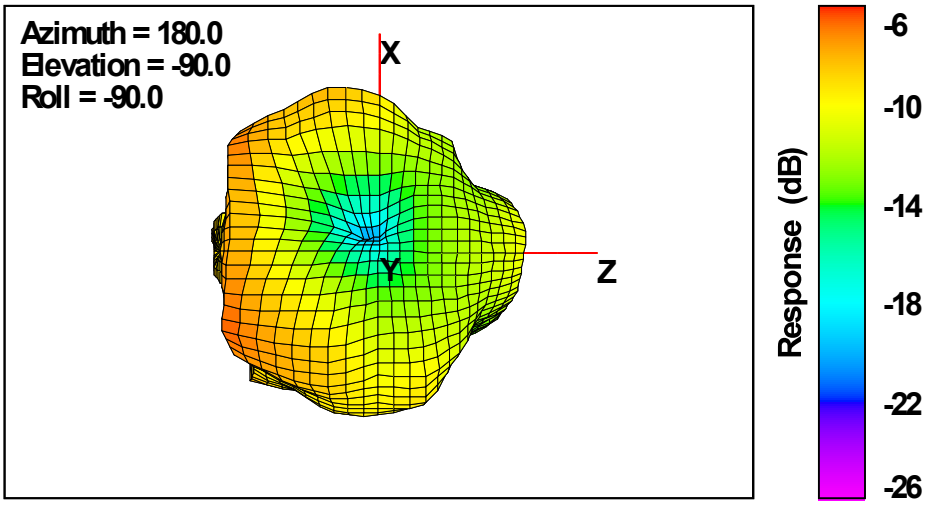

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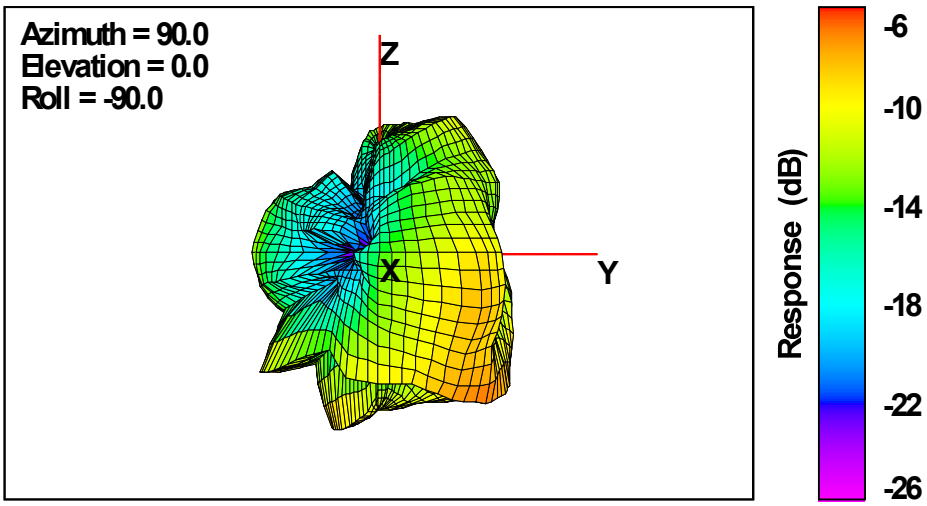

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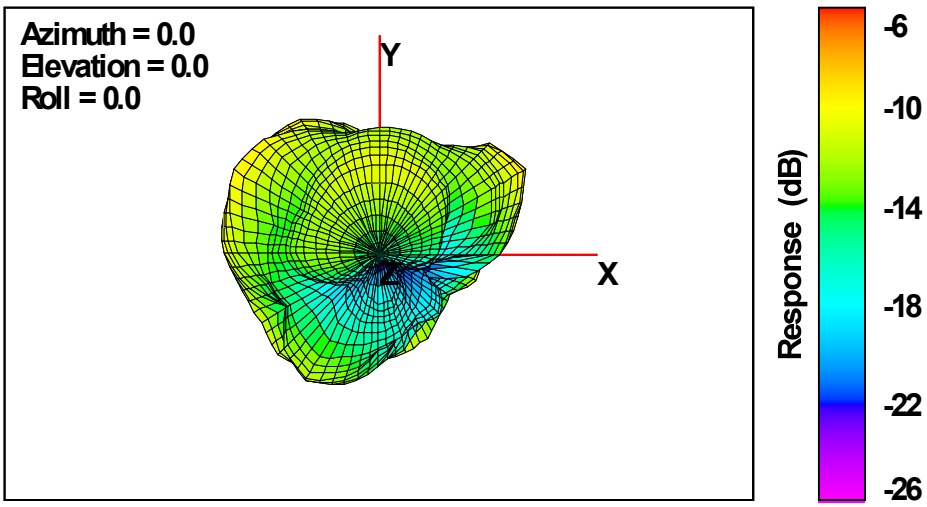

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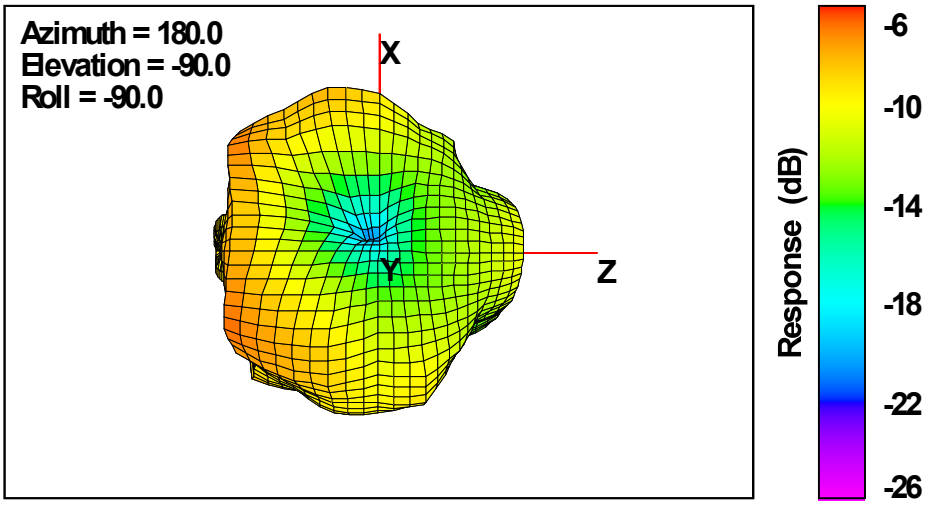

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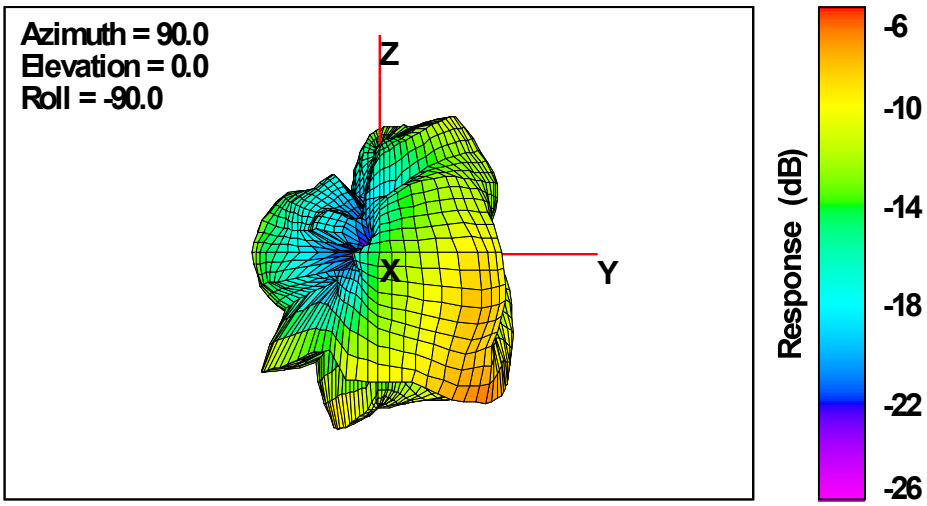

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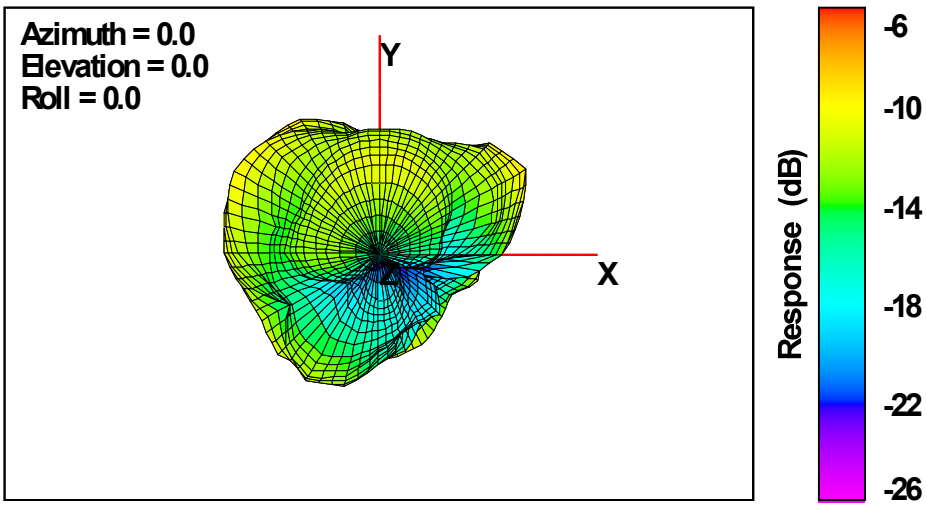

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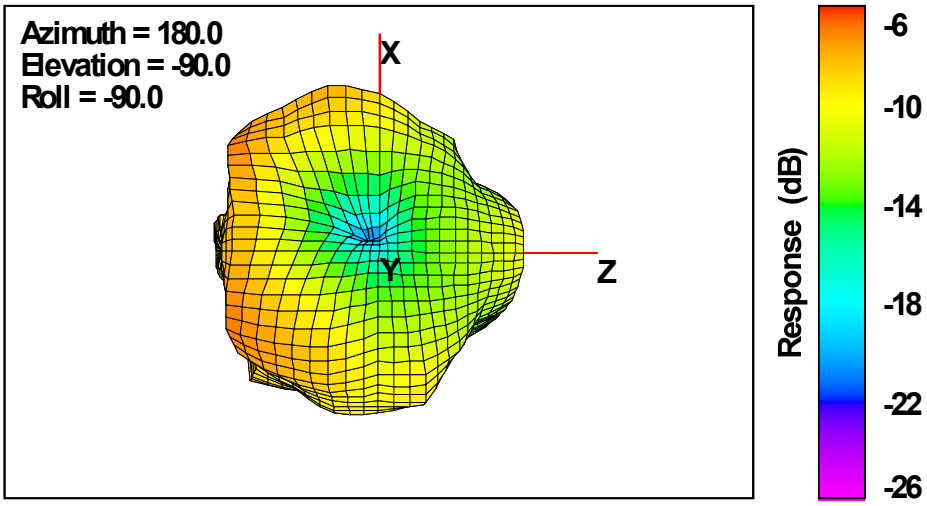

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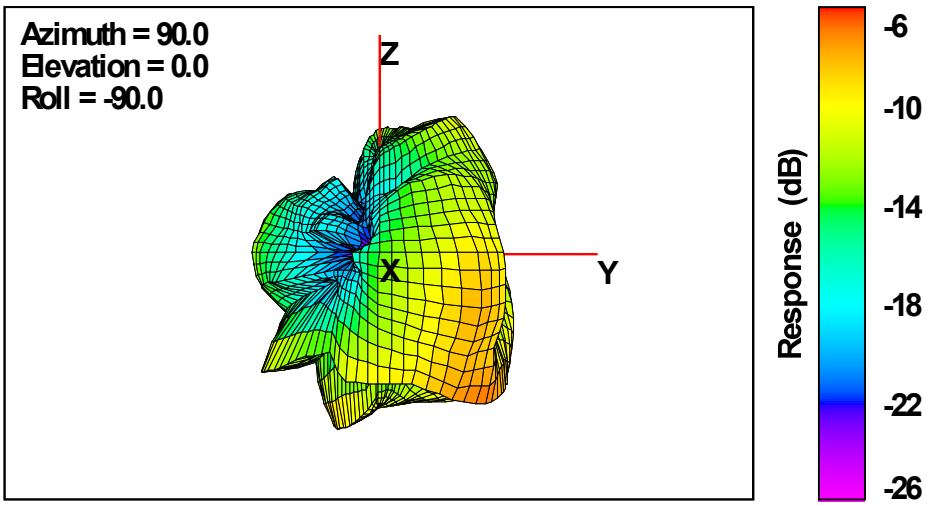

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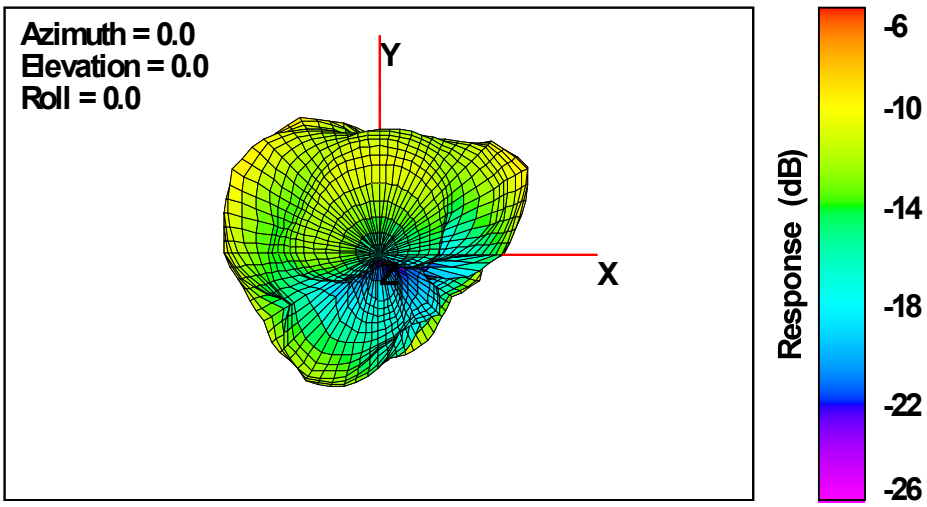

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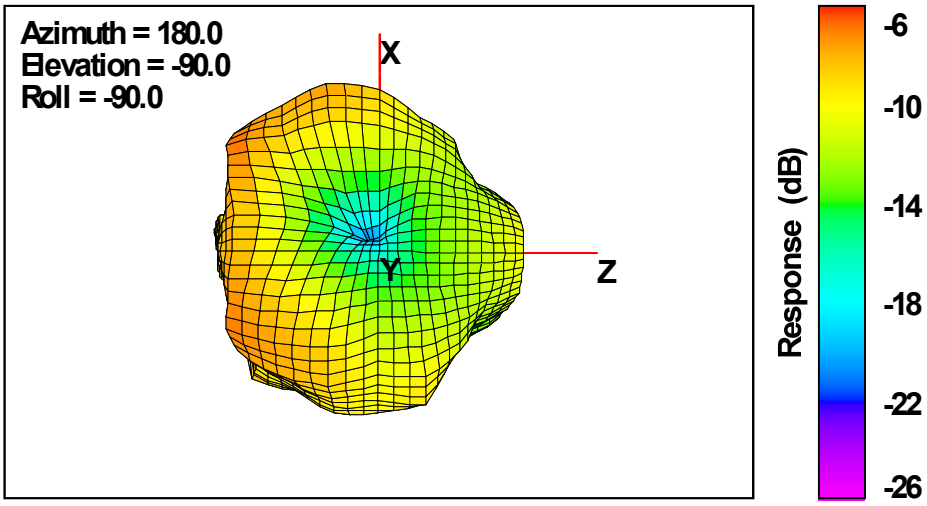

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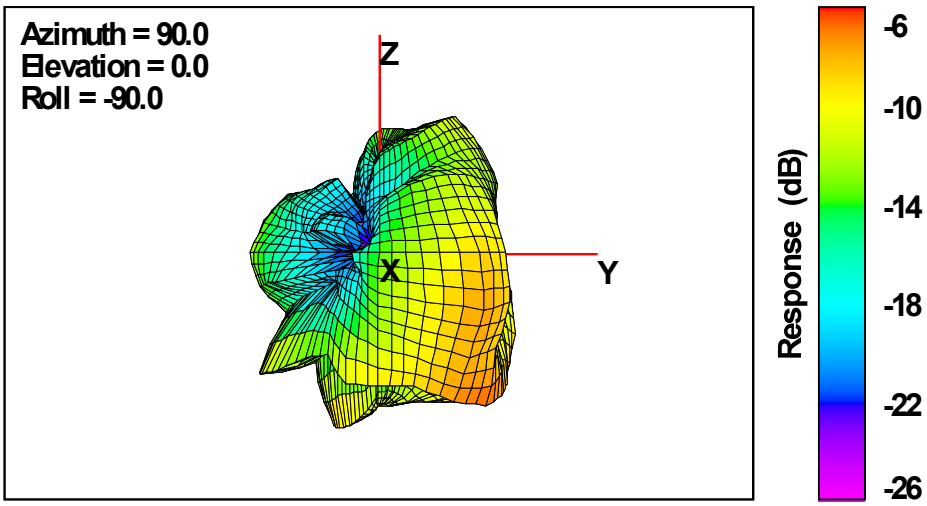

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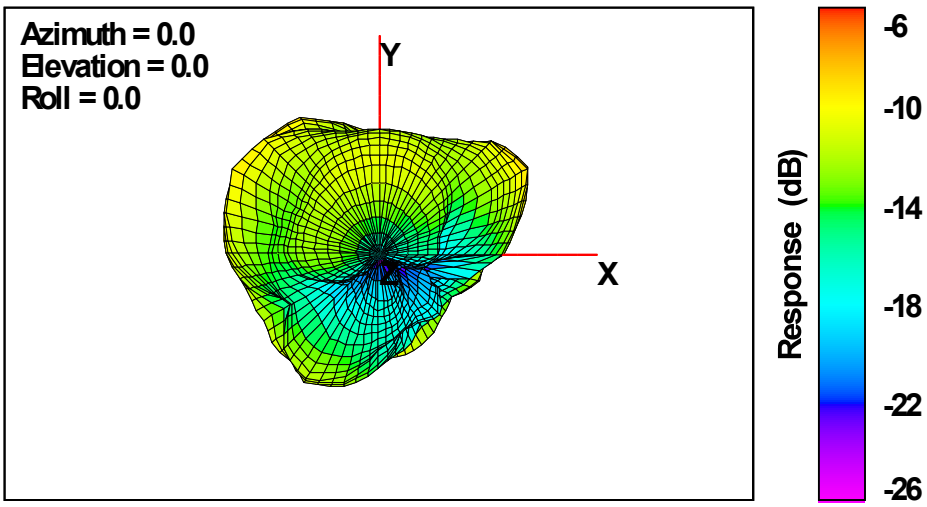

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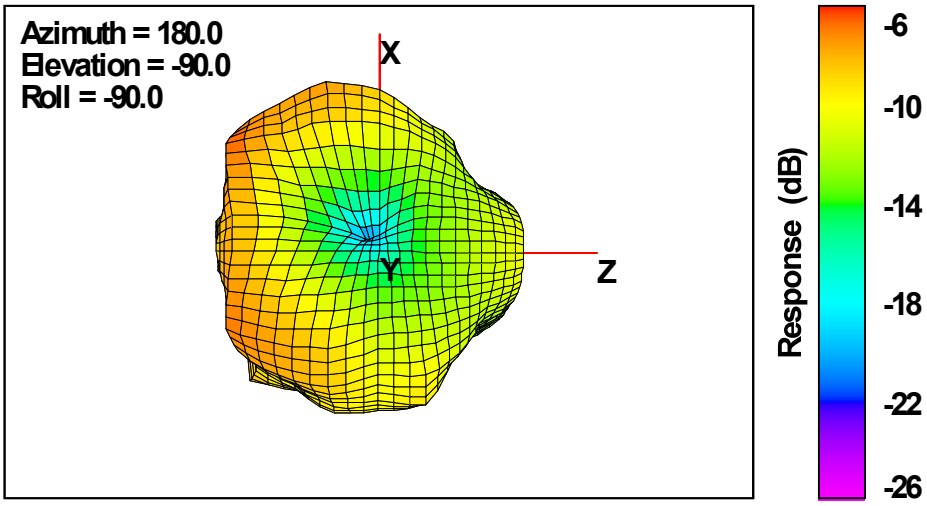

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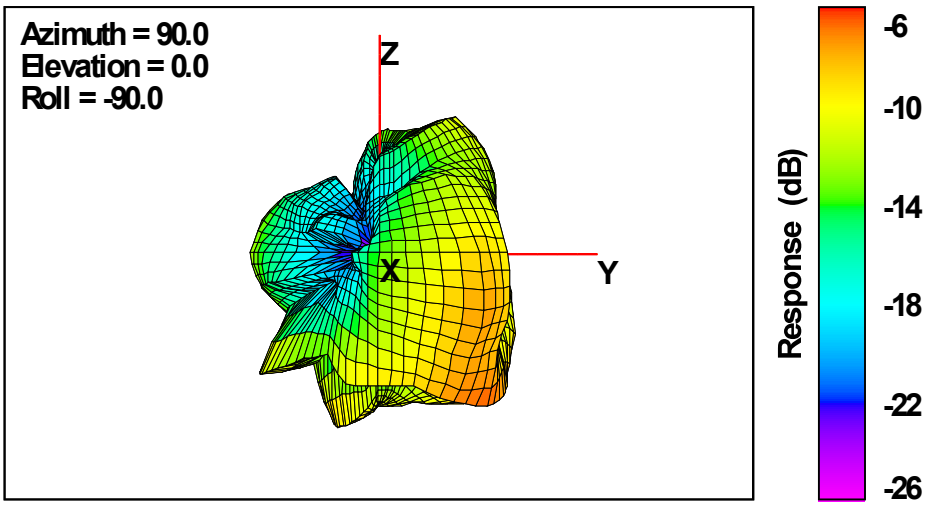

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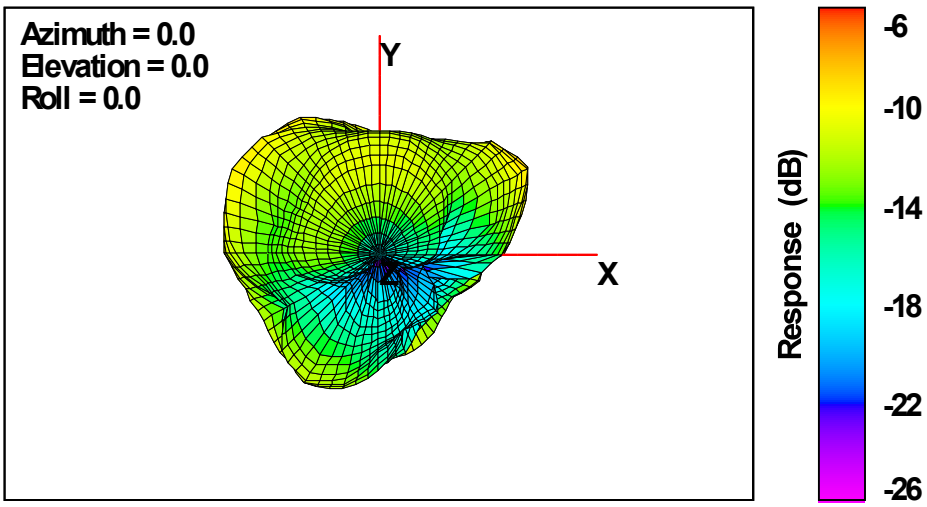

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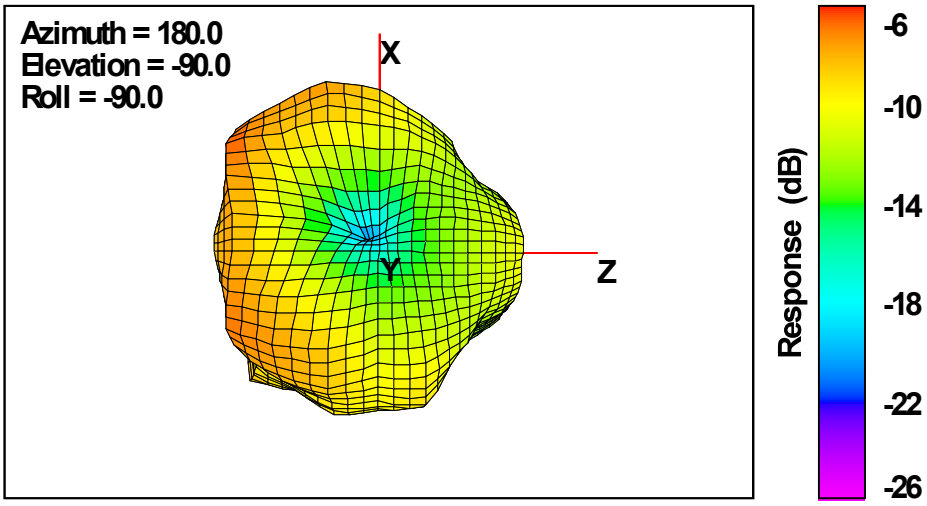

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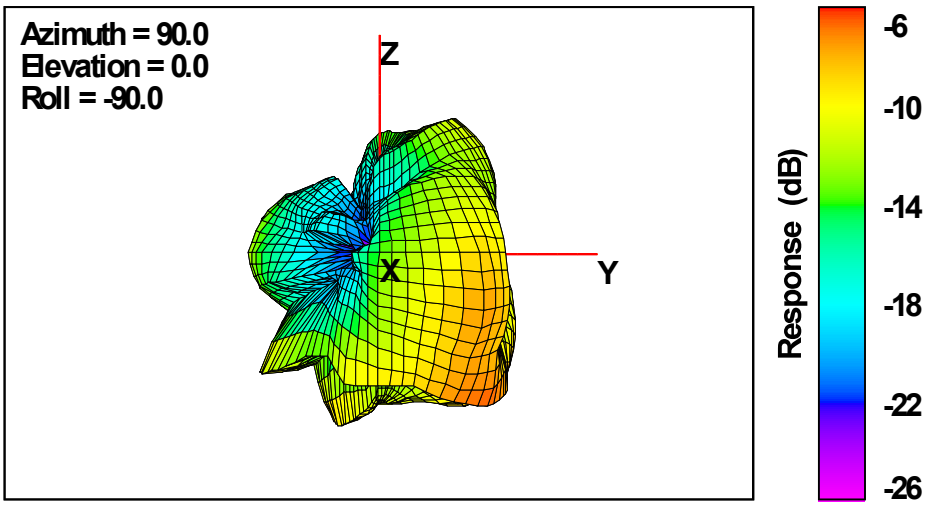

END OF REPORT