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Aperia Gemini Gateway Antenna Report

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REVISION HISTORY

REV	DESCRIPTION	DATE	DATE APPROVED
1.0	Initial Release	8/15/2023	N/A
2.0	Inclusion of the cellular bands B1/3/5/7/8/28B13/66	9/1/2023	
3.0	Updated Bluetooth section Added table of calibrated equipment Added test dates and names of test personnel	3/22/2024	

	Added test software information		
	Added test site information		
4.0	Added Cellular bands 20, 25, and 26	4/3/2024	
4.1	Added the radiation plots for 20,25,26	4/15/2024	

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1. Problem Statement

The Aperia Gemini TPMS gateway implements various embedded and/or custom antennas. Due to the deviation from the evaluation board of each off-the-shelf antenna and the proximity of other device components these antennas may perform differently than stated in their respective datasheets. The following document lists all possible antenna options sorted by radio technology and provides the device's free space radiation properties of each.

2. Test Information

Test Lab

Table 1: Test lab information.

Test	
Date	March 6, 2023
Personnel	Dan Haas/ Adam Presler/ Nicholas Jensen
Software	EMQuest 1.14 build 10265
Site	Element Test site MN10

Test Equipment

Table 2: OTA test equipment.

Description	Manufacturer	Model	Last Calibration	Calibration Due
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Chamber – OTA	ETS Lindgren	AMS-8923-195	2021-04-19	2024-04-19
Analyzer -Network Analyzer	Agilent	E5071C	2022-11-19	2025-11-19
Antenna - Dipole	ETS Lindgren	3126-400/PJ1900	2022-05-17	2025-05-17
Antenna - Dipole	ETS Lindgren	3126-450	2023-02-14	2026-02-14
Antenna - Dipole	ETS Lindgren	3126-2150	2023-02-15	2026-02-15
Antenna - Dipole	ETS Lindgren	3126-2450	2021-04-08	2024-04-08
Antenna – Double Ridge	ETS Lindgren	3115	2021-08-31	2023-08-31

3. Bluetooth

The Bluetooth radio utilizes three antennas that can be connected one at a time. The device uses two embedded chip antennas in a diversity configuration or one external whip antenna. The external whip antenna has the highest gain and is therefore the antenna used for certifications. The other two antennas will fall under the certification of the device with less gain and efficiency.

Whip Antenna: This antenna is used in accordance with the manufacture's instructions and testing. Hence, the datasheet can be used to determine the given parameters below.

Table 3: External Bluetooth antenna information.

Manufacturer	Taoglas
Manufacturer Part Number	GW.34.5153
Peak Gain (Bent)	5.89 dBi

Average Gain (Bent)	-0.8 dBi
Peak Gain (Straight)	4.22 dBi
Average Gain (Straight)	-1.05 dBi

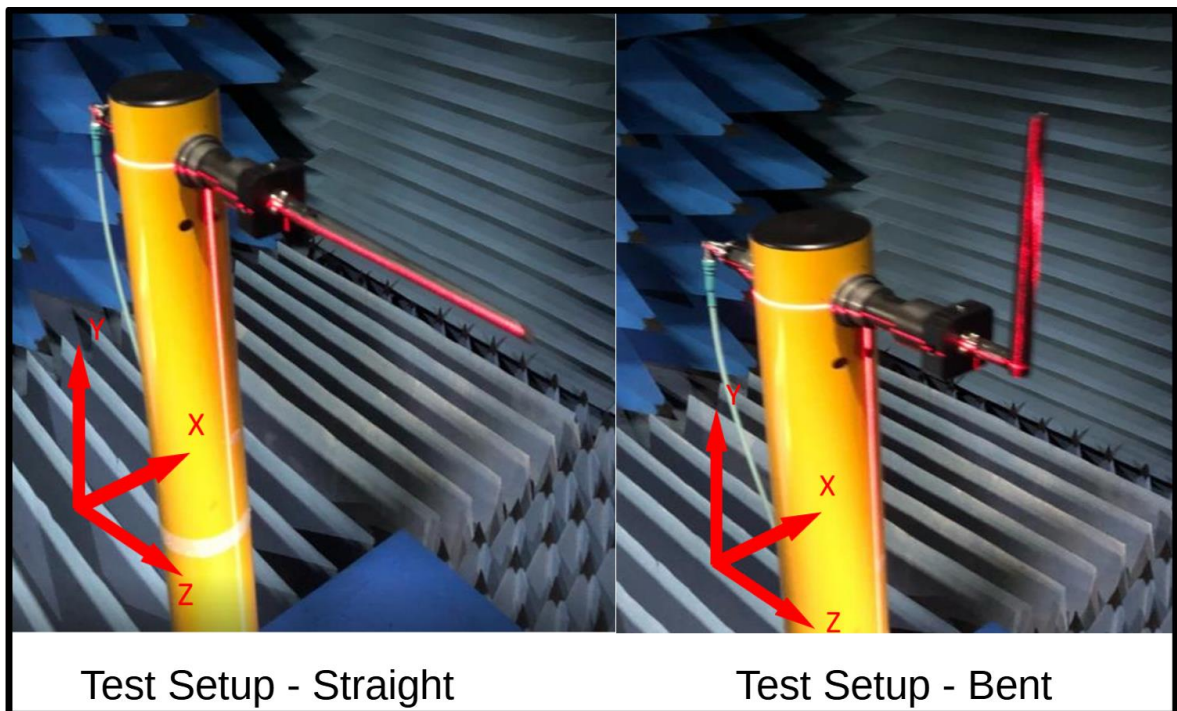


Figure 1: External Bluetooth Whip antenna test setup.

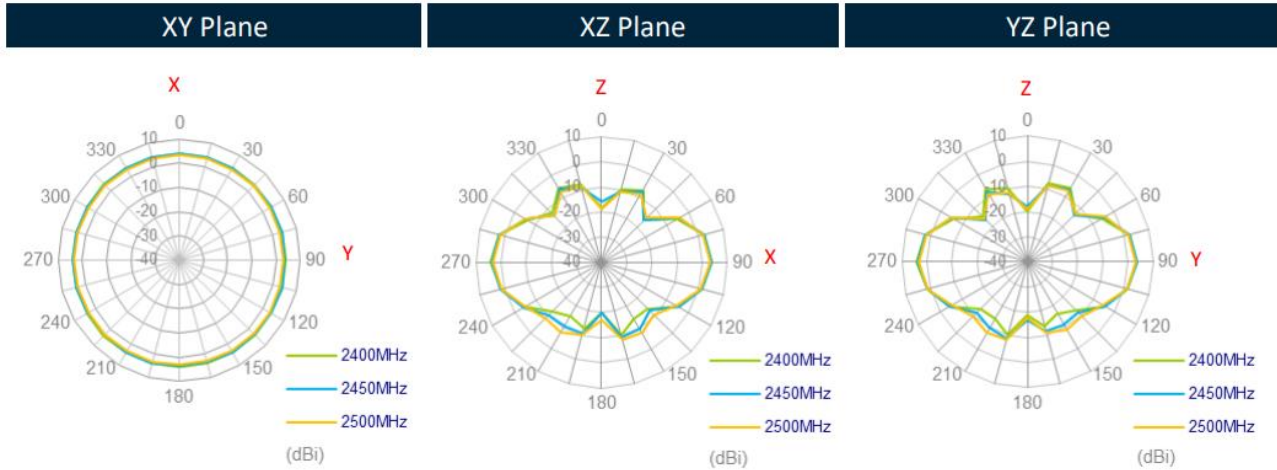


Figure 2: Polar plots for the whip antenna in a straight configuration.

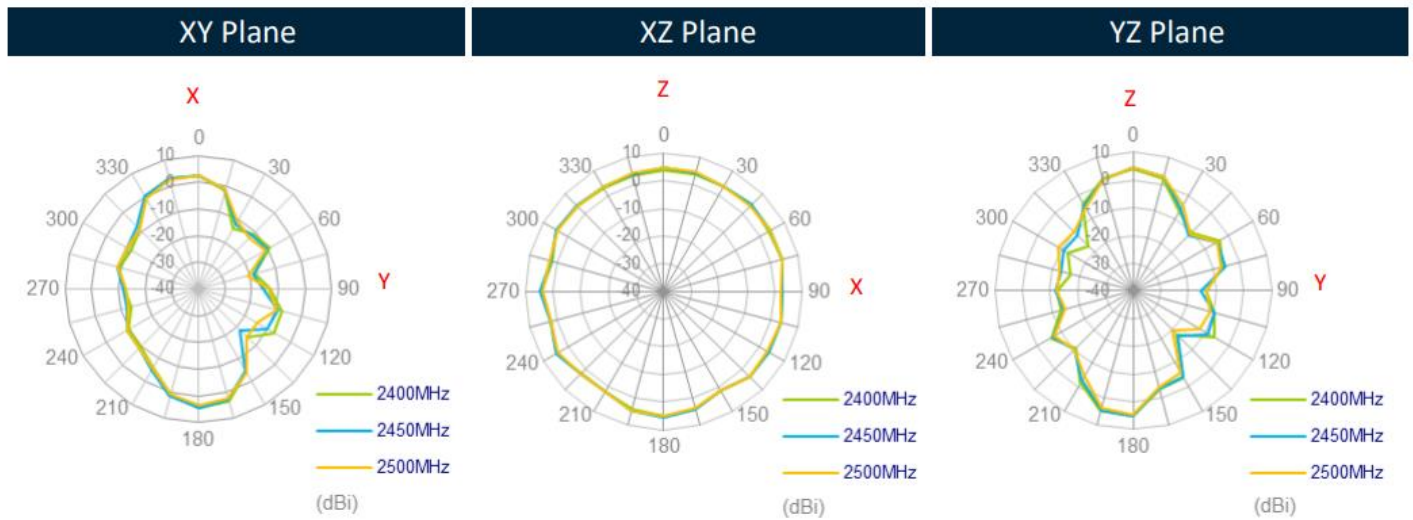


Figure 3: Polar plots for the whip antenna in a bent configuration.

Primary Embedded Ceramic Antenna:

Table 4: Primary Bluetooth antenna information.

Manufacturer	Taoglas
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Manufacturer Part Number	WLA.01
Peak Gain	2.57 dBi
Average Gain	-1.49 dBi

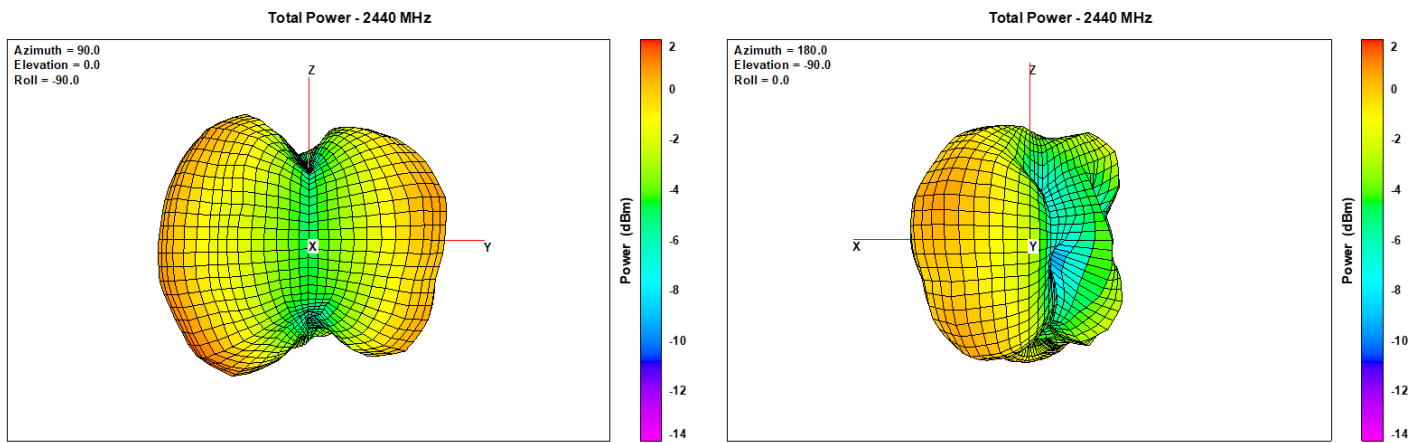


Figure 4: Radiation pattern for the WLA.01 in free space at 2.44 GHz.

Secondary Embedded Ceramic Antenna:

Table 5: Secondary Bluetooth antenna information.

Manufacturer	Taoglas
Manufacturer Part Number	GWLA.05
Peak Gain	1.70 dBi
Average Gain	-2.87 dBi

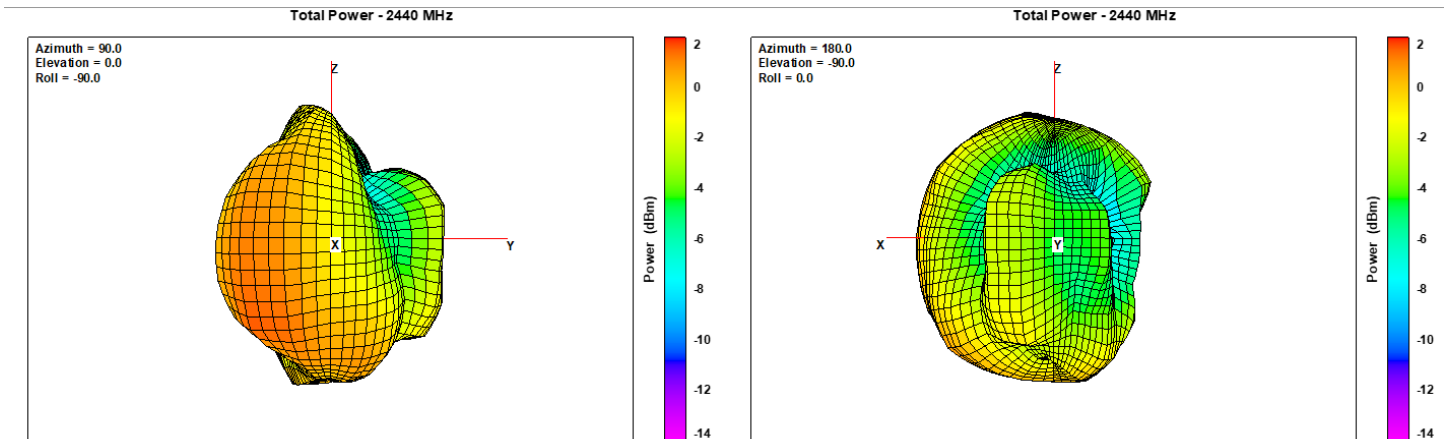


Figure 5: Radiation pattern for the GWLA.05 in free space at 2.44 GHz.

4. Cellular

The cellular radio has only one possible configuration. The cell utilizes an embedded ceramic chip antenna.

Table 6: Cellular antenna information/

Manufacturer	Taoglas
Manufacturer Part Number	PCS.06

Table 7: Gain per band

Band	Peak Gain (dBi)	Average Gain (dBi)
1	4.8	-0.2
2	4.82	-0.19
3	4.69	-1.04

4	4.69	-1.04
5	-1.81	-6.56
7	< 3.5	< -3
8	-2.18	-6.18
12	2.64	-3.27
13	2.64	-3.27
20	2.22	-2.11
25	4.69	-1.61
26	2.22	-2.11
28	2.64	-3.27
66	4.69	-1.04

The following is the reference image for the cellular radiation plots. Note: the green tape marks the location of the cellular antenna.

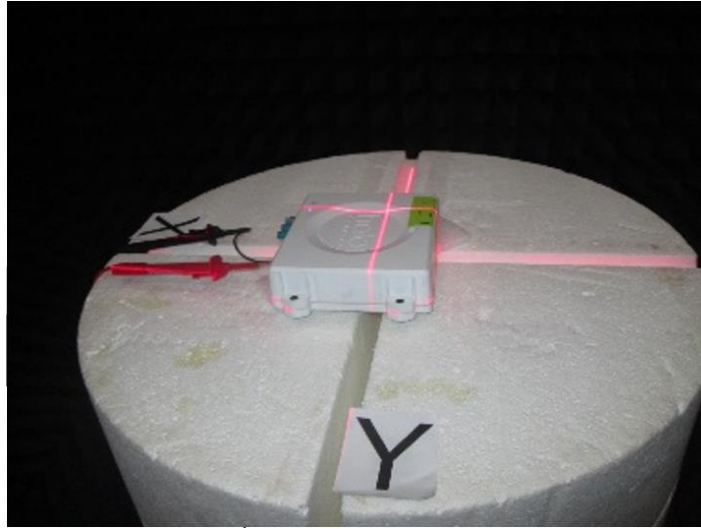


Figure 6: The reference image for the cellular radiation plots.

Band 1 (1950MHz) DS

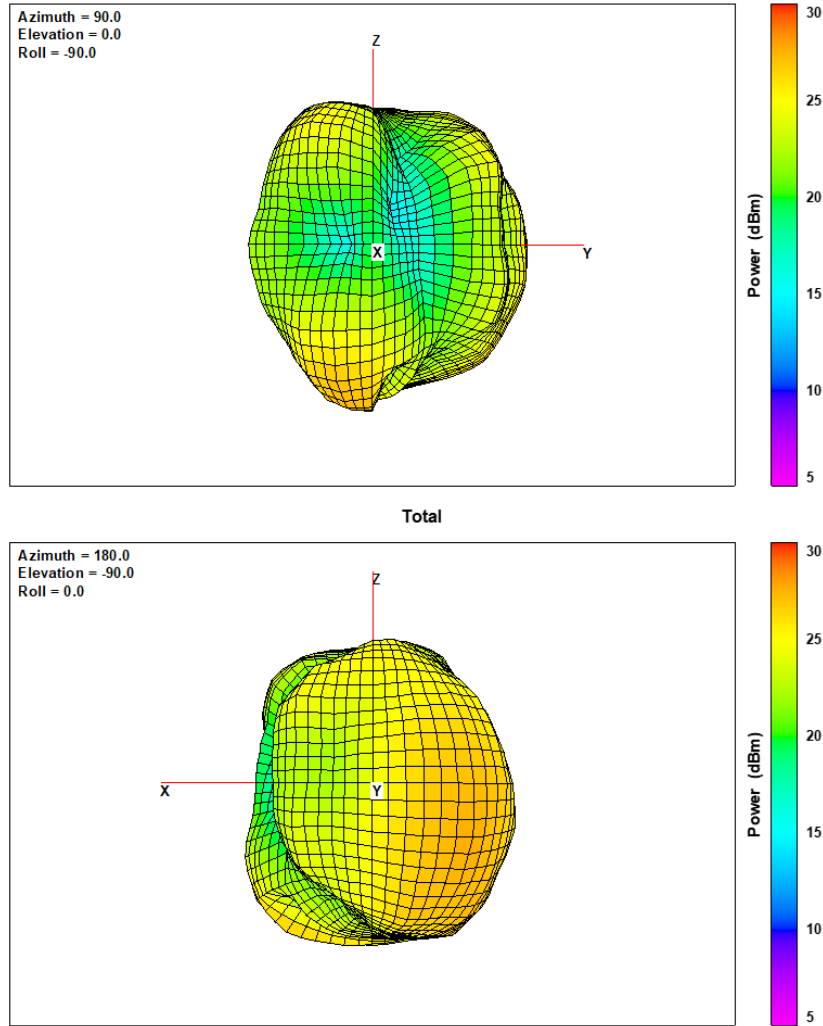


Figure 7: Band 1 radiation pattern.

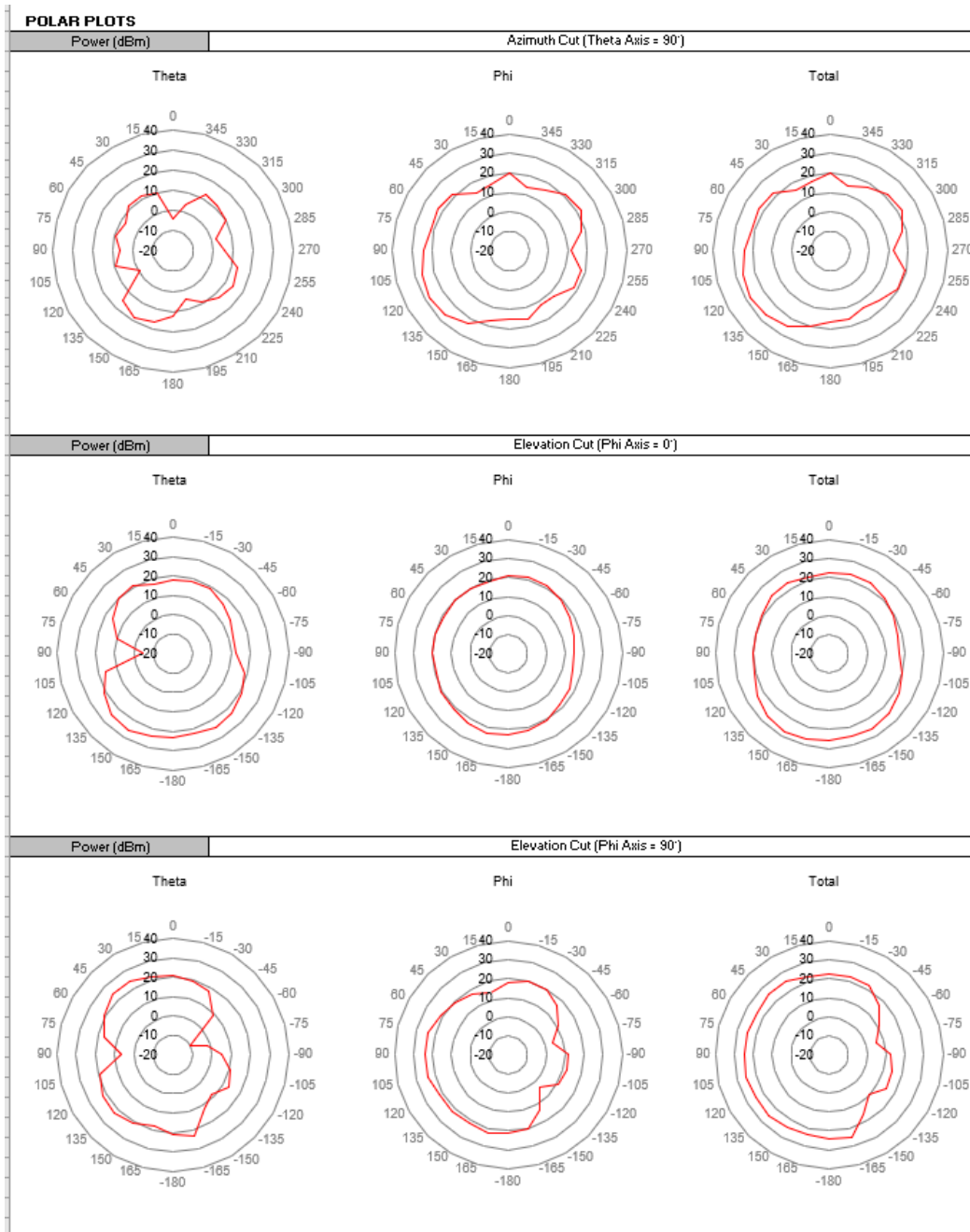


Figure 8: Band 1 polar plots.

Band 2 (1880MHz)

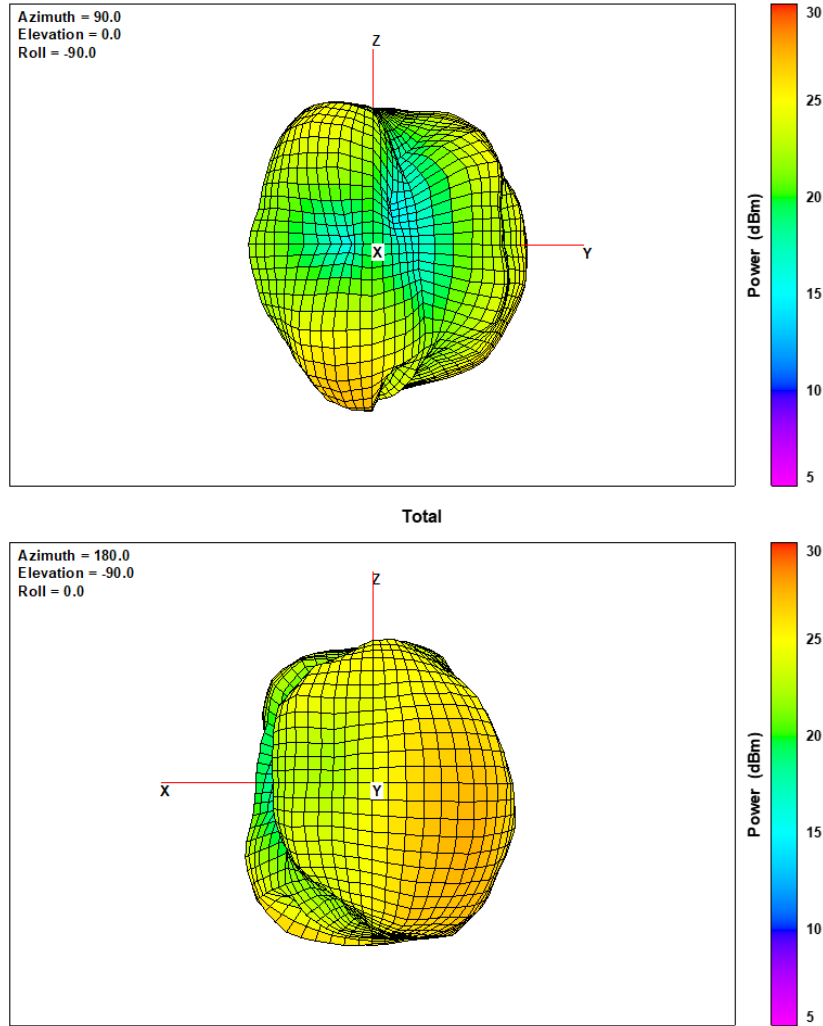


Figure 9: Band 2 radiation pattern.

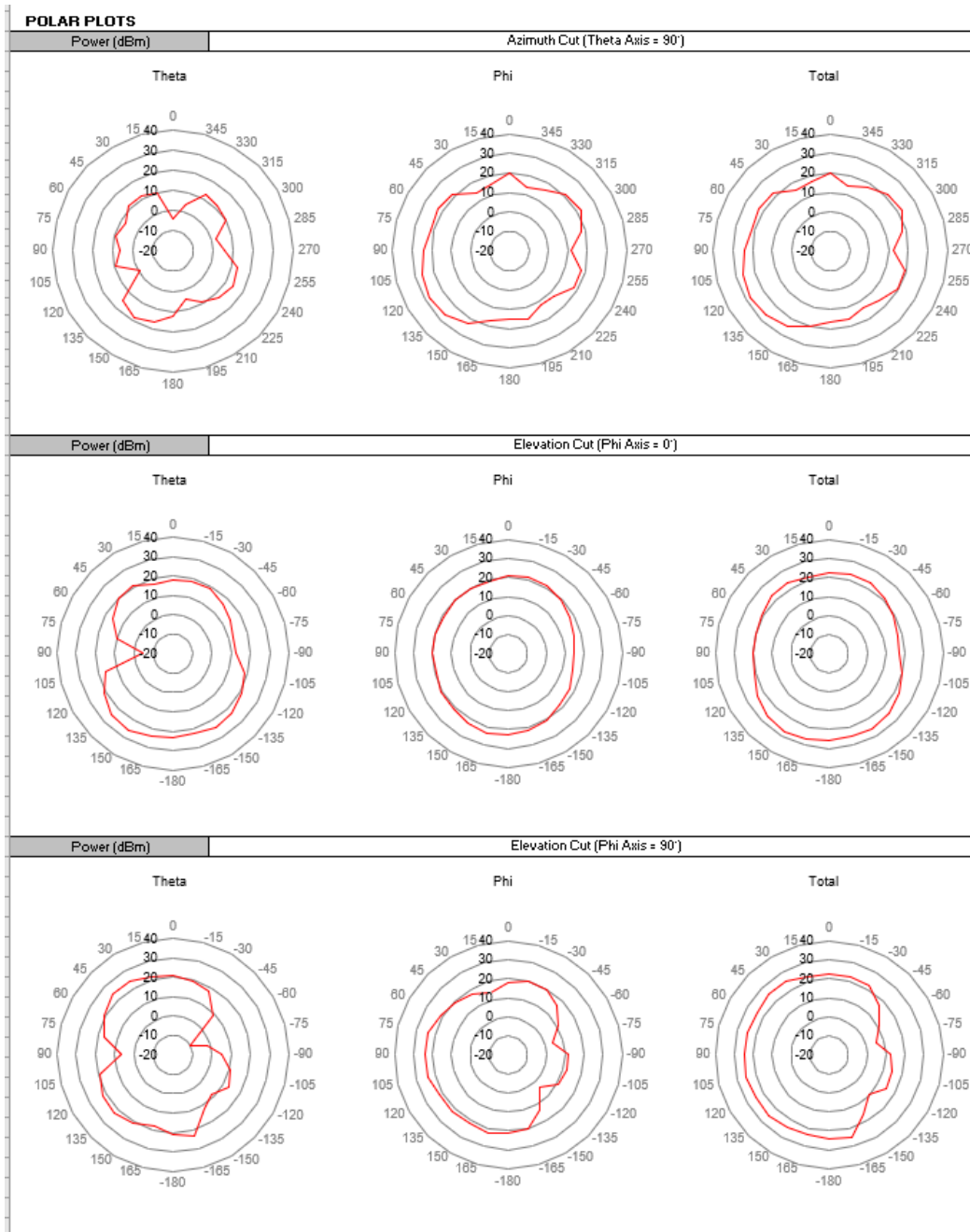


Figure 10: Band 2 polar plots.

Band 3 (1737.5MHz)

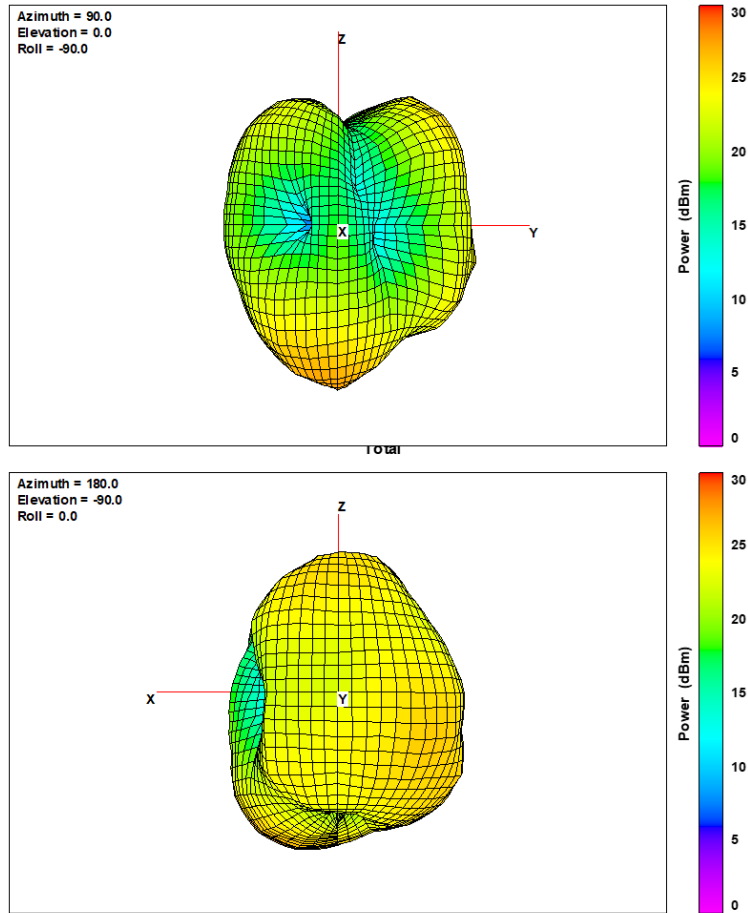


Figure 11: Band 3 radiation pattern.

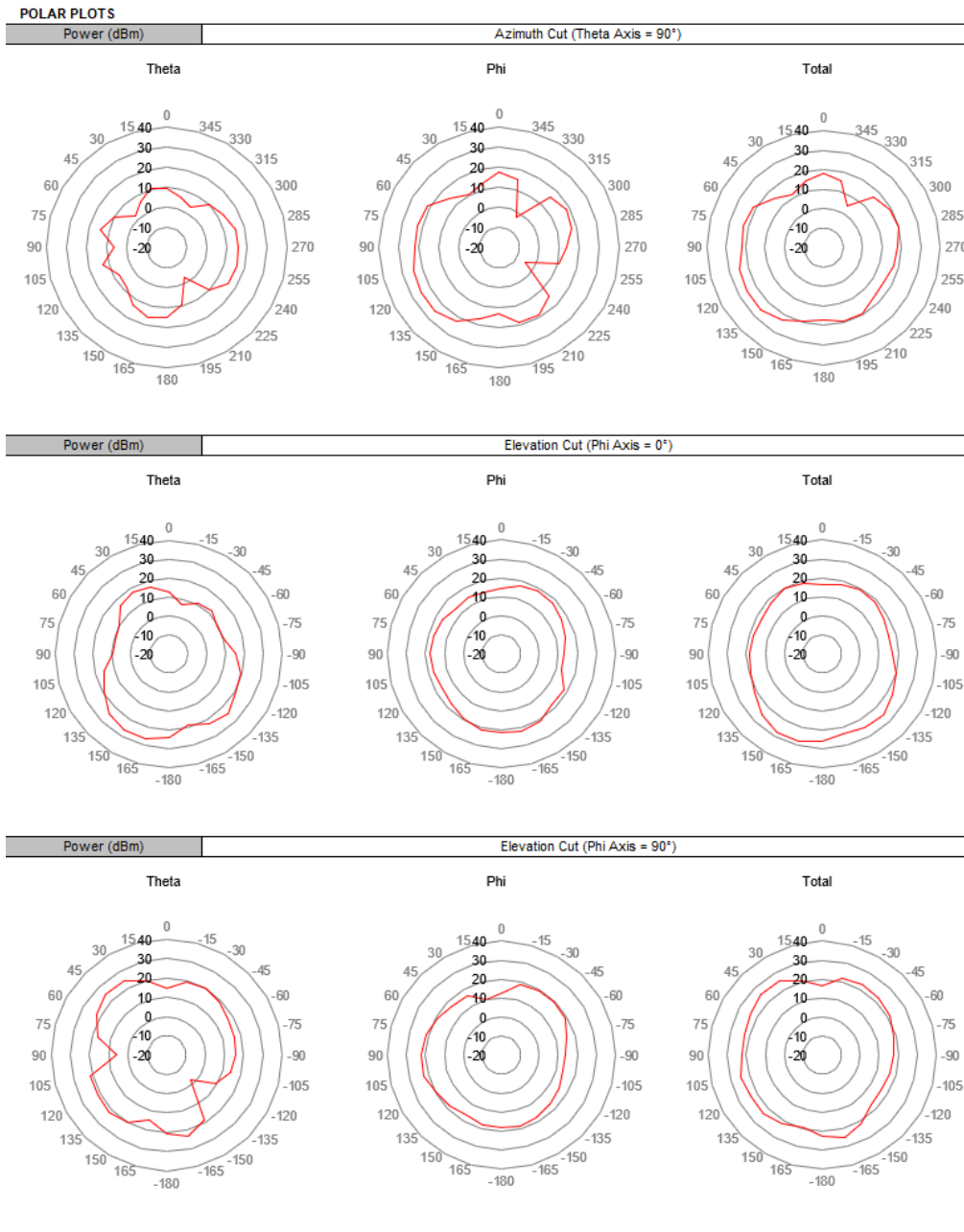


Figure 12: Band 3 polar plots.

Band 4 (1732.5MHz)

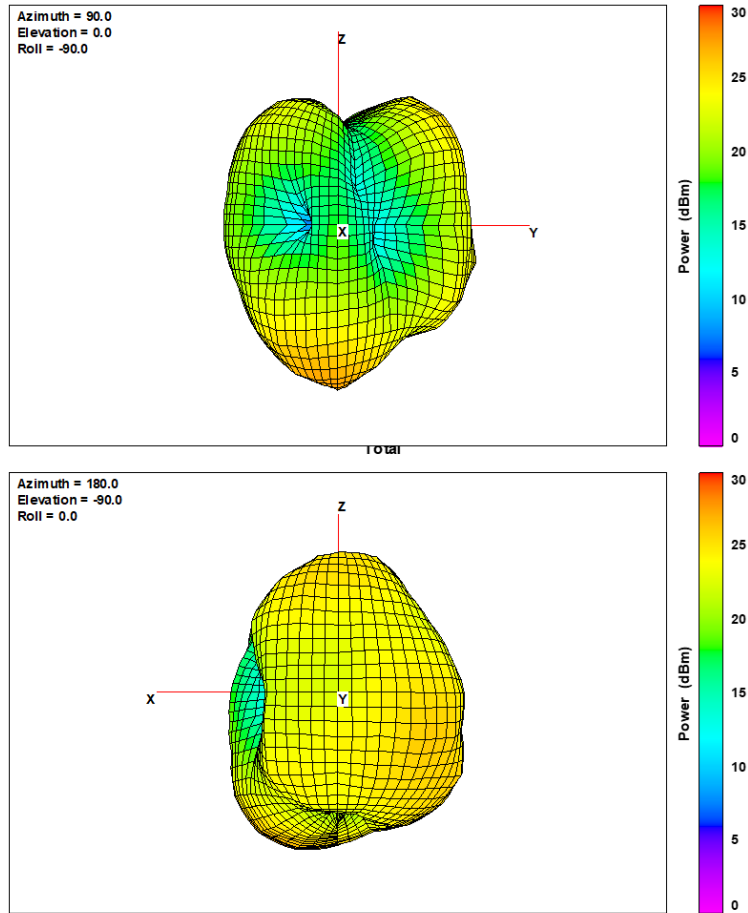


Figure 13: Band 4 radiation pattern.

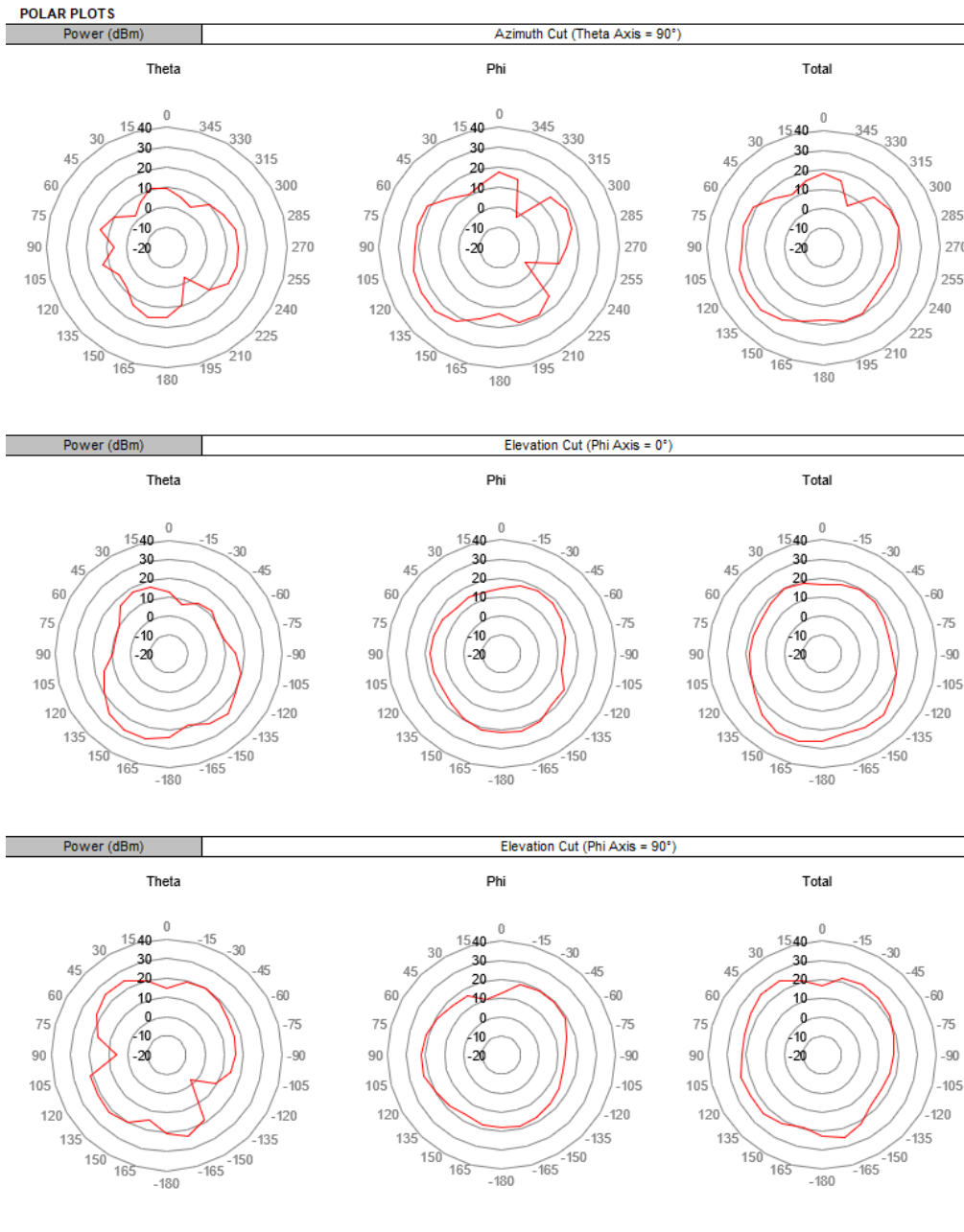


Figure 14: Band 4 polar plots.

Band 5 (836.5 MHz) DS

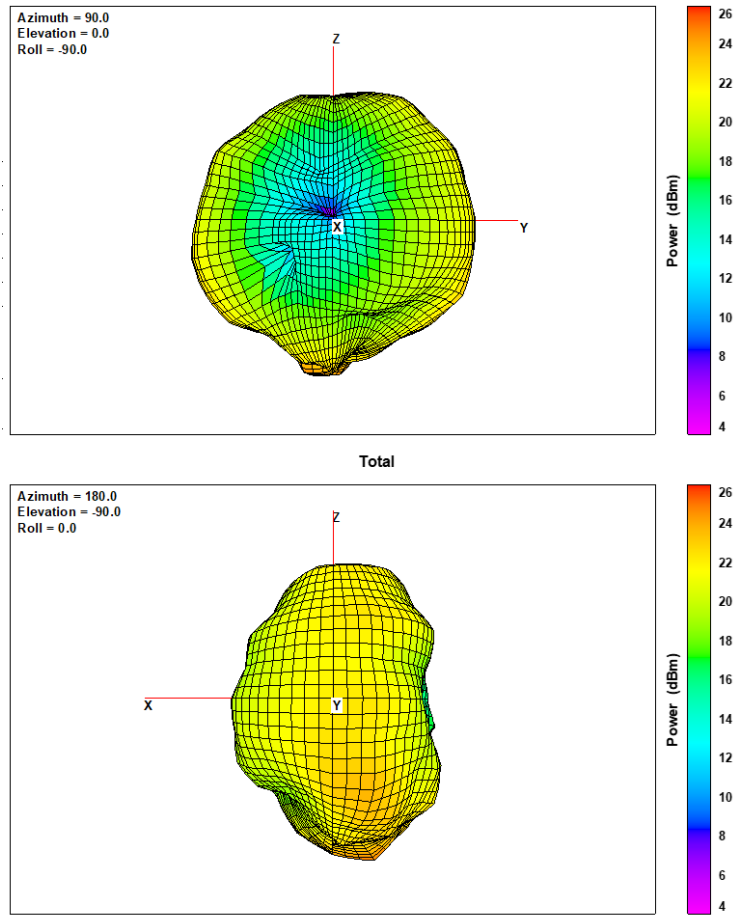


Figure 15: Band 5 radiation pattern.

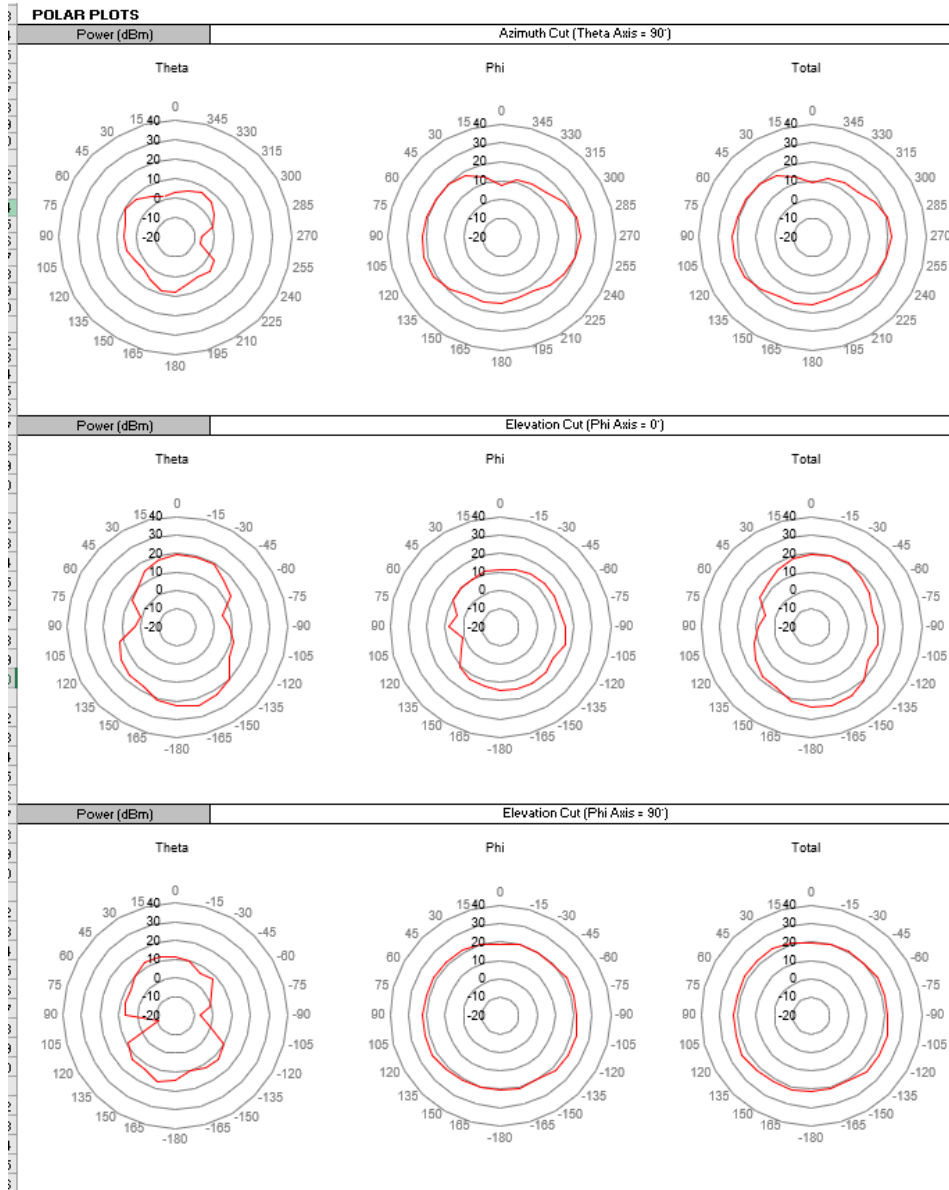


Figure 16: Band 5 polar plots.

Band 7 (2535MHz) DS

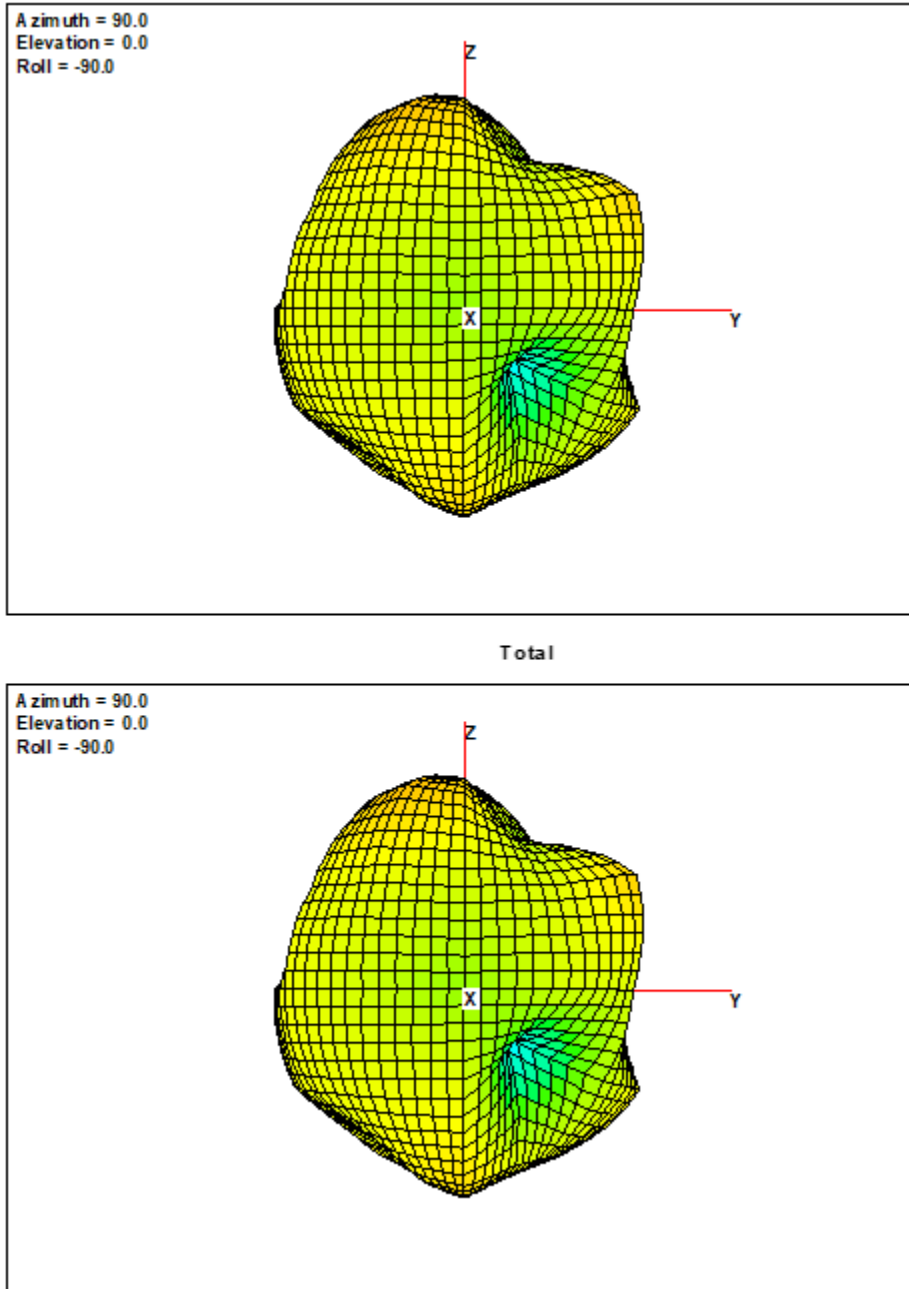
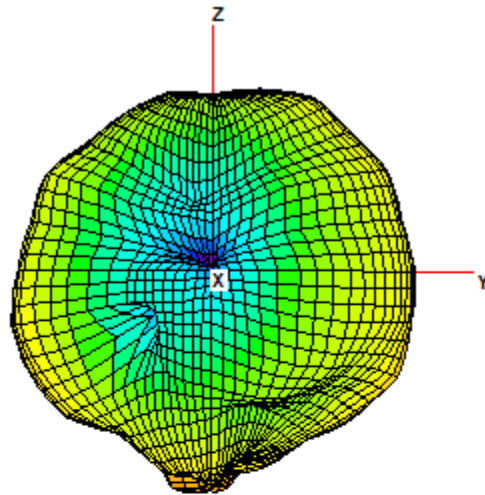


Figure 17: Band 7 radiation pattern.

Band 8 (897.5MHz) DS

Azimuth = 90.0
Elevation = 0.0
Roll = -90.0



Total

Azimuth = 180.0
Elevation = -90.0
Roll = 0.0

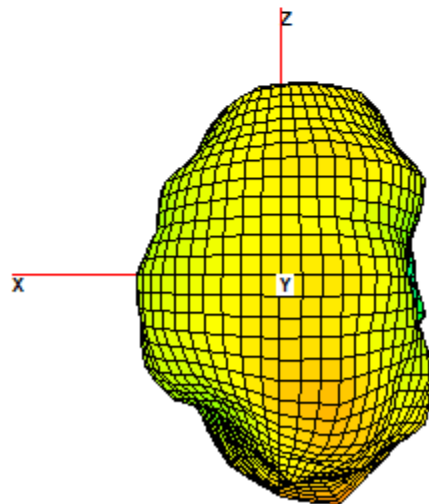


Figure 18: Band 8 radiation pattern.

Band 12 (707.68 MHz)

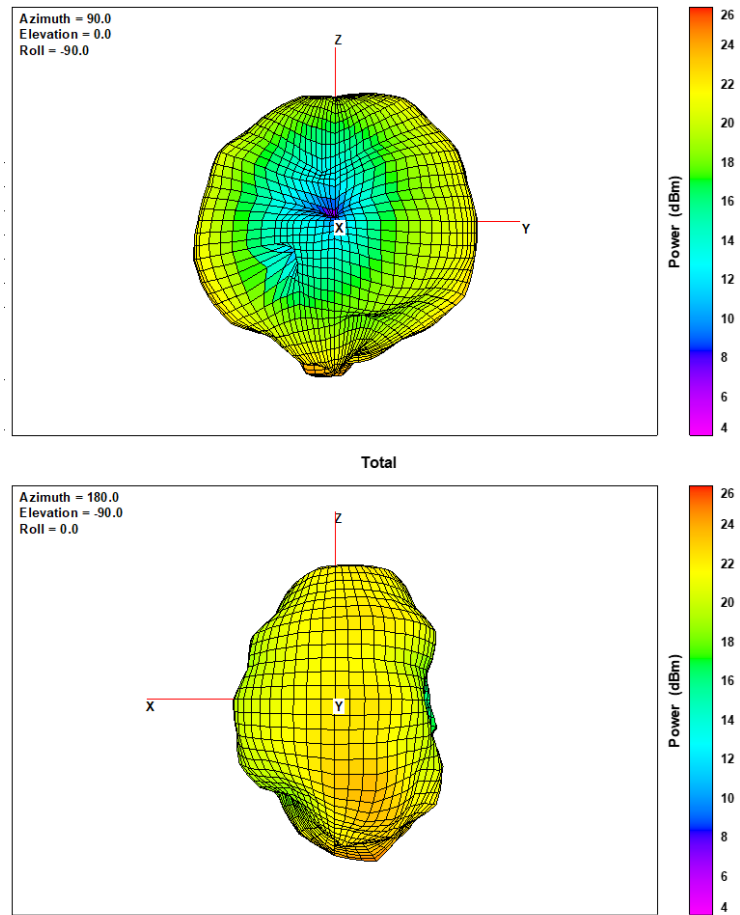


Figure 19: Band 12 radiation pattern.

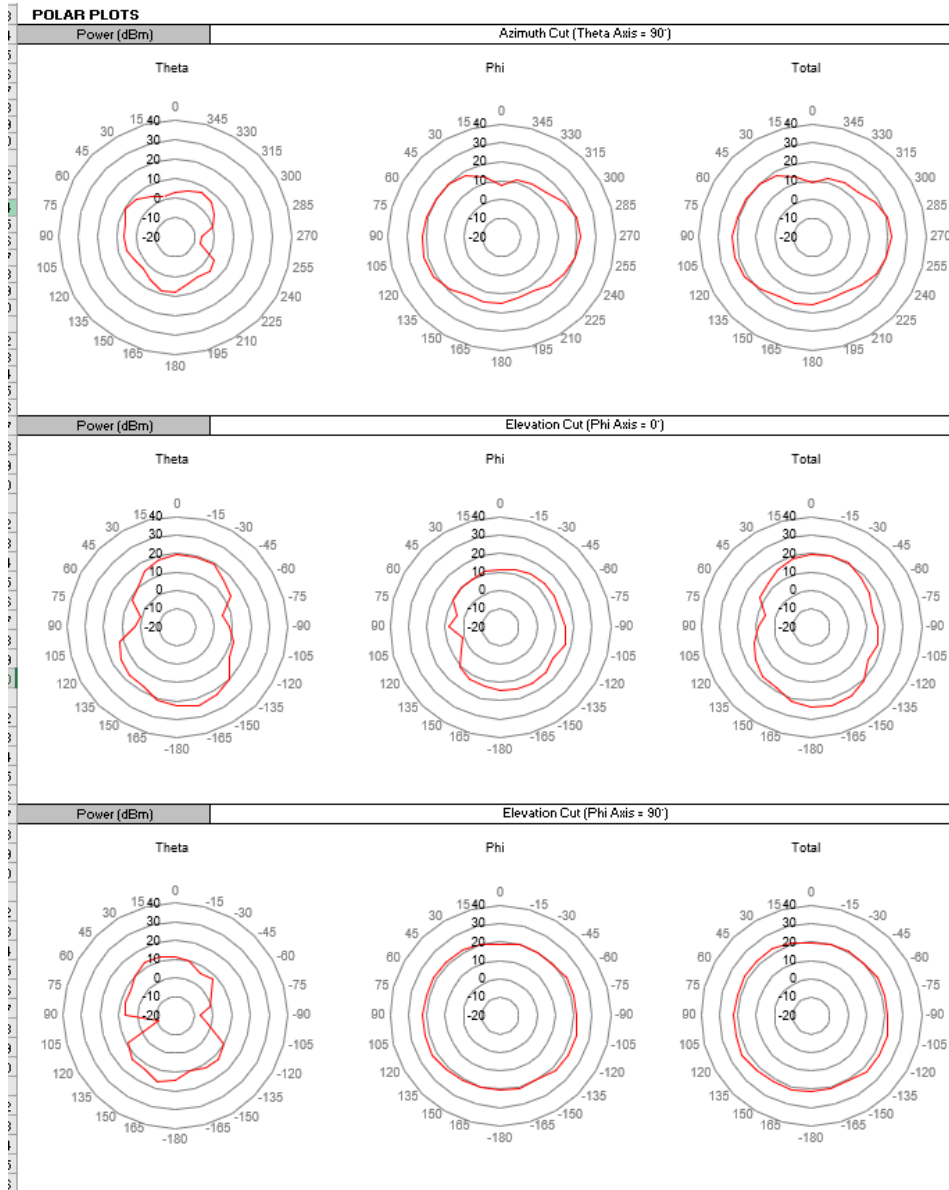
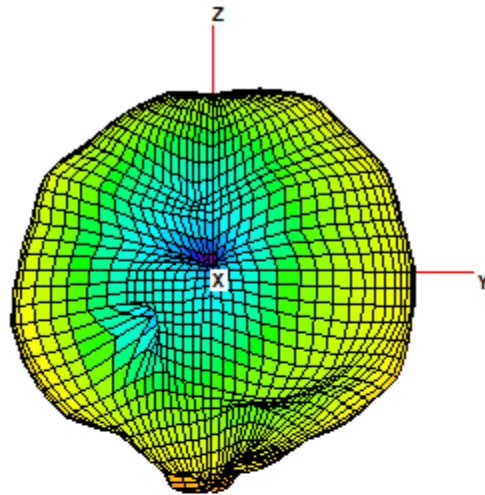


Figure 20: Band 12 polar plots.

Band 13 (782MHz)

Azimuth = 90.0
Elevation = 0.0
Roll = -90.0



Total

Azimuth = 180.0
Elevation = -90.0
Roll = 0.0

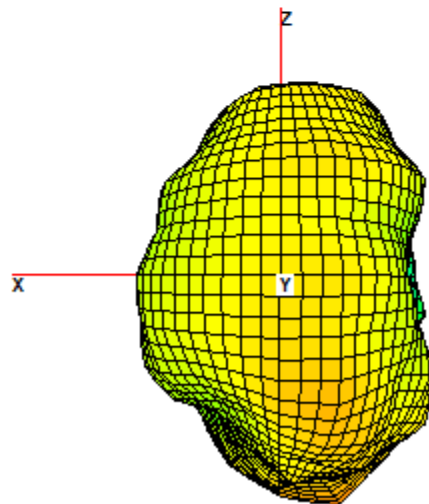


Figure 21: Band 13 radiation pattern.

Band 20 (836.5 MHz) DS

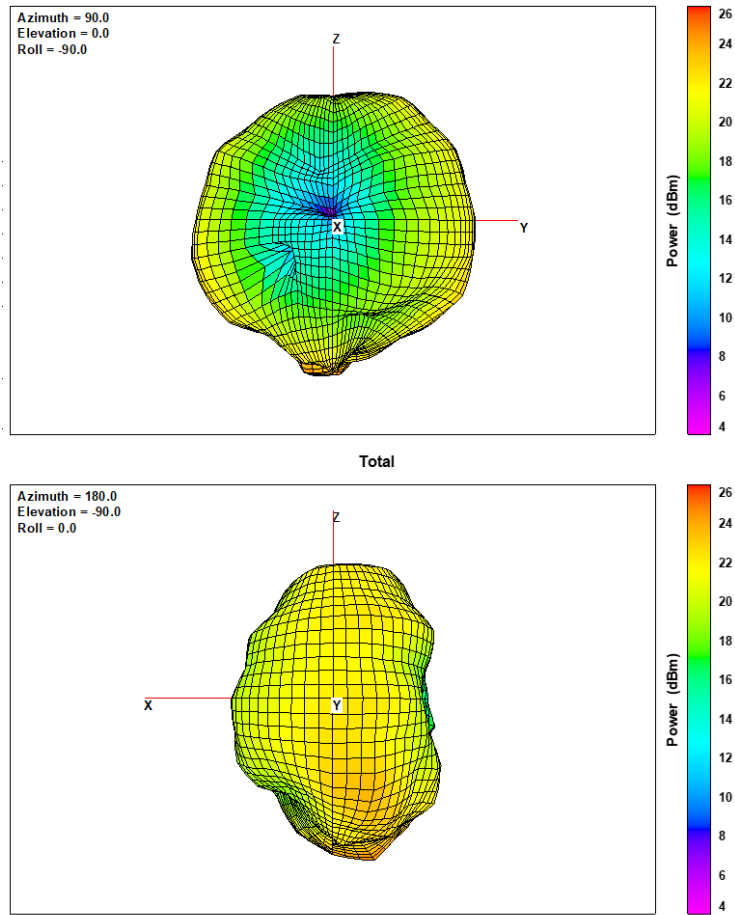


Figure 22: Band 20 radiation pattern.

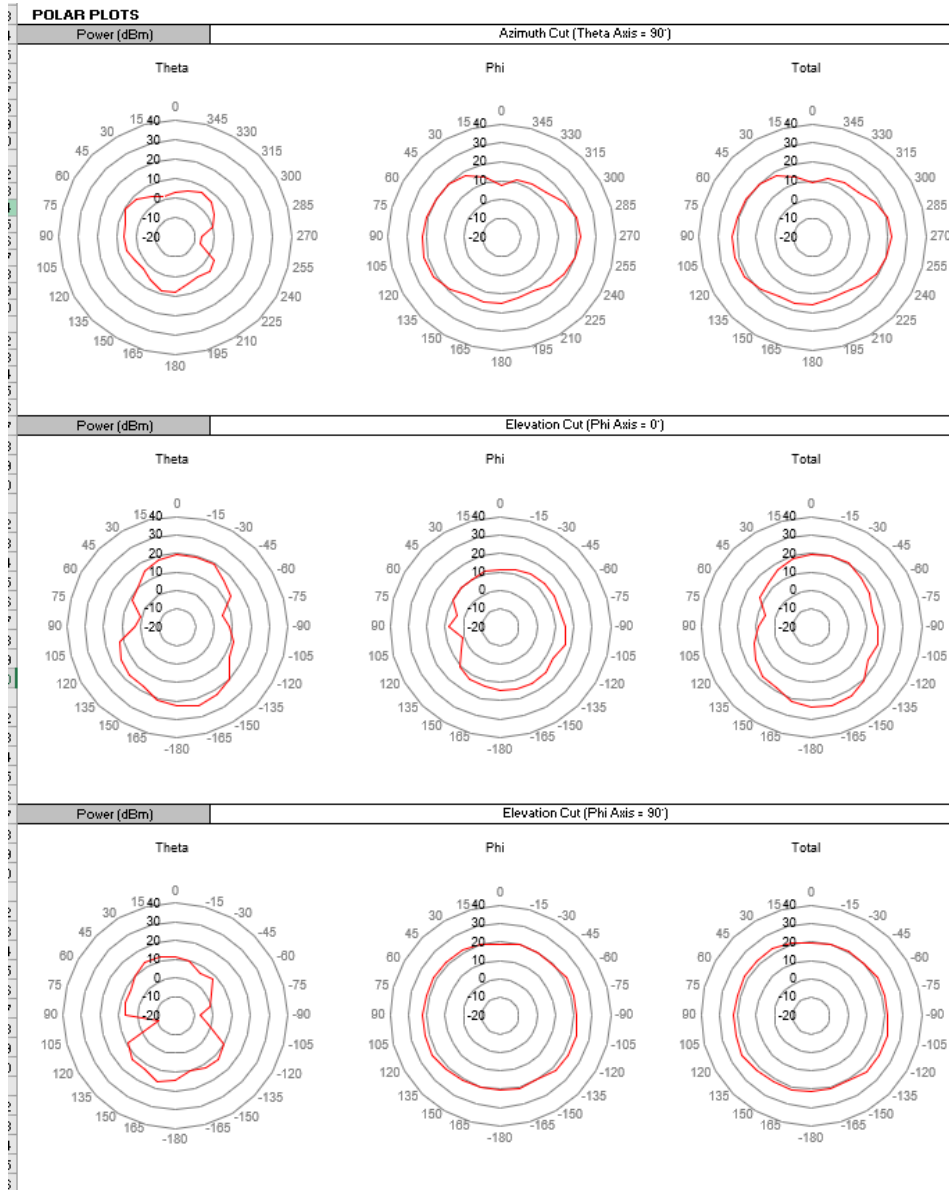


Figure 23: Band 20 polar plots.

Band 25 (1880MHz)

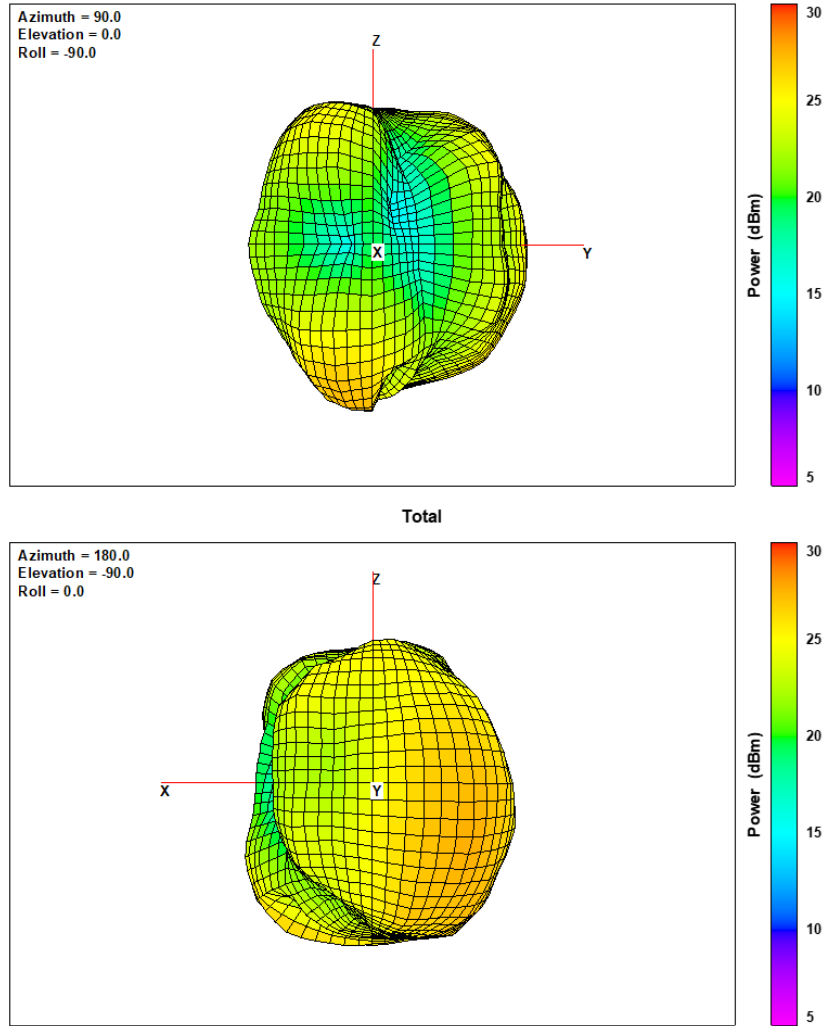


Figure 24: Band 25 radiation pattern.

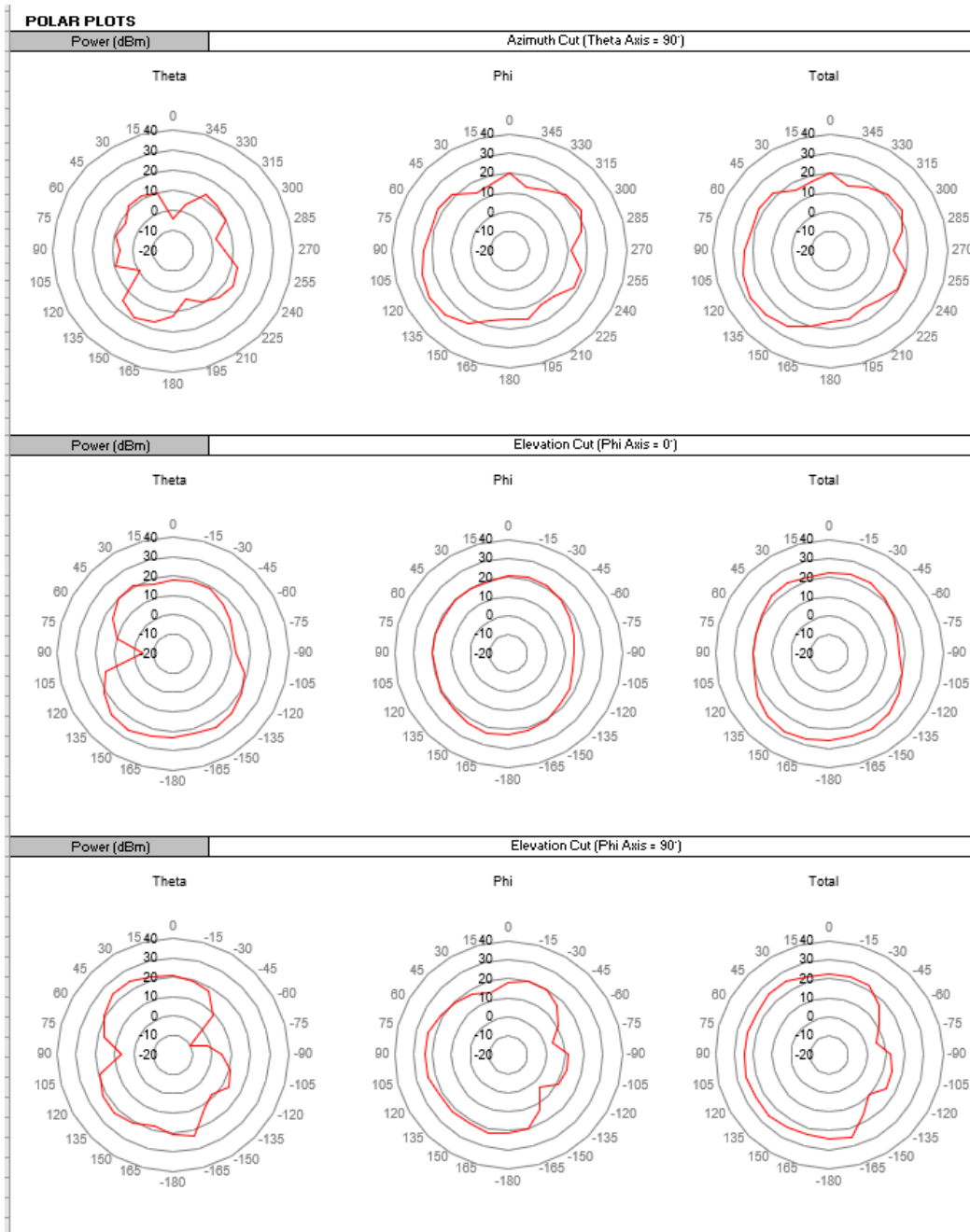


Figure 25: Band 25 polar plots.

Band 26 (836.5 MHz) DS

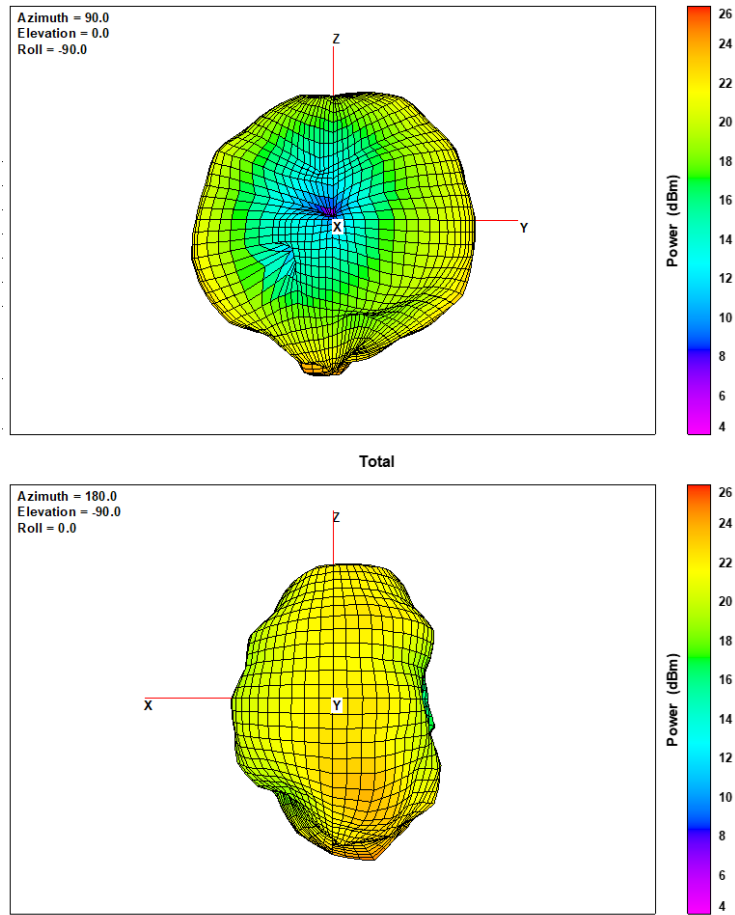


Figure 26: Band 26 radiation pattern.

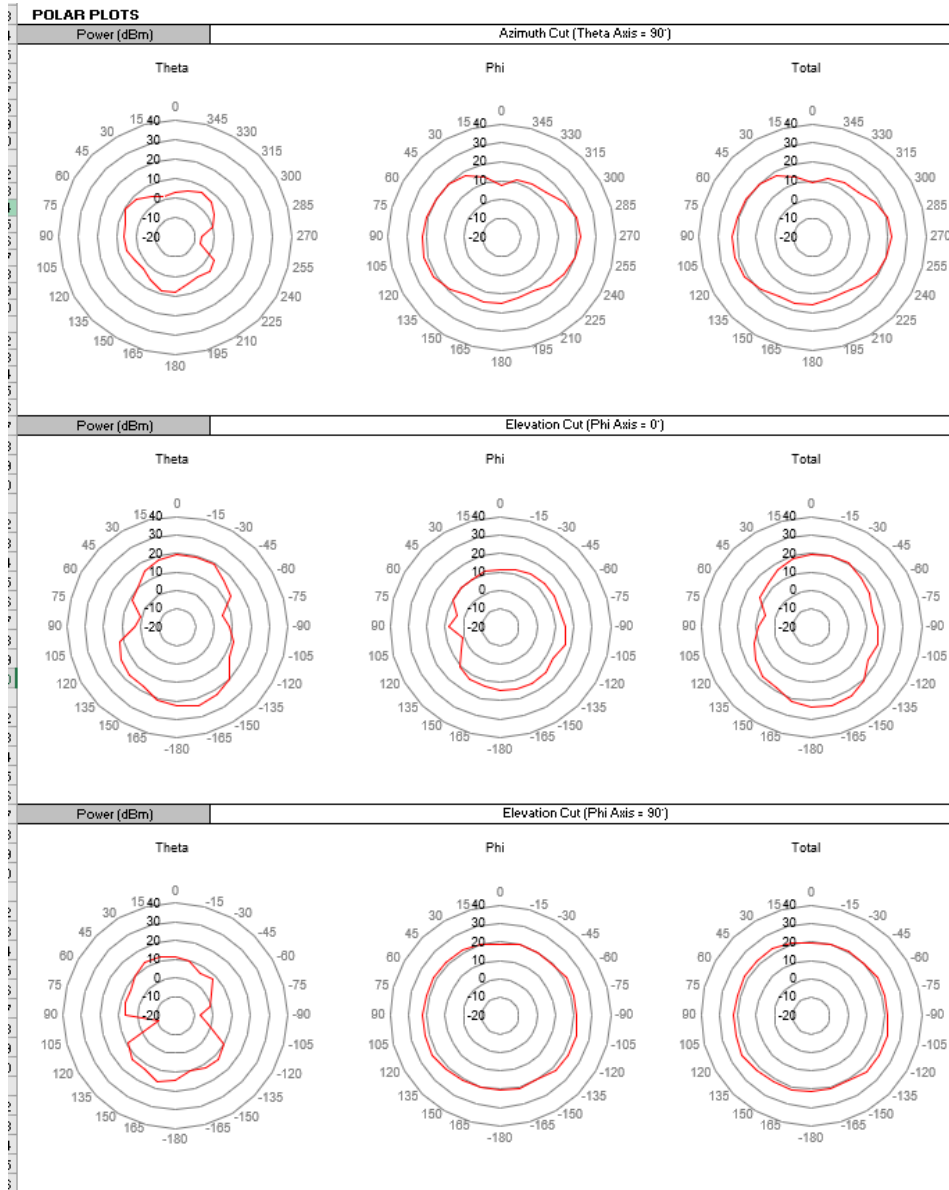
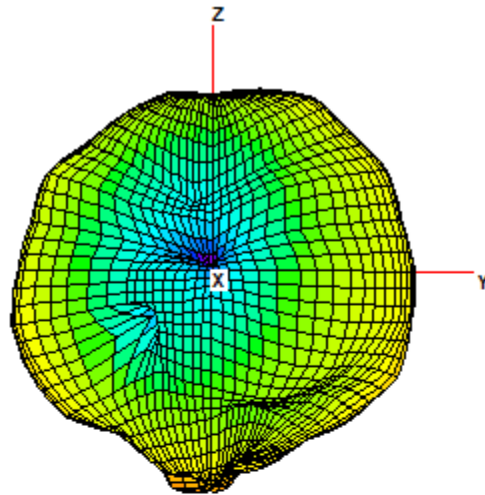


Figure 27: Band 26 polar plots.

Band 28 (725.5MHz)

Azimuth = 90.0
Elevation = 0.0
Roll = -90.0



Total

Azimuth = 180.0
Elevation = -90.0
Roll = 0.0

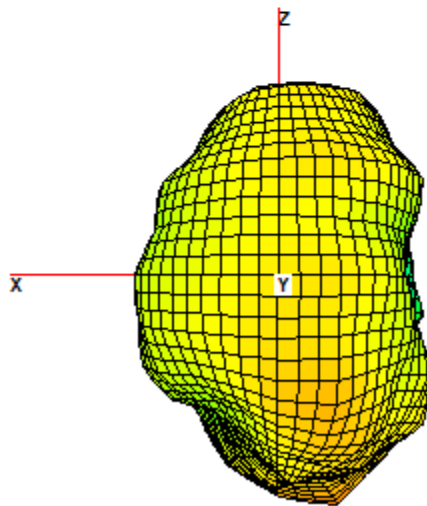


Figure 28: Band 28 radiation pattern.

Band 66 (1745MHz)

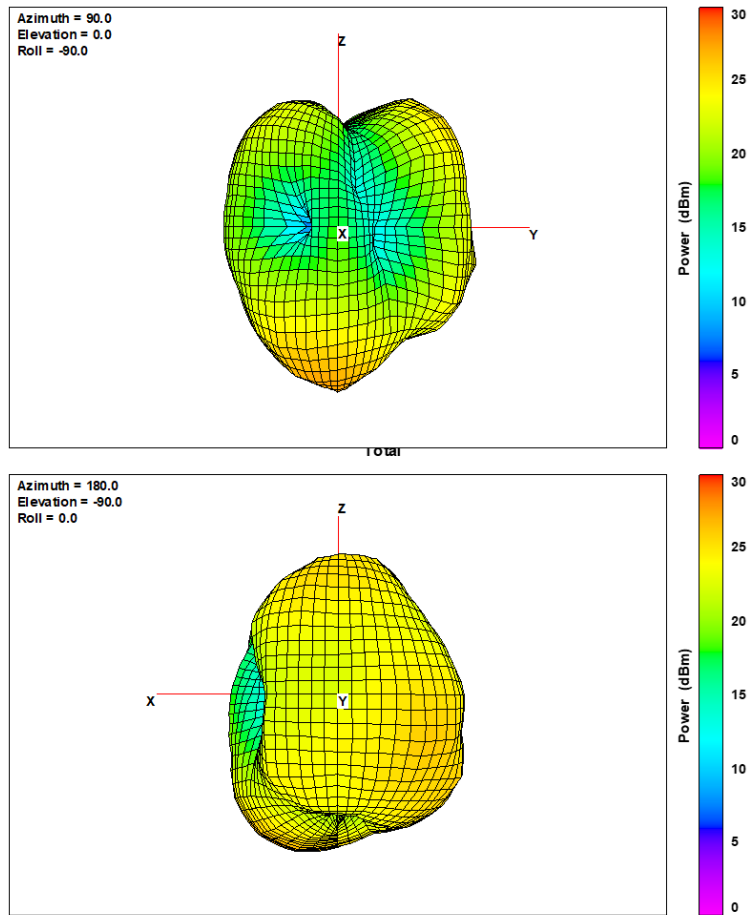


Figure 29: Band 66 radiation pattern.

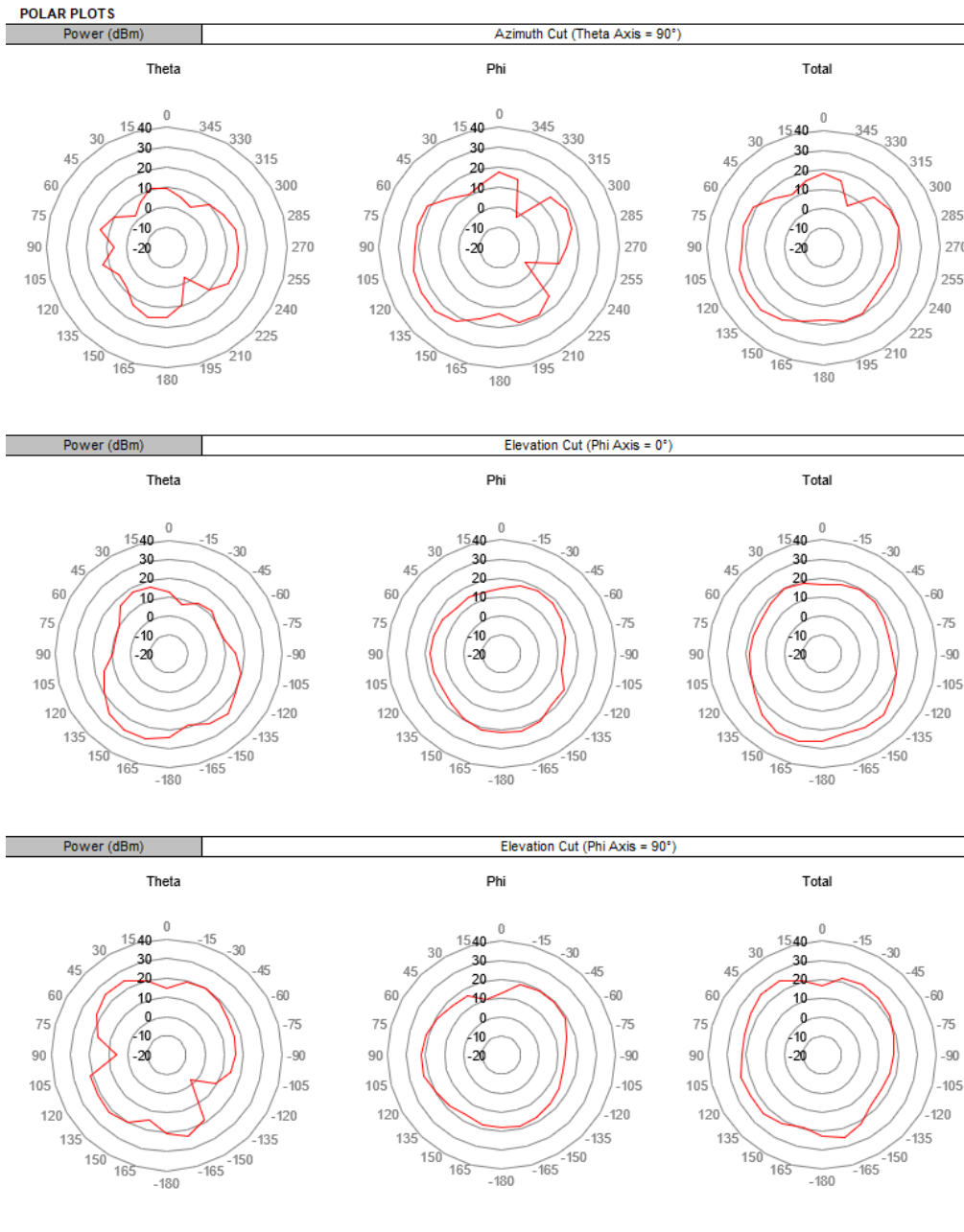


Figure 30: Band 66 polar plots.

5. GPS

This radio is a receiver only.

6. 433 MHz

This radio is a receiver only.