



Data From Testing Performed For Development Tests

Project Code	EEE2300595
For	Twisthink, LLC.
P.O. Number	979
Date Tested	March 15, 2023
Test Personnel	John Peters

Elite Electronic Engineering Inc.

1516 CENTRE CIRCLE
DOWNERS GROVE, IL 60515

TEL: 630 - 495 - 9770
FAX: 630 - 495 - 9785

www.elltetest.com

EUT Details

EUT Name	691098 A.3
Product Name	ESPBAT
EUT Description	Irrigation Controller
HW Version	Rev.4
Antenna Type	Inverted F Antenna
Antenna Frequency Span	2400-2500MHz
Manufacturer Name	Twistthink, LLC.
Manufacturer Address	109 Michigan St NW #600, Grand Rapids, MI 49503

Test Equipment

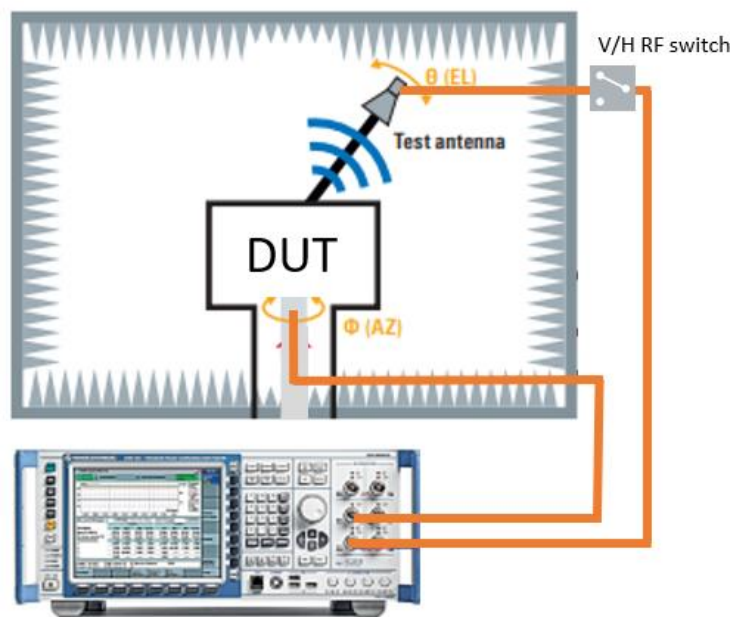
Equipment Description	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
OSP130 RF switchbox	ROHDE & SCHWARZ	OSP130	101195	NOTE 1	Part of the system calibration
OSP150 RF switchbox	ROHDE & SCHWARZ	OSP150	101024	NOTE 1	
VECTOR NETWORK ANALYZER	ROHDE & SCHWARZ	ZND	101137	11/15/2021	11/15/2023

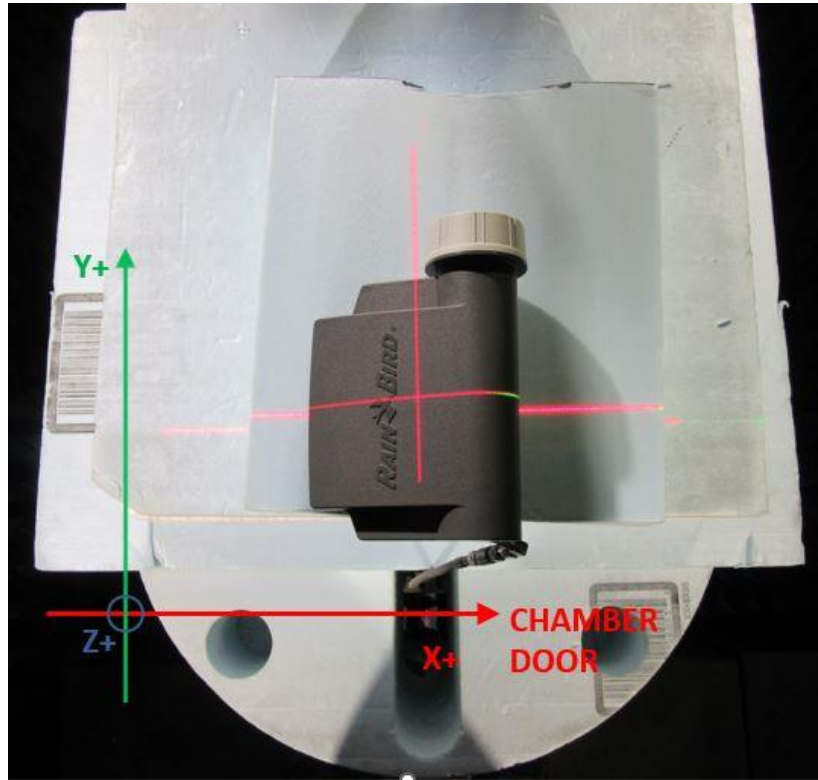
Passive Antenna Pattern Tests using Vector Network Analyzer (VNA)

The radiation pattern was measured every 15 degrees in AZ (azimuth, 0 - 360°) and every 15 degrees in EL (elevation, 0 - 165°) using a dual-linear polarized test antenna to capture both polarizations, Theta (vertical) and Phi (horizontal).

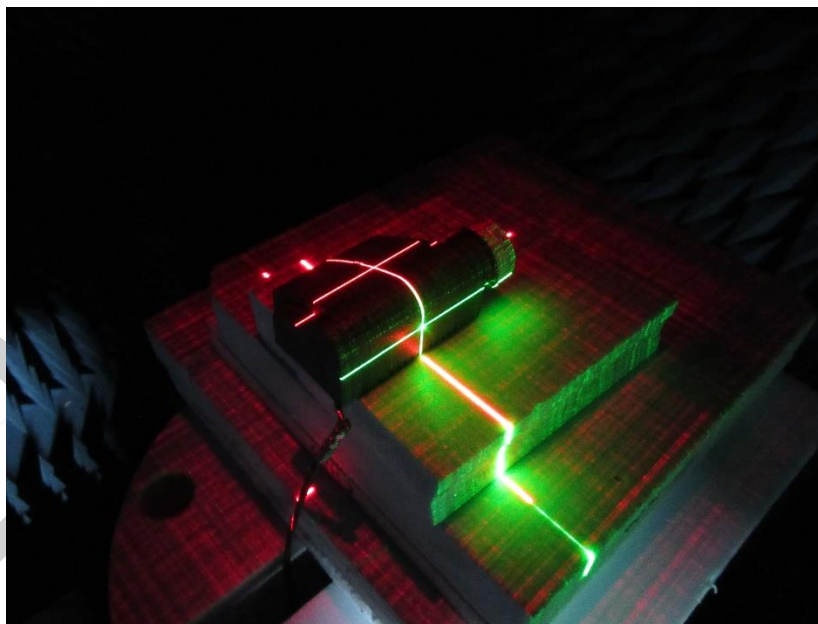
Measuring with a VNA allows the radiation pattern to be tested sweeping multiple frequencies at each test coordinate/polarization so multiple test frequency patterns can be generated from one antenna scan. The DUT is driven through VNA (Port 1). Port 1 is connected to an RF cable that is run through a bulkhead in the chamber shielding, to the chamber turntable, through a RF rotary joint, and through a RF cable that terminates with a 10dB attenuator (used to help with standing wave effects in the cables). A picture of this connection is included in this document. The measurement port (Port 2) of the VNA is connected to the dual-linear polarized probe antenna to capture both antenna polarizations, Theta (V) and Phi (H).

The antenna pattern was characterized in a Rohde and Schwarz WPTC-M anechoic chamber with a R&S ZND8 Vector Network Analyzer:

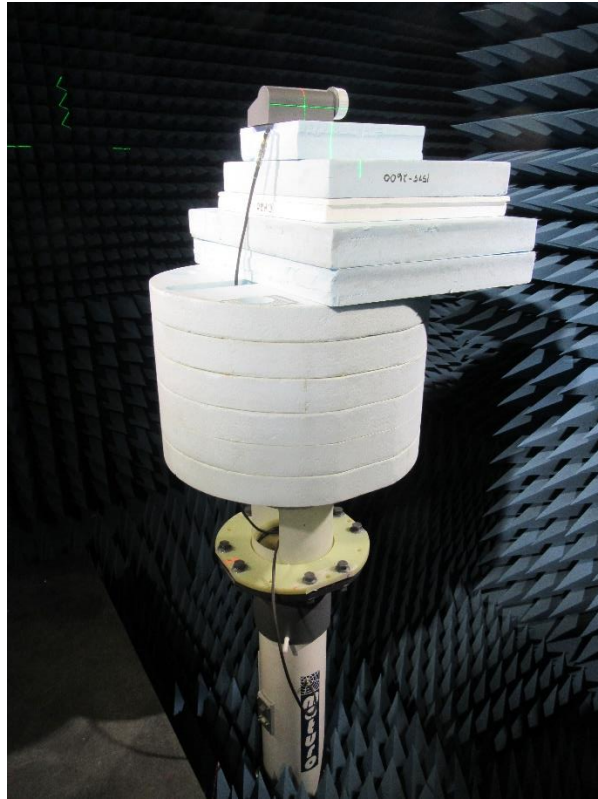




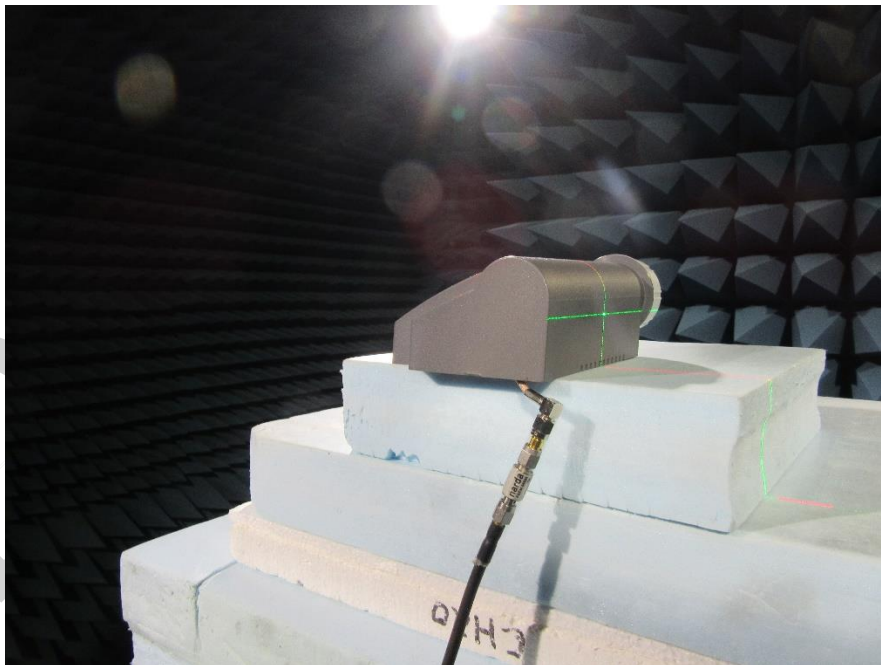
Plot Orientation



Laser Alignment

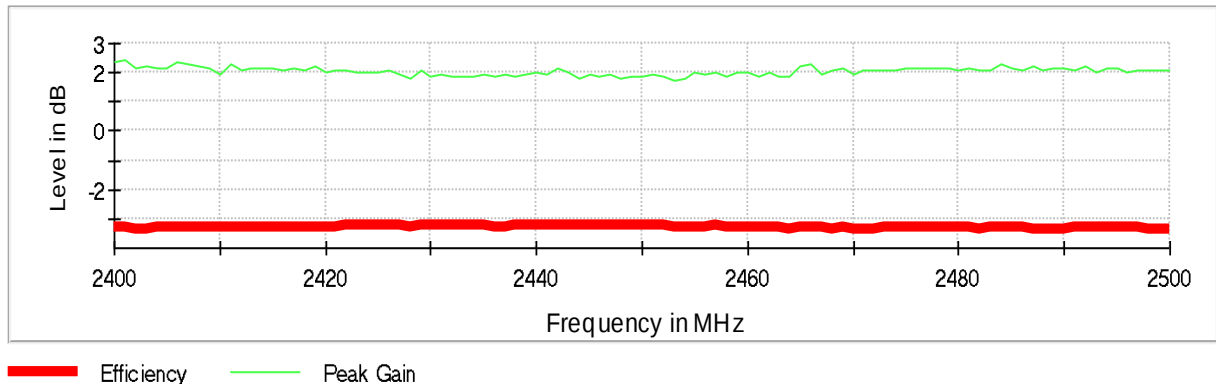


EUT Support



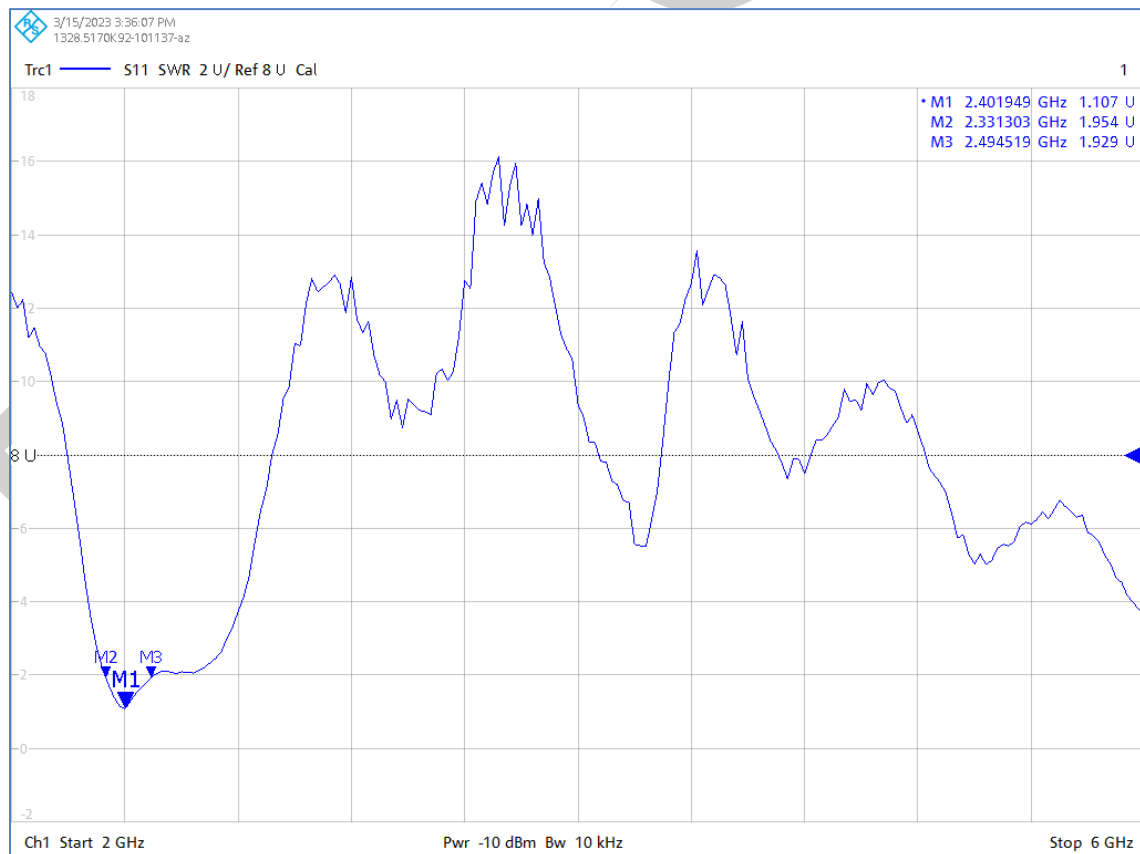
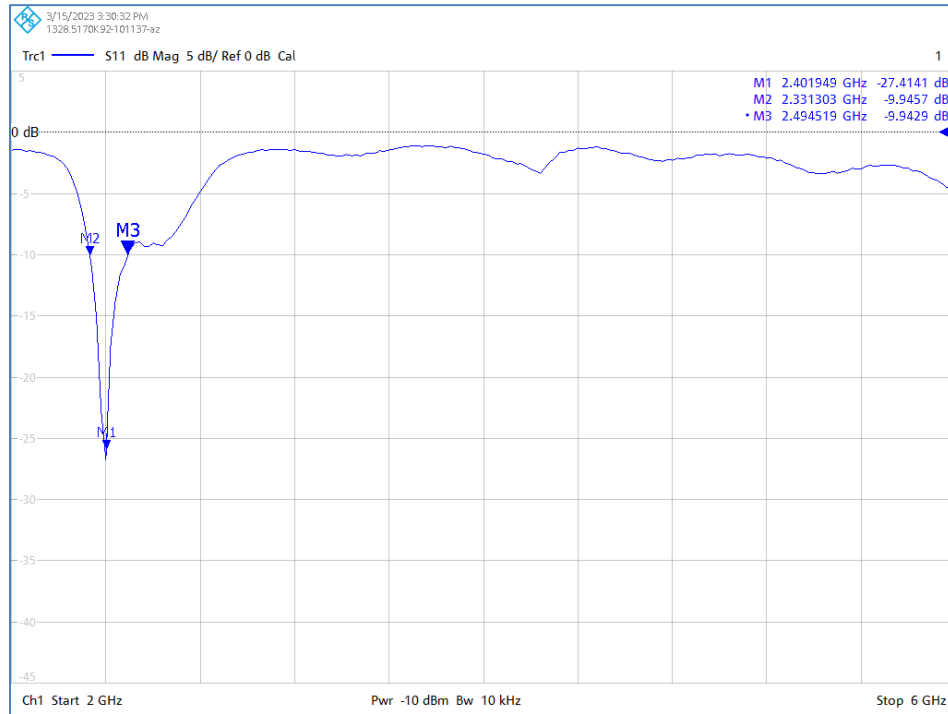
RF Connection

ANTENNA GAIN AND EFFICIENCY



Gain Table																								
Frequency (MHz)	2400	2402	2405	2410	2415	2420	2425	2426	2430	2435	2440	2445	2450	2455	2460	2465	2470	2475	2480	2485	2490	2495	2500	
Tot. Rad. Pwr. (dBm)	-3.29	-3.33	-3.26	-3.29	-3.27	-3.28	-3.24	-3.22	-3.25	-3.24	-3.20	-3.24	-3.24	-3.27	-3.28	-3.31	-3.34	-3.31	-3.33	-3.31	-3.33	-3.31	-3.34	
Peak EIRP (dBm)	2.35	2.12	2.17	1.96	2.14	2.04	1.99	2.07	1.90	1.92	2.03	1.97	1.88	2.04	2.03	2.21	1.92	2.16	2.05	2.12	2.16	2.13	2.05	
Directivity (dBi)	5.64	5.45	5.43	5.25	5.41	5.32	5.23	5.29	5.15	5.16	5.23	5.21	5.12	5.32	5.31	5.52	5.26	5.47	5.38	5.43	5.49	5.44	5.39	
Efficiency (dB)	-3.29	-3.33	-3.26	-3.29	-3.27	-3.28	-3.24	-3.22	-3.25	-3.24	-3.20	-3.24	-3.24	-3.27	-3.28	-3.31	-3.34	-3.31	-3.33	-3.31	-3.33	-3.31	-3.34	
Efficiency (%)	46.84	46.40	47.18	46.87	47.10	46.99	47.44	47.61	47.34	47.41	47.87	47.41	47.38	47.06	46.98	46.66	46.31	46.69	46.48	46.65	46.41	46.70	46.40	
Gain (dBi)	2.35	2.12	2.17	1.96	2.14	2.04	1.99	2.07	1.90	1.92	2.03	1.97	1.88	2.04	2.03	2.21	1.92	2.16	2.05	2.12	2.16	2.13	2.05	
NHPRP +/-Pi/4 (dBm)	-4.20	-4.25	-4.16	-4.19	-4.17	-4.18	-4.14	-4.11	-4.14	-4.12	-4.07	-4.11	-4.10	-4.12	-4.12	-4.14	-4.18	-4.12	-4.14	-4.12	-4.15	-4.10	-4.12	
NHPRP +/-Pi/6 (dBm)	-5.67	-5.72	-5.62	-5.66	-5.65	-5.64	-5.61	-5.58	-5.61	-5.58	-5.53	-5.55	-5.53	-5.53	-5.53	-5.53	-5.56	-5.50	-5.51	-5.50	-5.53	-5.48	-5.50	
NHPRP +/-Pi/8 (dBm)	-6.86	-6.91	-6.81	-6.86	-6.85	-6.84	-6.82	-6.78	-6.82	-6.79	-6.74	-6.76	-6.74	-6.74	-6.73	-6.73	-6.76	-6.70	-6.72	-6.72	-6.74	-6.70	-6.72	
Boresight Phi (deg)	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	240	240	240	300	240	240	240	300	
Boresight Theta (deg)	105	105	105	105	105	105	105	105	120	120	120	120	105	105	105	105	90	105	105	90	105	90	105	

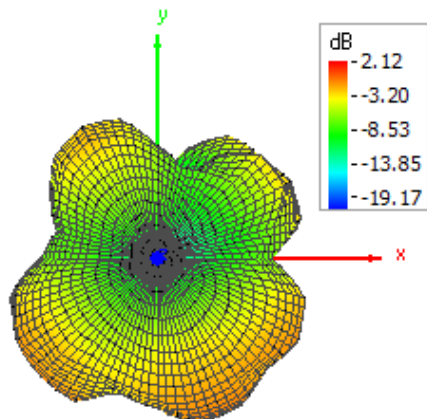
NETWORK ANALYZER MEASUREMENTS



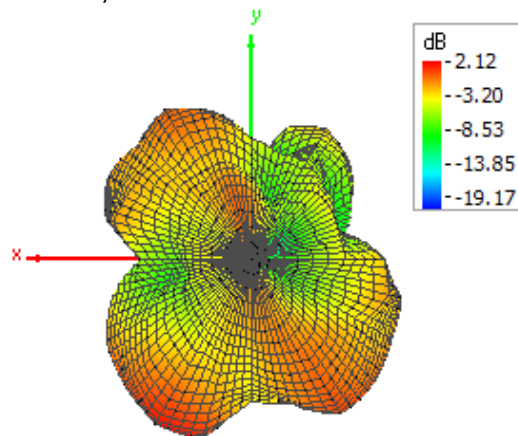
PLOTS

2402MHz

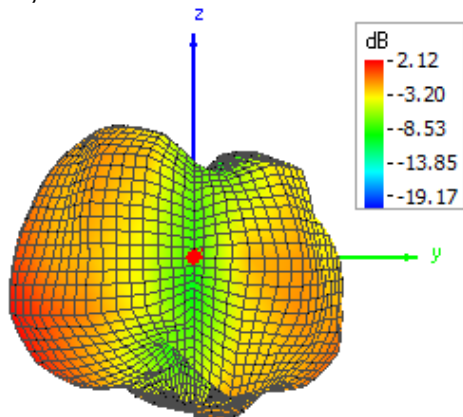
Theta = 0, Phi = 0



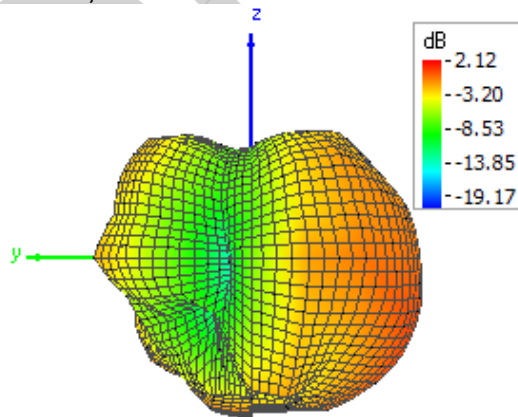
Theta = 180, Phi = 0



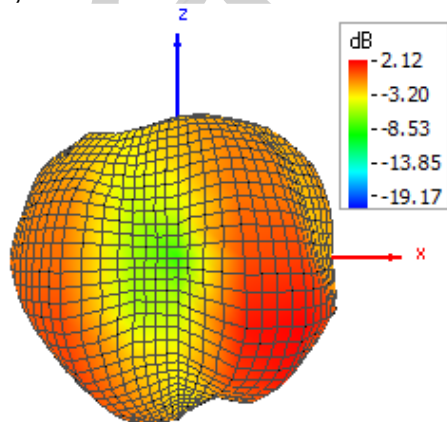
Theta = 90, Phi = 0



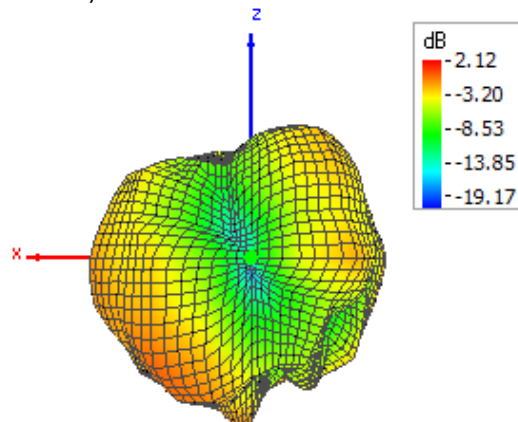
Theta = 90, Phi = 180



Theta = 90, Phi = 270

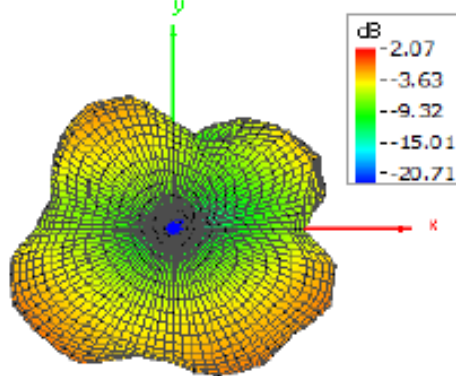


Theta = 90, Phi = 90

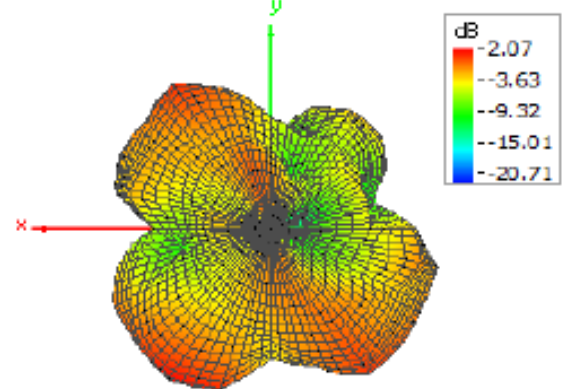


2426MHz

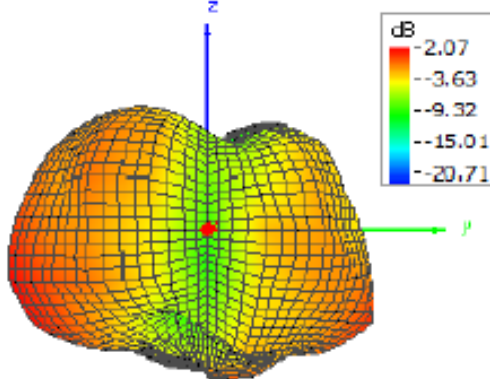
Theta = 0, Phi = 0



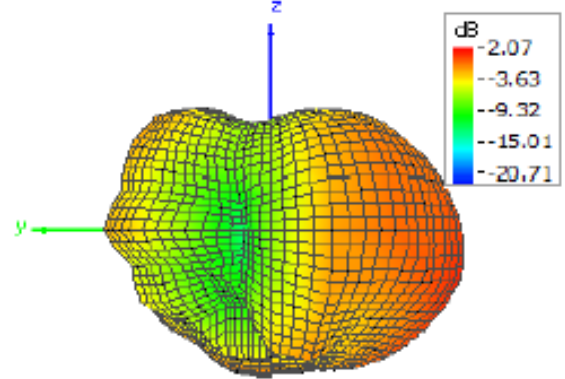
Theta = 180, Phi = 0



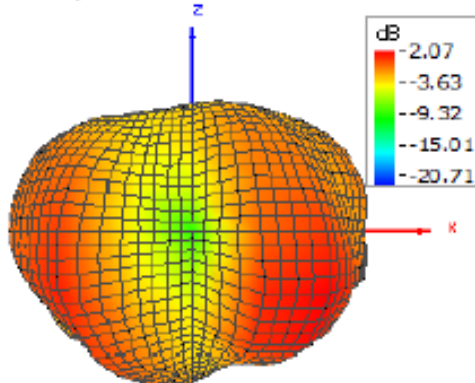
Theta = 90, Phi = 0



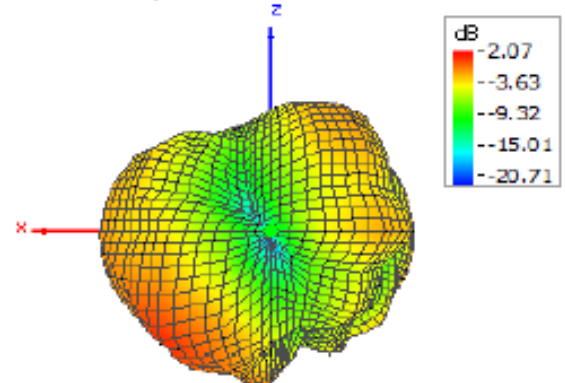
Theta = 90, Phi = 180



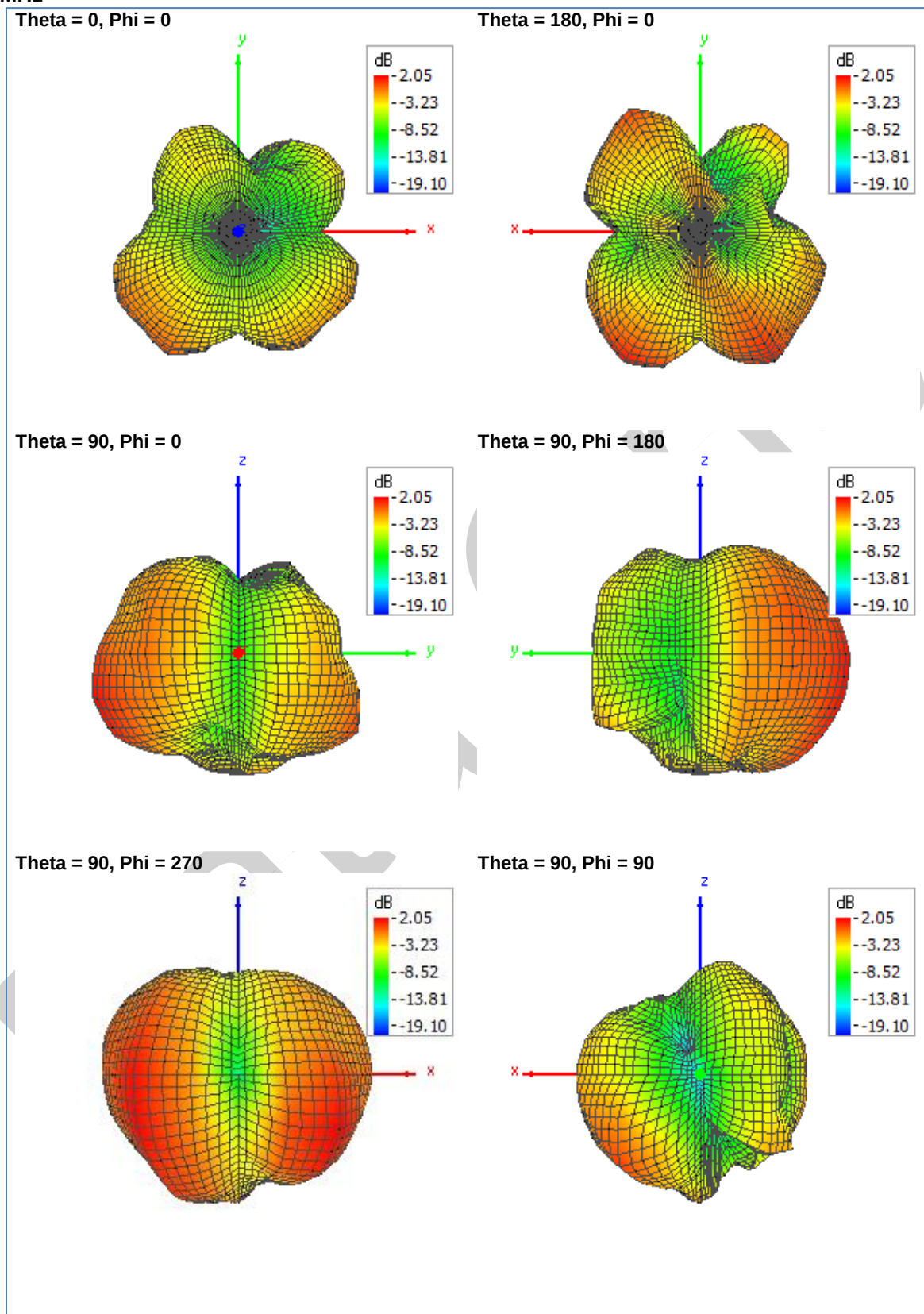
Theta = 90, Phi = 270



Theta = 90, Phi = 90

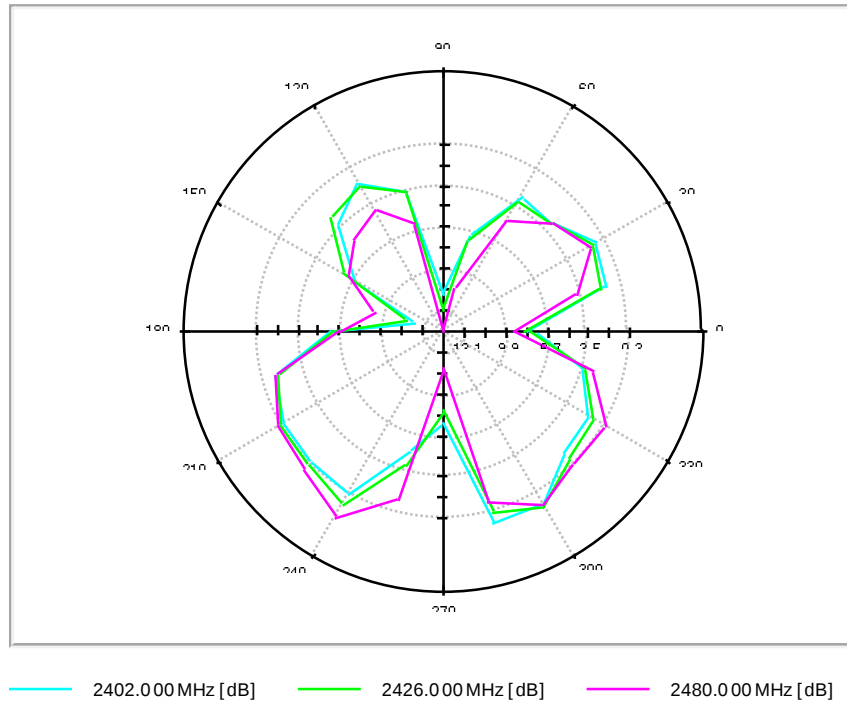


2480MHz

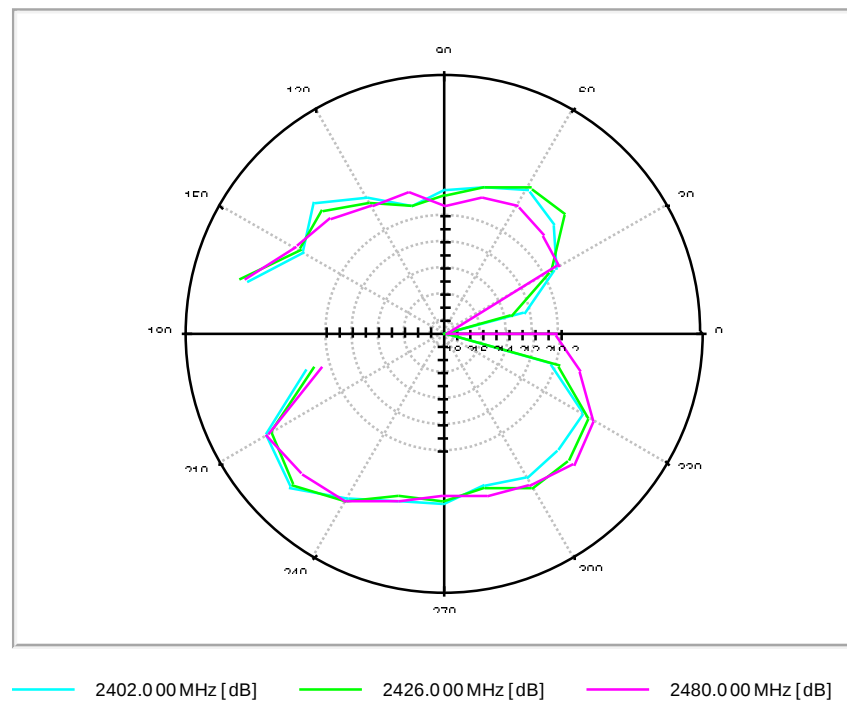


MAIN CUT PLOTS

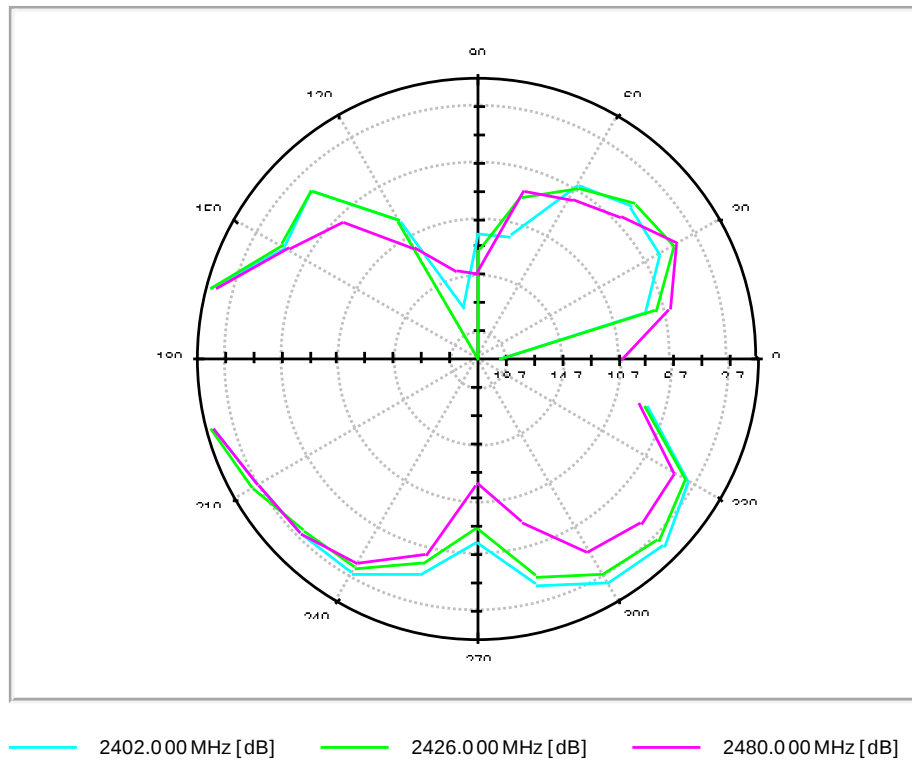
MainCutsPlot_XY Plane



MainCutsPlot_XZ Plane



MainCutsPlot_YZ Plane



— 2402.000 MHz [dB] — 2426.000 MHz [dB] — 2480.000 MHz [dB]