Over-the-Air (OTA) Test Report

Engineering Test Report	2402531-01
DUT Name	Quarter-wave Monopole Antenna
DUT Type	Antenna and PCB
Manufacturer Name	Multitech
Manufacturer Address	2205 Woodale Drive, Mounds View, MN 55112
Requested By	Jason Panjikaran
PO Number	11231
Test Dates	10/28/2024
Test Facility	Elite Electronic Engineering, Inc. 1516 Centre Circle Downers Grove, IL 60515
Signature	
Tested by	John Peters Senior Wireless Test Engineer
Signature	
Approved by	Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specification(s). The data presented in this test report pertains to the DUTon the test date(s) specified. Any electrical or mechanical modifications made to the DUT subsequent to the specified test date will serve to invalidate the data and void this certification.

1. REPORT REVISION HISTORY

Revision	Date	Description
-	01/01/2024	Initial release

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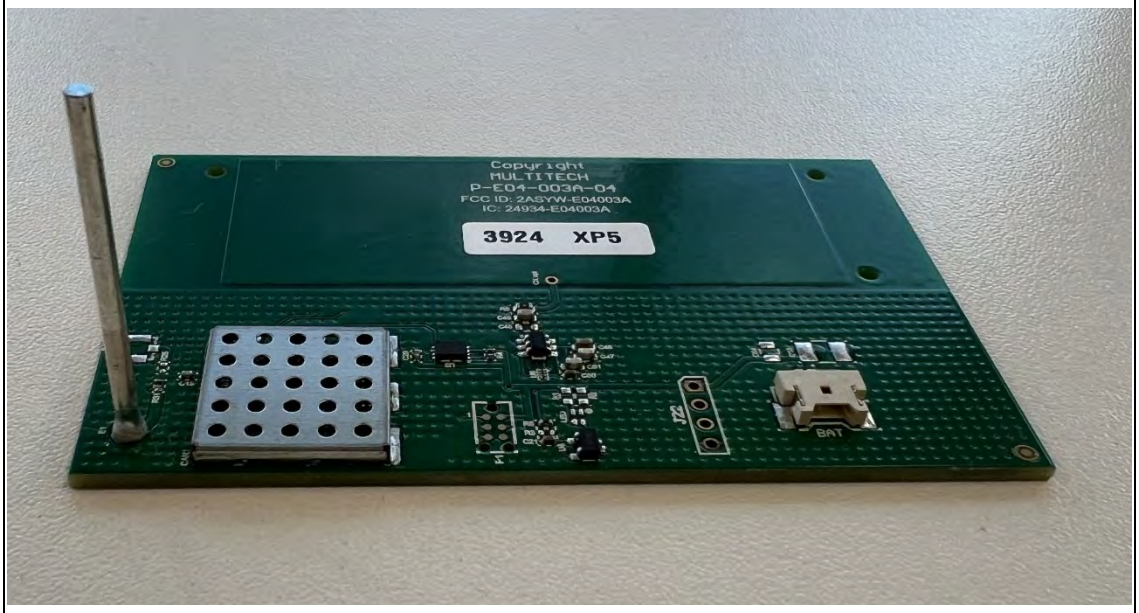
3. DESCRIPTION OF DEVICE UNDER TEST (DUT)

3.1. PRODUCT DESCRIPTION

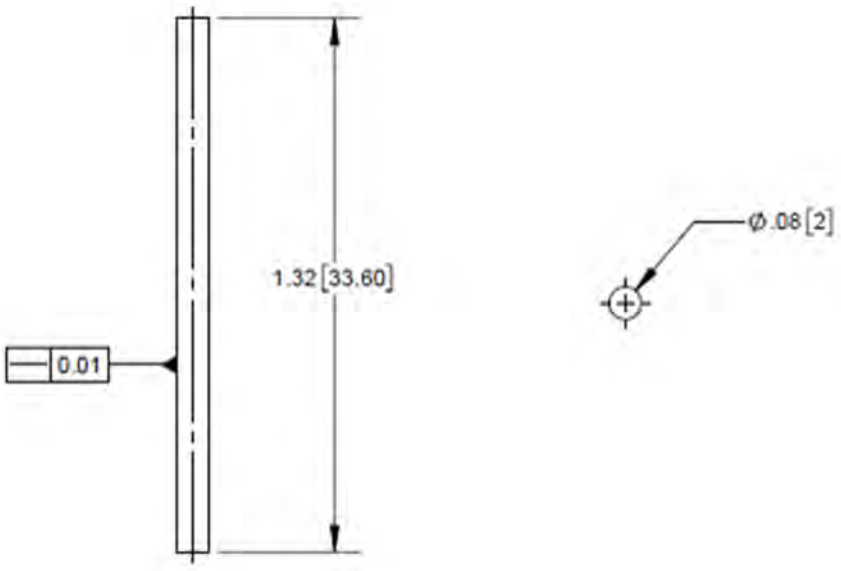
Product Description		
DUT Description		Antenna soldered to PCB containing backplane
Antenna Description		1/4 wave monopole antenna, Part# ANT-B001-0001F-001
Measurements Notes		Insertion Loss of approximately 100mm RG178 feed cable was accounted for in this measurement. Calculated insertion loss table below.
DUT Quantity		1
DUT Dimensions		Approximately 33mm long, 2mm dia.
Mechanical Mode		Freespace, Normal operation is PCB horizontal orientation
Frequency Evaluation Span		2400-2500MHz
Input Power	Internal	N/A
	External	N/A

COAXIAL CABLE LOSSES (calculated)

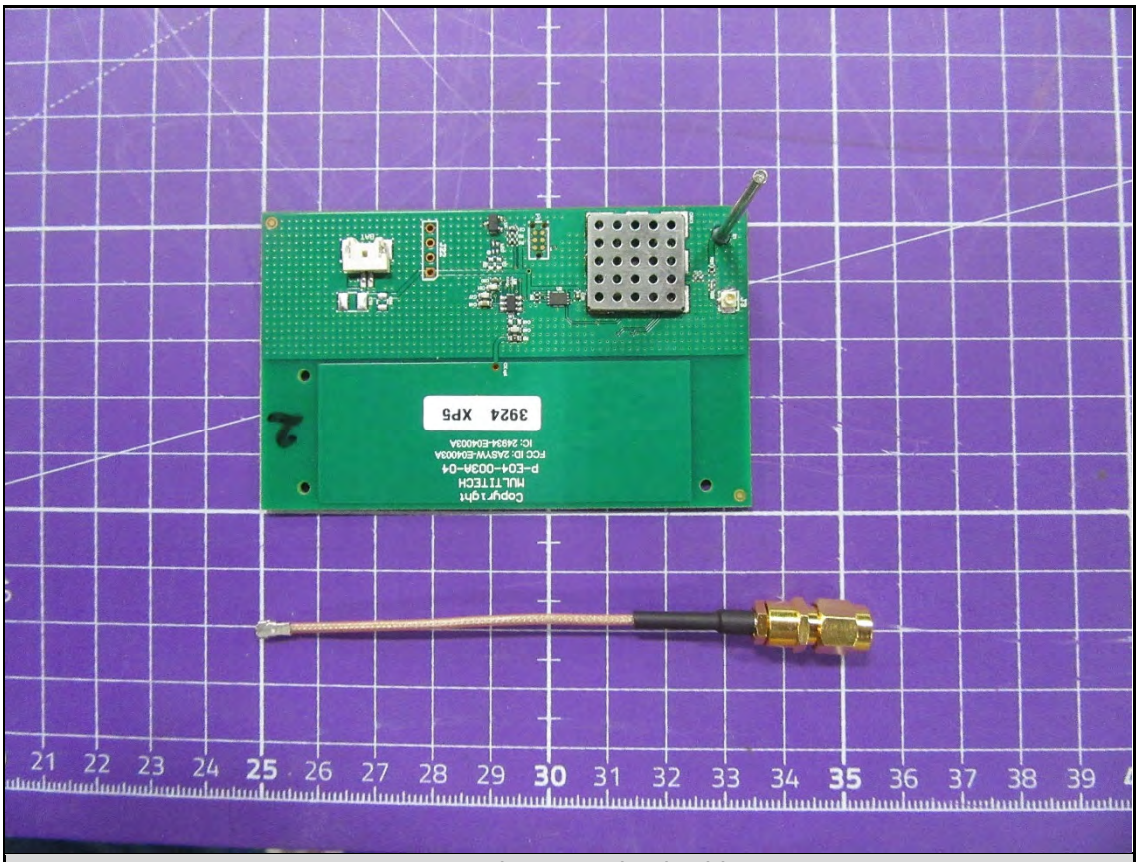
Frequency (GHz)	RG178 Coaxial Pathloss (dB/100m)		Frequency (GHz)	RG178 Coaxial Pathloss (dB/.1m)
0.1	45.31		2.402	0.2
0.4	91.21		2.44	0.2
1	145.7		2.48	0.2
3	257.22			



DUT

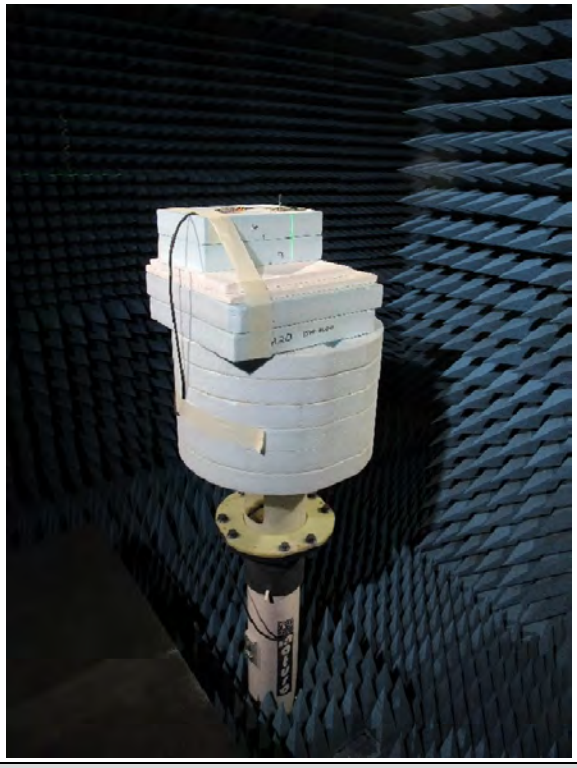


DUT (Dimensions)

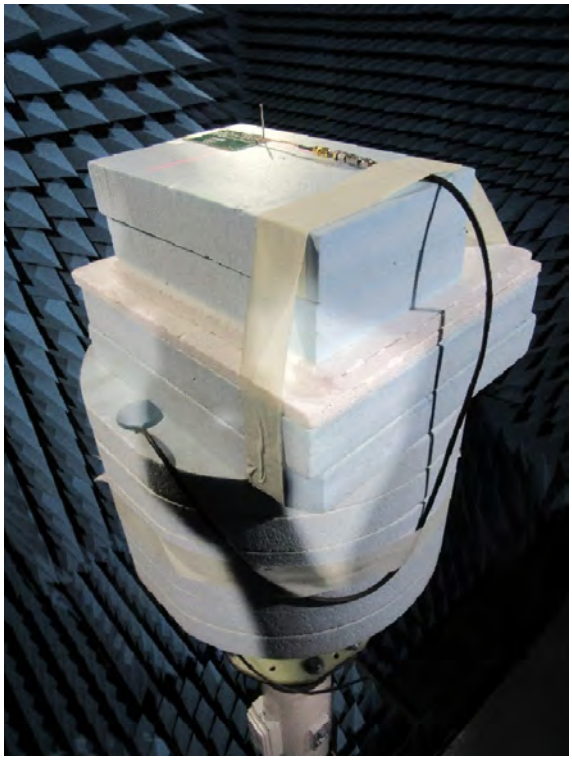


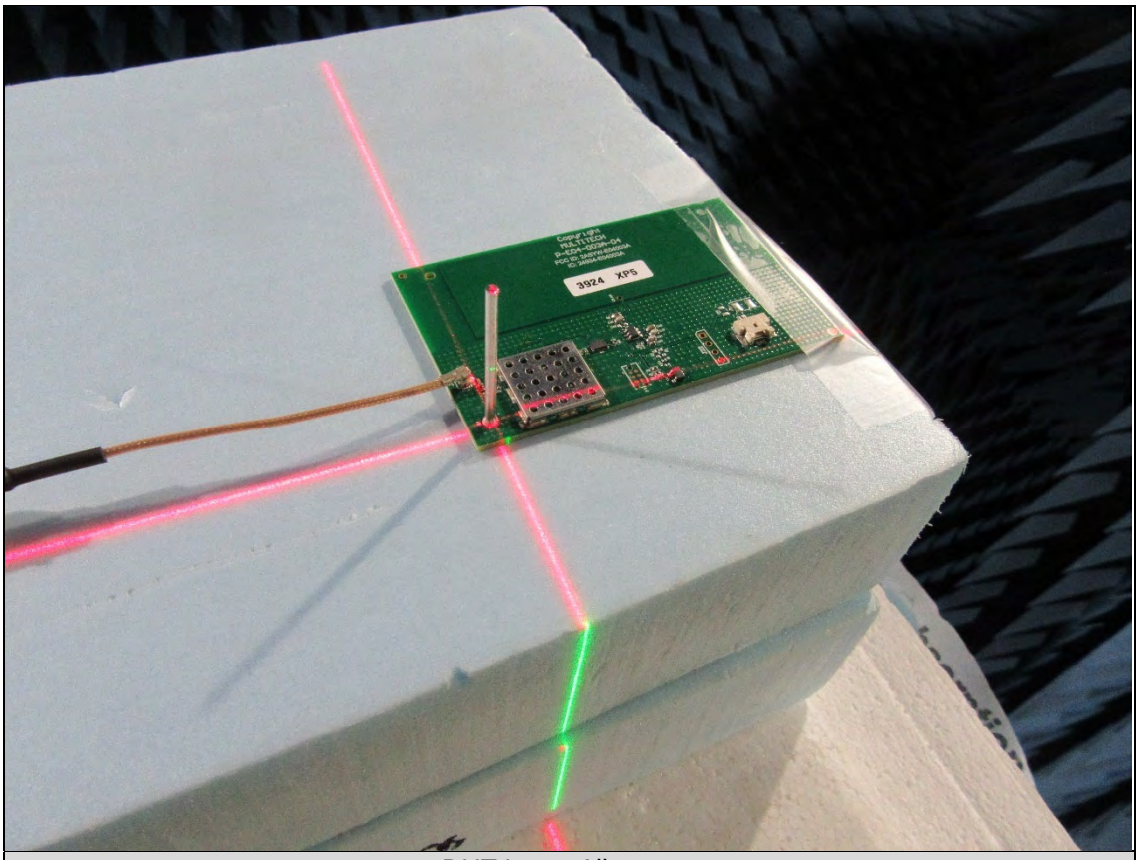
PCB and Antenna lead cable

3.2. DUT SETUP PHOTOGRAPHS

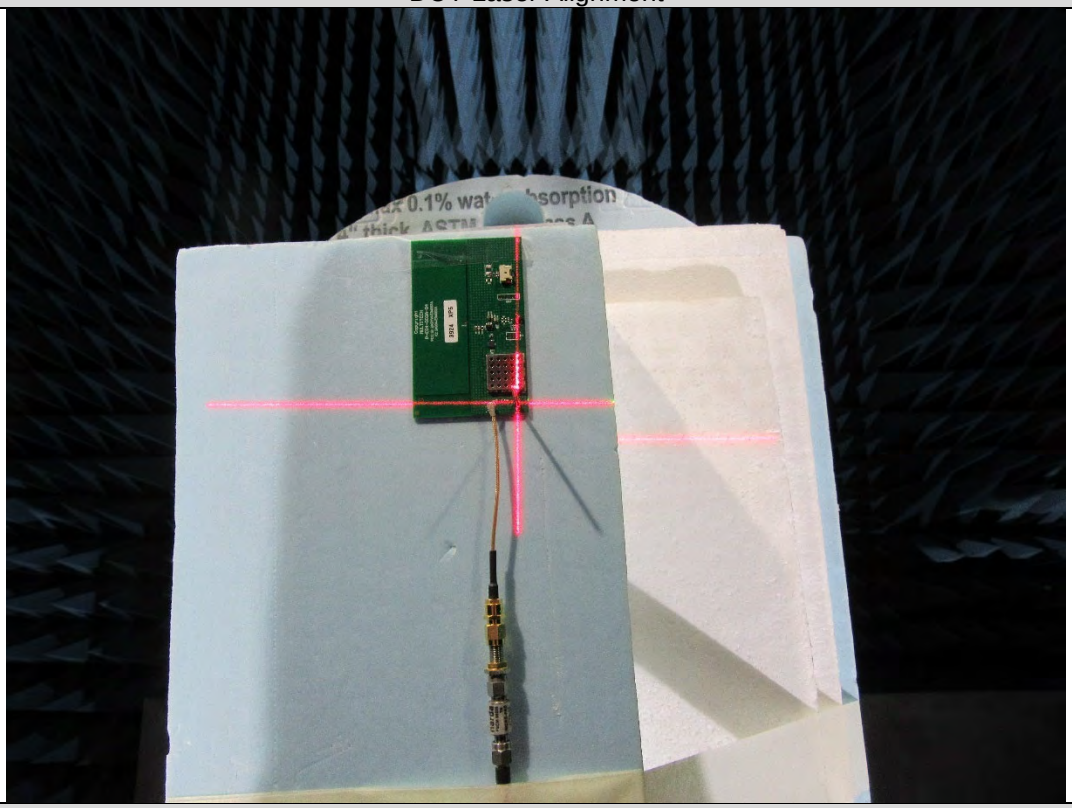


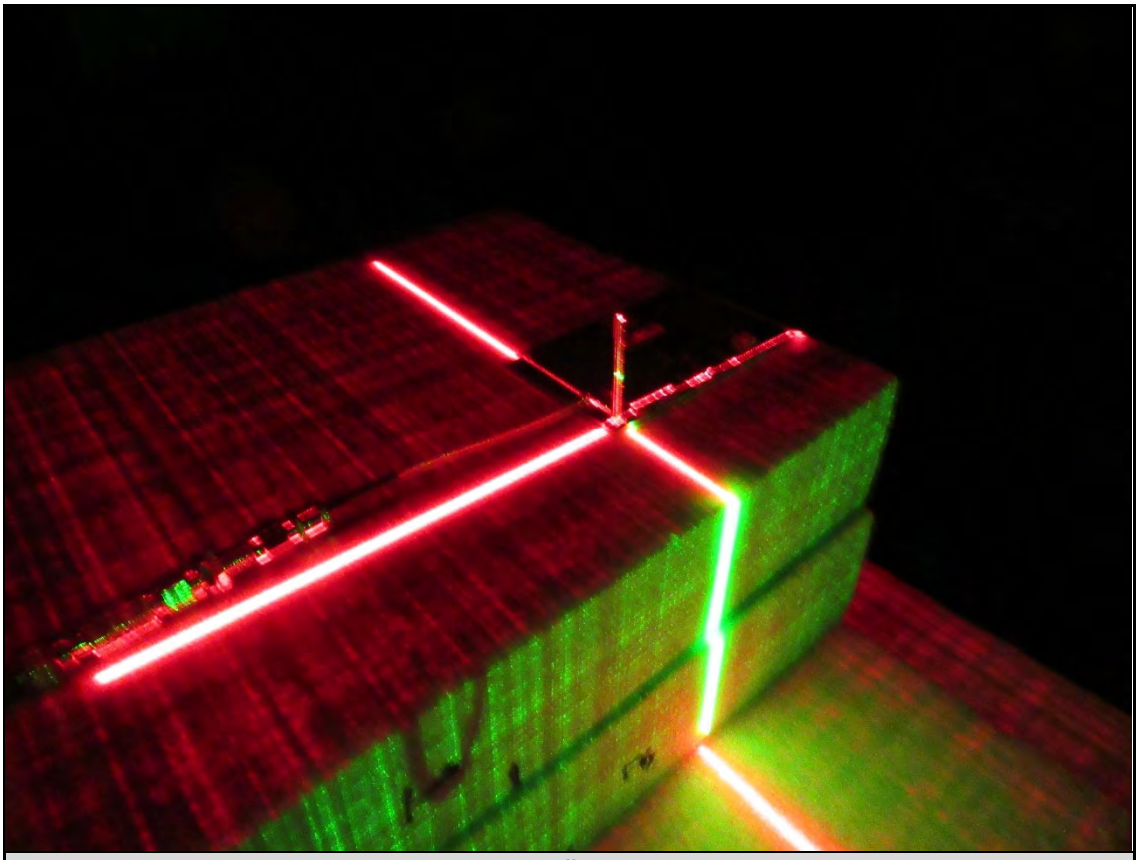
DUT Support





DUT Laser Alignment





Laser Alignment

4. LIST OF TEST EQUIPMENT:

Equipment Description	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
VECTOR NETWORK ANALYZER	Rohde & Schwarz	ZND	101137	5/8/2024	5/8/2025
RF SWITCH BOX	Rohde & Schwarz	OSP130	101195	Included in range calibration	
RF SWITCH BOX	Rohde & Schwarz	OSP150	101024		

5. MEASUREMENT UNCERTAINTY BUDGET:

Measurement Uncertainty (k=2, 95% Confidence Interval)											
Frequency (MHz)	617-	699-	814-	1574-	1695-	1850-	2110-	2300-	3300-	2400-	5150-
	698	798	894	1606	1780	2020	2180	2800	3800	2500	5825
FREE SPACE (50cm) Passive (dB)	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36

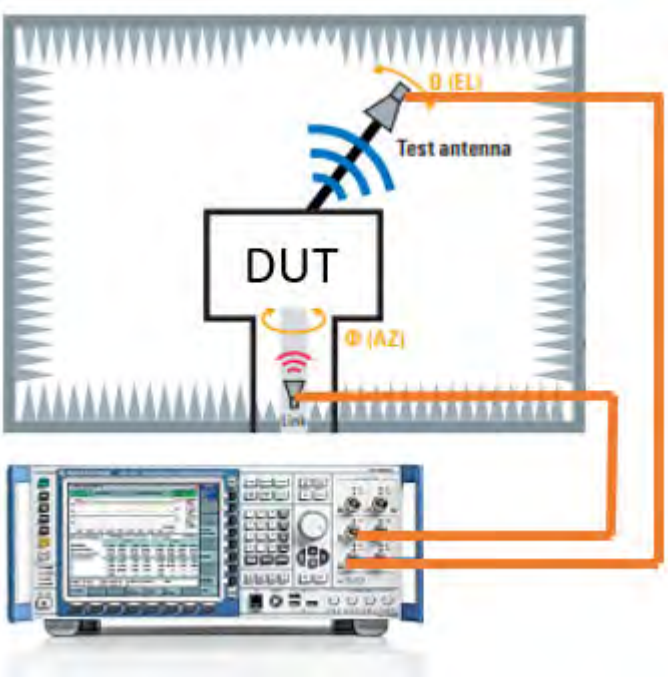
6. TEST METHOD

6.1. PASSIVE ANTENNA PATTERN TESTS USING VECTOR NETWORK ANALYZER (VNA)

The radiation pattern was measured with a VNA every 15 degrees in azimuth (0 - 360°) and every 15 degrees in elevation (0 - 165°) using dual-linear polarized test antenna to capture two principal 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). The measurement port (Port 2) of the VNA is connected to the dual-linear polarized probe antenna.

Antenna patterns are found in Section 8. The antenna pattern was characterized with a R&S ZND8 Vector Network Analyzer.

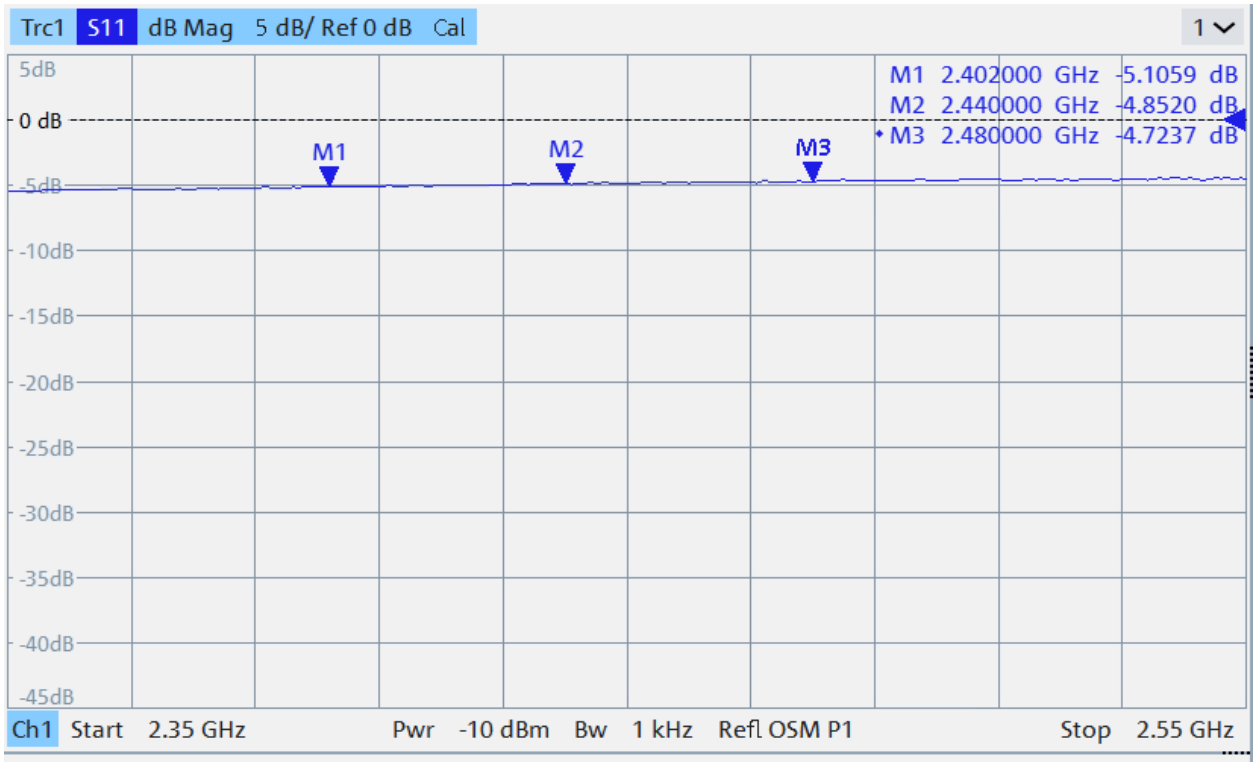


7. SUMMARY OF TEST RESULTS

7.1. ENVIRONMENTAL CONDITIONS:

The temperature at the time of the test was 23°C and the relative humidity was 32%.

7.2. RETURN LOSS

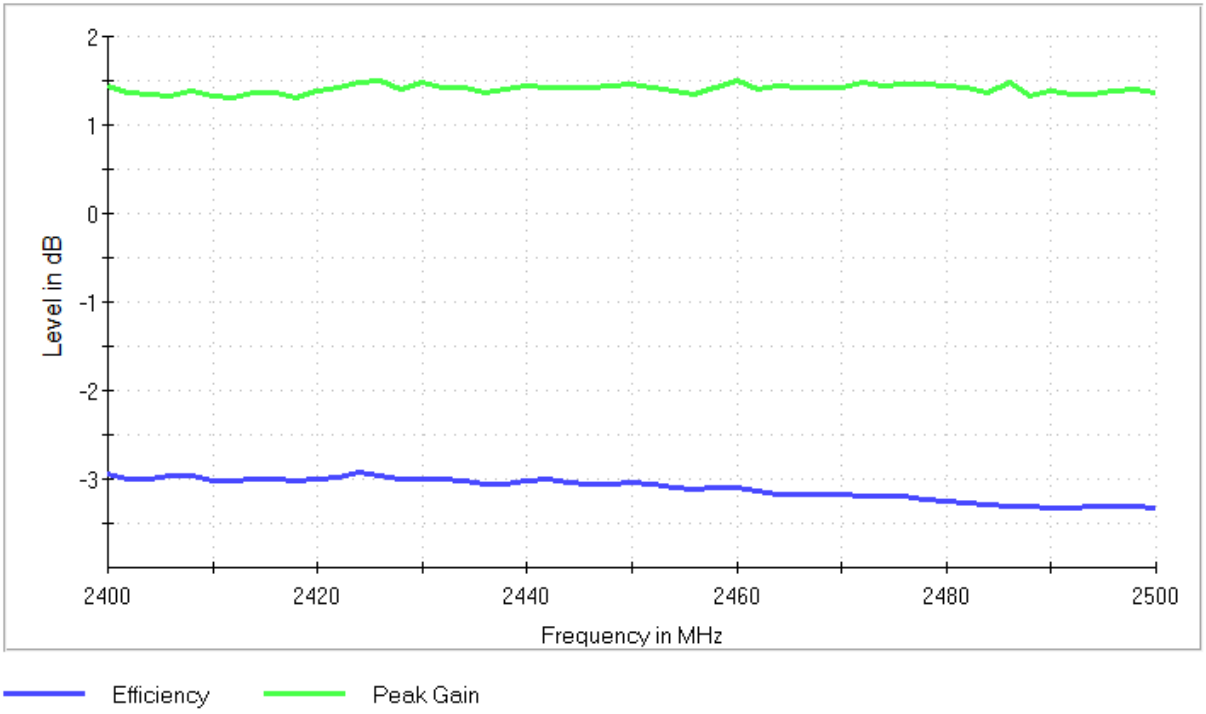


7.3. MEASUREMENT RESULTS

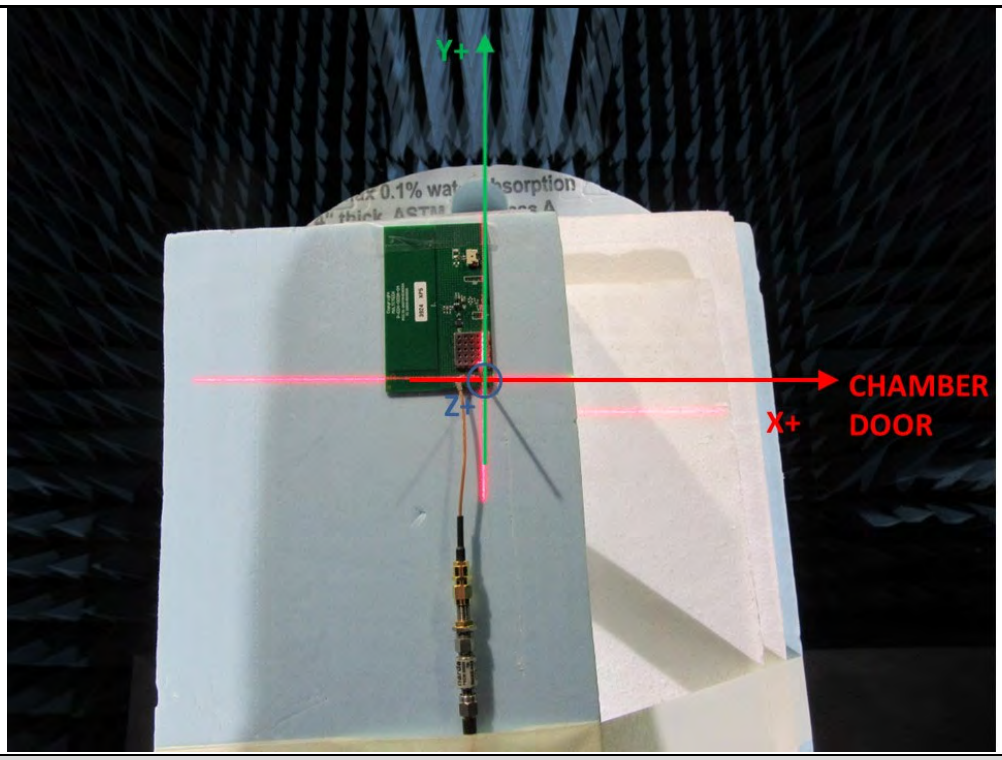
Frequency (MHz)	Gain	Directivity	Total Radiated Power	Total Efficiency
	(dBi)	(dBi)	(dBm)	(%)
2402MHz	1.37	4.37	-3.00	50.08
2440MHz	1.44	4.45	-3.01	49.98
2480MHz	1.45	4.70	-3.25	47.31

EXPANDED TABLE												
Frequency (MHz)	2400	2402	2410	2420	2430	2440	2450	2460	2470	2480	2490	2500
Total Rad. Power (dBm)	-2.95	-3.00	-3.02	-3.01	-3.01	-3.01	-3.04	-3.09	-3.17	-3.25	-3.32	-3.32
Peak EIRP (dBm)	1.45	1.37	1.32	1.38	1.49	1.44	1.46	1.49	1.42	1.45	1.39	1.37
Directivity (dBi)	4.40	4.37	4.34	4.39	4.50	4.45	4.50	4.58	4.59	4.70	4.71	4.70
Efficiency (dB)	-2.95	-3.00	-3.02	-3.01	-3.01	-3.01	-3.04	-3.09	-3.17	-3.25	-3.32	-3.32
Efficiency (%)	50.73	50.08	49.93	50.02	50.01	49.98	49.69	49.08	48.17	47.31	46.57	46.53
Gain (dBi)	1.45	1.37	1.32	1.38	1.49	1.44	1.46	1.49	1.42	1.45	1.39	1.37

ANTENNA GAIN AND EFFICIENCY

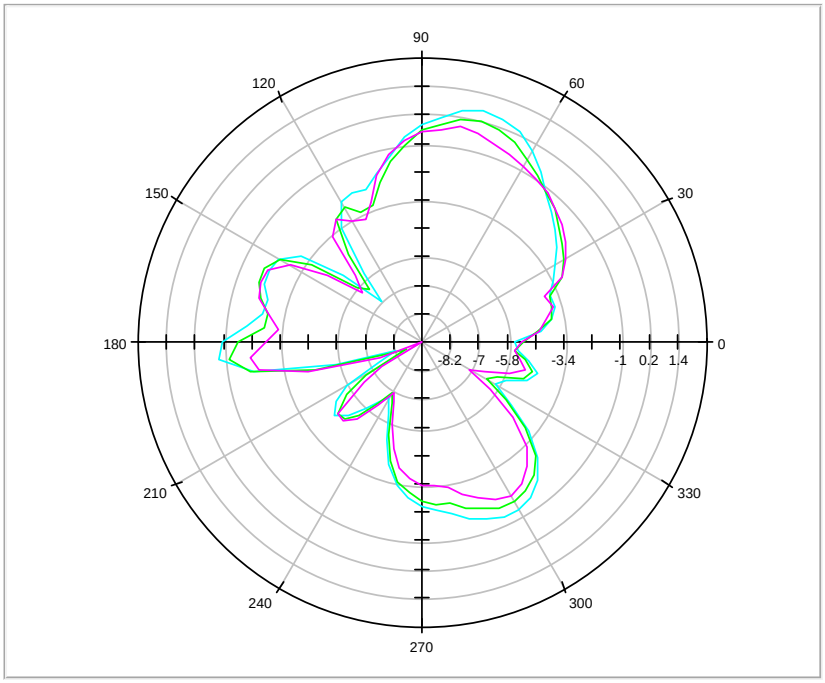


8. ANTENNA PLOTS

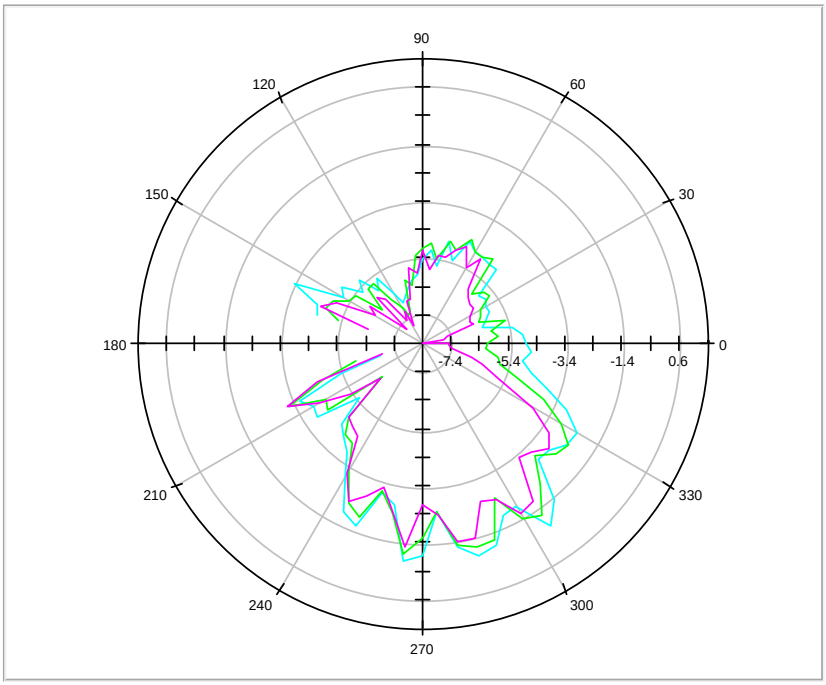


DUT (Top-view) Plot Orientation

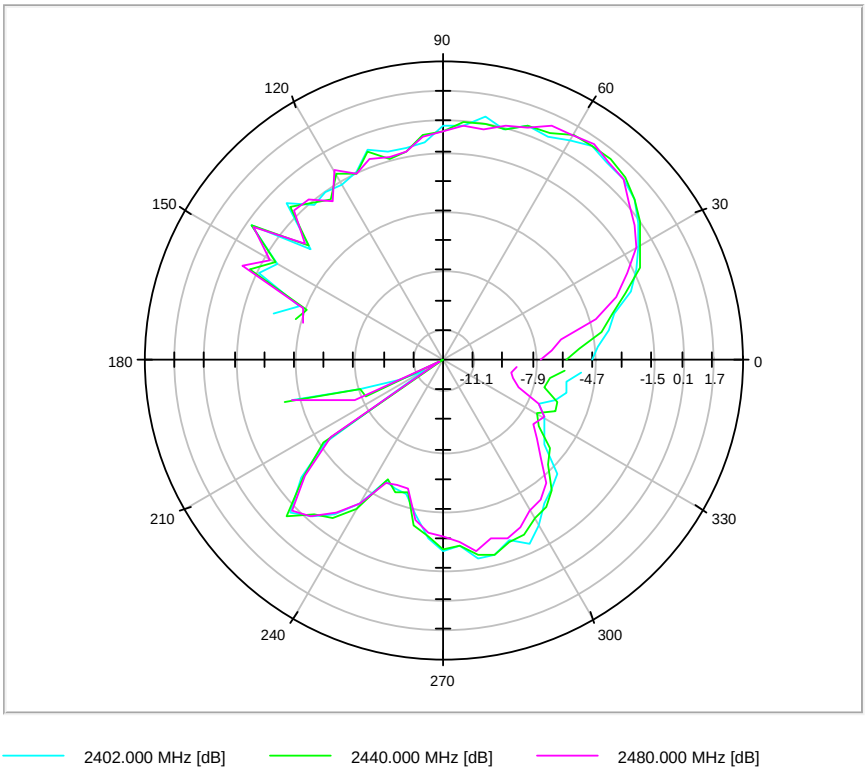
8.1. 2D MAIN CUTS



XY Main Cut Plot



XZ Main Cut Plot (Turntable is 180°)

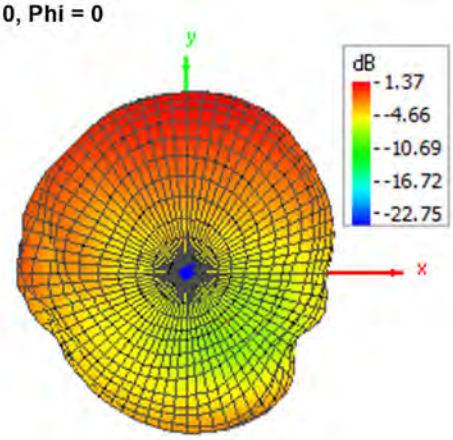


YZ Main Cut Plot (Turntable is 180°)

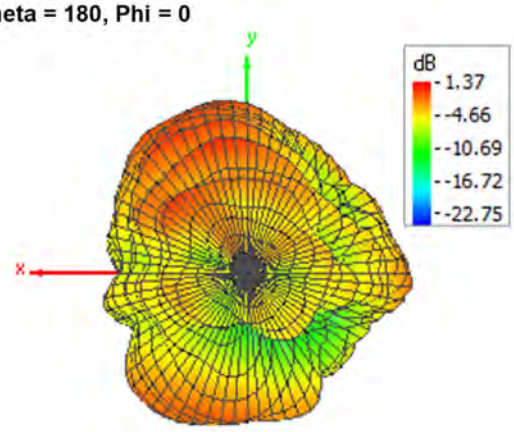
8.2. 3D PLOTS

2402MHz

Theta = 0, Phi = 0



Theta = 180, Phi = 0



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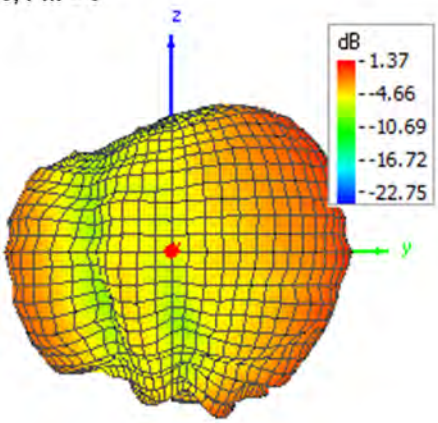

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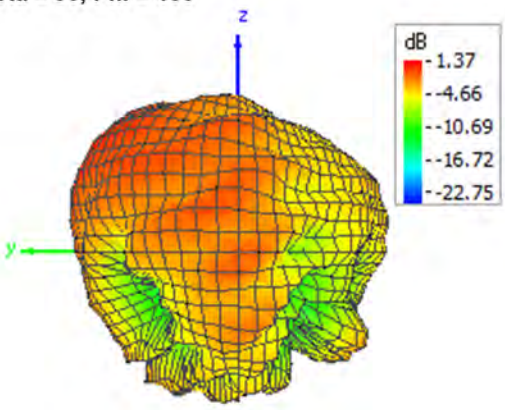

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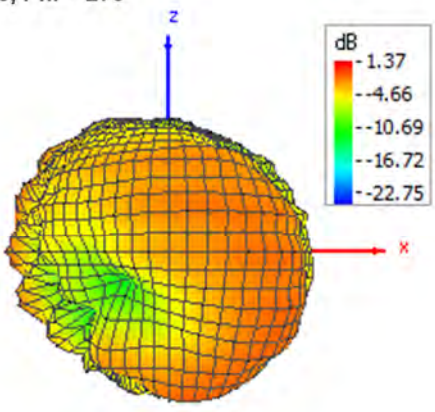

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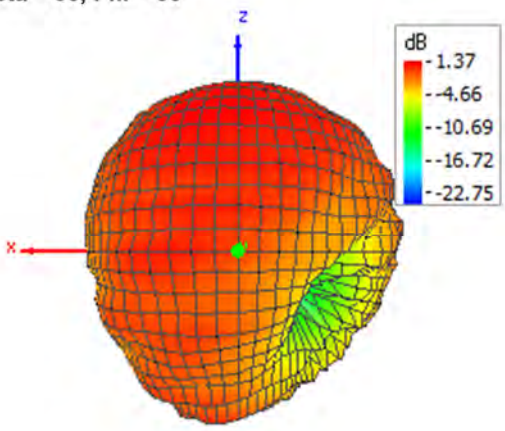

2440MHz

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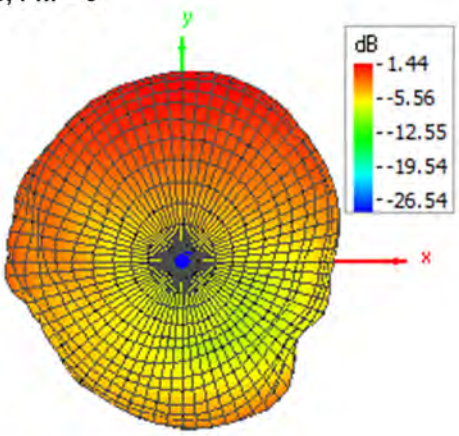
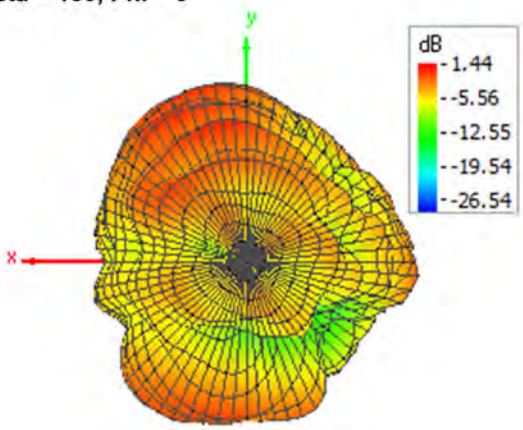
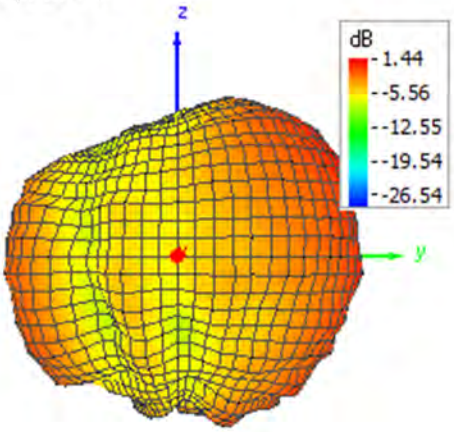


Theta = 180, Phi = 0



Theta = 90, Phi = 0



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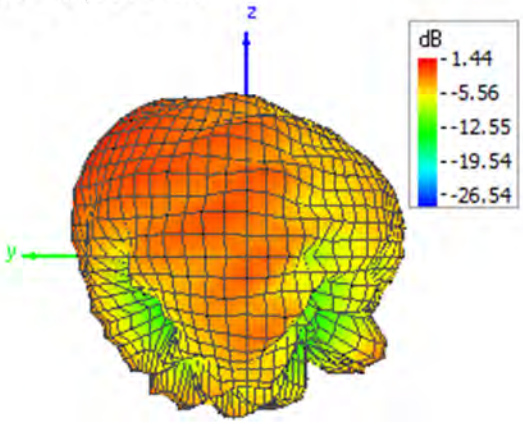

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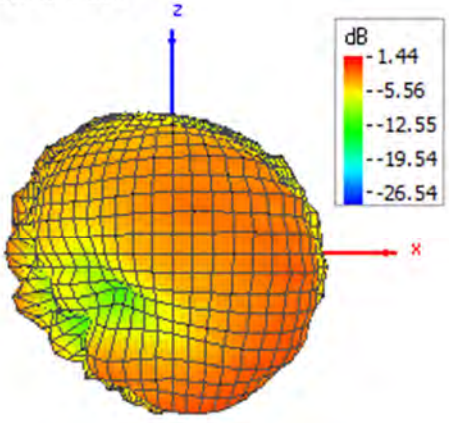

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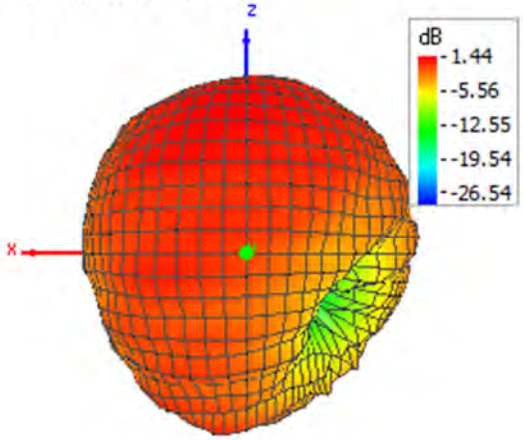

2480MHz

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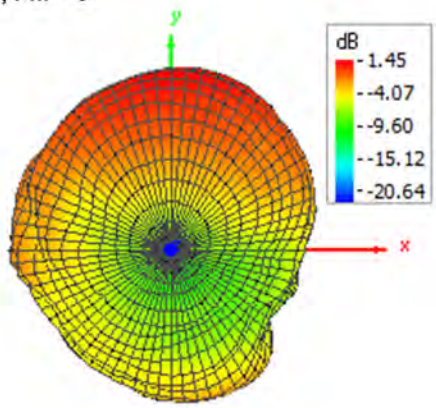

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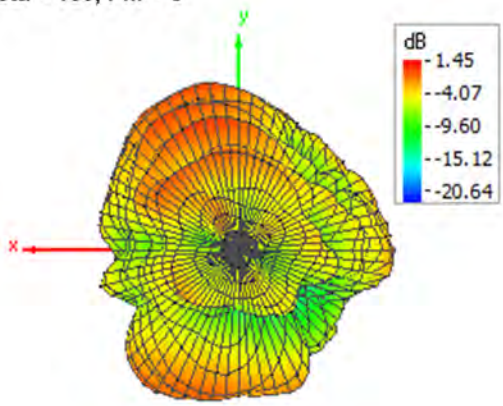

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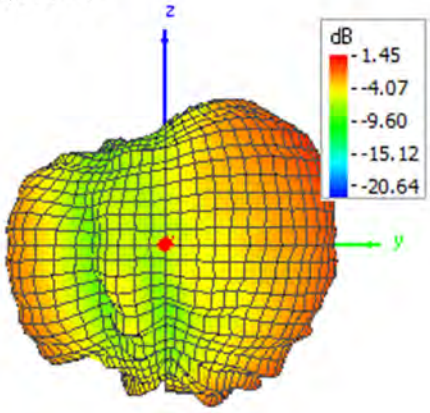

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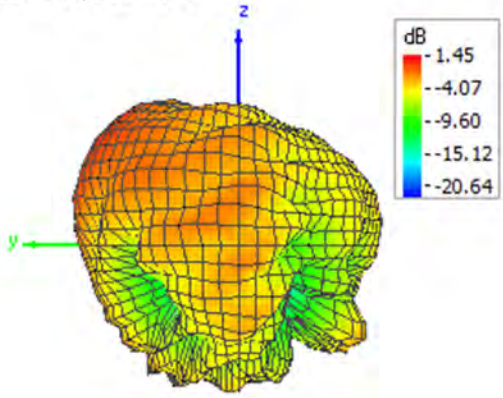

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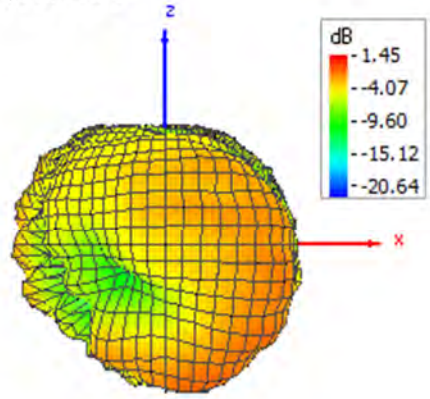

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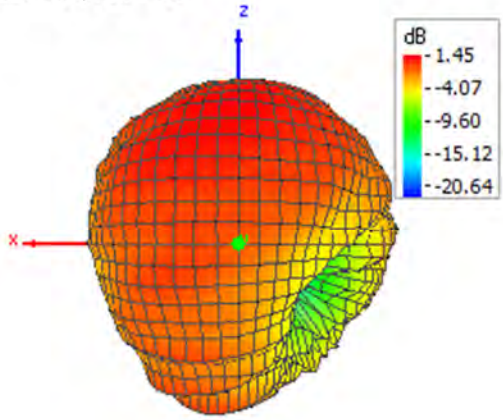

END OF REPORT