HP WLAN 2.4/5 GHz DB PCB Trace Antennas for the Umbriel Module

V1.1

Antenna Report

Model – SNPRC-2351

15NOV2023

1) UMBRIEL Milligrid HW3 Module (Top Side /Bottom Side)

Please refer "UMBRIEL_ANTENNA_DATASHEET_1_1(Photo)"

2) UMBRIEL RA Milligrid Module HW3 (Top Side/Bottom Side)

Please refer "UMBRIEL_ANTENNA_DATASHEET_1_1(Photo)"

3) UMBRIEL Module Dimensions (all variations) – 37mm x 40mm

Please refer "UMBRIEL_ANTENNA_DATASHEET_1_1(Photo)"

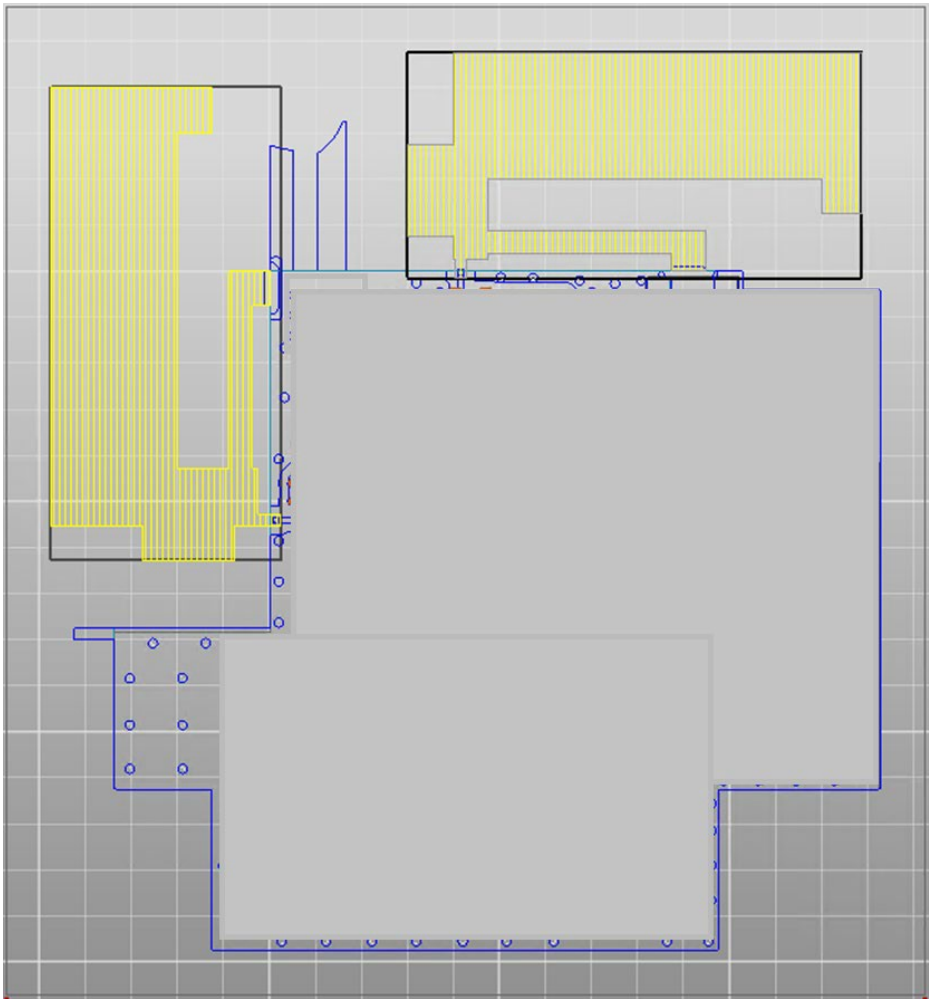
4)Antenna Layout Details for the UMBRIEL Module

Antenna 1

(Main Antenna Below)

Antenna 2

(Aux Antenna Below)



5) Features:

- Dual 2.4/5 GHz PCB Trace Antenna: Model – 2019_DB_X02
- Orthogonal antenna orientation for optimal coverage (Diversity)
- 2.4 GHz:
  - 2.4-2.5 GHz Frequency Range
  - VSWR Better than 2.5:1 across Frequency Range
  - Measured Efficiency > 70% across Frequency Range
  - Typical Gain 2.4-2.5 GHz: 3.5 dbi

- 5 GHz:
  - 5.1-5.9 GHz Frequency Range
  - VSWR Better than 2.5:1 across Frequency Range
  - Measured Efficiency > 60% across Frequency Range
  - Typical Gain 5-6 GHz: 4.5 dbi

6) Date of Test:

19OCT2023

7) Location of Test:

SATIMO SG-64 Chamber

Attn: Jim Acree , Measurements performed by Kyle Davis.

MVG Inc.

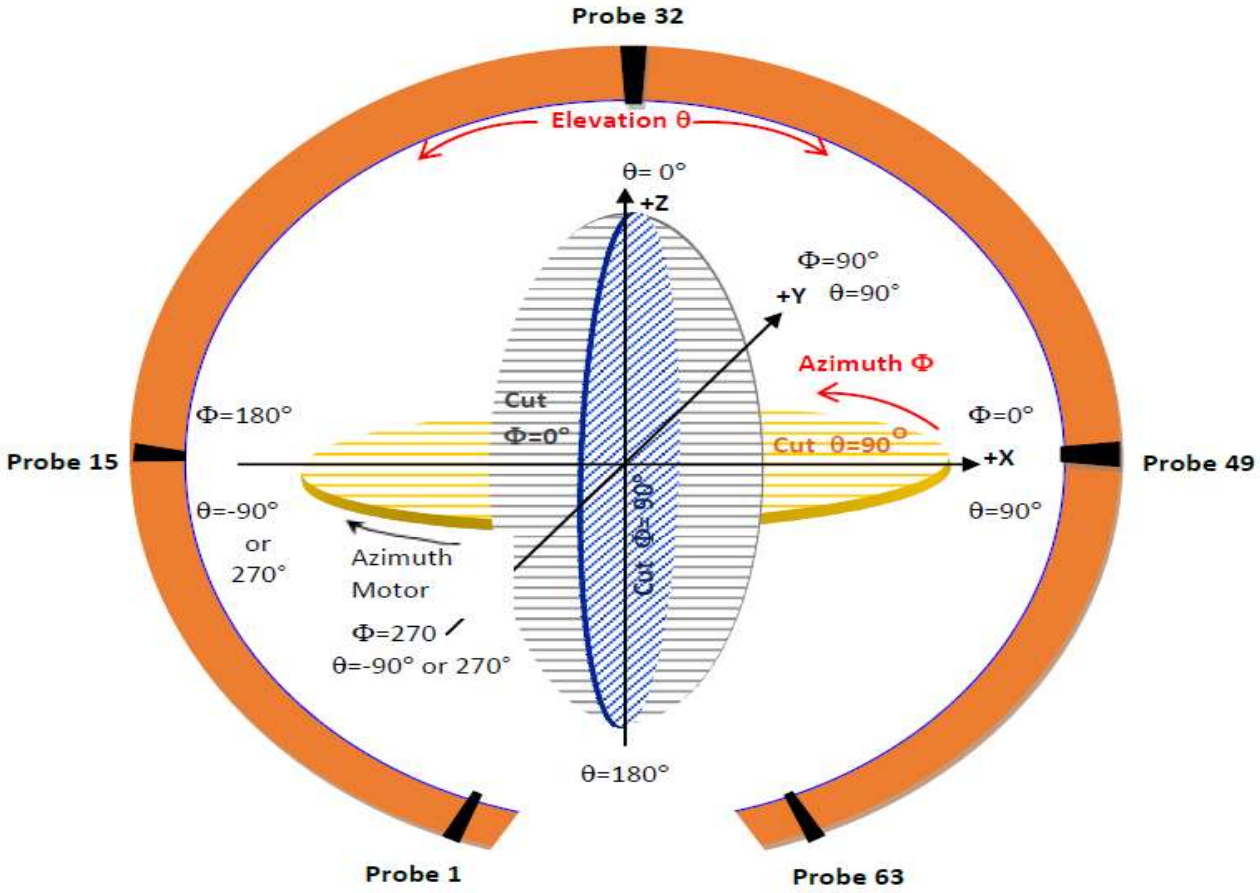
450 Franklin Gateway, Suite 100

Marietta, GA 30067

8) UMBRIEL WLAN Module in Chamber - (Module Front facing the –Y Direction)

Please refer "UMBRIEL_ANTENNA_DATASHEET_1_1(Photo)"

MVG SG64 Coordinate System

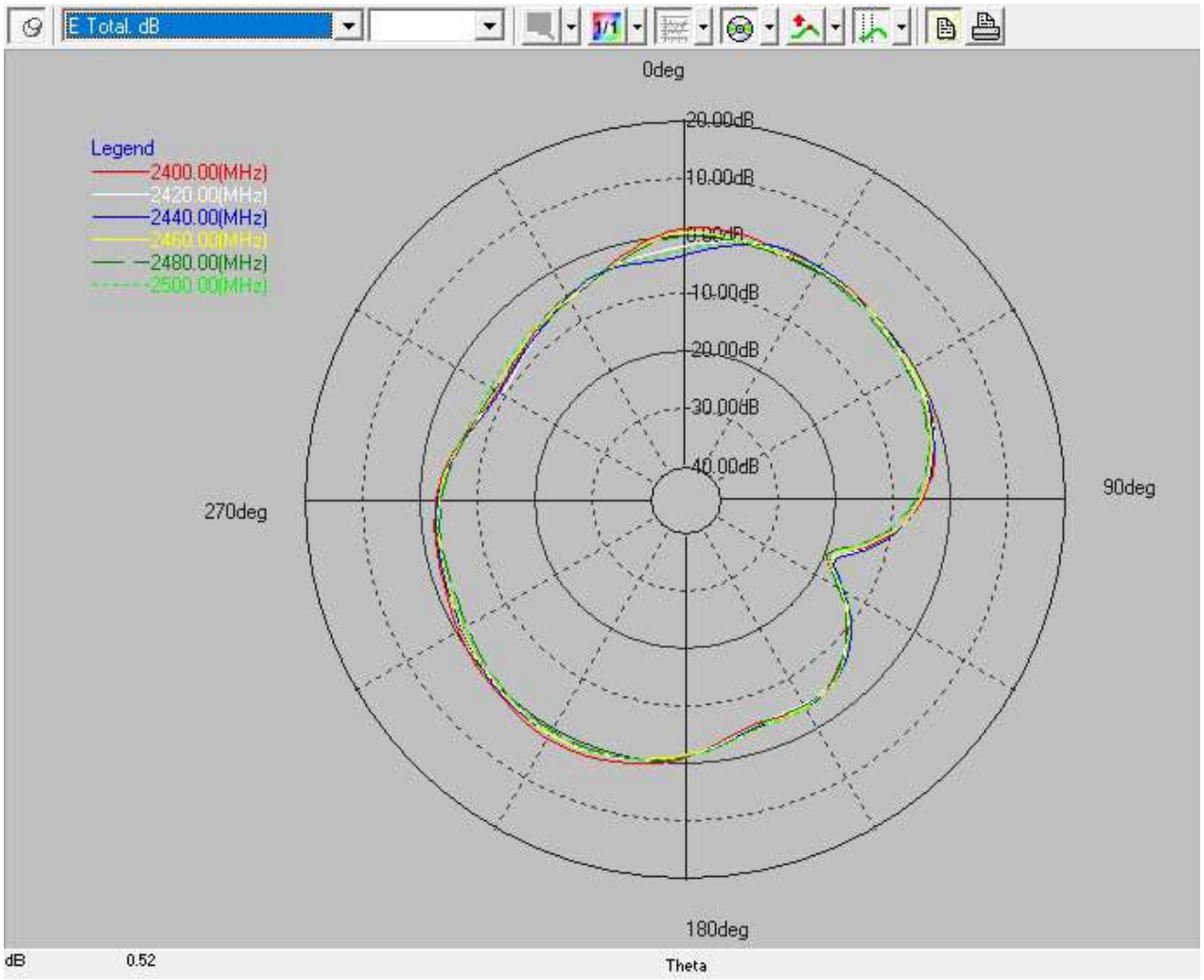


UMBRIEL Module Antenna Data

1) UMBRIEL Antenna 1 (MAIN) 2.4-2.5 GHz

Phi=0.00deg

E Total. dB



Average

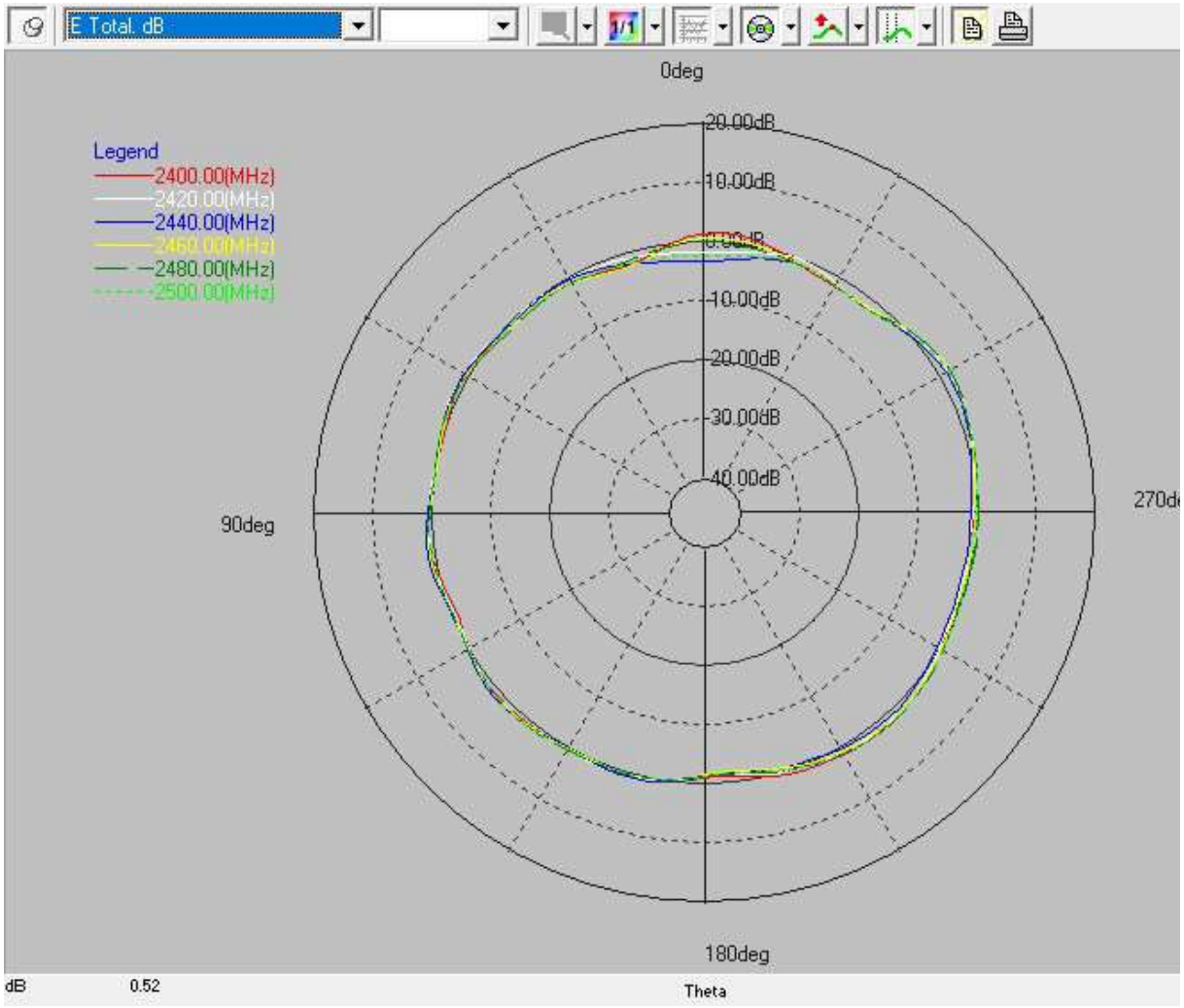
- 1:- 2.403 dB
- 2:0 dB
- 3:0 dB
- 4:- 2.403 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value

2400(MHz)	1.90 dB	-153.00 deg	-18.90 dB	114.00 deg	66.18 deg	20.80 dB	-2.40 dB	4.53	----	----	----	----
2420(MHz)	1.11 dB	-150.00 deg	-18.48 dB	114.00 deg	----	19.59 dB	-3.00 dB	4.25	----	----	----	----
2440(MHz)	0.94 dB	-150.00 deg	-17.84 dB	114.00 deg	----	18.78 dB	-2.97 dB	4.14	----	----	----	----
2460(MHz)	0.92 dB	-153.00 deg	-18.83 dB	111.00 deg	----	19.75 dB	-2.82 dB	4.31	----	----	----	----
2480(MHz)	0.40 dB	-153.00 deg	-19.81 dB	111.00 deg	----	20.21 dB	-3.29 dB	4.31	----	----	----	----
2500(MHz)	0.74 dB	-153.00 deg	-19.07 dB	111.00 deg	----	19.81 dB	-3.07 dB	4.11	----	----	----	----

Phi=90.00deg

E Total. dB



Average

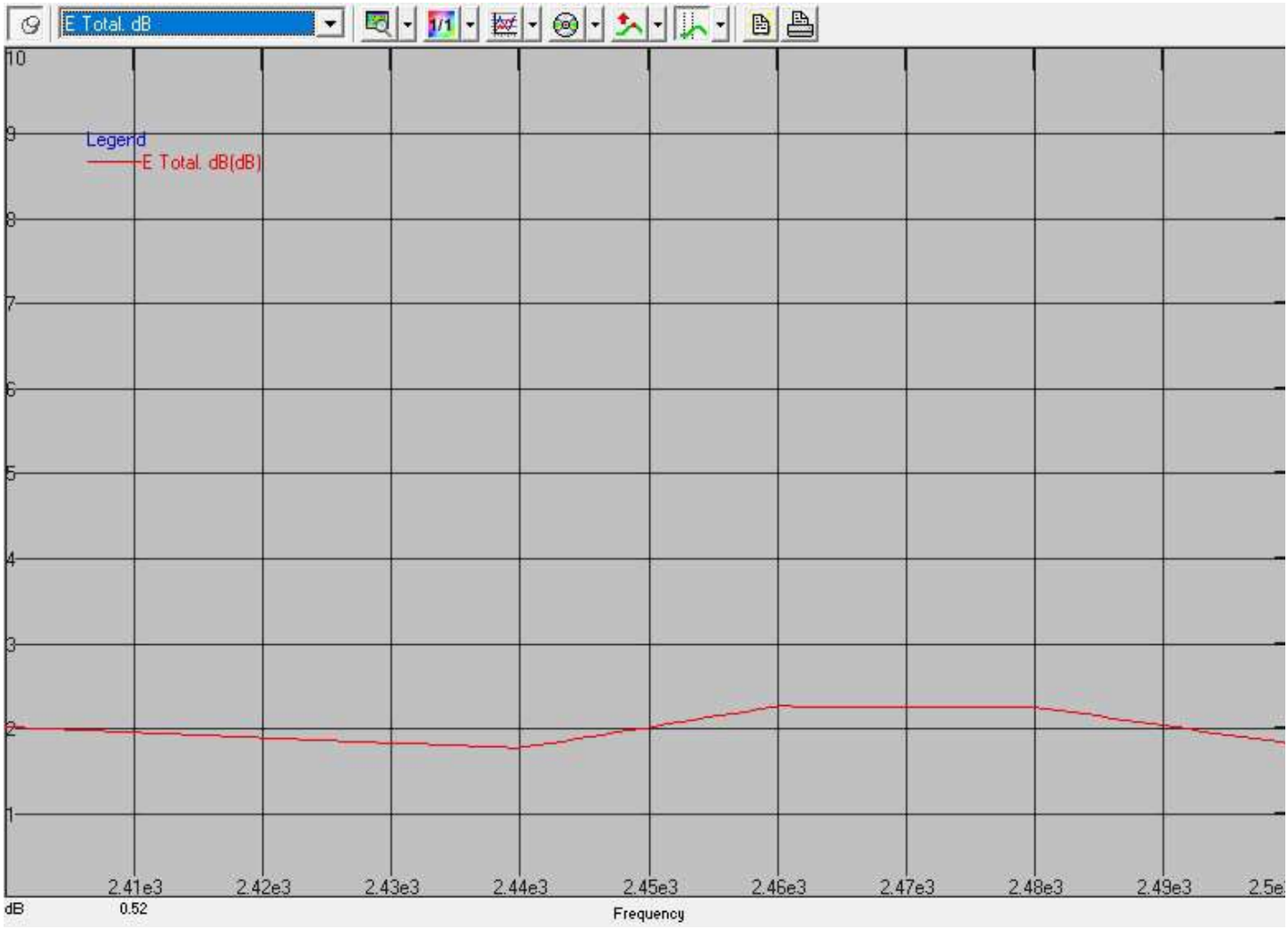
- 1:0.005 084 dB
- 2:0 dB
- 3:0 dB
- 4:0.005 084 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/ Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
2400(MHz)	1.68 dB	-63.00 deg	-2.36 dB	18.00 deg	134.52 deg	4.04 dB	0.01 dB	0.98	----	----	----	----
2420(MHz)	1.50 dB	-63.00 deg	-1.94 dB	-36.00 deg	132.68 deg	3.43 dB	-0.04 dB	0.92	----	----	----	----

2440(MHz)	1.35 dB	-63.00 deg	-3.53 dB	3.00 deg	128.45 deg	4.88 dB	-0.32 dB	1.18	----	----	----	----
2460(MHz)	1.99 dB	-63.00 deg	-2.65 dB	18.00 deg	121.40 deg	4.64 dB	-0.07 dB	0.99	----	----	----	----
2480(MHz)	1.95 dB	-60.00 deg	-2.07 dB	-36.00 deg	124.81 deg	4.03 dB	0.05 dB	0.98	----	----	----	----
2500(MHz)	1.58 dB	-63.00 deg	-2.64 dB	0.00 deg	127.21 deg	4.22 dB	-0.12 dB	1.14	----	----	----	----

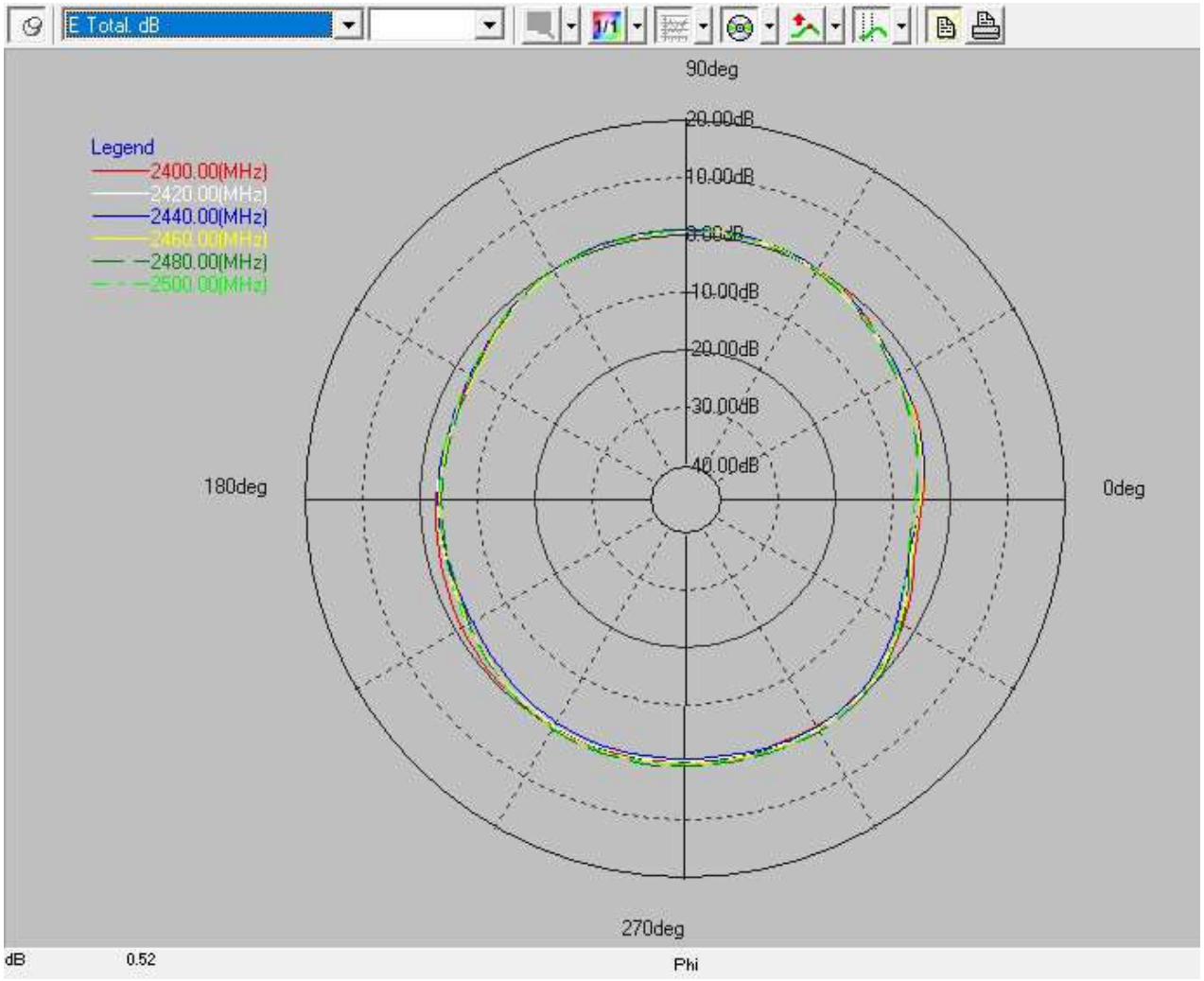
NF to FF transform Maximum Maximum

E Total. dB



Theta=90.00deg

E Total. dB



Average

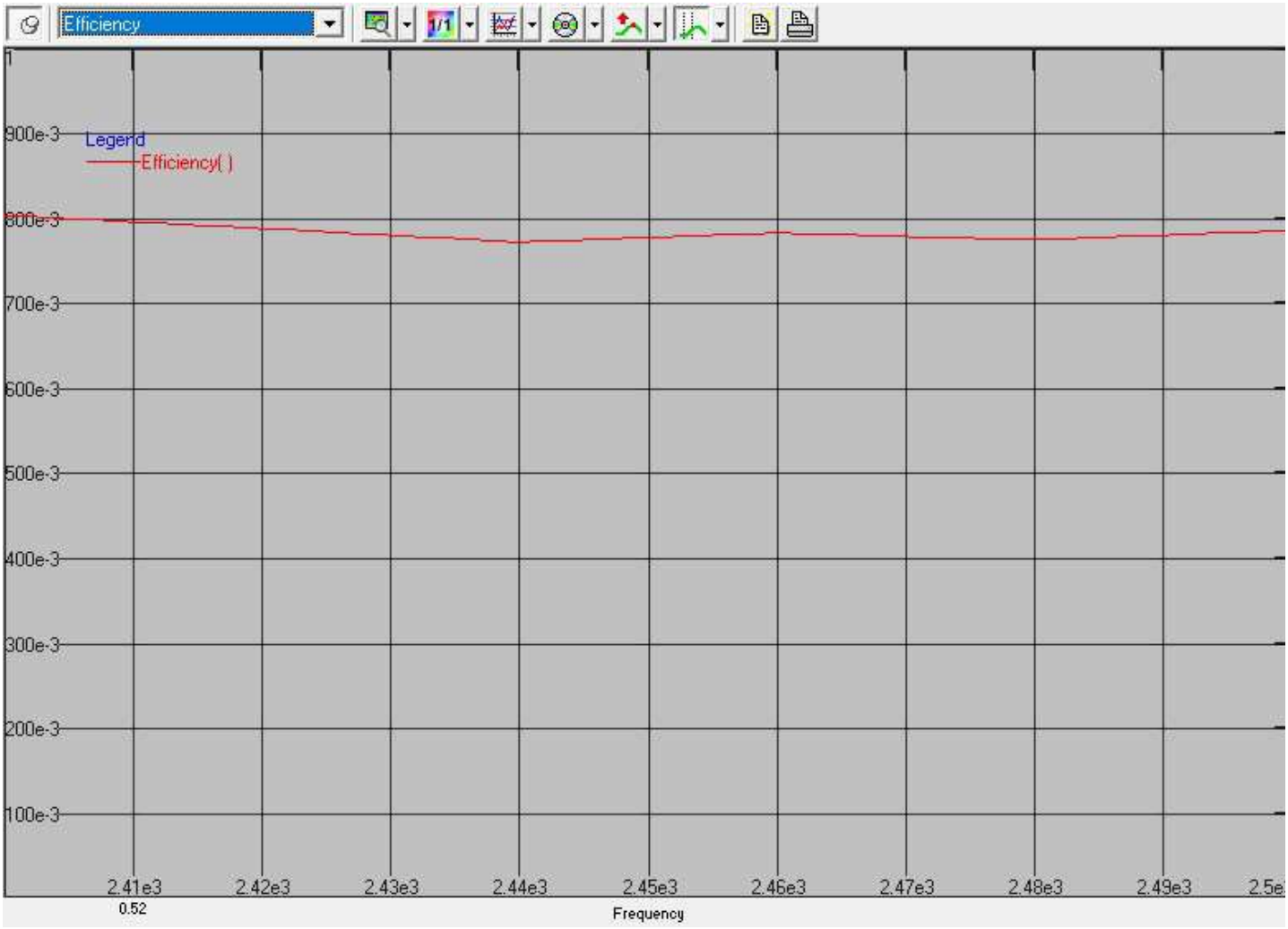
- 1:-1.365 dB
- 2:0 dB
- 3:0 dB
- 4:-1.365 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
2400(MHz)	0.78 dB	87.00 deg	-5.15 dB	351.00 deg	99.26 deg	5.93 dB	-1.37 dB	1.60	----	----	----	----
2420(MHz)	0.60 dB	87.00 deg	-5.69 dB	351.00 deg	101.07 deg	6.29 dB	-1.58 dB	1.70	----	----	----	----

2440(MHz)	0.73 dB	84.00 deg	-5.89 dB	348.00 deg	102.81 deg	6.62 dB	-1.73 dB	1.74	----	----	----	----
2460(MHz)	0.56 dB	84.00 deg	-5.60 dB	351.00 deg	99.80 deg	6.16 dB	-1.52 dB	1.82	----	----	----	----
2480(MHz)	0.64 dB	300.00 deg	-6.31 dB	354.00 deg	116.51 deg	6.95 dB	-1.48 dB	2.12	----	----	----	----
2500(MHz)	0.48 dB	84.00 deg	-6.51 dB	351.00 deg	107.68 deg	6.99 dB	-1.52 dB	2.01	----	----	----	----

NF to FF transform Efficiency

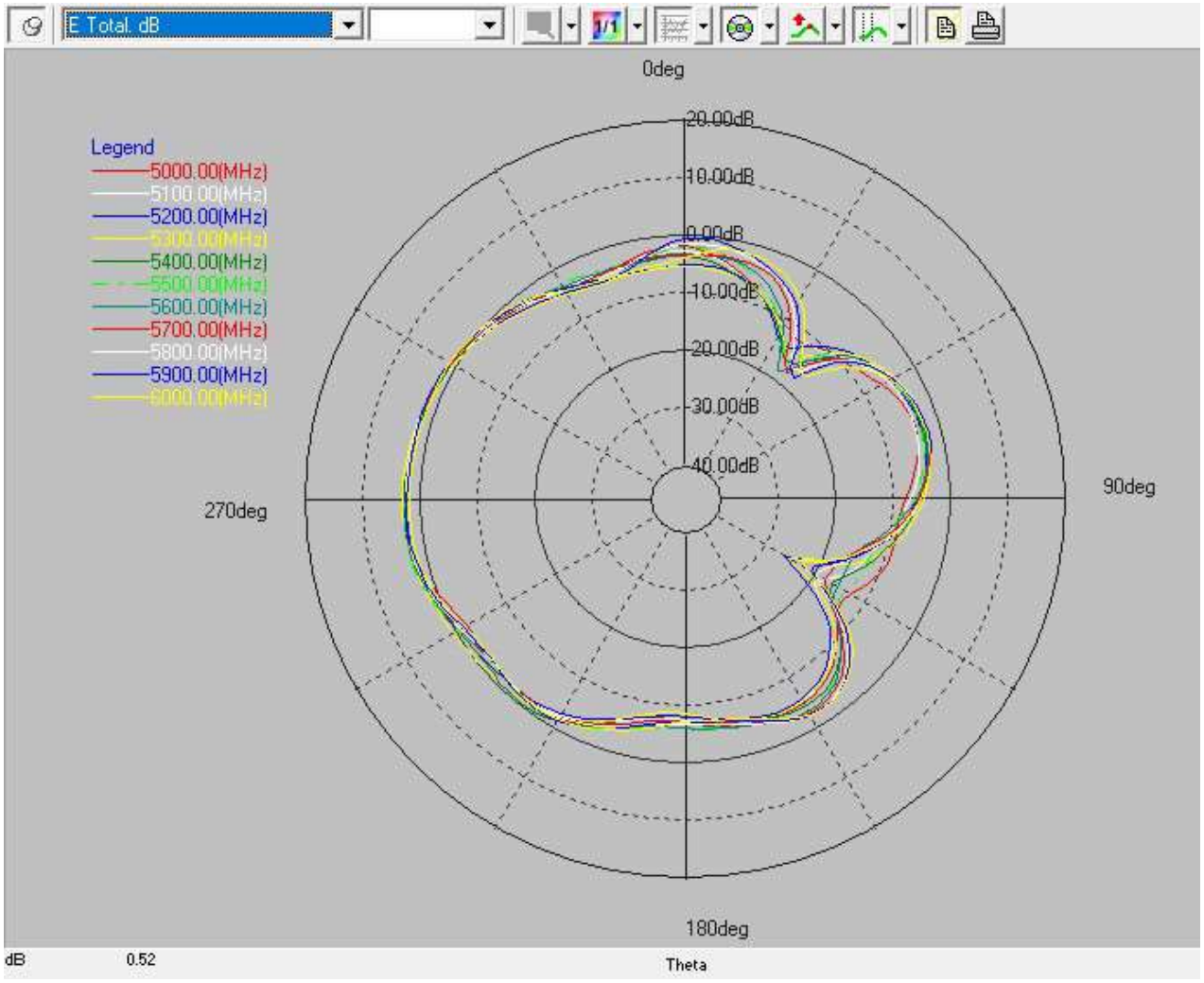
Efficiency



2)UMBRIEL Antenna 1 (MAIN) 5.0 – 6.0 GHz

Phi=0.00deg

E Total. dB



Average

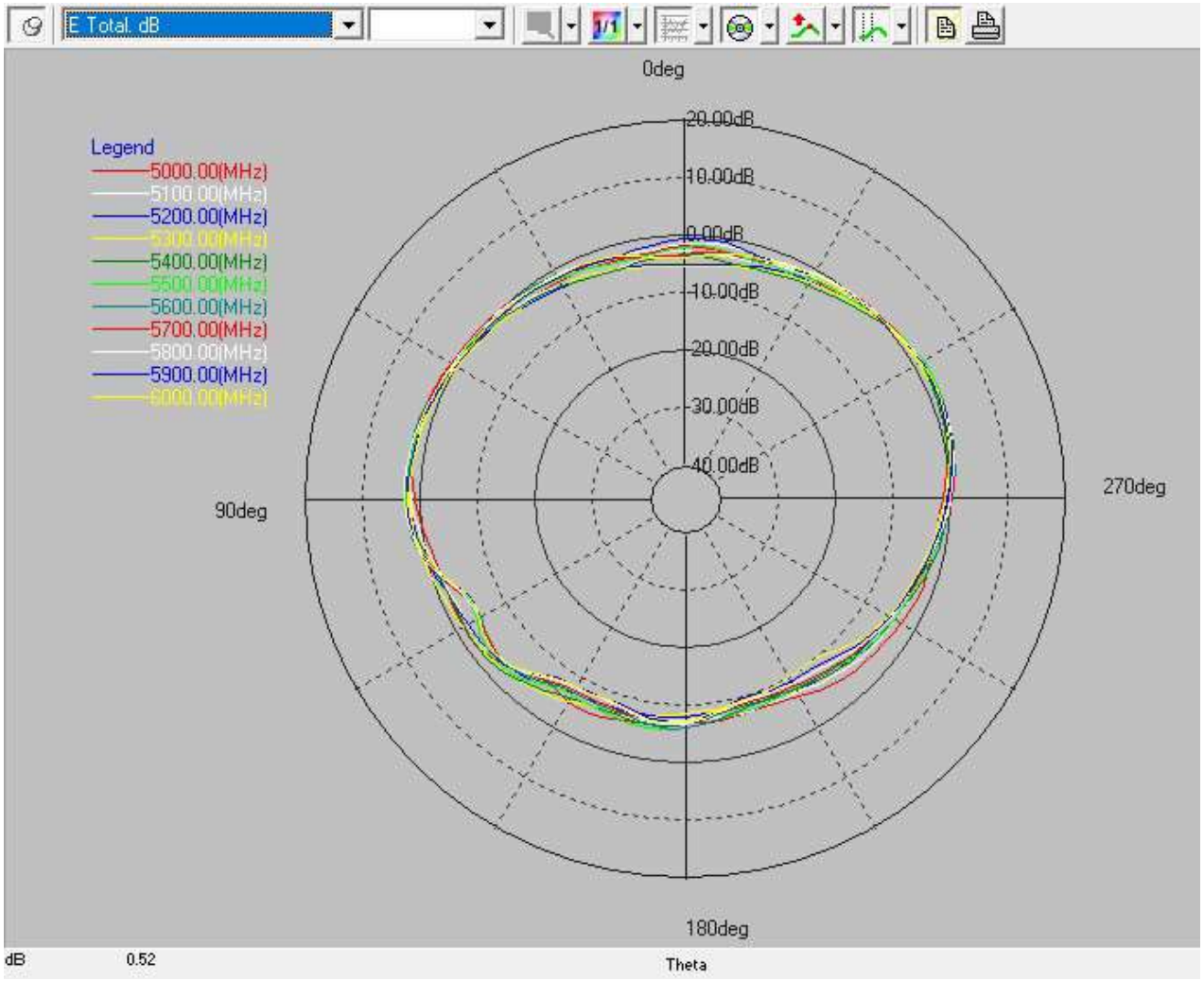
- 1:- 3.699 dB
- 2:0 dB
- 3:0 dB
- 4:- 3.699 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/ Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
5000(MHz)	2.83 dB	-93.00 deg	-13.49 dB	123.00 deg	57.49 deg	16.32 dB	-3.70 dB	4.13	----	----	----	----

5100(MHz)	2.65 dB	-93.00 deg	-19.08 dB	123.00 deg	62.71 deg	21.73 dB	-3.92 dB	4.76	----	----	----	----
5200(MHz)	2.79 dB	-93.00 deg	-25.96 dB	120.00 deg	63.94 deg	28.75 dB	-4.00 dB	5.50	----	----	----	----
5300(MHz)	3.13 dB	-90.00 deg	-25.20 dB	120.00 deg	65.23 deg	28.33 dB	-3.68 dB	5.42	----	----	----	----
5400(MHz)	2.92 dB	-93.00 deg	-16.47 dB	120.00 deg	65.78 deg	19.40 dB	-3.37 dB	4.81	----	----	----	----
5500(MHz)	2.93 dB	-96.00 deg	-15.41 dB	36.00 deg	67.85 deg	18.34 dB	-3.16 dB	4.59	----	----	----	----
5600(MHz)	2.59 dB	-93.00 deg	-18.43 dB	36.00 deg	69.95 deg	21.01 dB	-3.35 dB	4.89	----	----	----	----
5700(MHz)	2.58 dB	-93.00 deg	-17.95 dB	39.00 deg	68.52 deg	20.53 dB	-3.35 dB	5.00	----	----	----	----
5800(MHz)	2.60 dB	-93.00 deg	-19.62 dB	120.00 deg	69.01 deg	22.22 dB	-3.10 dB	4.99	----	----	----	----
5900(MHz)	2.43 dB	-93.00 deg	-20.80 dB	120.00 deg	70.47 deg	23.22 dB	-3.06 dB	5.12	----	----	----	----
6000(MHz)	1.94 dB	-93.00 deg	-23.08 dB	117.00 deg	74.35 deg	25.01 dB	-3.34 dB	5.05	----	----	----	----

Phi=90.00deg

E Total. dB



Average

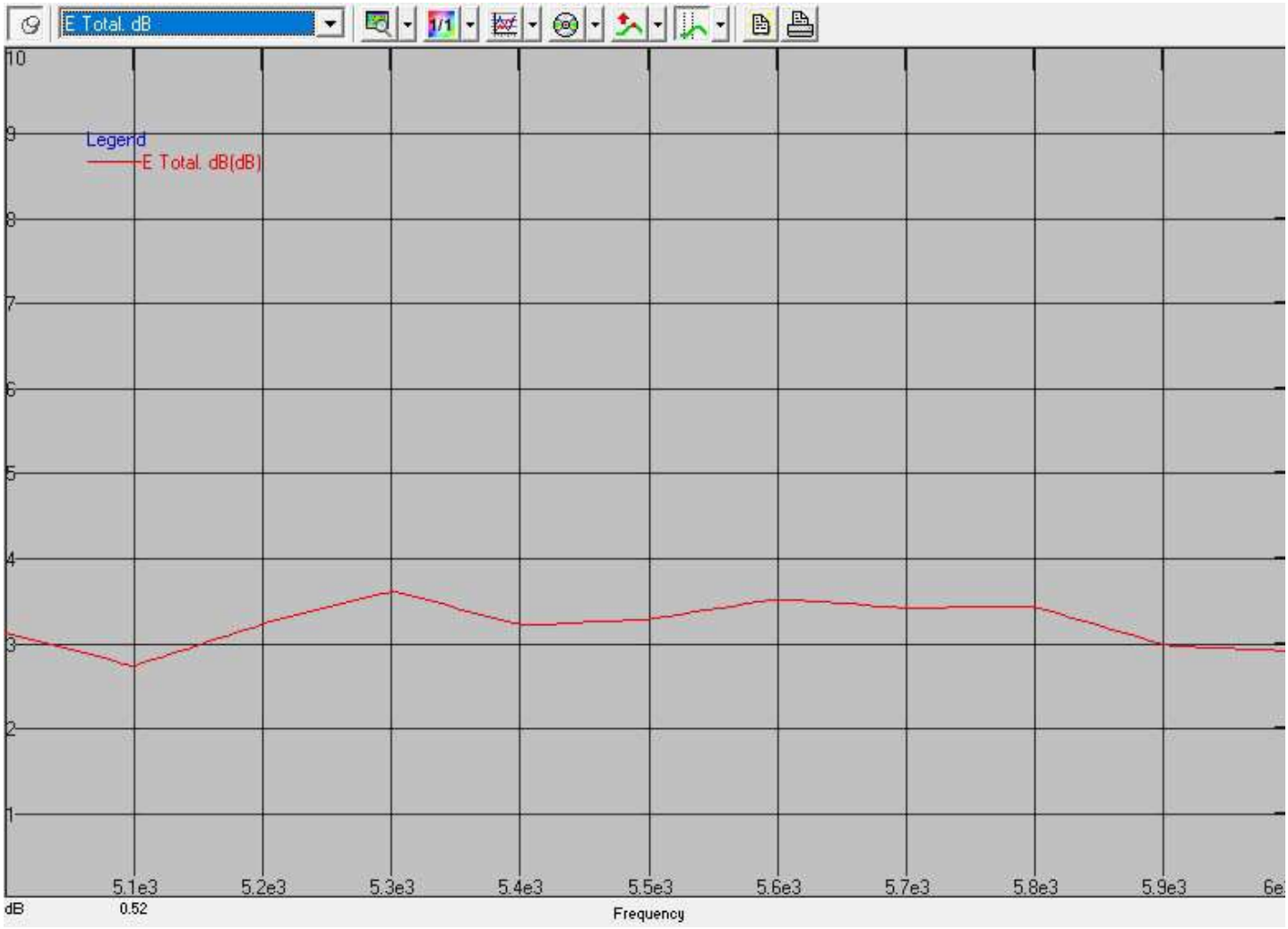
- 1:- 2.0 11 dB
- 2:0 dB
- 3:0 dB
- 4:- 2.0 11 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/ Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
5000(MHz)	2.08 dB	75.00 deg	-7.47 dB	-162.00 deg	55.50 deg	9.55 dB	-2.01 dB	2.70	----	----	----	----
5100(MHz)	1.98 dB	81.00 deg	-7.64 dB	-174.00 deg	57.31 deg	9.63 dB	-2.28 dB	2.96	----	----	----	----

5200(MHz)	2.17 dB	84.00 deg	-8.76 dB	-168.00 deg	55.15 deg	10.93 dB	-2.60 dB	3.28	----	----	----	----
5300(MHz)	1.97 dB	84.00 deg	-8.98 dB	-174.00 deg	61.80 deg	10.95 dB	-2.54 dB	3.28	----	----	----	----
5400(MHz)	2.37 dB	84.00 deg	-8.54 dB	-162.00 deg	52.38 deg	10.91 dB	-2.32 dB	3.03	----	----	----	----
5500(MHz)	2.41 dB	87.00 deg	-7.99 dB	-153.00 deg	59.72 deg	10.40 dB	-1.99 dB	3.09	----	----	----	----
5600(MHz)	2.71 dB	87.00 deg	-8.37 dB	-159.00 deg	63.56 deg	11.08 dB	-1.94 dB	3.35	----	----	----	----
5700(MHz)	2.71 dB	87.00 deg	-8.96 dB	-162.00 deg	61.85 deg	11.67 dB	-2.03 dB	3.55	----	----	----	----
5800(MHz)	2.72 dB	87.00 deg	-9.26 dB	-159.00 deg	60.19 deg	11.98 dB	-2.00 dB	3.65	----	----	----	----
5900(MHz)	2.23 dB	90.00 deg	-9.95 dB	-162.00 deg	60.53 deg	12.18 dB	-2.27 dB	3.71	----	----	----	----
6000(MHz)	2.04 dB	90.00 deg	-10.32 dB	-144.00 deg	67.12 deg	12.36 dB	-2.51 dB	3.71	----	----	----	----

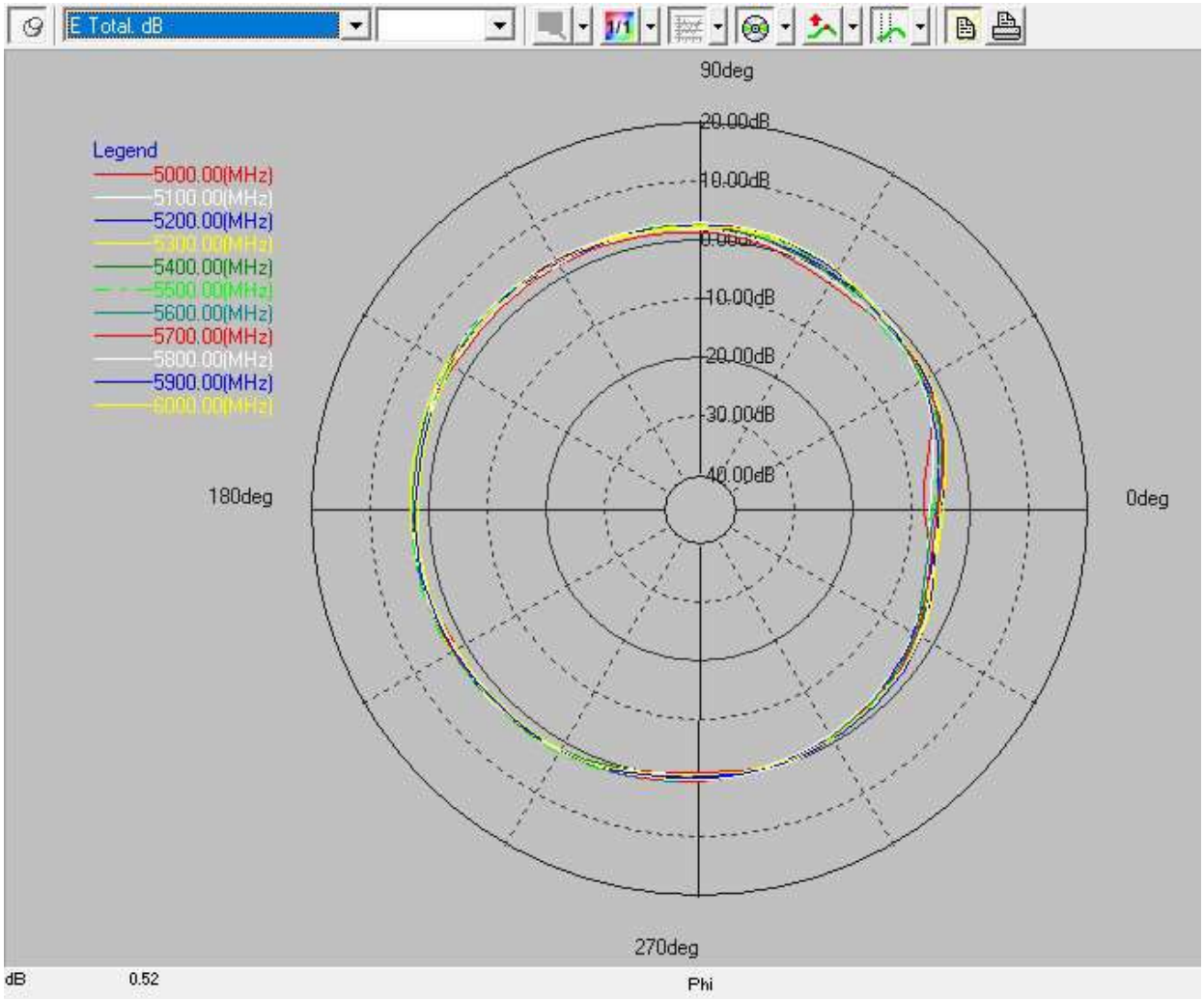
NF to FF transform Maximum Maximum

E Total. dB



Theta=90.00deg

E Total. dB



Average

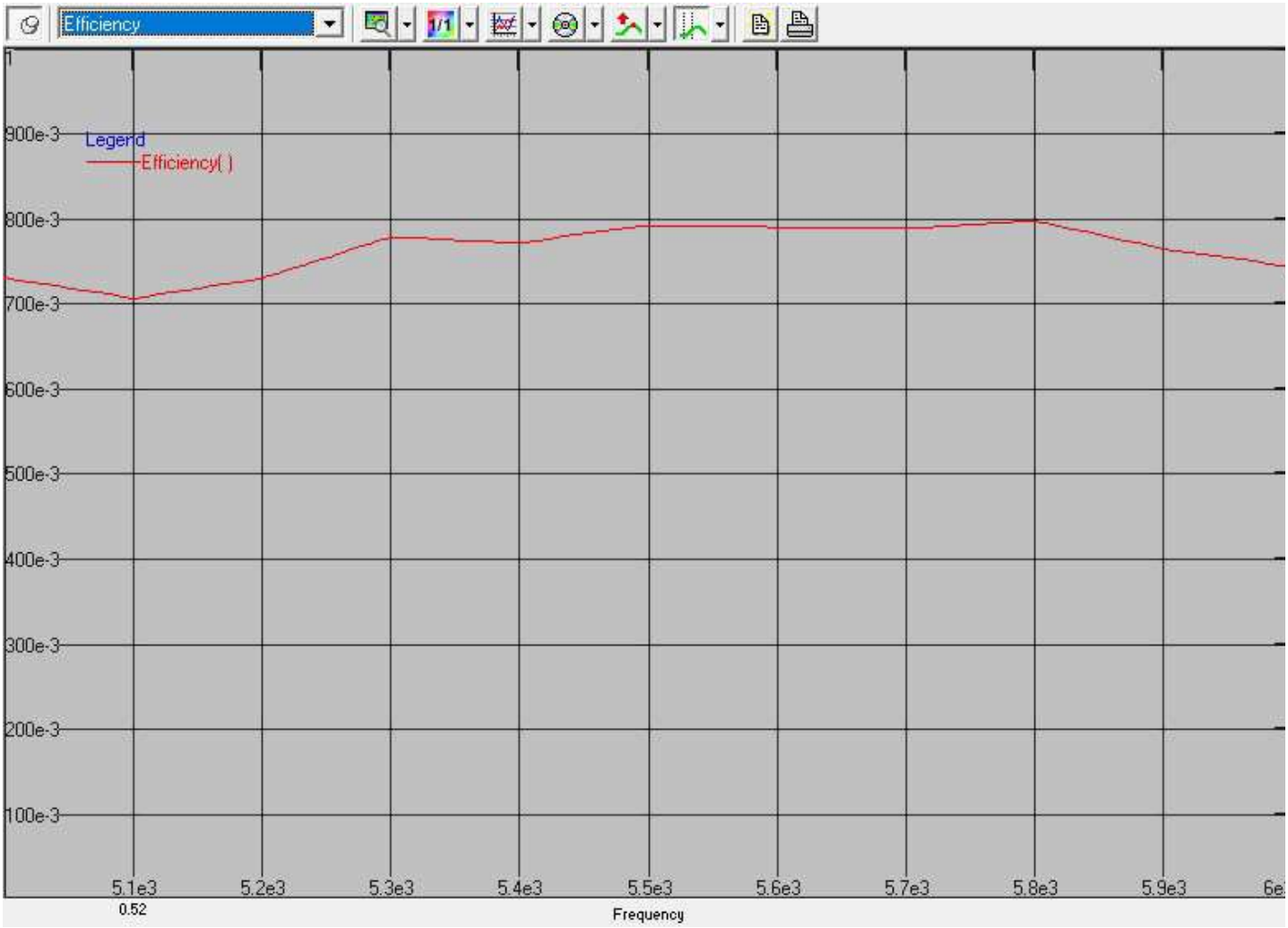
- 1:- 0.06934 dB
- 2:0 dB
- 3:0 dB
- 4:- 0.06934 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/ Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
5000(MHz)	2.83 dB	168.00 deg	-7.85 dB	3.00 deg	183.04 deg	10.68 dB	-0.07 dB	2.79	----	----	----	----
5100(MHz)	2.64 dB	174.00 deg	-6.86 dB	357.00 deg	191.94 deg	9.50 dB	0.03 dB	2.79	----	----	----	----

5200(MHz)	3.24 dB	153.00 deg	-5.70 dB	354.00 deg	192.87 deg	8.94 dB	0.46 dB	2.69	----	----	----	----
5300(MHz)	3.62 dB	150.00 deg	-4.93 dB	348.00 deg	197.58 deg	8.55 dB	0.81 dB	2.57	----	----	----	----
5400(MHz)	3.13 dB	147.00 deg	-5.29 dB	354.00 deg	188.79 deg	8.42 dB	0.62 dB	2.53	----	----	----	----
5500(MHz)	3.27 dB	195.00 deg	-6.82 dB	354.00 deg	206.94 deg	10.08 dB	0.66 dB	2.89	----	----	----	----
5600(MHz)	3.50 dB	141.00 deg	-6.52 dB	351.00 deg	208.22 deg	10.02 dB	0.75 dB	2.81	----	----	----	----
5700(MHz)	3.41 dB	141.00 deg	-5.93 dB	351.00 deg	207.65 deg	9.33 dB	0.80 dB	2.63	----	----	----	----
5800(MHz)	3.41 dB	141.00 deg	-5.36 dB	354.00 deg	203.99 deg	8.77 dB	0.88 dB	2.47	----	----	----	----
5900(MHz)	2.92 dB	138.00 deg	-5.30 dB	354.00 deg	211.75 deg	8.22 dB	0.66 dB	2.30	----	----	----	----
6000(MHz)	2.81 dB	141.00 deg	-5.15 dB	354.00 deg	207.60 deg	7.95 dB	0.48 dB	2.22	----	----	----	----

NF to FF transform Efficiency

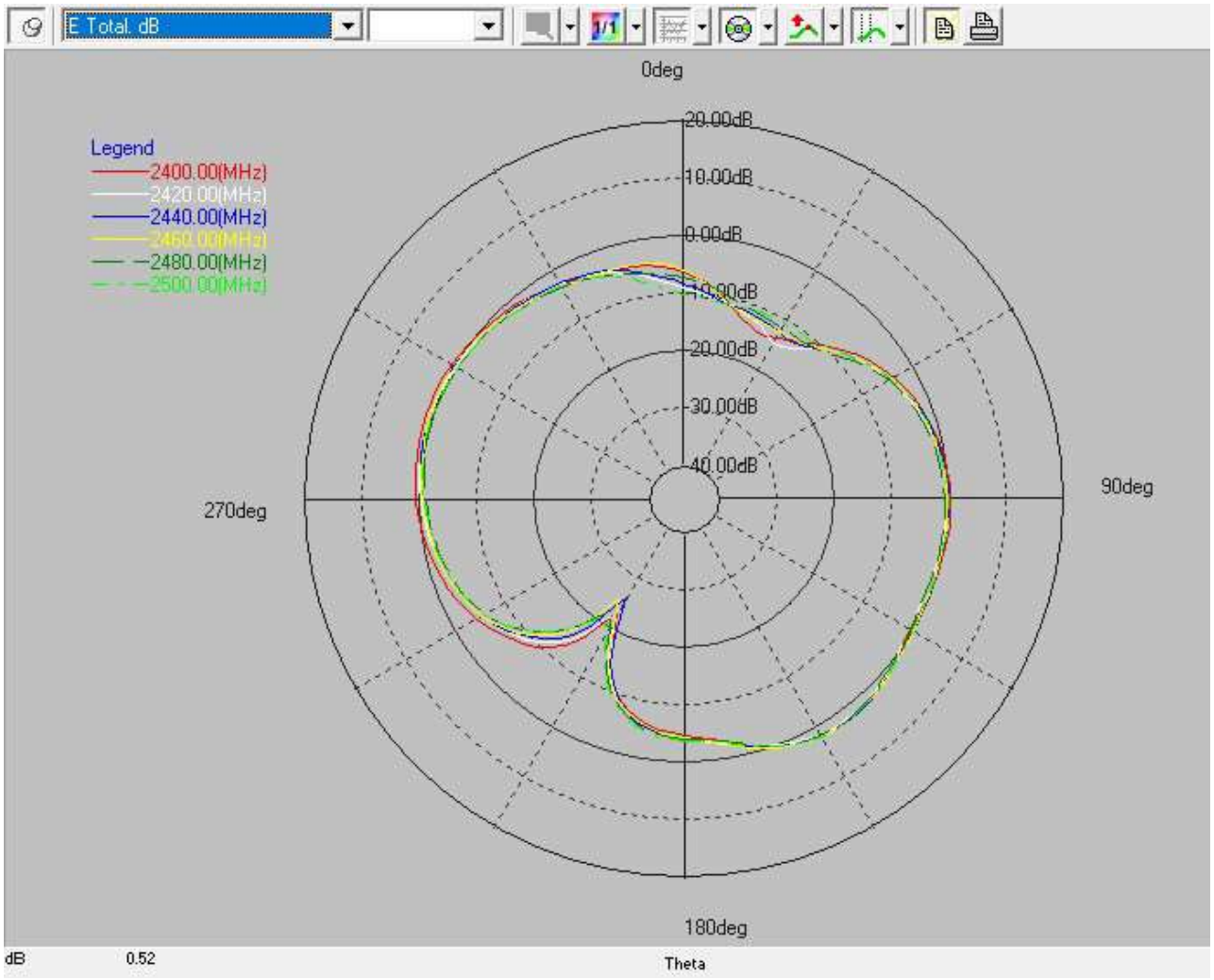
Efficiency



3) UMBRIEL Antenna 2 (AUX) 2.4-2.5 GHz

Phi=0.00deg

E Total. dB



Average

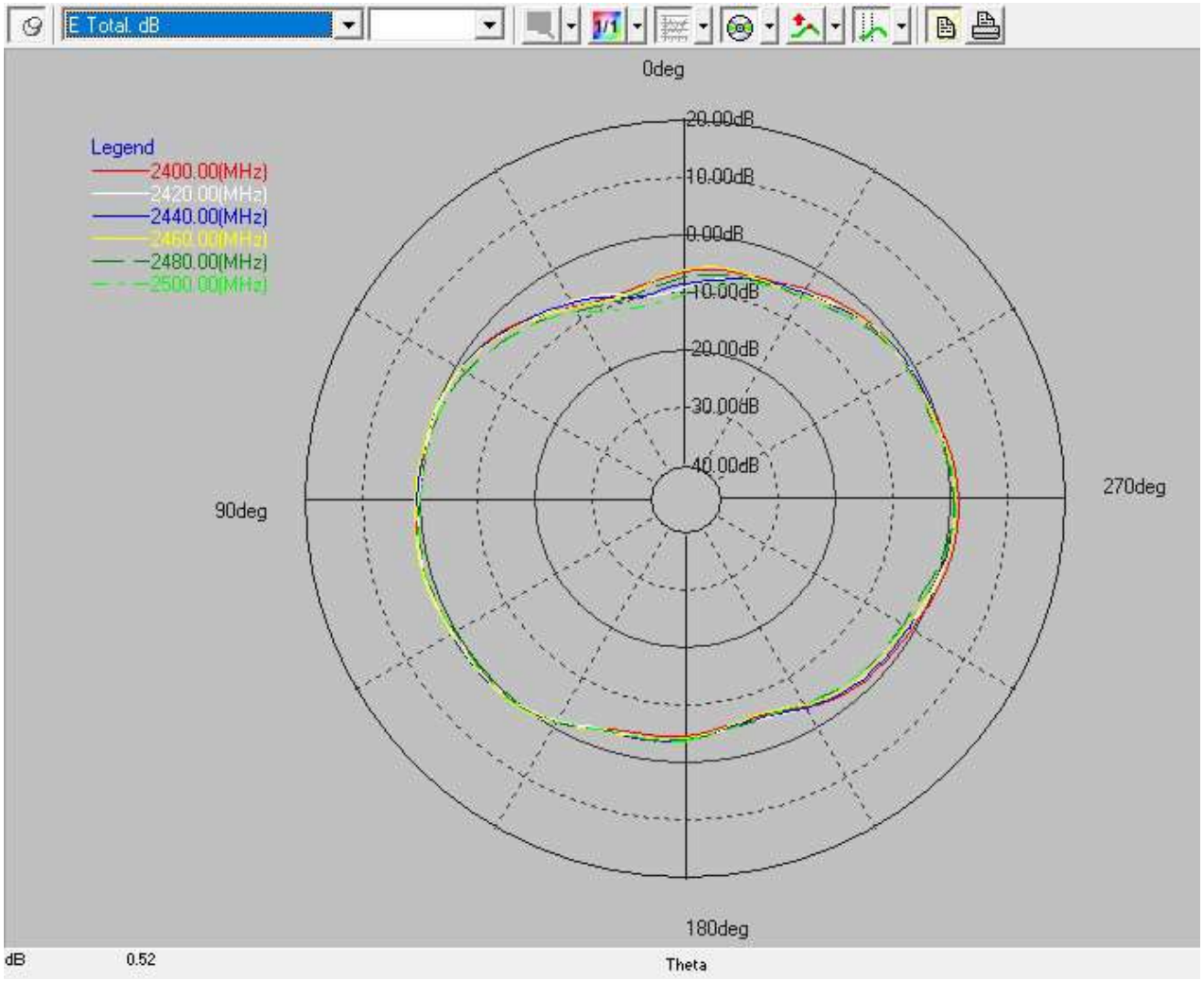
- 1:- 2. 75 dB
- 2: 0 dB
- 3: 0 dB
- 4:- 2. 75 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/ Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
2400(MHz)	1.97 dB	144.00 deg	-23.05 dB	-150.00 deg	89.64 deg	25.01 dB	-2.75 dB	5.36	----	----	----	----

2420(MHz)	1.77 dB	144.00 deg	-22.46 dB	-150.00 deg	88.13 deg	24.23 dB	-3.26 dB	5.34	----	----	----	----
2440(MHz)	2.12 dB	144.00 deg	-26.03 dB	-150.00 deg	86.67 deg	28.15 dB	-3.07 dB	5.59	----	----	----	----
2460(MHz)	2.05 dB	144.00 deg	-25.29 dB	-147.00 deg	86.11 deg	27.34 dB	-3.08 dB	5.47	----	----	----	----
2480(MHz)	1.81 dB	144.00 deg	-22.59 dB	-147.00 deg	82.75 deg	24.39 dB	-3.49 dB	5.12	----	----	----	----
2500(MHz)	2.05 dB	144.00 deg	-21.01 dB	-147.00 deg	86.26 deg	23.05 dB	-3.26 dB	5.19	----	----	----	----

Phi=90.00deg

E Total. dB



Average

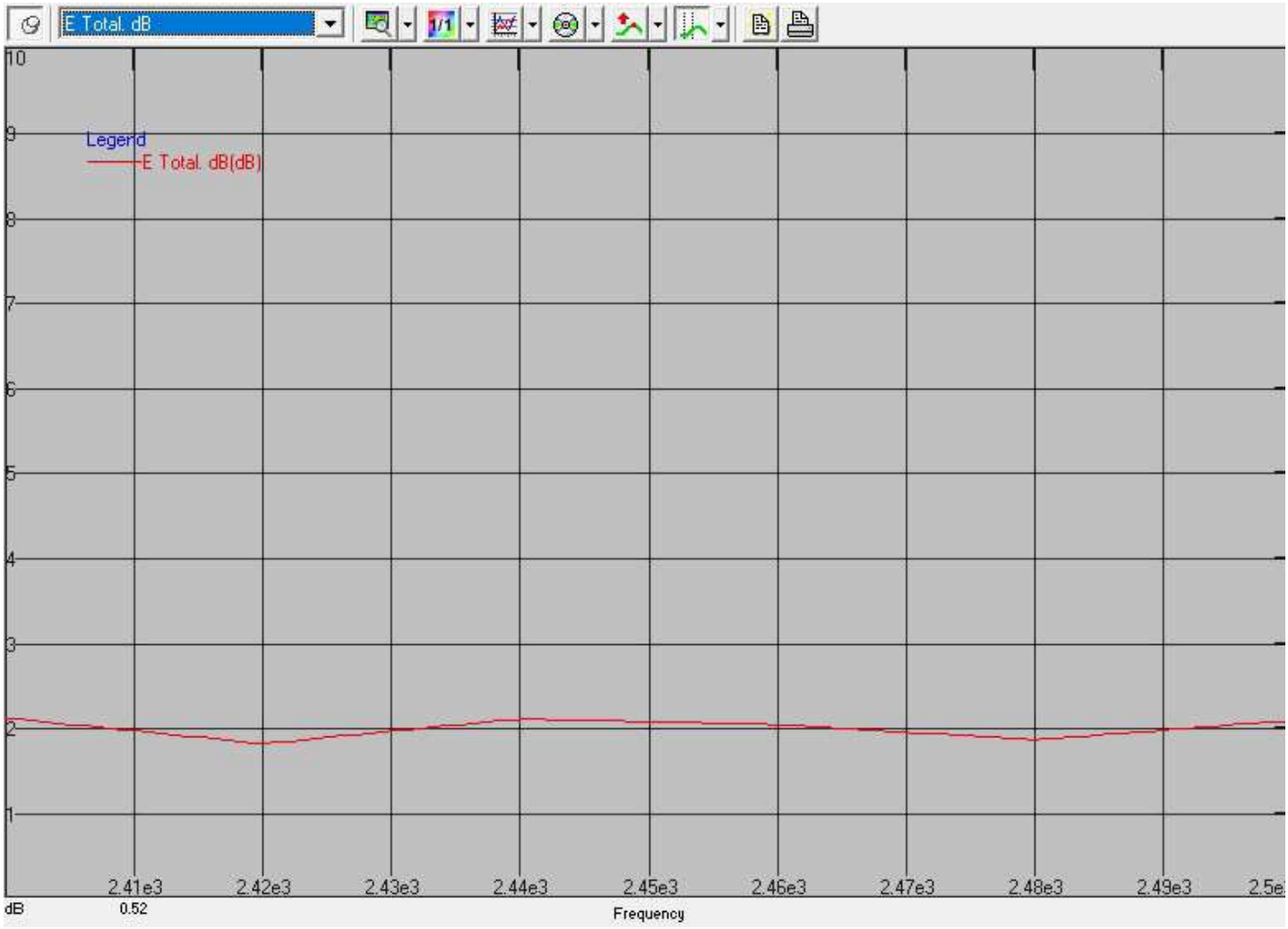
- 1:-1.919 dB
- 2:0 dB
- 3:0 dB
- 4:-1.919 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
2400(MHz)	1.68 dB	-93.00 deg	-8.69 dB	18.00 deg	80.40 deg	10.37 dB	-1.92 dB	2.98	----	----	----	----
2420(MHz)	1.07 dB	105.00 deg	-10.52 dB	9.00 deg	98.35 deg	11.59 dB	-2.18 dB	3.06	----	----	----	----

2440(MHz)	1.54 dB	105.00 deg	-10.13 dB	12.00 deg	95.72 deg	11.67 dB	-2.03 dB	3.15	----	----	----	----
2460(MHz)	1.49 dB	105.00 deg	-9.20 dB	18.00 deg	95.77 deg	10.68 dB	-2.04 dB	2.99	----	----	----	----
2480(MHz)	0.99 dB	105.00 deg	-9.81 dB	18.00 deg	93.60 deg	10.80 dB	-2.56 dB	2.97	----	----	----	----
2500(MHz)	0.94 dB	-93.00 deg	-11.93 dB	12.00 deg	70.88 deg	12.86 dB	-2.64 dB	3.51	----	----	----	----

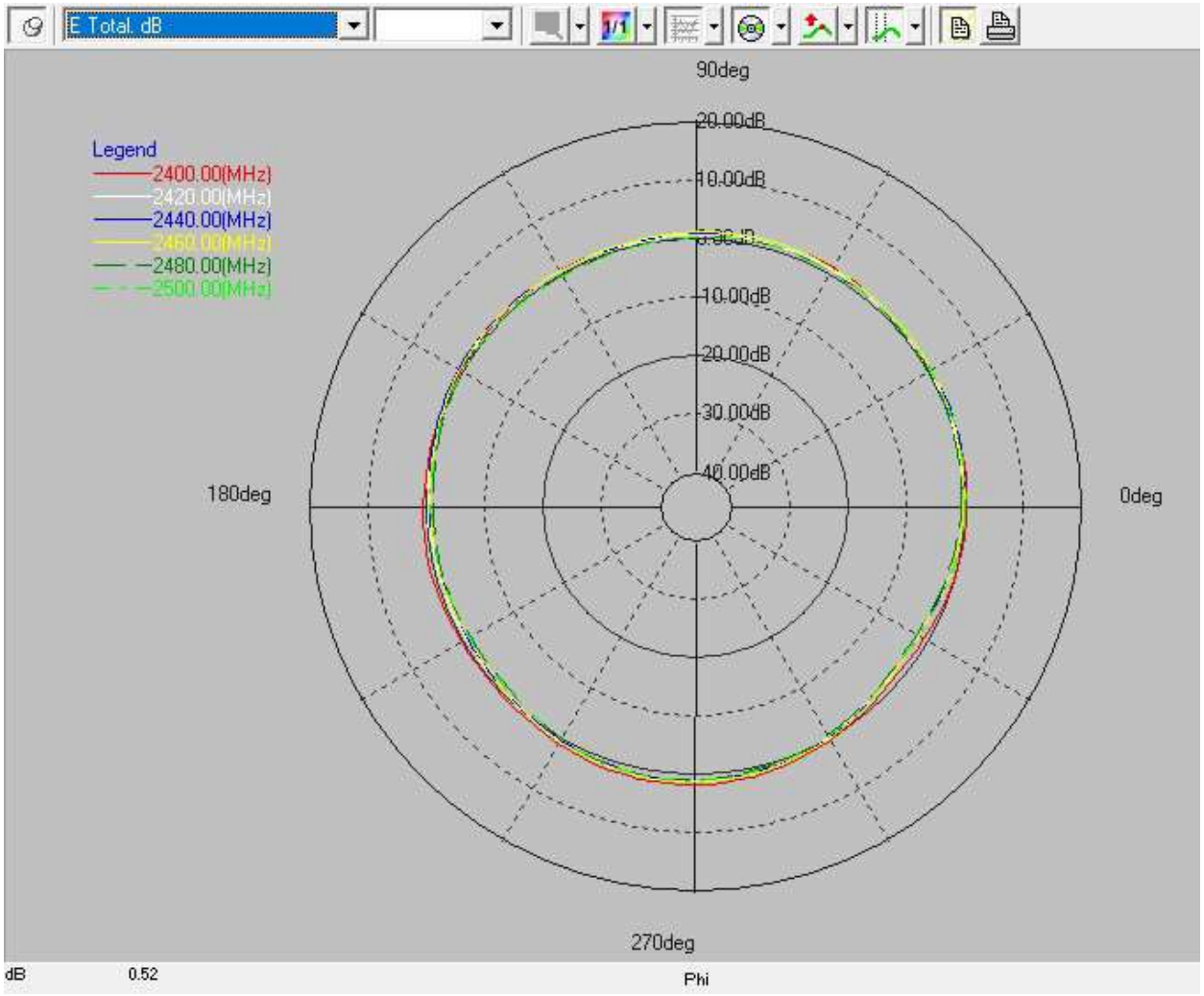
NF to FF transform Maximum Maximum

E Total. dB



Theta=90.00deg

E Total. dB



Average

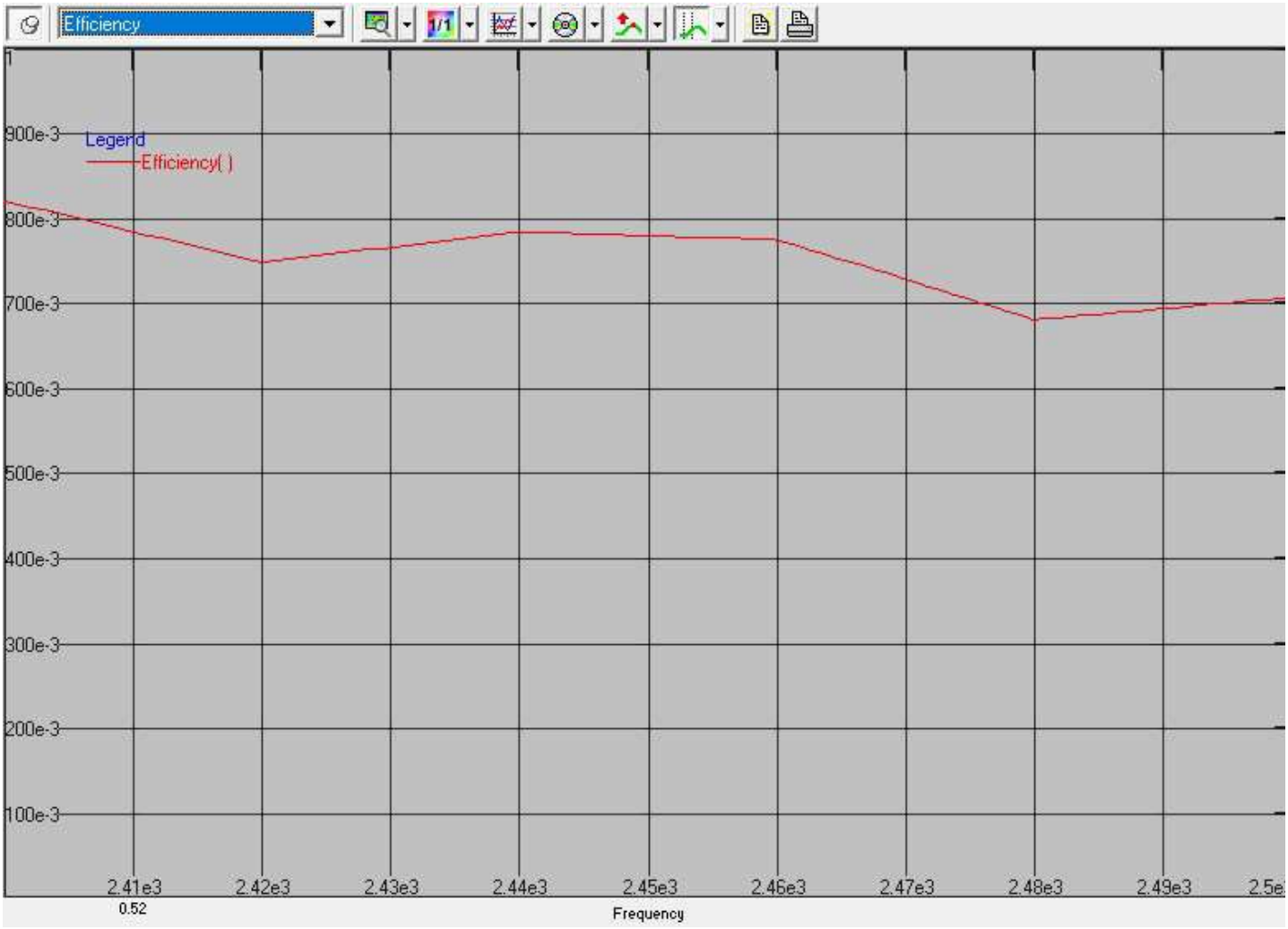
- 1:0.569 dB
- 2:0 dB
- 3:0 dB
- 4:0.569 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
2400(MHz)	1.64 dB	264.00 deg	-1.01 dB	321.00 deg	---	2.65 dB	0.57 dB	0.57	---	---	----	----
2420(MHz)	0.92 dB	270.00 deg	-1.86 dB	324.00 deg	---	2.78 dB	0.06 dB	0.69	---	---	----	----

2440(MHz)	1.05 dB	66.00 deg	-1.92 dB	327.00 deg	---	2.97 dB	0.15 dB	0.82	---	---	----	----
2460(MHz)	1.12 dB	261.00 deg	-1.84 dB	327.00 deg	---	2.96 dB	0.15 dB	0.82	---	---	----	----
2480(MHz)	0.80 dB	261.00 deg	-2.34 dB	327.00 deg	---	3.14 dB	-0.38 dB	0.80	---	---	----	----
2500(MHz)	0.97 dB	264.00 deg	-2.01 dB	324.00 deg	---	2.98 dB	-0.18 dB	0.75	---	---	----	----

NF to FF transform Efficiency

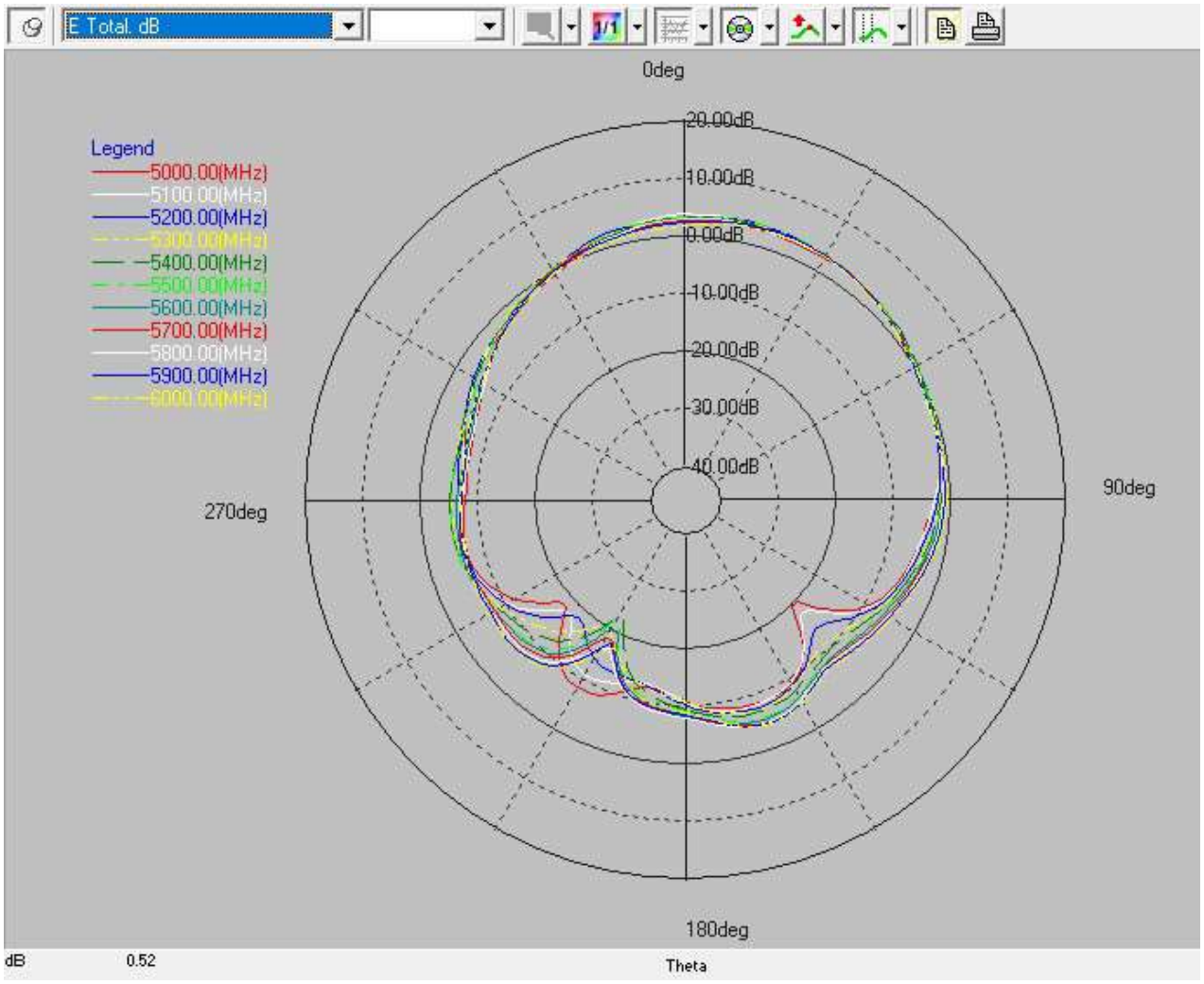
Efficiency



4) UMBRIEL Antenna 2 (AUX) 5.0-6.0 GHz

Phi=0.00deg

E Total. dB



Average

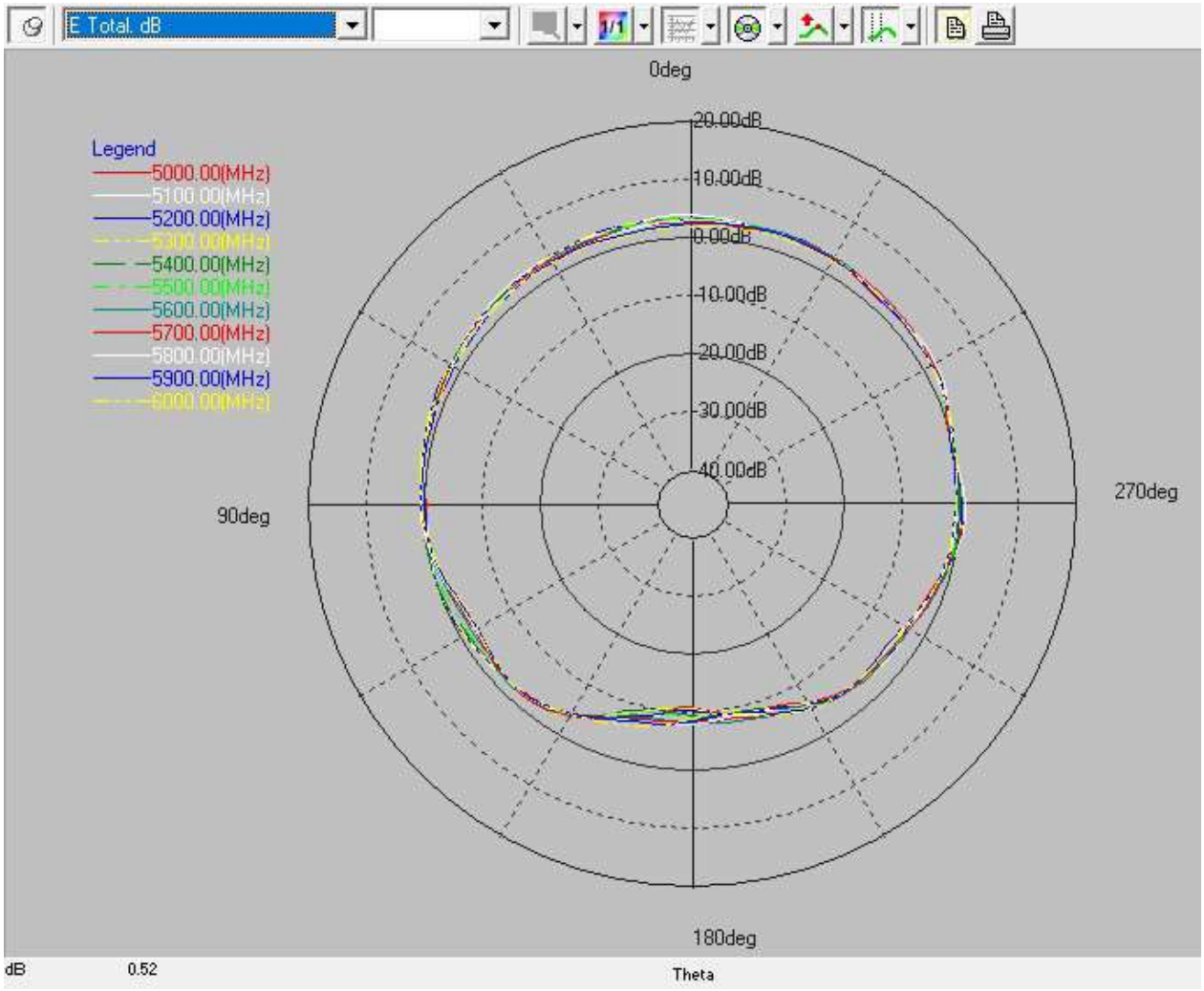
- 1:- 3.655 dB
- 2:0 dB
- 3:0 dB
- 4:- 3.655 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/ Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
5000(MHz)	2.82 dB	6.00 deg	-19.75 dB	132.00 deg	92.40 deg	22.57 dB	-3.65 dB	5.86	----	----	----	----

5100(MHz)	3.61 dB	3.00 deg	-18.09 dB	-135.00 deg	81.58 deg	21.70 dB	-3.40 dB	6.00	----	----	----	----
5200(MHz)	3.49 dB	15.00 deg	-18.45 dB	-138.00 deg	88.67 deg	21.94 dB	-3.24 dB	5.98	----	----	----	----
5300(MHz)	3.18 dB	18.00 deg	-19.91 dB	-147.00 deg	97.30 deg	23.09 dB	-3.06 dB	5.97	----	----	----	----
5400(MHz)	3.26 dB	9.00 deg	-22.66 dB	-150.00 deg	90.10 deg	25.92 dB	-3.01 dB	5.84	----	----	----	----
5500(MHz)	3.45 dB	15.00 deg	-22.04 dB	-150.00 deg	88.07 deg	25.49 dB	-2.74 dB	5.47	----	----	----	----
5600(MHz)	3.06 dB	21.00 deg	-20.14 dB	-153.00 deg	88.87 deg	23.19 dB	-3.00 dB	5.06	----	----	----	----
5700(MHz)	3.08 dB	18.00 deg	-18.41 dB	-150.00 deg	87.90 deg	21.49 dB	-2.96 dB	4.88	----	----	----	----
5800(MHz)	3.01 dB	9.00 deg	-16.94 dB	-153.00 deg	85.44 deg	19.95 dB	-2.90 dB	4.61	----	----	----	----
5900(MHz)	3.10 dB	24.00 deg	-17.97 dB	-153.00 deg	84.86 deg	21.08 dB	-2.82 dB	4.61	----	----	----	----
6000(MHz)	2.82 dB	21.00 deg	-17.46 dB	-153.00 deg	87.50 deg	20.29 dB	-2.92 dB	4.53	----	----	----	----

Phi=90.00deg

E Total. dB



Average

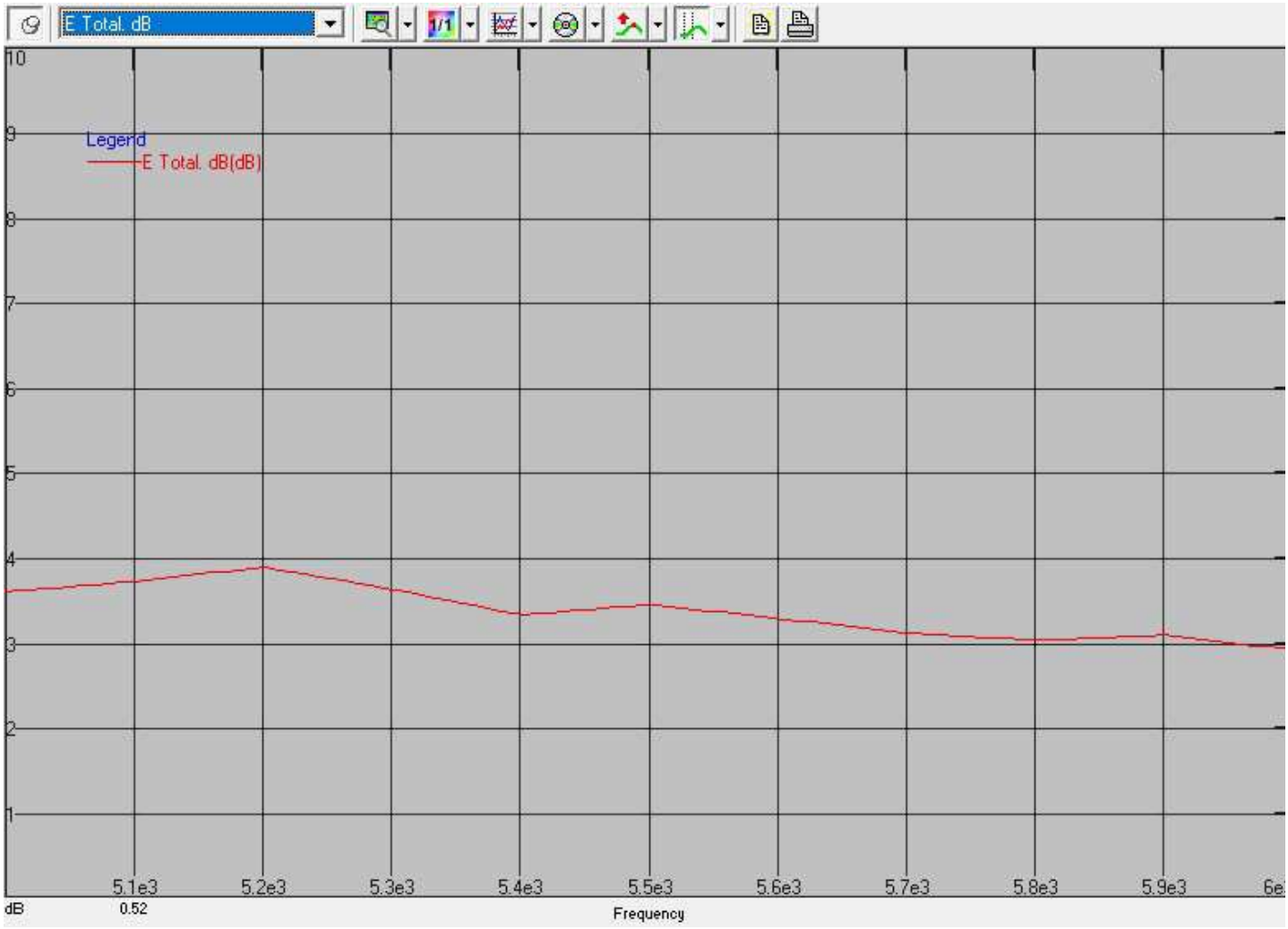
- 1:-0.3332 dB
- 2:0 dB
- 3:0 dB
- 4:-0.3332 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
5000(MHz)	3.13 dB	15.00 deg	-10.98 dB	-180.00 deg	157.03 deg	14.11 dB	-0.33 dB	4.09	----	----	----	----
5100(MHz)	3.64 dB	3.00 deg	-10.71 dB	-180.00 deg	154.13 deg	14.35 dB	-0.08 dB	4.10	----	----	----	----

5200(MHz)	3.31 dB	15.00 deg	-10.40 dB	177.00 deg	159.09 deg	13.71 dB	-0.23 dB	4.05	----	----	----	----
5300(MHz)	3.21 dB	18.00 deg	-10.80 dB	177.00 deg	175.19 deg	14.01 dB	-0.20 dB	4.20	----	----	----	----
5400(MHz)	3.13 dB	6.00 deg	-10.06 dB	171.00 deg	181.64 deg	13.19 dB	-0.27 dB	4.02	----	----	----	----
5500(MHz)	3.13 dB	3.00 deg	-9.64 dB	174.00 deg	174.85 deg	12.77 dB	-0.32 dB	3.80	----	----	----	----
5600(MHz)	3.02 dB	-24.00 deg	-8.56 dB	171.00 deg	178.01 deg	11.58 dB	-0.38 dB	3.59	----	----	----	----
5700(MHz)	2.73 dB	-21.00 deg	-8.65 dB	-177.00 deg	184.50 deg	11.38 dB	-0.44 dB	3.62	----	----	----	----
5800(MHz)	2.80 dB	-6.00 deg	-8.78 dB	-171.00 deg	182.09 deg	11.58 dB	-0.55 dB	3.58	----	----	----	----
5900(MHz)	2.63 dB	-18.00 deg	-9.35 dB	-171.00 deg	182.90 deg	11.98 dB	-0.74 dB	3.59	----	----	----	----
6000(MHz)	2.23 dB	-30.00 deg	-9.73 dB	-174.00 deg	197.90 deg	11.96 dB	-0.78 dB	3.51	----	----	----	----

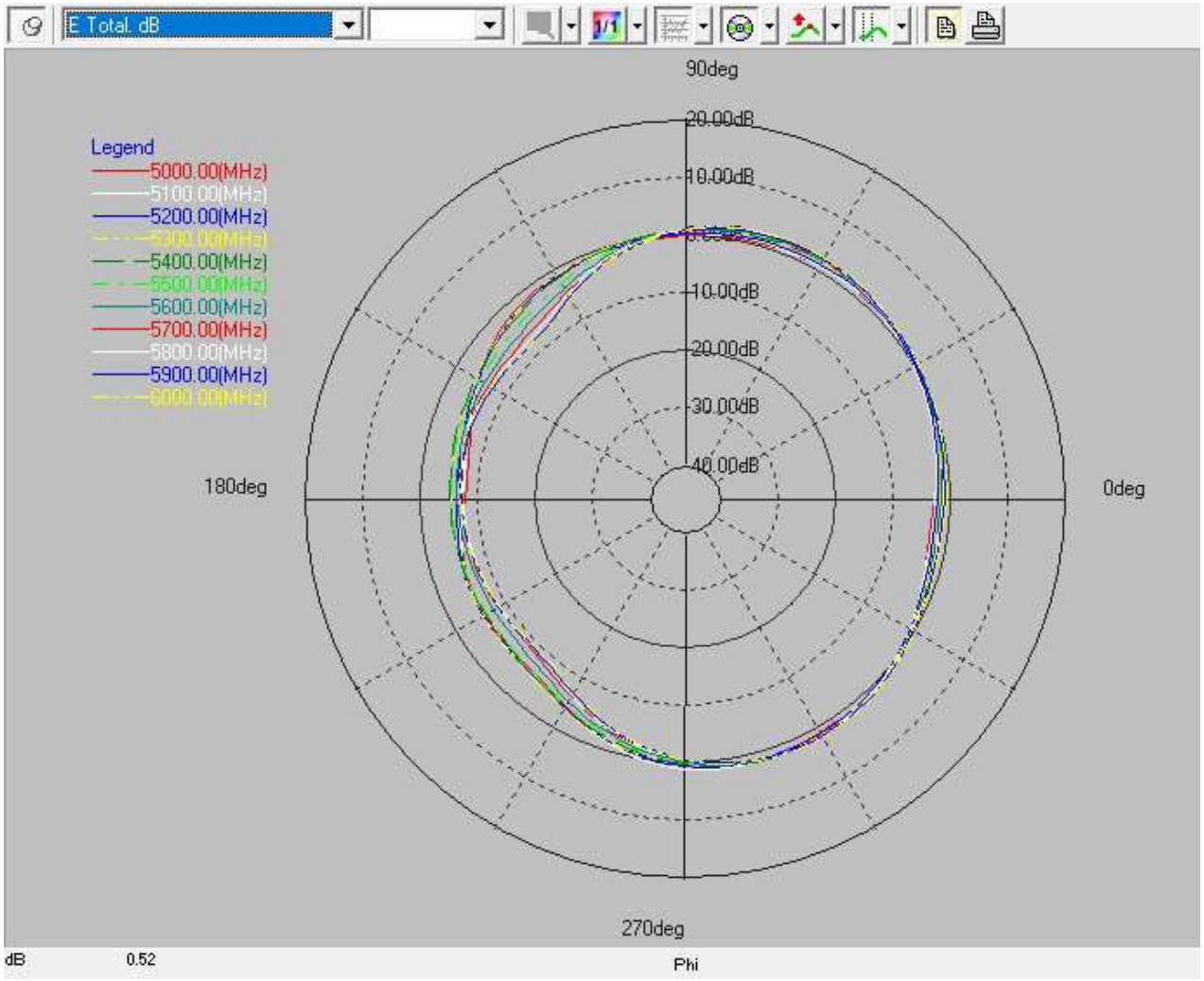
NF to FF transform Maximum Maximum

E Total. dB



Theta=90.00deg

E Total. dB



Average

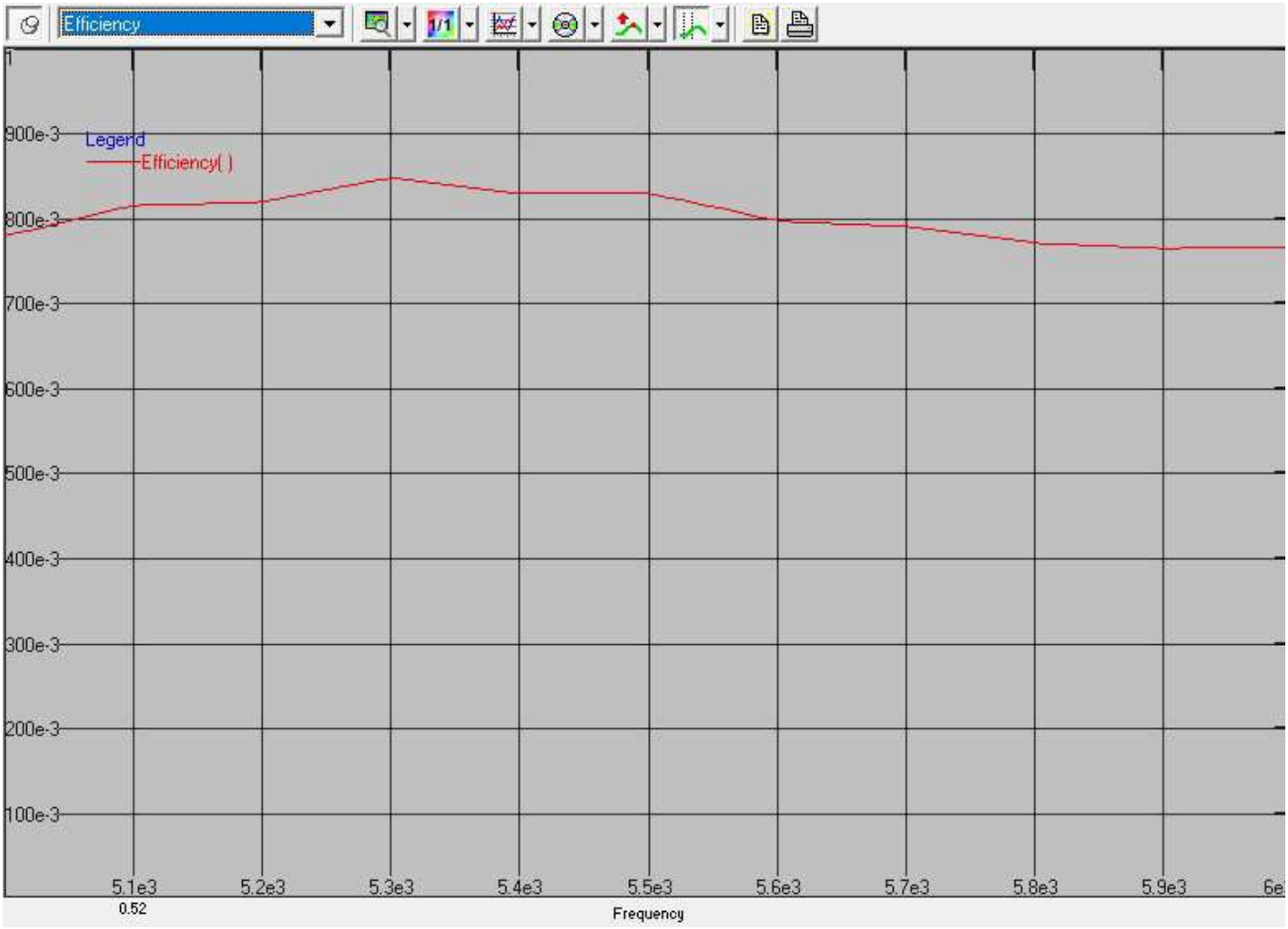
- 1:-1.636 dB
- 2:0 dB
- 3:0 dB
- 4:-1.636 dB

Layer	Max value	Position	Min value	Position	Beam Width	Max/Min	Average	Standard Deviation	Marker 1 pos	Marker 1 value	Marker 2 pos	Marker 2 value
5000(MHz)	1.27 dB	282.00 deg	-8.00 dB	174.00 deg	85.17 deg	9.27 dB	-1.64 dB	2.79	----	----	----	----
5100(MHz)	1.37 dB	282.00 deg	-7.45 dB	174.00 deg	83.96 deg	8.82 dB	-1.58 dB	2.69	----	----	----	----

5200(MHz)	1.15 dB	294.00 deg	-6.38 dB	177.00 deg	88.17 deg	7.53 dB	-1.50 dB	2.54	----	----	----	----
5300(MHz)	1.52 dB	57.00 deg	-5.63 dB	213.00 deg	119.78 deg	7.16 dB	-1.20 dB	2.45	----	----	----	----
5400(MHz)	1.60 dB	57.00 deg	-6.06 dB	216.00 deg	114.16 deg	7.66 dB	-1.22 dB	2.55	----	----	----	----
5500(MHz)	1.77 dB	60.00 deg	-6.29 dB	219.00 deg	----	8.07 dB	-1.33 dB	2.73	----	----	----	----
5600(MHz)	1.84 dB	63.00 deg	-7.75 dB	216.00 deg	----	9.59 dB	-1.63 dB	3.25	----	----	----	----
5700(MHz)	1.95 dB	63.00 deg	-8.75 dB	219.00 deg	99.55 deg	10.70 dB	-1.82 dB	3.66	----	----	----	----
5800(MHz)	2.09 dB	63.00 deg	-9.02 dB	219.00 deg	97.21 deg	11.10 dB	-1.88 dB	3.84	----	----	----	----
5900(MHz)	2.03 dB	63.00 deg	-9.04 dB	222.00 deg	99.85 deg	11.07 dB	-1.96 dB	3.90	----	----	----	----
6000(MHz)	2.31 dB	63.00 deg	-9.36 dB	225.00 deg	----	11.68 dB	-1.80 dB	4.04	----	----	----	----

NF to FF transform Efficiency

Efficiency



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mailto:info@metraware.com

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9) TEST SOFTWARE – Measurements completed using the proprietary Satenv
(c) METRAWARE & SATIMO Software

10) SATIMO SG-64 Chamber – Equipment Summary/calibration Sheet Below.

Introduction

This document summarizes the antenna gain measurements performed at MVG Inc. The purpose of this document is to provide a summary of the measurement procedure, traceability information, expanded uncertainties and the calibration data for the Antenna Under Test (AUT).

Measurement System Information

General Information

The antenna calibration is performed in a MVG SG-64 system with 63 probe antennas mounted with equal spacing on a circular arch. Electronic switching of the probe antennas provides outstanding measurement speed. The geometry of the setup, with only a Styrofoam column within 1.6 meters of the AUT, ensures minimum interference and low ripple on the measured radiation patterns.

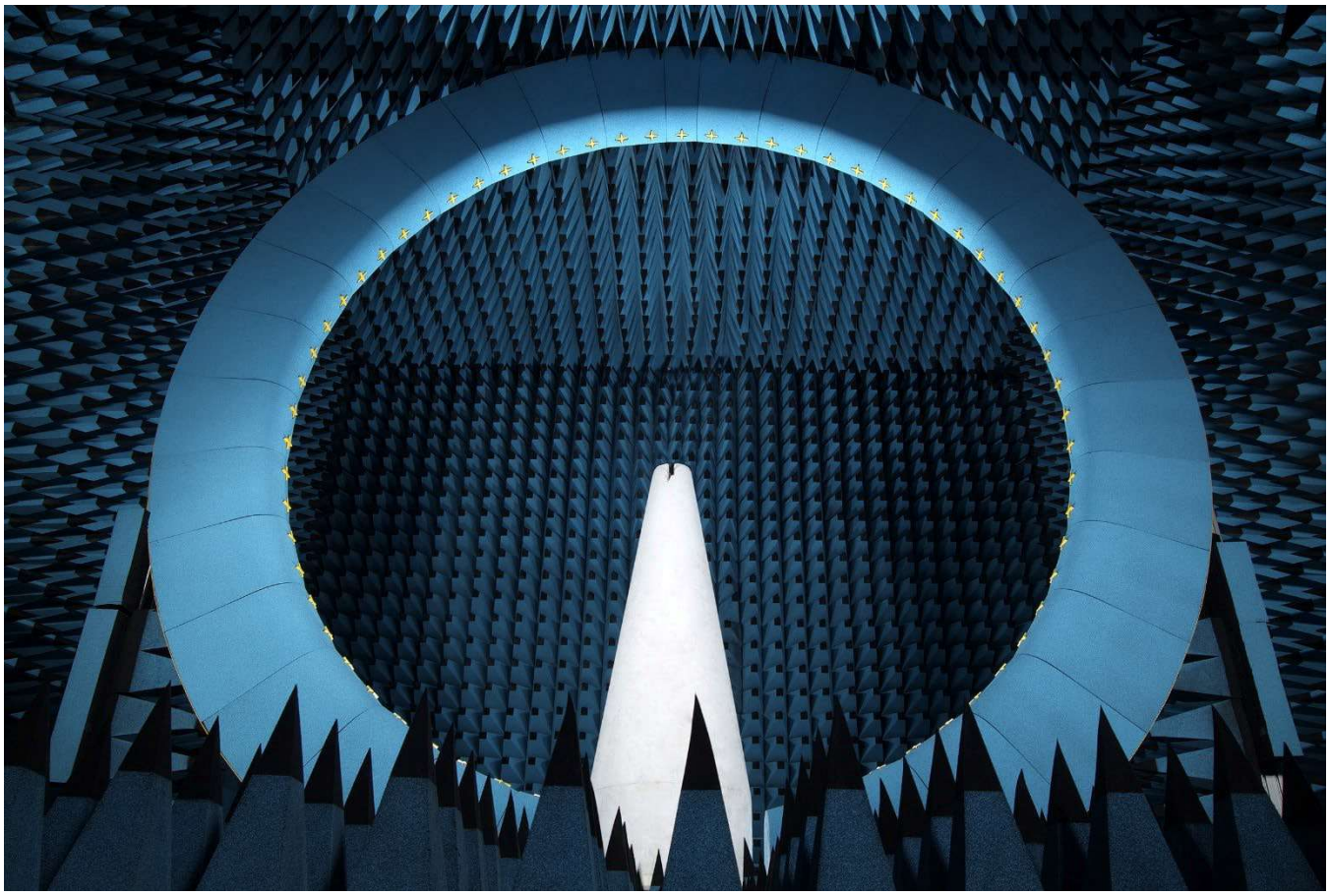

Figure 1 – *The SG-64. The AUT is placed on top of the pedestal, in the center of the system.*

List of Equipment

Equipment Summary Sheet				
Equipment Description	**Manufacturer**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
SG-64 Probe Array	MVG	1102389-0006	12/2022	12/2023
RF Transmitter/ Receiver Unit (NPAC)	MVG	1102730-9110	characterized prior to test and in annual calibration	characterized prior to test and in annual calibration
Reference Horn Antenna	MVG	SH400 sn# 0017	08/2004	Verified in monthly checks. No cal required.
Reference Horn Antenna	MVG	SH800 sn# 0025	08/2004	Verified in monthly checks. No cal required.

Gain Calibration

Gain Definition

The reported boresight antenna ***gain*** is 4π times the ratio of the power radiated per unit solid angle in that direction to the net power delivered to the antenna by a 50Ω generator. This definition is also referred to as ***realized antenna gain*** which is less than the IEEE definition [IEEE Standard Test Procedures for Antennas, ANSI/IEEE Std 149-2021] by the value of the return loss.

Calibration Standard

The calibrated substitution antenna is a dual ridge horn as shown in Figure 2 below. This horn has been calibrated at NIST (Boulder, CO) which ensures direct traceability to a National Metrology Institute.

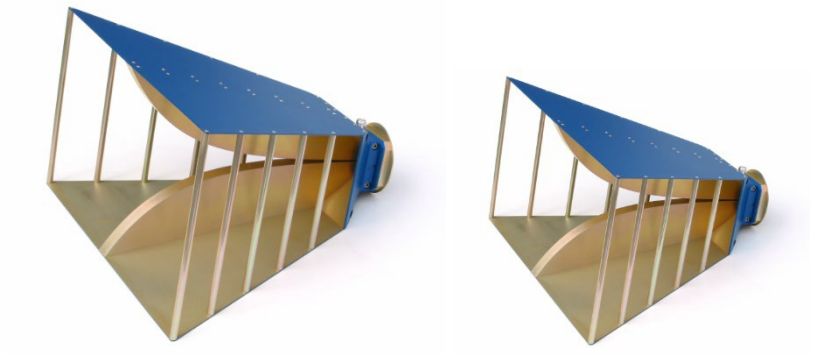

Figure 2 – MVG *SH400-SN0017 and SH800-SN0025 horns.*

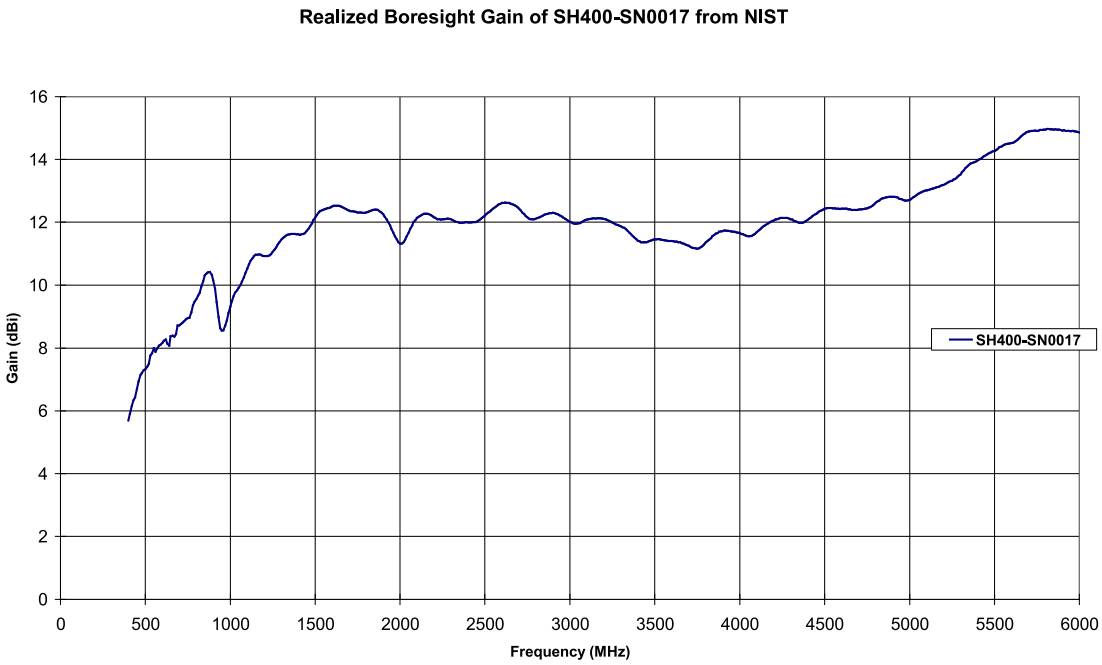

Figure 3 – *NIST calibrated boresight gain vs. frequency plot of the MVG SH400-SN0017*

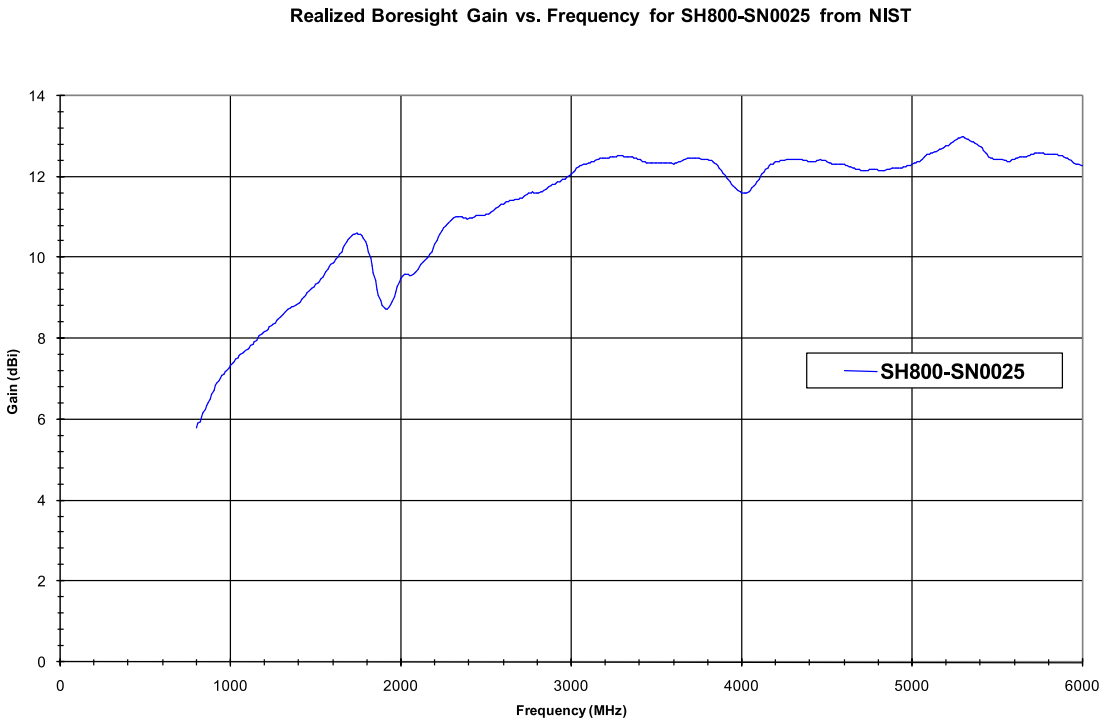

Figure 4 – *NIST calibrated boresight gain vs. frequency plot of the MVG SH800-SN0025*

Measurement Uncertainty

The following uncertainties apply to the gain measurement:

Frequency band	Expanded Uncertainty on Gain
400-800 MHz	0.89 dB
800-1000 MHz	0.84 dB
1000-6000 MHz	0.69 dB

These uncertainties represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2 traceable to the Internationally Accepted Guide to Measurement Uncertainty.

Measurement Setup

The AUT is mounted on a Styrofoam column as shown in the picture below.

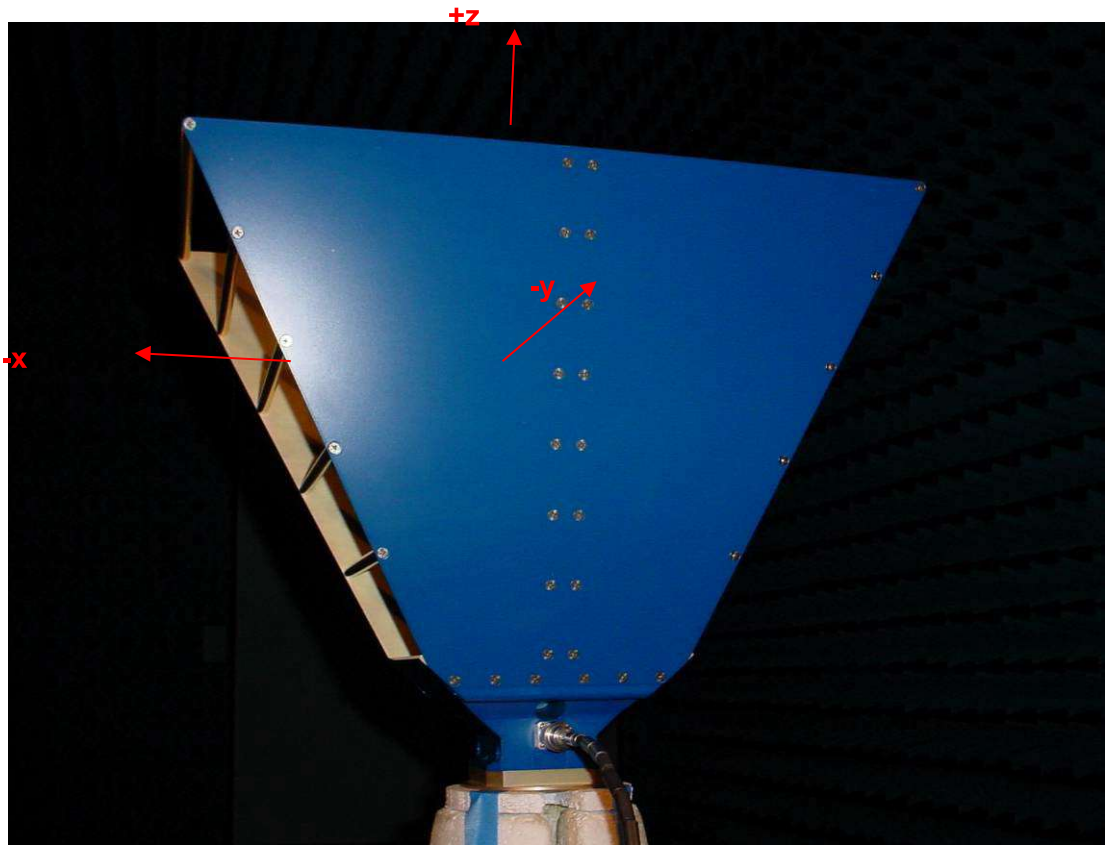

Figure 5 – *Photograph illustrating an antenna mounted in the test range. For clarity, a coordinate system has been superimposed on the picture.*

Coordinate System

The system coordinate system is shown in Figure 6.

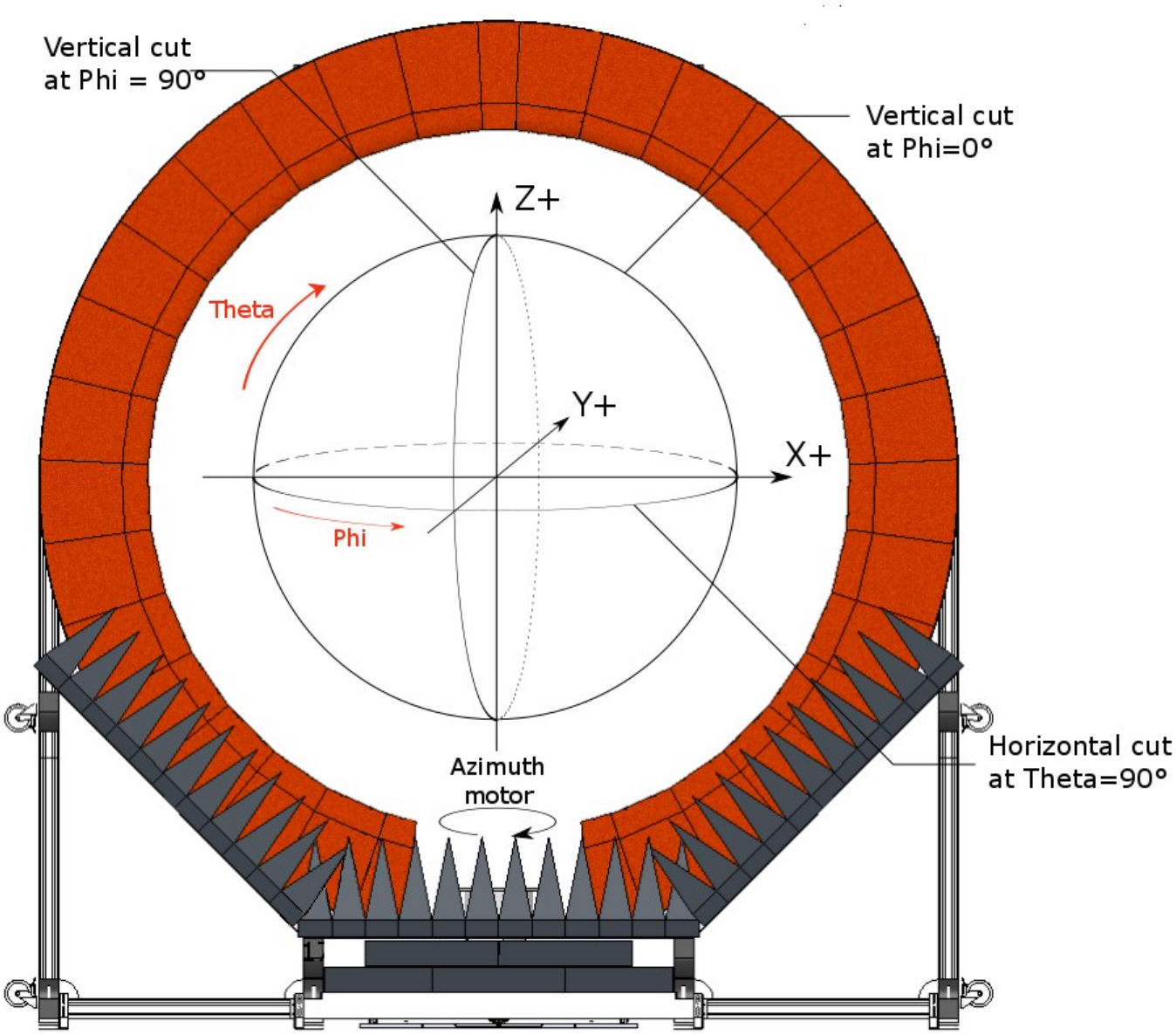

Figure 6: Coordinate System

TEST PROCEDURES

CALIBRATION

DEPENDING ON THE FREQUENCY BAND, EITHER THE NIST CALIBRATED SH400-SN0017 OR SH800-SN0025 ANTENNA IS FIRST PLACED IN THE MEASUREMENT SYSTEM AS SHOWN IN FIGURE 5 AND, USING THE FREQUENCIES TABULATED IN THE RFQ, THE TEST ENGINEER MEASURES THE ANTENNA USING MVG'S PROPRIETARY WAVESTUDIO SOFTWARE. A NEAR-FIELD TO FAR-FIELD COMPUTATION IS PERFORMED USING SATENV, WHICH OUTPUTS THE BORESIGHT FAR-FIELD GAIN. THE SOFTWARE COMPARES THESE GAIN MEASUREMENTS, AS A FUNCTION OF FREQUENCY, TO THE COMPILED NIST MEASURED VALUES TO SERVE AS THE GAIN REFERENCE.

ANTENNA MEASUREMENT

The test engineer follows measures each customer antenna at the requested frequencies. SatEnv is then used to compute the far-field gain of the antenna using the reference data computed during the calibration process. Care is spent reviewing all details given in the RFQ to ensure data is output in the requested format.