

***Directional Antenna System  
for  
WAYQ, Clarksville, Tennessee***

September 11, 2003

Electronics Research Inc. is providing a custom fabricated antenna system that is specially designed to meet the FCC requirements and the general needs of radio station WAYQ.

The antenna is the ERI model MP-4E-DA configuration. The circular polarized system consists of 4 full-wavelength spaced bays using one driven circular polarized radiating element and two horizontal parasitic elements placed one-quarter wave above and below each bay. The antenna was mounted on the North 284 degrees East tower face with bracketry to provide an antenna orientation of North 284 degrees East. The antenna was tested on a 57" ERI tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 88.3 megahertz, which is the center of the FM broadcast channel assigned to WAYQ.

Pattern measurements were made on a sixty-acre antenna pattern range that is owned and operated by Electronics Research, Inc. The tests were performed under the direction of Thomas B. Silliman, president of Electronics Research, Inc. Mr. Silliman has the Bachelor of Electrical Engineering and the Master of Electrical Engineering degrees from Cornell University and is a registered professional engineer in the states of Indiana, Maryland and Minnesota.

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For  
WAYQ, Clarksville, Tennessee

(Continued)

DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of two bay levels of the circular polarized system with the associated horizontal parasitic elements. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the antenna. A section of 3 1/8 inch o.d. rigid coaxial line was used to feed the test antenna, and a section of 3 1/8 inch o.d. rigid outer conductor only was attached above the test antenna. The lines were properly grounded during all tests.

The power distribution and phase relationship to the antenna elements was adjusted in order to achieve the directional radiation patterns for both horizontal and vertical polarization components.

The proof-of-performance was accomplished using a 57" ERI tower with identical dimension and configuration including all braces, ladders, conduits, coaxial lines and other appurtenances that are included in the actual aperture at which the antenna will be installed. The structure was erected vertically on a turntable mounted on a non-metallic building with the antenna centered vertically on the structure, making the center of radiation of the test approximately 30 feet above ground. The turntable is equipped with a motor drive and azimuth indicating mechanism, resolution of this azimuth measuring device is one-tenth of a degree.

The antenna under test was operated in the transmitting mode and fed from a Wavetek Model 3000 signal generator. The frequency of the signal source was set at 88.3 MHz and was constantly monitored by an Anritsu Model ML521B measuring receiver.

A broad-band horizontal and vertical dipole system, located approximately 628 feet from the test antenna, was used to receive the emitted test signals. The dipole system was mounted at the same height above terrain as the center of the antenna under test. The signals received by the dipole system were fed to the test building by way of two buried Heliax cables to an Anritsu Model ML521B measuring receiver. This data was interfaced to a Hewlett-Packard Laser Jet 4P printer by means of a Pentium computer system. Relative field strength was plotted as a function of azimuth.

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(Continued)

The measurements were performed by rotating the test antenna in a counter-clockwise direction and plotting the received signal on polar co-ordinated graph paper in a clockwise direction. Both horizontal and vertical components were recorded separately.

## CONCLUSIONS

The circular polarized system consists of 4 full-wavelength spaced bays using one driven circular polarized radiating element and two horizontal parasitic elements placed one quarter wave above and below each bay. The power distribution and phase relationship will be fixed when antenna is manufactured. Proper maintenance of the elements should be all that is required to maintain the pattern in adjustment.

The MP-4E-DA array is to be mounted on the North 284 degrees East tower face of the 57" ERI tower at a bearing of North 284 degrees East. Blue prints provided with the antenna will show the proper antenna orientation alignment. The antenna alignment procedure should be directed by a licensed surveyor as prescribed by the FCC.

Figure #1 represents the maximum value of either the horizontal or vertical component at any azimuth. The measured horizontal plane relative field pattern, for both the horizontal and vertical polarization components, is shown on Figure #2 attached. The actual measured pattern does not exceed the authorized FCC composite pattern at any azimuth. A calculated vertical plane relative field pattern is shown on Figure #3 attached. The power in the maximum will reach 14 kilowatts (11.461 dBk).

The power at North 100-110 degrees East does not exceed 0.56 kilowatts (-2.518 dBk).

The RMS of the vertically polarized horizontal plane component does not exceed the RMS of the horizontally polarized horizontal plane component.

The composite horizontal and vertical maximum relative field pattern obtained from the measured data as shown on Figure #1 has an RMS that is greater than 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 49 feet if the antenna is to be top mounted.

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(Continued)

The directional antenna should not be mounted on the top of an antenna tower that includes a top-mounted platform larger than the cross-sectional area of the tower in the horizontal plane. No obstructions other than those that are specified by the blue prints supplied with the antenna are to be mounted within 75 ft. horizontally of the system. The vertical distance to the nearest obstruction should be a minimum of 10 ft. from the directional antenna. Metallic guy wires should be a minimum distance of forty feet horizontally from the antenna.

ELECTRONICS RESEARCH, INC.

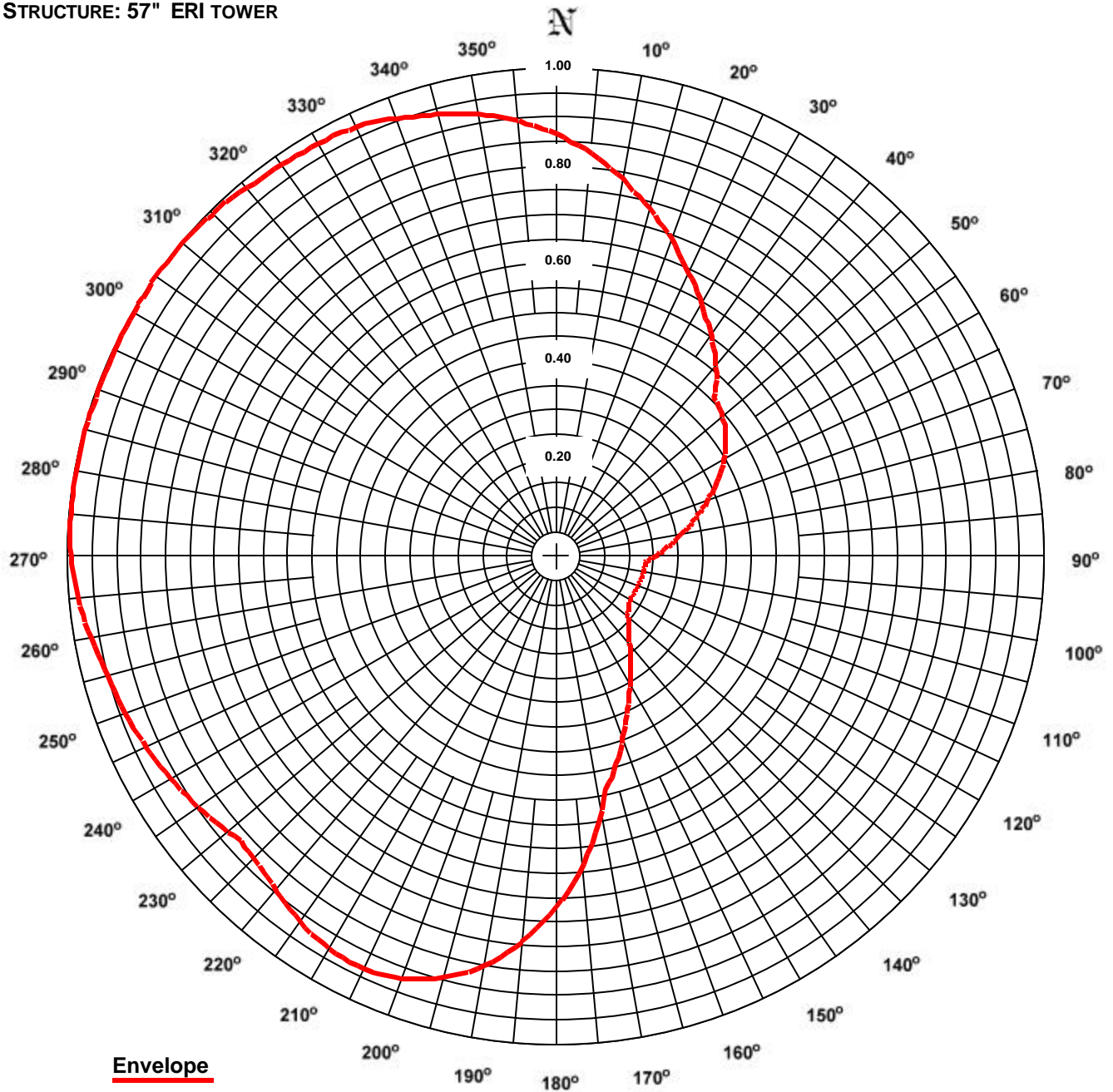
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# **ERI**® *Horizontal Plane Relative Field Pattern*

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

FIGURE: 1  
STATION: WAYQ  
LOCATION: CLARKSVILLE, TN  
ANTENNA TYPE: MP-4E-DA  
STRUCTURE: 57" ERI TOWER

DATE: 9/11/03  
FREQUENCY: 88.3 MHz  
ORIENTATION: 284° TRUE  
MOUNTING: CUSTOM



RMS: 0.738  
Maximum: 1.000 @ 276° True  
Minimum: 0.176 @ 120° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN DOES NOT EXCEED THE FCC FILED COMPOSITE PATTERN AT ANY AZIMUTH. THE RMS OF THIS PATTERN IS GREATER THAN 85% OF THE FILED FCC COMPOSITE PATTERN BPED-19961021MB.

# ERI<sup>®</sup> *Horizontal Plane Relative Field List*

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

**Station: WAYQ**  
**Location: Clarksville, TN**  
**Frequency: 88.3 MHz**

**Antenna: MP-4E-DA**  
**Orientation: 284° True**  
**Tower: 57" ERI tower**

**Figure: 1**  
**Date: 9/11/03**  
**Reference: wayq1m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.865	10.48	10.21	Vertical	180°	0.720	7.26	8.61	Horizontal
5°	0.828	9.61	9.83	Vertical	185°	0.793	8.80	9.45	Horizontal
10°	0.785	8.63	9.36	Vertical	190°	0.851	10.13	10.05	Horizontal
15°	0.737	7.61	8.81	Vertical	195°	0.893	11.16	10.48	Horizontal
20°	0.692	6.70	8.26	Vertical	200°	0.920	11.86	10.74	Horizontal
25°	0.642	5.76	7.61	Vertical	205°	0.932	12.17	10.85	Horizontal
30°	0.595	4.96	6.95	Vertical	210°	0.929	12.08	10.82	Horizontal
35°	0.552	4.26	6.30	Vertical	215°	0.915	11.72	10.69	Horizontal
40°	0.508	3.61	5.58	Vertical	220°	0.893	11.16	10.48	Horizontal
45°	0.457	2.92	4.65	Horizontal	225°	0.877	10.76	10.32	Horizontal
50°	0.443	2.75	4.40	Horizontal	230°	0.878	10.79	10.33	Vertical
55°	0.423	2.50	3.98	Horizontal	235°	0.896	11.23	10.50	Vertical
60°	0.396	2.19	3.40	Horizontal	240°	0.912	11.64	10.66	Vertical
65°	0.363	1.84	2.65	Horizontal	245°	0.927	12.03	10.80	Vertical
70°	0.328	1.51	1.78	Horizontal	250°	0.940	12.38	10.93	Vertical
75°	0.293	1.20	0.80	Horizontal	255°	0.952	12.70	11.04	Vertical
80°	0.262	0.96	-0.17	Horizontal	260°	0.968	13.12	11.18	Horizontal
85°	0.231	0.74	-1.28	Horizontal	265°	0.985	13.57	11.33	Horizontal
90°	0.203	0.58	-2.39	Horizontal	270°	0.995	13.86	11.42	Horizontal
95°	0.182	0.46	-3.34	Vertical	275°	1.000	13.99	11.46	Horizontal
100°	0.181	0.46	-3.36	Vertical	280°	1.000	14.00	11.46	Horizontal
105°	0.180	0.45	-3.44	Vertical	285°	1.000	13.99	11.46	Horizontal
110°	0.178	0.44	-3.54	Vertical	290°	0.999	13.98	11.45	Horizontal
115°	0.176	0.44	-3.61	Vertical	295°	1.000	14.00	11.46	Vertical
120°	0.176	0.43	-3.64	Vertical	300°	1.000	14.00	11.46	Vertical
125°	0.180	0.45	-3.44	Vertical	305°	1.000	14.00	11.46	Vertical
130°	0.191	0.51	-2.94	Vertical	310°	0.998	13.94	11.44	Vertical
135°	0.208	0.61	-2.18	Vertical	315°	0.994	13.82	11.41	Vertical
140°	0.232	0.75	-1.22	Vertical	320°	0.987	13.63	11.35	Vertical
145°	0.263	0.97	-0.14	Vertical	325°	0.981	13.48	11.30	Horizontal
150°	0.301	1.27	1.02	Vertical	330°	0.977	13.36	11.26	Horizontal
155°	0.345	1.67	2.21	Vertical	335°	0.971	13.21	11.21	Horizontal
160°	0.396	2.19	3.41	Vertical	340°	0.956	12.80	11.07	Horizontal
165°	0.454	2.88	4.59	Vertical	345°	0.938	12.32	10.91	Vertical
170°	0.529	3.92	5.93	Horizontal	350°	0.920	11.86	10.74	Vertical
175°	0.632	5.60	7.48	Horizontal	355°	0.896	11.24	10.51	Vertical

**Polarization:**  
**Maximum Field:**  
**Minimum Field:**  
**RMS:**  
**Maximum ERP:**  
**Maximum Power Gain:**

**Envelope**  
**1.000 @ 276° True**  
**0.176 @ 120° True**  
**0.738**  
**14.000 kW**  
**3.964 (5.982 dB)**

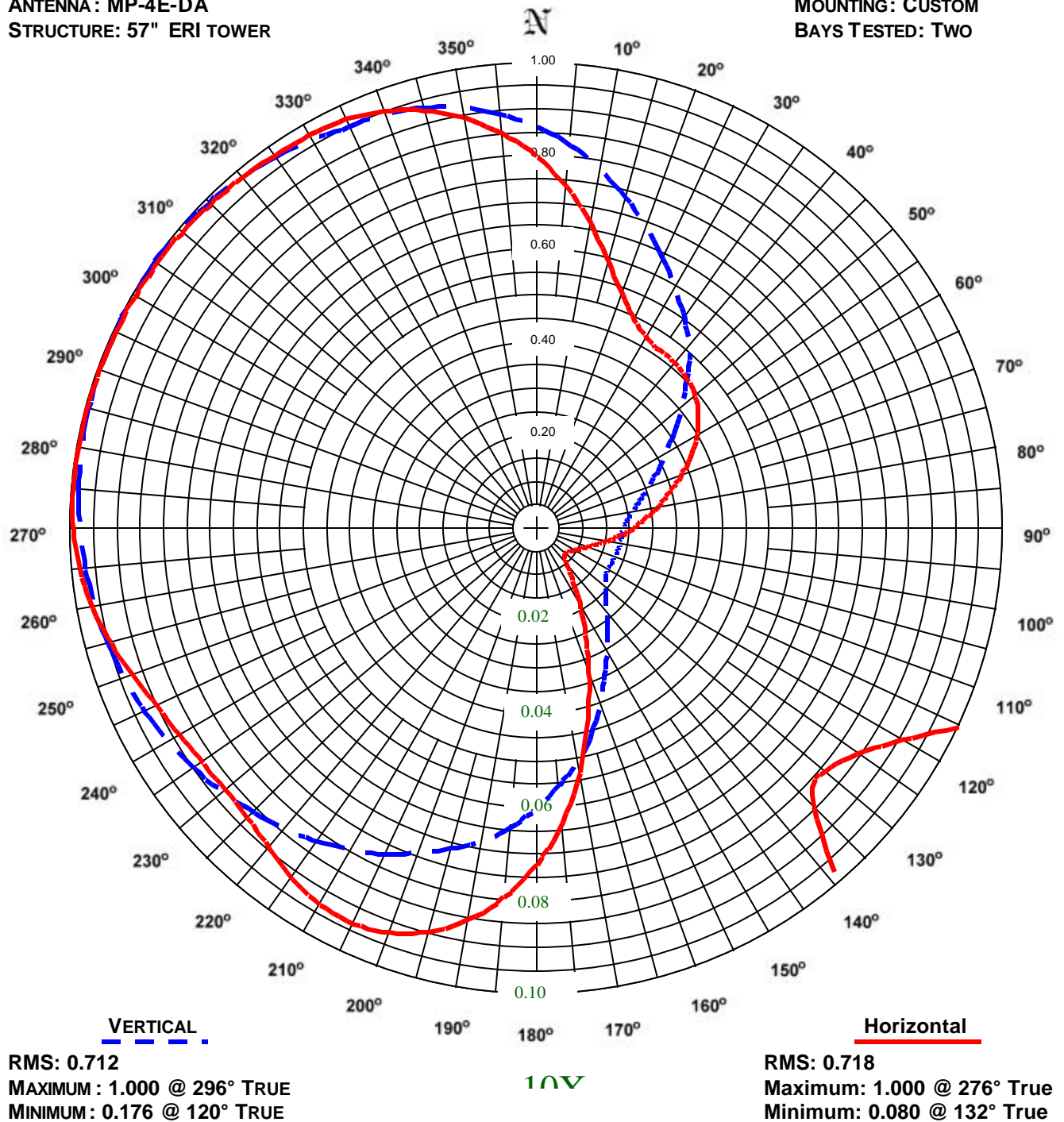
**Total Input Power: 3.531 kW**

# ERI<sup>®</sup> Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

FIGURE NO: 2  
STATION: WAYQ  
LOCATION: CLARKSVILLE, TN  
ANTENNA: MP-4E-DA  
STRUCTURE: 57" ERI TOWER

DATE: 9/11/03  
FREQUENCY: 88.3 MHz  
ORIENTATION: 284° TRUE  
MOUNTING: CUSTOM  
BAYS TESTED: TWO



COMMENTS: MEASURED PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONENTS.

# ERI<sup>®</sup> Horizontal Plane Relative Field List

Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 <http://www.eriinc.com/>

**Station: WAYQ**  
**Location: Clarksville, TN**  
**Frequency: 88.3 MHz**

**Antenna: MP-4E-DA**  
**Orientation: 284° True**  
**Tower: 57" ERI tower**

**Figure: 2**  
**Date: 9/11/03**  
**Reference: wayq1m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.801	8.99	9.54	0.865	10.48	10.21	180°	0.720	7.26	8.61	0.599	5.03	7.02
5°	0.739	7.64	8.83	0.828	9.61	9.83	185°	0.793	8.80	9.45	0.642	5.76	7.61
10°	0.667	6.23	7.94	0.785	8.63	9.36	190°	0.851	10.13	10.05	0.679	6.45	8.09
15°	0.594	4.93	6.93	0.737	7.61	8.81	195°	0.893	11.16	10.48	0.708	7.02	8.46
20°	0.537	4.04	6.06	0.692	6.70	8.26	200°	0.920	11.86	10.74	0.738	7.62	8.82
25°	0.497	3.46	5.39	0.642	5.76	7.61	205°	0.932	12.17	10.85	0.768	8.26	9.17
30°	0.474	3.14	4.97	0.595	4.96	6.95	210°	0.929	12.08	10.82	0.794	8.82	9.45
35°	0.467	3.05	4.84	0.552	4.26	6.30	215°	0.915	11.72	10.69	0.817	9.34	9.70
40°	0.464	3.01	4.79	0.508	3.61	5.58	220°	0.893	11.16	10.48	0.838	9.84	9.93
45°	0.457	2.92	4.65	0.455	2.90	4.63	225°	0.877	10.76	10.32	0.859	10.33	10.14
50°	0.443	2.75	4.40	0.404	2.28	3.58	230°	0.871	10.62	10.26	0.878	10.79	10.33
55°	0.423	2.50	3.98	0.358	1.79	2.53	235°	0.874	10.70	10.30	0.896	11.23	10.50
60°	0.396	2.19	3.40	0.317	1.41	1.48	240°	0.884	10.93	10.39	0.912	11.64	10.66
65°	0.363	1.84	2.65	0.282	1.11	0.45	245°	0.899	11.31	10.54	0.927	12.03	10.80
70°	0.328	1.51	1.78	0.252	0.89	-0.52	250°	0.920	11.85	10.74	0.940	12.38	10.93
75°	0.293	1.20	0.80	0.227	0.72	-1.42	255°	0.946	12.53	10.98	0.952	12.70	11.04
80°	0.262	0.96	-0.17	0.208	0.60	-2.19	260°	0.968	13.12	11.18	0.963	12.99	11.14
85°	0.231	0.74	-1.28	0.194	0.53	-2.79	265°	0.985	13.57	11.33	0.973	13.24	11.22
90°	0.203	0.58	-2.39	0.185	0.48	-3.19	270°	0.995	13.86	11.42	0.981	13.46	11.29
95°	0.174	0.42	-3.73	0.182	0.46	-3.34	275°	1.000	13.99	11.46	0.987	13.65	11.35
100°	0.149	0.31	-5.07	0.181	0.46	-3.36	280°	1.000	14.00	11.46	0.992	13.79	11.40
105°	0.129	0.23	-6.29	0.180	0.45	-3.44	285°	1.000	13.99	11.46	0.996	13.90	11.43
110°	0.113	0.18	-7.46	0.178	0.44	-3.54	290°	0.999	13.98	11.45	0.999	13.97	11.45
115°	0.100	0.14	-8.52	0.176	0.44	-3.61	295°	0.998	13.94	11.44	1.000	14.00	11.46
120°	0.090	0.11	-9.41	0.176	0.43	-3.64	300°	0.996	13.90	11.43	1.000	14.00	11.46
125°	0.084	0.10	-10.06	0.180	0.45	-3.44	305°	0.994	13.84	11.41	1.000	14.00	11.46
130°	0.081	0.09	-10.40	0.191	0.51	-2.94	310°	0.992	13.77	11.39	0.998	13.94	11.44
135°	0.084	0.10	-10.06	0.208	0.61	-2.18	315°	0.989	13.69	11.36	0.994	13.82	11.41
140°	0.102	0.15	-8.36	0.232	0.75	-1.22	320°	0.985	13.59	11.33	0.987	13.63	11.35
145°	0.135	0.26	-5.90	0.263	0.97	-0.14	325°	0.981	13.48	11.30	0.978	13.38	11.26
150°	0.184	0.47	-3.24	0.301	1.27	1.02	330°	0.977	13.36	11.26	0.966	13.06	11.16
155°	0.248	0.86	-0.66	0.345	1.67	2.21	335°	0.971	13.21	11.21	0.955	12.76	11.06
160°	0.327	1.49	1.74	0.396	2.19	3.41	340°	0.956	12.80	11.07	0.950	12.63	11.01
165°	0.421	2.48	3.94	0.454	2.88	4.59	345°	0.932	12.15	10.85	0.938	12.32	10.91
170°	0.529	3.92	5.93	0.507	3.61	5.57	350°	0.898	11.28	10.52	0.920	11.86	10.74
175°	0.632	5.60	7.48	0.553	4.29	6.32	355°	0.854	10.21	10.09	0.896	11.24	10.51

<b>Polarization:</b>	<b>Horizontal</b>	<b>Vertical</b>
<b>Maximum Field:</b>	<b>1.000 @ 276° True</b>	<b>1.000 @ 296° True</b>
<b>Minimum Field:</b>	<b>0.080 @ 132° True</b>	<b>0.176 @ 120° True</b>
<b>RMS:</b>	<b>0.718</b>	<b>0.712</b>
<b>Maximum ERP:</b>	<b>14.000 kW</b>	<b>14.000 kW</b>
<b>Maximum Power Gain:</b>	<b>3.964 (5.982 dB)</b>	<b>3.964 (5.982 dB)</b>

**Total Input Power: 3.531 kW**





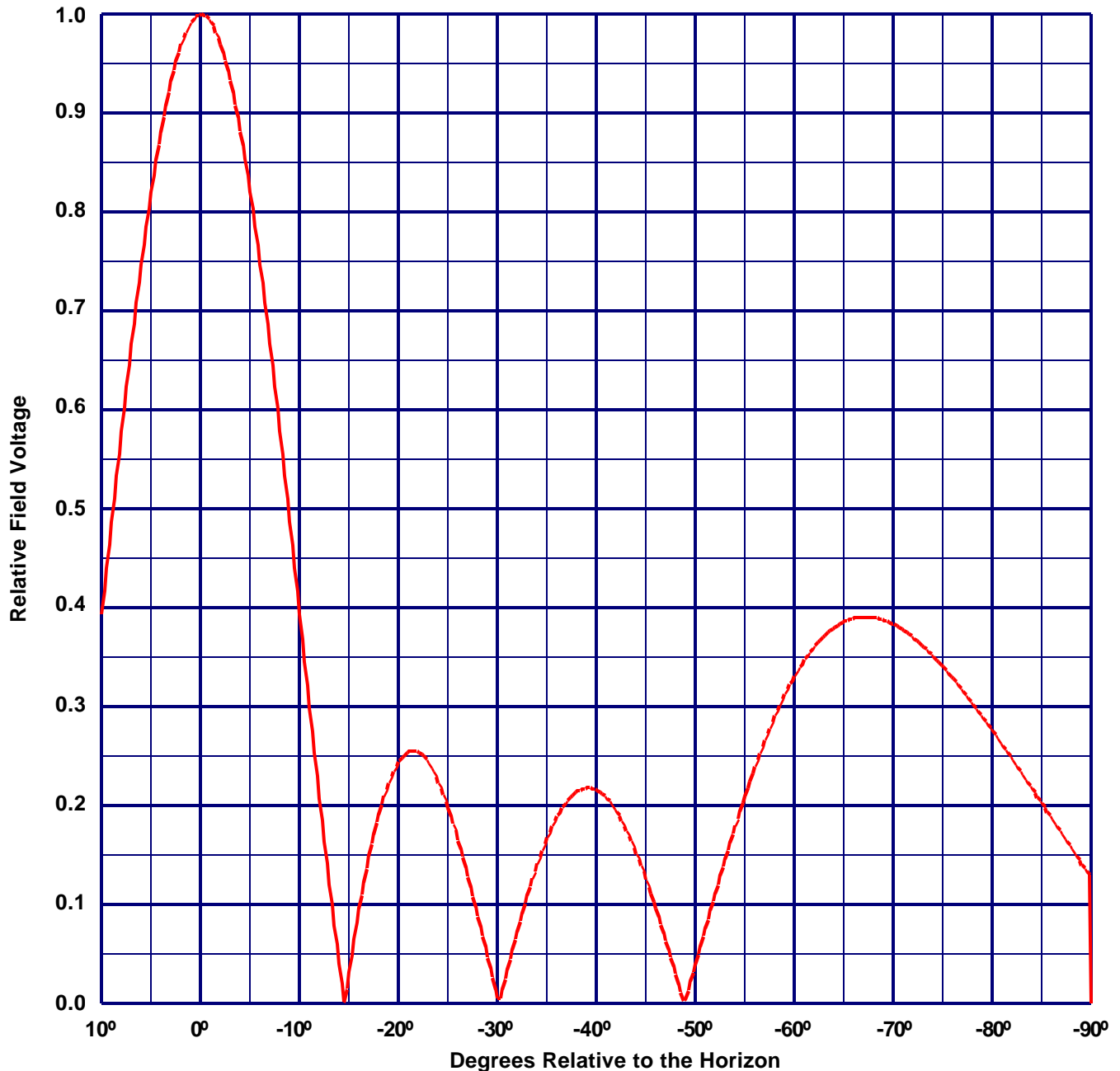
## Vertical Plane Relative Field Pattern

WAYQ, Clarksville, TN, 88.3 MHz

Figure#: 3

Date: 9/11/03

*A 4 level, 1 wave-length spaced MP-4E-DA directional antenna  
with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.000*



**Vertical Polarization Gain:**

**Maximum: 3.964 (5.982 dB)**

**Horizontal Plane: 3.964 (5.982 dB)**

**Horizontal Polarization Gain:**

**Maximum: 3.964 (5.982 dB)**

**Horizontal Plane: 3.964 (5.982 dB)**

# Directional Antenna System for WAYQ, Clarksville, Tennessee

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type: MP-4E-DA  
Frequency: 88.3 MHz  
Number of Bays: 4

## MECHANICAL SPECIFICATIONS

Mounting: Standard  
System length: 42 ft 3 in  
Aperture length required: 49 ft.  
Orientation: 284° true  
Input flange to the antenna 3 1/8 inch female

## ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP: 14 kW (11.461 dBk)  
Horizontal maximum power gain: 3.964 (5.982 dB)  
Maximum vertical ERP: 14 kW (11.461 dBk)  
Vertical maximum power gain: 3.964 (5.982 dB)  
Total input power: 3.531 kW (5.479 dBk)

