

***Directional Antenna System  
for  
KSRD, St. Joseph, Missouri***

August 18, 2004

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 KSRD.

The antenna is the ERI model LP-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 319 degrees East tower leg with bracketry to provide an antenna orientation of North 306 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 91.9 megahertz, which is the center of the FM broadcast channel assigned to KSRD.

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.

# Directional Antenna System For KSRD, St. Joseph, Missouri

(Continued)

## DESCRIPTION OF THE TEST PROCEDURE

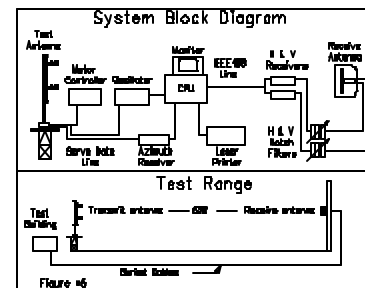
The test antenna consisted of two bay levels of the circular polarized system with the associated horizontal parasitic elements. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the antenna. A section of 1 5/8 inch o.d. rigid coaxial line was used to feed the test antenna, and a section of 1 5/8 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 91.9 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.



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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.

The measurements were performed by rotating the test antenna in a counter-clockwise direction and plotting the received signal on polar coordinated 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 LP-4E-DA array is to be mounted on the North 319 degrees East tower leg of the 57" ERI tower at a bearing of North 306 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 10 kilowatts (10 dBk).

The power at North 130 degrees East does not exceed 0.317 kilowatts (-4.989 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.

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(Continued)

The clear vertical length of the structure required to support the antenna is 47 feet if the antenna is to be top mounted.

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.



# **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: KSRD

LOCATION: ST. JOSEPH, MO

Antenna Type: LP-4E-DA

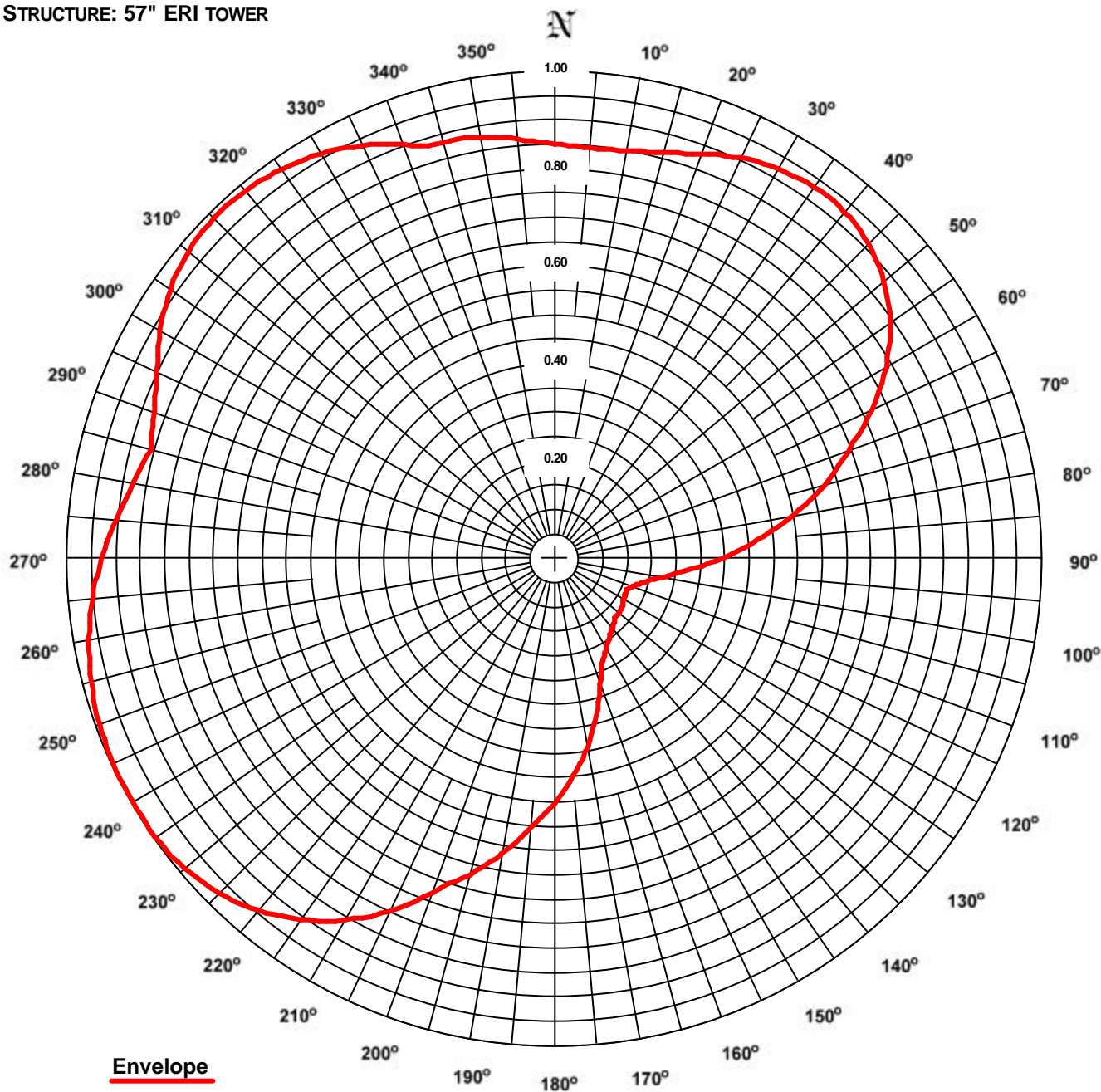
STRUCTURE: 57" ERI TOWER

DATE: 8/13/2004

FREQUENCY: 91.9 MHz

ORIENTATION: 306° TRUE

MOUNTING: CUSTOM



RMS: 0.763

Maximum: 1.000 @ 236° True

Minimum: 0.163 @ 115° 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-19970313MM.

# **ERI**® *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: KSRD**  
**Location: St. Joseph, MO**  
**Frequency: 91.9 MHz**

**Antenna: LP-4E-DA**  
**Orientation: 306° True**  
**Tower: 57" ERI tower**

**Figure: 1**  
**Date: 8/13/2004**  
**Reference: ksrld1m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.849	7.21	8.58	Horizontal	180°	0.505	2.55	4.06	Vertical
5°	0.844	7.12	8.53	Horizontal	185°	0.557	3.11	4.92	Vertical
10°	0.849	7.20	8.58	Horizontal	190°	0.616	3.79	5.79	Vertical
15°	0.861	7.42	8.70	Horizontal	195°	0.673	4.52	6.55	Vertical
20°	0.882	7.78	8.91	Horizontal	200°	0.732	5.35	7.29	Horizontal
25°	0.905	8.20	9.14	Horizontal	205°	0.800	6.40	8.06	Horizontal
30°	0.921	8.48	9.29	Horizontal	210°	0.859	7.37	8.68	Horizontal
35°	0.929	8.63	9.36	Horizontal	215°	0.907	8.22	9.15	Horizontal
40°	0.927	8.59	9.34	Horizontal	220°	0.945	8.93	9.51	Horizontal
45°	0.911	8.30	9.19	Horizontal	225°	0.973	9.48	9.77	Horizontal
50°	0.883	7.79	8.92	Horizontal	230°	0.992	9.83	9.93	Horizontal
55°	0.841	7.08	8.50	Horizontal	235°	1.000	9.99	10.00	Horizontal
60°	0.787	6.19	7.92	Horizontal	240°	1.000	10.00	10.00	Horizontal
65°	0.719	5.17	7.14	Horizontal	245°	0.999	9.98	9.99	Horizontal
70°	0.642	4.12	6.15	Vertical	250°	0.994	9.87	9.95	Horizontal
75°	0.571	3.26	5.14	Vertical	255°	0.984	9.68	9.86	Horizontal
80°	0.498	2.48	3.94	Vertical	260°	0.970	9.41	9.74	Horizontal
85°	0.420	1.76	2.46	Vertical	265°	0.952	9.06	9.57	Horizontal
90°	0.347	1.21	0.81	Vertical	270°	0.929	8.63	9.36	Horizontal
95°	0.279	0.78	-1.09	Vertical	275°	0.902	8.14	9.11	Horizontal
100°	0.227	0.51	-2.88	Vertical	280°	0.878	7.71	8.87	Horizontal
105°	0.192	0.37	-4.33	Vertical	285°	0.858	7.36	8.67	Vertical
110°	0.171	0.29	-5.36	Vertical	290°	0.874	7.64	8.83	Vertical
115°	0.163	0.26	-5.78	Vertical	295°	0.900	8.09	9.08	Vertical
120°	0.165	0.27	-5.65	Vertical	300°	0.934	8.72	9.40	Vertical
125°	0.171	0.29	-5.35	Vertical	305°	0.961	9.24	9.66	Vertical
130°	0.174	0.30	-5.19	Vertical	310°	0.979	9.59	9.82	Vertical
135°	0.176	0.31	-5.09	Horizontal	315°	0.987	9.74	9.89	Vertical
140°	0.186	0.35	-4.62	Horizontal	320°	0.985	9.70	9.87	Vertical
145°	0.198	0.39	-4.06	Horizontal	325°	0.975	9.50	9.78	Vertical
150°	0.214	0.46	-3.41	Horizontal	330°	0.957	9.17	9.62	Vertical
155°	0.235	0.55	-2.59	Horizontal	335°	0.933	8.71	9.40	Vertical
160°	0.277	0.77	-1.15	Vertical	340°	0.902	8.14	9.10	Vertical
165°	0.334	1.12	0.48	Vertical	345°	0.884	7.81	8.93	Horizontal
170°	0.394	1.56	1.92	Vertical	350°	0.877	7.69	8.86	Horizontal
175°	0.449	2.01	3.04	Vertical	355°	0.862	7.43	8.71	Horizontal

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

**Envelope**  
**1.000 @ 236° True**  
**0.163 @ 115° True**  
**0.763**  
**10.000 kW**  
**3.702 (5.684 dB)**

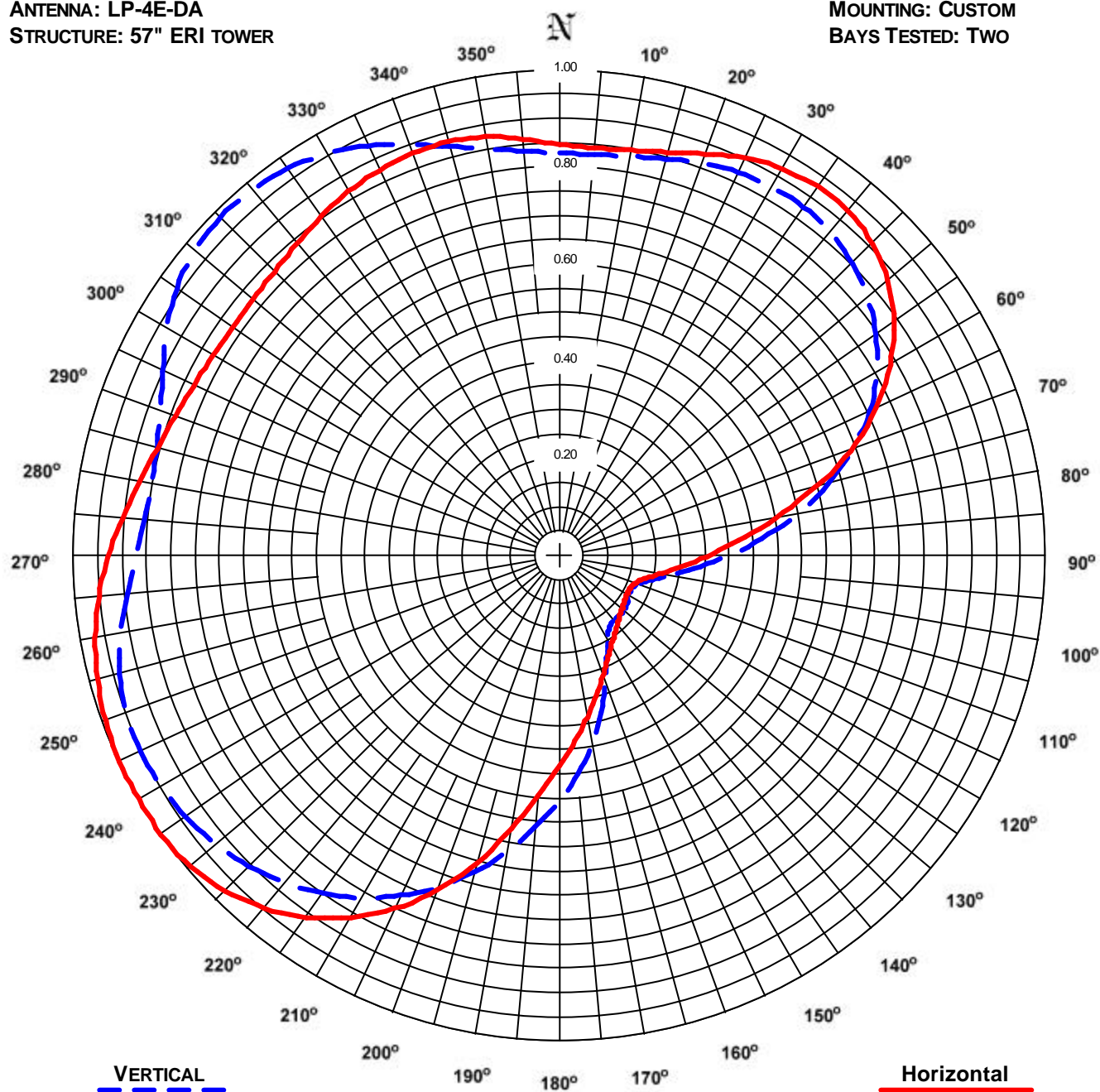
**Total Input Power: 2.702 kW**

# **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 NO: 2  
STATION: KSRD  
LOCATION: ST. JOSEPH, MO  
ANTENNA: LP-4E-DA  
STRUCTURE: 57" ERI TOWER

DATE: 8/13/2004  
FREQUENCY: 91.9 MHz  
ORIENTATION: 306° TRUE  
MOUNTING: CUSTOM  
BAYS TESTED: TWO



**VERTICAL**  
RMS: 0.740  
MAXIMUM: 0.988 @ 316° TRUE  
MINIMUM: 0.163 @ 115° TRUE

**Horizontal**  
RMS: 0.740  
Maximum: 1.000 @ 236° True  
Minimum: 0.160 @ 115° True

COMMENTS: MEASURED PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONENTS.

# **ERI**® *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: KSRD**  
**Location: St. Joseph, MO**  
**Frequency: 91.9 MHz**

**Antenna: LP-4E-DA**  
**Orientation: 306° True**  
**Tower: 57" ERI tower**

**Figure: 2**  
**Date: 8/13/2004**  
**Reference: ksrd1m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.849	7.21	8.58	0.830	6.90	8.39	180°	0.432	1.87	2.71	0.505	2.55	4.06
5°	0.844	7.12	8.53	0.831	6.90	8.39	185°	0.494	2.44	3.88	0.557	3.11	4.92
10°	0.849	7.20	8.58	0.837	7.00	8.45	190°	0.568	3.23	5.09	0.616	3.79	5.79
15°	0.861	7.42	8.70	0.847	7.18	8.56	195°	0.653	4.26	6.30	0.673	4.52	6.55
20°	0.882	7.78	8.91	0.862	7.42	8.71	200°	0.732	5.35	7.29	0.724	5.24	7.19
25°	0.905	8.20	9.14	0.872	7.61	8.81	205°	0.800	6.40	8.06	0.770	5.93	7.73
30°	0.921	8.48	9.29	0.878	7.71	8.87	210°	0.859	7.37	8.68	0.811	6.58	8.18
35°	0.929	8.63	9.36	0.878	7.71	8.87	215°	0.907	8.22	9.15	0.847	7.17	8.56
40°	0.927	8.59	9.34	0.870	7.57	8.79	220°	0.945	8.93	9.51	0.877	7.70	8.86
45°	0.911	8.30	9.19	0.854	7.29	8.63	225°	0.973	9.48	9.77	0.902	8.14	9.11
50°	0.883	7.79	8.92	0.829	6.87	8.37	230°	0.992	9.83	9.93	0.922	8.51	9.30
55°	0.841	7.08	8.50	0.796	6.34	8.02	235°	1.000	9.99	10.00	0.937	8.78	9.44
60°	0.787	6.19	7.92	0.755	5.71	7.56	240°	1.000	10.00	10.00	0.947	8.96	9.52
65°	0.719	5.17	7.14	0.706	4.99	6.98	245°	0.999	9.98	9.99	0.951	9.04	9.56
70°	0.639	4.08	6.11	0.642	4.12	6.15	250°	0.994	9.87	9.95	0.948	8.98	9.53
75°	0.545	2.98	4.74	0.571	3.26	5.14	255°	0.984	9.68	9.86	0.936	8.77	9.43
80°	0.452	2.04	3.10	0.498	2.48	3.94	260°	0.970	9.41	9.74	0.917	8.41	9.25
85°	0.372	1.38	1.40	0.420	1.76	2.46	265°	0.952	9.06	9.57	0.891	7.94	9.00
90°	0.304	0.93	-0.34	0.347	1.21	0.81	270°	0.929	8.63	9.36	0.870	7.57	8.79
95°	0.250	0.62	-2.05	0.279	0.78	-1.09	275°	0.902	8.14	9.11	0.857	7.35	8.66
100°	0.208	0.43	-3.63	0.227	0.51	-2.88	280°	0.878	7.71	8.87	0.852	7.26	8.61
105°	0.180	0.32	-4.91	0.192	0.37	-4.33	285°	0.858	7.36	8.67	0.858	7.36	8.67
110°	0.164	0.27	-5.70	0.171	0.29	-5.36	290°	0.842	7.09	8.51	0.874	7.64	8.83
115°	0.160	0.25	-5.94	0.163	0.26	-5.78	295°	0.831	6.90	8.39	0.900	8.09	9.08
120°	0.160	0.26	-5.90	0.165	0.27	-5.65	300°	0.824	6.78	8.31	0.934	8.72	9.40
125°	0.163	0.27	-5.74	0.171	0.29	-5.35	305°	0.821	6.74	8.29	0.961	9.24	9.66
130°	0.168	0.28	-5.47	0.174	0.30	-5.19	310°	0.823	6.78	8.31	0.979	9.59	9.82
135°	0.176	0.31	-5.09	0.173	0.30	-5.22	315°	0.830	6.88	8.38	0.987	9.74	9.89
140°	0.186	0.35	-4.62	0.172	0.30	-5.28	320°	0.840	7.05	8.48	0.985	9.70	9.87
145°	0.198	0.39	-4.06	0.180	0.32	-4.91	325°	0.854	7.29	8.63	0.975	9.50	9.78
150°	0.214	0.46	-3.41	0.200	0.40	-4.00	330°	0.867	7.52	8.76	0.957	9.17	9.62
155°	0.235	0.55	-2.59	0.232	0.54	-2.69	335°	0.877	7.69	8.86	0.933	8.71	9.40
160°	0.263	0.69	-1.62	0.277	0.77	-1.15	340°	0.882	7.79	8.91	0.902	8.14	9.10
165°	0.296	0.88	-0.57	0.334	1.12	0.48	345°	0.884	7.81	8.93	0.873	7.63	8.82
170°	0.336	1.13	0.53	0.394	1.56	1.92	350°	0.877	7.69	8.86	0.852	7.26	8.61
175°	0.381	1.45	1.62	0.449	2.01	3.04	355°	0.862	7.43	8.71	0.838	7.02	8.46

<b>Polarization:</b>	<b>Horizontal</b>	<b>Vertical</b>
<b>Maximum Field:</b>	<b>1.000 @ 236° True</b>	<b>0.988 @ 316° True</b>
<b>Minimum Field:</b>	<b>0.160 @ 115° True</b>	<b>0.163 @ 115° True</b>
<b>RMS:</b>	<b>0.740</b>	<b>0.740</b>
<b>Maximum ERP:</b>	<b>10.000 kW</b>	<b>9.752 kW</b>
<b>Maximum Power Gain:</b>	<b>3.702 (5.684 dB)</b>	<b>3.610 (5.575 dB)</b>

**Total Input Power: 2.702 kW**





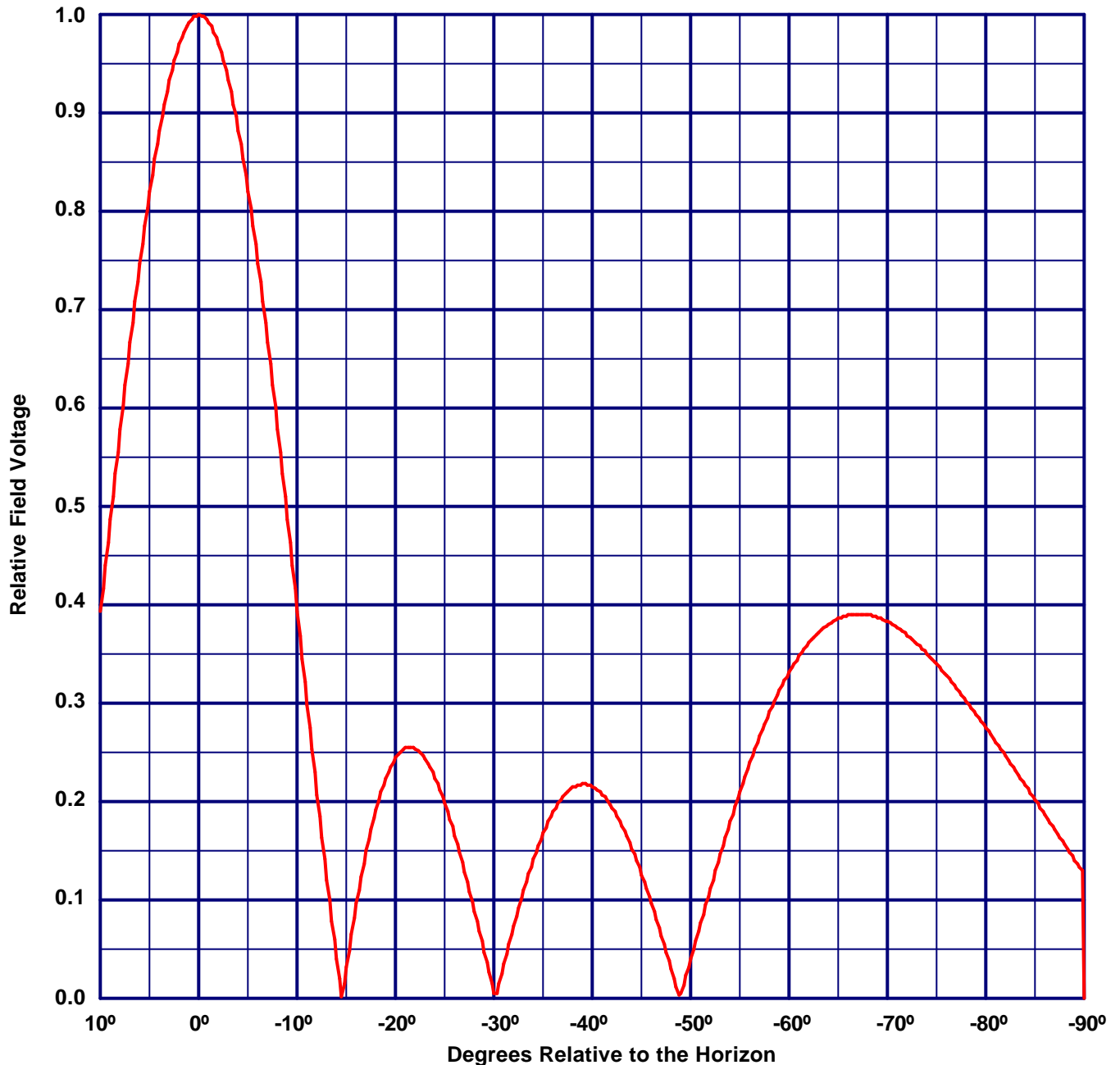
## Vertical Plane Relative Field Pattern

**KSRD, St. Joseph, MO, 91.9 MHz**

Figure#: 3

Date: 8/13/2004

*A 4 level, 1 wave-length spaced LP-4E-DA directional antenna  
with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.025*



**Vertical Polarization Gain:**

**Maximum: 3.610 (5.575 dB)**

**Horizontal Plane: 3.610 (5.575 dB)**

**Horizontal Polarization Gain:**

**Maximum: 3.702 (5.684 dB)**

**Horizontal Plane: 3.702 (5.684 dB)**

# Directional Antenna System for KSRD, St. Joseph, Missouri

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type:	LP-4E-DA
Frequency:	91.9 MHz
Number of Bays:	4

## MECHANICAL SPECIFICATIONS

Mounting:	Custom
System length:	40 ft 8 in
Aperture length required:	47 ft.
Orientation:	306° true
Input flange to the antenna	1 5/8 inch female

## ELECTRICAL SPECIFICATIONS (For directional use)

Maximum horizontal ERP:	10 kW (10 dBk)
Horizontal maximum power gain:	3.702 (5.684 dB)
Maximum vertical ERP:	9.752 kW (9.891 dBk)
Vertical maximum power gain:	3.610 (5.575 dB)
Total input power:	2.702 kW (4.317 dBk)

