

***Directional Antenna System  
for  
KKHK/KOSI, Denver, Colorado***

December 17, 2001

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

The antenna is the ERI model LP-8AC-DA-SP configuration. The circular polarized system consists of eight 84" spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements placed above and below each bay and two vertical parasitic elements. The antenna was tested on a 14" o.d. pole, which is the structure the station plans to use to support the array. All tests were performed on frequencies of 99.5 and 101.1 megahertz which are the centers of FM broadcast channels assigned to KKKH and KOSI respectively.

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 KKHK/KOSI, Denver, Colorado

(Continued)

## DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of the complete circular polarized system with the associated horizontal and vertical parasitic elements. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the antenna.

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.

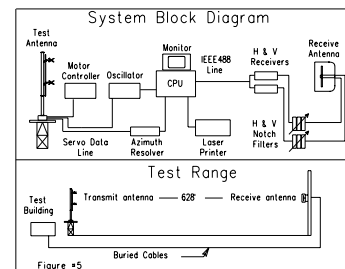
The proof-of-performance was accomplished using the actual 14" o.d. pole on which the antenna will be installed. The structure was erected vertically on a turntable mounted on a non-metallic building with the antenna centered vertically on the structure, making the center of radiation of the test approximately 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 99.5 and 101.1 MHz respectively 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 for each station 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 co-ordinated graph paper in a clockwise direction. Both horizontal and vertical components for each station were recorded separately.



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(Continued)

CONCLUSIONS

The circular polarized system consists of eight 84" spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements placed above and below each bay and two vertical parasitic elements. The power distribution and phase relationship was fixed when the antenna was manufactured. Proper maintenance of the elements should be all that is required to maintain the pattern in adjustment.

The LP-8AC-DA-SP array is to be mounted on the 14" o.d. pole at a bearing of North 122 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 for each station represents the maximum value of either the horizontal or vertical component at any azimuth. The measured horizontal plane relative field patterns, for both the horizontal and vertical polarization components, are shown on Figure #2 attached for each station. The actual measured patterns do not exceed the authorized FCC composite patterns filed for each of the stations at any azimuth. A calculated vertical plane relative field pattern for KKKH is shown on Figure #3 attached. A calculated vertical plane relative field pattern for KOSI is shown on Figure #3A attached. The elevation plots do not include the  $-3^{\circ}$  of mechanical beam tilt that may be included in the final installation at the site. The power in the maximum will reach 100 kilowatts (20 dBk) for each.

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(Continued)

The power at North 280 degrees East does not exceed 4.709 kilowatts (6.729 dBk) for either of the patterns developed for KKKH or KOSI.

The power at North 290 degrees East does not exceed 4.796 kilowatts (6.809 dBk) for either of the patterns developed for KKKH or KOSI.

The power at North 300 degrees East does not exceed 4.709 kilowatts (6.729 dBk) for either of the patterns developed for KKKH or KOSI.

The power at North 320 degrees East does not exceed 4.796 kilowatts (6.809 dBk) for either of the patterns developed for KKKH or KOSI.

The RMS of the vertically polarized horizontal plane component does not exceed the RMS of the horizontally polarized horizontal plane component for either of the patterns developed for KKKH or KOSI.

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

The clear vertical length of the structure required to support the antenna is 66 feet.

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.

ELECTRONICS RESEARCH, INC.



# Maximum 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: KOSI

LOCATION: DENVER, CO.

ANTENNA TYPE: LP-8AC-DA-SP

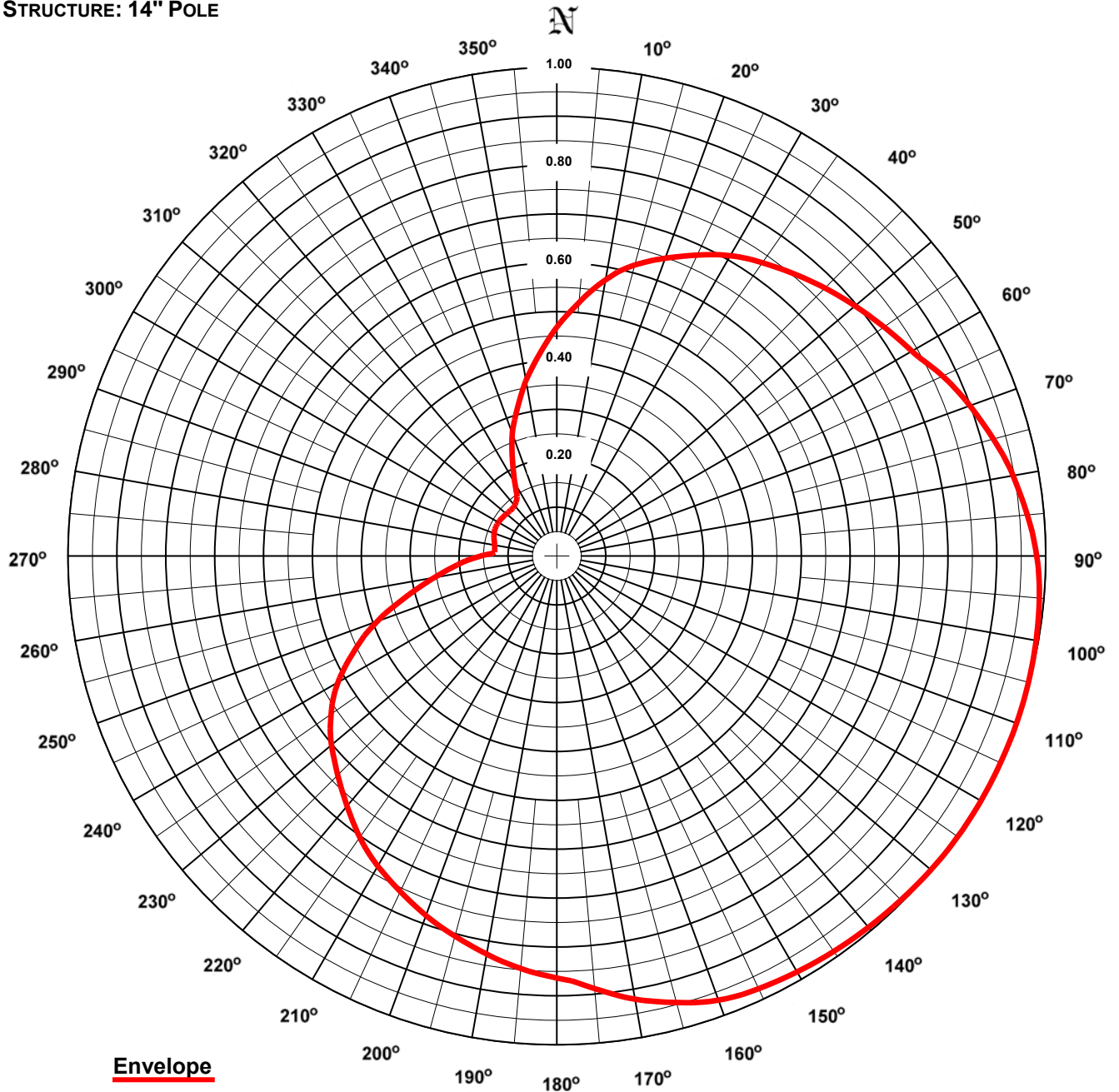
STRUCTURE: 14" POLE

DATE: 12/12/01

FREQUENCY: 101.1 MHz

ORIENTATION: 122° TRUE

MOUNTING: CUSTOM



RMS: 0.707

Maximum: 1.000 @ 113° True

Minimum: 0.128 @ 275° 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 BPH-20010214ABZ.

# 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: KOSI**  
**Location: Denver, CO.**  
**Frequency: 101.1 MHz**

**Antenna: LP-8AC-DA-SP**  
**Orientation: 122° True**  
**Tower: 14" Pole**

**Figure: 1**  
**Date: 12/12/01**  
**Reference: kosi1m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.472	22.29	13.48	Horizontal	180°	0.860	73.95	18.69	Horizontal
5°	0.525	27.54	14.40	Horizontal	185°	0.844	71.19	18.52	Horizontal
10°	0.578	33.41	15.24	Horizontal	190°	0.824	67.85	18.32	Horizontal
15°	0.621	38.53	15.86	Horizontal	195°	0.802	64.34	18.08	Horizontal
20°	0.652	42.57	16.29	Horizontal	200°	0.780	60.85	17.84	Horizontal
25°	0.683	46.72	16.69	Horizontal	205°	0.755	56.98	17.56	Horizontal
30°	0.713	50.90	17.07	Horizontal	210°	0.730	53.35	17.27	Horizontal
35°	0.736	54.24	17.34	Horizontal	215°	0.701	49.13	16.91	Horizontal
40°	0.758	57.39	17.59	Horizontal	220°	0.666	44.40	16.47	Horizontal
45°	0.779	60.72	17.83	Horizontal	225°	0.633	40.05	16.03	Horizontal
50°	0.799	63.90	18.05	Horizontal	230°	0.601	36.13	15.58	Horizontal
55°	0.820	67.25	18.28	Horizontal	235°	0.564	31.81	15.03	Horizontal
60°	0.841	70.77	18.50	Horizontal	240°	0.519	26.91	14.30	Horizontal
65°	0.874	76.39	18.83	Vertical	245°	0.460	21.13	13.25	Horizontal
70°	0.902	81.28	19.10	Vertical	250°	0.397	15.73	11.97	Horizontal
75°	0.927	85.85	19.34	Vertical	255°	0.325	10.59	10.25	Horizontal
80°	0.949	90.06	19.55	Vertical	260°	0.263	6.92	8.40	Horizontal
85°	0.967	93.52	19.71	Vertical	265°	0.213	4.52	6.55	Horizontal
90°	0.982	96.49	19.84	Vertical	270°	0.168	2.82	4.51	Horizontal
95°	0.991	98.15	19.92	Vertical	275°	0.128	1.63	2.13	Vertical
100°	0.995	99.02	19.96	Vertical	280°	0.129	1.67	2.22	Vertical
105°	0.998	99.61	19.98	Vertical	285°	0.133	1.76	2.44	Vertical
110°	1.000	99.93	20.00	Vertical	290°	0.137	1.88	2.74	Vertical
115°	1.000	99.98	20.00	Vertical	295°	0.140	1.95	2.90	Vertical
120°	1.000	100.00	20.00	Horizontal	300°	0.140	1.96	2.92	Vertical
125°	0.999	99.82	19.99	Horizontal	305°	0.139	1.93	2.86	Vertical
130°	0.997	99.34	19.97	Horizontal	310°	0.137	1.88	2.74	Vertical
135°	0.993	98.56	19.94	Horizontal	315°	0.136	1.84	2.66	Vertical
140°	0.989	97.80	19.90	Vertical	320°	0.136	1.86	2.70	Vertical
145°	0.985	96.93	19.86	Vertical	325°	0.144	2.07	3.15	Vertical
150°	0.979	95.93	19.82	Vertical	330°	0.170	2.88	4.60	Horizontal
155°	0.974	94.79	19.77	Vertical	335°	0.214	4.57	6.60	Horizontal
160°	0.963	92.81	19.68	Vertical	340°	0.267	7.14	8.54	Horizontal
165°	0.942	88.77	19.48	Vertical	345°	0.314	9.89	9.95	Horizontal
170°	0.917	84.09	19.25	Vertical	350°	0.367	13.49	11.30	Horizontal
175°	0.885	78.31	18.94	Vertical	355°	0.417	17.38	12.40	Horizontal

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

**Envelope**  
**1.000 @ 113° True**  
**0.128 @ 275° True**  
**0.707**  
**100.000 kW**  
**7.171 (8.556dB)**

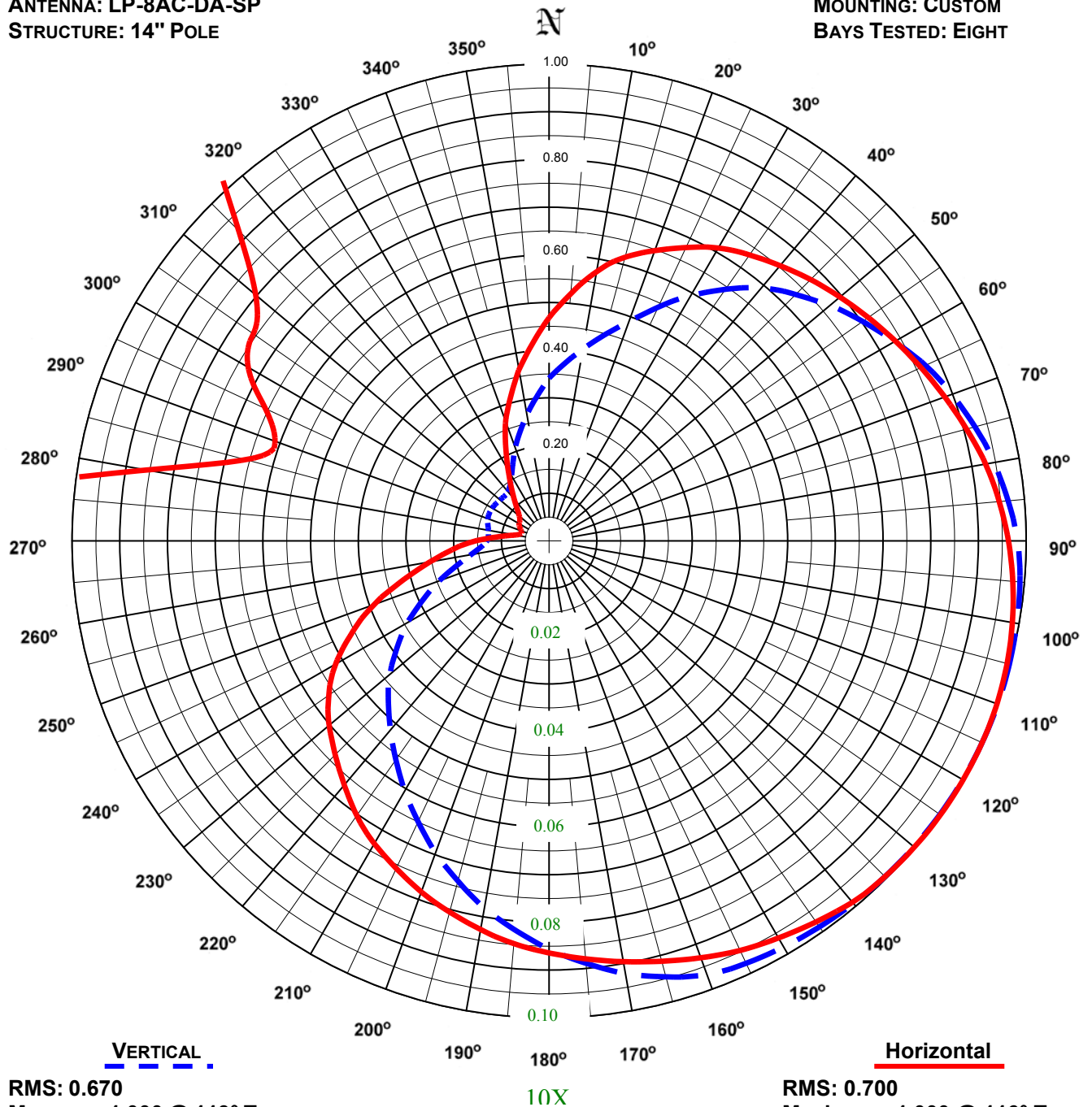
**Total Input Power: 13.945 kW**

# 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: KOSI  
LOCATION: DENVER, CO.  
ANTENNA: LP-8AC-DA-SP  
STRUCTURE: 14" POLE

DATE: 12/12/01  
FREQUENCY: 101.1 MHz  
ORIENTATION: 122° TRUE  
MOUNTING: CUSTOM  
BAYS TESTED: EIGHT



COMMENTS: MEASURED PATTERN OF THE HORIZONTAL AND VERTICAL COMPONENTS.



# Maximum 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: KOSI**  
**Location: Denver, CO.**  
**Frequency: 101.1 MHz**

**Antenna: LP-8AC-DA-SP**  
**Orientation: 122° True**  
**Tower: 14" Pole**

**Figure: 2**  
**Date: 12/12/01**  
**Reference: kosi1m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.472	22.29	13.48	0.346	11.94	10.77	180°	0.860	73.95	18.69	0.852	72.64	18.61
5°	0.525	27.54	14.40	0.378	14.28	11.55	185°	0.844	71.19	18.52	0.815	66.45	18.22
10°	0.578	33.41	15.24	0.413	17.08	12.32	190°	0.824	67.85	18.32	0.778	60.54	17.82
15°	0.621	38.53	15.86	0.452	20.43	13.10	195°	0.802	64.34	18.08	0.735	54.06	17.33
20°	0.652	42.57	16.29	0.495	24.53	13.90	200°	0.780	60.85	17.84	0.693	48.05	16.82
25°	0.683	46.72	16.69	0.546	29.85	14.75	205°	0.755	56.98	17.56	0.647	41.92	16.22
30°	0.713	50.90	17.07	0.599	35.94	15.56	210°	0.730	53.35	17.27	0.604	36.48	15.62
35°	0.736	54.24	17.34	0.649	42.18	16.25	215°	0.701	49.13	16.91	0.559	31.23	14.95
40°	0.758	57.39	17.59	0.697	48.62	16.87	220°	0.666	44.40	16.47	0.517	26.73	14.27
45°	0.779	60.72	17.83	0.736	54.10	17.33	225°	0.633	40.05	16.03	0.476	22.70	13.56
50°	0.799	63.90	18.05	0.772	59.60	17.75	230°	0.601	36.13	15.58	0.436	19.02	12.79
55°	0.820	67.25	18.28	0.806	65.03	18.13	235°	0.564	31.81	15.03	0.391	15.28	11.84
60°	0.841	70.77	18.50	0.840	70.55	18.48	240°	0.519	26.91	14.30	0.347	12.01	10.79
65°	0.863	74.48	18.72	0.874	76.39	18.83	245°	0.460	21.13	13.25	0.297	8.80	9.45
70°	0.885	78.38	18.94	0.902	81.28	19.10	250°	0.397	15.73	11.97	0.253	6.40	8.06
75°	0.908	82.49	19.16	0.927	85.85	19.34	255°	0.325	10.59	10.25	0.209	4.35	6.39
80°	0.931	86.65	19.38	0.949	90.06	19.55	260°	0.263	6.92	8.40	0.174	3.03	4.81
85°	0.948	89.96	19.54	0.967	93.52	19.71	265°	0.213	4.52	6.55	0.149	2.22	3.46
90°	0.964	92.84	19.68	0.982	96.49	19.84	270°	0.168	2.82	4.51	0.134	1.78	2.51
95°	0.976	95.26	19.79	0.991	98.15	19.92	275°	0.122	1.49	1.74	0.128	1.63	2.13
100°	0.986	97.20	19.88	0.995	99.02	19.96	280°	0.087	0.76	-1.19	0.129	1.67	2.22
105°	0.993	98.63	19.94	0.998	99.61	19.98	285°	0.067	0.45	-3.51	0.133	1.76	2.44
110°	0.998	99.56	19.98	1.000	99.93	20.00	290°	0.061	0.37	-4.27	0.137	1.88	2.74
115°	1.000	99.98	20.00	1.000	99.98	20.00	295°	0.065	0.43	-3.70	0.140	1.95	2.90
120°	1.000	100.00	20.00	0.999	99.84	19.99	300°	0.073	0.53	-2.76	0.140	1.96	2.92
125°	0.999	99.82	19.99	0.998	99.54	19.98	305°	0.076	0.58	-2.40	0.139	1.93	2.86
130°	0.997	99.34	19.97	0.996	99.11	19.96	310°	0.080	0.64	-1.92	0.137	1.88	2.74
135°	0.993	98.56	19.94	0.993	98.53	19.94	315°	0.092	0.84	-0.75	0.136	1.84	2.66
140°	0.986	97.16	19.87	0.989	97.80	19.90	320°	0.111	1.22	0.87	0.136	1.86	2.70
145°	0.972	94.41	19.75	0.985	96.93	19.86	325°	0.137	1.87	2.71	0.144	2.07	3.15
150°	0.958	91.73	19.62	0.979	95.93	19.82	330°	0.170	2.88	4.60	0.158	2.51	4.00
155°	0.944	89.04	19.50	0.974	94.79	19.77	335°	0.214	4.57	6.60	0.180	3.26	5.13
160°	0.926	85.77	19.33	0.963	92.81	19.68	340°	0.267	7.14	8.54	0.209	4.38	6.42
165°	0.909	82.54	19.17	0.942	88.77	19.48	345°	0.314	9.89	9.95	0.239	5.70	7.56
170°	0.892	79.53	19.01	0.917	84.09	19.25	350°	0.367	13.49	11.30	0.272	7.38	8.68
175°	0.876	76.69	18.85	0.885	78.31	18.94	355°	0.417	17.38	12.40	0.306	9.39	9.73

**Polarization:**

**Maximum Field:**

**Minimum Field:**

**RMS:**

**Maximum ERP:**

**H Plane ERP**

**Maximum Power Gain:**

**Horizontal Plane Gain:**

**Total Input Power: 13.945 kW**

**Horizontal**

**1.000 @ 116° True**

**0.061 @ 289° True**

**0.700**

**100.000 kW**

**73.616 kW**

**7.171 (8.556dB)**

**5.279 (7.226 dB)**

**Vertical**

**1.000 @ 113° True**

**0.128 @ 275° True**

**0.670**

**100.000 kW**

**73.616 kW**

**7.171 (8.556dB)**

**5.279 (7.226 dB)**



Directional Antenna System  
for  
KKHK/KOSI, Denver, Colorado  
(Continued)

ANTENNA SPECIFICATIONS

Antenna Type: LP-8AC-DA-SP  
Frequency: 99.5/101.1 MHz  
Number of Bays: 8

MECHANICAL SPECIFICATIONS

Mounting: Custom  
System length: 82 ft 9 in  
Aperture length required: 66 ft.5 in  
Orientation: 122° true  
Input flange to the antenna 3 1/8 inch female

ELECTRICAL SPECIFICATIONS

KKHK

(For directional use)

Maximum horizontal ERP: 100 kW (20 dBk)  
Horizontal maximum power gain: 7.322 (8.647 dB)  
Maximum vertical ERP: 100 kW (20 dBk)  
Vertical maximum power gain: 7.322 (8.647 dB)  
H Plane horizontal ERP: 74.304 kW (18.710 dBk)  
H Plane gain horizontal: 5.441 (7.357 dB)  
H Plane vertical ERP: 74.304 kW (18.710 dBk)  
H Plane gain vertical: 5.441 (7.357 dB)  
Total input power: 13.657 kW (11.353 dBk)

ELECTRICAL SPECIFICATIONS

KOSI

(For directional use)

Maximum horizontal ERP: 100 kW (20 dBk)  
Horizontal maximum power gain: 7.322 (8.647 dB)  
Maximum vertical ERP: 100 kW (20 dBk)  
Vertical maximum power gain: 7.322 (8.647 dB)  
H Plane horizontal ERP: 73.616 (18.670 dBk)  
H Plane gain horizontal: 5.279 (7.226 dB)  
H Plane vertical ERP: 73.616 (18.670 dBk)  
H Plane gain vertical: 5.279 (7.226 dB)  
Total input power: 13.945 kW (11.444 dBk)

ELECTRONICS RESEARCH, INC.  
7777 GARDNER ROAD  
CHANDLER, IN. 47610

FIGURE 3A

-----THEORETICAL-----  
VERTICAL PLANE RELATIVE FIELD

ERI MODEL LP-8AC-DA-SP  
0 DEGREE(S) ELECTRICAL BEAM TILT  
0 PERCENT FIRST NULL FILL  
0 PERCENT SECOND NULL FILL

12/12/01

101.1 MHz.

ELEMENT SPACING:  
84.0 INCHES

