

***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.

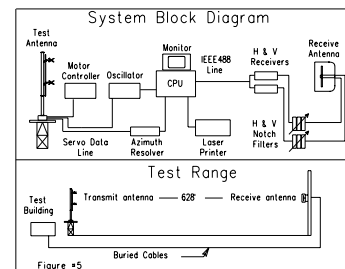
The proof-of-performance was accomplished using the actual 14" o.d. pole on which the antenna will be installed. The structure was erected vertically on a turntable mounted on a non-metallic building with the antenna centered vertically on the structure, making the center of radiation of the test approximately 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.



Directional Antenna System
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KKHK/KOSI, Denver, Colorado

(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° 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.

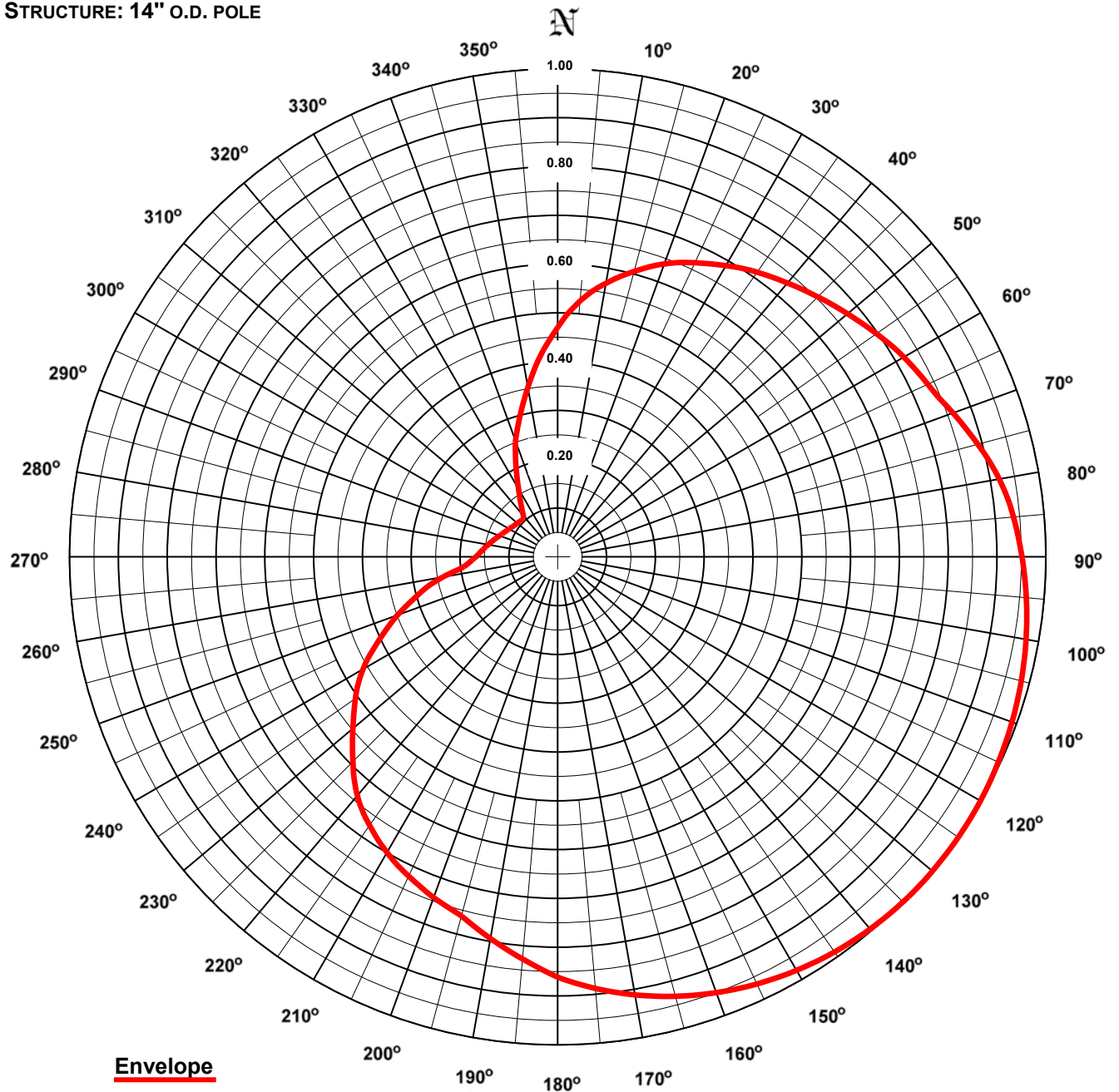
ELECTRONICS RESEARCH, INC.

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: KKHK
LOCATION: DENVER, CO.
ANTENNA TYPE: LP-8AC-DA-SP
STRUCTURE: 14" O.D. POLE

DATE: 12/12/01
FREQUENCY: 99.5 MHz
ORIENTATION: 122° TRUE
MOUNTING: CUSTOM



RMS: 0.691
Maximum: 1.000 @ 125° True
Minimum: 0.108 @ 320° 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-20010214AC.



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: KKKH
Location: Denver, CO.
Frequency: 99.5 MHz

Antenna: LP-8AC-DA-SP
Orientation: 122° True
Tower: 14" o.d. pole

Figure: 1
Date: 12/12/01
Reference: kkhk1m.fig

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.474	22.44	13.51	Horizontal	180°	0.858	73.62	18.67	Vertical
5°	0.530	28.13	14.49	Horizontal	185°	0.824	67.87	18.32	Vertical
10°	0.573	32.87	15.17	Horizontal	190°	0.791	62.57	17.96	Vertical
15°	0.610	37.15	15.70	Horizontal	195°	0.759	57.58	17.60	Vertical
20°	0.643	41.33	16.16	Horizontal	200°	0.740	54.80	17.39	Horizontal
25°	0.669	44.75	16.51	Horizontal	205°	0.719	51.75	17.14	Horizontal
30°	0.693	48.03	16.82	Horizontal	210°	0.697	48.59	16.87	Horizontal
35°	0.716	51.25	17.10	Horizontal	215°	0.670	44.88	16.52	Horizontal
40°	0.736	54.19	17.34	Horizontal	220°	0.637	40.63	16.09	Horizontal
45°	0.757	57.30	17.58	Horizontal	225°	0.593	35.18	15.46	Horizontal
50°	0.778	60.58	17.82	Horizontal	230°	0.548	30.03	14.78	Horizontal
55°	0.800	64.06	18.07	Horizontal	235°	0.506	25.63	14.09	Horizontal
60°	0.822	67.50	18.29	Horizontal	240°	0.462	21.39	13.30	Horizontal
65°	0.839	70.42	18.48	Horizontal	245°	0.407	16.60	12.20	Horizontal
70°	0.864	74.71	18.73	Vertical	250°	0.355	12.59	11.00	Horizontal
75°	0.893	79.83	19.02	Vertical	255°	0.300	9.02	9.55	Horizontal
80°	0.920	84.67	19.28	Vertical	260°	0.248	6.16	7.90	Horizontal
85°	0.938	88.04	19.45	Vertical	265°	0.193	3.71	5.70	Vertical
90°	0.952	90.62	19.57	Vertical	270°	0.172	2.96	4.71	Vertical
95°	0.964	92.91	19.68	Vertical	275°	0.158	2.51	4.00	Vertical
100°	0.974	94.90	19.77	Vertical	280°	0.148	2.19	3.40	Vertical
105°	0.983	96.57	19.85	Vertical	285°	0.139	1.92	2.83	Vertical
110°	0.990	97.92	19.91	Vertical	290°	0.130	1.70	2.31	Vertical
115°	0.995	98.94	19.95	Vertical	295°	0.124	1.53	1.84	Vertical
120°	0.999	99.70	19.99	Horizontal	300°	0.118	1.39	1.43	Vertical
125°	1.000	100.00	20.00	Horizontal	305°	0.114	1.29	1.10	Vertical
130°	1.000	99.98	20.00	Vertical	310°	0.110	1.22	0.86	Vertical
135°	0.998	99.55	19.98	Vertical	315°	0.108	1.17	0.70	Vertical
140°	0.993	98.59	19.94	Vertical	320°	0.108	1.16	0.64	Vertical
145°	0.985	97.11	19.87	Vertical	325°	0.129	1.68	2.24	Horizontal
150°	0.975	95.11	19.78	Vertical	330°	0.158	2.51	4.00	Horizontal
155°	0.962	92.62	19.67	Vertical	335°	0.201	4.03	6.05	Horizontal
160°	0.947	89.66	19.53	Vertical	340°	0.254	6.46	8.10	Horizontal
165°	0.929	86.24	19.36	Vertical	345°	0.300	9.02	9.55	Horizontal
170°	0.908	82.41	19.16	Vertical	350°	0.355	12.59	11.00	Horizontal
175°	0.884	78.19	18.93	Vertical	355°	0.416	17.27	12.37	Horizontal

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

Envelope
1.000 @ 125° True
0.108 @ 320° True
0.691
100.000 kW
7.322 (8.647 dB)

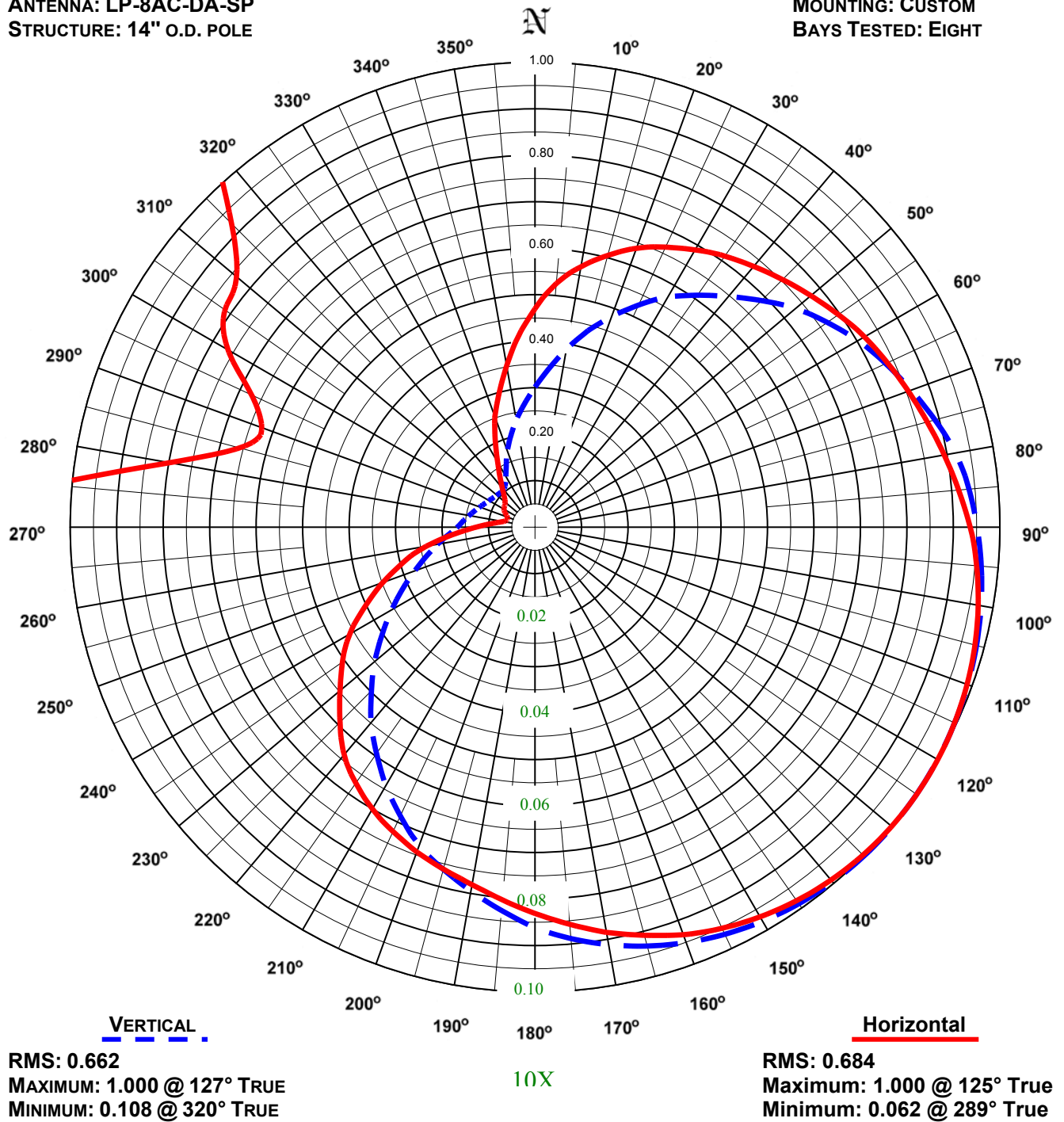
Total Input Power: 13.657 kW

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: KKKH
LOCATION: DENVER, CO.
ANTENNA: LP-8AC-DA-SP
STRUCTURE: 14" O.D. POLE

DATE: 12/12/01
FREQUENCY: 99.5 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: KKKH
Location: Denver, CO.
Frequency: 99.5 MHz

Antenna: LP-8AC-DA-SP
Orientation: 122° True
Tower: 14" o.d. pole

Figure: 2
Date: 12/12/01
Reference: kkhk1m.fig

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.474	22.44	13.51	0.305	9.31	9.69	180°	0.827	68.39	18.35	0.858	73.62	18.67
5°	0.530	28.13	14.49	0.347	12.02	10.80	185°	0.801	64.18	18.07	0.824	67.87	18.32
10°	0.573	32.87	15.17	0.394	15.52	11.91	190°	0.777	60.41	17.81	0.791	62.57	17.96
15°	0.610	37.15	15.70	0.442	19.54	12.91	195°	0.758	57.45	17.59	0.759	57.58	17.60
20°	0.643	41.33	16.16	0.488	23.80	13.77	200°	0.740	54.80	17.39	0.725	52.54	17.20
25°	0.669	44.75	16.51	0.532	28.34	14.52	205°	0.719	51.75	17.14	0.683	46.66	16.69
30°	0.693	48.03	16.82	0.577	33.33	15.23	210°	0.697	48.59	16.87	0.640	40.98	16.13
35°	0.716	51.25	17.10	0.614	37.69	15.76	215°	0.670	44.88	16.52	0.593	35.19	15.46
40°	0.736	54.19	17.34	0.653	42.61	16.29	220°	0.637	40.63	16.09	0.548	30.02	14.77
45°	0.757	57.30	17.58	0.694	48.17	16.83	225°	0.593	35.18	15.46	0.498	24.81	13.95
50°	0.778	60.58	17.82	0.736	54.11	17.33	230°	0.548	30.03	14.78	0.452	20.43	13.10
55°	0.800	64.06	18.07	0.772	59.55	17.75	235°	0.506	25.63	14.09	0.404	16.28	12.12
60°	0.822	67.50	18.29	0.807	65.11	18.14	240°	0.462	21.39	13.30	0.359	12.88	11.10
65°	0.839	70.42	18.48	0.836	69.81	18.44	245°	0.407	16.60	12.20	0.318	10.10	10.04
70°	0.857	73.48	18.66	0.864	74.71	18.73	250°	0.355	12.59	11.00	0.280	7.84	8.94
75°	0.876	76.69	18.85	0.893	79.83	19.02	255°	0.300	9.02	9.55	0.247	6.09	7.85
80°	0.896	80.24	19.04	0.920	84.67	19.28	260°	0.248	6.16	7.90	0.218	4.76	6.77
85°	0.916	83.96	19.24	0.938	88.04	19.45	265°	0.189	3.59	5.55	0.193	3.71	5.70
90°	0.937	87.85	19.44	0.952	90.62	19.57	270°	0.141	2.00	3.00	0.172	2.96	4.71
95°	0.954	91.06	19.59	0.964	92.91	19.68	275°	0.106	1.12	0.50	0.158	2.51	4.00
100°	0.968	93.71	19.72	0.974	94.90	19.77	280°	0.081	0.66	-1.82	0.148	2.19	3.40
105°	0.979	95.91	19.82	0.983	96.57	19.85	285°	0.067	0.44	-3.54	0.139	1.92	2.83
110°	0.988	97.65	19.90	0.990	97.92	19.91	290°	0.063	0.39	-4.07	0.130	1.70	2.31
115°	0.995	98.92	19.95	0.995	98.94	19.95	295°	0.067	0.45	-3.48	0.124	1.53	1.84
120°	0.999	99.70	19.99	0.998	99.62	19.98	300°	0.076	0.58	-2.38	0.118	1.39	1.43
125°	1.000	100.00	20.00	1.000	99.96	20.00	305°	0.082	0.67	-1.77	0.114	1.29	1.10
130°	0.999	99.76	19.99	1.000	99.98	20.00	310°	0.084	0.70	-1.53	0.110	1.22	0.86
135°	0.995	98.93	19.95	0.998	99.55	19.98	315°	0.092	0.85	-0.71	0.108	1.17	0.70
140°	0.987	97.51	19.89	0.993	98.59	19.94	320°	0.107	1.15	0.62	0.108	1.16	0.64
145°	0.977	95.52	19.80	0.985	97.11	19.87	325°	0.129	1.68	2.24	0.113	1.27	1.03
150°	0.964	92.97	19.68	0.975	95.11	19.78	330°	0.158	2.51	4.00	0.126	1.58	1.98
155°	0.948	89.89	19.54	0.962	92.62	19.67	335°	0.201	4.03	6.05	0.147	2.16	3.34
160°	0.929	86.30	19.36	0.947	89.66	19.53	340°	0.254	6.46	8.10	0.176	3.11	4.93
165°	0.905	81.84	19.13	0.929	86.24	19.36	345°	0.300	9.02	9.55	0.204	4.18	6.21
170°	0.881	77.62	18.90	0.908	82.41	19.16	350°	0.355	12.59	11.00	0.237	5.61	7.49
175°	0.854	72.86	18.62	0.884	78.19	18.93	355°	0.416	17.27	12.37	0.269	7.23	8.59

Polarization:

Maximum Field:

Minimum Field:

RMS:

Maximum ERP:

H Plane ERP:

Maximum Power Gain:

Horizontal Plane Gain:

Total Input Power: 13.657 kW

Horizontal

1.000 @ 125° True

0.062 @ 289° True

0.684

100.000 kW

74.304 kW

7.322 (8.647 dB)

5.441 (7.357 dB)

Vertical

1.000 @ 127° True

0.108 @ 320° True

0.662

100.000 kW

74.304 kW

7.322 (8.647 dB)

5.441 (7.357 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 3

-----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

99.5 MHz.

ELEMENT SPACING:
84.0 INCHES

