

***Directional Antenna System  
For  
KFMD, Denver, Colorado***

March 3, 2003

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

The antenna is the ERI model 1082-8CP-DA configuration. The circular polarized system consists of eight 92" spaced bays using two driven circular polarized radiating elements per bay. The antenna was tested on a 60" face ERI tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 95.7 megahertz, which is the center of the FM broadcast channel assigned to KFMD.

The other FM stations that will be transmitting from this directional antenna are KDJM @ 92.5 MHz, KCTL @ 93.3 MHz, KRFX @ 103.5 MHz, KALC @ 105.9 MHz and KBPI @ 106.7 MHz.

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 KFMD, Denver, Colorado

(Continued)

## DESCRIPTION OF THE TEST PROCEDURE

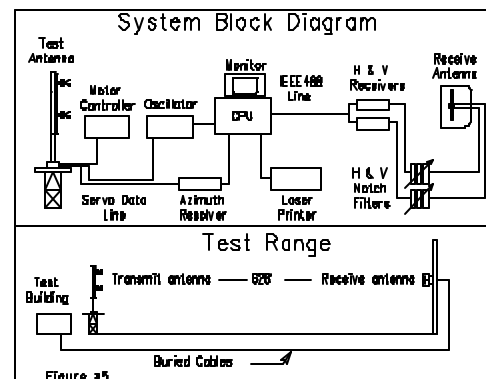
The test antenna consisted of four bay levels of the circular polarized system. The elements and brackets that were used in this test are the actual components that will be supplied with the antenna. The lines were properly grounded during all tests.

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 60" face 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 95.7 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.



# Directional Antenna System For KFMD, Denver, Colorado

(Continued)

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 eight 92" spaced bays using two driven circular polarized radiating elements per 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 1082-8CP-DA array is to be mounted on the 60" face ERI tower at a bearing of North 51 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. A calculated vertical plane relative field pattern is shown on Figure #3B attached. The power in the maximum will reach 100 kilowatts (20.00 dBk).

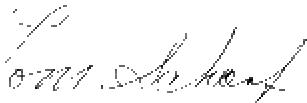
The RMS of the vertically polarized horizontal plane component does not exceed the RMS of the horizontally polarized horizontal plane component.

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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.

A handwritten signature in cursive script, appearing to read "L. M. Sherrill".

# **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: KFMD

LOCATION: DENVER, CO.

ANTENNA TYPE: 1082-8CP-DA

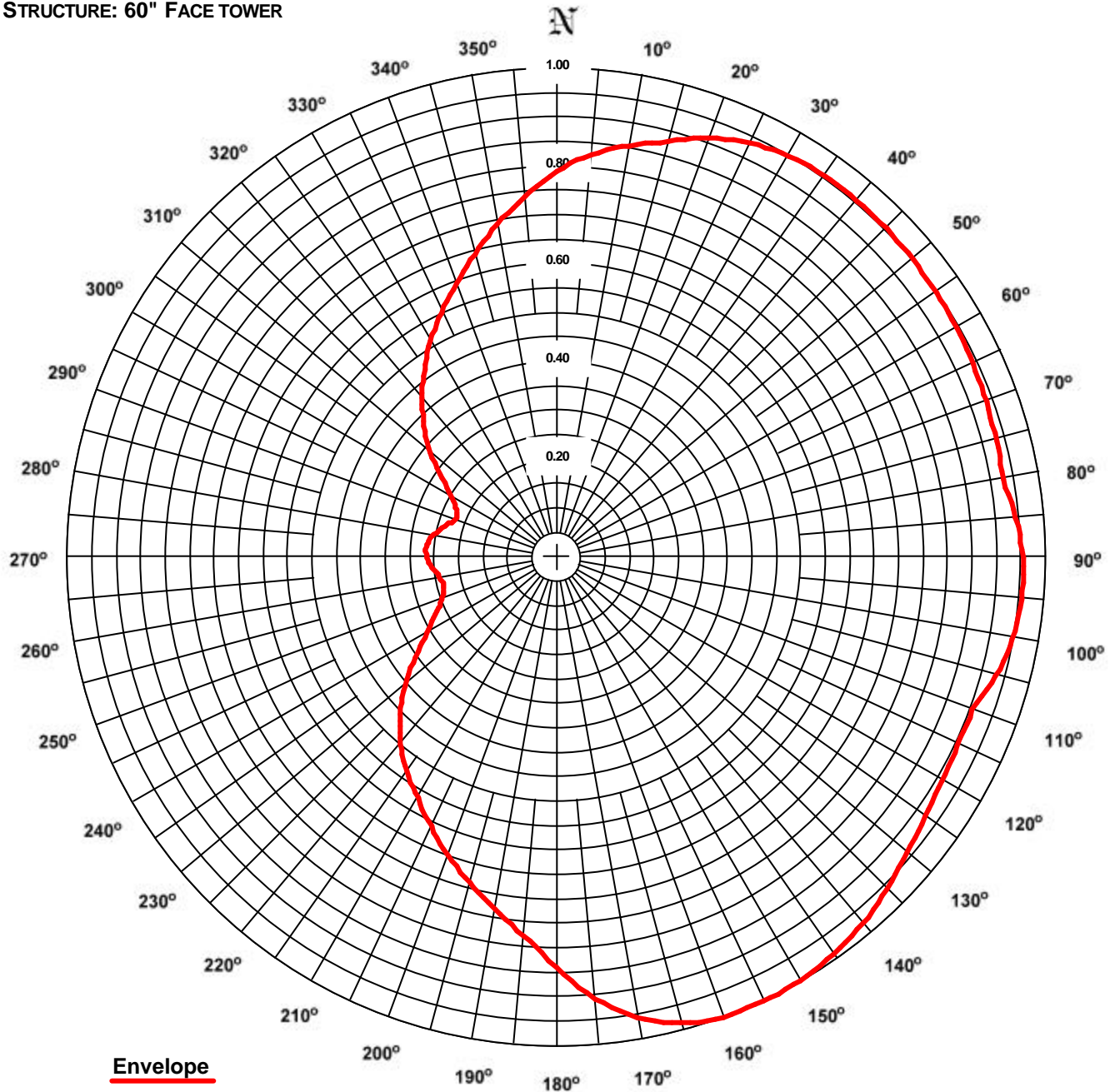
STRUCTURE: 60" FACE TOWER

DATE: 2/28/03

FREQUENCY: 95.7 MHz

ORIENTATION: 51° TRUE

MOUNTING: CUSTOM



RMS: 0.745

Maximum: 1.000 @ 155° True

Minimum: 0.220 @ 292° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES.

# 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: KFMD**  
**Location: Denver, CO.**  
**Frequency: 95.7 MHz**

**Antenna: 1082-8CP-DA**  
**Orientation: 51° True**  
**Tower: 60" Face tower**

**Figure: 1**  
**Date: 2/28/03**  
**Reference: kfmd1m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.790	62.48	17.96	Vertical	180°	0.837	70.06	18.45	Horizontal
5°	0.829	68.76	18.37	Vertical	185°	0.775	60.02	17.78	Vertical
10°	0.858	73.59	18.67	Vertical	190°	0.728	52.93	17.24	Vertical
15°	0.884	78.10	18.93	Horizontal	195°	0.687	47.16	16.74	Vertical
20°	0.915	83.67	19.23	Horizontal	200°	0.647	41.86	16.22	Vertical
25°	0.937	87.82	19.44	Horizontal	205°	0.606	36.75	15.65	Vertical
30°	0.951	90.42	19.56	Horizontal	210°	0.567	32.14	15.07	Vertical
35°	0.956	91.40	19.61	Horizontal	215°	0.532	28.29	14.52	Vertical
40°	0.956	91.30	19.60	Horizontal	220°	0.496	24.55	13.90	Vertical
45°	0.954	91.04	19.59	Horizontal	225°	0.451	20.37	13.09	Vertical
50°	0.952	90.61	19.57	Horizontal	230°	0.404	16.35	12.13	Vertical
55°	0.949	90.01	19.54	Horizontal	235°	0.352	12.38	10.93	Vertical
60°	0.945	89.25	19.51	Horizontal	240°	0.307	9.40	9.73	Vertical
65°	0.940	88.34	19.46	Horizontal	245°	0.273	7.44	8.72	Vertical
70°	0.935	87.50	19.42	Horizontal	250°	0.250	6.26	7.97	Vertical
75°	0.932	86.81	19.39	Horizontal	255°	0.239	5.71	7.57	Vertical
80°	0.929	86.30	19.36	Horizontal	260°	0.240	5.77	7.61	Vertical
85°	0.944	89.10	19.50	Vertical	265°	0.252	6.37	8.04	Vertical
90°	0.954	91.01	19.59	Vertical	270°	0.264	6.98	8.44	Vertical
95°	0.955	91.21	19.60	Vertical	275°	0.267	7.15	8.54	Vertical
100°	0.947	89.63	19.52	Vertical	280°	0.258	6.66	8.24	Vertical
105°	0.930	86.52	19.37	Vertical	285°	0.241	5.83	7.65	Vertical
110°	0.906	82.11	19.14	Horizontal	290°	0.225	5.04	7.03	Vertical
115°	0.906	82.01	19.14	Horizontal	295°	0.225	5.04	7.02	Vertical
120°	0.911	82.95	19.19	Horizontal	300°	0.247	6.09	7.84	Vertical
125°	0.921	84.83	19.29	Horizontal	305°	0.285	8.10	9.09	Vertical
130°	0.936	87.70	19.43	Horizontal	310°	0.336	11.32	10.54	Vertical
135°	0.957	91.55	19.62	Horizontal	315°	0.383	14.63	11.65	Vertical
140°	0.975	95.13	19.78	Horizontal	320°	0.427	18.24	12.61	Vertical
145°	0.989	97.75	19.90	Horizontal	325°	0.470	22.11	13.45	Vertical
150°	0.997	99.38	19.97	Horizontal	330°	0.514	26.41	14.22	Vertical
155°	1.000	100.00	20.00	Horizontal	335°	0.556	30.89	14.90	Vertical
160°	0.999	99.86	19.99	Horizontal	340°	0.599	35.91	15.55	Vertical
165°	0.985	97.06	19.87	Horizontal	345°	0.645	41.61	16.19	Vertical
170°	0.953	90.90	19.59	Horizontal	350°	0.694	48.23	16.83	Vertical
175°	0.904	81.73	19.12	Horizontal	355°	0.742	55.10	17.41	Vertical

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

**Envelope**  
**1.000 @ 155° True**  
**0.220 @ 292° True**  
**0.745**  
**100.000 kW**  
**6.889 (8.381 dB)**

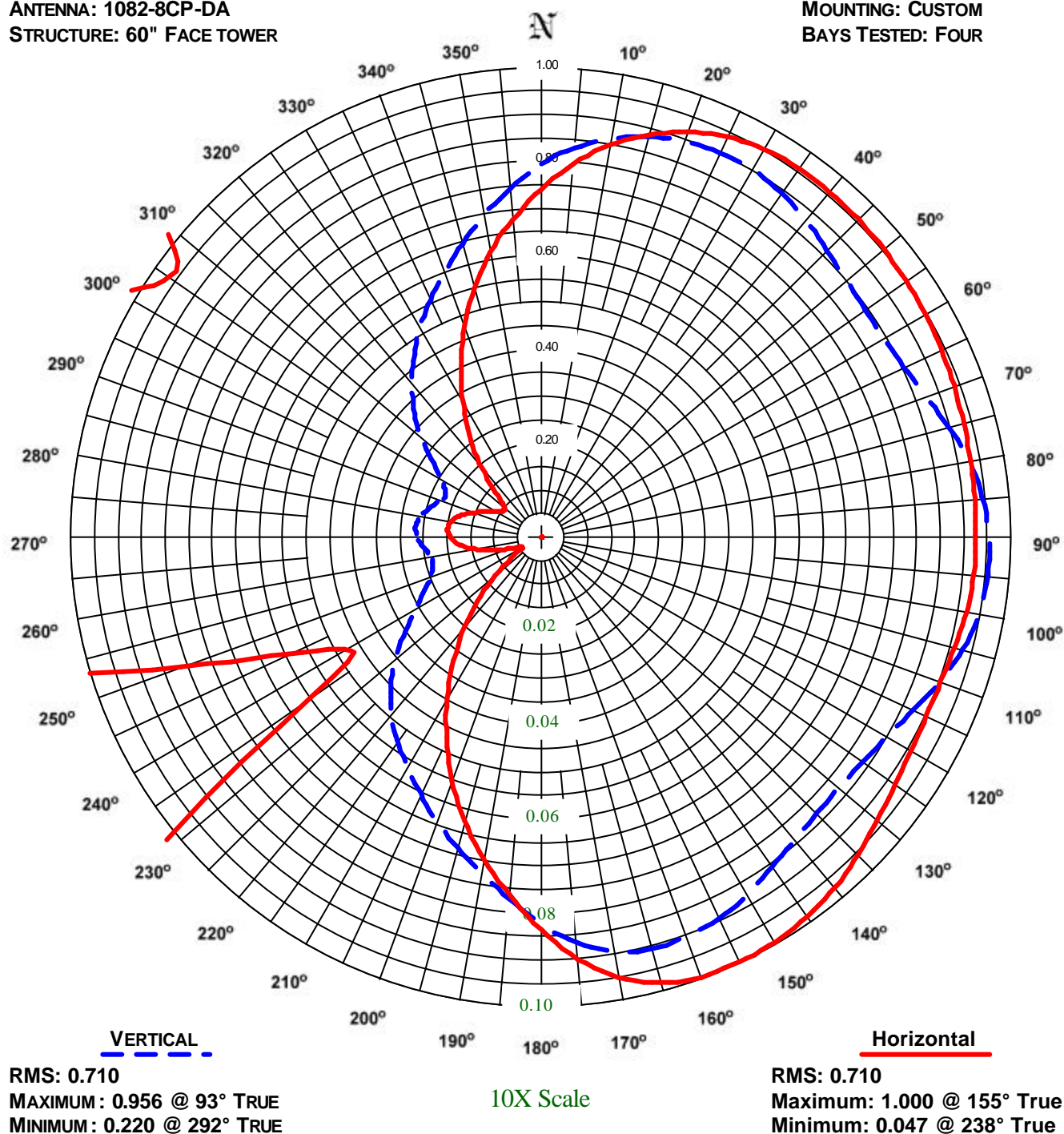
**Total Input Power: 14.516kW**

# **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: KFMD  
LOCATION: DENVER, CO.  
ANTENNA: 1082-8CP-DA  
STRUCTURE: 60" FACE TOWER

DATE: 2/28/03  
FREQUENCY: 95.7 MHz  
ORIENTATION: 51° TRUE  
MOUNTING: CUSTOM  
BAYS TESTED: FOUR



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: KFMD**  
**Location: Denver, CO.**  
**Frequency: 95.7 MHz**

**Antenna: 1082-8CP-DA**  
**Orientation: 51° True**  
**Tower: 60" Face tower**

**Figure: 2**  
**Date: 2/28/03**  
**Reference: kfmd1m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.739	54.62	17.37	0.790	62.48	17.96	180°	0.837	70.06	18.45	0.825	68.07	18.33
5°	0.796	63.35	18.02	0.829	68.76	18.37	185°	0.767	58.76	17.69	0.775	60.02	17.78
10°	0.844	71.25	18.53	0.858	73.59	18.67	190°	0.698	48.76	16.88	0.728	52.93	17.24
15°	0.884	78.10	18.93	0.879	77.32	18.88	195°	0.625	39.10	15.92	0.687	47.16	16.74
20°	0.915	83.67	19.23	0.894	79.85	19.02	200°	0.552	30.49	14.84	0.647	41.86	16.22
25°	0.937	87.82	19.44	0.901	81.14	19.09	205°	0.474	22.47	13.52	0.606	36.75	15.65
30°	0.951	90.42	19.56	0.900	81.02	19.09	210°	0.399	15.89	12.01	0.567	32.14	15.07
35°	0.956	91.40	19.61	0.893	79.66	19.01	215°	0.322	10.39	10.17	0.532	28.29	14.52
40°	0.956	91.30	19.60	0.879	77.20	18.88	220°	0.252	6.33	8.01	0.496	24.55	13.90
45°	0.954	91.04	19.59	0.861	74.08	18.70	225°	0.180	3.24	5.10	0.451	20.37	13.09
50°	0.952	90.61	19.57	0.848	71.92	18.57	230°	0.115	1.32	1.20	0.404	16.35	12.13
55°	0.949	90.01	19.54	0.842	70.85	18.50	235°	0.060	0.36	-4.44	0.352	12.38	10.93
60°	0.945	89.25	19.51	0.843	71.07	18.52	240°	0.048	0.23	-6.34	0.307	9.40	9.73
65°	0.940	88.34	19.46	0.853	72.78	18.62	245°	0.059	0.35	-4.54	0.273	7.44	8.72
70°	0.935	87.50	19.42	0.872	75.97	18.81	250°	0.082	0.67	-1.77	0.250	6.26	7.97
75°	0.932	86.81	19.39	0.899	80.73	19.07	255°	0.115	1.32	1.21	0.239	5.71	7.57
80°	0.929	86.30	19.36	0.925	85.64	19.33	260°	0.152	2.32	3.66	0.240	5.77	7.61
85°	0.927	85.94	19.34	0.944	89.10	19.50	265°	0.179	3.21	5.06	0.252	6.37	8.04
90°	0.926	85.75	19.33	0.954	91.01	19.59	270°	0.195	3.79	5.79	0.264	6.98	8.44
95°	0.925	85.61	19.33	0.955	91.21	19.60	275°	0.199	3.95	5.97	0.267	7.15	8.54
100°	0.921	84.73	19.28	0.947	89.63	19.52	280°	0.191	3.65	5.63	0.258	6.66	8.24
105°	0.912	83.14	19.20	0.930	86.52	19.37	285°	0.174	3.03	4.81	0.241	5.83	7.65
110°	0.906	82.11	19.14	0.905	81.96	19.14	290°	0.147	2.17	3.37	0.225	5.04	7.03
115°	0.906	82.01	19.14	0.875	76.59	18.84	295°	0.121	1.46	1.65	0.225	5.04	7.02
120°	0.911	82.95	19.19	0.852	72.59	18.61	300°	0.104	1.08	0.32	0.247	6.09	7.84
125°	0.921	84.83	19.29	0.837	70.07	18.46	305°	0.096	0.93	-0.34	0.285	8.10	9.09
130°	0.936	87.70	19.43	0.830	68.96	18.39	310°	0.106	1.13	0.54	0.336	11.32	10.54
135°	0.957	91.55	19.62	0.833	69.37	18.41	315°	0.144	2.06	3.15	0.383	14.63	11.65
140°	0.975	95.13	19.78	0.843	71.01	18.51	320°	0.203	4.10	6.13	0.427	18.24	12.61
145°	0.989	97.75	19.90	0.859	73.85	18.68	325°	0.264	6.96	8.43	0.470	22.11	13.45
150°	0.997	99.38	19.97	0.881	77.68	18.90	330°	0.332	11.02	10.42	0.514	26.41	14.22
155°	1.000	100.00	20.00	0.898	80.65	19.07	335°	0.402	16.13	12.08	0.556	30.89	14.90
160°	0.999	99.86	19.99	0.908	82.41	19.16	340°	0.475	22.61	13.54	0.599	35.91	15.55
165°	0.985	97.06	19.87	0.910	82.81	19.18	345°	0.545	29.71	14.73	0.645	41.61	16.19
170°	0.953	90.90	19.59	0.897	80.53	19.06	350°	0.614	37.73	15.77	0.694	48.23	16.83
175°	0.904	81.73	19.12	0.869	75.53	18.78	355°	0.676	45.73	16.60	0.742	55.10	17.41

<b>Polarization:</b>	<b>Horizontal</b>	<b>Vertical</b>
<b>Maximum Field:</b>	<b>1.000 @ 155° True</b>	<b>0.956 @ 93° True</b>
<b>Minimum Field:</b>	<b>0.047 @ 238° True</b>	<b>0.220 @ 292° True</b>
<b>RMS:</b>	<b>0.710</b>	<b>0.710</b>
<b>Maximum ERP:</b>	<b>100.000 kW</b>	<b>91.398 kW</b>
<b>Maximum Power Gain:</b>	<b>6.889 (8.381 dB)</b>	<b>6.296 (7.991 dB)</b>

**Total Input Power: 14.516 kW**

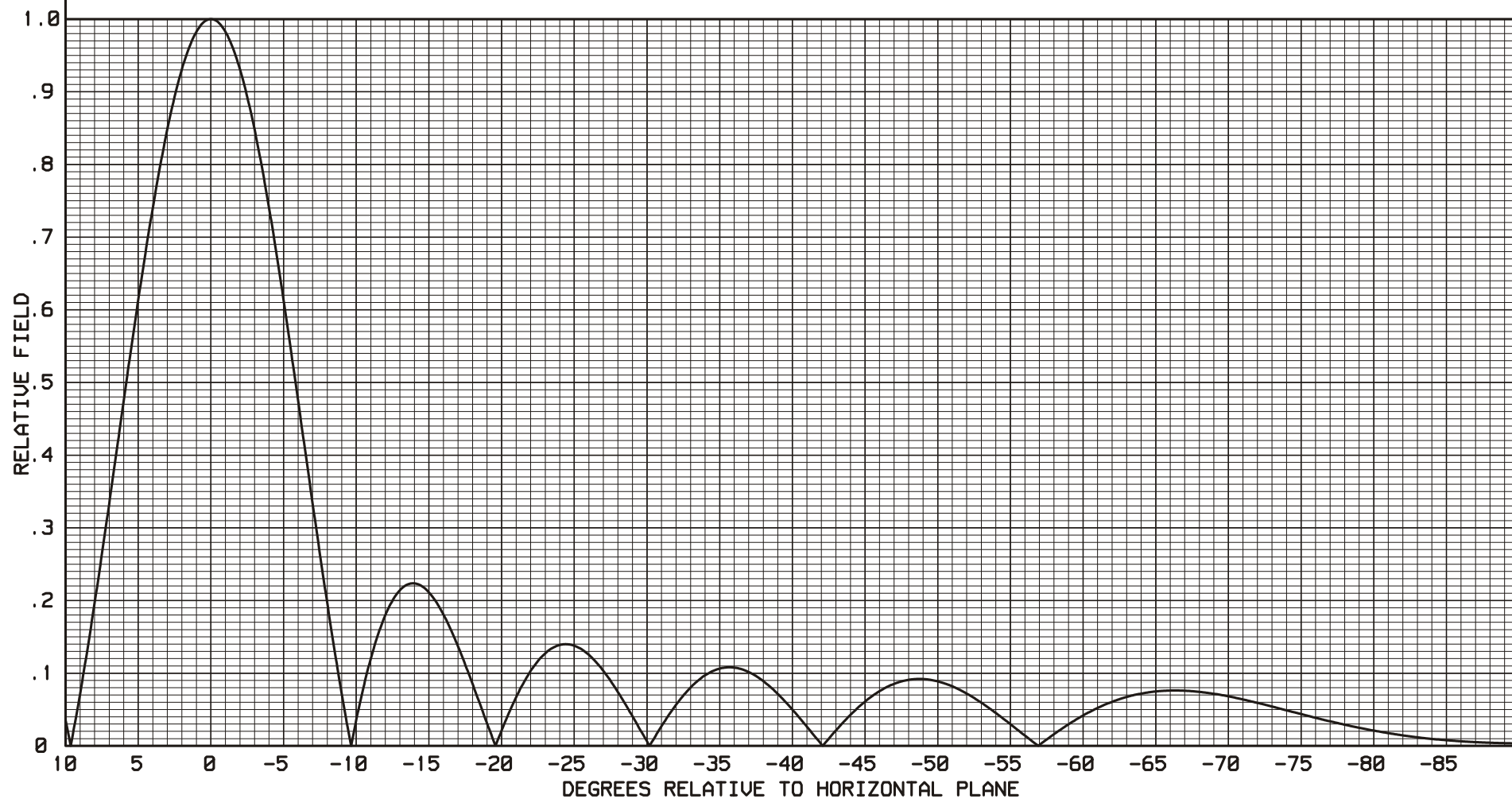


ELECTRONICS RESEARCH, INC.  
7777 GARDNER ROAD  
CHANDLER, IN. 47610

FIGURE 3B

----THEORETICAL----  
VERTICAL PLANE RELATIVE FIELD  
ERI TYPE 1082-8CP-DA ANTENNA  
0 DEGREE BEAM TILT  
0 PERCENT NULL FILL

95.7 MHz.  
BAY SPACING  
92.00 INCHES



# Directional Antenna System for KFMD, Denver, Colorado

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type:	1082-8CP-DA
Frequency:	95.7 MHz
Number of Bays:	eight

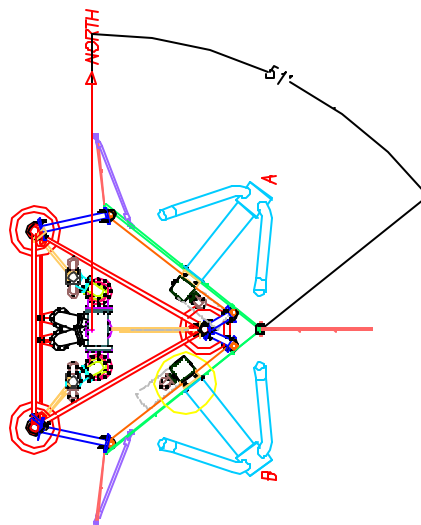
## MECHANICAL SPECIFICATIONS

Mounting:	Custom
System length:	61.33 ft
Orientation:	51° true
Input flange to the antenna	6 1/8 inch female

## ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP:	100 kW (20.00 dBk)
Horizontal maximum power gain:	6.889 (8.381 dB)
Maximum vertical ERP:	91.398 kW (19.609 dBk)
Vertical maximum power gain:	6.296 (7.991 dB)
Total input power:	14.516 kW (11.618 dBk)



Directional Antenna System  
For  
KFMD, Denver, Colorado

(Continued)

Four Bay Test Model  
Of The Eight Bay Array

