

***Directional Antenna System  
For  
KRFX, 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 KRFX.

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 103.5 megahertz, which is the center of the FM broadcast channel assigned to KRFX.

The other FM stations that will be transmitting from this directional antenna are KDJM @ 92.5 MHz, KCTL @ 93.3 MHz, KFMD @ 95.7 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 KRFX, Denver, Colorado

(Continued)

## DESCRIPTION OF THE TEST PROCEDURE

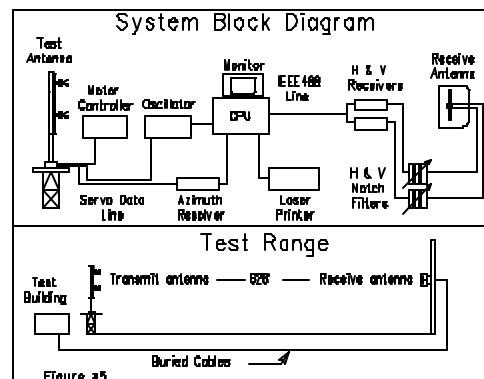
The test antenna consisted of four bay levels of the circular polarized system. The elements and brackets that were used in this test are the actual components that will be supplied with the antenna. The lines were properly grounded during all tests.

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 103.5 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 KRFX, 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 #3C attached. The power in the maximum will reach 100 kilowatts (20.00 dBk).

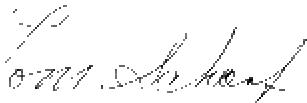
The RMS of the vertically polarized horizontal plane component does not exceed the RMS of the horizontally polarized horizontal plane component.

Directional Antenna System  
For  
KRFX, Denver, Colorado

(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.

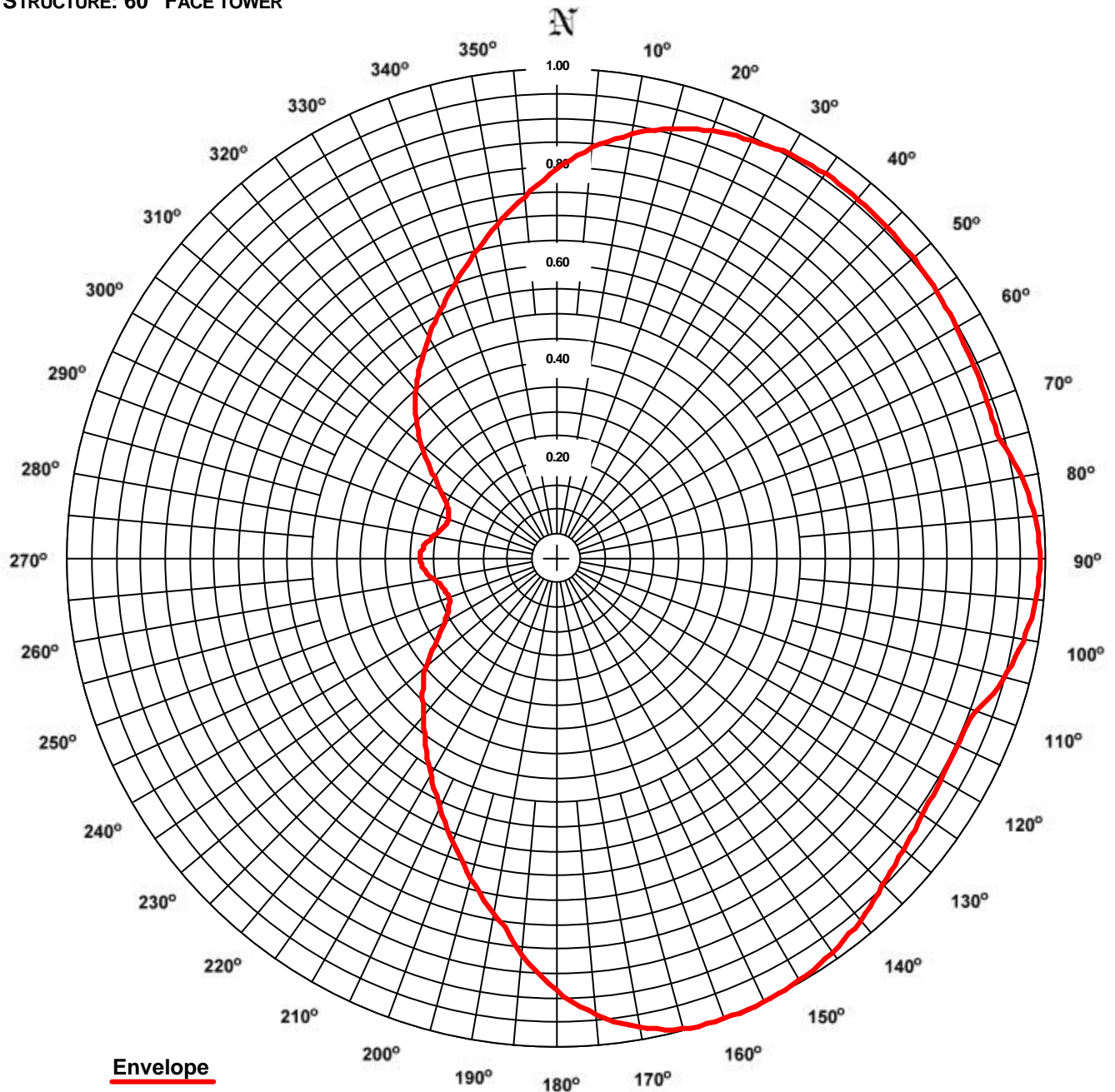
A handwritten signature in cursive script, appearing to read "L. M. Sherrill".

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

DATE: 2/27/03  
FREQUENCY: 103.5 MHz  
ORIENTATION: 51° TRUE  
MOUNTING: CUSTOM



RMS: 0.749  
Maximum: 1.000 @ 157° True  
Minimum: 0.232 @ 251° 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: KRFX**  
**Location: Denver, CO.**  
**Frequency: 103.5 MHz**

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

**Figure: 1**  
**Date: 2/27/03**  
**Reference: krfx1m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.799	63.88	18.05	Vertical	180°	0.881	77.64	18.90	Horizontal
5°	0.846	71.53	18.54	Vertical	185°	0.812	65.99	18.19	Horizontal
10°	0.884	78.08	18.93	Vertical	190°	0.735	54.02	17.33	Vertical
15°	0.913	83.33	19.21	Vertical	195°	0.675	45.58	16.59	Vertical
20°	0.934	87.15	19.40	Vertical	200°	0.618	38.19	15.82	Vertical
25°	0.946	89.41	19.51	Vertical	205°	0.563	31.65	15.00	Vertical
30°	0.957	91.64	19.62	Horizontal	210°	0.512	26.23	14.19	Vertical
35°	0.962	92.54	19.66	Horizontal	215°	0.465	21.62	13.35	Vertical
40°	0.961	92.40	19.66	Horizontal	220°	0.422	17.83	12.51	Vertical
45°	0.959	92.02	19.64	Horizontal	225°	0.387	14.94	11.74	Vertical
50°	0.956	91.41	19.61	Horizontal	230°	0.349	12.20	10.86	Vertical
55°	0.952	90.57	19.57	Horizontal	235°	0.304	9.24	9.66	Vertical
60°	0.946	89.55	19.52	Horizontal	240°	0.267	7.14	8.54	Vertical
65°	0.942	88.72	19.48	Horizontal	245°	0.243	5.93	7.73	Vertical
70°	0.939	88.12	19.45	Horizontal	250°	0.233	5.43	7.35	Vertical
75°	0.941	88.48	19.47	Vertical	255°	0.237	5.60	7.48	Vertical
80°	0.967	93.45	19.71	Vertical	260°	0.251	6.31	8.00	Vertical
85°	0.983	96.58	19.85	Vertical	265°	0.270	7.27	8.62	Vertical
90°	0.989	97.76	19.90	Vertical	270°	0.278	7.73	8.88	Vertical
95°	0.983	96.69	19.85	Vertical	275°	0.274	7.51	8.76	Vertical
100°	0.969	93.87	19.73	Vertical	280°	0.259	6.71	8.27	Vertical
105°	0.945	89.37	19.51	Vertical	285°	0.242	5.85	7.67	Vertical
110°	0.913	83.32	19.21	Vertical	290°	0.235	5.54	7.43	Vertical
115°	0.905	81.95	19.14	Horizontal	295°	0.245	5.98	7.77	Vertical
120°	0.906	82.15	19.15	Horizontal	300°	0.269	7.24	8.59	Vertical
125°	0.913	83.38	19.21	Horizontal	305°	0.309	9.53	9.79	Vertical
130°	0.926	85.67	19.33	Horizontal	310°	0.359	12.92	11.11	Vertical
135°	0.944	89.05	19.50	Horizontal	315°	0.404	16.36	12.14	Vertical
140°	0.965	93.20	19.69	Horizontal	320°	0.447	19.99	13.01	Vertical
145°	0.982	96.50	19.85	Horizontal	325°	0.485	23.55	13.72	Vertical
150°	0.994	98.74	19.94	Horizontal	330°	0.524	27.44	14.38	Vertical
155°	0.999	99.86	19.99	Horizontal	335°	0.562	31.57	14.99	Vertical
160°	1.000	100.00	20.00	Horizontal	340°	0.603	36.31	15.60	Vertical
165°	0.994	98.75	19.95	Horizontal	345°	0.648	41.94	16.23	Vertical
170°	0.972	94.45	19.75	Horizontal	350°	0.696	48.45	16.85	Vertical
175°	0.934	87.29	19.41	Horizontal	355°	0.746	55.63	17.45	Vertical

**Polarization:**  
**Maximum Field:** 1.000 @ 157° True  
**Minimum Field:** 0.232 @ 251° True  
**RMS:** 0.749  
**Maximum ERP:** 100.000 kW  
**Maximum Power Gain:** 7.162 (8.550 dB)

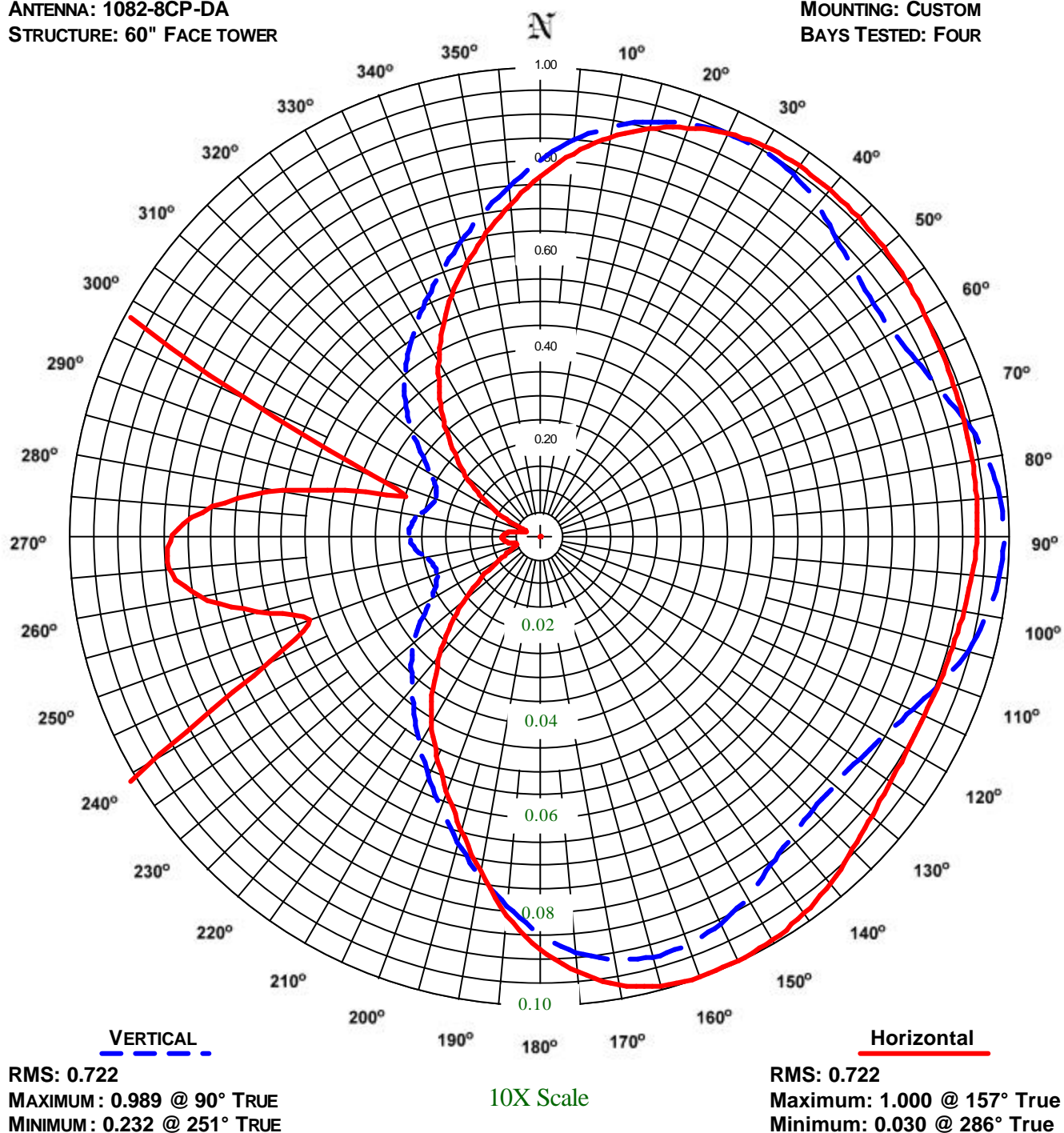
**Total Input Power: 13.963 kW**

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

DATE: 2/27/03  
FREQUENCY: 103.5 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: KRFX**  
**Location: Denver, CO.**  
**Frequency: 103.5 MHz**

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

**Figure: 2**  
**Date: 2/27/03**  
**Reference: krfx1m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.765	58.52	17.67	0.799	63.88	18.05	180°	0.881	77.64	18.90	0.849	72.05	18.58
5°	0.817	66.68	18.24	0.846	71.53	18.54	185°	0.812	65.99	18.19	0.791	62.61	17.97
10°	0.860	74.02	18.69	0.884	78.08	18.93	190°	0.727	52.86	17.23	0.735	54.02	17.33
15°	0.896	80.34	19.05	0.913	83.33	19.21	195°	0.648	41.99	16.23	0.675	45.58	16.59
20°	0.924	85.46	19.32	0.934	87.15	19.40	200°	0.580	33.67	15.27	0.618	38.19	15.82
25°	0.945	89.26	19.51	0.946	89.41	19.51	205°	0.518	26.83	14.29	0.563	31.65	15.00
30°	0.957	91.64	19.62	0.949	89.99	19.54	210°	0.461	21.24	13.27	0.512	26.23	14.19
35°	0.962	92.54	19.66	0.940	88.39	19.46	215°	0.396	15.70	11.96	0.465	21.62	13.35
40°	0.961	92.40	19.66	0.921	84.84	19.29	220°	0.330	10.92	10.38	0.422	17.83	12.51
45°	0.959	92.02	19.64	0.894	79.93	19.03	225°	0.266	7.09	8.51	0.387	14.94	11.74
50°	0.956	91.41	19.61	0.875	76.56	18.84	230°	0.204	4.17	6.20	0.349	12.20	10.86
55°	0.952	90.57	19.57	0.867	75.08	18.76	235°	0.142	2.02	3.06	0.304	9.24	9.66
60°	0.946	89.55	19.52	0.870	75.71	18.79	240°	0.093	0.87	-0.59	0.267	7.14	8.54
65°	0.942	88.72	19.48	0.884	78.17	18.93	245°	0.063	0.40	-3.96	0.243	5.93	7.73
70°	0.939	88.12	19.45	0.908	82.48	19.16	250°	0.052	0.27	-5.66	0.233	5.43	7.35
75°	0.937	87.75	19.43	0.941	88.48	19.47	255°	0.062	0.39	-4.12	0.237	5.60	7.48
80°	0.936	87.61	19.43	0.967	93.45	19.71	260°	0.074	0.54	-2.66	0.251	6.31	8.00
85°	0.935	87.37	19.41	0.983	96.58	19.85	265°	0.079	0.63	-2.00	0.270	7.27	8.62
90°	0.931	86.73	19.38	0.989	97.76	19.90	270°	0.078	0.61	-2.14	0.278	7.73	8.88
95°	0.926	85.69	19.33	0.983	96.69	19.85	275°	0.070	0.49	-3.10	0.274	7.51	8.76
100°	0.918	84.30	19.26	0.969	93.87	19.73	280°	0.056	0.31	-5.10	0.259	6.71	8.27
105°	0.912	83.12	19.20	0.945	89.37	19.51	285°	0.034	0.11	-9.44	0.242	5.85	7.67
110°	0.907	82.34	19.16	0.913	83.32	19.21	290°	0.038	0.15	-8.29	0.235	5.54	7.43
115°	0.905	81.95	19.14	0.877	76.91	18.86	295°	0.070	0.48	-3.16	0.245	5.98	7.77
120°	0.906	82.15	19.15	0.850	72.23	18.59	300°	0.117	1.37	1.38	0.269	7.24	8.59
125°	0.913	83.38	19.21	0.832	69.19	18.40	305°	0.162	2.63	4.20	0.309	9.53	9.79
130°	0.926	85.67	19.33	0.823	67.69	18.31	310°	0.213	4.52	6.55	0.359	12.92	11.11
135°	0.944	89.05	19.50	0.824	67.90	18.32	315°	0.262	6.86	8.37	0.404	16.36	12.14
140°	0.965	93.20	19.69	0.836	69.89	18.44	320°	0.319	10.17	10.07	0.447	19.99	13.01
145°	0.982	96.50	19.85	0.858	73.59	18.67	325°	0.372	13.86	11.42	0.485	23.55	13.72
150°	0.994	98.74	19.94	0.888	78.87	18.97	330°	0.430	18.48	12.67	0.524	27.44	14.38
155°	0.999	99.86	19.99	0.912	83.17	19.20	335°	0.487	23.75	13.76	0.562	31.57	14.99
160°	1.000	100.00	20.00	0.926	85.72	19.33	340°	0.546	29.81	14.74	0.603	36.31	15.60
165°	0.994	98.75	19.95	0.929	86.35	19.36	345°	0.600	35.98	15.56	0.648	41.94	16.23
170°	0.972	94.45	19.75	0.917	84.15	19.25	350°	0.655	42.91	16.33	0.696	48.45	16.85
175°	0.934	87.29	19.41	0.891	79.30	18.99	355°	0.708	50.11	17.00	0.746	55.63	17.45

<b>Polarization:</b>	<b>Horizontal</b>	<b>Vertical</b>
<b>Maximum Field:</b>	<b>1.000 @ 157° True</b>	<b>0.989 @ 90° True</b>
<b>Minimum Field:</b>	<b>0.030 @ 286° True</b>	<b>0.232 @ 251° True</b>
<b>RMS:</b>	<b>0.722</b>	<b>0.722</b>
<b>Maximum ERP:</b>	<b>100.000 kW</b>	<b>97.763 kW</b>
<b>Maximum Power Gain:</b>	<b>7.162 (8.550 dB)</b>	<b>7.002 (8.452 dB)</b>

**Total Input Power: 13.963 kW**

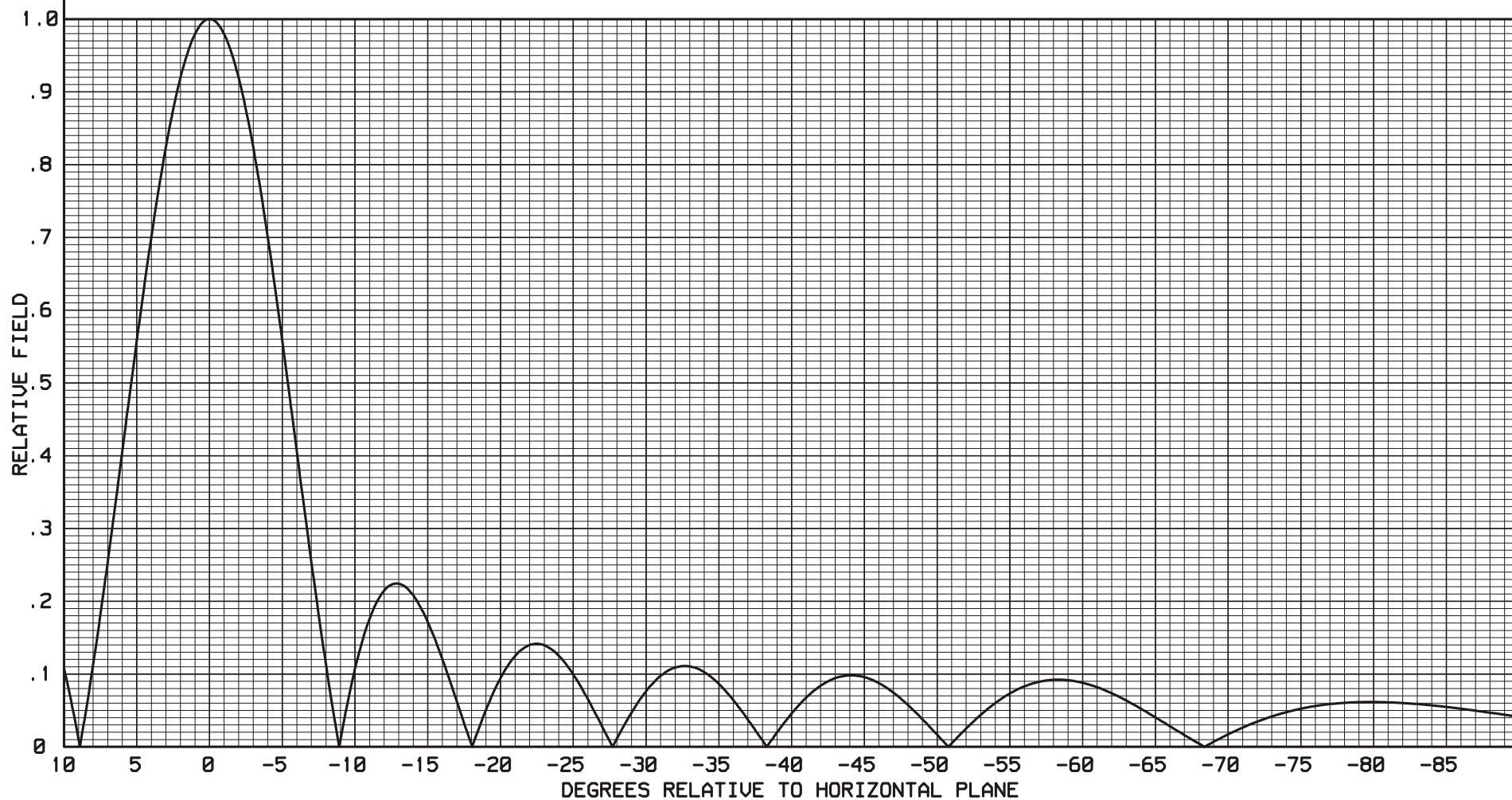


ELECTRONICS RESEARCH, INC.  
7777 GARDNER ROAD  
CHANDLER, IN. 47610

FIGURE 3C

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

103.5 MHz.  
BAY SPACING  
92.00 INCHES



# Directional Antenna System for KRFX, Denver, Colorado

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type:	1082-8CP-DA
Frequency:	103.5 MHz
Number of Bays:	eight

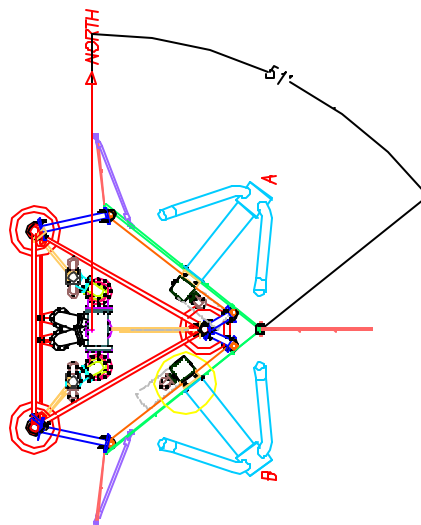
## MECHANICAL SPECIFICATIONS

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:	7.162 (8.550 dB)
Maximum vertical ERP:	97.763 kW (19.902 dBk)
Vertical maximum power gain:	7.002 (8.452 dB)
Total input power:	13.963 kW (11.450 dBk)



Directional Antenna System  
For  
KRFX, Denver, Colorado

(Continued)

Four Bay Test Model  
Of The Eight Bay Array

