ERI® Electronics Research, Inc.
Electronics Research, Inc. 7777 Gardner Rd. Chandler, In 47610 Phone (812) 925-6000 Fax (812) 925-4030 http://www.eriinc.com/

Directional Antenna System for WSHA Raleigh, North Carolina

January 15, 2003

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 WSHA.

The antenna is the E.R.I. DA1005-3B-DA configuration. The dual polarized system consists of 3 full-wavelength bays. The vertical component uses two driven vertical dipole per bay with two vertical parasitic elements at bay level. The horizontal component uses two driven horizontal dipoles per bay and four horizontal parasitic elements placed one-quarter wave above and below each bay and two horizontal parasites at bay level. A power divider was used near the bottom of the antenna to feed the system.

The antenna was tested on a 12 3/4" o.d. pole, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 88.9 megahertz, which is the center of the FM broadcast channel assigned to WSHA.

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
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DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of two bay levels of the dual 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. Sections of 3 1/8 inch o.d. rigid coaxial line were used to feed the test antenna and sections of 3 1/8 inch o.d. rigid outer conductor only were 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 12 3/4" o.d. pole 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 88.9 MHz and was constantly monitored by an Anritsu Model ML521B measuring receiver.

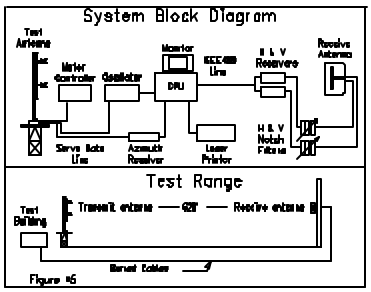

Figure #6

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 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 were recorded separately.

CONCLUSIONS

The dual polarized system consists of 3 full-wavelength bays. The vertical component uses two driven vertical dipole per bay with two vertical parasitic elements at bay level. The horizontal component uses two driven horizontal dipoles per bay and four horizontal parasitic elements placed one-quarter wave above and below each bay and two horizontal parasites at bay level. A power divider was used near the bottom of the antenna to feed the system.

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 DA1005-3B-DA array is to be mounted on the 12 3/4" o.d. pole at a bearing of North 124 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 for the vertically polarized component is shown on Figure #3 attached. A calculated vertical plane relative field pattern for the horizontally polarized component is shown on Figure #3A attached. The power in the maximum will reach 50 kilowatts (16.99 dBk).

Directional Antenna System
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WSHA Raleigh, North Carolina

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The power at North 80 degrees East does not exceed 12.5 kilowatts (10.969 dBk).

The power at North 110-120 degrees East does not exceed 7.8 kilowatts (8.921 dBk).

The power at North 185-190 degrees East does not exceed 25.1 kilowatts (13.997 dBk).

The power at North 320 degrees East does not exceed 1.75 kilowatts (2.43 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 that 85% of the filed composite pattern.

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.

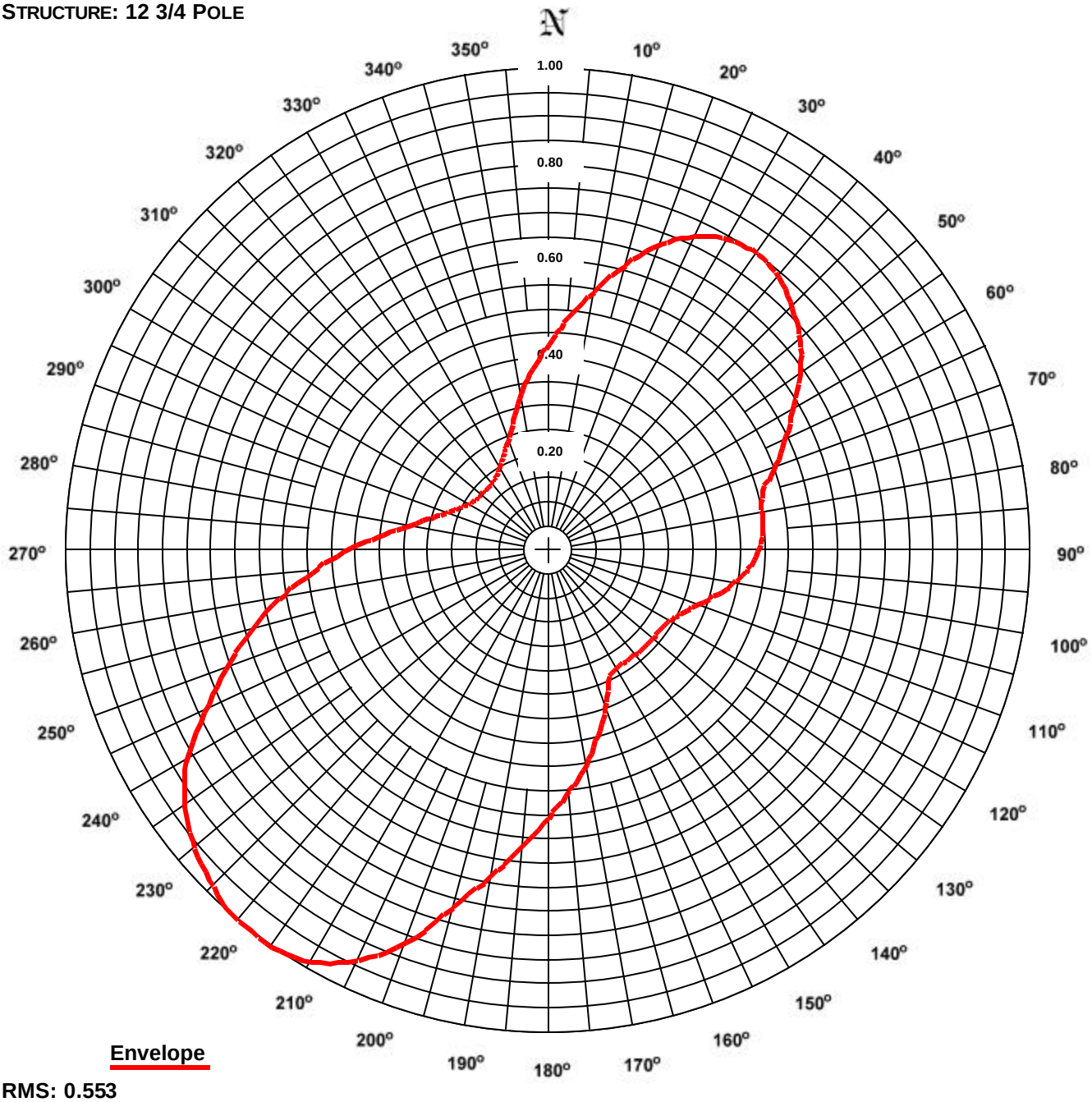
ELECTRONICS RESEARCH, INC.

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: WSHA
LOCATION: RALEIGH, NC
ANTENNA TYPE: DA-1005-3B-SP
STRUCTURE: 12 3/4 POLE

DATE: 1/15/03
FREQUENCY: 88.9 MHZ
ORIENTATION: 124° TRUE
MOUNTING: CUSTOM



Envelope

RMS: 0.553
Maximum: 1.000 @ 215° True
Minimum: 0.181 @ 318° 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-19990506IA.

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: WSHA
Location: Raleigh, NC
Frequency: 88.9 MHz

Antenna: DA-1005-3B-SP
Orientation: 124° True
Tower: 12 3/4 Pole

Figure: 1
Date: 1/15/03
Reference: wsha1m.fig

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0º	0.431	9.29	9.68	Horizontal	180º	0.554	15.35	11.86	Horizontal
5º	0.486	11.81	10.72	Horizontal	185º	0.615	18.92	12.77	Horizontal
10º	0.548	15.02	11.77	Horizontal	190º	0.683	23.32	13.68	Horizontal
15º	0.617	19.03	12.80	Horizontal	195º	0.765	29.27	14.66	Horizontal
20º	0.679	23.07	13.63	Horizontal	200º	0.863	37.26	15.71	Vertical
25º	0.723	26.15	14.17	Horizontal	205º	0.934	43.66	16.40	Horizontal
30º	0.749	28.03	14.48	Horizontal	210º	0.982	48.23	16.83	Horizontal
35º	0.756	28.54	14.55	Horizontal	215º	1.000	50.00	16.99	Horizontal
40º	0.743	27.63	14.41	Horizontal	220º	1.000	50.00	16.99	Vertical
45º	0.716	25.65	14.09	Horizontal	225º	0.984	48.43	16.85	Vertical
50º	0.682	23.28	13.67	Vertical	230º	0.958	45.89	16.62	Horizontal
55º	0.636	20.23	13.06	Vertical	235º	0.922	42.54	16.29	Horizontal
60º	0.585	17.10	12.33	Horizontal	240º	0.868	37.63	15.76	Horizontal
65º	0.540	14.60	11.64	Horizontal	245º	0.789	31.09	14.93	Horizontal
70º	0.497	12.36	10.92	Horizontal	250º	0.714	25.49	14.06	Horizontal
75º	0.460	10.57	10.24	Vertical	255º	0.639	20.39	13.09	Horizontal
80º	0.450	10.10	10.04	Vertical	260º	0.567	16.09	12.07	Horizontal
85º	0.446	9.94	9.97	Vertical	265º	0.493	12.16	10.85	Horizontal
90º	0.435	9.45	9.76	Vertical	270º	0.426	9.06	9.57	Horizontal
95º	0.416	8.65	9.37	Vertical	275º	0.356	6.35	8.03	Horizontal
100º	0.389	7.58	8.79	Vertical	280º	0.301	4.52	6.56	Horizontal
105º	0.355	6.32	8.00	Vertical	285º	0.262	3.42	5.34	Horizontal
110º	0.326	5.30	7.24	Vertical	290º	0.232	2.69	4.29	Horizontal
115º	0.304	4.61	6.63	Vertical	295º	0.209	2.19	3.40	Horizontal
120º	0.289	4.19	6.22	Vertical	300º	0.193	1.87	2.72	Horizontal
125º	0.283	4.01	6.03	Vertical	305º	0.185	1.71	2.33	Horizontal
130º	0.283	3.99	6.01	Vertical	310º	0.183	1.68	2.24	Horizontal
135º	0.282	3.96	5.98	Vertical	315º	0.182	1.65	2.18	Horizontal
140º	0.280	3.92	5.94	Vertical	320º	0.183	1.67	2.22	Vertical
145º	0.279	3.90	5.91	Vertical	325º	0.191	1.82	2.59	Vertical
150º	0.280	3.93	5.94	Vertical	330º	0.202	2.05	3.12	Vertical
155º	0.297	4.41	6.45	Horizontal	335º	0.220	2.42	3.83	Vertical
160º	0.345	5.94	7.74	Horizontal	340º	0.245	3.00	4.78	Vertical
165º	0.394	7.76	8.90	Horizontal	345º	0.283	3.99	6.01	Horizontal
170º	0.449	10.08	10.03	Horizontal	350º	0.333	5.54	7.43	Horizontal
175º	0.499	12.44	10.95	Horizontal	355º	0.381	7.24	8.60	Horizontal

Polarization: **Envelope**
Maximum Field: **1.000 @ 215° True**
Minimum Field: **0.181 @ 318° True**
RMS: **0.553**
Maximum ERP: **50.000 kW**
Maximum Power Gain: **5.323 (7.262 dB)**

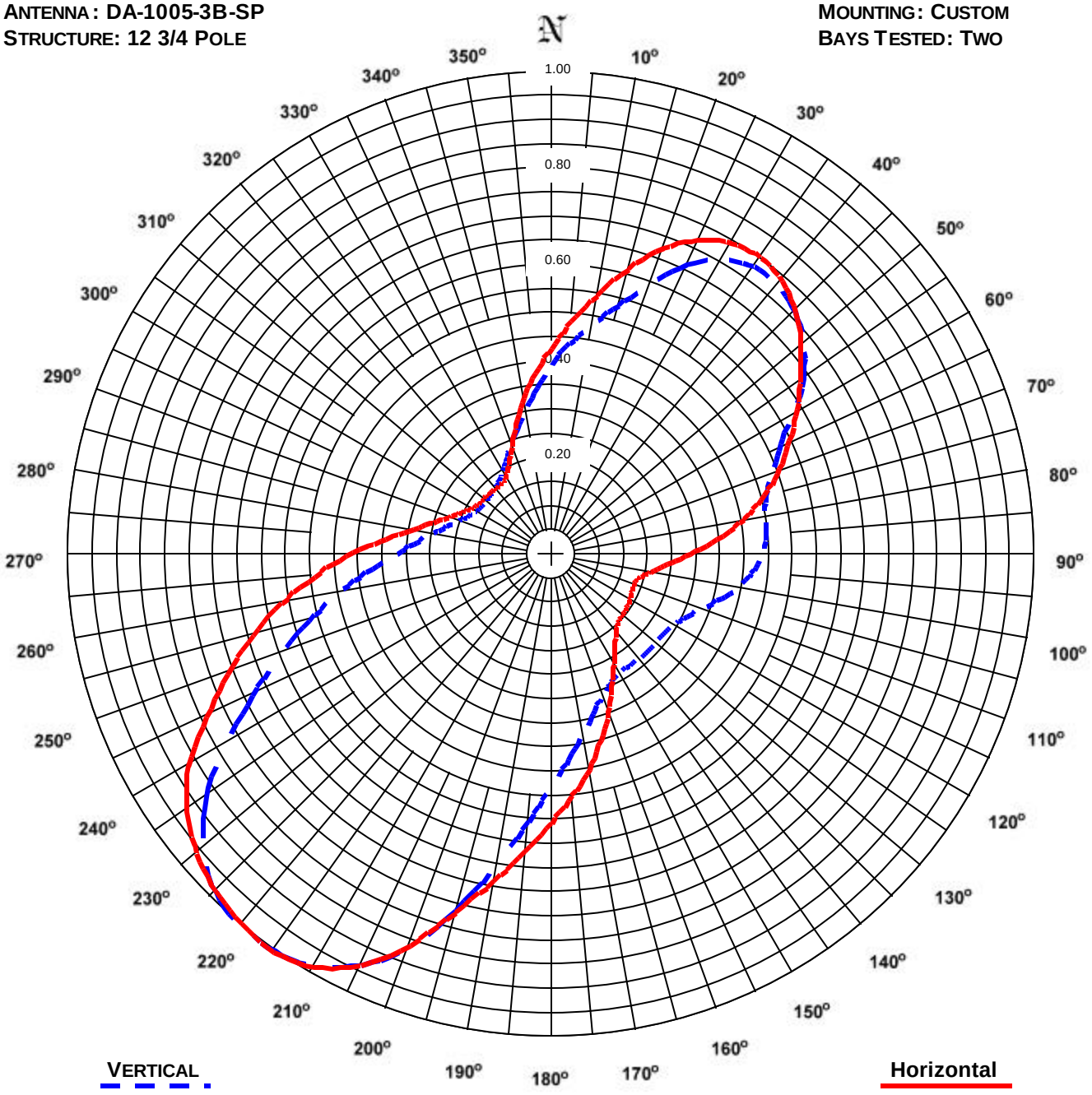
Total Input Power: 9.393 kW

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: WSHA
LOCATION: RALEIGH, NC
ANTENNA: DA-1005-3B-SP
STRUCTURE: 12 3/4 POLE

DATE: 1/15/03
FREQUENCY: 88.9 MHZ
ORIENTATION: 124° TRUE
MOUNTING: CUSTOM
BAYS TESTED: TWO



VERTICAL

RMS: 0.526
MAXIMUM: 1.000 @ 216° TRUE
MINIMUM: 0.176 @ 307° TRUE

Horizontal

RMS: 0.540
Maximum: 1.000 @ 215° True
Minimum: 0.179 @ 324° 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: WSHA
Location: Raleigh, NC
Frequency: 88.9 MHz

Antenna: DA-1005-3B-SP
Orientation: 124° True
Tower: 12 3/4 Pole

Figure: 1M
Date: 1/15/03
Reference: wsha1m.fig

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0º	0.431	9.29	9.68	0.396	7.85	8.95	180º	0.554	15.35	11.86	0.479	11.46	10.59
5º	0.486	11.81	10.72	0.442	9.79	9.91	185º	0.615	18.92	12.77	0.554	15.35	11.86
10º	0.548	15.02	11.77	0.488	11.92	10.76	190º	0.683	23.32	13.68	0.649	21.04	13.23
15º	0.617	19.03	12.80	0.539	14.52	11.62	195º	0.765	29.27	14.66	0.760	28.84	14.60
20º	0.679	23.07	13.63	0.601	18.06	12.57	200º	0.857	36.72	15.65	0.863	37.26	15.71
25º	0.723	26.15	14.17	0.666	22.16	13.45	205º	0.934	43.66	16.40	0.934	43.59	16.39
30º	0.749	28.03	14.48	0.710	25.21	14.02	210º	0.982	48.23	16.83	0.979	47.91	16.80
35º	0.756	28.54	14.55	0.732	26.82	14.28	215º	1.000	50.00	16.99	0.999	49.90	16.98
40º	0.743	27.63	14.41	0.732	26.76	14.27	220º	0.996	49.60	16.95	1.000	50.00	16.99
45º	0.716	25.65	14.09	0.714	25.50	14.07	225º	0.982	48.22	16.83	0.984	48.43	16.85
50º	0.674	22.71	13.56	0.682	23.28	13.67	230º	0.958	45.89	16.62	0.942	44.35	16.47
55º	0.628	19.75	12.96	0.636	20.23	13.06	235º	0.922	42.54	16.29	0.873	38.11	15.81
60º	0.585	17.10	12.33	0.575	16.55	12.19	240º	0.868	37.63	15.76	0.778	30.28	14.81
65º	0.540	14.60	11.64	0.519	13.48	11.30	245º	0.789	31.09	14.93	0.683	23.33	13.68
70º	0.497	12.36	10.92	0.483	11.67	10.67	250º	0.714	25.49	14.06	0.597	17.83	12.51
75º	0.449	10.07	10.03	0.460	10.57	10.24	255º	0.639	20.39	13.09	0.519	13.49	11.30
80º	0.396	7.83	8.94	0.450	10.10	10.04	260º	0.567	16.09	12.07	0.449	10.08	10.03
85º	0.333	5.54	7.44	0.446	9.94	9.97	265º	0.493	12.16	10.85	0.385	7.42	8.70
90º	0.277	3.84	5.85	0.435	9.45	9.76	270º	0.426	9.06	9.57	0.327	5.35	7.28
95º	0.234	2.74	4.38	0.416	8.65	9.37	275º	0.356	6.35	8.03	0.288	4.13	6.16
100º	0.204	2.08	3.17	0.389	7.58	8.79	280º	0.301	4.52	6.56	0.255	3.25	5.11
105º	0.186	1.73	2.38	0.355	6.32	8.00	285º	0.262	3.42	5.34	0.229	2.61	4.17
110º	0.181	1.64	2.15	0.326	5.30	7.24	290º	0.232	2.69	4.29	0.208	2.16	3.34
115º	0.183	1.67	2.23	0.304	4.61	6.63	295º	0.209	2.19	3.40	0.192	1.84	2.66
120º	0.187	1.74	2.41	0.289	4.19	6.22	300º	0.193	1.87	2.72	0.182	1.65	2.17
125º	0.191	1.82	2.59	0.283	4.01	6.03	305º	0.185	1.71	2.33	0.176	1.55	1.92
130º	0.192	1.85	2.67	0.283	3.99	6.01	310º	0.183	1.68	2.24	0.176	1.54	1.88
135º	0.196	1.92	2.83	0.282	3.96	5.98	315º	0.182	1.65	2.18	0.178	1.58	1.98
140º	0.208	2.17	3.35	0.280	3.92	5.94	320º	0.180	1.62	2.09	0.183	1.67	2.22
145º	0.229	2.62	4.19	0.279	3.90	5.91	325º	0.180	1.62	2.09	0.191	1.82	2.59
150º	0.259	3.35	5.24	0.280	3.93	5.94	330º	0.189	1.78	2.51	0.202	2.05	3.12
155º	0.297	4.41	6.45	0.290	4.20	6.23	335º	0.209	2.18	3.39	0.220	2.42	3.83
160º	0.345	5.94	7.74	0.309	4.76	6.78	340º	0.240	2.88	4.60	0.245	3.00	4.78
165º	0.394	7.76	8.90	0.337	5.68	7.54	345º	0.283	3.99	6.01	0.274	3.77	5.76
170º	0.449	10.08	10.03	0.375	7.02	8.46	350º	0.333	5.54	7.43	0.308	4.75	6.77
175º	0.499	12.44	10.95	0.422	8.90	9.50	355º	0.381	7.24	8.60	0.349	6.08	7.84

Polarization:	**Horizontal**	**Vertical**
Maximum Field:	**1.000 @ 215° True**	**1.000 @ 216° True**
Minimum Field:	**0.179 @ 324° True**	**0.176 @ 307° True**
RMS:	**0.540**	**0.526**
Maximum ERP:	**50.000 kW**	**50.000 kW**
Maximum Power Gain:	**5.323 (7.262 dB)**	**5.323 (7.262 dB)**

Total Input Power: 9.393 kW

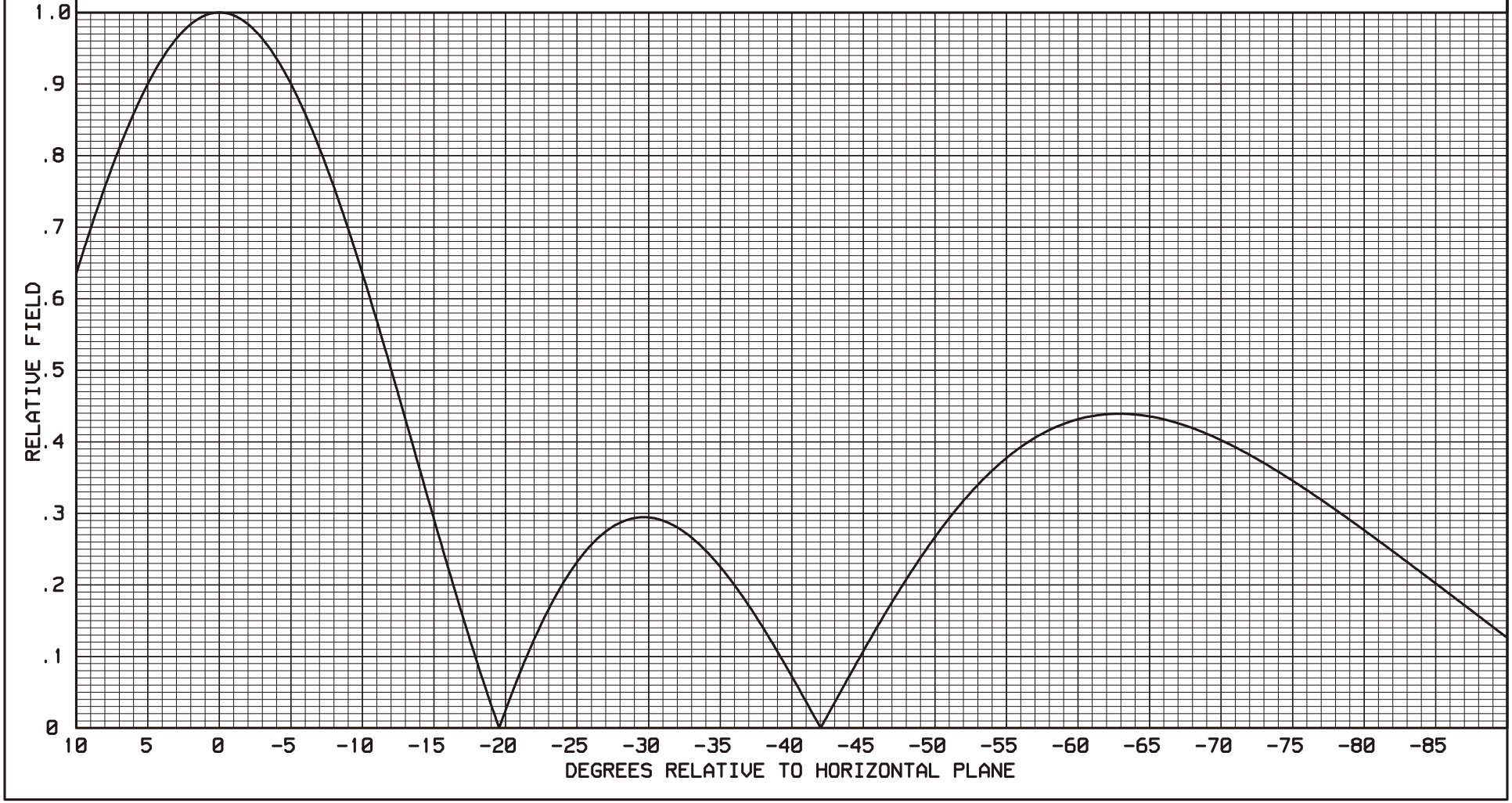
ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610

FIGURE 3

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

ERI TYPE DA-1005-3B-SP ANTENNA
VERTICALLY POLARIZED ELEMENTS
0 DEGREE ELECTRICAL BEAM TILT
0 PERCENT FIRST NULL FILL

ELEMENT SPACING:
ONE WAVELENGTH



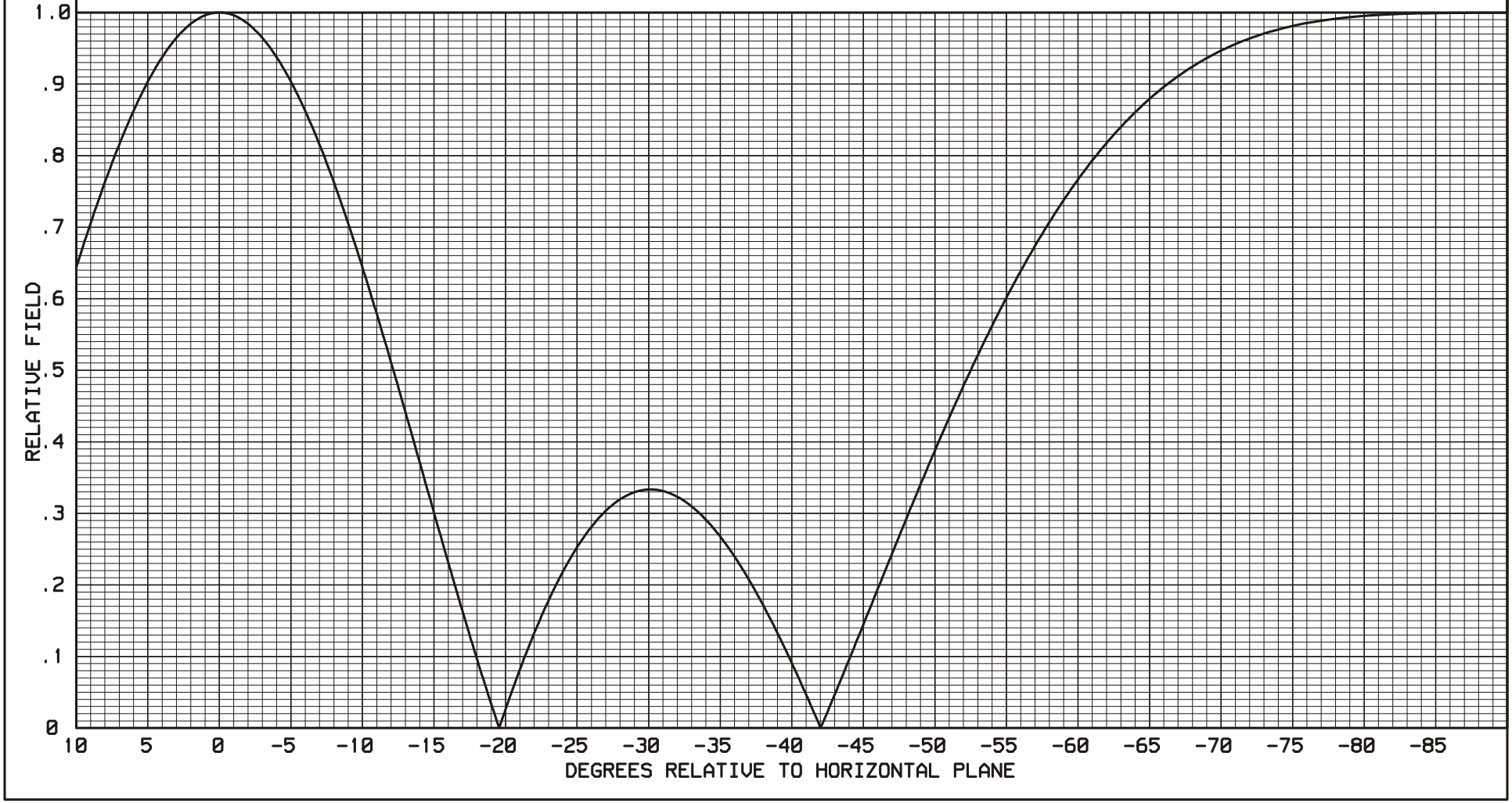
ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610

FIGURE 3A

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

ERI TYPE DA-1005-3B-SP ANTENNA
HORIZONTALLY POLARIZED ELEMENTS
0 DEGREE ELECTRICAL BEAM TILT
0 PERCENT FIRST NULL FILL

ELEMENT SPACING:
ONE WAVELENGTH



Directional Antenna System
for
WSHA Raleigh, North Carolina

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	DA1005-3B-DA-SP
Frequency:	88.9 MHz
Number of Bays:	3

MECHANICAL SPECIFICATIONS

Mounting:	Custom
Orientation:	124° true

Input flange to the antenna 3 1/8 inch female

ELECTRICAL SPECIFICATIONS
(For directional use)

Maximum horizontal ERP:	50 kW (16.99 dBk)
Horizontal maximum power gain:	5.323 (7.262 dB)
Maximum vertical ERP:	50 kW (16.99 dBk)
Vertical maximum power gain:	5.323 (7.262 dB)
Total input power:	9.393 kW (9.728 dBk)

Test Antenna