

***Directional Antenna System
for
WKNC, Raleigh, North Carolina***

April 29, 2016

Electronics Research Inc. is providing modification to an existing directional antenna system that is specially designed to meet the FCC requirements and the general needs of radio station WKNC.

The antenna is the ERI model MP-4E-DA-HW configuration. The circular polarized system consists of 4 half-wavelength spaced bays using one driven circular polarized radiating element per bay and two vertical parasitic elements interleaved between alternate bay pairs. The antenna was mounted on the North 345 degrees East tower face with bracketry to provide an antenna orientation of North 6.5 degrees East. The antenna was tested on an 8' 6 3/4" face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 88.1 megahertz, which is the center of the FM broadcast channel assigned to WKNC.

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 WKNC, Raleigh, North Carolina

(Continued)

DESCRIPTION OF THE TEST PROCEDURE

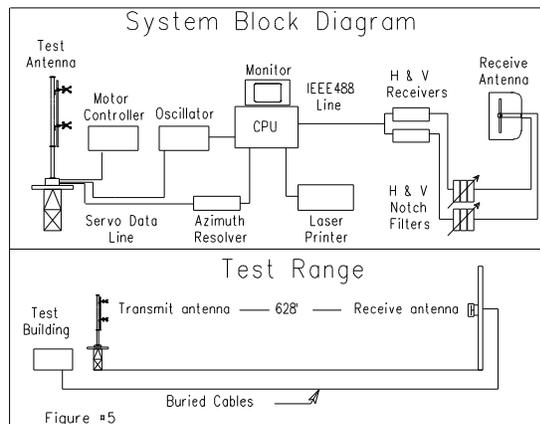
The test antenna consisted of two bay levels of the circular polarized system with the associated vertical parasitic elements. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the antenna. A section of 3 1/8 inch o.d. rigid coaxial line was used to feed the test antenna, and a section of 3 1/8 inch o.d. rigid outer conductor only was 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 8' 6 3/4" face 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 a US Digital angle position indicator. The resolution of this angle position indicator is one-hundredth of a degree.

The antenna under test was operated in the transmitting mode and fed from a HP8657D signal generator. The frequency of the signal source was set at 88.1 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.

A broadband horizontal and vertical dipole system, located approximately 628 feet from the test antenna, was used to receive the emitted test signals.



Directional Antenna System For WKNC, Raleigh, North Carolina

(Continued)

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 Heliac cables to a Rohde & Schwarz measuring receiver. This data was interfaced to a laser jet printer by means of a 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 4 half-wavelength spaced bays using one driven circular polarized radiating element per bay and two vertical parasitic elements interleaved between alternate bay pairs. The power distribution and phase relationship will be fixed when the antenna is manufactured. Proper maintenance of the elements should be all that is required to maintain the pattern in adjustment.

The MP-4E-DA-HW array is to be mounted on the North 345 degrees East tower face of the 8' 6 3/4" face tower at a bearing of North 6.5 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 measured individual horizontal and vertical components, the composite maximum of either the horizontal or vertical component at any azimuth and the FCC filed envelope pattern. The horizontal plane relative field list for the composite pattern and the individual H & V components are shown as Figure #1 & 1A respectively. The actual measured pattern does not exceed the authorized FCC composite pattern at any azimuth. A calculated vertical plane relative field pattern is shown on Figure #3 attached. The power in the maximum will reach 25 kilowatts (13.979 dBk).

The power at North 170-240 degrees East does not exceed 2.993 kilowatts (4.761 dBk).

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(Continued)

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 than 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 36 feet 8 inches.

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.



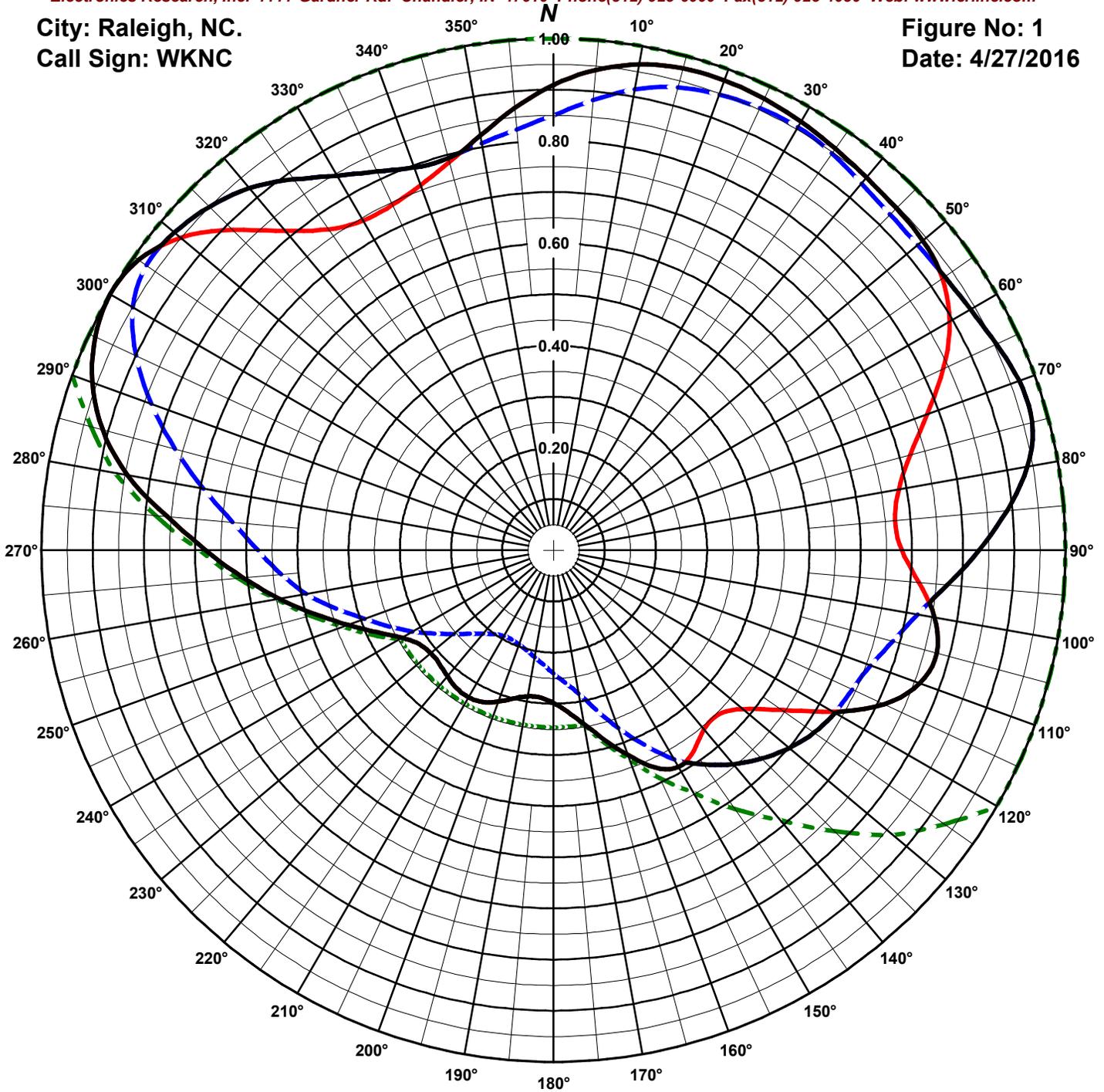
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ERI[®] Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: www.eriinc.com

City: Raleigh, NC.
Call Sign: WKNC

Figure No: 1
Date: 4/27/2016



Antenna Orientation: 6.5° True

Frequency: 88.1 MHz

Antenna Type: MP-4E-DA-HW

Antenna Mounting: Custom

Tower Type: 8' 6" Tower

HORIZONTAL

RMS: .706

Maximum: 1 @ 300°

Minimum: .288 @ 187°

VERTICAL

RMS: .706

Maximum: .971 @ 306°

Minimum: .193 @ 206°

COMPOSITE

RMS: .739

Maximum: 1 @ 300°

Minimum: .288 @ 187°

FCC ENVELOPE

RMS: .823

Maximum: 1 @ 0°

Minimum: .346 @ 170°

Measured patterns of the horizontal and vertical components. The composite pattern shows the maximum of either the H or V azimuth values. This patterns is greater than 85% of the FCC filed composite pattern BPED-20140117ANA.

ERI[®] Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: www.eriinc.com

Figure# 1

Date: 4/27/2016

Station: WKNC

Antenna: MP-4E-DA-HW

Location: Raleigh, NC.

Antenna Orientation: 6.5° True

Frequency: 88.1 MHz

Number of Bays: 4

Azimuth	Envelope			Polarization Maximum	Azimuth	Envelope			Polarization Maximum
	Field	kW	dBk			Field	kW	dBk	
0°	0.909	20.677	13.155	Horizontal	180°	0.299	2.228	3.478	Horizontal
5°	0.942	22.183	13.460	Horizontal	185°	0.289	2.093	3.208	Horizontal
10°	0.964	23.225	13.660	Horizontal	190°	0.290	2.102	3.226	Horizontal
15°	0.975	23.758	13.758	Horizontal	195°	0.300	2.246	3.514	Horizontal
20°	0.977	23.853	13.775	Horizontal	200°	0.315	2.479	3.942	Horizontal
25°	0.974	23.696	13.747	Horizontal	205°	0.327	2.674	4.272	Horizontal
30°	0.967	23.374	13.687	Horizontal	210°	0.332	2.753	4.399	Horizontal
35°	0.958	22.962	13.610	Horizontal	215°	0.329	2.711	4.332	Horizontal
40°	0.951	22.605	13.542	Horizontal	220°	0.322	2.589	4.131	Horizontal
45°	0.946	22.376	13.498	Horizontal	225°	0.315	2.474	3.934	Horizontal
50°	0.942	22.164	13.457	Horizontal	230°	0.313	2.443	3.879	Horizontal
55°	0.932	21.734	13.371	Vertical	235°	0.320	2.562	4.085	Horizontal
60°	0.941	22.133	13.450	Vertical	240°	0.342	2.927	4.665	Horizontal
65°	0.954	22.771	13.574	Vertical	245°	0.380	3.603	5.566	Horizontal
70°	0.968	23.427	13.697	Vertical	250°	0.427	4.554	6.584	Horizontal
75°	0.968	23.417	13.695	Vertical	255°	0.483	5.822	7.650	Horizontal
80°	0.940	22.098	13.443	Vertical	260°	0.544	7.404	8.695	Horizontal
85°	0.889	19.762	12.958	Vertical	265°	0.609	9.285	9.678	Horizontal
90°	0.832	17.287	12.377	Vertical	270°	0.680	11.562	10.631	Horizontal
95°	0.773	14.926	11.740	Vertical	275°	0.758	14.347	11.568	Horizontal
100°	0.756	14.280	11.547	Horizontal	280°	0.845	17.847	12.516	Horizontal
105°	0.775	15.012	11.764	Horizontal	285°	0.912	20.772	13.175	Horizontal
110°	0.761	14.484	11.609	Horizontal	290°	0.958	22.950	13.608	Horizontal
115°	0.712	12.668	11.027	Horizontal	295°	0.988	24.379	13.870	Horizontal
120°	0.635	10.069	10.030	Vertical	300°	1.000	25.000	13.979	Horizontal
125°	0.621	9.656	9.848	Vertical	305°	0.989	24.446	13.882	Horizontal
130°	0.601	9.031	9.557	Vertical	310°	0.966	23.338	13.681	Vertical
135°	0.576	8.284	9.183	Vertical	315°	0.950	22.543	13.530	Vertical
140°	0.546	7.450	8.722	Vertical	320°	0.924	21.330	13.290	Vertical
145°	0.511	6.529	8.148	Vertical	325°	0.885	19.572	12.916	Vertical
150°	0.489	5.970	7.760	Horizontal	330°	0.845	17.865	12.520	Vertical
155°	0.468	5.484	7.391	Horizontal	335°	0.816	16.665	12.218	Vertical
160°	0.426	4.542	6.572	Horizontal	340°	0.796	15.829	11.994	Vertical
165°	0.383	3.667	5.643	Horizontal	345°	0.793	15.732	11.968	Vertical
170°	0.345	2.974	4.733	Horizontal	350°	0.823	16.917	12.283	Horizontal
175°	0.317	2.511	3.998	Horizontal	355°	0.867	18.809	12.744	Horizontal

Horizontal Polarization:

Maximum: 2.491 (3.964 dB)

Horizontal Plane: 2.491 (3.964 dB)

Maximum ERP: 25.000 kW

Vertical Polarization:

Maximum: 2.350 (3.711 dB)

Horizontal Plane: 2.350 (3.711 dB)

Maximum ERP: 23.584 kW

Total Input Power: 10.035 kW

Reference: WKNC2M.FIG

This list shows the the maximum azimuth values of either the horizontal or vertical components.

ERI[®] Horizontal Plane Relative Field Pattern

Electronics Research, Inc. 7777 Gardner Rd. Chandler, IN 47610 Phone(812) 925-6000 Fax(812) 925-4030 Web: www.eriinc.com

Figure# 2A

Date: 4/27/2016

Station: WKNC

Antenna: MP-4E-DA-HW

Location: Raleigh, NC.

Antenna Orientation: 6.5° True

Frequency: 88.1 MHz

Number of Bays: 4

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.909	20.677	13.155	0.850	18.070	12.570	180°	0.299	2.228	3.478	0.241	1.449	1.611
5°	0.942	22.183	13.460	0.883	19.476	12.895	185°	0.289	2.093	3.208	0.225	1.263	1.013
10°	0.964	23.225	13.660	0.914	20.906	13.203	190°	0.290	2.102	3.226	0.212	1.123	0.504
15°	0.975	23.758	13.758	0.936	21.922	13.409	195°	0.300	2.246	3.514	0.202	1.024	0.101
20°	0.977	23.853	13.775	0.947	22.436	13.509	200°	0.315	2.479	3.942	0.196	0.960	-0.178
25°	0.974	23.696	13.747	0.954	22.733	13.567	205°	0.327	2.674	4.272	0.193	0.929	-0.321
30°	0.967	23.374	13.687	0.955	22.791	13.578	210°	0.332	2.753	4.399	0.194	0.940	-0.269
35°	0.958	22.962	13.610	0.948	22.446	13.511	215°	0.329	2.711	4.332	0.201	1.007	0.029
40°	0.951	22.605	13.542	0.936	21.893	13.403	220°	0.322	2.589	4.131	0.213	1.135	0.549
45°	0.946	22.376	13.498	0.929	21.574	13.339	225°	0.315	2.474	3.934	0.231	1.335	1.254
50°	0.942	22.164	13.457	0.928	21.536	13.332	230°	0.313	2.443	3.879	0.255	1.622	2.101
55°	0.927	21.467	13.318	0.932	21.734	13.371	235°	0.320	2.562	4.085	0.284	2.016	3.046
60°	0.893	19.957	13.001	0.941	22.133	13.450	240°	0.342	2.927	4.665	0.318	2.529	4.030
65°	0.840	17.656	12.469	0.954	22.771	13.574	245°	0.380	3.603	5.566	0.353	3.115	4.935
70°	0.776	15.074	11.782	0.968	23.427	13.697	250°	0.427	4.554	6.584	0.392	3.839	5.842
75°	0.721	13.014	11.144	0.968	23.417	13.695	255°	0.483	5.822	7.650	0.439	4.823	6.833
80°	0.685	11.725	10.691	0.940	22.098	13.443	260°	0.544	7.404	8.695	0.490	6.011	7.789
85°	0.670	11.209	10.496	0.889	19.762	12.958	265°	0.609	9.285	9.678	0.534	7.129	8.530
90°	0.680	11.574	10.635	0.832	17.287	12.377	270°	0.680	11.562	10.631	0.577	8.332	9.208
95°	0.716	12.824	11.080	0.773	14.926	11.740	275°	0.758	14.347	11.568	0.629	9.892	9.953
100°	0.756	14.280	11.547	0.722	13.037	11.152	280°	0.845	17.847	12.516	0.694	12.039	10.806
105°	0.775	15.012	11.764	0.686	11.776	10.710	285°	0.912	20.772	13.175	0.765	14.631	11.653
110°	0.761	14.484	11.609	0.659	10.859	10.358	290°	0.958	22.950	13.608	0.836	17.468	12.422
115°	0.712	12.668	11.027	0.644	10.356	10.152	295°	0.988	24.379	13.870	0.900	20.235	13.061
120°	0.631	9.939	9.973	0.635	10.069	10.030	300°	1.000	25.000	13.979	0.948	22.491	13.520
125°	0.544	7.411	8.699	0.621	9.656	9.848	305°	0.989	24.446	13.882	0.970	23.545	13.719
130°	0.483	5.826	7.654	0.601	9.031	9.557	310°	0.950	22.581	13.537	0.966	23.338	13.681
135°	0.455	5.172	7.136	0.576	8.284	9.183	315°	0.885	19.590	12.920	0.950	22.543	13.530
140°	0.458	5.238	7.192	0.546	7.450	8.722	320°	0.815	16.593	12.199	0.924	21.330	13.290
145°	0.478	5.714	7.570	0.511	6.529	8.148	325°	0.766	14.660	11.661	0.885	19.572	12.916
150°	0.489	5.970	7.760	0.472	5.564	7.454	330°	0.744	13.828	11.408	0.845	17.865	12.520
155°	0.468	5.484	7.391	0.419	4.397	6.431	335°	0.744	13.850	11.415	0.816	16.665	12.218
160°	0.426	4.542	6.572	0.369	3.413	5.332	340°	0.759	14.407	11.586	0.796	15.829	11.994
165°	0.383	3.667	5.643	0.323	2.613	4.172	345°	0.785	15.421	11.881	0.793	15.732	11.968
170°	0.345	2.974	4.733	0.285	2.024	3.063	350°	0.823	16.917	12.283	0.807	16.289	12.119
175°	0.317	2.511	3.998	0.260	1.691	2.281	355°	0.867	18.809	12.744	0.826	17.036	12.314

Horizontal Polarization:

Maximum: 2.491 (3.964 dB)

Horizontal Plane: 2.491 (3.964 dB)

Maximum ERP: 25.000 kW

Vertical Polarization:

Maximum: 2.350 (3.711 dB)

Horizontal Plane: 2.350 (3.711 dB)

Maximum ERP: 23.584 kW

Total Input Power: 10.035 kW

Reference: WKNC2M.FIG

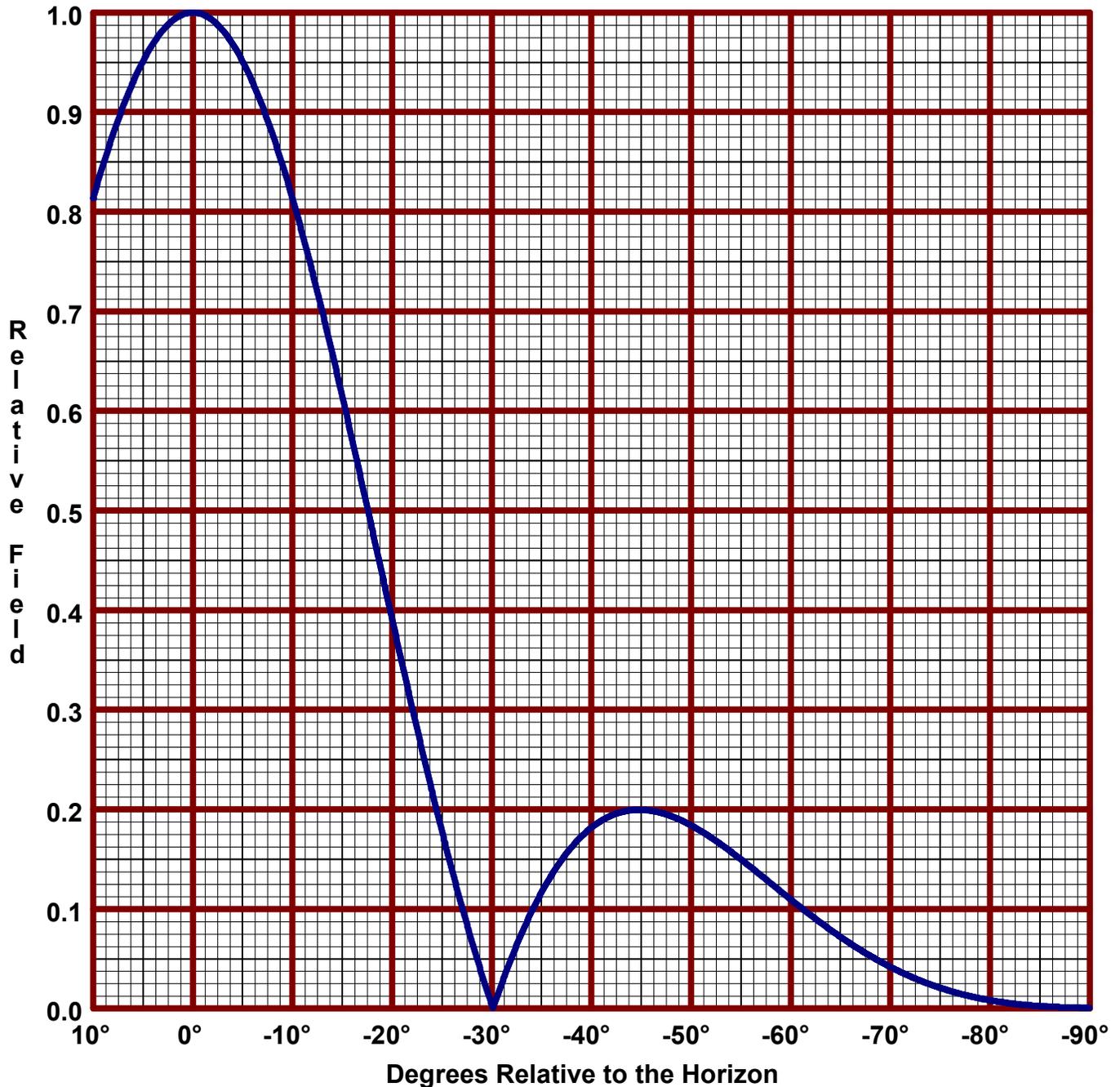
This list shows the azimuth values for the horizontal and vertical components.

ERI[®] Vertical Plane Relative Field Pattern

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Figure No: 3
Call Sign: WKNC
Location: Raleigh, NC.
Frequency: 88.1 MHz
Antenna: 4 bay MP-4E-DA-HW

Date: 4/27/2016
H/V Power Ratio: 1
.5 Wave-length Spacing
0° Beam Tilt
0% First Null Fill



Horizontal Polarization:
Maximum: 2.491 (3.964 dB)
Horizontal Plane: 2.491 (3.964 dB)
Maximum ERP: 25.000 kW

Vertical Polarization:
Maximum: 2.350 (3.711 dB)
Horizontal Plane: 2.350 (3.711 dB)
Maximum ERP: 23.584 kW

Directional Antenna System for WKNC, Raleigh, North Carolina

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	MP-4E-DA
Frequency:	88.1 MHz
Number of Bays:	Four

MECHANICAL SPECIFICATIONS

Mounting:	Custom
System length:	25 ft 8 in
Aperture length required:	36 ft 8 in
Orientation:	6.5° true

Input flange to the antenna 3 1/8" female.

ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP:	25.000 kW (13.979 dBk)
Horizontal maximum power gain:	2.491 (3.964 dB)
Maximum vertical ERP:	23.584 (13.726 dB)
Vertical maximum power gain:	2.350 (3.711 dB)
Total input power:	10.035 kW (10.015 dBk)

