

***Directional Antenna System  
for  
WOSA, Grove City, Ohio***

December 21, 2019

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

The antenna is the ERI model LP-4E-DA-HW configuration. The circular polarized system consists of 4 half-wavelength spaced bays using one driven circular polarized radiating element and two horizontal parasitic elements per bay. The antenna was mounted on the North 12 degrees East tower face with bracketry to provide an antenna orientation of North 12 degrees East. The antenna was tested on a 24" face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 101.1 megahertz, which is the center of the FM broadcast channel assigned to WOSA.

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 WOSA, Grove City, Ohio

(Continued)

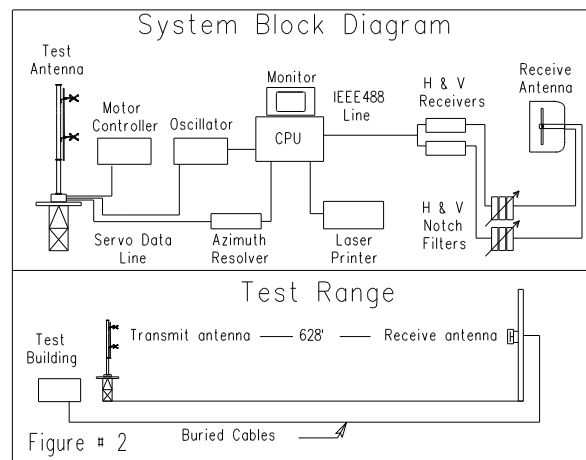
## DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of two bay levels of the circular polarized system with the associated 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 1 5/8 inch o.d. rigid coaxial line was used to feed the test antenna, and a section of 1 5/8 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 24" 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 101.1 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.



# Directional Antenna System For WOSA, Grove City, Ohio

(Continued)

A broadband 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 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 and two horizontal parasitic elements per bay. 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 LP-4E-DA-HW array is to be mounted on the North 12 degrees East tower face of the 24" face tower at a bearing of North 12 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

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For  
WOSA, Grove City, Ohio

(Continued)

pattern is shown on Figure #3 attached. The power in the maximum will reach 6.0 kilowatts (7.7815 dBk).

The power at North 170 degrees East does not exceed 0.925 kilowatts (-0.3386 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 than 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 29.54 feet if the antenna is to be top mounted.

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 black ink, reading "Dan Dowdle", is centered below a horizontal line.

**Daniel Dowdle**  
**ERI Test Range Director**

The Microsoft Word document on file electronically at Electronic Research, Inc. governs the specifications, scope, and configuration of the product described. All other representations whether verbal, printed, or electronic are subordinate to the master copy of this document on file at ERI.

# Directional Antenna System for WOSA, Grove City, Ohio

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type: LP-4E-DA-HW  
Frequency: 101.1 MHz  
Number of Bays: four

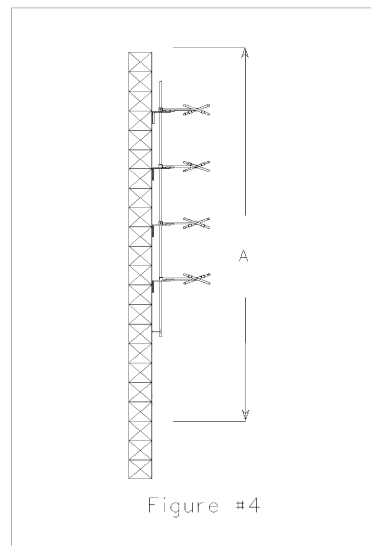
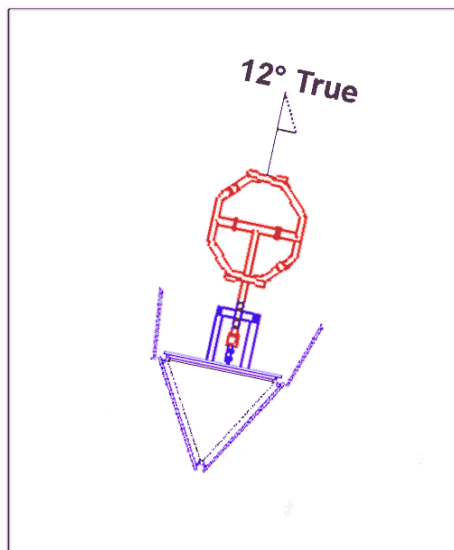
## MECHANICAL SPECIFICATIONS

Mounting: Custom  
System length: 23 ft  
Aperture length required: 29.54' <sup>1</sup>  
Orientation: 12° true  
Input flange to the antenna 1 5/8" female.

## ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum Horizontal ERP: 6.00 kW (7.7815 dBk)  
Horizontal Maximum Power Gain: 2.143 (3.310 dB)  
Maximum Vertical ERP: 5.830 kW (7.657 dBk)  
Vertical Maximum Power Gain: 2.082 (3.185 dB)  
Total Input Power: 2.800 kW (5.307 dBk)

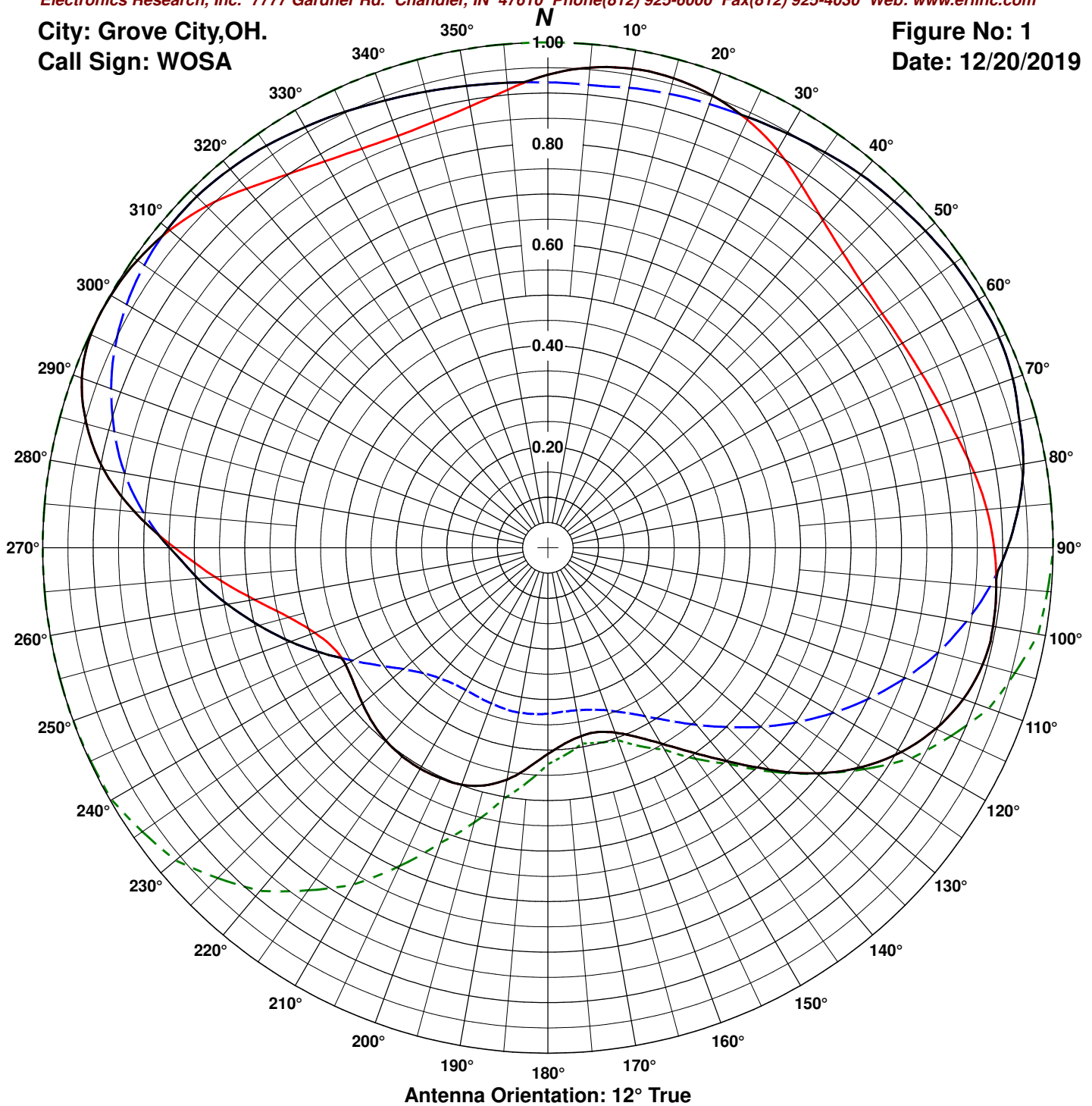


# Horizontal Plane Relative Field Pattern

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

City: Grove City, OH.  
Call Sign: WOSA

Figure No: 1  
Date: 12/20/2019



Frequency: 101.1 MHz

Antenna Type: LP-4E-DA-HW

Antenna Mounting: 20" Radome

Tower Type: 24" Tower

## HORIZONTAL

RMS: .761

Maximum: 1 @ 297°

Minimum: .376 @ 167°

## VERTICAL

RMS: .761

Maximum: .986 @ 64°

Minimum: .325 @ 209°

## COMPOSITE

RMS: .797

Maximum: 1 @ 297°

Minimum: .376 @ 167°

## FCC ENVELOPE

RMS: .897

Maximum: 1 @ 0°

Minimum: .393 @ 170°

Two-bay test.

# 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: 12/20/2019

Station: WOSA

Antenna: LP-4E-DA-HW

Location: Grove City, OH

Antenna Orientation: 12° True

Frequency: 101.1 MHz

Number of Bays: 4

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.936	5.258	7.208	0.921	5.088	7.065	180°	0.408	0.999	-0.006	0.328	0.646	-1.895
5°	0.954	5.459	7.371	0.920	5.075	7.054	185°	0.436	1.140	0.570	0.330	0.654	-1.844
10°	0.963	5.561	7.451	0.924	5.127	7.099	190°	0.466	1.301	1.141	0.331	0.657	-1.822
15°	0.962	5.551	7.444	0.930	5.188	7.150	195°	0.487	1.420	1.524	0.330	0.653	-1.851
20°	0.952	5.440	7.356	0.935	5.241	7.194	200°	0.499	1.493	1.740	0.328	0.644	-1.912
25°	0.934	5.239	7.193	0.940	5.299	7.242	205°	0.503	1.517	1.811	0.326	0.637	-1.961
30°	0.909	4.954	6.950	0.947	5.381	7.308	210°	0.505	1.528	1.842	0.325	0.634	-1.980
35°	0.876	4.599	6.627	0.955	5.475	7.384	215°	0.503	1.520	1.819	0.328	0.645	-1.907
40°	0.847	4.300	6.334	0.964	5.578	7.465	220°	0.498	1.491	1.734	0.336	0.678	-1.691
45°	0.826	4.090	6.117	0.970	5.641	7.514	225°	0.490	1.442	1.589	0.351	0.737	-1.324
50°	0.813	3.963	5.980	0.976	5.710	7.567	230°	0.479	1.378	1.393	0.373	0.837	-0.774
55°	0.808	3.916	5.928	0.981	5.776	7.616	235°	0.469	1.318	1.199	0.406	0.989	-0.047
60°	0.810	3.938	5.953	0.984	5.811	7.642	240°	0.462	1.281	1.077	0.446	1.194	0.769
65°	0.816	3.997	6.017	0.985	5.826	7.654	245°	0.468	1.316	1.194	0.493	1.457	1.634
70°	0.826	4.094	6.122	0.979	5.753	7.599	250°	0.491	1.449	1.611	0.543	1.768	2.474
75°	0.840	4.231	6.264	0.967	5.607	7.487	255°	0.531	1.689	2.277	0.592	2.105	3.232
80°	0.857	4.405	6.440	0.956	5.480	7.388	260°	0.590	2.087	3.196	0.644	2.490	3.963
85°	0.872	4.563	6.592	0.936	5.251	7.202	265°	0.662	2.627	4.194	0.696	2.906	4.633
90°	0.883	4.683	6.705	0.910	4.967	6.961	270°	0.739	3.274	5.150	0.749	3.362	5.265
95°	0.891	4.763	6.779	0.878	4.629	6.655	275°	0.822	4.050	6.074	0.804	3.875	5.883
100°	0.895	4.804	6.816	0.841	4.241	6.275	280°	0.893	4.785	6.798	0.851	4.343	6.378
105°	0.891	4.764	6.780	0.800	3.838	5.841	285°	0.946	5.364	7.295	0.889	4.738	6.756
110°	0.875	4.593	6.621	0.753	3.400	5.315	290°	0.982	5.784	7.622	0.920	5.078	7.057
115°	0.847	4.306	6.340	0.703	2.968	4.725	295°	0.998	5.980	7.767	0.945	5.355	7.288
120°	0.808	3.915	5.927	0.653	2.558	4.080	300°	0.999	5.989	7.773	0.963	5.563	7.453
125°	0.757	3.437	5.361	0.602	2.172	3.369	305°	0.992	5.903	7.711	0.975	5.705	7.563
130°	0.694	2.892	4.612	0.551	1.821	2.604	310°	0.978	5.733	7.584	0.982	5.786	7.624
135°	0.621	2.311	3.639	0.502	1.509	1.788	315°	0.956	5.484	7.391	0.983	5.797	7.632
140°	0.551	1.823	2.608	0.457	1.256	0.988	320°	0.928	5.163	7.129	0.978	5.741	7.590
145°	0.493	1.460	1.644	0.417	1.046	0.194	325°	0.902	4.879	6.883	0.971	5.661	7.529
150°	0.447	1.199	0.788	0.385	0.889	-0.509	330°	0.883	4.679	6.702	0.961	5.546	7.440
155°	0.412	1.020	0.086	0.360	0.778	-1.091	335°	0.872	4.558	6.588	0.952	5.436	7.353
160°	0.389	0.909	-0.416	0.342	0.703	-1.532	340°	0.867	4.514	6.545	0.942	5.326	7.264
165°	0.378	0.855	-0.679	0.332	0.660	-1.803	345°	0.873	4.569	6.598	0.934	5.238	7.192
170°	0.378	0.859	-0.662	0.327	0.640	-1.939	350°	0.887	4.719	6.738	0.928	5.169	7.134
175°	0.389	0.907	-0.425	0.326	0.637	-1.962	355°	0.910	4.967	6.961	0.924	5.121	7.093

Horizontal Polarization:

Maximum: 2.143 (3.310 dB)

Horizontal Plane: 2.143 (3.310 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 2.082 (3.185 dB)

Horizontal Plane: 2.082 (3.185 dB)

Maximum ERP: 5.830 kW

Total Input Power: 2.800 kW

Reference: WOSA1.FIG

# 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: 12/20/2019

Station: WOSA

Antenna: LP-4E-DA-HW

Location: Grove City, OH

Antenna Orientation: 12° True

Frequency: 101.1 MHz

Number of Bays: 4

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.936	5.258	7.208	Horizontal	180°	0.408	0.999	-0.006	Horizontal
5°	0.954	5.459	7.371	Horizontal	185°	0.436	1.140	0.570	Horizontal
10°	0.963	5.561	7.451	Horizontal	190°	0.466	1.301	1.141	Horizontal
15°	0.962	5.551	7.444	Horizontal	195°	0.487	1.420	1.524	Horizontal
20°	0.952	5.440	7.356	Horizontal	200°	0.499	1.493	1.740	Horizontal
25°	0.940	5.299	7.242	Vertical	205°	0.503	1.517	1.811	Horizontal
30°	0.947	5.381	7.308	Vertical	210°	0.505	1.528	1.842	Horizontal
35°	0.955	5.475	7.384	Vertical	215°	0.503	1.520	1.819	Horizontal
40°	0.964	5.578	7.465	Vertical	220°	0.498	1.491	1.734	Horizontal
45°	0.970	5.641	7.514	Vertical	225°	0.490	1.442	1.589	Horizontal
50°	0.976	5.710	7.567	Vertical	230°	0.479	1.378	1.393	Horizontal
55°	0.981	5.776	7.616	Vertical	235°	0.469	1.318	1.199	Horizontal
60°	0.984	5.811	7.642	Vertical	240°	0.462	1.281	1.077	Horizontal
65°	0.985	5.826	7.654	Vertical	245°	0.493	1.457	1.634	Vertical
70°	0.979	5.753	7.599	Vertical	250°	0.543	1.768	2.474	Vertical
75°	0.967	5.607	7.487	Vertical	255°	0.592	2.105	3.232	Vertical
80°	0.956	5.480	7.388	Vertical	260°	0.644	2.490	3.963	Vertical
85°	0.936	5.251	7.202	Vertical	265°	0.696	2.906	4.633	Vertical
90°	0.910	4.967	6.961	Vertical	270°	0.749	3.362	5.265	Vertical
95°	0.891	4.763	6.779	Horizontal	275°	0.822	4.050	6.074	Horizontal
100°	0.895	4.804	6.816	Horizontal	280°	0.893	4.785	6.798	Horizontal
105°	0.891	4.764	6.780	Horizontal	285°	0.946	5.364	7.295	Horizontal
110°	0.875	4.593	6.621	Horizontal	290°	0.982	5.784	7.622	Horizontal
115°	0.847	4.306	6.340	Horizontal	295°	0.998	5.980	7.767	Horizontal
120°	0.808	3.915	5.927	Horizontal	300°	0.999	5.989	7.773	Horizontal
125°	0.757	3.437	5.361	Horizontal	305°	0.992	5.903	7.711	Horizontal
130°	0.694	2.892	4.612	Horizontal	310°	0.982	5.786	7.624	Vertical
135°	0.621	2.311	3.639	Horizontal	315°	0.983	5.797	7.632	Vertical
140°	0.551	1.823	2.608	Horizontal	320°	0.978	5.741	7.590	Vertical
145°	0.493	1.460	1.644	Horizontal	325°	0.971	5.661	7.529	Vertical
150°	0.447	1.199	0.788	Horizontal	330°	0.961	5.546	7.440	Vertical
155°	0.412	1.020	0.086	Horizontal	335°	0.952	5.436	7.353	Vertical
160°	0.389	0.909	-0.416	Horizontal	340°	0.942	5.326	7.264	Vertical
165°	0.378	0.855	-0.679	Horizontal	345°	0.934	5.238	7.192	Vertical
170°	0.378	0.859	-0.662	Horizontal	350°	0.928	5.169	7.134	Vertical
175°	0.389	0.907	-0.425	Horizontal	355°	0.924	5.121	7.093	Vertical

Horizontal Polarization:

Maximum: 2.143 (3.310 dB)

Horizontal Plane: 2.143 (3.310 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 2.082 (3.185 dB)

Horizontal Plane: 2.082 (3.185 dB)

Maximum ERP: 5.830 kW

Total Input Power: 2.800 kW

Reference: WOSA1.FIG



# Vertical 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 No: 3

Call Sign: WOSA

Location: Grove City, OH

Frequency: 101.1 MHz

Antenna: 4 bay LP-4E-DA-HW

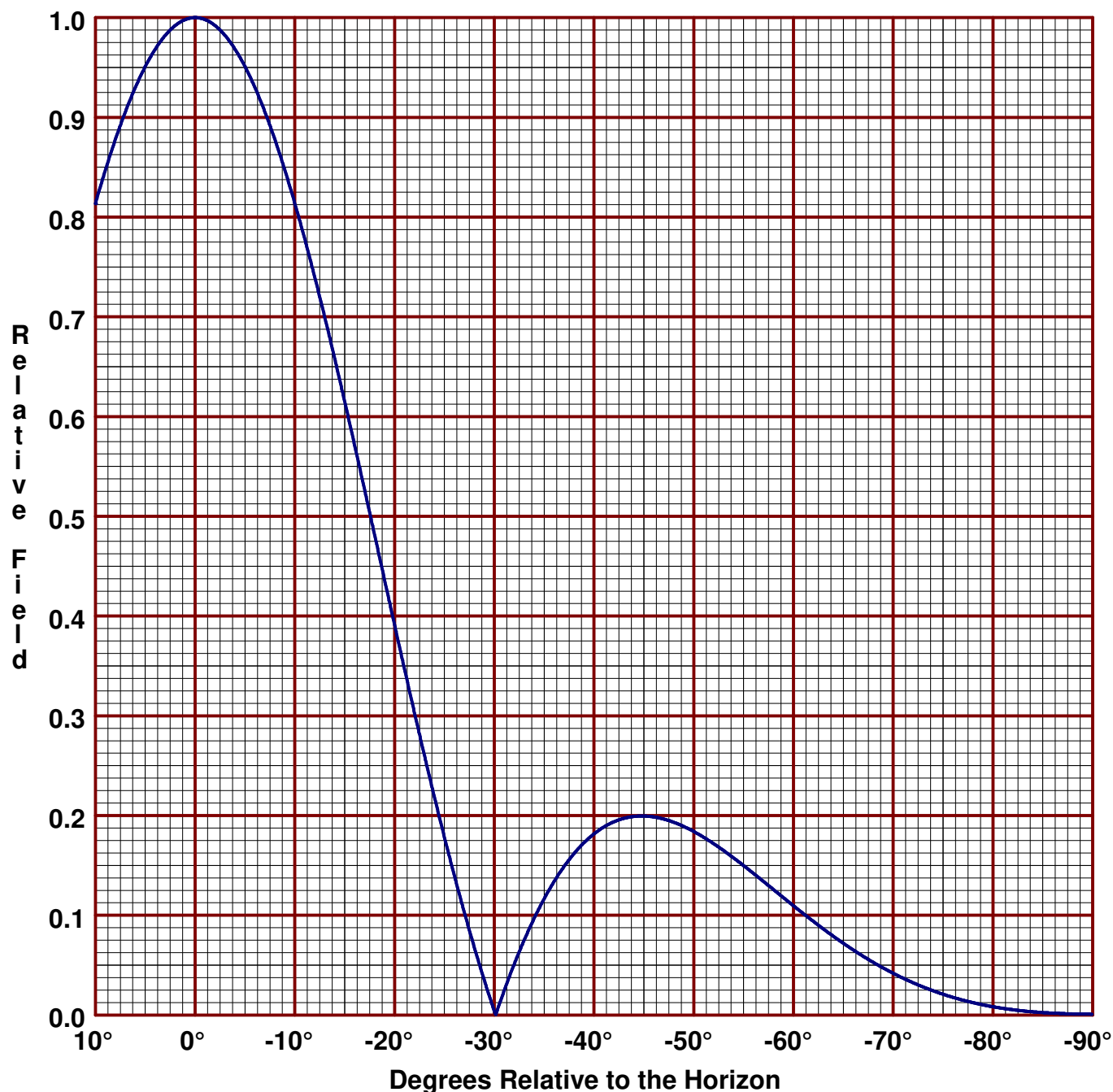
Date: 12/20/2019

H/V Power Ratio: 1

.5 Wave-length Spacing

0° Beam Tilt

0% First Null Fill



Horizontal Polarization:

Maximum: 2.143 (3.310 dB)

Horizontal Plane: 2.143 (3.310 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 2.082 (3.185 dB)

Horizontal Plane: 2.082 (3.185 dB)

Maximum ERP: 5.830 kW