

## ***Directional Antenna System for WELL, Waverly, Alabama***

October 3, 2017

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 WELL.

The antenna is the ERI model LP-5E-DA configuration. The circular polarized system consists of 5 full-wavelength spaced bays using one driven circular polarized radiating element, three horizontal parasitic elements placed one quarter wave above and below each bay and two vertical parasitic elements per bay. The antenna was mounted on the North 264 degrees East tower leg with bracketry to provide an antenna orientation of North 279 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 88.7 megahertz, which is the center of the FM broadcast channel assigned to WELL.

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 WELL, Waverly, Alabama

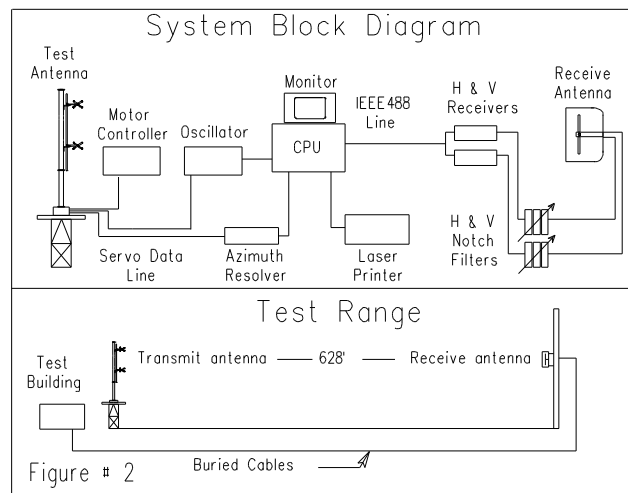
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## DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of two bay levels of the circular 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. 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 88.7 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.

# Directional Antenna System For WELL, Waverly, Alabama

(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 Helix 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 5 full-wavelength spaced bays using one driven circular polarized radiating element, three horizontal parasitic elements placed one quarter wave above and below each bay and two vertical 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-5E-DA array is to be mounted on the North 264 degrees East tower leg of the 24" face tower at a bearing of North 279 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 60 kilowatts (17.782 dBk).

Directional Antenna System  
For  
WELL, Waverly, Alabama

(Continued)

The power at North 74-184 degrees East does not exceed 5.4 kilowatts (7.324 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 64 feet 2 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.

A handwritten signature in black ink, reading "Tom Scharf". The signature is written in a cursive style with a large, stylized 'T' and 'S'.

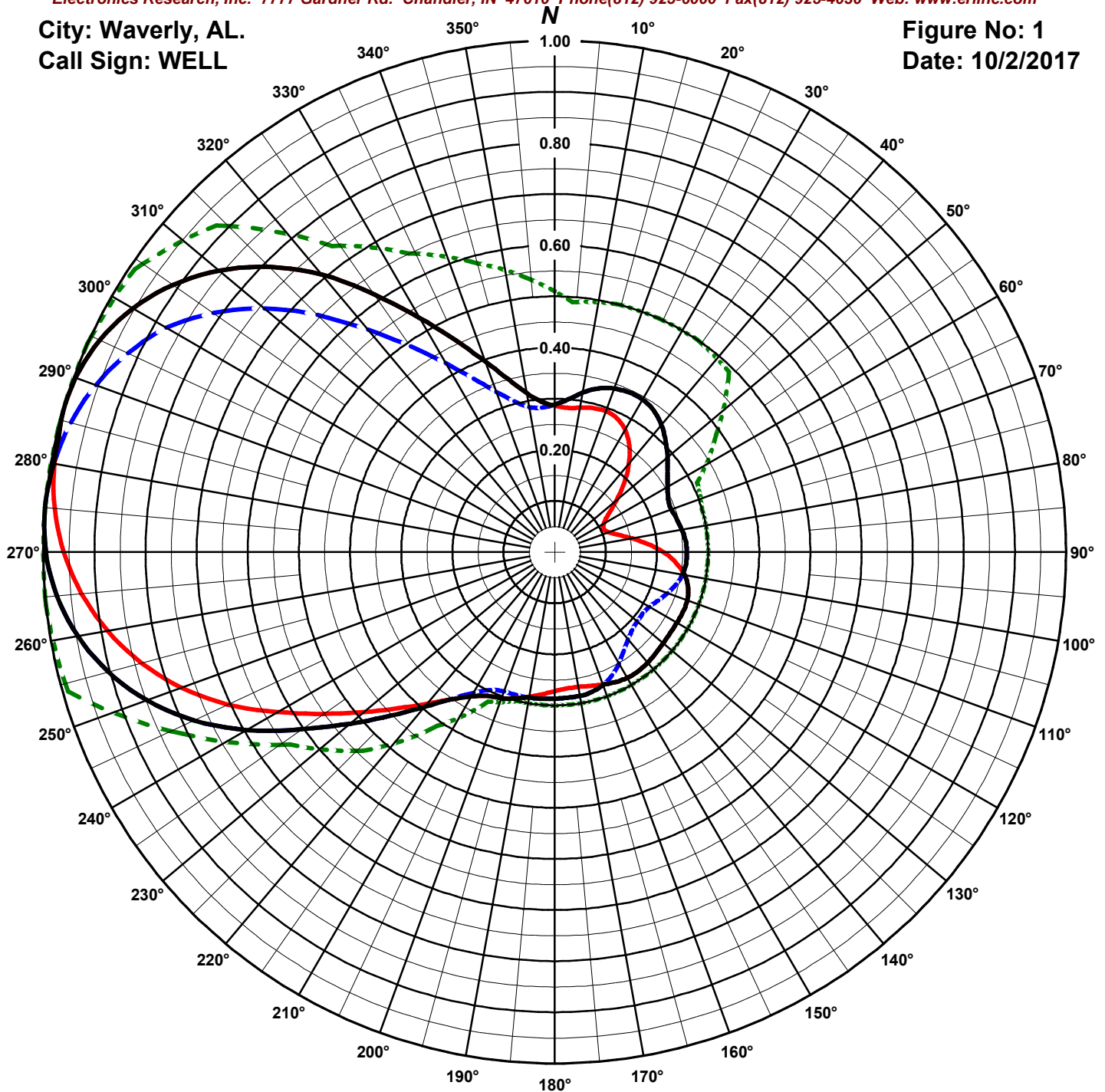
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# ERI® Horizontal Plane Relative Field Pattern

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

City: Waverly, AL.  
Call Sign: WELL

Figure No: 1  
Date: 10/2/2017



Antenna Orientation: 279° True

Frequency: 88.7 MHz  
Antenna Type: LP-5E-DA

Antenna Mounting: Standard  
Tower Type: 24" face tower

## HORIZONTAL

RMS: .506  
Maximum: 1 @ 287°  
Minimum: .106 @ 64°

## VERTICAL

RMS: .503  
Maximum: 1 @ 274°  
Minimum: .21 @ 125°

## COMPOSITE

RMS: .528  
Maximum: 1 @ 274°  
Minimum: .242 @ 69°

## FCC ENVELOPE

RMS: .593  
Maximum: 1 @ 264°  
Minimum: .3 @ 74°

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-20170328AAG.

# ERI<sup>®</sup> 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

Station: WELL

Location: Waverly, AL.

Frequency: 88.7 MHz

Date: 10/2/2017

Antenna: LP-5E-DA

Antenna Orientation: 279° True

Number of Bays: 5

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.288	4.982	6.974	Vertical	180°	0.287	4.931	6.929	Vertical
5°	0.300	5.388	7.314	Vertical	185°	0.288	4.966	6.960	Vertical
10°	0.317	6.012	7.790	Vertical	190°	0.289	5.000	6.990	Vertical
15°	0.331	6.588	8.187	Vertical	195°	0.296	5.262	7.212	Horizontal
20°	0.340	6.944	8.416	Vertical	200°	0.305	5.565	7.455	Horizontal
25°	0.344	7.114	8.521	Vertical	205°	0.310	5.782	7.621	Horizontal
30°	0.344	7.117	8.523	Vertical	210°	0.326	6.380	8.048	Horizontal
35°	0.338	6.837	8.349	Vertical	215°	0.352	7.416	8.701	Horizontal
40°	0.325	6.324	8.010	Vertical	220°	0.395	9.350	9.708	Vertical
45°	0.307	5.652	7.522	Vertical	225°	0.452	12.264	10.886	Vertical
50°	0.288	4.984	6.976	Vertical	230°	0.522	16.344	12.134	Vertical
55°	0.270	4.376	6.411	Vertical	235°	0.604	21.904	13.405	Vertical
60°	0.255	3.908	5.920	Vertical	240°	0.696	29.051	14.632	Vertical
65°	0.245	3.608	5.572	Vertical	245°	0.778	36.328	15.602	Vertical
70°	0.243	3.532	5.481	Vertical	250°	0.848	43.139	16.349	Vertical
75°	0.247	3.673	5.650	Vertical	255°	0.904	48.999	16.902	Vertical
80°	0.252	3.823	5.824	Vertical	260°	0.947	53.783	17.306	Vertical
85°	0.257	3.959	5.976	Vertical	265°	0.977	57.294	17.581	Vertical
90°	0.258	4.009	6.030	Vertical	270°	0.995	59.393	17.737	Vertical
95°	0.258	3.990	6.010	Vertical	275°	1.000	60.000	17.782	Vertical
100°	0.258	3.989	6.009	Horizontal	280°	0.994	59.321	17.732	Vertical
105°	0.270	4.381	6.415	Horizontal	285°	0.999	59.839	17.770	Horizontal
110°	0.276	4.567	6.596	Horizontal	290°	0.997	59.626	17.754	Horizontal
115°	0.277	4.604	6.632	Horizontal	295°	0.981	57.771	17.617	Horizontal
120°	0.276	4.580	6.609	Horizontal	300°	0.953	54.448	17.360	Horizontal
125°	0.276	4.568	6.597	Horizontal	305°	0.911	49.789	16.971	Horizontal
130°	0.277	4.607	6.634	Horizontal	310°	0.856	43.991	16.434	Horizontal
135°	0.280	4.695	6.716	Horizontal	315°	0.789	37.310	15.718	Horizontal
140°	0.283	4.795	6.808	Horizontal	320°	0.708	30.063	14.780	Horizontal
145°	0.285	4.858	6.864	Horizontal	325°	0.615	22.714	13.563	Horizontal
150°	0.284	4.839	6.848	Horizontal	330°	0.529	16.812	12.256	Horizontal
155°	0.281	4.728	6.747	Horizontal	335°	0.456	12.500	10.969	Horizontal
160°	0.276	4.585	6.613	Vertical	340°	0.397	9.435	9.747	Horizontal
165°	0.283	4.805	6.816	Vertical	345°	0.350	7.336	8.655	Horizontal
170°	0.285	4.890	6.893	Vertical	350°	0.316	5.985	7.771	Horizontal
175°	0.286	4.908	6.909	Vertical	355°	0.295	5.221	7.178	Horizontal

Horizontal Polarization:

Maximum: 10.136 (10.059 dB)

Horizontal Plane: 10.136 (10.059 dB)

Maximum ERP: 60.000 kW

Vertical Polarization:

Maximum: 10.136 (10.059 dB)

Horizontal Plane: 10.136 (10.059 dB)

Maximum ERP: 60.000 kW

Total Input Power: 5.919 kW

Reference: WELL2M.FIG

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

# ERI<sup>®</sup> 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# 1A

Station: WELL

Location: Waverly, AL.

Frequency: 88.7 MHz

Date: 10/2/2017

Antenna: LP-5E-DA

Antenna Orientation: 279° True

Number of Bays: 5

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.287	4.949	6.945	0.288	4.982	6.974	180°	0.272	4.440	6.474	0.287	4.931	6.929
5°	0.283	4.805	6.817	0.300	5.388	7.314	185°	0.279	4.669	6.692	0.288	4.966	6.960
10°	0.286	4.922	6.922	0.317	6.012	7.790	190°	0.288	4.960	6.955	0.289	5.000	6.990
15°	0.291	5.096	7.072	0.331	6.588	8.187	195°	0.296	5.262	7.212	0.289	5.022	7.009
20°	0.293	5.156	7.123	0.340	6.944	8.416	200°	0.305	5.565	7.455	0.290	5.048	7.031
25°	0.288	4.988	6.979	0.344	7.114	8.521	205°	0.310	5.782	7.621	0.298	5.311	7.252
30°	0.275	4.552	6.582	0.344	7.117	8.523	210°	0.326	6.380	8.048	0.317	6.047	7.816
35°	0.254	3.883	5.892	0.338	6.837	8.349	215°	0.352	7.416	8.701	0.350	7.345	8.660
40°	0.226	3.066	4.866	0.325	6.324	8.010	220°	0.387	8.978	9.532	0.395	9.350	9.708
45°	0.192	2.222	3.467	0.307	5.652	7.522	225°	0.432	11.191	10.489	0.452	12.264	10.886
50°	0.158	1.491	1.734	0.288	4.984	6.976	230°	0.487	14.214	11.527	0.522	16.344	12.134
55°	0.128	0.986	-0.059	0.270	4.376	6.411	235°	0.551	18.240	12.610	0.604	21.904	13.405
60°	0.110	0.732	-1.354	0.255	3.908	5.920	240°	0.626	23.497	13.710	0.696	29.051	14.632
65°	0.106	0.675	-1.706	0.245	3.608	5.572	245°	0.705	29.841	14.748	0.778	36.328	15.602
70°	0.113	0.768	-1.147	0.243	3.532	5.481	250°	0.776	36.107	15.576	0.848	43.139	16.349
75°	0.129	1.006	0.024	0.247	3.673	5.650	255°	0.836	41.981	16.230	0.904	48.999	16.902
80°	0.154	1.414	1.505	0.252	3.823	5.824	260°	0.887	47.248	16.744	0.947	53.783	17.306
85°	0.183	2.002	3.014	0.257	3.959	5.976	265°	0.929	51.730	17.137	0.977	57.294	17.581
90°	0.212	2.706	4.323	0.258	4.009	6.030	270°	0.960	55.281	17.426	0.995	59.393	17.737
95°	0.238	3.406	5.322	0.258	3.990	6.010	275°	0.981	57.791	17.619	1.000	60.000	17.782
100°	0.258	3.989	6.009	0.254	3.863	5.869	280°	0.993	59.184	17.722	0.994	59.321	17.732
105°	0.270	4.381	6.415	0.245	3.612	5.578	285°	0.999	59.839	17.770	0.979	57.529	17.599
110°	0.276	4.567	6.596	0.235	3.307	5.194	290°	0.997	59.626	17.754	0.955	54.675	17.378
115°	0.277	4.604	6.632	0.224	2.998	4.769	295°	0.981	57.771	17.617	0.921	50.844	17.062
120°	0.276	4.580	6.609	0.214	2.747	4.388	300°	0.953	54.448	17.360	0.877	46.151	16.642
125°	0.276	4.568	6.597	0.210	2.635	4.208	305°	0.911	49.789	16.971	0.815	39.858	16.005
130°	0.277	4.607	6.634	0.211	2.666	4.258	310°	0.856	43.991	16.434	0.741	32.957	15.179
135°	0.280	4.695	6.716	0.215	2.773	4.430	315°	0.789	37.310	15.718	0.655	25.766	14.110
140°	0.283	4.795	6.808	0.223	2.989	4.755	320°	0.708	30.063	14.780	0.567	19.304	12.856
145°	0.285	4.858	6.864	0.235	3.327	5.220	325°	0.615	22.714	13.563	0.491	14.460	11.602
150°	0.284	4.839	6.848	0.251	3.789	5.785	330°	0.529	16.812	12.256	0.427	10.917	10.381
155°	0.281	4.728	6.747	0.266	4.239	6.272	335°	0.456	12.500	10.969	0.374	8.397	9.241
160°	0.276	4.560	6.590	0.276	4.585	6.613	340°	0.397	9.435	9.747	0.334	6.676	8.245
165°	0.271	4.398	6.432	0.283	4.805	6.816	345°	0.350	7.336	8.655	0.305	5.580	7.466
170°	0.268	4.302	6.337	0.285	4.890	6.893	350°	0.316	5.985	7.771	0.288	4.986	6.977
175°	0.268	4.313	6.348	0.286	4.908	6.909	355°	0.295	5.221	7.178	0.284	4.823	6.833

Horizontal Polarization:

Maximum: 10.136 (10.059 dB)

Horizontal Plane: 10.136 (10.059 dB)

Maximum ERP: 60.000 kW

Vertical Polarization:

Maximum: 10.136 (10.059 dB)

Horizontal Plane: 10.136 (10.059 dB)

Maximum ERP: 60.000 kW

Total Input Power: 5.919 kW

Reference: WELL2M.FIG

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

# ERI® 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: WELL

Location: Waverly, AL.

Frequency: 88.7 MHz

Antenna: 5 bay LP-5E-DA

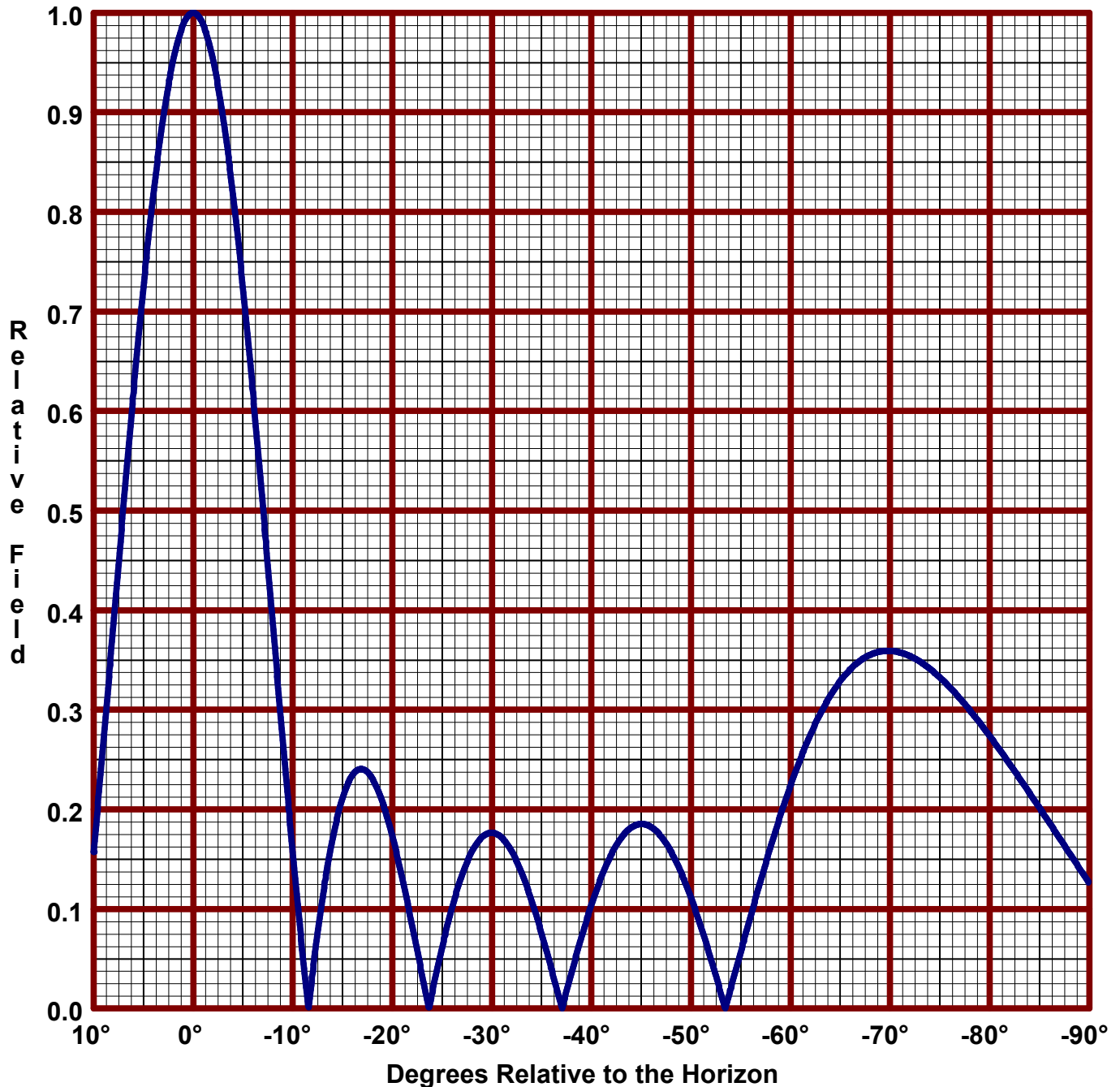
Date: 10/2/2017

H/V Power Ratio: 1

1 Wave-length Spacing

0° Beam Tilt

0% First Null Fill



Horizontal Polarization:

Maximum: 10.136 (10.059 dB)

Horizontal Plane: 10.136 (10.059 dB)

Maximum ERP: 60.000 kW

Vertical Polarization:

Maximum: 10.136 (10.059 dB)

Horizontal Plane: 10.136 (10.059 dB)

Maximum ERP: 60.000 kW



# Directional Antenna System for WELL, Waverly, Alabama

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type:	LP-5E-DA
Frequency:	88.7 MHz
Number of Bays:	Five

## MECHANICAL SPECIFICATIONS

Mounting:	Standard
System length:	53 ft
Aperture length required:	64 ft 2 in
Orientation:	279° true
Input flange to the antenna 1 5/8" female.	

## ELECTRICAL SPECIFICATIONS (For directional use)

Maximum horizontal ERP:	60.00 kW (17.782 dBk)
Horizontal maximum power gain:	10.137 (10.059 dB)
Maximum vertical ERP:	60.00 kW (17.782 dBk)
Vertical maximum power gain:	10.137 (10.059 dB)
Total input power:	5.919 kW (7.723 dBk)

