

***Directional Antenna System  
for  
WBCG, Murdock, Florida***

June 6, 2007

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

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 per bay, one horizontal parasitic element per bay and one vertical parasitic element interleaved between alternate bay pairs. The antenna was mounted on the North 104 degrees East tower face with bracketry to provide an antenna orientation of North 104 degrees East. The antenna was tested on a 21" **ERI<sup>®</sup>λ MOUNTING SYSTEM**, tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 98.9 megahertz, which is the center of the FM broadcast channel assigned to WBCG.

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 Proposed For WBCG, Murdock, Florida

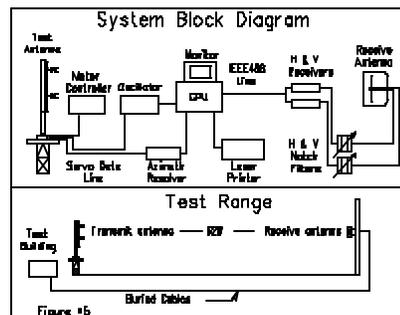
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## DESCRIPTION OF THE TEST PROCEDURE

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 21" **ERI**<sup>®</sup> **MOUNTING SYSTEM**, 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 98.9 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. 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 a Rohde & Schwarz measuring receiver.

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Proposed For  
WBCG, Murdock, Florida

(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 4 half-wavelength spaced bays using one driven circular polarized radiating element per bay, one horizontal parasitic element per bay and one vertical parasitic element interleaved between alternate bay pairs. 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 LP-4E-DA-HW array is to be mounted on the North 104 degrees East tower face of the 21" **ERI**<sup>®</sup> *λ MOUNTING SYSTEM*, tower at a bearing of North 104 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 is shown on Figure #3 attached. The power in the maximum will reach 5.5 kilowatts (7.404 dBk).

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

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Proposed For  
WBCG, Murdock, Florida

(Continued)

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 32 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, appearing to read "Tom Schaefer". The signature is written in a cursive, flowing style.

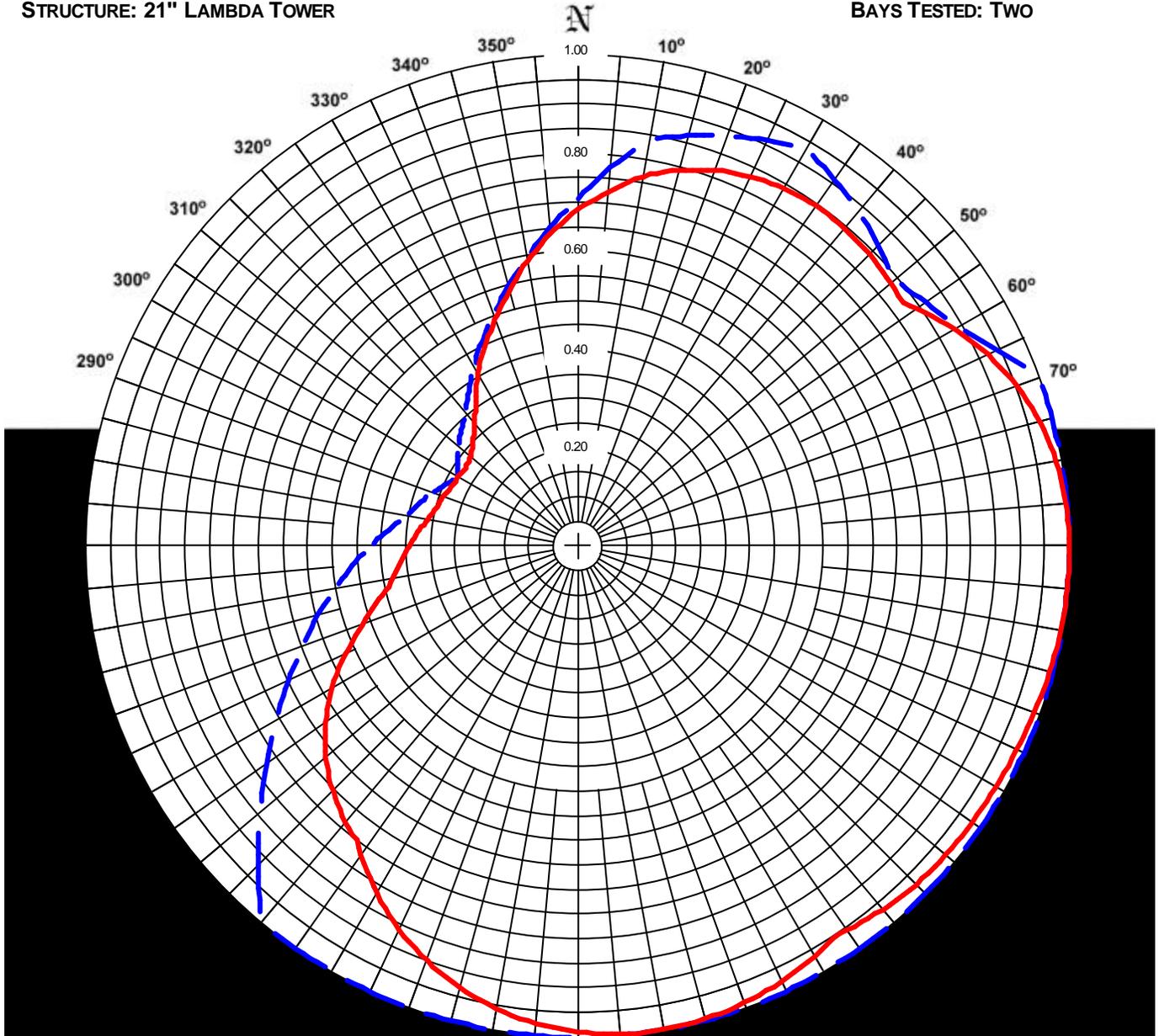
The Microsoft Word document on file electronically at Electronic Research, Inc. governs the specifications, scope, and configuration of the product described. All other representations whether verbal, printed, or electronic are subordinate to the master copy of this document on file at ERI.

# 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 <http://www.eriinc.com/>

FIGURE NO: 1  
STATION: WBCG  
LOCATION: MURDOCK, FL  
ANTENNA: LP-4E-DA-HW  
STRUCTURE: 21" LAMBDA TOWER

DATE: 4/18/2007  
FREQUENCY: 98.9 MHz  
ORIENTATION: 104° TRUE  
MOUNTING: STANDARD  
BAYS TESTED: TWO



**FCC COMPOSITE**

RMS: 0.824  
MAXIMUM: 1.000 @ 70° TRUE  
MINIMUM: 0.281 @ 300° TRUE

**Measured Composite:**

RMS: 0.774  
Maximum: 1.000 @ 92° True  
Minimum: 0.279 @ 305° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN IS GREATER THAN 85% OF THE FCC FILED COMPOSITE PATTERN BPH-20070228AAB.

# **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: WBCG**  
**Location: Murdock, FL**  
**Frequency: 98.9 MHz**

**Antenna: LP-4E-DA-HW**  
**Orientation: 104° True**  
**Tower: 21" Lambda Tower**

**Figure: 1**  
**Date: 4/18/2007**  
**Reference: wbcg1m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.688	2.60	4.15	Vertical	180°	0.989	5.38	7.31	Vertical
5°	0.726	2.90	4.62	Vertical	185°	0.975	5.23	7.19	Vertical
10°	0.766	3.22	5.08	Vertical	190°	0.956	5.02	7.01	Vertical
15°	0.793	3.46	5.39	Vertical	195°	0.930	4.76	6.77	Vertical
20°	0.815	3.65	5.63	Vertical	200°	0.898	4.44	6.47	Vertical
25°	0.831	3.80	5.80	Vertical	205°	0.861	4.08	6.10	Vertical
30°	0.841	3.89	5.90	Vertical	210°	0.818	3.68	5.66	Vertical
35°	0.846	3.94	5.95	Vertical	215°	0.769	3.25	5.12	Vertical
40°	0.845	3.93	5.94	Vertical	220°	0.734	2.96	4.71	Horizontal
45°	0.840	3.88	5.89	Vertical	225°	0.705	2.73	4.36	Horizontal
50°	0.833	3.81	5.81	Vertical	230°	0.669	2.46	3.91	Horizontal
55°	0.844	3.92	5.93	Horizontal	235°	0.626	2.16	3.34	Horizontal
60°	0.885	4.31	6.35	Horizontal	240°	0.577	1.83	2.63	Horizontal
65°	0.921	4.67	6.69	Horizontal	245°	0.522	1.50	1.76	Horizontal
70°	0.952	4.98	6.97	Horizontal	250°	0.468	1.20	0.81	Horizontal
75°	0.974	5.21	7.17	Horizontal	255°	0.419	0.97	-0.15	Horizontal
80°	0.988	5.37	7.30	Horizontal	260°	0.383	0.81	-0.93	Vertical
85°	0.997	5.46	7.38	Horizontal	265°	0.362	0.72	-1.43	Vertical
90°	1.000	5.50	7.40	Horizontal	270°	0.343	0.65	-1.90	Vertical
95°	1.000	5.50	7.40	Horizontal	275°	0.326	0.58	-2.33	Vertical
100°	0.998	5.48	7.39	Horizontal	280°	0.312	0.53	-2.72	Vertical
105°	0.994	5.44	7.36	Horizontal	285°	0.300	0.50	-3.04	Vertical
110°	0.989	5.38	7.31	Horizontal	290°	0.291	0.47	-3.31	Vertical
115°	0.985	5.33	7.27	Horizontal	295°	0.285	0.45	-3.51	Vertical
120°	0.982	5.30	7.24	Horizontal	300°	0.281	0.43	-3.63	Vertical
125°	0.980	5.28	7.23	Horizontal	305°	0.279	0.43	-3.68	Vertical
130°	0.978	5.26	7.21	Horizontal	310°	0.285	0.45	-3.50	Vertical
135°	0.973	5.21	7.17	Horizontal	315°	0.301	0.50	-3.03	Vertical
140°	0.965	5.12	7.09	Horizontal	320°	0.326	0.59	-2.32	Vertical
145°	0.954	5.00	6.99	Horizontal	325°	0.362	0.72	-1.43	Vertical
150°	0.964	5.11	7.09	Vertical	330°	0.407	0.91	-0.41	Vertical
155°	0.979	5.27	7.22	Vertical	335°	0.447	1.10	0.41	Vertical
160°	0.990	5.39	7.31	Vertical	340°	0.491	1.33	1.22	Vertical
165°	0.997	5.46	7.38	Vertical	345°	0.539	1.60	2.03	Vertical
170°	1.000	5.50	7.40	Vertical	350°	0.592	1.92	2.84	Vertical
175°	0.998	5.47	7.38	Vertical	355°	0.638	2.24	3.50	Vertical

**Polarization:**  
**Maximum Field:**  
**Minimum Field:**  
**RMS:**  
**Maximum ERP:**  
**Maximum Power Gain:**

**Envelope**  
**1.000 @ 92° True**  
**0.279 @ 305° True**  
**0.774**  
**5.500 kW**  
**2.345 (3.702 dB)**

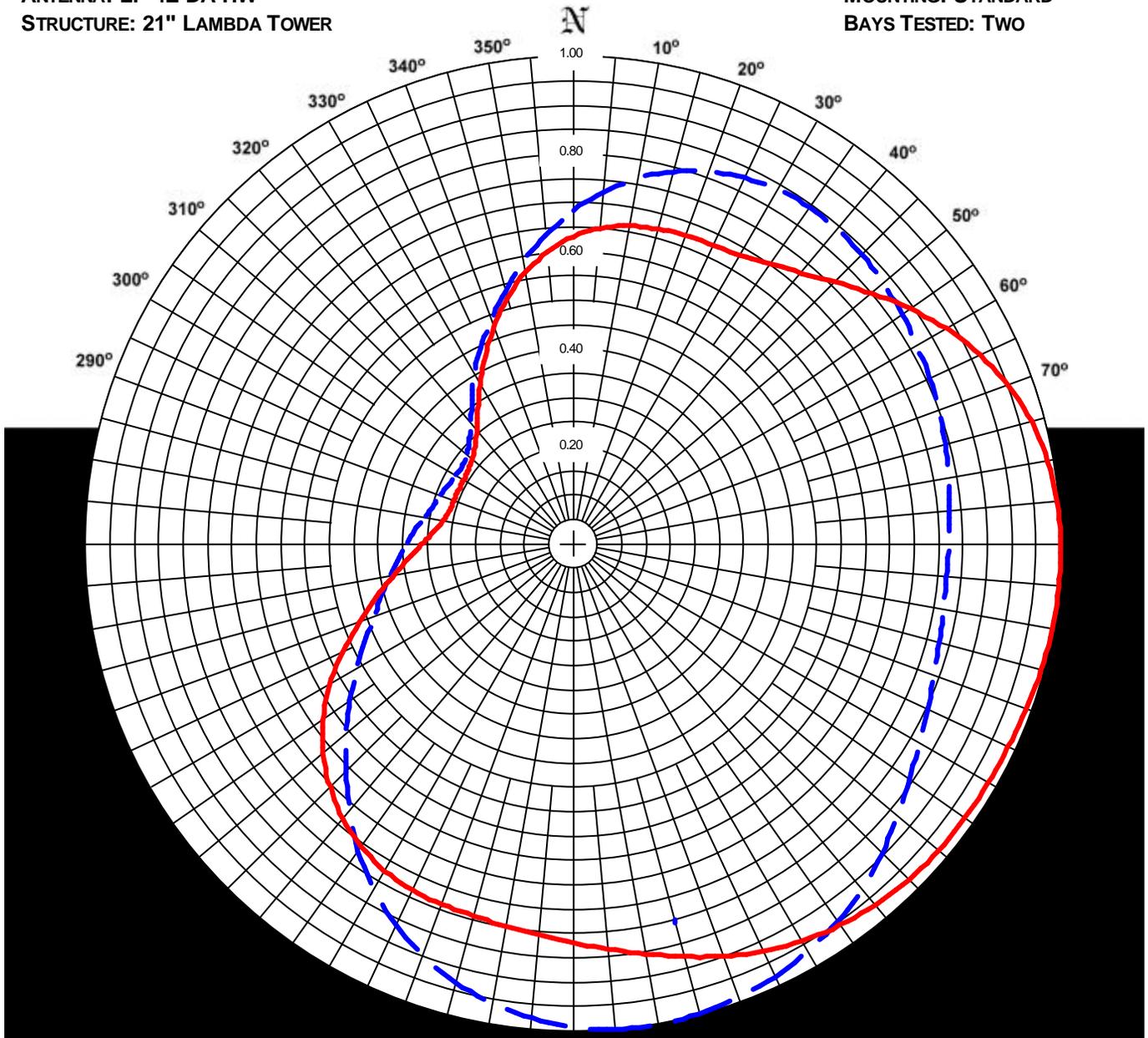
**Total Input Power: 2.345 kW**

# 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 <http://www.eriinc.com/>

FIGURE NO: 2  
STATION: WBCG  
LOCATION: MURDOCK, FL  
ANTENNA: LP-4E-DA-HW  
STRUCTURE: 21" LAMBDA TOWER

DATE: 4/18/2007  
FREQUENCY: 98.9 MHz  
ORIENTATION: 104° TRUE  
MOUNTING: STANDARD  
BAYS TESTED: TWO



VERTICAL

RMS: 0.725  
MAXIMUM: 1.000 @ 171° TRUE  
MINIMUM: 0.279 @ 305° TRUE

Horizontal

RMS: 0.731  
Maximum: 1.000 @ 92° True  
Minimum: 0.260 @ 298° True

COMMENTS: MEASURED PATTERN 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: WBCG**  
**Location: Murdock, FL**  
**Frequency: 98.9 MHz**

**Antenna: LP-4E-DA-HW**  
**Orientation: 104° True**  
**Tower: 21" Lambda Tower**

**Figure: 2**  
**Date: 4/18/2007**  
**Reference: wbcg1m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.633	2.20	3.43	0.688	2.60	4.15	180°	0.817	3.67	5.65	0.989	5.38	7.31
5°	0.652	2.34	3.69	0.726	2.90	4.62	185°	0.804	3.56	5.51	0.975	5.23	7.19
10°	0.665	2.43	3.86	0.766	3.22	5.08	190°	0.795	3.47	5.41	0.956	5.02	7.01
15°	0.672	2.48	3.94	0.793	3.46	5.39	195°	0.789	3.42	5.34	0.930	4.76	6.77
20°	0.675	2.51	3.99	0.815	3.65	5.63	200°	0.786	3.39	5.31	0.898	4.44	6.47
25°	0.679	2.54	4.04	0.831	3.80	5.80	205°	0.782	3.36	5.26	0.861	4.08	6.10
30°	0.687	2.59	4.14	0.841	3.89	5.90	210°	0.772	3.28	5.16	0.818	3.68	5.66
35°	0.704	2.72	4.35	0.846	3.94	5.95	215°	0.756	3.15	4.98	0.769	3.25	5.12
40°	0.729	2.92	4.66	0.845	3.93	5.94	220°	0.734	2.96	4.71	0.714	2.80	4.47
45°	0.763	3.20	5.05	0.840	3.88	5.89	225°	0.705	2.73	4.36	0.659	2.39	3.78
50°	0.802	3.54	5.49	0.833	3.81	5.81	230°	0.669	2.46	3.91	0.608	2.03	3.08
55°	0.844	3.92	5.93	0.824	3.74	5.72	235°	0.626	2.16	3.34	0.558	1.72	2.34
60°	0.885	4.31	6.35	0.816	3.66	5.63	240°	0.577	1.83	2.63	0.513	1.45	1.60
65°	0.921	4.67	6.69	0.807	3.58	5.54	245°	0.522	1.50	1.76	0.472	1.22	0.88
70°	0.952	4.98	6.97	0.799	3.51	5.45	250°	0.468	1.20	0.81	0.434	1.04	0.15
75°	0.974	5.21	7.17	0.790	3.43	5.36	255°	0.419	0.97	-0.15	0.407	0.91	-0.40
80°	0.988	5.37	7.30	0.782	3.36	5.26	260°	0.377	0.78	-1.08	0.383	0.81	-0.93
85°	0.997	5.46	7.38	0.775	3.30	5.19	265°	0.341	0.64	-1.95	0.362	0.72	-1.43
90°	1.000	5.50	7.40	0.771	3.27	5.14	270°	0.312	0.53	-2.73	0.343	0.65	-1.90
95°	1.000	5.50	7.40	0.769	3.25	5.12	275°	0.289	0.46	-3.38	0.326	0.58	-2.33
100°	0.998	5.48	7.39	0.771	3.27	5.15	280°	0.273	0.41	-3.87	0.312	0.53	-2.72
105°	0.994	5.44	7.36	0.778	3.33	5.22	285°	0.264	0.38	-4.17	0.300	0.50	-3.04
110°	0.989	5.38	7.31	0.788	3.41	5.33	290°	0.261	0.37	-4.28	0.291	0.47	-3.31
115°	0.985	5.33	7.27	0.802	3.54	5.49	295°	0.261	0.37	-4.27	0.285	0.45	-3.51
120°	0.982	5.30	7.24	0.820	3.70	5.68	300°	0.261	0.37	-4.28	0.281	0.43	-3.63
125°	0.980	5.28	7.23	0.842	3.90	5.91	305°	0.264	0.38	-4.18	0.279	0.43	-3.68
130°	0.978	5.26	7.21	0.867	4.14	6.17	310°	0.271	0.40	-3.95	0.285	0.45	-3.50
135°	0.973	5.21	7.17	0.896	4.42	6.45	315°	0.285	0.45	-3.50	0.301	0.50	-3.03
140°	0.965	5.12	7.09	0.923	4.68	6.71	320°	0.307	0.52	-2.84	0.326	0.59	-2.32
145°	0.954	5.00	6.99	0.945	4.91	6.92	325°	0.340	0.64	-1.96	0.362	0.72	-1.43
150°	0.939	4.85	6.85	0.964	5.11	7.09	330°	0.381	0.80	-0.98	0.407	0.91	-0.41
155°	0.921	4.66	6.68	0.979	5.27	7.22	335°	0.427	1.00	0.02	0.447	1.10	0.41
160°	0.899	4.45	6.48	0.990	5.39	7.31	340°	0.476	1.24	0.95	0.491	1.33	1.22
165°	0.875	4.21	6.25	0.997	5.46	7.38	345°	0.523	1.50	1.77	0.539	1.60	2.03
170°	0.853	4.00	6.02	1.000	5.50	7.40	350°	0.567	1.77	2.48	0.592	1.92	2.84
175°	0.833	3.82	5.82	0.998	5.47	7.38	355°	0.604	2.00	3.02	0.638	2.24	3.50

<b>Polarization:</b>	<b>Horizontal</b>	<b>Vertical</b>
<b>Maximum Field:</b>	<b>1.000 @ 92° True</b>	<b>1.000 @ 171° True</b>
<b>Minimum Field:</b>	<b>0.260 @ 298° True</b>	<b>0.279 @ 305° True</b>
<b>RMS:</b>	<b>0.731</b>	<b>0.725</b>
<b>Maximum ERP:</b>	<b>5.500 kW</b>	<b>5.500 kW</b>
<b>Maximum Power Gain:</b>	<b>2.345 (3.702 dB)</b>	<b>2.345 (3.702 dB)</b>

**Total Input Power: 2.345 kW**



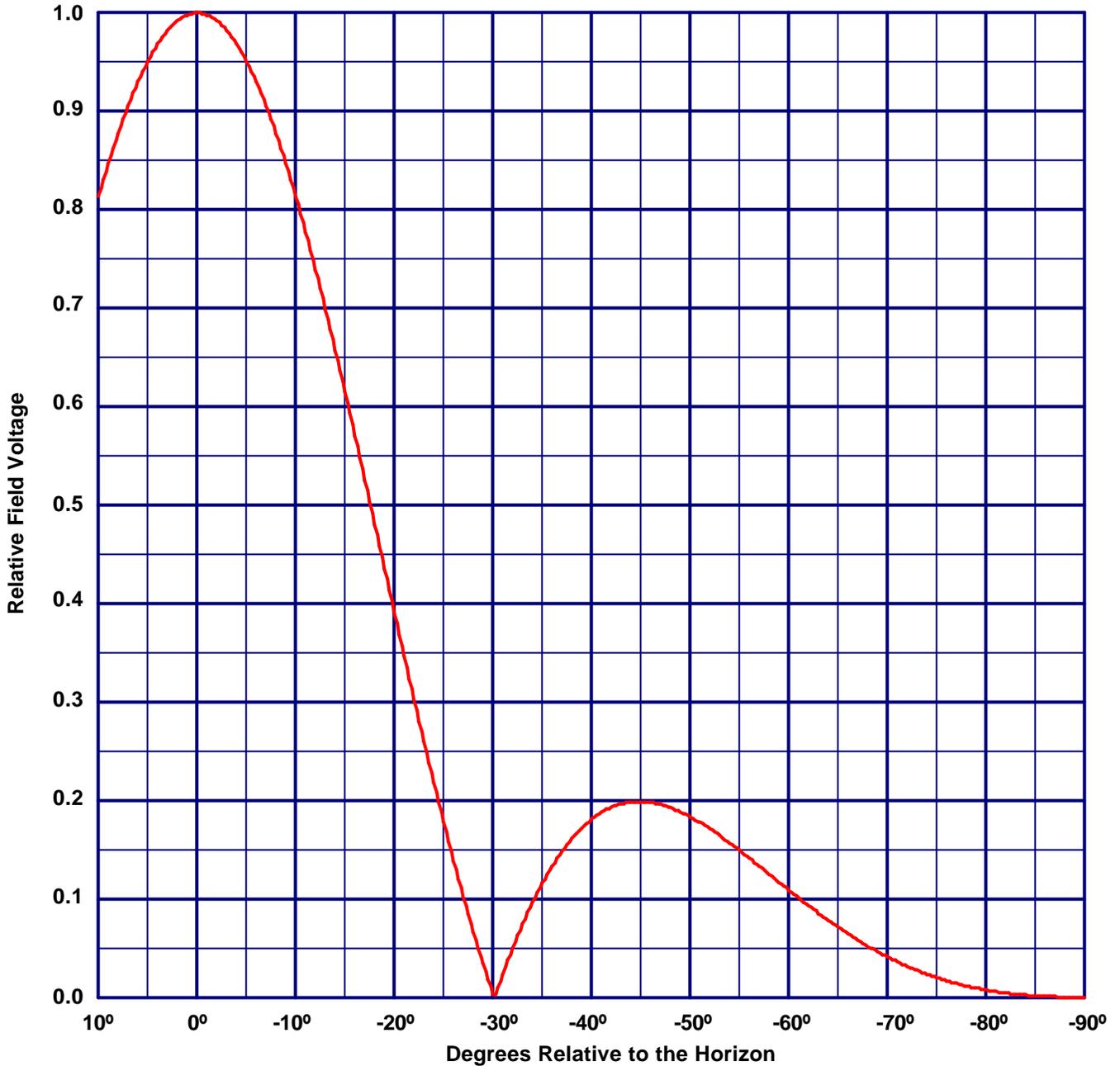
# Vertical Plane Relative Field Pattern

WBCG, Murdock, FL, 98.9 MHz

Figure#: 3

Date: 4/18/2007

A 4 level, .5 wave-length spaced LP-4E-DA-HW directional antenna with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.000



<b>Vertical Polarization Gain:</b>
Maximum: 2.345 (3.702 dB)
Horizontal Plane: 2.345 (3.702 dB)

<b>Horizontal Polarization Gain:</b>
Maximum: 2.345 (3.702 dB)
Horizontal Plane: 2.345 (3.702 dB)

# Directional Antenna System for WBCG, Murdock, Florida

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type: LP-4E-DA-HW  
Frequency: 98.9 MHZ  
Number of Bays: four

## MECHANICAL SPECIFICATIONS

Mounting: Standard  
System length: 23 ft 6 in  
Aperture length required: 30 ft.  
Orientation: 104° true  
Input flange to the antenna 1 5/8" female.

## ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP: 5.5 kW (7.404 dBk)  
Horizontal maximum power gain: 2.345 (3.702 dB)  
Maximum vertical ERP: 5.5 kW (7.404 dBk)  
Vertical maximum power gain: 2.345 (3.702 dB)  
Total input power: 2.345 kW (3.701 dBk)

