

Directional Antenna System for WWBB, Providence, Rhode Island

August 7, 2015

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 WWBB.

The antenna is the ERI model LP-2E-DA-HW configuration. The circular polarized system consists of two half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and two vertical parasitic elements interleaved between the bays. The antenna was tested on a 11"o.d. pole, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 101.5 megahertz, which is the center of the FM broadcast channel assigned to WWBB.

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 WWBB, Providence, Rhode Island

(Continued)

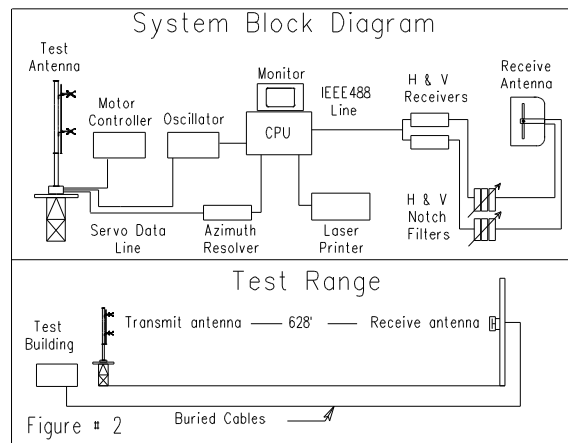
DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of a full-scale model of the complete 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 steel 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 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 101.5 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.



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(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 Heliax 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 two half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and two vertical parasitic elements interleaved between the bays. 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-2E-DA-HW array is to be mounted on the 11" o.d. pole at a bearing of North 211 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 6 kilowatts (7.782 dBk).

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(Continued)

The power at North 0-50 degrees East does not exceed 0.32 kilowatts (-4.949 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 19 feet 10 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, appearing to read "Tom Scharf". The signature is fluid and cursive, with a large initial "T" and a stylized "S".

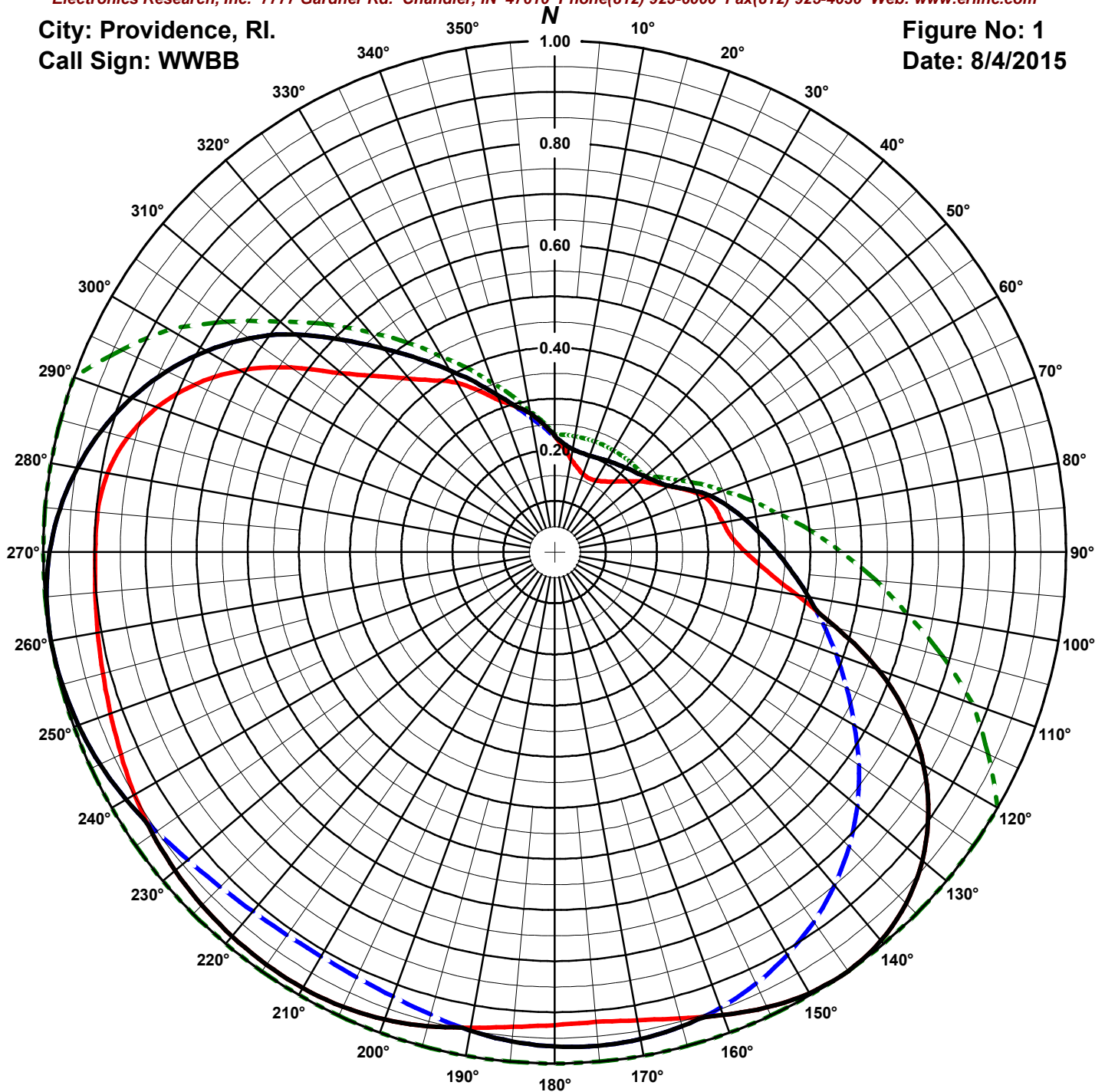
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ERI[®] Horizontal Plane Relative Field Pattern

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

City: Providence, RI.
Call Sign: WWBB

Figure No: 1
Date: 8/4/2015



Antenna Orientation: 211° True

Frequency: 101.5 MHz

Antenna Type: LP-2E-DA-HW

Antenna Mounting: Standard

Tower Type: 11" Pole

HORIZONTAL

RMS: .715

Maximum: 1 @ 146°

Minimum: .159 @ 25°

VERTICAL

RMS: .713

Maximum: 1 @ 261°

Minimum: .2 @ 18°

COMPOSITE

RMS: .741

Maximum: 1 @ 146°

Minimum: .2 @ 18°

FCC ENVELOPE

RMS: .785

Maximum: 1 @ 120°

Minimum: .23 @ 0°

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 BPH-20150213ACG.

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: 8/4/2015

Station: WWBB

Antenna: LP-2E-DA-HW

Location: Providence, RI.

Antenna Orientation: 211° True

Frequency: 101.5 MHz

Number of Bays: 2

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.227	0.310	-5.085	Horizontal	180°	0.967	5.607	7.488	Vertical
5°	0.213	0.271	-5.670	Vertical	185°	0.960	5.535	7.431	Vertical
10°	0.204	0.250	-6.018	Vertical	190°	0.950	5.418	7.339	Vertical
15°	0.201	0.243	-6.153	Vertical	195°	0.960	5.527	7.425	Horizontal
20°	0.201	0.241	-6.173	Vertical	200°	0.973	5.675	7.540	Horizontal
25°	0.203	0.247	-6.073	Vertical	205°	0.981	5.772	7.613	Horizontal
30°	0.206	0.255	-5.934	Vertical	210°	0.984	5.815	7.646	Horizontal
35°	0.210	0.266	-5.756	Vertical	215°	0.984	5.807	7.640	Horizontal
40°	0.215	0.278	-5.554	Vertical	220°	0.981	5.773	7.614	Horizontal
45°	0.222	0.295	-5.296	Vertical	225°	0.976	5.715	7.570	Horizontal
50°	0.230	0.317	-4.988	Vertical	230°	0.969	5.633	7.507	Horizontal
55°	0.242	0.351	-4.548	Vertical	235°	0.960	5.527	7.425	Horizontal
60°	0.259	0.401	-3.964	Vertical	240°	0.968	5.618	7.496	Vertical
65°	0.289	0.501	-3.002	Vertical	245°	0.981	5.774	7.615	Vertical
70°	0.323	0.625	-2.040	Vertical	250°	0.991	5.890	7.701	Vertical
75°	0.350	0.734	-1.344	Vertical	255°	0.997	5.965	7.756	Vertical
80°	0.376	0.850	-0.707	Vertical	260°	1.000	5.998	7.780	Vertical
85°	0.404	0.981	-0.085	Vertical	265°	0.997	5.964	7.755	Vertical
90°	0.435	1.133	0.542	Vertical	270°	0.987	5.850	7.671	Vertical
95°	0.468	1.313	1.181	Vertical	275°	0.971	5.656	7.525	Vertical
100°	0.504	1.524	1.829	Vertical	280°	0.948	5.388	7.314	Vertical
105°	0.570	1.950	2.901	Horizontal	285°	0.918	5.051	7.034	Vertical
110°	0.674	2.722	4.349	Horizontal	290°	0.881	4.652	6.676	Vertical
115°	0.761	3.474	5.408	Horizontal	295°	0.837	4.200	6.233	Vertical
120°	0.833	4.164	6.195	Horizontal	300°	0.786	3.707	5.690	Vertical
125°	0.892	4.775	6.790	Horizontal	305°	0.728	3.184	5.030	Vertical
130°	0.938	5.283	7.229	Horizontal	310°	0.662	2.628	4.196	Vertical
135°	0.972	5.665	7.532	Horizontal	315°	0.587	2.069	3.157	Vertical
140°	0.992	5.907	7.714	Horizontal	320°	0.519	1.616	2.085	Vertical
145°	1.000	5.999	7.781	Horizontal	325°	0.461	1.276	1.058	Vertical
150°	0.996	5.950	7.745	Horizontal	330°	0.411	1.011	0.049	Vertical
155°	0.982	5.790	7.627	Horizontal	335°	0.366	0.805	-0.943	Vertical
160°	0.963	5.567	7.456	Horizontal	340°	0.327	0.643	-1.915	Vertical
165°	0.960	5.531	7.428	Vertical	345°	0.295	0.523	-2.817	Horizontal
170°	0.967	5.611	7.490	Vertical	350°	0.276	0.456	-3.412	Horizontal
175°	0.969	5.635	7.509	Vertical	355°	0.252	0.380	-4.206	Horizontal

Horizontal Polarization:

Maximum: 1.309 (1.170 dB)

Horizontal Plane: 1.309 (1.170 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 1.309 (1.170 dB)

Horizontal Plane: 1.309 (1.170 dB)

Maximum ERP: 6.000 kW

Total Input Power: 4.583 kW

Reference: WWBB1M.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# 1A

Date: 8/4/2015

Station: WWBB

Antenna: LP-2E-DA-HW

Location: Providence, RI.

Antenna Orientation: 211° True

Frequency: 101.5 MHz

Number of Bays: 2

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.227	0.310	-5.085	0.226	0.307	-5.132	180°	0.925	5.132	7.103	0.967	5.607	7.488
5°	0.204	0.249	-6.031	0.213	0.271	-5.670	185°	0.932	5.213	7.171	0.960	5.535	7.431
10°	0.185	0.205	-6.888	0.204	0.250	-6.018	190°	0.944	5.347	7.281	0.950	5.418	7.339
15°	0.171	0.175	-7.567	0.201	0.243	-6.153	195°	0.960	5.527	7.425	0.937	5.263	7.212
20°	0.162	0.158	-8.012	0.201	0.241	-6.173	200°	0.973	5.675	7.540	0.925	5.132	7.103
25°	0.159	0.152	-8.178	0.203	0.247	-6.073	205°	0.981	5.772	7.613	0.917	5.045	7.029
30°	0.162	0.157	-8.049	0.206	0.255	-5.934	210°	0.984	5.815	7.646	0.913	5.002	6.992
35°	0.169	0.171	-7.681	0.210	0.266	-5.756	215°	0.984	5.807	7.640	0.913	5.006	6.995
40°	0.180	0.194	-7.113	0.215	0.278	-5.554	220°	0.981	5.773	7.614	0.918	5.052	7.035
45°	0.196	0.230	-6.384	0.222	0.295	-5.296	225°	0.976	5.715	7.570	0.925	5.137	7.107
50°	0.215	0.278	-5.561	0.230	0.317	-4.988	230°	0.969	5.633	7.507	0.937	5.262	7.212
55°	0.236	0.333	-4.773	0.242	0.351	-4.548	235°	0.960	5.527	7.425	0.951	5.429	7.347
60°	0.258	0.401	-3.970	0.259	0.401	-3.964	240°	0.949	5.400	7.324	0.968	5.618	7.496
65°	0.286	0.492	-3.079	0.289	0.501	-3.002	245°	0.936	5.254	7.205	0.981	5.774	7.615
70°	0.313	0.589	-2.297	0.323	0.625	-2.040	250°	0.924	5.124	7.096	0.991	5.890	7.701
75°	0.325	0.635	-1.970	0.350	0.734	-1.344	255°	0.915	5.019	7.006	0.997	5.965	7.756
80°	0.334	0.669	-1.748	0.376	0.850	-0.707	260°	0.907	4.938	6.935	1.000	5.998	7.780
85°	0.347	0.724	-1.404	0.404	0.981	-0.085	265°	0.902	4.879	6.884	0.997	5.964	7.755
90°	0.373	0.835	-0.783	0.435	1.133	0.542	270°	0.898	4.844	6.852	0.987	5.850	7.671
95°	0.416	1.039	0.164	0.468	1.313	1.181	275°	0.897	4.830	6.840	0.971	5.656	7.525
100°	0.480	1.383	1.408	0.504	1.524	1.829	280°	0.888	4.728	6.747	0.948	5.388	7.314
105°	0.570	1.950	2.901	0.543	1.772	2.484	285°	0.865	4.486	6.518	0.918	5.051	7.034
110°	0.674	2.722	4.349	0.586	2.060	3.138	290°	0.827	4.107	6.135	0.881	4.652	6.676
115°	0.761	3.474	5.408	0.630	2.384	3.773	295°	0.776	3.610	5.576	0.837	4.200	6.233
120°	0.833	4.164	6.195	0.677	2.747	4.389	300°	0.710	3.022	4.803	0.786	3.707	5.690
125°	0.892	4.775	6.790	0.726	3.164	5.003	305°	0.629	2.377	3.760	0.728	3.184	5.030
130°	0.938	5.283	7.229	0.773	3.582	5.541	310°	0.545	1.780	2.503	0.662	2.628	4.196
135°	0.972	5.665	7.532	0.814	3.979	5.997	315°	0.487	1.422	1.529	0.587	2.069	3.157
140°	0.992	5.907	7.714	0.851	4.345	6.380	320°	0.443	1.177	0.706	0.519	1.616	2.085
145°	1.000	5.999	7.781	0.883	4.675	6.698	325°	0.410	1.007	0.029	0.461	1.276	1.058
150°	0.996	5.950	7.745	0.910	4.963	6.958	330°	0.382	0.876	-0.574	0.411	1.011	0.049
155°	0.982	5.790	7.627	0.931	5.204	7.164	335°	0.348	0.725	-1.397	0.366	0.805	-0.943
160°	0.963	5.567	7.456	0.948	5.395	7.320	340°	0.316	0.600	-2.220	0.327	0.643	-1.915
165°	0.944	5.348	7.282	0.960	5.531	7.428	345°	0.295	0.523	-2.817	0.295	0.521	-2.832
170°	0.930	5.186	7.148	0.967	5.611	7.490	350°	0.276	0.456	-3.412	0.267	0.426	-3.702
175°	0.922	5.101	7.077	0.969	5.635	7.509	355°	0.252	0.380	-4.206	0.244	0.359	-4.455

Horizontal Polarization:

Maximum: 1.309 (1.170 dB)

Horizontal Plane: 1.309 (1.170 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 1.309 (1.170 dB)

Horizontal Plane: 1.309 (1.170 dB)

Maximum ERP: 6.000 kW

Total Input Power: 4.583 kW

Reference: WWBB1M.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: WWBB

Location: Providence, RI.

Frequency: 101.5 MHz

2 bay LP-2E-DA-HW antenna

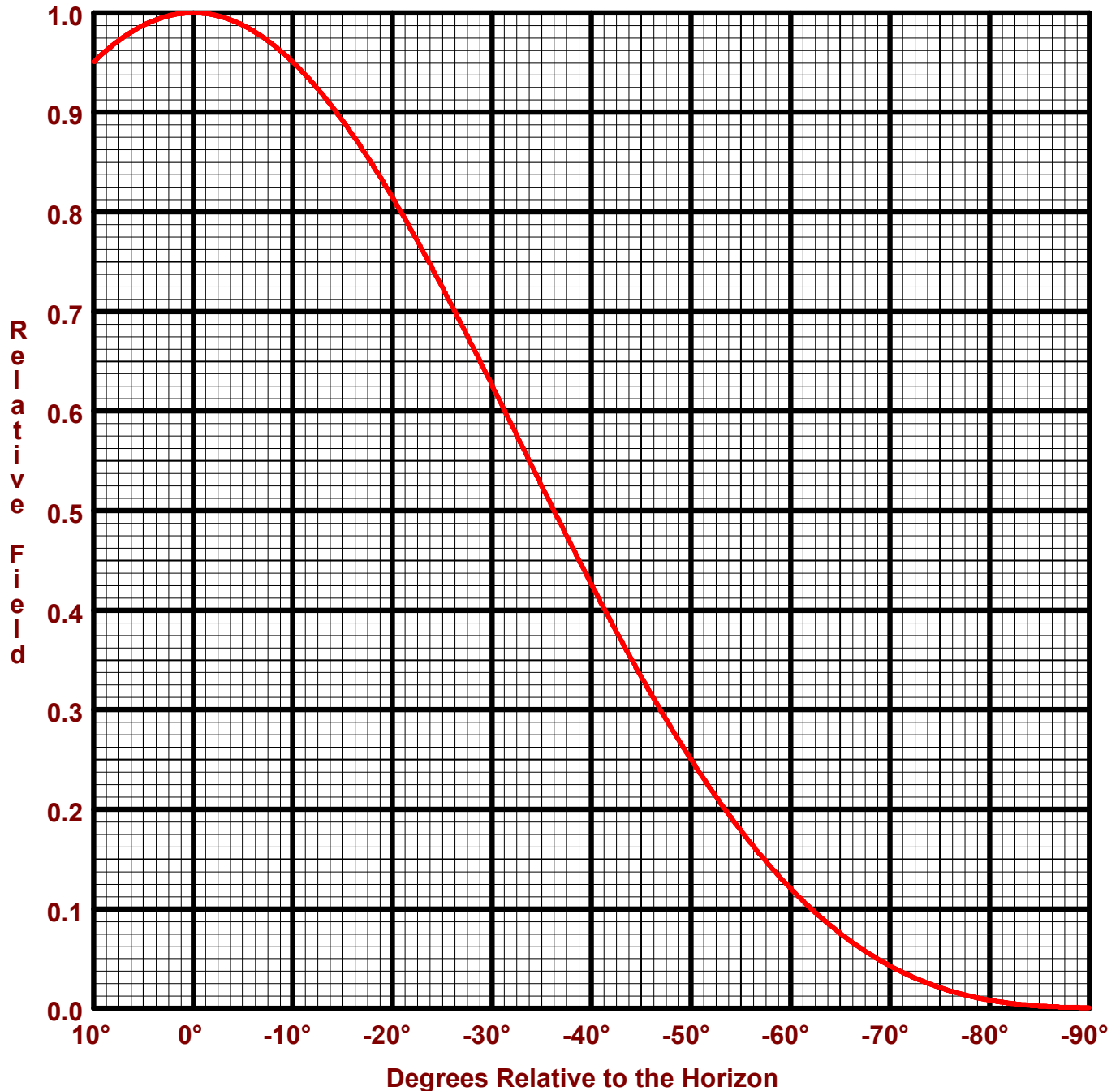
Date: 8/4/2015

H/V Power Ratio: 1

.5 Wave-length Spacing

0° Beam Tilt

0% First Null Fill



Horizontal Polarization:

Maximum: 1.309 (1.170 dB)

Horizontal Plane: 1.309 (1.170 dB)

Maximum ERP: 6.000 kW

Vertical Polarization:

Maximum: 1.309 (1.170 dB)

Horizontal Plane: 1.309 (1.170 dB)

Maximum ERP: 6.000 kW

Directional Antenna System for WWBB, Providence, Rhode Island

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type: LP-2E-DA-HW
Frequency: 101.5 MHz
Number of Bays: Two

MECHANICAL SPECIFICATIONS

Mounting: Standard
System length: 13 ft 4 in
Aperture length required: 19 ft 10 in
Orientation: 211° true
Input flange to the antenna 1 5/8" female.

ELECTRICAL SPECIFICATIONS (For directional use)

Maximum horizontal ERP: 6.000 kW (7.782 dBk)
Horizontal maximum power gain: 1.309 (1.170 dB)
Maximum vertical ERP: 6.000 kW (7.782 dBk)
Vertical maximum power gain: 1.309 (1.170 dB)
Total input power: 4.583 kW (6.612 dBk)

