ELECTRONICS RESEARCH, INC. ERI®

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

Directional Antenna System for WMNI, Worthington, Ohio

June 28, 2013

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 WMNI.

The antenna is the ERI model LP-2E-DA configuration. The circular polarized system consists of 2 full-wavelength spaced bays using one driven circular polarized radiating element, one 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 80 degrees East tower face with bracketry to provide an antenna orientation of North 80 degrees East. The antenna was tested on a 24" lambda tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 103.9 megahertz, which is the center of the FM broadcast channel assigned to WMNI.

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
WMNI, Worthington, Ohio

(Continued)

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" ERI®λ ***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.

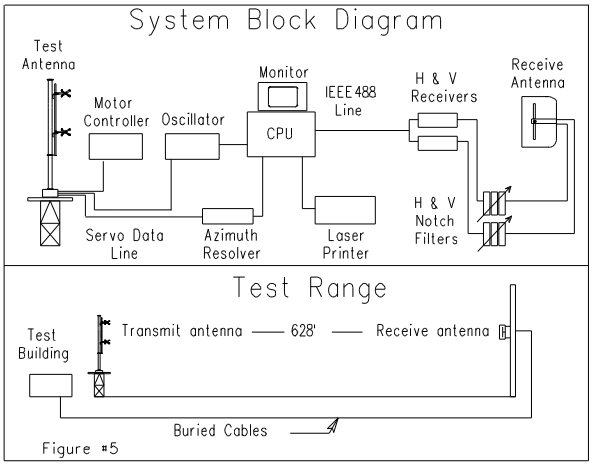

Figure #5

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 103.9 MHz and was constantly monitored by a Rohde & Schwarz ESVD measuring receiver.

(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 co-ordinated graph paper in a clockwise direction. Both horizontal and vertical components were recorded separately.

CONCLUSIONS

The circular polarized system consists of 2 full-wavelength spaced bays using one driven circular polarized radiating element, one 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 antenna is manufactured. Proper maintenance of the elements should be all that is required to maintain the pattern in adjustment.

The LP-2E-DA array is to be mounted on the North 80 degrees East tower face of the 24" ERI® λ ***MOUNTING SYSTEM***, tower at a bearing of North 80 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).

Directional Antenna System
For
WMNI, Worthington, Ohio

(Continued)

The power at North 250-260 degrees East does not exceed 1.2 kilowatts (0.792 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 that 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 24 feet 5 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.

ERI® Horizontal Plane Relative Field Pattern

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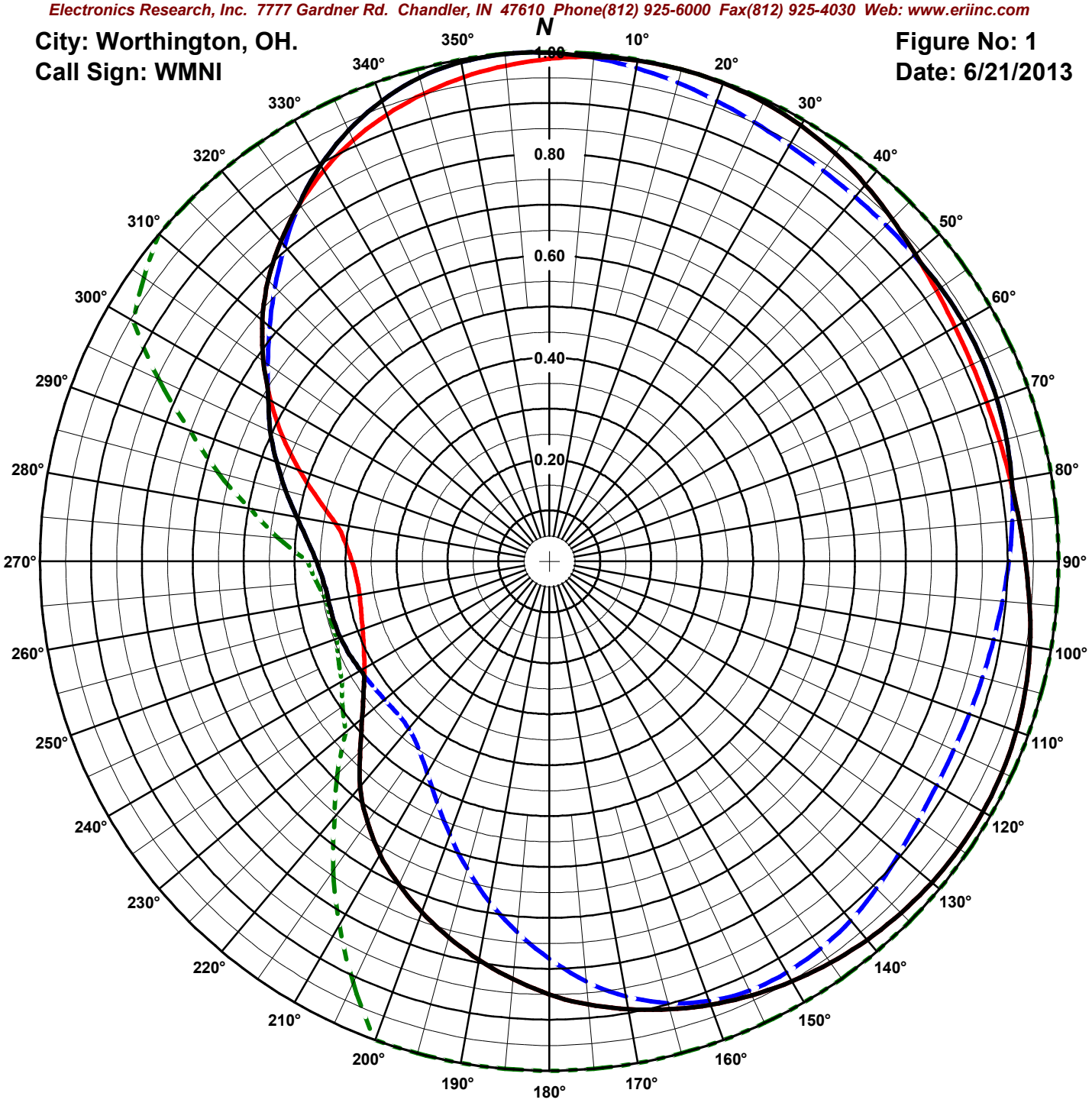
City: Worthington, OH.
Call Sign: WMNI

Figure No: 1
Date: 6/21/2013



Antenna Orientation: 80° True

Frequency: 103.9 MHz
Antenna Type: LP-2E-DA

Antenna Mounting: Standard
Tower Type: 24" Lambda

HORIZONTAL	VERTICAL	COMPOSITE	FCC ENVELOPE
RMS: .827	RMS: .8	RMS: .836	RMS: .913
Maximum: 1 @ 16°	Maximum: 1 @ 357°	Maximum: 1 @ 16°	Maximum: 1 @ 0°
Minimum: .378 @ 261°	Minimum: .422 @ 227°	Minimum: .427 @ 239°	Minimum: .444 @ 250°

Measured patterns of the horizontal and vertical components, with the composite maximum of either the the H or V components and the filed FCC envelope pattern BPH-20101004ACN.

ERI® Horizontal Plane Relative Field Pattern

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Figure# 1 **Date: 6/21/2013**
Station: WMNI **Antenna: LP-2E-DA**
Location: Worthington, OH. **Antenna Orientation: 80° True**
Frequency: 103.9 MHz **Number of Bays: 2**

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk	Maximum		Field	kW	dBk	Maximum
0°	0.999	5.983	7.769	Vertical	180°	0.850	4.338	6.373	Horizontal
5°	0.994	5.929	7.730	Horizontal	185°	0.823	4.066	6.091	Horizontal
10°	0.998	5.978	7.766	Horizontal	190°	0.795	3.790	5.786	Horizontal
15°	1.000	6.000	7.781	Horizontal	195°	0.764	3.500	5.440	Horizontal
20°	0.999	5.987	7.772	Horizontal	200°	0.732	3.218	5.075	Horizontal
25°	0.995	5.939	7.737	Horizontal	205°	0.699	2.935	4.676	Horizontal
30°	0.988	5.857	7.676	Horizontal	210°	0.665	2.651	4.233	Horizontal
35°	0.978	5.742	7.590	Horizontal	215°	0.623	2.328	3.670	Horizontal
40°	0.966	5.594	7.477	Horizontal	220°	0.578	2.005	3.022	Horizontal
45°	0.951	5.427	7.346	Horizontal	225°	0.525	1.654	2.186	Horizontal
50°	0.938	5.280	7.226	Horizontal	230°	0.480	1.380	1.399	Horizontal
55°	0.937	5.272	7.220	Vertical	235°	0.445	1.189	0.752	Horizontal
60°	0.939	5.288	7.233	Vertical	240°	0.428	1.099	0.411	Vertical
65°	0.938	5.276	7.223	Vertical	245°	0.433	1.123	0.506	Vertical
70°	0.934	5.240	7.193	Vertical	250°	0.437	1.144	0.583	Vertical
75°	0.929	5.181	7.144	Vertical	255°	0.439	1.156	0.630	Vertical
80°	0.922	5.100	7.076	Vertical	260°	0.440	1.163	0.655	Vertical
85°	0.926	5.144	7.113	Horizontal	265°	0.445	1.189	0.751	Vertical
90°	0.935	5.244	7.197	Horizontal	270°	0.457	1.254	0.983	Vertical
95°	0.946	5.373	7.302	Horizontal	275°	0.477	1.364	1.348	Vertical
100°	0.958	5.509	7.411	Horizontal	280°	0.504	1.523	1.826	Vertical
105°	0.968	5.624	7.501	Horizontal	285°	0.535	1.720	2.356	Vertical
110°	0.976	5.712	7.568	Horizontal	290°	0.569	1.946	2.890	Vertical
115°	0.981	5.771	7.612	Horizontal	295°	0.604	2.192	3.409	Vertical
120°	0.983	5.800	7.634	Horizontal	300°	0.637	2.436	3.866	Vertical
125°	0.983	5.798	7.633	Horizontal	305°	0.685	2.817	4.499	Horizontal
130°	0.981	5.772	7.613	Horizontal	310°	0.735	3.246	5.113	Horizontal
135°	0.977	5.722	7.575	Horizontal	315°	0.781	3.656	5.630	Horizontal
140°	0.970	5.649	7.520	Horizontal	320°	0.820	4.037	6.060	Horizontal
145°	0.962	5.555	7.447	Horizontal	325°	0.856	4.394	6.429	Vertical
150°	0.952	5.440	7.356	Horizontal	330°	0.898	4.838	6.847	Vertical
155°	0.940	5.304	7.246	Horizontal	335°	0.933	5.224	7.180	Vertical
160°	0.926	5.148	7.117	Horizontal	340°	0.962	5.552	7.444	Vertical
165°	0.910	4.974	6.967	Horizontal	345°	0.983	5.800	7.635	Vertical
170°	0.893	4.782	6.796	Horizontal	350°	0.995	5.944	7.741	Vertical
175°	0.873	4.573	6.602	Horizontal	355°	0.999	5.993	7.777	Vertical

Horizontal Polarization:
Maximum: 1.431 (1.556 dB)
Horizontal Plane: 1.431 (1.556 dB)
Maximum ERP: 6.000 kW

Vertical Polarization:
Maximum: 1.431 (1.556 dB)
Horizontal Plane: 1.431 (1.556 dB)
Maximum ERP: 6.000 kW

Total Input Power: 4.193 kW
Reference: WMNI1M.FIG
This list shows the the maximum azimuth values of either the horizontal or vertical components.

ERI® Horizontal Plane Relative Field Pattern

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Figure# 1A **Date: 6/21/2013**
Station: WMNI **Antenna: LP-2E-DA**
Location: Worthington, OH. **Antenna Orientation: 80° True**
Frequency: 103.9 MHz **Number of Bays: 2**

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.987	5.843	7.666	0.999	5.983	7.769	180°	0.850	4.338	6.373	0.780	3.650	5.623
5°	0.994	5.929	7.730	0.992	5.910	7.716	185°	0.823	4.066	6.091	0.730	3.201	5.053
10°	0.998	5.978	7.766	0.983	5.803	7.637	190°	0.795	3.790	5.786	0.678	2.761	4.411
15°	1.000	6.000	7.781	0.973	5.682	7.545	195°	0.764	3.500	5.440	0.624	2.339	3.690
20°	0.999	5.987	7.772	0.962	5.552	7.444	200°	0.732	3.218	5.075	0.571	1.955	2.912
25°	0.995	5.939	7.737	0.951	5.431	7.349	205°	0.699	2.935	4.676	0.522	1.632	2.127
30°	0.988	5.857	7.676	0.943	5.332	7.269	210°	0.665	2.651	4.233	0.480	1.380	1.398
35°	0.978	5.742	7.590	0.937	5.267	7.216	215°	0.623	2.328	3.670	0.448	1.205	0.809
40°	0.966	5.594	7.477	0.934	5.237	7.191	220°	0.578	2.005	3.022	0.429	1.105	0.435
45°	0.951	5.427	7.346	0.934	5.233	7.187	225°	0.525	1.654	2.186	0.422	1.071	0.296
50°	0.938	5.280	7.226	0.935	5.247	7.199	230°	0.480	1.380	1.399	0.422	1.070	0.295
55°	0.928	5.164	7.130	0.937	5.272	7.220	235°	0.445	1.189	0.752	0.424	1.081	0.337
60°	0.920	5.081	7.060	0.939	5.288	7.233	240°	0.419	1.052	0.220	0.428	1.099	0.411
65°	0.916	5.031	7.016	0.938	5.276	7.223	245°	0.402	0.969	-0.138	0.433	1.123	0.506
70°	0.914	5.013	7.001	0.934	5.240	7.193	250°	0.390	0.913	-0.395	0.437	1.144	0.583
75°	0.915	5.028	7.014	0.929	5.181	7.144	255°	0.382	0.877	-0.568	0.439	1.156	0.630
80°	0.919	5.072	7.052	0.922	5.100	7.076	260°	0.379	0.860	-0.656	0.440	1.163	0.655
85°	0.926	5.144	7.113	0.913	4.998	6.988	265°	0.380	0.866	-0.625	0.445	1.189	0.751
90°	0.935	5.244	7.197	0.902	4.884	6.888	270°	0.387	0.901	-0.453	0.457	1.254	0.983
95°	0.946	5.373	7.302	0.893	4.785	6.799	275°	0.401	0.967	-0.147	0.477	1.364	1.348
100°	0.958	5.509	7.411	0.886	4.707	6.728	280°	0.426	1.087	0.361	0.504	1.523	1.826
105°	0.968	5.624	7.501	0.881	4.652	6.676	285°	0.469	1.322	1.213	0.535	1.720	2.356
110°	0.976	5.712	7.568	0.877	4.618	6.644	290°	0.522	1.634	2.132	0.569	1.946	2.890
115°	0.981	5.771	7.612	0.876	4.607	6.634	295°	0.577	1.998	3.006	0.604	2.192	3.409
120°	0.983	5.800	7.634	0.879	4.632	6.657	300°	0.632	2.398	3.798	0.637	2.436	3.866
125°	0.983	5.798	7.633	0.885	4.699	6.720	305°	0.685	2.817	4.499	0.675	2.733	4.366
130°	0.981	5.772	7.613	0.895	4.808	6.820	310°	0.735	3.246	5.113	0.716	3.078	4.883
135°	0.977	5.722	7.575	0.909	4.953	6.949	315°	0.781	3.656	5.630	0.762	3.482	5.418
140°	0.970	5.649	7.520	0.920	5.081	7.060	320°	0.820	4.037	6.060	0.809	3.923	5.936
145°	0.962	5.555	7.447	0.928	5.168	7.134	325°	0.855	4.390	6.424	0.856	4.394	6.429
150°	0.952	5.440	7.356	0.932	5.213	7.170	330°	0.886	4.708	6.729	0.898	4.838	6.847
155°	0.940	5.304	7.246	0.930	5.188	7.150	335°	0.912	4.988	6.980	0.933	5.224	7.180
160°	0.926	5.148	7.117	0.918	5.062	7.043	340°	0.933	5.223	7.179	0.962	5.552	7.444
165°	0.910	4.974	6.967	0.898	4.835	6.844	345°	0.951	5.424	7.343	0.983	5.800	7.635
170°	0.893	4.782	6.796	0.867	4.515	6.547	350°	0.965	5.593	7.476	0.995	5.944	7.741
175°	0.873	4.573	6.602	0.828	4.111	6.140	355°	0.977	5.725	7.578	0.999	5.993	7.777

Horizontal Polarization:
Maximum: 1.431 (1.556 dB)
Horizontal Plane: 1.431 (1.556 dB)
Maximum ERP: 6.000 kW

Vertical Polarization:
Maximum: 1.431 (1.556 dB)
Horizontal Plane: 1.431 (1.556 dB)
Maximum ERP: 6.000 kW

Total Input Power: 4.193 kW
Reference: WMNI1M.FIG

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

ERI® Vertical Plane Relative Field Pattern

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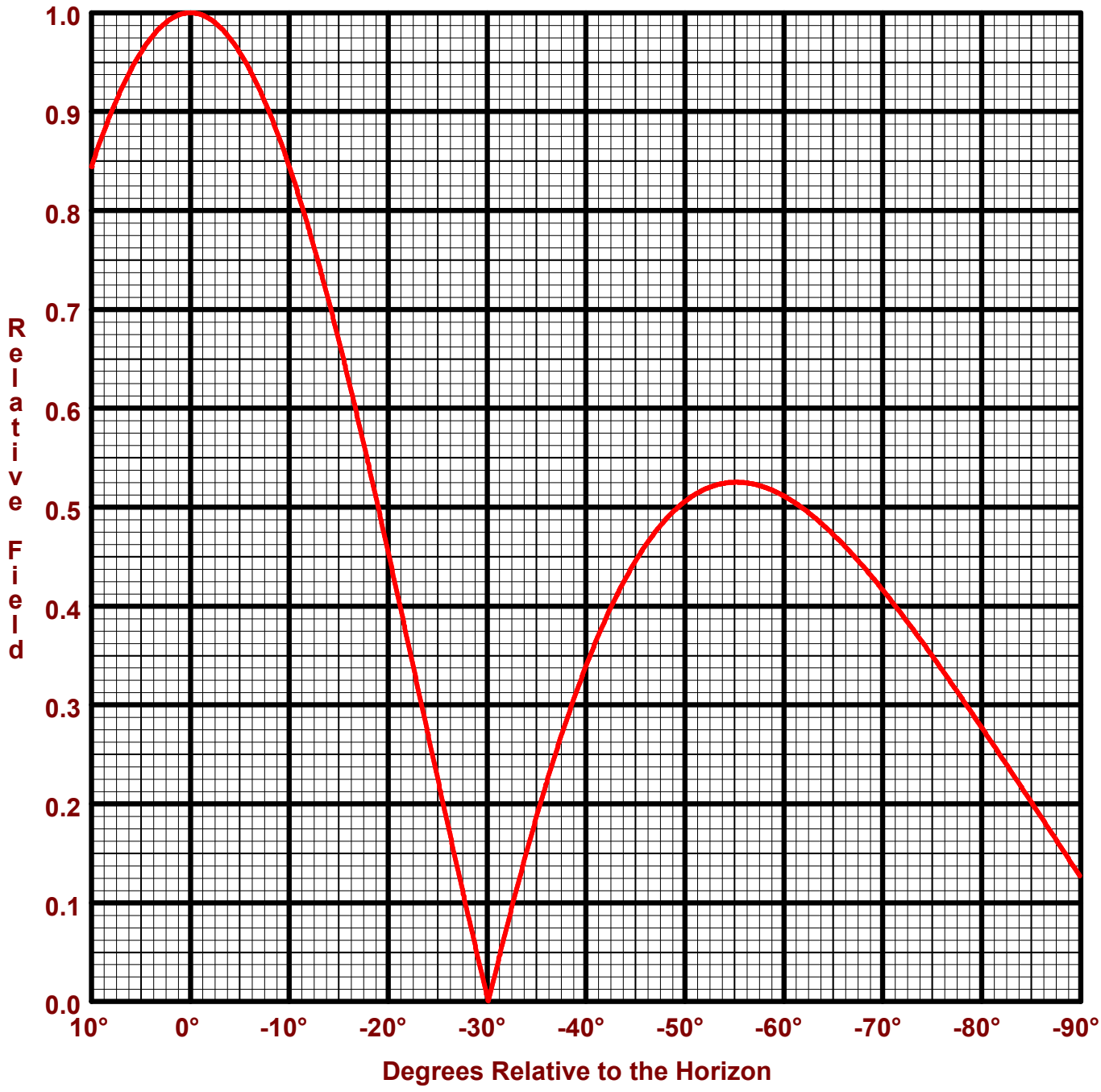
Figure No: 3
Call Sign: WMNI
Location: Worthington, OH.
Frequency: 103.9 MHz
2 bay LP-2E-DA antenna

Date: 6/21/2013
H/V Power Ratio: 1
1 Wave-length Spacing
0° Beam Tilt
0% First Null Fill



Horizontal Polarization:
Maximum: 1.431 (1.556 dB)
Horizontal Plane: 1.431 (1.556 dB)
Maximum ERP: 6.000 kW

Vertical Polarization:
Maximum: 1.431 (1.556 dB)
Horizontal Plane: 1.431 (1.556 dB)
Maximum ERP: 6.000 kW

Directional Antenna System
for
WMNI, Worthington, Ohio

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	LP-2E-DA
Frequency:	103.9 MHz
Number of Bays:	Two

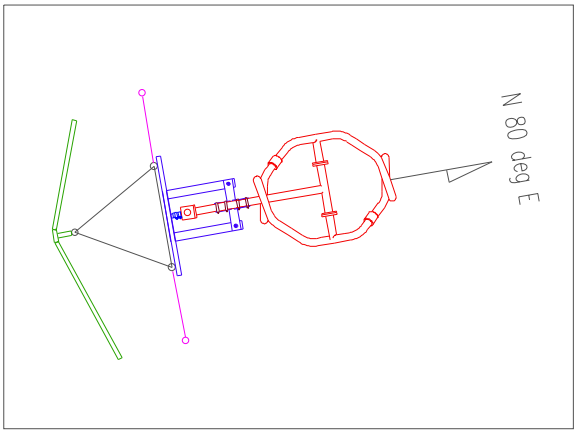
MECHANICAL SPECIFICATIONS

Mounting:	Standard
System length:	17 ft 11 in
Aperture length required:	24 ft 5 in
Orientation:	80 °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:	1.431 (1.556 dB)
Maximum vertical ERP:	6.000 kW (7.782 dBk)
Vertical maximum power gain:	1.431 (1.556 dB)
Total input power:	4.193 kW (6.225 dBk)



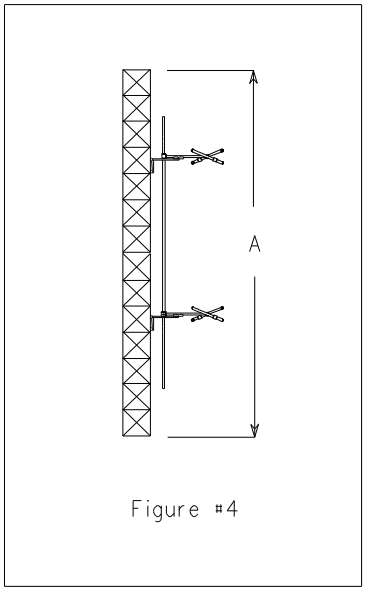


Figure #4