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 WTMK, Wanatah, Indiana

February 23, 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 WTMK.

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 per bay. The antenna was tested on an 8 5/8" o.d. pole, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 88.5 megahertz, which is the center of the FM broadcast channel assigned to WTMK.

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
WTMK, Wanatah, Indiana

(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 8 5/8" o.d. 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.

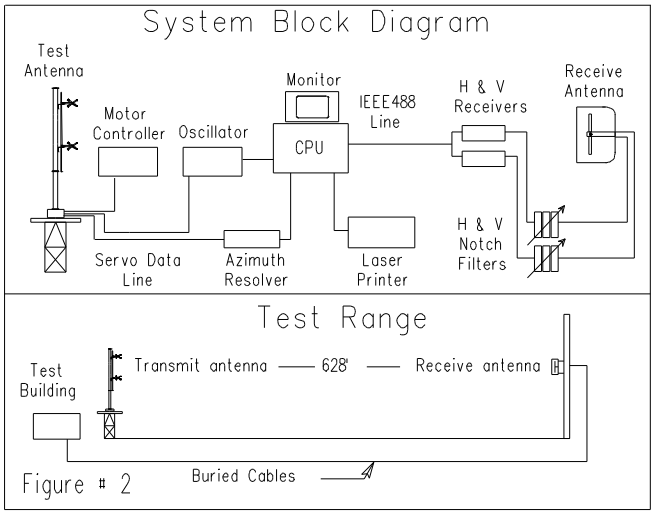

Figure # 2

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

Directional Antenna System
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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 co-ordinated 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 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-HW array is to be mounted on the 8 5/8" o.d. pole at a bearing of North 108 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. A calculated vertical plane relative field pattern is shown on Figure #3 attached. The power in the maximum will reach 3.400 kilowatts (5.315 dBk).

The power at North 270-290 degrees East does not exceed 0.195 kilowatts (-7.100 dBk).

(Continued)

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 20 feet 6 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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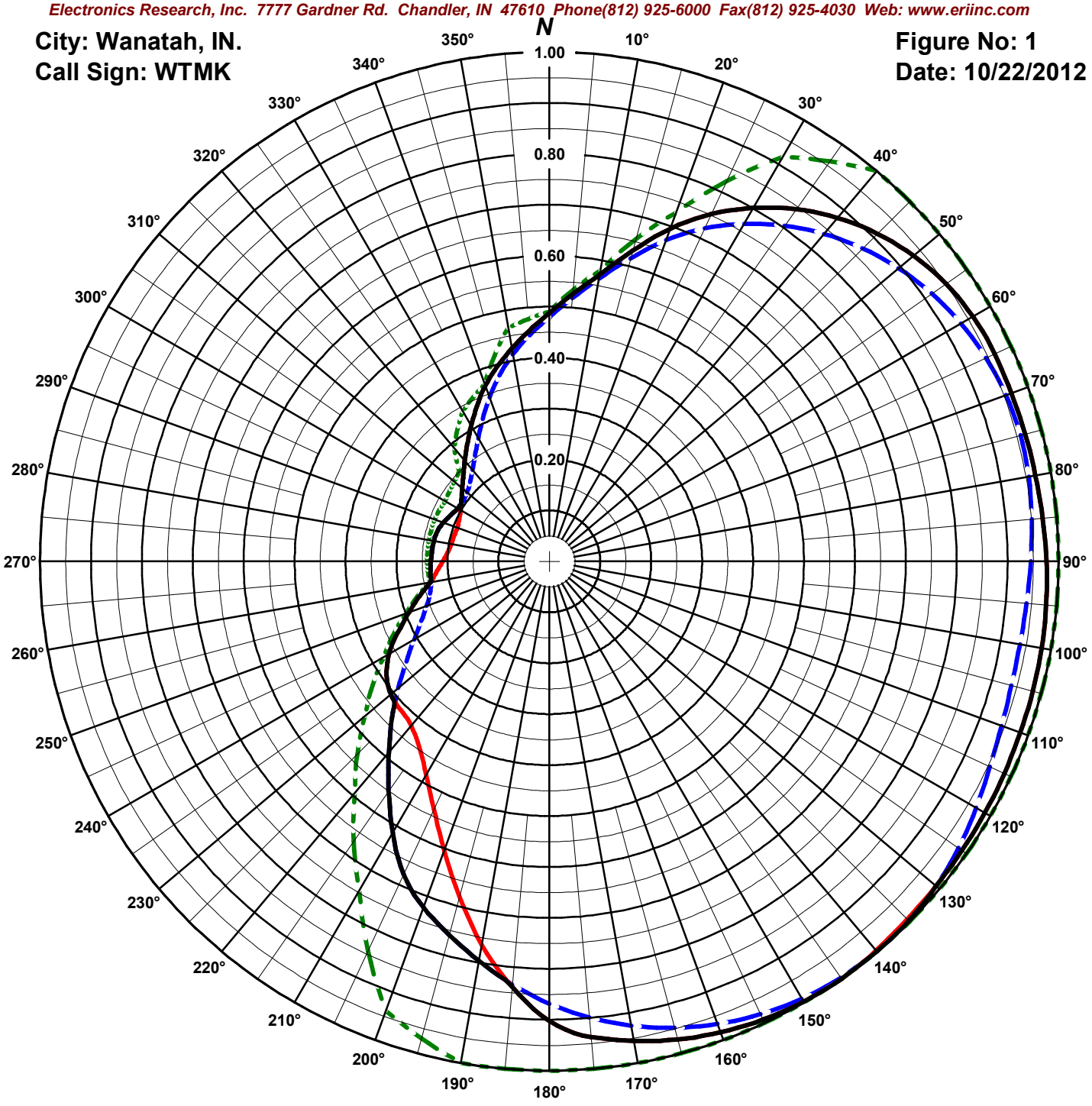
City: Wanatah, IN.
Call Sign: WTMK

Figure No: 1
Date: 10/22/2012



Antenna Orientation: 108° True

Frequency: 88.5 MHz
Antenna Type: LP-2E-DA-HW

Antenna Mounting: Standard
Tower Type: 8 5\8" Pole

HORIZONTAL	VERTICAL	COMPOSITE	FCC ENVELOPE
RMS: .71	RMS: .701	RMS: .719	RMS: .765
Maximum: 1 @ 145°	Maximum: 1 @ 140°	Maximum: 1 @ 140°	Maximum: 1 @ 40°
Minimum: .192 @ 289°	Minimum: .206 @ 304°	Minimum: .206 @ 303°	Minimum: .236 @ 300°

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 BMPED-20140210AAL.

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: 10/22/2012**
Station: WTMK **Antenna: LP-2E-DA-HW**
Location: Wanatah, IN. **Antenna Orientation: 108° True**
Frequency: 88.5 MHz **Number of Bays: 2**

Azimuth	Envelope			Polarization	Azimuth	Envelope			Polarization
	Field	kW	dBk	Maximum		Field	kW	dBk	Maximum
0°	0.487	0.808	-0.926	Horizontal	180°	0.902	2.769	4.424	Horizontal
5°	0.527	0.944	-0.249	Horizontal	185°	0.838	2.387	3.779	Horizontal
10°	0.572	1.114	0.468	Horizontal	190°	0.796	2.155	3.335	Vertical
15°	0.631	1.353	1.314	Horizontal	195°	0.759	1.960	2.922	Vertical
20°	0.695	1.644	2.159	Horizontal	200°	0.723	1.776	2.494	Vertical
25°	0.752	1.922	2.838	Horizontal	205°	0.677	1.561	1.933	Vertical
30°	0.801	2.183	3.390	Horizontal	210°	0.615	1.285	1.089	Vertical
35°	0.844	2.422	3.842	Horizontal	215°	0.550	1.028	0.119	Vertical
40°	0.880	2.635	4.208	Horizontal	220°	0.490	0.818	-0.873	Vertical
45°	0.910	2.816	4.497	Horizontal	225°	0.437	0.648	-1.881	Vertical
50°	0.933	2.963	4.717	Horizontal	230°	0.406	0.561	-2.509	Horizontal
55°	0.950	3.071	4.872	Horizontal	235°	0.390	0.517	-2.865	Horizontal
60°	0.961	3.138	4.967	Horizontal	240°	0.363	0.449	-3.476	Horizontal
65°	0.965	3.164	5.003	Horizontal	245°	0.327	0.363	-4.401	Horizontal
70°	0.966	3.171	5.011	Horizontal	250°	0.294	0.293	-5.331	Horizontal
75°	0.967	3.180	5.024	Horizontal	255°	0.264	0.237	-6.260	Horizontal
80°	0.969	3.195	5.045	Horizontal	260°	0.237	0.191	-7.190	Horizontal
85°	0.973	3.216	5.073	Horizontal	265°	0.234	0.186	-7.294	Vertical
90°	0.976	3.240	5.106	Horizontal	270°	0.233	0.184	-7.352	Vertical
95°	0.979	3.261	5.134	Horizontal	275°	0.231	0.182	-7.409	Vertical
100°	0.982	3.276	5.154	Horizontal	280°	0.230	0.180	-7.447	Vertical
105°	0.983	3.286	5.166	Horizontal	285°	0.228	0.176	-7.541	Vertical
110°	0.984	3.291	5.174	Horizontal	290°	0.222	0.167	-7.776	Vertical
115°	0.986	3.304	5.191	Horizontal	295°	0.214	0.155	-8.096	Vertical
120°	0.987	3.315	5.205	Horizontal	300°	0.208	0.147	-8.331	Vertical
125°	0.989	3.328	5.221	Horizontal	305°	0.210	0.151	-8.224	Horizontal
130°	0.991	3.342	5.240	Vertical	310°	0.223	0.169	-7.718	Horizontal
135°	0.998	3.385	5.296	Vertical	315°	0.239	0.194	-7.118	Horizontal
140°	1.000	3.400	5.315	Vertical	320°	0.258	0.227	-6.445	Horizontal
145°	1.000	3.400	5.315	Horizontal	325°	0.281	0.268	-5.716	Horizontal
150°	0.998	3.387	5.298	Horizontal	330°	0.307	0.320	-4.950	Horizontal
155°	0.993	3.351	5.251	Horizontal	335°	0.336	0.384	-4.159	Horizontal
160°	0.984	3.291	5.174	Horizontal	340°	0.367	0.459	-3.386	Horizontal
165°	0.972	3.210	5.066	Horizontal	345°	0.395	0.531	-2.746	Horizontal
170°	0.956	3.108	4.925	Horizontal	350°	0.424	0.612	-2.134	Horizontal
175°	0.937	2.986	4.751	Horizontal	355°	0.454	0.702	-1.536	Horizontal

Horizontal Polarization:
Maximum: 1.340 (1.271 dB)
Horizontal Plane: 1.340 (1.271 dB)
Maximum ERP: 3.400 kW

Vertical Polarization:
Maximum: 1.340 (1.271 dB)
Horizontal Plane: 1.340 (1.271 dB)
Maximum ERP: 3.400 kW

Total Input Power: 2.537 kW
Reference: WTMK1M.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: 10/22/2012**
Station: WTMK **Antenna: LP-2E-DA-HW**
Location: Wanatah, IN. **Antenna Orientation: 108° True**
Frequency: 88.5 MHz **Number of Bays: 2**

Azimuth	Horizontal			Vertical			Azimuth	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.487	0.808	-0.926	0.479	0.781	-1.074	180°	0.902	2.769	4.424	0.868	2.564	4.090
5°	0.527	0.944	-0.249	0.519	0.915	-0.384	185°	0.838	2.387	3.779	0.834	2.364	3.737
10°	0.572	1.114	0.468	0.564	1.081	0.340	190°	0.765	1.988	2.984	0.796	2.155	3.335
15°	0.631	1.353	1.314	0.616	1.289	1.102	195°	0.681	1.577	1.979	0.759	1.960	2.922
20°	0.695	1.644	2.159	0.671	1.532	1.851	200°	0.604	1.239	0.929	0.723	1.776	2.494
25°	0.752	1.922	2.838	0.721	1.769	2.476	205°	0.536	0.979	-0.094	0.677	1.561	1.933
30°	0.801	2.183	3.390	0.765	1.991	2.990	210°	0.484	0.795	-0.997	0.615	1.285	1.089
35°	0.844	2.422	3.842	0.804	2.200	3.425	215°	0.445	0.674	-1.712	0.550	1.028	0.119
40°	0.880	2.635	4.208	0.839	2.394	3.792	220°	0.422	0.605	-2.184	0.490	0.818	-0.873
45°	0.910	2.816	4.497	0.869	2.570	4.100	225°	0.412	0.578	-2.379	0.437	0.648	-1.881
50°	0.933	2.963	4.717	0.895	2.725	4.354	230°	0.406	0.561	-2.509	0.387	0.509	-2.936
55°	0.950	3.071	4.872	0.917	2.857	4.559	235°	0.390	0.517	-2.865	0.343	0.400	-3.982
60°	0.961	3.138	4.967	0.934	2.964	4.718	240°	0.363	0.449	-3.476	0.306	0.319	-4.959
65°	0.965	3.164	5.003	0.946	3.043	4.833	245°	0.327	0.363	-4.401	0.277	0.262	-5.820
70°	0.966	3.171	5.011	0.954	3.095	4.907	250°	0.294	0.293	-5.331	0.256	0.223	-6.514
75°	0.967	3.180	5.024	0.958	3.118	4.938	255°	0.264	0.237	-6.260	0.242	0.200	-6.992
80°	0.969	3.195	5.045	0.956	3.107	4.923	260°	0.237	0.191	-7.190	0.236	0.190	-7.221
85°	0.973	3.216	5.073	0.951	3.075	4.879	265°	0.221	0.166	-7.791	0.234	0.186	-7.294
90°	0.976	3.240	5.106	0.945	3.039	4.828	270°	0.209	0.148	-8.285	0.233	0.184	-7.352
95°	0.979	3.261	5.134	0.941	3.010	4.786	275°	0.200	0.136	-8.652	0.231	0.182	-7.409
100°	0.982	3.276	5.154	0.938	2.993	4.761	280°	0.195	0.130	-8.873	0.230	0.180	-7.447
105°	0.983	3.286	5.166	0.939	3.001	4.772	285°	0.193	0.127	-8.961	0.228	0.176	-7.541
110°	0.984	3.291	5.174	0.945	3.036	4.823	290°	0.192	0.126	-8.997	0.222	0.167	-7.776
115°	0.986	3.304	5.191	0.955	3.098	4.911	295°	0.195	0.129	-8.879	0.214	0.155	-8.096
120°	0.987	3.315	5.205	0.968	3.184	5.030	300°	0.201	0.137	-8.617	0.208	0.147	-8.331
125°	0.989	3.328	5.221	0.981	3.273	5.149	305°	0.210	0.151	-8.224	0.207	0.145	-8.382
130°	0.991	3.341	5.239	0.991	3.342	5.240	310°	0.223	0.169	-7.718	0.211	0.151	-8.214
135°	0.994	3.357	5.260	0.998	3.385	5.296	315°	0.239	0.194	-7.118	0.220	0.164	-7.839
140°	0.998	3.384	5.294	1.000	3.400	5.315	320°	0.258	0.227	-6.445	0.234	0.187	-7.287
145°	1.000	3.400	5.315	0.998	3.385	5.295	325°	0.281	0.268	-5.716	0.254	0.219	-6.589
150°	0.998	3.387	5.298	0.991	3.341	5.239	330°	0.307	0.320	-4.950	0.279	0.264	-5.781
155°	0.993	3.351	5.251	0.981	3.271	5.147	335°	0.336	0.384	-4.159	0.309	0.324	-4.896
160°	0.984	3.291	5.174	0.966	3.176	5.018	340°	0.367	0.459	-3.386	0.343	0.399	-3.986
165°	0.972	3.210	5.066	0.948	3.055	4.851	345°	0.395	0.531	-2.746	0.377	0.484	-3.147
170°	0.956	3.108	4.925	0.925	2.912	4.642	350°	0.424	0.612	-2.134	0.413	0.579	-2.371
175°	0.937	2.986	4.751	0.899	2.748	4.390	355°	0.454	0.702	-1.536	0.446	0.675	-1.708

Horizontal Polarization:
Maximum: 1.340 (1.271 dB)
Horizontal Plane: 1.340 (1.271 dB)
Maximum ERP: 3.400 kW

Vertical Polarization:
Maximum: 1.340 (1.271 dB)
Horizontal Plane: 1.340 (1.271 dB)
Maximum ERP: 3.400 kW

Total Input Power: 2.537 kW
Reference: WTMK1M.FIG

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

ERI® Vertical Plane Relative Field Pattern

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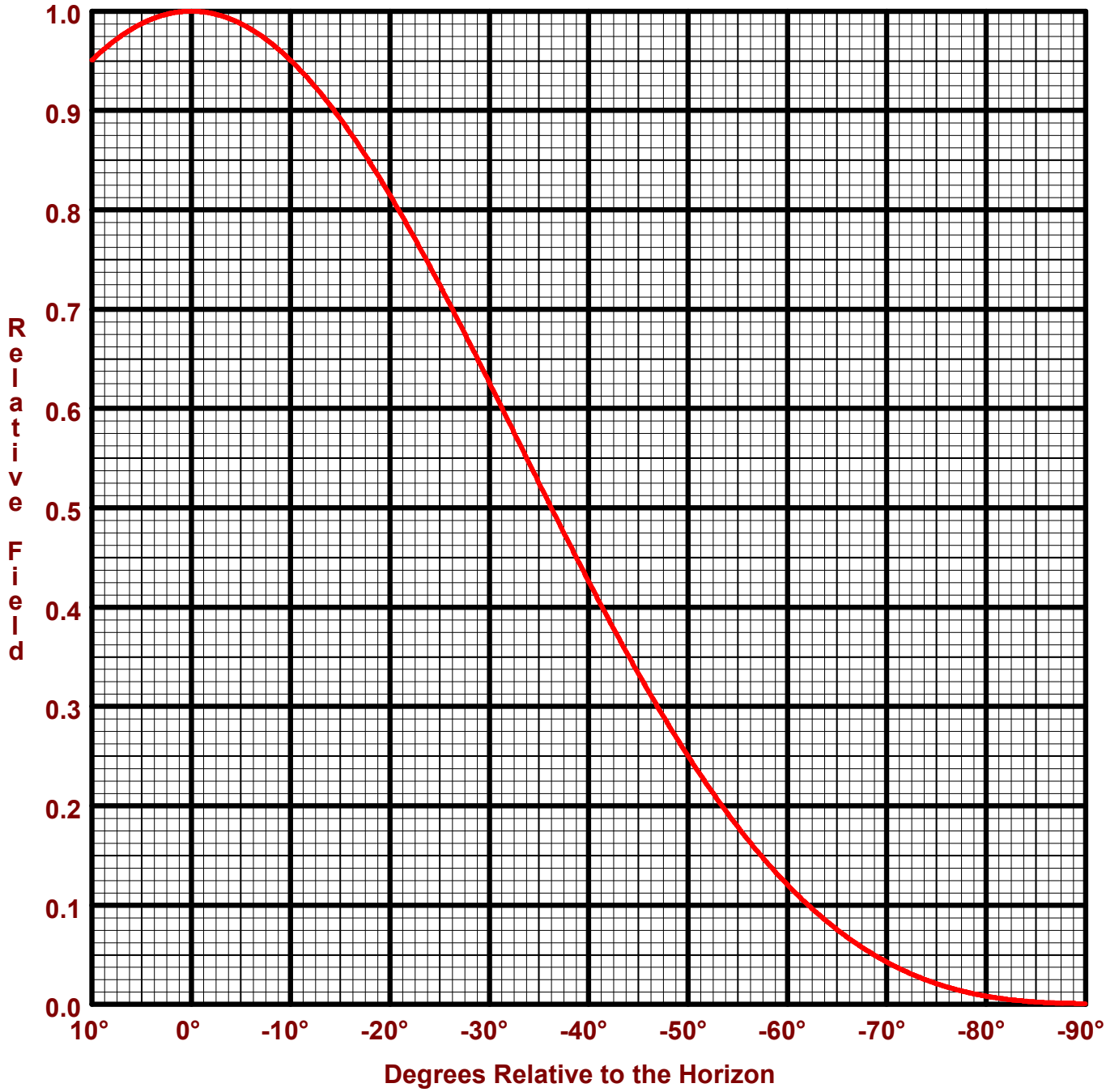
Figure No: 3
Call Sign: WTMK
Location: Wanatah, IN.
Frequency: 88.5 MHz
2 bay LP-2E-DA-HW antenna

Date: 10/22/2012
H/V Power Ratio: 1
.5 Wave-length Spacing
0° Beam Tilt
0% First Null Fill



Horizontal Polarization:
Maximum: 1.340 (1.271 dB)
Horizontal Plane: 1.340 (1.271 dB)
Maximum ERP: 3.400 kW

Vertical Polarization:
Maximum: 1.340 (1.271 dB)
Horizontal Plane: 1.340 (1.271 dB)
Maximum ERP: 3.400 kW

Directional Antenna System
for
WTMK, Wanatah, Indiana

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	LP-2E-DA-HW
Frequency:	88.5 MHz
Number of Bays:	Two

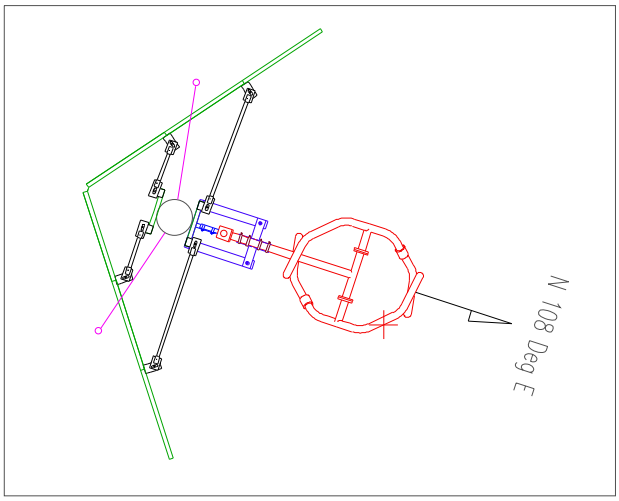
MECHANICAL SPECIFICATIONS

Mounting:	Standard
System length:	14 ft 5 in
Aperture length required:	20 ft 6 in
Orientation:	108° true

Input flange to the antenna 1 5/8” female.

ELECTRICAL SPECIFICATIONS
(For directional use)

Maximum horizontal ERP:	3.400 kW (5.315 dBk)
Horizontal maximum power gain:	1.340 (1.271 dB)
Maximum vertical ERP:	3.400 kW (5.315 dBk)
Vertical maximum power gain:	1.340 (1.271 dB)
Total input power:	2.537 kW (4.043 dBk)



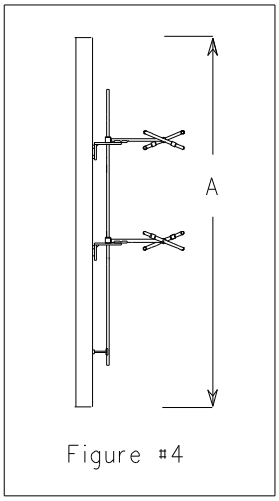


Figure #4