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 WJCD, Norfolk, Virginia

November 19, 2009

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 WJCD.

The antenna is the ERI model MP-4C-DA-HW configuration. The circular polarized system consists of 4 half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and four vertical parasitic elements interleaved between alternate bay pairs. The antenna was mounted on the North 151 degrees East tower face with bracketry to provide an antenna orientation of North 151 degrees East. The antenna was tested on a 42" Pi-Rod tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 107.7 megahertz, which is the center of the FM broadcast channel assigned to WJCD.

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
WJCD, Norfolk, Virginia

(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 3 1/8 inch o.d. rigid coaxial line was used to feed the test antenna, and a section of 3 1/8 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 42" Pi-Rod 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.

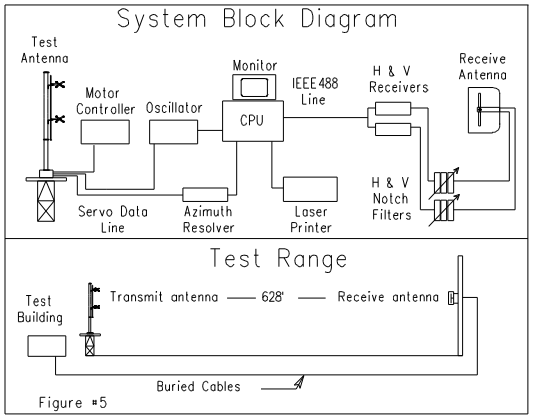


Figure #5

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 107.7 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 4 half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and four vertical parasitic elements 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 MP-4C-DA-HW array is to be mounted on the North 151 degrees East tower face of the 42" Pi-Rod tower at a bearing of North 151 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 15.000 kilowatts (11.761 dBk).

The power at North 330 degrees East does not exceed 5.800 kilowatts (7.634 dBk).

Directional Antenna System
Proposed For
WJCD, Norfolk, Virginia

(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 33 feet 8 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.

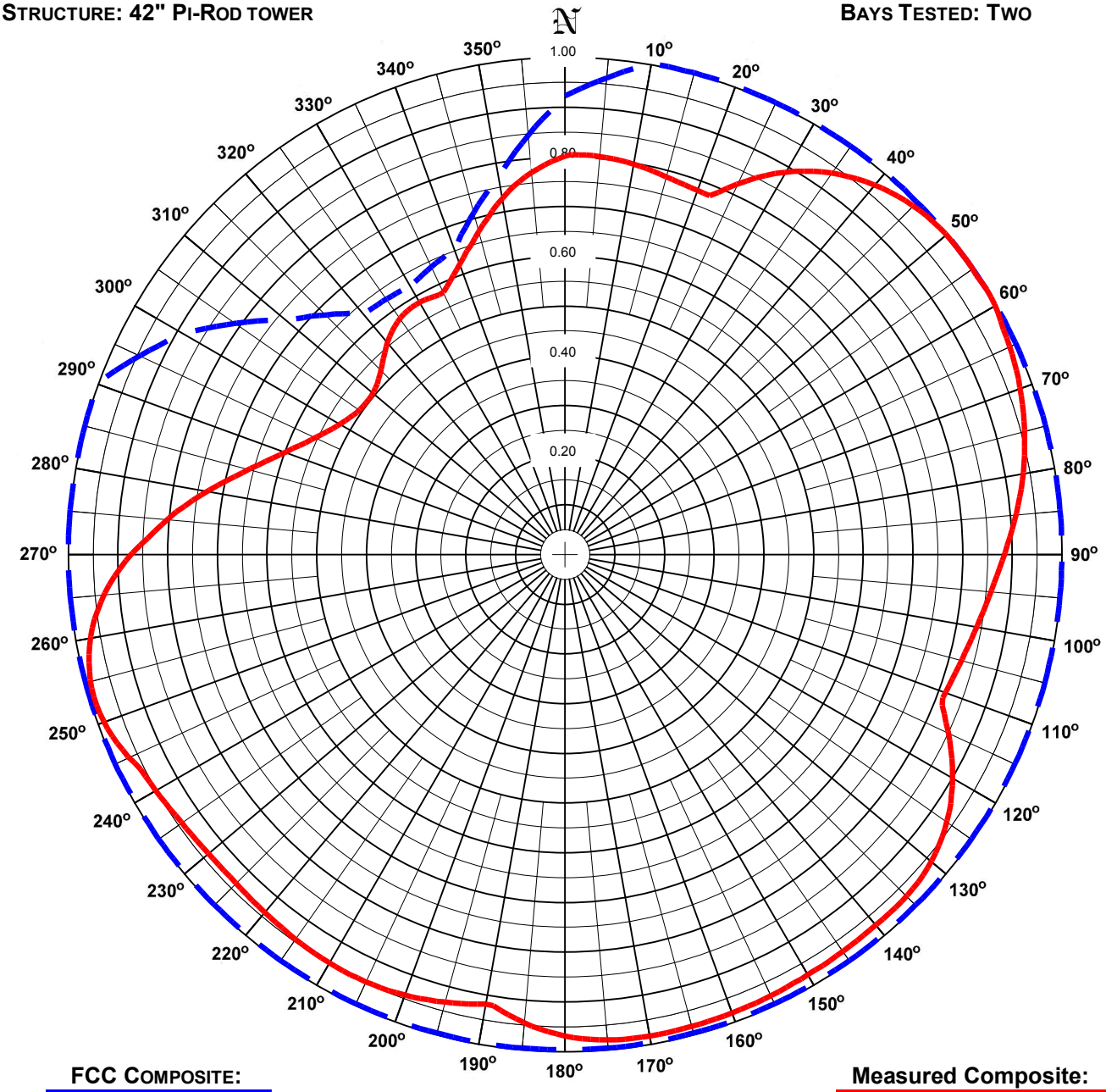
ELECTRONICS RESEARCH, INC.

ERI® Horizontal Plane Relative Field Pattern

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: WJCD
LOCATION: NORFOLK, VA
ANTENNA: MP-4C-HW-DA
STRUCTURE: 42" PI-ROD TOWER

DATE: 11/6/2009
FREQUENCY: 107.7 MHz
ORIENTATION: 151° TRUE
MOUNTING: CUSTOM
BAYS TESTED: TWO



FCC COMPOSITE:

RMS: 0.956
MAXIMUM: 1.000 @ 10° TRUE
MINIMUM: 0.621 @ 330° TRUE

Measured Composite:

RMS: 0.867
Maximum: 1.000 @ 53° True
Minimum: 0.501 @ 308° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN IS GREATER THAT 85% OF THE FCC FILED COMPOSITE PATTERN BPH-20081223ACP.

ERI® Horizontal Plane Relative Field List

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Station: WJCD
Location: Norfolk, VA
Frequency: 107.7 MHz

Antenna: MP-4C-HW-DA
Orientation: 151° True
Tower: 42" Pi-Rod tower

Figure: 1
Date: 11/6/2009
Reference: wjcd2m.fig

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0º	0.799	9.58	9.81	Horizontal	180º	0.972	14.17	11.51	Horizontal
5º	0.801	9.62	9.83	Horizontal	185º	0.949	13.50	11.30	Horizontal
10º	0.794	9.47	9.76	Horizontal	190º	0.922	12.76	11.06	Vertical
15º	0.784	9.23	9.65	Horizontal	195º	0.936	13.13	11.18	Vertical
20º	0.776	9.04	9.56	Horizontal	200º	0.946	13.44	11.28	Vertical
25º	0.818	10.04	10.02	Vertical	205º	0.952	13.59	11.33	Vertical
30º	0.885	11.74	10.70	Vertical	210º	0.952	13.58	11.33	Vertical
35º	0.933	13.07	11.16	Vertical	215º	0.948	13.47	11.29	Vertical
40º	0.967	14.02	11.47	Vertical	220º	0.942	13.32	11.25	Vertical
45º	0.989	14.66	11.66	Vertical	225º	0.939	13.22	11.21	Vertical
50º	0.999	14.97	11.75	Vertical	230º	0.939	13.22	11.21	Vertical
55º	1.000	14.99	11.76	Vertical	235º	0.944	13.37	11.26	Vertical
60º	0.998	14.95	11.75	Horizontal	240º	0.953	13.62	11.34	Vertical
65º	0.987	14.61	11.65	Vertical	245º	0.970	14.11	11.50	Horizontal
70º	0.974	14.24	11.53	Vertical	250º	0.989	14.67	11.66	Horizontal
75º	0.957	13.75	11.38	Vertical	255º	0.989	14.68	11.67	Horizontal
80º	0.936	13.15	11.19	Vertical	260º	0.970	14.10	11.49	Horizontal
85º	0.911	12.46	10.95	Vertical	265º	0.930	12.97	11.13	Horizontal
90º	0.885	11.75	10.70	Vertical	270º	0.870	11.37	10.56	Horizontal
95º	0.862	11.14	10.47	Vertical	275º	0.801	9.61	9.83	Vertical
100º	0.842	10.64	10.27	Vertical	280º	0.727	7.92	8.99	Vertical
105º	0.827	10.26	10.11	Vertical	285º	0.656	6.45	8.09	Vertical
110º	0.816	9.99	10.00	Vertical	290º	0.597	5.34	7.27	Vertical
115º	0.850	10.85	10.35	Horizontal	295º	0.551	4.56	6.59	Vertical
120º	0.901	12.17	10.85	Horizontal	300º	0.520	4.06	6.09	Vertical
125º	0.939	13.22	11.21	Horizontal	305º	0.504	3.80	5.80	Vertical
130º	0.963	13.91	11.43	Horizontal	310º	0.503	3.80	5.80	Vertical
135º	0.974	14.23	11.53	Horizontal	315º	0.523	4.11	6.13	Vertical
140º	0.976	14.29	11.55	Horizontal	320º	0.555	4.62	6.65	Vertical
145º	0.977	14.33	11.56	Horizontal	325º	0.577	5.00	6.99	Vertical
150º	0.979	14.39	11.58	Horizontal	330º	0.583	5.09	7.07	Vertical
155º	0.982	14.47	11.61	Horizontal	335º	0.579	5.03	7.01	Horizontal
160º	0.985	14.54	11.63	Horizontal	340º	0.619	5.75	7.60	Horizontal
165º	0.986	14.59	11.64	Horizontal	345º	0.670	6.73	8.28	Horizontal
170º	0.987	14.61	11.65	Horizontal	350º	0.725	7.88	8.97	Horizontal
175º	0.984	14.52	11.62	Horizontal	355º	0.768	8.86	9.47	Horizontal

Polarization: **Envelope**
Maximum Field: **1.000 @ 53° True**
Minimum Field: **0.501 @ 308° True**
RMS: **0.867**
Maximum ERP: **15.000 kW**
Maximum Power Gain: **1.816 (2.591 dB)**

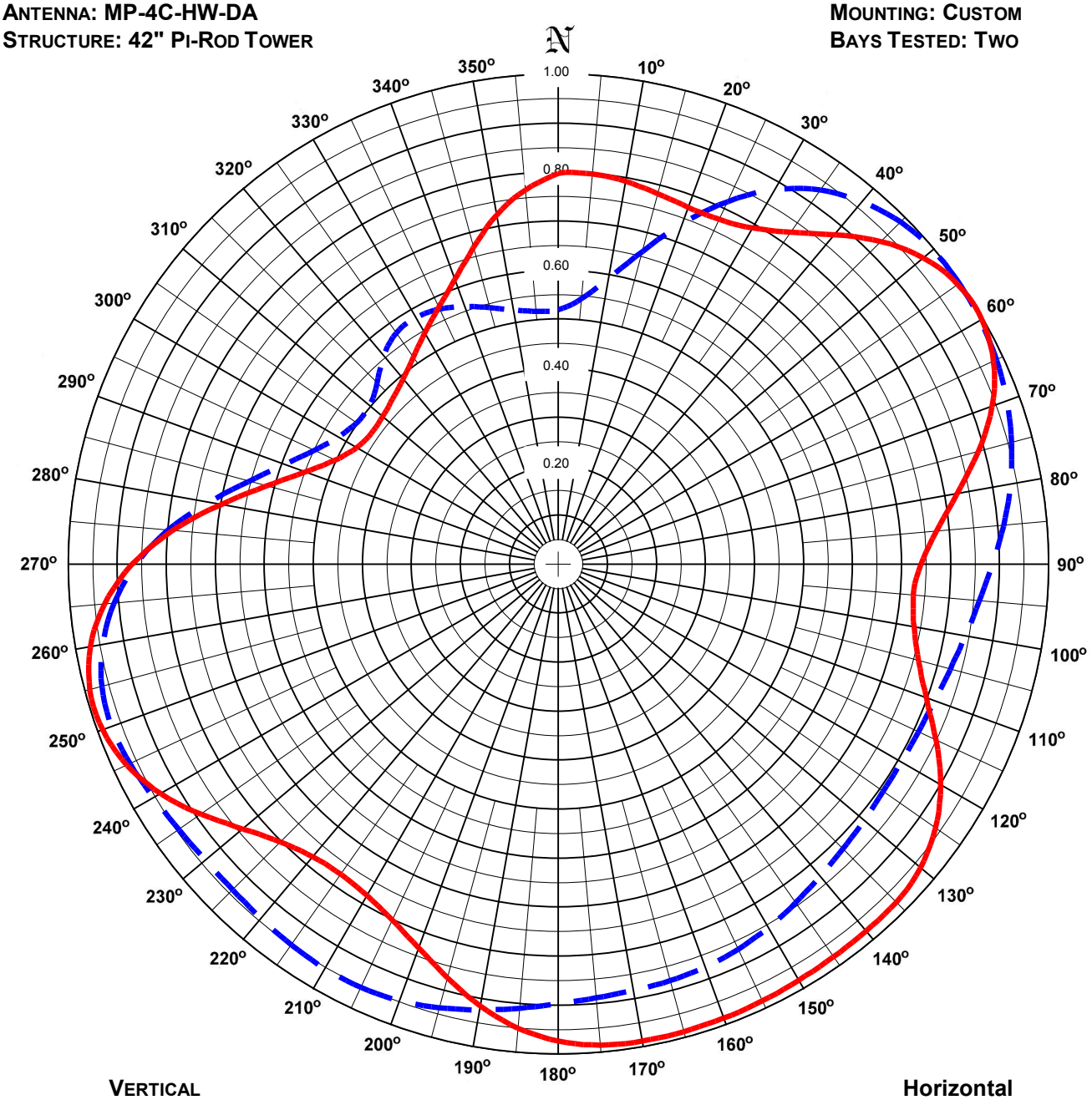
Total Input Power: 8.261 kW

ERI® 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: WJCD
LOCATION: NORFOLK, VA
ANTENNA: MP-4C-HW-DA
STRUCTURE: 42" PI-ROD TOWER

DATE: 11/6/2009
FREQUENCY: 107.7 MHz
ORIENTATION: 151° TRUE
MOUNTING: CUSTOM
BAYS TESTED: TWO



VERTICAL

RMS: 0.825
MAXIMUM: 1.000 @ 53° TRUE
MINIMUM: 0.501 @ 308° TRUE

Horizontal

RMS: 0.829
Maximum: 1.000 @ 58° True
Minimum: 0.467 @ 306° True

COMMENTS: MEASURED PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONENTS.

ERI® Horizontal Plane Relative Field List

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Station: WJCD
Location: Norfolk, VA
Frequency: 107.7 MHz

Antenna: MP-4C-HW-DA
Orientation: 151° True
Tower: 42" Pi-Rod tower

Figure: 2
Date: 11/6/2009
Reference: wjcd2m.fig

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0º	0.799	9.58	9.81	0.521	4.07	6.09	180º	0.972	14.17	11.51	0.896	12.04	10.81
5º	0.801	9.62	9.83	0.545	4.46	6.49	185º	0.949	13.50	11.30	0.908	12.38	10.93
10º	0.794	9.47	9.76	0.594	5.30	7.24	190º	0.915	12.55	10.99	0.922	12.76	11.06
15º	0.784	9.23	9.65	0.663	6.59	8.19	195º	0.872	11.42	10.57	0.936	13.13	11.18
20º	0.776	9.04	9.56	0.742	8.25	9.16	200º	0.832	10.38	10.16	0.946	13.44	11.28
25º	0.777	9.07	9.57	0.818	10.04	10.02	205º	0.800	9.61	9.83	0.952	13.59	11.33
30º	0.794	9.45	9.76	0.885	11.74	10.70	210º	0.780	9.12	9.60	0.952	13.58	11.33
35º	0.829	10.30	10.13	0.933	13.07	11.16	215º	0.772	8.93	9.51	0.948	13.47	11.29
40º	0.880	11.61	10.65	0.967	14.02	11.47	220º	0.778	9.08	9.58	0.942	13.32	11.25
45º	0.933	13.05	11.16	0.989	14.66	11.66	225º	0.801	9.61	9.83	0.939	13.22	11.21
50º	0.974	14.22	11.53	0.999	14.97	11.75	230º	0.839	10.56	10.24	0.939	13.22	11.21
55º	0.996	14.89	11.73	1.000	14.99	11.76	235º	0.888	11.84	10.73	0.944	13.37	11.26
60º	0.998	14.95	11.75	0.995	14.86	11.72	240º	0.935	13.12	11.18	0.953	13.62	11.34
65º	0.980	14.40	11.58	0.987	14.61	11.65	245º	0.970	14.11	11.50	0.963	13.91	11.43
70º	0.942	13.30	11.24	0.974	14.24	11.53	250º	0.989	14.67	11.66	0.969	14.10	11.49
75º	0.886	11.77	10.71	0.957	13.75	11.38	255º	0.989	14.68	11.67	0.964	13.94	11.44
80º	0.825	10.20	10.09	0.936	13.15	11.19	260º	0.970	14.10	11.49	0.944	13.38	11.26
85º	0.773	8.97	9.53	0.911	12.46	10.95	265º	0.930	12.97	11.13	0.910	12.44	10.95
90º	0.739	8.20	9.14	0.885	11.75	10.70	270º	0.870	11.37	10.56	0.863	11.16	10.48
95º	0.727	7.93	8.99	0.862	11.14	10.47	275º	0.792	9.40	9.73	0.801	9.61	9.83
100º	0.737	8.14	9.11	0.842	10.64	10.27	280º	0.702	7.39	8.69	0.727	7.92	8.99
105º	0.761	8.69	9.39	0.827	10.26	10.11	285º	0.619	5.74	7.59	0.656	6.45	8.09
110º	0.799	9.58	9.82	0.816	9.99	10.00	290º	0.552	4.57	6.60	0.597	5.34	7.27
115º	0.850	10.85	10.35	0.810	9.83	9.93	295º	0.504	3.82	5.82	0.551	4.56	6.59
120º	0.901	12.17	10.85	0.807	9.77	9.90	300º	0.477	3.41	5.32	0.520	4.06	6.09
125º	0.939	13.22	11.21	0.809	9.81	9.91	305º	0.467	3.27	5.15	0.504	3.80	5.80
130º	0.963	13.91	11.43	0.813	9.91	9.96	310º	0.469	3.30	5.19	0.503	3.80	5.80
135º	0.974	14.23	11.53	0.820	10.09	10.04	315º	0.479	3.44	5.36	0.523	4.11	6.13
140º	0.976	14.29	11.55	0.830	10.34	10.14	320º	0.494	3.66	5.63	0.555	4.62	6.65
145º	0.977	14.33	11.56	0.843	10.65	10.27	325º	0.517	4.00	6.02	0.577	5.00	6.99
150º	0.979	14.39	11.58	0.855	10.98	10.40	330º	0.546	4.47	6.50	0.583	5.09	7.07
155º	0.982	14.47	11.61	0.866	11.25	10.51	335º	0.579	5.03	7.01	0.576	4.97	6.97
160º	0.985	14.54	11.63	0.874	11.45	10.59	340º	0.619	5.75	7.60	0.561	4.72	6.74
165º	0.986	14.59	11.64	0.879	11.58	10.64	345º	0.670	6.73	8.28	0.543	4.43	6.46
170º	0.987	14.61	11.65	0.882	11.66	10.67	350º	0.725	7.88	8.97	0.528	4.18	6.22
175º	0.984	14.52	11.62	0.887	11.80	10.72	355º	0.768	8.86	9.47	0.520	4.05	6.07

Polarization:	**Horizontal**	**Vertical**
Maximum Field:	**1.000 @ 58° True**	**1.000 @ 53° True**
Minimum Field:	**0.467 @ 306° True**	**0.501 @ 308° True**
RMS:	**0.829**	**0.825**
Maximum ERP:	**15.000 kW**	**15.000 kW**
Maximum Power Gain:	**1.816 (2.591 dB)**	**1.816 (2.591 dB)**

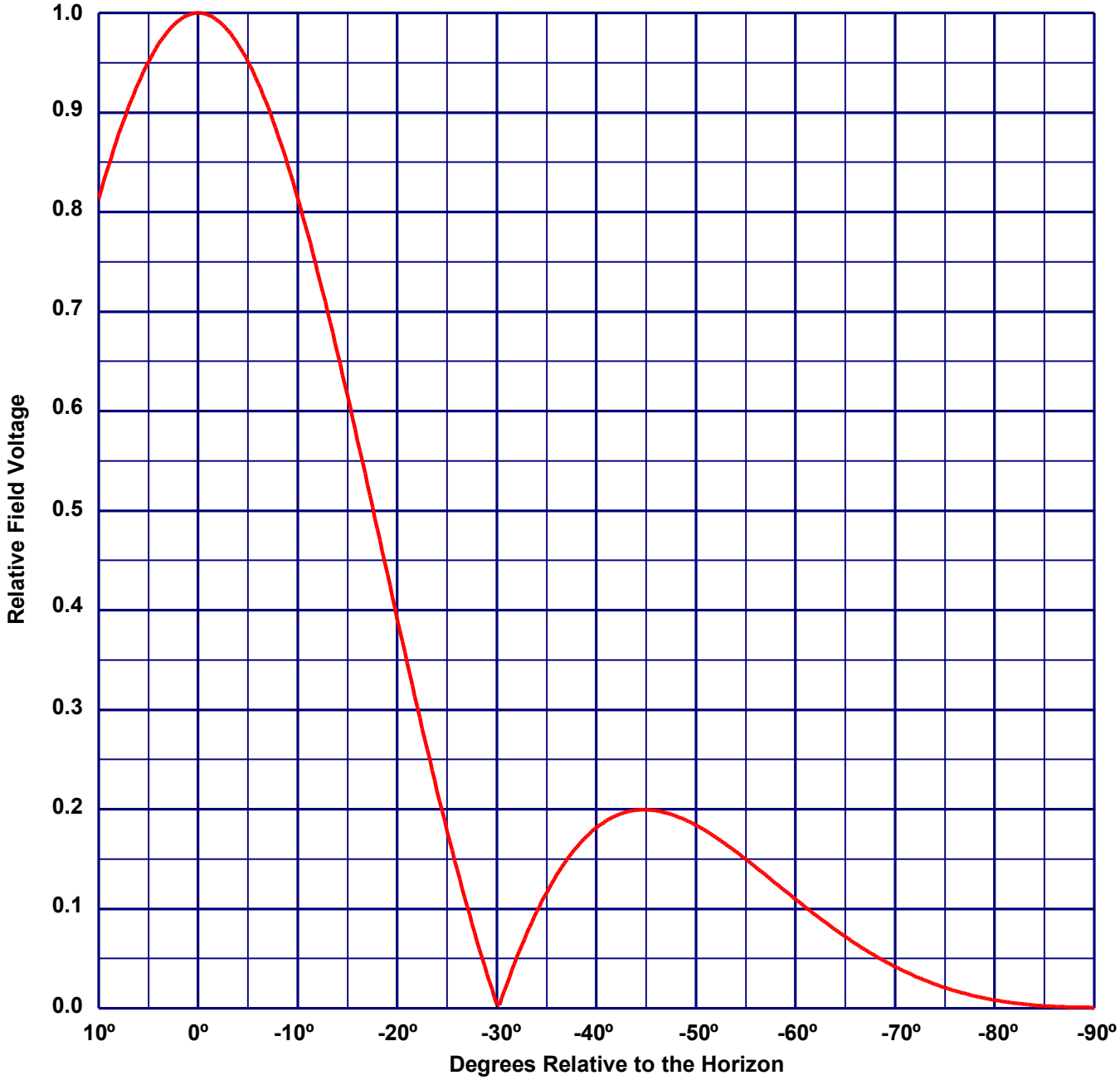
Total Input Power: 8.261 kW

Vertical Plane Relative Field Pattern

WJCD, Norfolk, VA, 107.7 MHz

Figure#: 3 Date: 11/6/2009

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



Vertical Polarization Gain:	Horizontal Polarization Gain:
Maximum: 1.816 (2.591 dB) Horizontal Plane: 1.816 (2.591 dB)	Maximum: 1.816 (2.591 dB) Horizontal Plane: 1.816 (2.591 dB)

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Directional Antenna System
for
WJCD, Norfolk, Virginia

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	MP-4C-DA-HW
Frequency:	107.7 MHz
Number of Bays:	Four

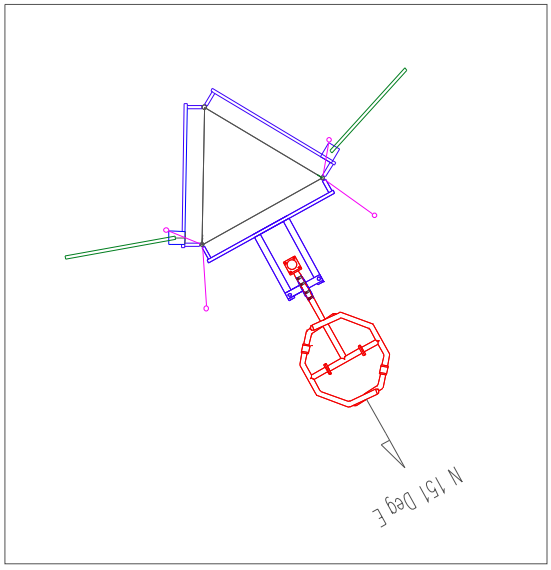
MECHANICAL SPECIFICATIONS

Mounting:	Custom
System length:	17 ft 3 in [1]
Aperture length required:	33 ft 8 in
Orientation:	151° true

Input flange to the antenna 3 1/8“ female.

ELECTRICAL SPECIFICATIONS
(For directional use)

Maximum horizontal ERP:	15.000 kW (11.761 dBk)
Horizontal maximum power gain:	1.816 (2.591 dB)
Maximum vertical ERP:	15.000 kW (11.761 dBk)
Vertical maximum power gain:	1.816 (2.591 dB)
Total input power:	8.261 kW (9.171 dBk)



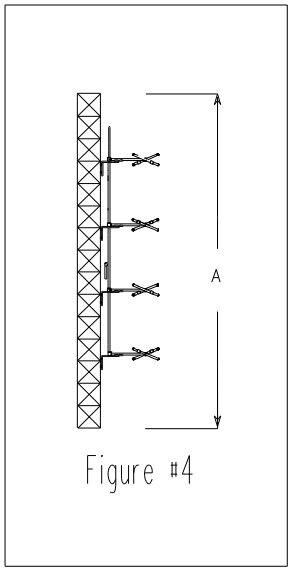


Figure #4