

***Modifications to an Existing
Directional Antenna System for
WMAG, High Point, North Carolina***

January 17, 2005

Electronics Research Inc. is providing modification changes to the number of antenna bays from three to six to an existing circular polarized FM Broadcast antenna that is now in service for WMAG, High point, North Carolina. The modifications were designed specifically to meet the FCC requirements and the general needs of radio station WMAG.

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.

The modified antenna will consists of ERI SHP elements, which are identical to the original Harris Corporation FHM elements that were used in the tests. The circular polarized system will consists of 6 full-wavelength spaced bays using one driven circular polarized radiating element and two vertical parasitic elements per bay. Special extended mounting brackets are used to mount the antenna on the N 81° 37' 55" E tower leg with an orientation of N 23° 38 07" E. The antenna was tested on a 10' face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 99.5 megahertz, which is the center of the FM broadcast channel assigned to WMAG.

Modifications to an Existing Directional Antenna System for WMAG, High Point, North Carolina

(Continued)

In conjunction with the driven element, each bay has (2) screens sections masking the two faces of the adjacent to the leg on which the antenna is mounted. These screens span each of the two faces and are one wavelength long per bay with the driven element centered vertically for each bay. The orientation of each of the screened faces is N 21 37' 55" E and N 141 37' 55" E respectively. The use of the screens were found to be required, as without screens, the directional patterns varies considerably with a movement of the antenna vertically on the tower leg, due to the different environmental conditions at different vertical levels on the electrical equivalent tower section.

The present directional antenna configuration includes two vertical parasitic elements per bay.

DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of one bay level of the circular polarized system with the associated vertical parasitic elements and screen on both the adjacent faces. 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.

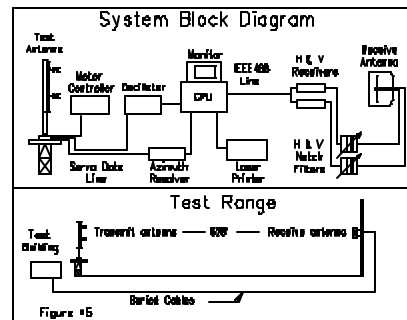
The proof-of-performance was accomplished using a 10' face tower with identical dimension and configuration including all braces, ladders, conduits, coaxial lines and other appurtenances that are included in the actual aperture at which the antenna will be installed. The structure was erected vertically 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 azimuth indicating mechanism, resolution of this azimuth measuring device is one-tenth of a degree.

Modifications to an Existing Directional Antenna System for WMAG, High Point, North Carolina

(Continued)

The antenna under test was operated in the transmitting mode and fed from a Wavetek Model 3000 signal generator. The frequency of the signal source was set at 99.5 MHz. The frequency of this signal source was constantly monitored by a Heathkit Model IM4110 frequency counter.

A broad-band 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 an Anritsu Model ML521B measuring receiver. This data was interfaced to a Hewlett-Packard HP9872C plotter by means of a Hewlett-Packard 86 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 modified circular polarized system consists of 6 full-wavelength spaced bays using one driven circular polarized radiating element 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 SHP-6AC-DA array is to be mounted on the N 81° 37' 55" E tower leg of the 10' face tower at a bearing of N 23° 38 07" E. 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.

Modifications to an Existing Directional Antenna System for WMAG, High Point, North Carolina

(Continued)

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 100 kilowatts (20 dBk).

The radiated field at N 238.5° E does not exceed 10.0 kilowatts (10.00 dBk), and the radiated field at N 329.7° E does not exceed 50.00 kilowatts (16.99 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 69 ft 3 in.

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: 1

STATION: WMAG

LOCATION: HIGH POINT, NC

ANTENNA TYPE: SHP-6AC-DA

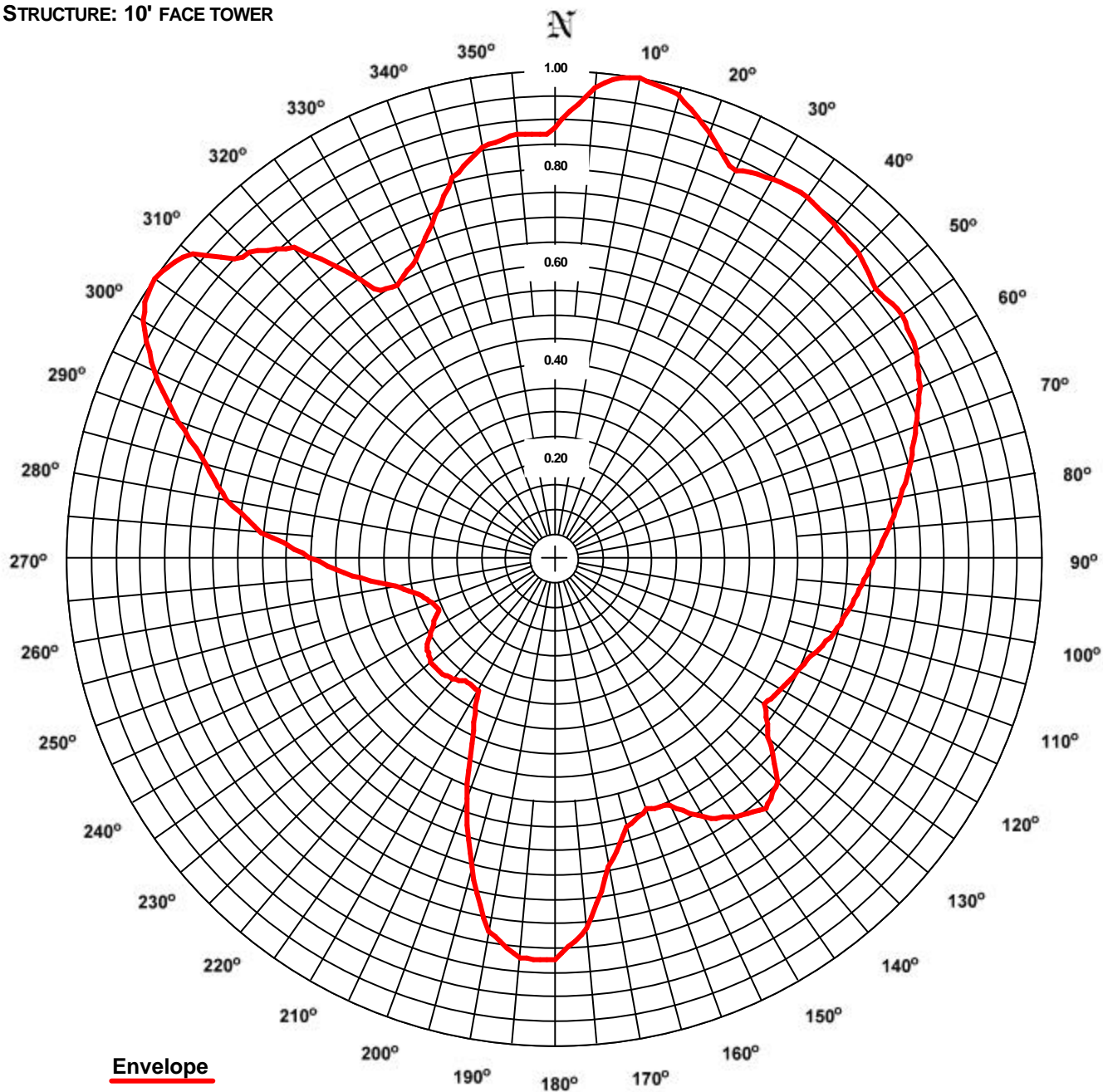
STRUCTURE: 10' FACE TOWER

DATE: 1/17/2005

FREQUENCY: 99.5 MHz

ORIENTATION: 23.6353° TRUE

MOUNTING: STANDARD



RMS: 0.705

Maximum: 1.000 @ 10° True

Minimum: 0.260 @ 246° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN DOES NOT EXCEED THE FCC FILED COMPOSITE PATTERN AT ANY AZIMUTH. THE RMS OF THIS PATTERN IS GREATER THAN 85% OF THE FILED FCC COMPOSITE PATTERN BMLH-19900404KC.

ERI® *Horizontal Plane Relative Field List*

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Station: WMAG
Location: High Point, NC
Frequency: 99.5 MHz

Antenna: SHP-6AC-DA
Orientation: 23.6353° True
Tower: 10' face tower

Figure: 1
Date: 1/17/2005
Reference: wmag1m.fig

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.883	77.97	18.92	Horizontal	180°	0.824	67.90	18.32	Horizontal
5°	0.969	93.90	19.73	Horizontal	185°	0.825	68.06	18.33	Horizontal
10°	1.000	100.00	20.00	Horizontal	190°	0.778	60.53	17.82	Horizontal
15°	0.983	96.63	19.85	Horizontal	195°	0.658	43.30	16.36	Horizontal
20°	0.930	86.49	19.37	Horizontal	200°	0.525	27.56	14.40	Horizontal
25°	0.878	77.09	18.87	Vertical	205°	0.391	15.29	11.84	Horizontal
30°	0.898	80.64	19.07	Vertical	210°	0.314	9.86	9.94	Horizontal
35°	0.904	81.72	19.12	Vertical	215°	0.311	9.67	9.86	Horizontal
40°	0.893	79.74	19.02	Vertical	220°	0.325	10.56	10.24	Horizontal
45°	0.883	77.97	18.92	Vertical	225°	0.332	11.02	10.42	Horizontal
50°	0.860	73.96	18.69	Vertical	230°	0.332	11.02	10.42	Horizontal
55°	0.870	75.69	18.79	Vertical	235°	0.320	10.24	10.10	Horizontal
60°	0.856	73.27	18.65	Vertical	240°	0.290	8.41	9.25	Horizontal
65°	0.828	68.56	18.36	Vertical	245°	0.262	6.86	8.37	Horizontal
70°	0.788	62.09	17.93	Vertical	250°	0.269	7.24	8.60	Vertical
75°	0.757	57.30	17.58	Vertical	255°	0.288	8.29	9.19	Vertical
80°	0.721	51.98	17.16	Vertical	260°	0.332	11.02	10.42	Vertical
85°	0.688	47.33	16.75	Vertical	265°	0.418	17.47	12.42	Vertical
90°	0.655	42.90	16.32	Vertical	270°	0.503	25.30	14.03	Vertical
95°	0.634	40.20	16.04	Vertical	275°	0.603	36.36	15.61	Horizontal
100°	0.614	37.70	15.76	Vertical	280°	0.683	46.65	16.69	Horizontal
105°	0.593	35.16	15.46	Vertical	285°	0.740	54.76	17.38	Horizontal
110°	0.570	32.49	15.12	Vertical	290°	0.821	67.40	18.29	Vertical
115°	0.552	30.47	14.84	Horizontal	295°	0.907	82.26	19.15	Vertical
120°	0.536	28.73	14.58	Horizontal	300°	0.974	94.87	19.77	Vertical
125°	0.525	27.56	14.40	Horizontal	305°	1.000	100.00	20.00	Vertical
130°	0.573	32.83	15.16	Horizontal	310°	0.969	93.90	19.73	Vertical
135°	0.649	42.12	16.24	Horizontal	315°	0.887	78.68	18.96	Horizontal
140°	0.673	45.29	16.56	Horizontal	320°	0.830	68.89	18.38	Horizontal
145°	0.649	42.12	16.24	Horizontal	325°	0.699	48.86	16.89	Horizontal
150°	0.616	37.95	15.79	Horizontal	330°	0.645	41.60	16.19	Vertical
155°	0.560	31.36	14.96	Horizontal	335°	0.674	45.43	16.57	Vertical
160°	0.549	30.14	14.79	Horizontal	340°	0.731	53.44	17.28	Vertical
165°	0.573	32.83	15.16	Horizontal	345°	0.807	65.12	18.14	Vertical
170°	0.644	41.47	16.18	Horizontal	350°	0.854	72.93	18.63	Vertical
175°	0.763	58.22	17.65	Horizontal	355°	0.873	76.21	18.82	Vertical

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

Envelope
1.000 @ 10° True
0.260 @ 246° True
0.705
100.000 kW
7.791 (8.916 dB)

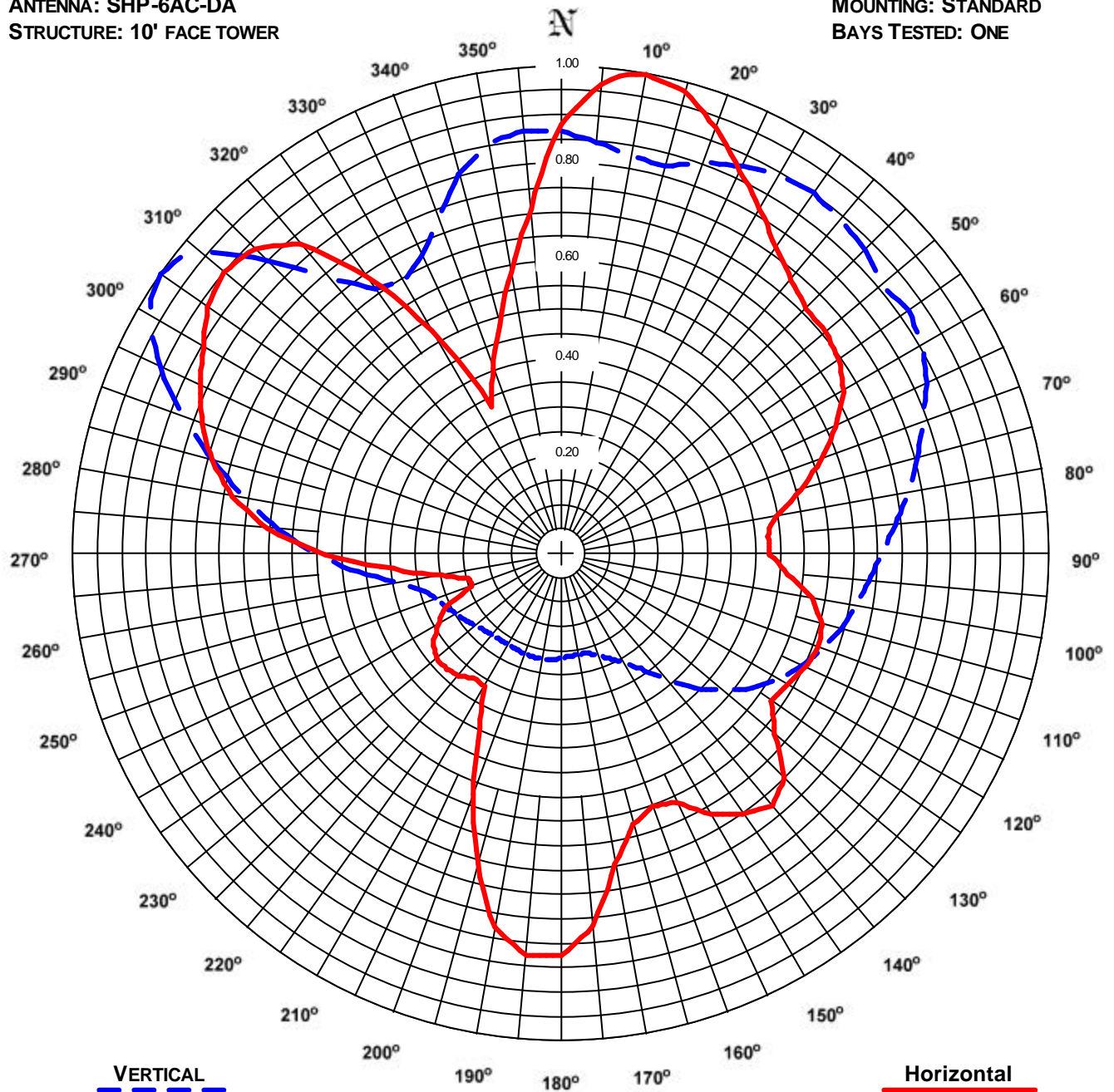
Total Input Power: 12.835 kW

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: WMAG
LOCATION: HIGH POINT, NC
ANTENNA: SHP-6AC-DA
STRUCTURE: 10' FACE TOWER

DATE: 1/17/2005
FREQUENCY: 99.5 MHz
ORIENTATION: 23.6353° TRUE
MOUNTING: STANDARD
BAYS TESTED: ONE



VERTICAL

RMS: 0.629
MAXIMUM: 1.000 @ 305° TRUE
MINIMUM: 0.209 @ 165° TRUE

Horizontal

RMS: 0.636
Maximum: 1.000 @ 10° True
Minimum: 0.193 @ 250° True

COMMENTS: MEASURED PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONENT.

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: WMAG
Location: High Point, NC
Frequency: 99.5 MHz

Antenna: SHP-6AC-DA
Orientation: 23.6353° True
Tower: 10' face tower

Figure: 2
Date: 1/17/2005
Reference: wmag1m.fig

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.883	77.97	18.92	0.867	75.17	18.76	180°	0.824	67.90	18.32	0.213	4.54	6.57
5°	0.969	93.90	19.73	0.848	71.91	18.57	185°	0.825	68.06	18.33	0.218	4.75	6.77
10°	1.000	100.00	20.00	0.829	68.72	18.37	190°	0.778	60.53	17.82	0.218	4.75	6.77
15°	0.983	96.63	19.85	0.824	67.90	18.32	195°	0.658	43.30	16.36	0.218	4.75	6.77
20°	0.930	86.49	19.37	0.854	72.93	18.63	200°	0.525	27.56	14.40	0.218	4.75	6.77
25°	0.868	75.34	18.77	0.878	77.09	18.87	205°	0.391	15.29	11.84	0.215	4.62	6.65
30°	0.817	66.75	18.24	0.898	80.64	19.07	210°	0.314	9.86	9.94	0.213	4.54	6.57
35°	0.768	58.98	17.71	0.904	81.72	19.12	215°	0.311	9.67	9.86	0.215	4.62	6.65
40°	0.735	54.02	17.33	0.893	79.74	19.02	220°	0.325	10.56	10.24	0.216	4.67	6.69
45°	0.711	50.55	17.04	0.883	77.97	18.92	225°	0.332	11.02	10.42	0.221	4.88	6.89
50°	0.708	50.13	17.00	0.860	73.96	18.69	230°	0.332	11.02	10.42	0.228	5.20	7.16
55°	0.696	48.44	16.85	0.870	75.69	18.79	235°	0.320	10.24	10.10	0.237	5.62	7.49
60°	0.669	44.76	16.51	0.856	73.27	18.65	240°	0.290	8.41	9.25	0.247	6.10	7.85
65°	0.622	38.69	15.88	0.828	68.56	18.36	245°	0.262	6.86	8.37	0.258	6.66	8.23
70°	0.566	32.04	15.06	0.788	62.09	17.93	250°	0.193	3.72	5.71	0.269	7.24	8.60
75°	0.511	26.11	14.17	0.757	57.30	17.58	255°	0.195	3.80	5.80	0.288	8.29	9.19
80°	0.449	20.16	13.04	0.721	51.98	17.16	260°	0.248	6.15	7.89	0.332	11.02	10.42
85°	0.427	18.23	12.61	0.688	47.33	16.75	265°	0.344	11.83	10.73	0.418	17.47	12.42
90°	0.428	18.32	12.63	0.655	42.90	16.32	270°	0.482	23.23	13.66	0.503	25.30	14.03
95°	0.468	21.90	13.40	0.634	40.20	16.04	275°	0.603	36.36	15.61	0.579	33.52	15.25
100°	0.523	27.35	14.37	0.614	37.70	15.76	280°	0.683	46.65	16.69	0.655	42.90	16.32
105°	0.554	30.69	14.87	0.593	35.16	15.46	285°	0.740	54.76	17.38	0.736	54.17	17.34
110°	0.560	31.36	14.96	0.570	32.49	15.12	290°	0.782	61.15	17.86	0.821	67.40	18.29
115°	0.552	30.47	14.84	0.544	29.59	14.71	295°	0.815	66.42	18.22	0.907	82.26	19.15
120°	0.536	28.73	14.58	0.513	26.32	14.20	300°	0.846	71.57	18.55	0.974	94.87	19.77
125°	0.525	27.56	14.40	0.479	22.94	13.61	305°	0.884	78.15	18.93	1.000	100.00	20.00
130°	0.573	32.83	15.16	0.432	18.66	12.71	310°	0.902	81.36	19.10	0.969	93.90	19.73
135°	0.649	42.12	16.24	0.389	15.13	11.80	315°	0.887	78.68	18.96	0.851	72.42	18.60
140°	0.673	45.29	16.56	0.332	11.02	10.42	320°	0.830	68.89	18.38	0.736	54.17	17.34
145°	0.649	42.12	16.24	0.285	8.12	9.10	325°	0.699	48.86	16.89	0.664	44.09	16.44
150°	0.616	37.95	15.79	0.256	6.55	8.16	330°	0.530	28.09	14.49	0.645	41.60	16.19
155°	0.560	31.36	14.96	0.235	5.52	7.42	335°	0.333	11.09	10.45	0.674	45.43	16.57
160°	0.549	30.14	14.79	0.220	4.84	6.85	340°	0.406	16.48	12.17	0.731	53.44	17.28
165°	0.573	32.83	15.16	0.209	4.37	6.40	345°	0.487	23.72	13.75	0.807	65.12	18.14
170°	0.644	41.47	16.18	0.209	4.37	6.40	350°	0.587	34.46	15.37	0.854	72.93	18.63
175°	0.763	58.22	17.65	0.209	4.37	6.40	355°	0.710	50.41	17.03	0.873	76.21	18.82

Polarization:	Horizontal	Vertical
Maximum Field:	1.000 @ 10° True	1.000 @ 305° True
Minimum Field:	0.193 @ 250° True	0.209 @ 165° True
RMS:	0.638	0.632
Maximum ERP:	100.000 kW	100.000 kW
Maximum Power Gain:	7.791 (8.916 dB)	7.791 (8.916 dB)

Total Input Power: 12.835 kW



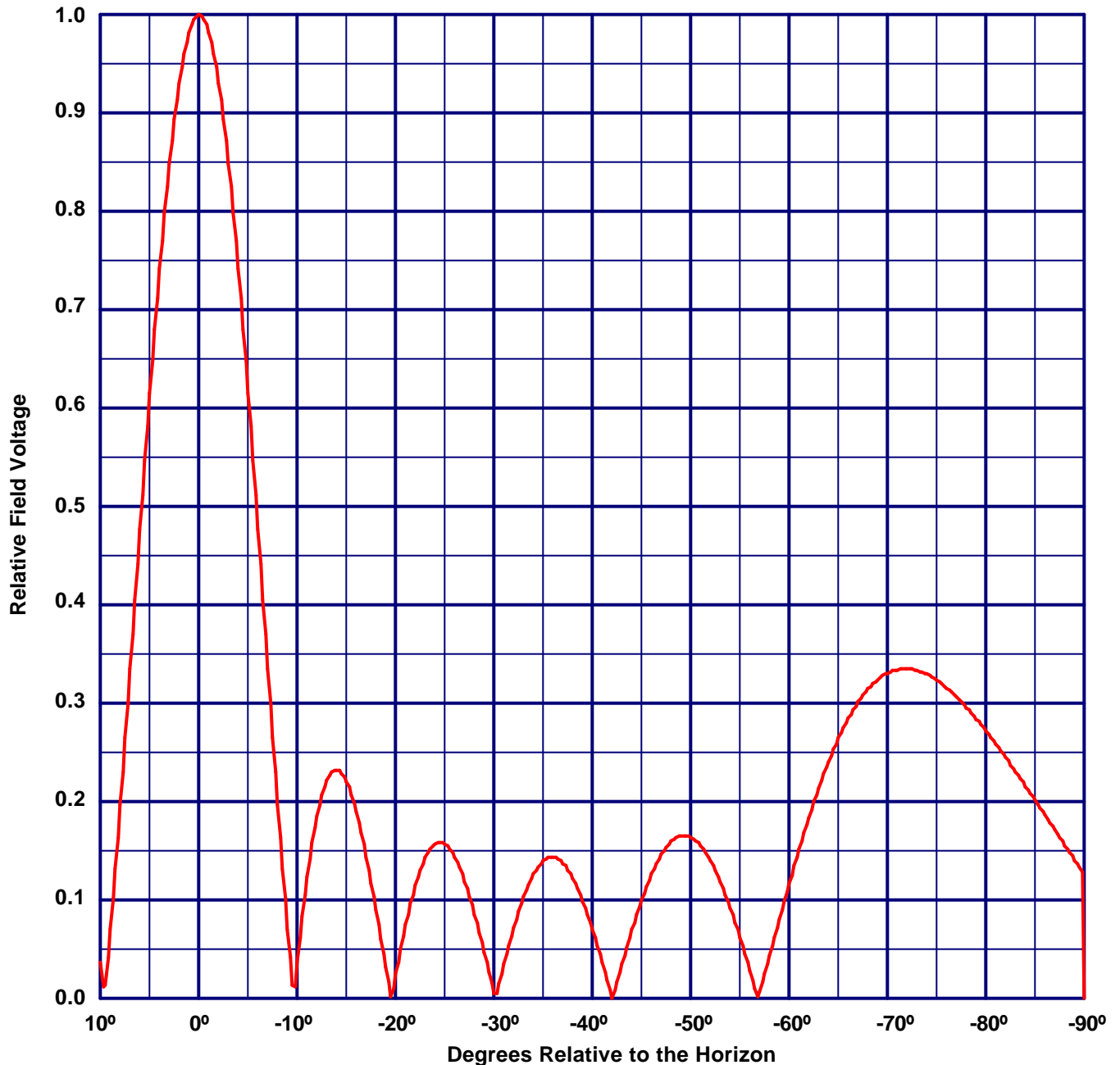
Vertical Plane Relative Field Pattern

WMAG, High Point, NC, 99.5 MHz

Figure#: 3

Date: 1/17/2005

A 6 level, 1 wave-length spaced SHP-6AC-DA directional antenna with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.000



Vertical Polarization Gain:

Maximum: 7.791 (8.916 dB)

Horizontal Plane: 7.791(8.916 dB)

Horizontal Polarization Gain:

Maximum: 7.791 (8.916 dB)

Horizontal Plane: 7.791 (8.916 dB)

Modifications to an Existing Directional Antenna System for WMAG, High Point, North Carolina

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	SHP-6AC-DA
Frequency:	99.5 MHz
Number of Bays:	6

MECHANICAL SPECIFICATIONS

Mounting:	Custom
System length:	57 ft 8 in
Aperture length required:	69 ft 3 in.
Orientation:	23.6353° true
Input flange to the antenna 3 1/8 inch female	

ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP:	100 kW (20 dBk)
Horizontal maximum power gain:	7.791 (8.916 dB)
Maximum vertical ERP:	100 kW (20 dBk)
Vertical maximum power gain:	7.791 (8.916 dB)
Total input power:	12.835 kW (11.084 dBk)