Electronics Research, Inc.

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 WFCM-FM-FM, Murfreesboro, Tennessee

June 18, 2004

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 WFCM-FM.

The antenna is the ERI model 1093-1CP-DA configuration. The circular polarized system consists of one level using three driven circular polarized radiating elements, one horizontal parasitic element placed one quarter wave above and below the bay and two vertical parasitic elements at bay level. The antenna was mounted on the tower with bracketry to provide an antenna orientation of North 274 degrees East. The antenna was tested on a 48" face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 91.7 megahertz, which is the center of the FM broadcast channel assigned to WFCM-FM.

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.

APPENDIX B - ANTENNA PATTERN CERTIFICATION
WFCM-FM - MURFREESBORO, TN

Directional Antenna System
For
WFCM-FM, Murfreesboro, Tennessee

(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. 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 48" 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.

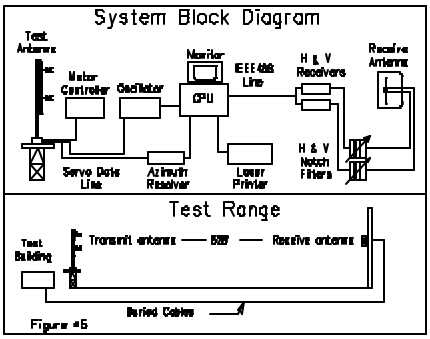


Figure #5

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 91.7 MHz and was constantly monitored by an Anritsu Model ML521B measuring receiver.

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 an Anritsu Model ML521B measuring receiver.

This data was interfaced to a Hewlett-Packard Laser Jet 4P printer by means of a Pentium 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 one level using three driven circular polarized radiating element, one horizontal parasitic element placed one quarter wave above and below the bay and two vertical parasitic elements at bay level. 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 1093-1CP-DA array is to be mounted on the 48" face tower at a bearing of North 274 degrees East. Blue prints provided with the antenna will show the proper antenna orientation alignment. The surveyor's alignment is 90 degrees counter clockwise from the antenna orientation described in this report. 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 2.5 kilowatts (3.979 dBk).

The power at North 30 degrees East does not exceed 0.529 kilowatts (-2.765 dBk).

The RMS of the vertically polarized horizontal plane component does not exceed the RMS of the horizontally polarized horizontal plane component.

Directional Antenna System
For
WFCM-FM, Murfreesboro, Tennessee

(Continued)

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.

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.

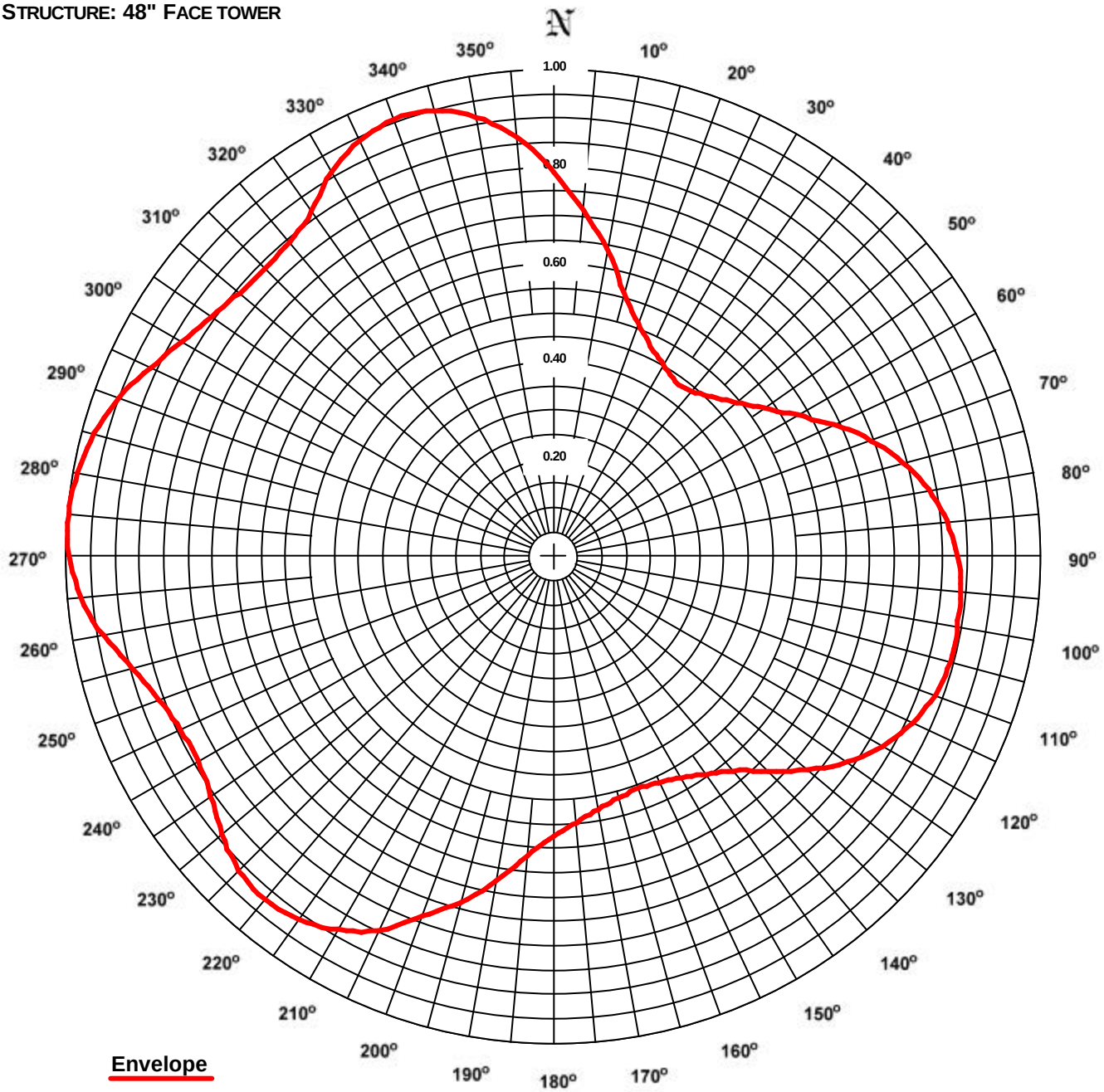
ELECTRONICS RESEARCH, INC.

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: WFCM-FM
LOCATION: MURFREESBORO, TN
ANTENNA TYPE: 1093-1CP-DA
STRUCTURE: 48" FACE TOWER

DATE: 6/18/04
FREQUENCY: 91.7 MHz
ORIENTATION: 274° TRUE
MOUNTING: CUSTOM



Envelope

RMS: 0.773
Maximum: 1.000 @ 274° True
Minimum: 0.435 @ 36° 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 BPED-20000703ADU.

ERI® Horizontal Plane Relative Field List

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Station: WFCM-FM
Location: Murfreesboro, TN
Frequency: 91.7 MHz

Antenna: 1093-1CP-DA
Orientation: 274° True
Tower: 48" Face tower

Figure: 1
Date: 6/18/2004
Reference: WFCM-FM3m.fig

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0º	0.789	1.56	1.92	Vertical	180º	0.576	0.83	-0.82	Vertical
5º	0.711	1.26	1.02	Vertical	185º	0.619	0.96	-0.18	Horizontal
10º	0.641	1.03	0.12	Vertical	190º	0.678	1.15	0.60	Horizontal
15º	0.560	0.79	-1.05	Horizontal	195º	0.736	1.35	1.31	Horizontal
20º	0.509	0.65	-1.89	Horizontal	200º	0.788	1.55	1.91	Horizontal
25º	0.474	0.56	-2.51	Horizontal	205º	0.848	1.80	2.55	Vertical
30º	0.453	0.51	-2.91	Horizontal	210º	0.886	1.96	2.93	Horizontal
35º	0.437	0.48	-3.21	Horizontal	215º	0.912	2.08	3.18	Horizontal
40º	0.442	0.49	-3.10	Vertical	220º	0.922	2.13	3.27	Horizontal
45º	0.462	0.53	-2.73	Vertical	225º	0.913	2.08	3.19	Horizontal
50º	0.491	0.60	-2.20	Vertical	230º	0.888	1.97	2.95	Horizontal
55º	0.530	0.70	-1.54	Vertical	235º	0.858	1.84	2.65	Horizontal
60º	0.578	0.84	-0.78	Vertical	240º	0.843	1.78	2.49	Horizontal
65º	0.636	1.01	0.05	Vertical	245º	0.845	1.78	2.51	Horizontal
70º	0.695	1.21	0.81	Vertical	250º	0.862	1.86	2.69	Horizontal
75º	0.743	1.38	1.40	Vertical	255º	0.894	2.00	3.01	Horizontal
80º	0.782	1.53	1.84	Vertical	260º	0.939	2.20	3.43	Horizontal
85º	0.811	1.64	2.16	Vertical	265º	0.974	2.37	3.75	Horizontal
90º	0.830	1.72	2.37	Vertical	270º	0.994	2.47	3.93	Horizontal
95º	0.840	1.76	2.47	Vertical	275º	1.000	2.50	3.98	Horizontal
100º	0.843	1.78	2.50	Horizontal	280º	0.992	2.46	3.91	Horizontal
105º	0.845	1.78	2.51	Horizontal	285º	0.975	2.38	3.76	Horizontal
110º	0.834	1.74	2.40	Horizontal	290º	0.949	2.25	3.53	Horizontal
115º	0.812	1.65	2.18	Horizontal	295º	0.914	2.09	3.20	Horizontal
120º	0.780	1.52	1.82	Horizontal	300º	0.881	1.94	2.88	Horizontal
125º	0.737	1.36	1.33	Horizontal	305º	0.856	1.83	2.63	Horizontal
130º	0.683	1.17	0.67	Horizontal	310º	0.842	1.77	2.48	Horizontal
135º	0.624	0.97	-0.12	Horizontal	315º	0.836	1.75	2.42	Horizontal
140º	0.576	0.83	-0.81	Vertical	320º	0.843	1.78	2.49	Horizontal
145º	0.547	0.75	-1.26	Vertical	325º	0.865	1.87	2.72	Vertical
150º	0.526	0.69	-1.60	Vertical	330º	0.910	2.07	3.16	Vertical
155º	0.513	0.66	-1.82	Vertical	335º	0.941	2.21	3.45	Vertical
160º	0.508	0.65	-1.90	Vertical	340º	0.954	2.28	3.57	Vertical
165º	0.515	0.66	-1.79	Vertical	345º	0.946	2.24	3.50	Vertical
170º	0.528	0.70	-1.56	Vertical	350º	0.916	2.10	3.21	Vertical
175º	0.549	0.75	-1.24	Vertical	355º	0.863	1.86	2.70	Vertical

Polarization: **Envelope**
Maximum Field: **1.000 @ 274° True**
Minimum Field: **0.435 @ 36° True**
RMS: **0.773**
Maximum ERP: **2.500 kW**
Maximum Power Gain: **0.759 (-1.199 dB)**

Total Input Power: 3.295 kW

ERI® Horizontal Plane Relative Field Pattern

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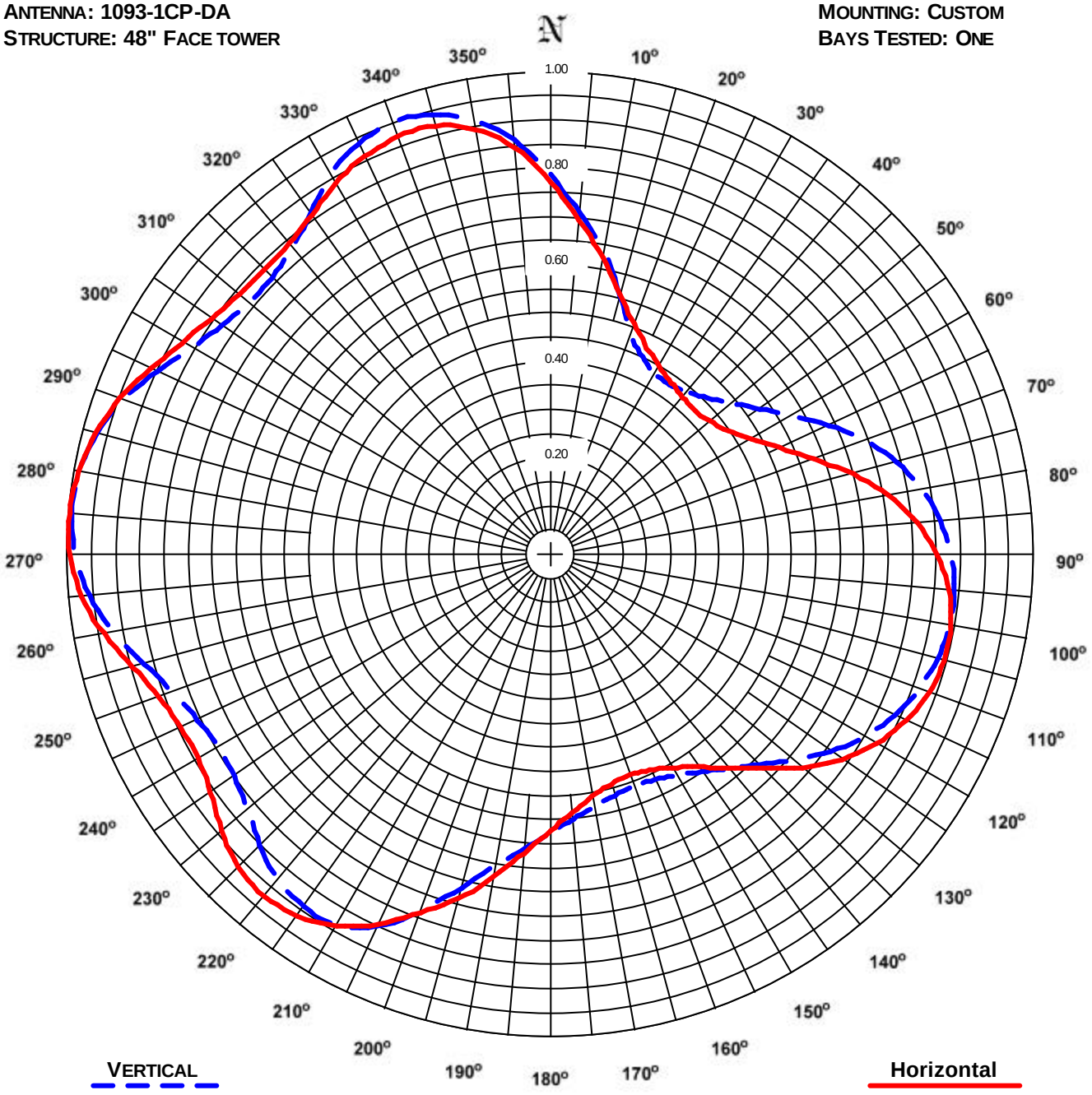
FIGURE NO: 2
STATION: WFCM-FM
LOCATION: MURFREESBORO, TN
ANTENNA: 1093-1CP-DA
STRUCTURE: 48" FACE TOWER

DATE: 6/18/2004
FREQUENCY: 91.7 MHZ
ORIENTATION: 274° TRUE
MOUNTING: CUSTOM
BAYS TESTED: ONE



VERTICAL

RMS: 0.760
MAXIMUM: 0.995 @ 276° TRUE
MINIMUM: 0.432 @ 33° TRUE

Horizontal

RMS: 0.760
Maximum: 1.000 @ 274° True
Minimum: 0.424 @ 45° True

COMMENTS: MEASURED PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONETS.

ERI® Horizontal Plane Relative Field List

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Station: WFCM-FM
Location: Murfreesboro, TN
Frequency: 91.7 MHz

Antenna: 1093-1CP-DA
Orientation: 274° True
Tower: 48" Face tower

Figure: 2
Date: 6/18/2004
Reference: WFCM-FM3m.fig

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.774	1.50	1.75	0.789	1.56	1.92	180°	0.572	0.82	-0.88	0.576	0.83	-0.82
5°	0.697	1.21	0.84	0.711	1.26	1.02	185°	0.619	0.96	-0.18	0.610	0.93	-0.32
10°	0.627	0.98	-0.08	0.641	1.03	0.12	190°	0.678	1.15	0.60	0.650	1.06	0.24
15°	0.560	0.79	-1.05	0.558	0.78	-1.08	195°	0.736	1.35	1.31	0.713	1.27	1.05
20°	0.509	0.65	-1.89	0.486	0.59	-2.29	200°	0.788	1.55	1.91	0.783	1.53	1.85
25°	0.474	0.56	-2.51	0.453	0.51	-2.90	205°	0.843	1.78	2.50	0.848	1.80	2.55
30°	0.453	0.51	-2.91	0.435	0.47	-3.25	210°	0.886	1.96	2.93	0.884	1.95	2.91
35°	0.437	0.48	-3.21	0.433	0.47	-3.30	215°	0.912	2.08	3.18	0.890	1.98	2.96
40°	0.428	0.46	-3.40	0.442	0.49	-3.10	220°	0.922	2.13	3.27	0.876	1.92	2.83
45°	0.424	0.45	-3.47	0.462	0.53	-2.73	225°	0.913	2.08	3.19	0.850	1.80	2.56
50°	0.431	0.47	-3.32	0.491	0.60	-2.20	230°	0.888	1.97	2.95	0.818	1.67	2.24
55°	0.451	0.51	-2.94	0.530	0.70	-1.54	235°	0.858	1.84	2.65	0.799	1.60	2.03
60°	0.482	0.58	-2.35	0.578	0.84	-0.78	240°	0.843	1.78	2.49	0.795	1.58	1.98
65°	0.526	0.69	-1.60	0.636	1.01	0.05	245°	0.845	1.78	2.51	0.806	1.62	2.10
70°	0.582	0.85	-0.73	0.695	1.21	0.81	250°	0.862	1.86	2.69	0.831	1.73	2.37
75°	0.649	1.05	0.23	0.743	1.38	1.40	255°	0.894	2.00	3.01	0.870	1.89	2.77
80°	0.712	1.27	1.03	0.782	1.53	1.84	260°	0.939	2.20	3.43	0.919	2.11	3.25
85°	0.763	1.46	1.63	0.811	1.64	2.16	265°	0.974	2.37	3.75	0.958	2.30	3.61
90°	0.802	1.61	2.06	0.830	1.72	2.37	270°	0.994	2.47	3.93	0.983	2.42	3.83
95°	0.829	1.72	2.35	0.840	1.76	2.47	275°	1.000	2.50	3.98	0.995	2.47	3.93
100°	0.843	1.78	2.50	0.839	1.76	2.46	280°	0.992	2.46	3.91	0.990	2.45	3.89
105°	0.845	1.78	2.51	0.830	1.72	2.36	285°	0.975	2.38	3.76	0.972	2.36	3.74
110°	0.834	1.74	2.40	0.812	1.65	2.17	290°	0.949	2.25	3.53	0.942	2.22	3.46
115°	0.812	1.65	2.18	0.786	1.54	1.88	295°	0.914	2.09	3.20	0.899	2.02	3.05
120°	0.780	1.52	1.82	0.751	1.41	1.50	300°	0.881	1.94	2.88	0.858	1.84	2.65
125°	0.737	1.36	1.33	0.709	1.26	0.99	305°	0.856	1.83	2.63	0.830	1.72	2.37
130°	0.683	1.17	0.67	0.659	1.09	0.36	310°	0.842	1.77	2.48	0.815	1.66	2.20
135°	0.624	0.97	-0.12	0.614	0.94	-0.26	315°	0.836	1.75	2.42	0.814	1.66	2.19
140°	0.575	0.83	-0.83	0.576	0.83	-0.81	320°	0.843	1.78	2.49	0.831	1.73	2.37
145°	0.536	0.72	-1.44	0.547	0.75	-1.26	325°	0.861	1.85	2.68	0.865	1.87	2.72
150°	0.508	0.64	-1.91	0.526	0.69	-1.60	330°	0.889	1.98	2.96	0.910	2.07	3.16
155°	0.491	0.60	-2.21	0.513	0.66	-1.82	335°	0.912	2.08	3.18	0.941	2.21	3.45
160°	0.484	0.59	-2.32	0.508	0.65	-1.90	340°	0.923	2.13	3.28	0.954	2.28	3.57
165°	0.490	0.60	-2.21	0.515	0.66	-1.79	345°	0.921	2.12	3.27	0.946	2.24	3.50
170°	0.507	0.64	-1.92	0.528	0.70	-1.56	350°	0.897	2.01	3.03	0.916	2.10	3.21
175°	0.534	0.71	-1.47	0.549	0.75	-1.24	355°	0.848	1.80	2.54	0.863	1.86	2.70

Polarization:	**Horizontal**	**Vertical**
Maximum Field:	**1.000 @ 274° True**	**0.995 @ 276° True**
Minimum Field:	**0.424 @ 45° True**	**0.432 @ 33° True**
RMS:	**0.760**	**0.760**
Maximum ERP:	**2.500 kW**	**2.475 kW**
Maximum Power Gain:	**0.759 (-1.199 dB)**	**0.751 (-1.242 dB)**

Total Input Power: 3.295 kW

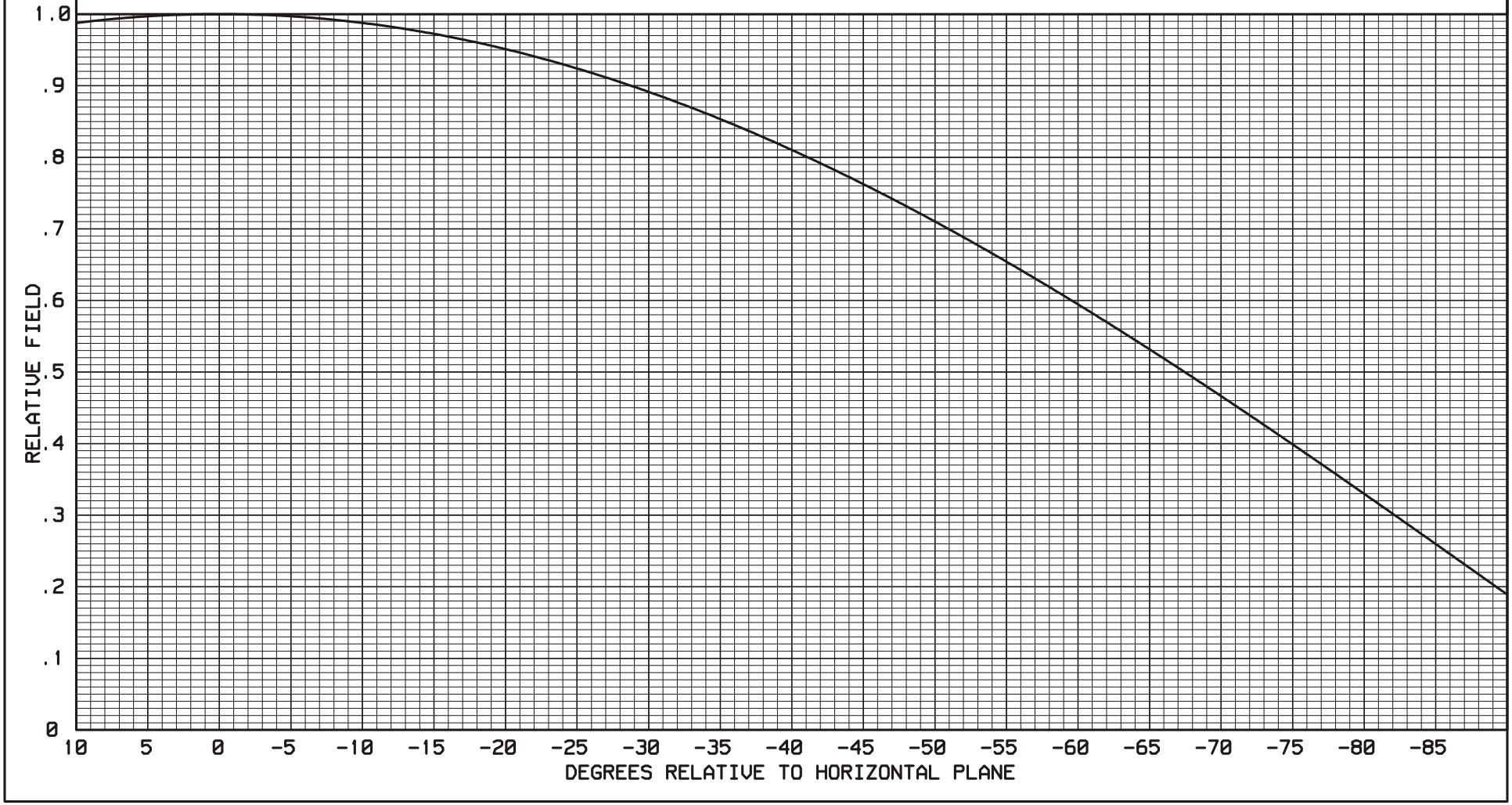
ELECTRONICS RESEARCH,INC.
7777 GARDNER ROAD
CHANDLER, IN. 47610

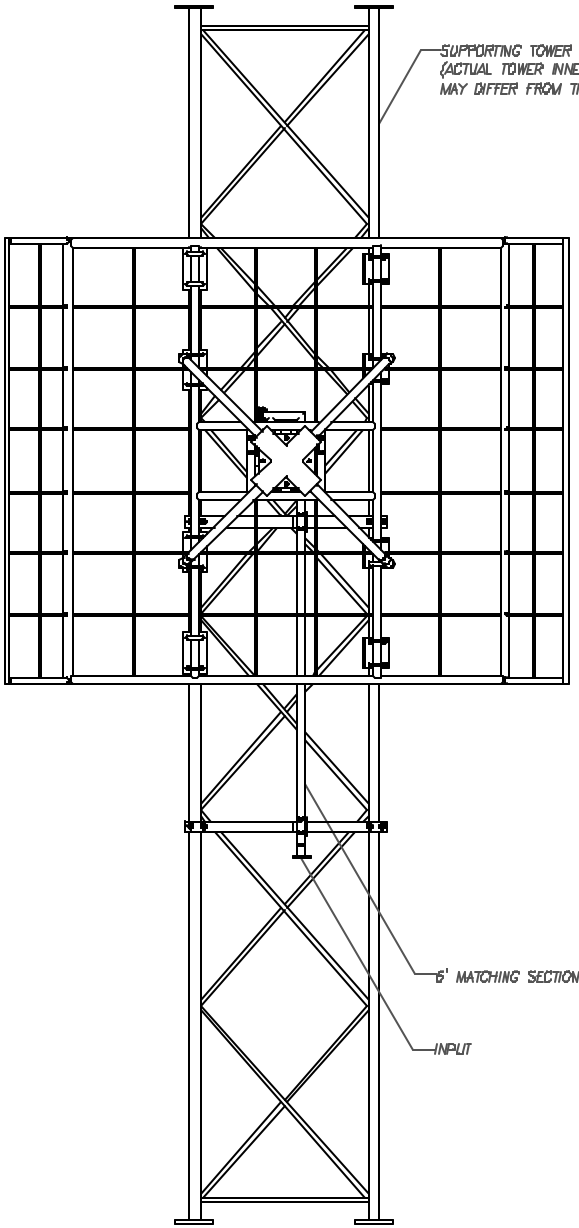
FIGURE 3

----THEORETICAL----
VERTICAL PLANE RELATIVE FIELD

ERI TYPE 1093-1CP-DA ANTENNA

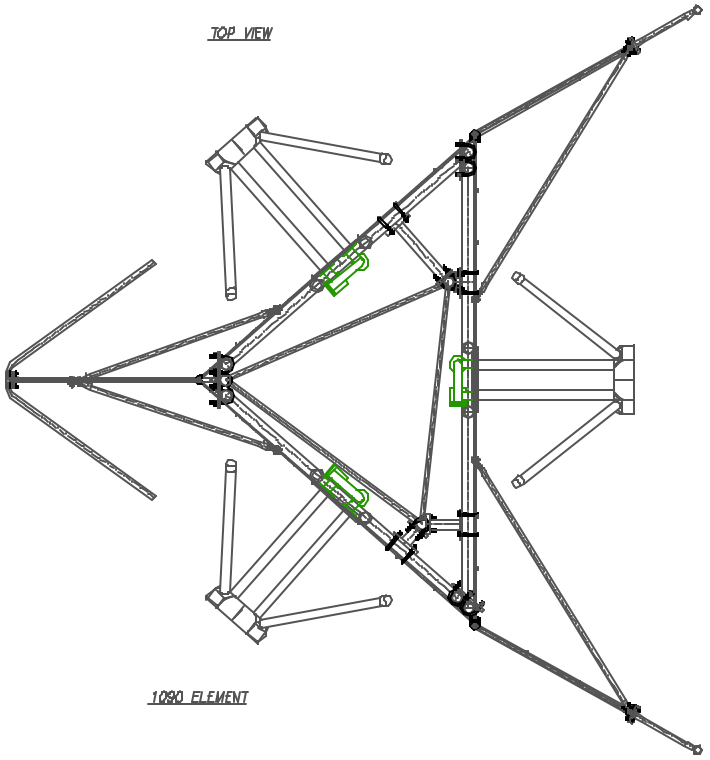
SINGLE LEVEL





ELEVATION VIEW

TOP VIEW



1090 ELEMENT

WFCM Murfreesboro, TN 1093-1CP-DA

Directional Antenna System
for
WFCM-FM, Murfreesboro, Tennessee

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type:	1093-1CP-DA
Frequency:	91.7 MHz
Number of Bays:	one

MECHANICAL SPECIFICATIONS

Mounting:	Custom
System length:	10 ft
Aperture length required:	20 ft.
Orientation:	274° true

Input flange to the antenna 1 5/8 inch female

ELECTRICAL SPECIFICATIONS
(For directional use)

Maximum horizontal ERP:	2.5 kW (3.979 dBk)
Horizontal maximum power gain:	0.759 (-1.199 dB)
Maximum vertical ERP:	2.475 kW (3.937 dBk)
Vertical maximum power gain:	0.751 (-1.242 dB)
Total input power:	3.295 kW (5.179 dBk)