



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  
KSMT, Breckenridge, Colorado***

March 20, 2007

Electronics Research Inc. is providing modifications to an existing FM directional antenna system that is specially designed to meet the FCC requirements and the general needs of radio station KSMT.

The antenna is the ERI model MP-2AE-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. The antenna was mounted on the North 247 degrees East tower leg with bracketry to provide an antenna orientation of North 226 degrees East. The antenna was tested on a 24" Pi-Rod tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 102.1 megahertz, which is the center of the FM broadcast channel assigned to KSMT.

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 KSMT, Breckenridge, Colorado

(Continued)

## DESCRIPTION OF THE TEST PROCEDURE

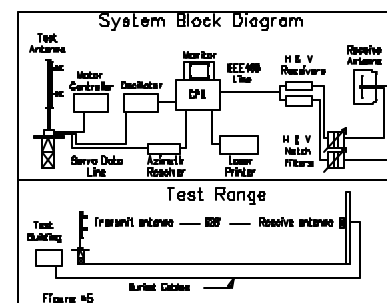
The test antenna consisted of a full-scale model of the complete circular polarized system with the associated horizontal and vertical parasitic elements. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the antenna. A section of 3 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 24" 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 azimuth indicating mechanism, resolution of this azimuth measuring device is one-tenth of a degree.

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 102.1 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.



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For  
KSMT, Breckenridge, Colorado

(Continued)

This data was interfaced to a Hewlett-Packard Laser Jet 4P 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 coordinated 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. 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-2AE-DA-HW array is to be mounted on the North 247 degrees East tower leg of the 24" Pi-Rod tower at a bearing of North 226 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 6 kilowatts (7.782 dBk).

The power at North 30 degrees East does not exceed 0.730 kilowatts (-1.367 dBk).

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

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(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 than 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 19 feet 9 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.

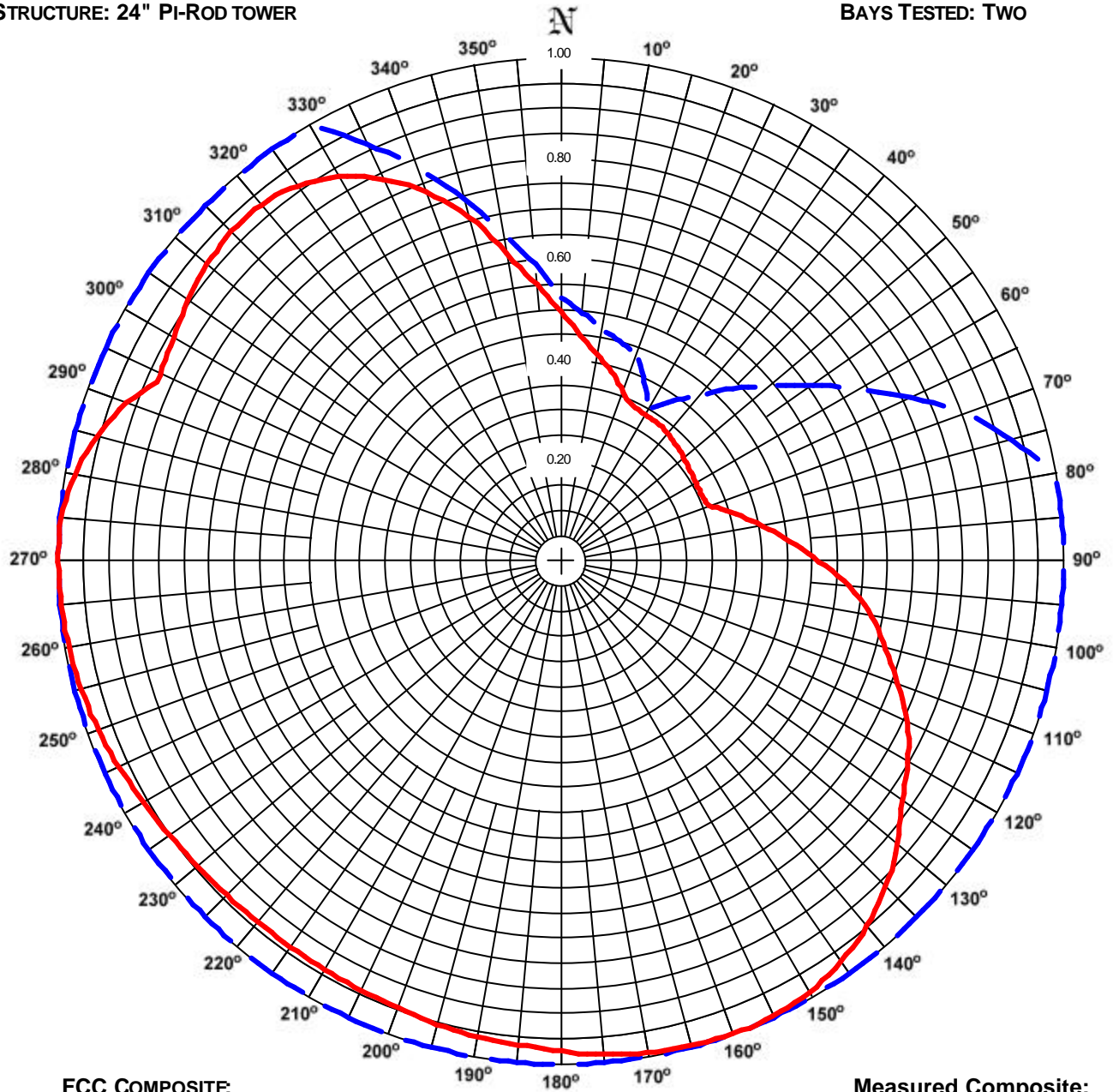


# **ERI**® *Horizontal Plane Relative Field Pattern*

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

FIGURE NO: 1  
STATION: KSMT  
LOCATION: BRECKENRIDGE, CO  
ANTENNA: MP-2AE-DA-HW  
STRUCTURE: 24" PI-ROD TOWER

DATE: 3/20/2007  
FREQUENCY: 102.1 MHz  
ORIENTATION: 226° TRUE  
MOUNTING: CUSTOM  
BAYS TESTED: TWO



FCC COMPOSITE  
RMS: 0.907  
MAXIMUM: 1.000 @ 80° TRUE  
MINIMUM: 0.348 @ 30° TRUE

Measured Composite:  
RMS: 0.800  
Maximum: 1.000 @ 158° True  
Minimum: 0.310 @ 65° True

COMMENTS: COMPOSITE PATTERN: THIS PATTERN SHOWS THE MAXIMUM OF EITHER THE H OR V AZIMUTH VALUES. THIS PATTERN IS GREATER THAN 85% OF THE FCC FILED COMPOSITE PATTERN BPH-20061002BWT.

# **ERI**® *Horizontal Plane Relative Field List*

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**Station: KSMT**  
**Location: Breckenridge, CO**  
**Frequency: 102.1 MHz**

**Antenna: MP-2AE-DA-HW**  
**Orientation: 226° True**  
**Tower: 24" Pi-Rod tower**

**Figure: 1**  
**Date: 3/20/2007**  
**Reference: ksmt2m.fig**

Angle	Envelope			Polarization	Angle	Envelope			Polarization
	Field	kW	dBk			Field	kW	dBk	
0°	0.495	1.47	1.68	Vertical	180°	0.974	5.70	7.56	Vertical
5°	0.452	1.23	0.88	Horizontal	185°	0.965	5.59	7.47	Horizontal
10°	0.418	1.05	0.21	Horizontal	190°	0.960	5.53	7.42	Horizontal
15°	0.390	0.91	-0.39	Horizontal	195°	0.953	5.45	7.36	Horizontal
20°	0.358	0.77	-1.14	Horizontal	200°	0.946	5.37	7.30	Horizontal
25°	0.341	0.70	-1.56	Vertical	205°	0.941	5.31	7.25	Horizontal
30°	0.336	0.68	-1.69	Vertical	210°	0.938	5.28	7.22	Horizontal
35°	0.335	0.67	-1.72	Vertical	215°	0.936	5.26	7.21	Horizontal
40°	0.332	0.66	-1.81	Vertical	220°	0.936	5.26	7.21	Horizontal
45°	0.326	0.64	-1.95	Vertical	225°	0.939	5.29	7.23	Horizontal
50°	0.319	0.61	-2.13	Vertical	230°	0.943	5.34	7.28	Horizontal
55°	0.314	0.59	-2.27	Vertical	235°	0.950	5.41	7.34	Horizontal
60°	0.311	0.58	-2.36	Vertical	240°	0.959	5.51	7.41	Horizontal
65°	0.310	0.58	-2.40	Vertical	245°	0.969	5.64	7.51	Horizontal
70°	0.320	0.62	-2.10	Horizontal	250°	0.979	5.75	7.60	Horizontal
75°	0.361	0.78	-1.06	Horizontal	255°	0.988	5.85	7.67	Horizontal
80°	0.408	1.00	-0.01	Horizontal	260°	0.994	5.92	7.73	Horizontal
85°	0.458	1.26	0.99	Horizontal	265°	0.998	5.97	7.76	Horizontal
90°	0.514	1.59	2.00	Horizontal	270°	1.000	6.00	7.78	Horizontal
95°	0.576	1.99	2.99	Horizontal	275°	0.997	5.97	7.76	Horizontal
100°	0.628	2.37	3.74	Horizontal	280°	0.983	5.80	7.63	Horizontal
105°	0.670	2.69	4.30	Horizontal	285°	0.957	5.49	7.40	Horizontal
110°	0.714	3.06	4.85	Horizontal	290°	0.919	5.06	7.05	Horizontal
115°	0.760	3.47	5.40	Horizontal	295°	0.880	4.64	6.67	Vertical
120°	0.797	3.81	5.81	Horizontal	300°	0.890	4.75	6.77	Vertical
125°	0.829	4.12	6.15	Horizontal	305°	0.905	4.92	6.92	Vertical
130°	0.874	4.58	6.61	Vertical	310°	0.919	5.07	7.05	Vertical
135°	0.914	5.02	7.00	Vertical	315°	0.927	5.15	7.12	Vertical
140°	0.947	5.38	7.31	Vertical	320°	0.926	5.15	7.12	Vertical
145°	0.972	5.67	7.53	Vertical	325°	0.912	4.99	6.98	Vertical
150°	0.989	5.87	7.68	Vertical	330°	0.883	4.68	6.70	Vertical
155°	0.998	5.98	7.77	Vertical	335°	0.839	4.23	6.26	Vertical
160°	1.000	6.00	7.78	Vertical	340°	0.781	3.66	5.64	Vertical
165°	0.997	5.97	7.76	Vertical	345°	0.709	3.02	4.79	Vertical
170°	0.992	5.91	7.71	Vertical	350°	0.622	2.32	3.66	Vertical
175°	0.985	5.82	7.65	Vertical	355°	0.552	1.83	2.62	Vertical

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

**Envelope**  
**1.000 @ 158° True**  
**0.310 @ 65° True**  
**0.800**  
**6.000 kW**  
**1.100 (0.413 dB)**

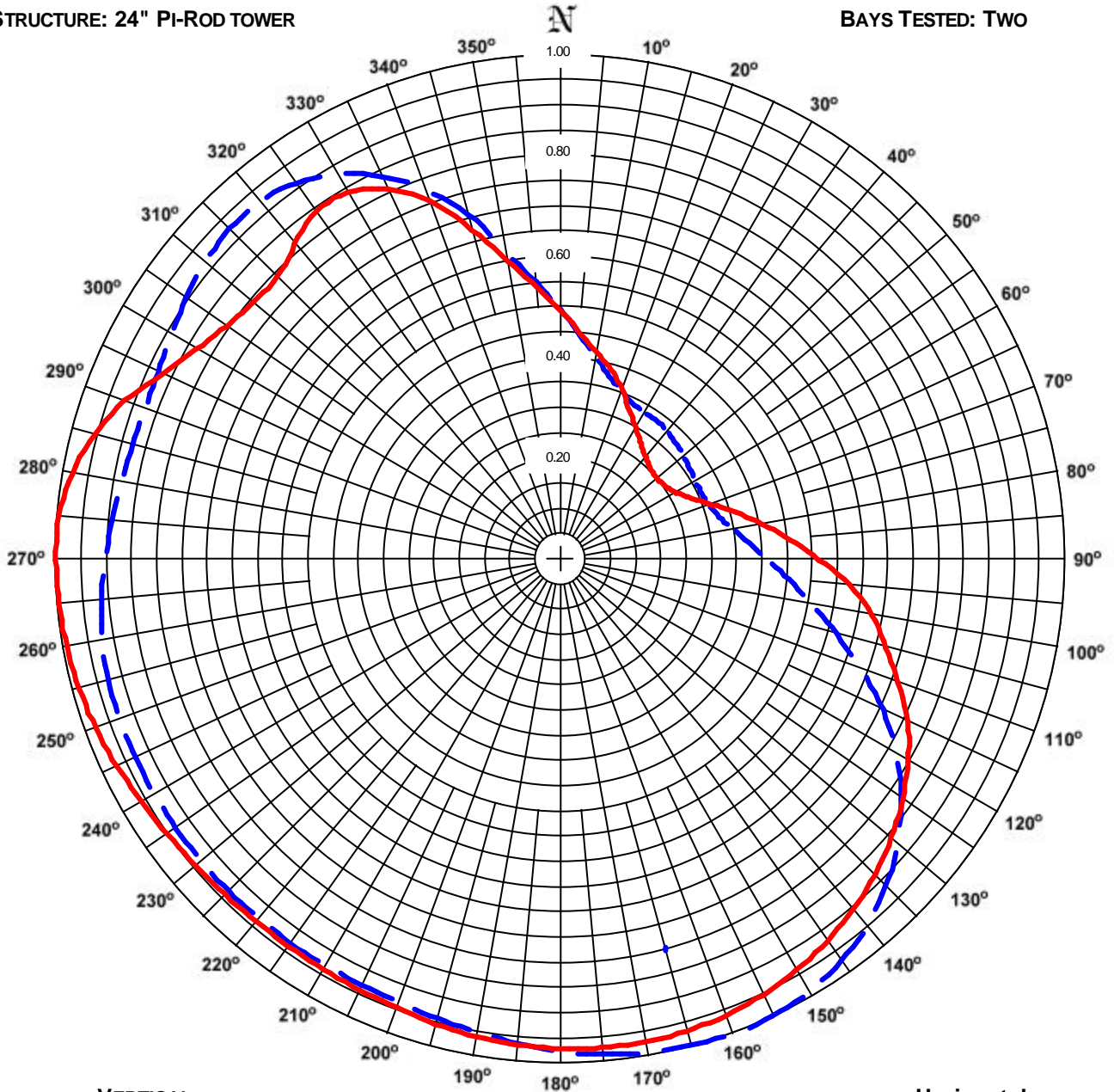
**Total Input Power: 5.455 kW**

# **ERI**® *Horizontal Plane Relative Field Pattern*

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FIGURE NO: 2  
STATION: KSMT  
LOCATION: BRECKENRIDGE, CO  
ANTENNA: MP-2AE-DA-HW  
STRUCTURE: 24" PI-ROD TOWER

DATE: 3/20/2007  
FREQUENCY: 102.1 MHz  
ORIENTATION: 226° TRUE  
MOUNTING: CUSTOM  
BAYS TESTED: TWO



VERTICAL

RMS: 0.777  
MAXIMUM: 1.000 @ 158° TRUE  
MINIMUM: 0.310 @ 65° TRUE

Horizontal

RMS: 0.780  
Maximum: 1.000 @ 272° True  
Minimum: 0.250 @ 51° True

COMMENTS: MEASURE PATTERNS OF THE HORIZONTAL AND VERTICAL COMPONENTS.

# **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: KSMT**

**Location: Breckenridge, CO**

**Frequency: 102.1 MHz**

**Antenna: MP-2AE-DA-HW**

**Orientation: 226° True**

**Tower: 24" Pi-Rod tower**

**Figure: 2**

**Date: 3/20/2007**

**Reference: ksmt2m.fig**

Angle	Horizontal			Vertical			Angle	Horizontal			Vertical		
	Field	kW	dBk	Field	kW	dBk		Field	kW	dBk	Field	kW	dBk
0°	0.495	1.47	1.67	0.495	1.47	1.68	180°	0.969	5.63	7.50	0.974	5.70	7.56
5°	0.452	1.23	0.88	0.447	1.20	0.79	185°	0.965	5.59	7.47	0.962	5.55	7.44
10°	0.418	1.05	0.21	0.408	1.00	-0.01	190°	0.960	5.53	7.42	0.950	5.42	7.34
15°	0.390	0.91	-0.39	0.377	0.85	-0.69	195°	0.953	5.45	7.36	0.941	5.31	7.25
20°	0.358	0.77	-1.14	0.355	0.76	-1.22	200°	0.946	5.37	7.30	0.935	5.24	7.19
25°	0.327	0.64	-1.94	0.341	0.70	-1.56	205°	0.941	5.31	7.25	0.930	5.19	7.16
30°	0.300	0.54	-2.66	0.336	0.68	-1.69	210°	0.938	5.28	7.22	0.929	5.18	7.14
35°	0.280	0.47	-3.29	0.335	0.67	-1.72	215°	0.936	5.26	7.21	0.929	5.18	7.14
40°	0.264	0.42	-3.77	0.332	0.66	-1.81	220°	0.936	5.26	7.21	0.929	5.18	7.14
45°	0.255	0.39	-4.10	0.326	0.64	-1.95	225°	0.939	5.29	7.23	0.929	5.18	7.14
50°	0.250	0.38	-4.25	0.319	0.61	-2.13	230°	0.943	5.34	7.28	0.929	5.18	7.14
55°	0.254	0.39	-4.13	0.314	0.59	-2.27	235°	0.950	5.41	7.34	0.929	5.18	7.14
60°	0.267	0.43	-3.70	0.311	0.58	-2.36	240°	0.959	5.51	7.41	0.929	5.18	7.14
65°	0.289	0.50	-3.00	0.310	0.58	-2.40	245°	0.969	5.64	7.51	0.929	5.18	7.14
70°	0.320	0.62	-2.10	0.314	0.59	-2.27	250°	0.979	5.75	7.60	0.929	5.18	7.14
75°	0.361	0.78	-1.06	0.327	0.64	-1.93	255°	0.988	5.85	7.67	0.927	5.16	7.12
80°	0.408	1.00	-0.01	0.348	0.72	-1.40	260°	0.994	5.92	7.73	0.922	5.10	7.08
85°	0.458	1.26	0.99	0.376	0.85	-0.72	265°	0.998	5.97	7.76	0.914	5.01	7.00
90°	0.514	1.59	2.00	0.412	1.02	0.08	270°	1.000	6.00	7.78	0.902	4.89	6.89
95°	0.576	1.99	2.99	0.456	1.25	0.96	275°	0.997	5.97	7.76	0.891	4.76	6.78
100°	0.628	2.37	3.74	0.508	1.55	1.90	280°	0.983	5.80	7.63	0.883	4.68	6.70
105°	0.670	2.69	4.30	0.568	1.94	2.87	285°	0.957	5.49	7.40	0.878	4.62	6.65
110°	0.714	3.06	4.85	0.636	2.42	3.85	290°	0.919	5.06	7.05	0.876	4.60	6.63
115°	0.760	3.47	5.40	0.707	3.00	4.76	295°	0.872	4.56	6.59	0.880	4.64	6.67
120°	0.797	3.81	5.81	0.770	3.56	5.51	300°	0.834	4.17	6.20	0.890	4.75	6.77
125°	0.829	4.12	6.15	0.826	4.09	6.12	305°	0.808	3.91	5.93	0.905	4.92	6.92
130°	0.857	4.41	6.44	0.874	4.58	6.61	310°	0.793	3.78	5.77	0.919	5.07	7.05
135°	0.882	4.67	6.69	0.914	5.02	7.00	315°	0.794	3.78	5.77	0.927	5.15	7.12
140°	0.904	4.91	6.91	0.947	5.38	7.31	320°	0.818	4.02	6.04	0.926	5.15	7.12
145°	0.923	5.11	7.09	0.972	5.67	7.53	325°	0.843	4.26	6.30	0.912	4.99	6.98
150°	0.939	5.29	7.24	0.989	5.87	7.68	330°	0.840	4.23	6.27	0.883	4.68	6.70
155°	0.952	5.43	7.35	0.998	5.98	7.77	335°	0.810	3.94	5.95	0.839	4.23	6.26
160°	0.961	5.54	7.44	1.000	6.00	7.78	340°	0.755	3.42	5.35	0.781	3.66	5.64
165°	0.967	5.62	7.49	0.997	5.97	7.76	345°	0.678	2.76	4.41	0.709	3.02	4.79
170°	0.971	5.65	7.52	0.992	5.91	7.71	350°	0.602	2.18	3.38	0.622	2.32	3.66
175°	0.971	5.65	7.52	0.985	5.82	7.65	355°	0.543	1.77	2.48	0.552	1.83	2.62

**Polarization:**

**Maximum Field:**

**Minimum Field:**

**RMS:**

**Maximum ERP:**

**Maximum Power Gain:**

**Horizontal**

**1.000 @ 272° True**

**0.250 @ 51° True**

**0.780**

**6.000 kW**

**1.100 (0.413 dB)**

**Vertical**

**1.000 @ 158° True**

**0.310 @ 65° True**

**0.777**

**6.000 kW**

**1.100 (0.413 dB)**

**Total Input Power: 5.455 kW**



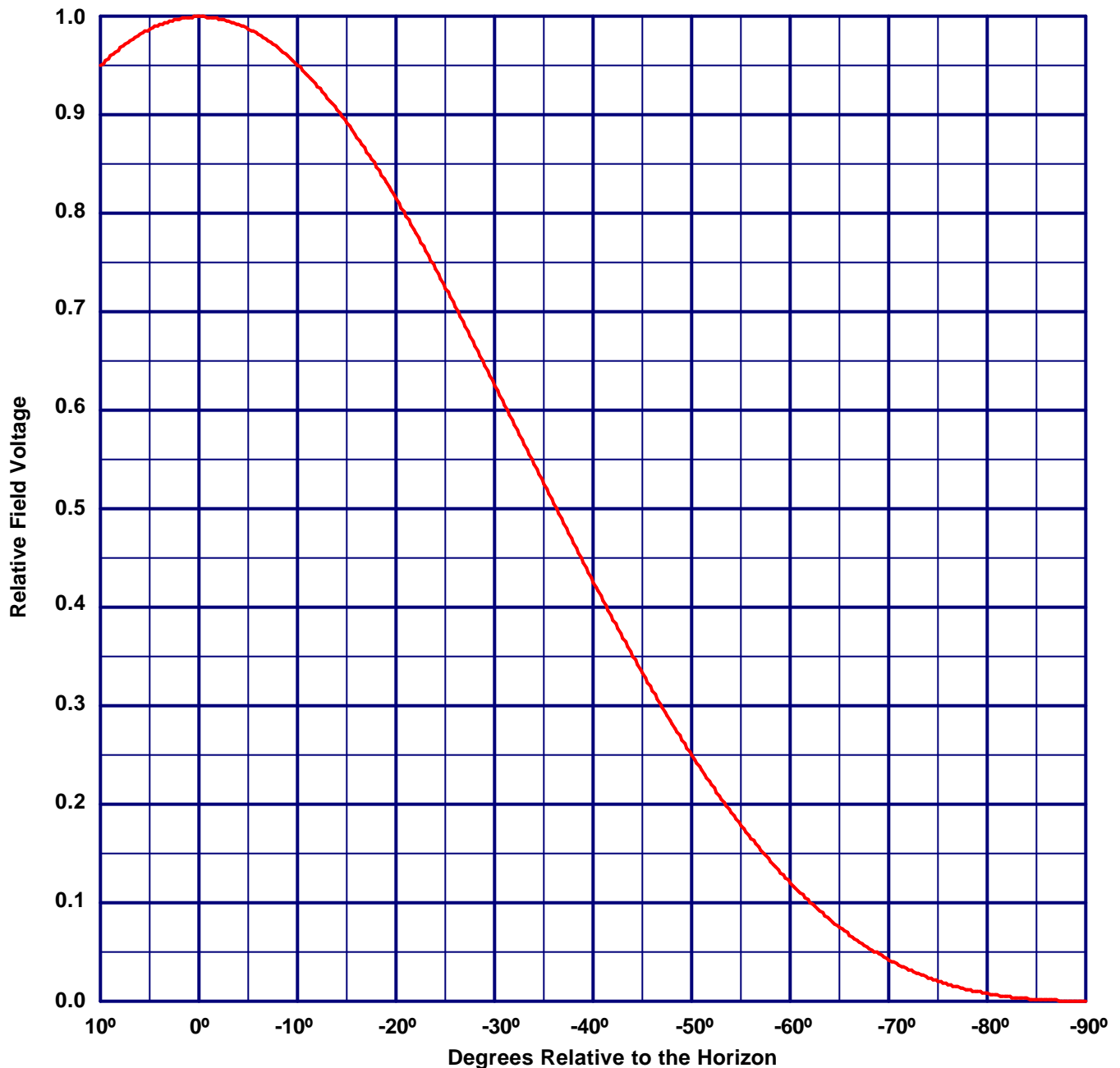
## Vertical Plane Relative Field Pattern

**KSMT, Breckenridge, CO, 102.1 MHz**

**Figure#: 3**

**Date: 3/20/2007**

**A 2 level, .5 wave-length spaced MP-2AE-DA-HW directional antenna  
with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.000**



**Vertical Polarization Gain:**

**Maximum: 1.100 (0.413 dB)**

**Horizontal Plane: 1.100 (0.413 dB)**

**Horizontal Polarization Gain:**

**Maximum: 1.100 (0.413 dB)**

**Horizontal Plane: 1.100 (0.413 dB)**

# Directional Antenna System for KSMT, Breckenridge, Colorado

(Continued)

## ANTENNA SPECIFICATIONS

Antenna Type: MP-2E-DA-HW  
Frequency: 102.1 MHz  
Number of Bays: 2

## MECHANICAL SPECIFICATIONS

Mounting: Custom  
System length: 13 ft 2 in  
Aperture length required: 19 ft 9 in.  
Orientation: 226° true  
Input flange to the antenna 3 1/8 inch female

## ELECTRICAL SPECIFICATIONS

(For directional use)

Maximum horizontal ERP: 6 kW (7.782 dBk)  
Horizontal maximum power gain: 1.100 (0.413 dB)  
Maximum vertical ERP: 6 kW (7.782 dBk)  
Vertical maximum power gain: 1.100 (0.413 dB)  
Total input power: 5.455 kW (7.368 dBk)

