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 KJRF, Lawton, Oklahoma*

October 27, 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 KJRF.

The antenna is the ERI model MP-8C-DA-HW configuration. The circular polarized system consists of 8 half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and two vertical parasitic elements interleaved between alternate bay pairs. The antenna was mounted on the North 220 degrees East tower face with bracketry to provide an antenna orientation of North 220 degrees East. The antenna was tested on a 24" face tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 91.1 megahertz, which is the center of the FM broadcast channel assigned to KJRF.

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
# KJRF, Lawton, Oklahoma

(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 24" 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 a US Digital angle position indicator. The resolution of this angle position indicator is one-hundredth of a degree.

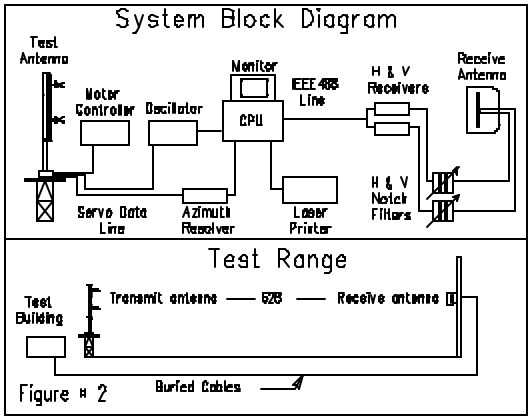


Figure # 2

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 91.1 MHz and was constantly monitored by a Rohde & Schwarz ESVD 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.

(Continued)

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 8 half-wavelength spaced bays using one driven circular polarized radiating element per bay, two horizontal parasitic elements per bay and two 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-8C-DA-HW array is to be mounted on the North 220 degrees East tower face of the 24" face tower at a bearing of North 220 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 100 kilowatts (20.000 dBk).

The power at North 30 degrees East does not exceed 4.900 kilowatts (6.902 dBk).

The power at North 120 degrees East does not exceed 8.700 kilowatts (9.395 dBk).

(Continued)

The power at North 280 degrees East does not exceed 59.000 kilowatts (17.709 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 that 85% of the filed composite pattern.

The clear vertical length of the structure required to support the antenna is 52 ft 8 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.

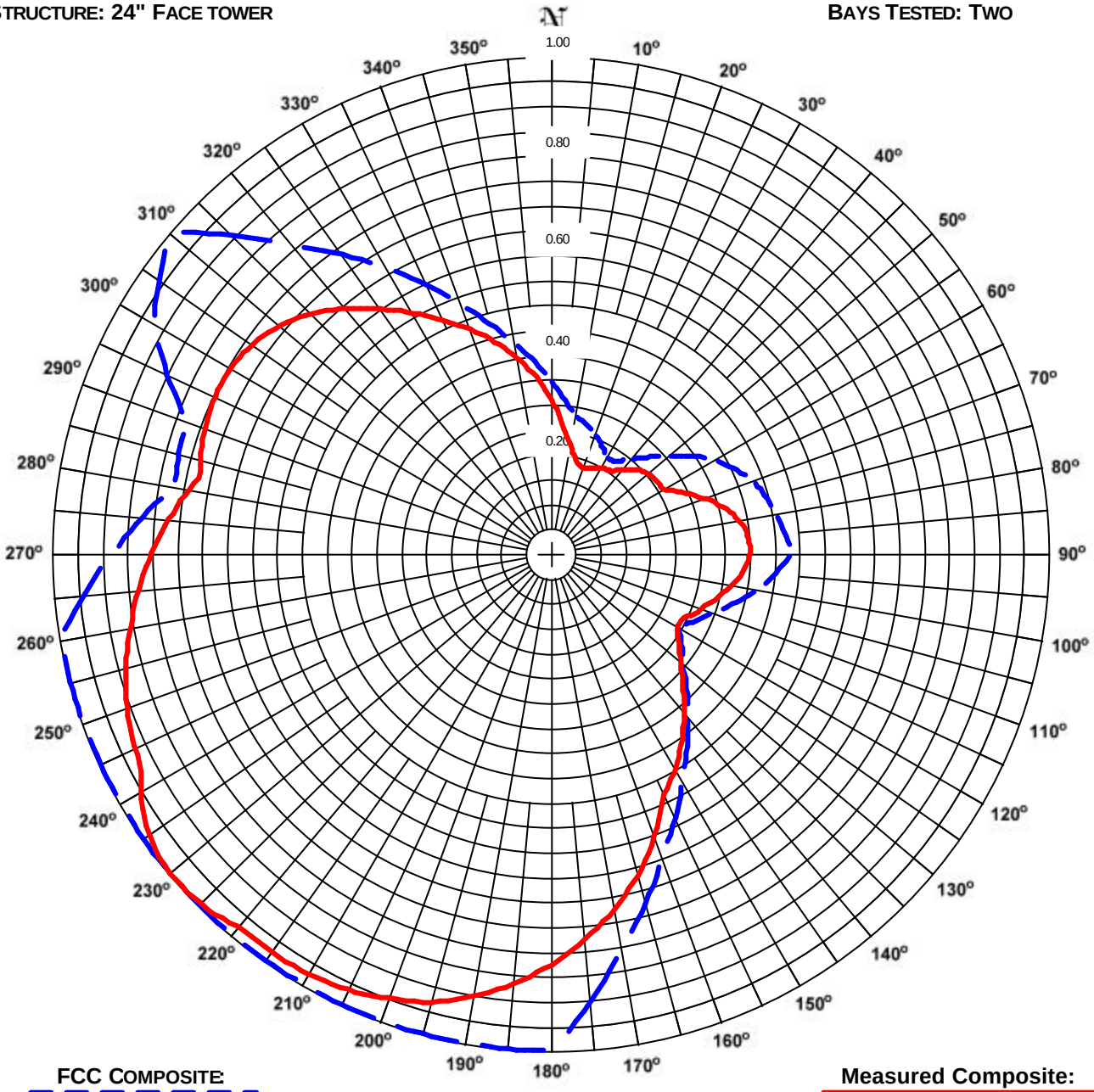
ELECTRONICS RESEARCH, INC.

# 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: KJRF**
**LOCATION: LAWTON, OK**
**ANTENNA: MP-8C-HW-DA**
**STRUCTURE: 24" FACE TOWER**

**DATE: 10/26/2009**
**FREQUENCY: 91.1 MHZ**
**ORIENTATION: 220° TRUE**
**MOUNTING: CUSTOM**
**BAYS TESTED: TWO**




**FCC COMPOSITE:**
**RMS: 0.699**
**MAXIMUM: 1.000 @ 180° TRUE**
**MINIMUM: 0.222 @ 30° TRUE**

**Measured Composite:**
**RMS: 0.629**
**Maximum: 1.000 @ 229° True**
**Minimum: 0.183 @ 21° 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 BMPED-20090529AKR.**

# 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: KJRF**
**Location: Lawton, OK**
**Frequency: 91.1 MHz**

**Antenna: MP-8C-HW-DA**
**Orientation: 220° True**
**Tower: 24" Face tower**

**Figure: 1**
**Date: 10/26/2009**
**Reference: kjrf1m.fig**

| Angle | Envelope | | | Polarization | Angle | Envelope | | | Polarization |
|---|---|---|---|---|---|---|---|---|---|
| | Field | kW | dBk | | | Field | kW | dBk | |
| 0º | 0.308 | 9.47 | 9.76 | Horizontal | 180º | 0.827 | 68.38 | 18.35 | Vertical |
| 5º | 0.261 | 6.79 | 8.32 | Horizontal | 185º | 0.869 | 75.43 | 18.78 | Vertical |
| 10º | 0.220 | 4.84 | 6.85 | Horizontal | 190º | 0.904 | 81.72 | 19.12 | Vertical |
| 15º | 0.193 | 3.72 | 5.70 | Horizontal | 195º | 0.934 | 87.15 | 19.40 | Vertical |
| 20º | 0.183 | 3.34 | 5.24 | Horizontal | 200º | 0.952 | 90.68 | 19.58 | Vertical |
| 25º | 0.187 | 3.50 | 5.44 | Horizontal | 205º | 0.968 | 93.72 | 19.72 | Vertical |
| 30º | 0.196 | 3.86 | 5.87 | Horizontal | 210º | 0.977 | 95.44 | 19.80 | Vertical |
| 35º | 0.203 | 4.14 | 6.16 | Horizontal | 215º | 0.980 | 96.00 | 19.82 | Vertical |
| 40º | 0.219 | 4.80 | 6.82 | Vertical | 220º | 0.981 | 96.22 | 19.83 | Horizontal |
| 45º | 0.237 | 5.62 | 7.50 | Vertical | 225º | 0.995 | 99.08 | 19.96 | Horizontal |
| 50º | 0.249 | 6.22 | 7.94 | Vertical | 230º | 1.000 | 99.95 | 20.00 | Horizontal |
| 55º | 0.256 | 6.56 | 8.17 | Vertical | 235º | 0.987 | 97.36 | 19.88 | Horizontal |
| 60º | 0.257 | 6.60 | 8.20 | Vertical | 240º | 0.953 | 90.82 | 19.58 | Horizontal |
| 65º | 0.288 | 8.32 | 9.20 | Horizontal | 245º | 0.923 | 85.17 | 19.30 | Vertical |
| 70º | 0.324 | 10.48 | 10.21 | Horizontal | 250º | 0.906 | 82.12 | 19.14 | Vertical |
| 75º | 0.356 | 12.70 | 11.04 | Horizontal | 255º | 0.884 | 78.19 | 18.93 | Vertical |
| 80º | 0.382 | 14.56 | 11.63 | Horizontal | 260º | 0.858 | 73.58 | 18.67 | Vertical |
| 85º | 0.396 | 15.70 | 11.96 | Horizontal | 265º | 0.832 | 69.24 | 18.40 | Vertical |
| 90º | 0.399 | 15.91 | 12.02 | Horizontal | 270º | 0.802 | 64.39 | 18.09 | Vertical |
| 95º | 0.389 | 15.15 | 11.80 | Horizontal | 275º | 0.771 | 59.42 | 17.74 | Vertical |
| 100º | 0.370 | 13.67 | 11.36 | Horizontal | 280º | 0.737 | 54.39 | 17.35 | Vertical |
| 105º | 0.345 | 11.93 | 10.77 | Horizontal | 285º | 0.729 | 53.13 | 17.25 | Horizontal |
| 110º | 0.323 | 10.45 | 10.19 | Horizontal | 290º | 0.739 | 54.65 | 17.38 | Horizontal |
| 115º | 0.302 | 9.14 | 9.61 | Horizontal | 295º | 0.745 | 55.49 | 17.44 | Horizontal |
| 120º | 0.293 | 8.61 | 9.35 | Horizontal | 300º | 0.743 | 55.21 | 17.42 | Horizontal |
| 125º | 0.312 | 9.75 | 9.89 | Horizontal | 305º | 0.731 | 53.50 | 17.28 | Horizontal |
| 130º | 0.340 | 11.53 | 10.62 | Horizontal | 310º | 0.710 | 50.43 | 17.03 | Horizontal |
| 135º | 0.374 | 14.00 | 11.46 | Horizontal | 315º | 0.679 | 46.12 | 16.64 | Horizontal |
| 140º | 0.415 | 17.20 | 12.36 | Horizontal | 320º | 0.641 | 41.07 | 16.13 | Horizontal |
| 145º | 0.457 | 20.90 | 13.20 | Horizontal | 325º | 0.599 | 35.84 | 15.54 | Horizontal |
| 150º | 0.498 | 24.82 | 13.95 | Horizontal | 330º | 0.556 | 30.93 | 14.90 | Horizontal |
| 155º | 0.535 | 28.67 | 14.57 | Horizontal | 335º | 0.516 | 26.63 | 14.25 | Horizontal |
| 160º | 0.606 | 36.68 | 15.64 | Vertical | 340º | 0.478 | 22.84 | 13.59 | Horizontal |
| 165º | 0.670 | 44.89 | 16.52 | Vertical | 345º | 0.439 | 19.29 | 12.85 | Horizontal |
| 170º | 0.727 | 52.84 | 17.23 | Vertical | 350º | 0.398 | 15.86 | 12.00 | Horizontal |
| 175º | 0.778 | 60.53 | 17.82 | Vertical | 355º | 0.354 | 12.56 | 10.99 | Horizontal |

**Polarization:** **Envelope**
**Maximum Field:** **1.000 @ 229° True**
**Minimum Field:** **0.183 @ 21° True**
**RMS:** **0.629**
**Maximum ERP:** **100.000 kW**
**Maximum Power Gain:** **6.838 (8.349 dB)**

**Total Input Power: 14.625 kW**

# ERI® Horizontal Plane Relative Field Pattern

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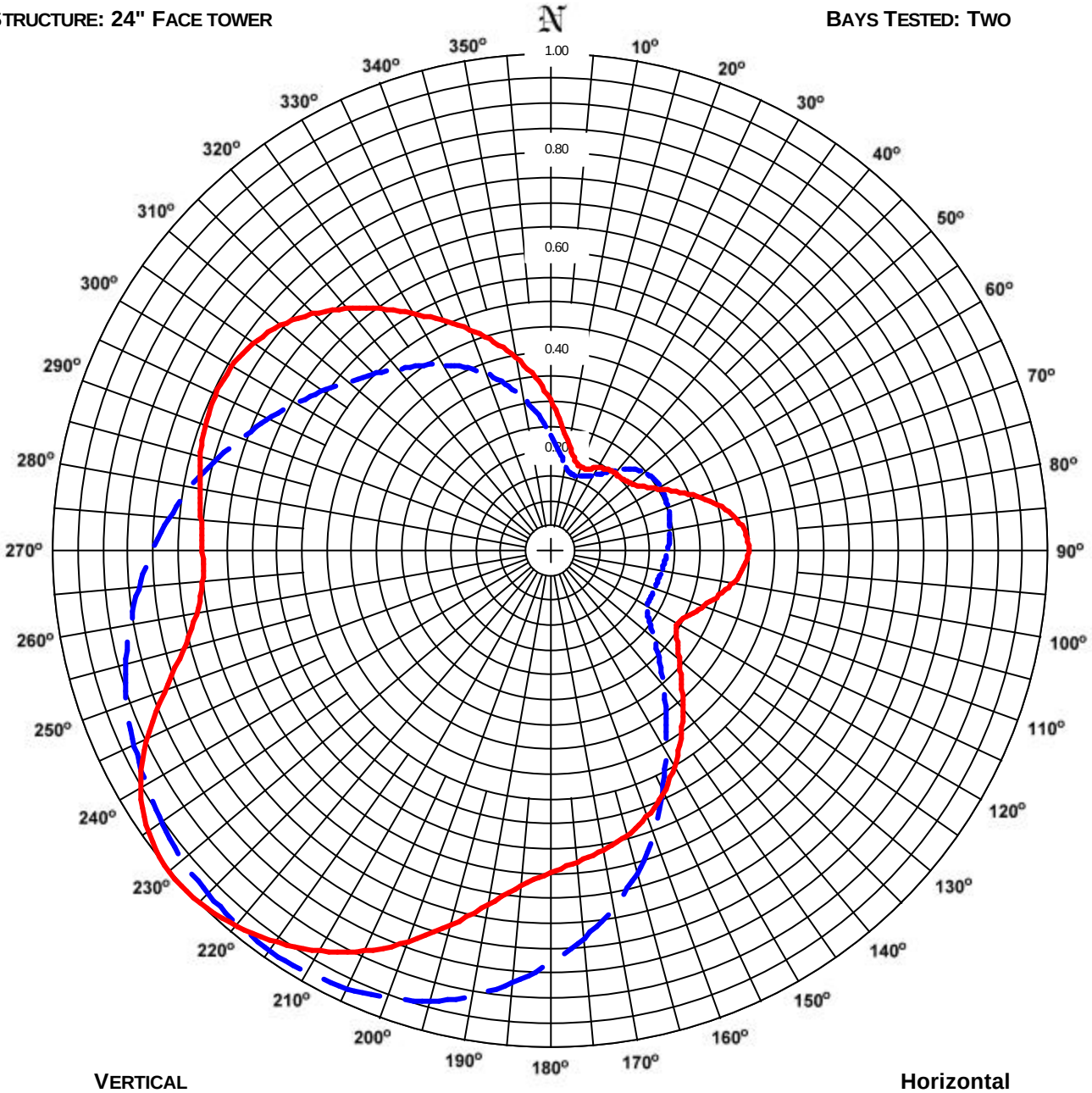
**FIGURE NO: 2**
**STATION: KJRF**
**LOCATION: LAWTON, OK**
**ANTENNA: MP-8C-HW-DA**
**STRUCTURE: 24" FACE TOWER**

**DATE: 10/26/2009**
**FREQUENCY: 91.1 MHZ**
**ORIENTATION: 220° TRUE**
**MOUNTING: CUSTOM**
**BAYS TESTED: TWO**




**VERTICAL**

**RMS: 0.592**
**MAXIMUM: 0.980 @ 214° TRUE**
**MINIMUM: 0.163 @ 17° TRUE**

**Horizontal**

**RMS: 0.592**
**Maximum: 1.000 @ 229° True**
**Minimum: 0.183 @ 21° True**

**COMMENTS: MEASURED 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: KJRF**
**Location: Lawton, OK**
**Frequency: 91.1 MHz**

**Antenna: MP-8C-HW-DA**
**Orientation: 220° True**
**Tower: 24" Face tower**

**Figure: 2**
**Date: 10/26/2009**
**Reference: kjrf1m.fig**

| Angle | Horizontal | | | Vertical | | | Angle | Horizontal | | | Vertical | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Field | kW | dBk | Field | kW | dBk | | Field | kW | dBk | Field | kW | dBk |
| 0º | 0.308 | 9.47 | 9.76 | 0.237 | 5.64 | 7.51 | 180º | 0.644 | 41.47 | 16.18 | 0.827 | 68.38 | 18.35 |
| 5º | 0.261 | 6.79 | 8.32 | 0.204 | 4.15 | 6.19 | 185º | 0.672 | 45.20 | 16.55 | 0.869 | 75.43 | 18.78 |
| 10º | 0.220 | 4.84 | 6.85 | 0.177 | 3.14 | 4.96 | 190º | 0.718 | 51.61 | 17.13 | 0.904 | 81.72 | 19.12 |
| 15º | 0.193 | 3.72 | 5.70 | 0.164 | 2.70 | 4.31 | 195º | 0.775 | 60.05 | 17.79 | 0.934 | 87.15 | 19.40 |
| 20º | 0.183 | 3.34 | 5.24 | 0.164 | 2.69 | 4.30 | 200º | 0.833 | 69.37 | 18.41 | 0.952 | 90.68 | 19.58 |
| 25º | 0.187 | 3.50 | 5.44 | 0.170 | 2.88 | 4.59 | 205º | 0.883 | 78.03 | 18.92 | 0.968 | 93.72 | 19.72 |
| 30º | 0.196 | 3.86 | 5.87 | 0.181 | 3.27 | 5.15 | 210º | 0.925 | 85.55 | 19.32 | 0.977 | 95.44 | 19.80 |
| 35º | 0.203 | 4.14 | 6.16 | 0.198 | 3.91 | 5.92 | 215º | 0.957 | 91.67 | 19.62 | 0.980 | 96.00 | 19.82 |
| 40º | 0.206 | 4.25 | 6.28 | 0.219 | 4.80 | 6.82 | 220º | 0.981 | 96.22 | 19.83 | 0.978 | 95.57 | 19.80 |
| 45º | 0.208 | 4.34 | 6.38 | 0.237 | 5.62 | 7.50 | 225º | 0.995 | 99.08 | 19.96 | 0.973 | 94.62 | 19.76 |
| 50º | 0.215 | 4.64 | 6.67 | 0.249 | 6.22 | 7.94 | 230º | 1.000 | 99.95 | 20.00 | 0.965 | 93.04 | 19.69 |
| 55º | 0.231 | 5.33 | 7.27 | 0.256 | 6.56 | 8.17 | 235º | 0.987 | 97.36 | 19.88 | 0.953 | 90.87 | 19.58 |
| 60º | 0.256 | 6.54 | 8.16 | 0.257 | 6.60 | 8.20 | 240º | 0.953 | 90.82 | 19.58 | 0.938 | 88.04 | 19.45 |
| 65º | 0.288 | 8.32 | 9.20 | 0.255 | 6.51 | 8.14 | 245º | 0.898 | 80.67 | 19.07 | 0.923 | 85.17 | 19.30 |
| 70º | 0.324 | 10.48 | 10.21 | 0.253 | 6.38 | 8.05 | 250º | 0.828 | 68.50 | 18.36 | 0.906 | 82.12 | 19.14 |
| 75º | 0.356 | 12.70 | 11.04 | 0.249 | 6.21 | 7.93 | 255º | 0.766 | 58.66 | 17.68 | 0.884 | 78.19 | 18.93 |
| 80º | 0.382 | 14.56 | 11.63 | 0.245 | 6.00 | 7.78 | 260º | 0.724 | 52.40 | 17.19 | 0.858 | 73.58 | 18.67 |
| 85º | 0.396 | 15.70 | 11.96 | 0.240 | 5.75 | 7.60 | 265º | 0.703 | 49.39 | 16.94 | 0.832 | 69.24 | 18.40 |
| 90º | 0.399 | 15.91 | 12.02 | 0.235 | 5.50 | 7.41 | 270º | 0.700 | 48.98 | 16.90 | 0.802 | 64.39 | 18.09 |
| 95º | 0.389 | 15.15 | 11.80 | 0.230 | 5.29 | 7.24 | 275º | 0.705 | 49.73 | 16.97 | 0.771 | 59.42 | 17.74 |
| 100º | 0.370 | 13.67 | 11.36 | 0.226 | 5.12 | 7.09 | 280º | 0.716 | 51.23 | 17.09 | 0.737 | 54.39 | 17.35 |
| 105º | 0.345 | 11.93 | 10.77 | 0.223 | 4.99 | 6.98 | 285º | 0.729 | 53.13 | 17.25 | 0.702 | 49.33 | 16.93 |
| 110º | 0.323 | 10.45 | 10.19 | 0.221 | 4.89 | 6.90 | 290º | 0.739 | 54.65 | 17.38 | 0.665 | 44.21 | 16.45 |
| 115º | 0.302 | 9.14 | 9.61 | 0.220 | 4.84 | 6.84 | 295º | 0.745 | 55.49 | 17.44 | 0.631 | 39.77 | 16.00 |
| 120º | 0.293 | 8.61 | 9.35 | 0.223 | 4.99 | 6.98 | 300º | 0.743 | 55.21 | 17.42 | 0.596 | 35.48 | 15.50 |
| 125º | 0.312 | 9.75 | 9.89 | 0.243 | 5.93 | 7.73 | 305º | 0.731 | 53.50 | 17.28 | 0.564 | 31.78 | 15.02 |
| 130º | 0.340 | 11.53 | 10.62 | 0.274 | 7.48 | 8.74 | 310º | 0.710 | 50.43 | 17.03 | 0.534 | 28.53 | 14.55 |
| 135º | 0.374 | 14.00 | 11.46 | 0.311 | 9.67 | 9.85 | 315º | 0.679 | 46.12 | 16.64 | 0.507 | 25.67 | 14.09 |
| 140º | 0.415 | 17.20 | 12.36 | 0.356 | 12.65 | 11.02 | 320º | 0.641 | 41.07 | 16.13 | 0.482 | 23.23 | 13.66 |
| 145º | 0.457 | 20.90 | 13.20 | 0.407 | 16.60 | 12.20 | 325º | 0.599 | 35.84 | 15.54 | 0.459 | 21.04 | 13.23 |
| 150º | 0.498 | 24.82 | 13.95 | 0.467 | 21.77 | 13.38 | 330º | 0.556 | 30.93 | 14.90 | 0.437 | 19.05 | 12.80 |
| 155º | 0.535 | 28.67 | 14.57 | 0.533 | 28.39 | 14.53 | 335º | 0.516 | 26.63 | 14.25 | 0.412 | 16.96 | 12.29 |
| 160º | 0.566 | 32.09 | 15.06 | 0.606 | 36.68 | 15.64 | 340º | 0.478 | 22.84 | 13.59 | 0.385 | 14.83 | 11.71 |
| 165º | 0.590 | 34.82 | 15.42 | 0.670 | 44.89 | 16.52 | 345º | 0.439 | 19.29 | 12.85 | 0.352 | 12.39 | 10.93 |
| 170º | 0.608 | 36.95 | 15.68 | 0.727 | 52.84 | 17.23 | 350º | 0.398 | 15.86 | 12.00 | 0.316 | 10.00 | 10.00 |
| 175º | 0.624 | 38.97 | 15.91 | 0.778 | 60.53 | 17.82 | 355º | 0.354 | 12.56 | 10.99 | 0.278 | 7.72 | 8.87 |

| **Polarization:** | **Horizontal** | **Vertical** |
|---|---|---|
| **Maximum Field:** | **1.000 @ 229° True** | **0.980 @ 214° True** |
| **Minimum Field:** | **0.183 @ 21° True** | **0.163 @ 17° True** |
| **RMS:** | **0.592** | **0.592** |
| **Maximum ERP:** | **100.000 kW** | **96.049 kW** |
| **Maximum Power Gain:** | **6.838 (8.349 dB)** | **6.567 (8.174 dB)** |

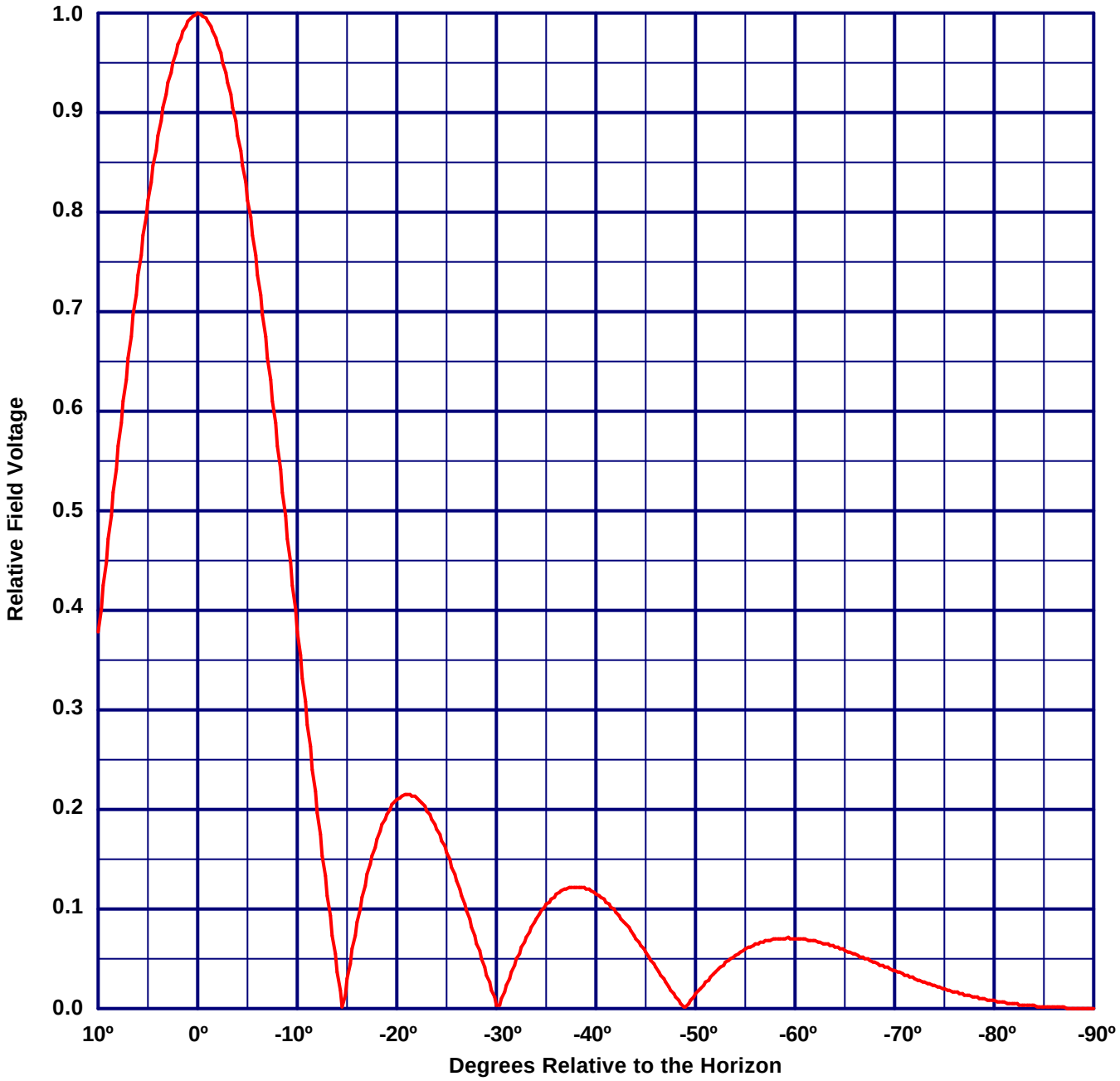
**Total Input Power: 14.625 kW**

# Vertical Plane Relative Field Pattern

## KJRF, Lawton, OK, 91.1 MHz

**Figure#: 3 Date: 10/26/2009**

***An 8 level, .5 wave-length spaced MP-8C-DA-HW directional antenna with 0° beam tilt, 0% null fill and a H/V maximum power ratio of 1.041***




| Vertical Polarization Gain: | Horizontal Polarization Gain: |
|---|---|
| Maximum: 6.838 (8.349 dB) | Maximum: 6.838 (8.349 dB) |
| Horizontal Plane: 6.838 (8.349 dB) | Horizontal Plane: 6.838 (8.349 dB) |

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# Directional Antenna System
# for
# KJRF, Lawton, Oklahoma

(Continued)

## ANTENNA SPECIFICATIONS

| | |
|---|---|
| Antenna Type: | MP-8C-DA-HW |
| Frequency: | 91.1 MHz |
| Number of Bays: | Eight |

## MECHANICAL SPECIFICATIONS

| | |
|---|---|
| Mounting: | Custom |
| System length: | 41 ft 8 in |
| Aperture length required: | 52 ft 8 in |
| Orientation: | 220° true |

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

## ELECTRICAL SPECIFICATIONS
(For directional use)

| | |
|---|---|
| Maximum horizontal ERP: | 100 kW (20 dBk) |
| Horizontal maximum power gain: | 6.838 (8.349 dB) |
| Maximum vertical ERP: | 96.049 kW (19.825 dBk) |
| Vertical maximum power gain: | 6.567 (8.174 dB) |
| Total input power: | 14.626 kW (11.651 dBk) |