

Directional Antenna System for KQKS, Lakewood, Colorado

July 7, 2017

Electronics Research Inc. is providing a custom fabricated diplexed antenna system that is specially designed to meet the FCC requirements and the general needs of radio station KQKS.

The antenna is the ERI model 1051-2CP-DA-SP configuration. The circular polarized system consists of two 60" spaced bays using one driven circular polarized radiating element per bay. The antenna was mounted on the North 60 degrees East tower leg with bracketry to provide an antenna orientation of North 70 degrees East. The antenna was tested on a Stainless G 8 tower, which is the structure the station plans to use to support the array. All tests were performed on a frequency of 107.5 megahertz, which is the center of the FM broadcast channel assigned to KQKS. The antenna system is diplexed with KQMT, Denver, Colorado at 99.5 MHz.

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.



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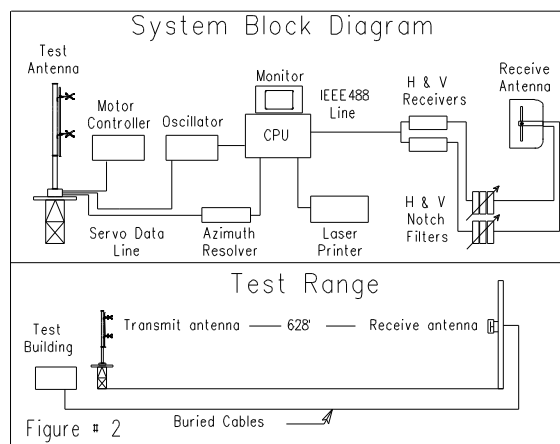
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DESCRIPTION OF THE TEST PROCEDURE

The test antenna consisted of one bay level of the circular polarized system. The elements and brackets that were used in this test are electrically equivalent to those that will be supplied with the antenna.

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 Stainless G 8 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.



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 107.5 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. 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.

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(Continued)

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 coordinated graph paper in a clockwise direction. Both horizontal and vertical components were recorded separately.

CONCLUSIONS

The circular polarized system consists of two 60" spaced bays using one driven circular polarized radiating element per bay. The power distribution and phase relationship will be fixed when the antenna is manufactured. Proper maintenance of the elements should be all that is required to maintain the pattern in adjustment.

The 1051-2CP-DA-SP array is to be mounted on the North 60 degrees East tower leg of the Stainless G 8 tower at a bearing of North 70 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 measured individual horizontal and vertical components, the composite maximum of either the horizontal or vertical component at any azimuth and the FCC filed envelope pattern. The horizontal plane relative field list for the composite pattern and the individual H & V components are shown as Figure #1 & 1A respectively. 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 33.000 kilowatts (15.185 dBk).

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

The clear vertical length of the structure required to support the antenna is 25 feet if the antenna is to be top mounted.

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.

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For
KQKS, Lakewood, Colorado

(Continued)

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.

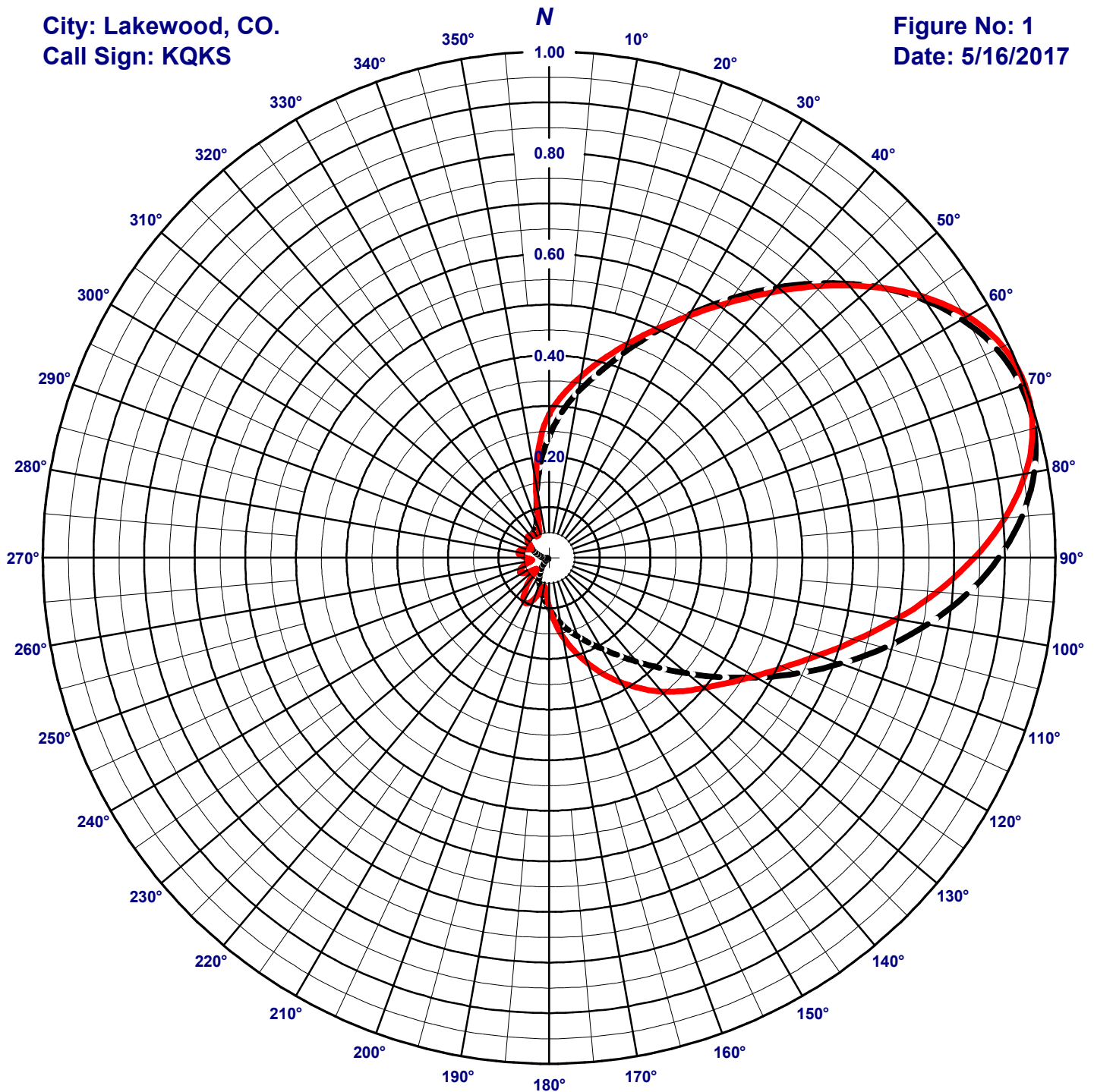
A handwritten signature in black ink, appearing to read "Tom Schaefer". The signature is fluid and cursive, with the first name "Tom" and last name "Schaefer" clearly distinguishable.

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ERI[®] Horizontal Plane Relative Field Pattern

City: Lakewood, CO.
Call Sign: KQKS

Figure No: 1
Date: 5/16/2017



Frequency: 107.5 MHz
Antenna Type: 1051-2CP-DA-SP
Antenna Orientation: 70° True
Antenna Mounting: Custom
Tower Type Stainless G 8 tower

VERTICAL
RMS: .44
Maximum: .994 @ 73°
Minimum: .004 @ 253°

HORIZONTAL
RMS: .44
Maximum: 1 @ 70°
Minimum: .033 @ 228°

Measured patterns of the horizontal and vertical components.

ERI[®] Horizontal Plane Relative Field Pattern

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Figure# 1

Station: KQKS

Location: Lakewood, CO.

Frequency: 107.5 MHz

Date: 5/16/2017

Antenna: 1051-2CP-DA-SP

Antenna Orientation: 70° True

Number of Bays: 2

| Azimuth | Envelope | | | Polarization | Azimuth | Envelope | | | Polarization |
|---------|----------|--------|--------|--------------|---------|----------|-------|---------|--------------|
| | Field | kW | dBk | | | Field | kW | dBk | |
| 0° | 0.284 | 2.656 | 4.242 | Horizontal | 180° | 0.101 | 0.337 | -4.725 | Vertical |
| 5° | 0.324 | 3.466 | 5.398 | Horizontal | 185° | 0.087 | 0.252 | -5.978 | Vertical |
| 10° | 0.364 | 4.372 | 6.406 | Horizontal | 190° | 0.076 | 0.188 | -7.250 | Vertical |
| 15° | 0.405 | 5.411 | 7.333 | Horizontal | 195° | 0.070 | 0.161 | -7.930 | Horizontal |
| 20° | 0.449 | 6.650 | 8.228 | Horizontal | 200° | 0.088 | 0.253 | -5.965 | Horizontal |
| 25° | 0.498 | 8.178 | 9.127 | Horizontal | 205° | 0.099 | 0.323 | -4.905 | Horizontal |
| 30° | 0.555 | 10.175 | 10.075 | Vertical | 210° | 0.100 | 0.329 | -4.834 | Horizontal |
| 35° | 0.624 | 12.869 | 11.095 | Vertical | 215° | 0.086 | 0.243 | -6.135 | Horizontal |
| 40° | 0.696 | 15.995 | 12.040 | Vertical | 220° | 0.063 | 0.131 | -8.827 | Horizontal |
| 45° | 0.767 | 19.435 | 12.886 | Vertical | 225° | 0.040 | 0.052 | -12.873 | Horizontal |
| 50° | 0.834 | 22.973 | 13.612 | Vertical | 230° | 0.035 | 0.039 | -14.050 | Horizontal |
| 55° | 0.900 | 26.745 | 14.272 | Horizontal | 235° | 0.048 | 0.076 | -11.166 | Horizontal |
| 60° | 0.954 | 30.038 | 14.777 | Horizontal | 240° | 0.061 | 0.122 | -9.135 | Horizontal |
| 65° | 0.989 | 32.255 | 15.086 | Horizontal | 245° | 0.064 | 0.135 | -8.684 | Horizontal |
| 70° | 1.000 | 33.000 | 15.185 | Horizontal | 250° | 0.058 | 0.110 | -9.590 | Horizontal |
| 75° | 0.992 | 32.459 | 15.113 | Vertical | 255° | 0.046 | 0.070 | -11.574 | Horizontal |
| 80° | 0.973 | 31.226 | 14.945 | Vertical | 260° | 0.036 | 0.043 | -13.695 | Horizontal |
| 85° | 0.937 | 28.990 | 14.622 | Vertical | 265° | 0.036 | 0.044 | -13.598 | Horizontal |
| 90° | 0.888 | 26.048 | 14.158 | Vertical | 270° | 0.046 | 0.071 | -11.475 | Horizontal |
| 95° | 0.828 | 22.620 | 13.545 | Vertical | 275° | 0.057 | 0.107 | -9.696 | Horizontal |
| 100° | 0.759 | 19.012 | 12.790 | Vertical | 280° | 0.062 | 0.125 | -9.015 | Horizontal |
| 105° | 0.686 | 15.546 | 11.916 | Vertical | 285° | 0.059 | 0.114 | -9.445 | Horizontal |
| 110° | 0.612 | 12.377 | 10.926 | Vertical | 290° | 0.049 | 0.080 | -10.964 | Horizontal |
| 115° | 0.541 | 9.657 | 9.848 | Vertical | 295° | 0.040 | 0.054 | -12.678 | Horizontal |
| 120° | 0.473 | 7.393 | 8.688 | Vertical | 300° | 0.041 | 0.056 | -12.530 | Vertical |
| 125° | 0.432 | 6.145 | 7.885 | Horizontal | 305° | 0.048 | 0.077 | -11.151 | Horizontal |
| 130° | 0.400 | 5.275 | 7.222 | Horizontal | 310° | 0.056 | 0.103 | -9.885 | Horizontal |
| 135° | 0.373 | 4.583 | 6.612 | Horizontal | 315° | 0.059 | 0.115 | -9.380 | Horizontal |
| 140° | 0.345 | 3.931 | 5.945 | Horizontal | 320° | 0.058 | 0.111 | -9.562 | Horizontal |
| 145° | 0.315 | 3.283 | 5.162 | Horizontal | 325° | 0.057 | 0.109 | -9.641 | Vertical |
| 150° | 0.284 | 2.671 | 4.267 | Horizontal | 330° | 0.060 | 0.118 | -9.282 | Vertical |
| 155° | 0.254 | 2.127 | 3.278 | Horizontal | 335° | 0.064 | 0.137 | -8.633 | Vertical |
| 160° | 0.222 | 1.623 | 2.104 | Horizontal | 340° | 0.073 | 0.176 | -7.533 | Vertical |
| 165° | 0.190 | 1.192 | 0.764 | Horizontal | 345° | 0.095 | 0.297 | -5.272 | Vertical |
| 170° | 0.159 | 0.836 | -0.777 | Horizontal | 350° | 0.149 | 0.729 | -1.373 | Horizontal |
| 175° | 0.128 | 0.542 | -2.658 | Horizontal | 355° | 0.224 | 1.661 | 2.205 | Horizontal |

Horizontal Polarization:

Maximum: 3.687 (5.667 dB)

Horizontal Plane: 3.687 (5.667 dB)

Maximum ERP: 33.000 kW

Vertical Polarization:

Maximum: 3.642 (5.614 dB)

Horizontal Plane: 3.642 (5.614 dB)

Maximum ERP: 32.600 kW

Total Input Power: 8.951 kW

Reference: KQKS1M.FIG

This list shows the the maximum azimuth values of either the horizontal or vertical components.

ERI[®] Horizontal Plane Relative Field Pattern

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Figure# 1A

Date: 5/16/2017

Station: KQKS

Antenna: 1051-2CP-DA-SP

Location: Lakewood, CO.

Antenna Orientation: 70° True

Frequency: 107.5 MHz

Number of Bays: 2

| Azimuth | Horizontal | | | Vertical | | | Azimuth | Horizontal | | | Vertical | | |
|---------|------------|--------|--------|----------|--------|--------|---------|------------|-------|---------|----------|-------|---------|
| | Field | kW | dBk | Field | kW | dBk | | Field | kW | dBk | Field | kW | dBk |
| 0° | 0.284 | 2.656 | 4.242 | 0.241 | 1.910 | 2.811 | 180° | 0.097 | 0.308 | -5.119 | 0.101 | 0.337 | -4.725 |
| 5° | 0.324 | 3.466 | 5.398 | 0.288 | 2.746 | 4.387 | 185° | 0.068 | 0.154 | -8.112 | 0.087 | 0.252 | -5.978 |
| 10° | 0.364 | 4.372 | 6.406 | 0.334 | 3.680 | 5.658 | 190° | 0.058 | 0.111 | -9.547 | 0.076 | 0.188 | -7.250 |
| 15° | 0.405 | 5.411 | 7.333 | 0.378 | 4.712 | 6.732 | 195° | 0.070 | 0.161 | -7.930 | 0.065 | 0.141 | -8.498 |
| 20° | 0.449 | 6.650 | 8.228 | 0.431 | 6.119 | 7.867 | 200° | 0.088 | 0.253 | -5.965 | 0.056 | 0.104 | -9.843 |
| 25° | 0.498 | 8.178 | 9.127 | 0.490 | 7.937 | 8.997 | 205° | 0.099 | 0.323 | -4.905 | 0.047 | 0.072 | -11.419 |
| 30° | 0.552 | 10.053 | 10.023 | 0.555 | 10.175 | 10.075 | 210° | 0.100 | 0.329 | -4.834 | 0.037 | 0.046 | -13.391 |
| 35° | 0.614 | 12.445 | 10.950 | 0.624 | 12.869 | 11.095 | 215° | 0.086 | 0.243 | -6.135 | 0.028 | 0.025 | -15.988 |
| 40° | 0.685 | 15.472 | 11.895 | 0.696 | 15.995 | 12.040 | 220° | 0.063 | 0.131 | -8.827 | 0.018 | 0.011 | -19.655 |
| 45° | 0.759 | 19.030 | 12.794 | 0.767 | 19.435 | 12.886 | 225° | 0.040 | 0.052 | -12.873 | 0.009 | 0.003 | -25.317 |
| 50° | 0.833 | 22.882 | 13.595 | 0.834 | 22.973 | 13.612 | 230° | 0.035 | 0.039 | -14.050 | 0.005 | 0.001 | -31.480 |
| 55° | 0.900 | 26.745 | 14.272 | 0.894 | 26.359 | 14.209 | 235° | 0.048 | 0.076 | -11.166 | 0.004 | 0.001 | -32.704 |
| 60° | 0.954 | 30.038 | 14.777 | 0.942 | 29.259 | 14.663 | 240° | 0.061 | 0.122 | -9.135 | 0.005 | 0.001 | -30.453 |
| 65° | 0.989 | 32.255 | 15.086 | 0.976 | 31.413 | 14.971 | 245° | 0.064 | 0.135 | -8.684 | 0.005 | 0.001 | -30.948 |
| 70° | 1.000 | 33.000 | 15.185 | 0.992 | 32.468 | 15.115 | 250° | 0.058 | 0.110 | -9.590 | 0.004 | 0.000 | -33.348 |
| 75° | 0.988 | 32.212 | 15.080 | 0.992 | 32.459 | 15.113 | 255° | 0.046 | 0.070 | -11.574 | 0.004 | 0.000 | -33.401 |
| 80° | 0.955 | 30.113 | 14.788 | 0.973 | 31.226 | 14.945 | 260° | 0.036 | 0.043 | -13.695 | 0.006 | 0.001 | -29.962 |
| 85° | 0.904 | 26.939 | 14.304 | 0.937 | 28.990 | 14.622 | 265° | 0.036 | 0.044 | -13.598 | 0.008 | 0.002 | -26.504 |
| 90° | 0.840 | 23.274 | 13.669 | 0.888 | 26.048 | 14.158 | 270° | 0.046 | 0.071 | -11.475 | 0.011 | 0.004 | -23.704 |
| 95° | 0.770 | 19.582 | 12.919 | 0.828 | 22.620 | 13.545 | 275° | 0.057 | 0.107 | -9.696 | 0.015 | 0.007 | -21.429 |
| 100° | 0.697 | 16.044 | 12.053 | 0.759 | 19.012 | 12.790 | 280° | 0.062 | 0.125 | -9.015 | 0.018 | 0.011 | -19.545 |
| 105° | 0.628 | 13.001 | 11.140 | 0.686 | 15.546 | 11.916 | 285° | 0.059 | 0.114 | -9.445 | 0.023 | 0.017 | -17.689 |
| 110° | 0.565 | 10.522 | 10.221 | 0.612 | 12.377 | 10.926 | 290° | 0.049 | 0.080 | -10.964 | 0.029 | 0.027 | -15.611 |
| 115° | 0.512 | 8.649 | 9.370 | 0.541 | 9.657 | 9.848 | 295° | 0.040 | 0.054 | -12.678 | 0.035 | 0.040 | -13.961 |
| 120° | 0.468 | 7.231 | 8.592 | 0.473 | 7.393 | 8.688 | 300° | 0.041 | 0.055 | -12.616 | 0.041 | 0.056 | -12.530 |
| 125° | 0.432 | 6.145 | 7.885 | 0.411 | 5.579 | 7.466 | 305° | 0.048 | 0.077 | -11.151 | 0.047 | 0.074 | -11.322 |
| 130° | 0.400 | 5.275 | 7.222 | 0.356 | 4.172 | 6.203 | 310° | 0.056 | 0.103 | -9.885 | 0.052 | 0.090 | -10.468 |
| 135° | 0.373 | 4.583 | 6.612 | 0.308 | 3.127 | 4.951 | 315° | 0.059 | 0.115 | -9.380 | 0.055 | 0.101 | -9.956 |
| 140° | 0.345 | 3.931 | 5.945 | 0.268 | 2.370 | 3.747 | 320° | 0.058 | 0.111 | -9.562 | 0.057 | 0.105 | -9.769 |
| 145° | 0.315 | 3.283 | 5.162 | 0.235 | 1.817 | 2.592 | 325° | 0.054 | 0.094 | -10.248 | 0.057 | 0.109 | -9.641 |
| 150° | 0.284 | 2.671 | 4.267 | 0.207 | 1.419 | 1.521 | 330° | 0.049 | 0.081 | -10.931 | 0.060 | 0.118 | -9.282 |
| 155° | 0.254 | 2.127 | 3.278 | 0.185 | 1.125 | 0.512 | 335° | 0.050 | 0.081 | -10.898 | 0.064 | 0.137 | -8.633 |
| 160° | 0.222 | 1.623 | 2.104 | 0.166 | 0.905 | -0.431 | 340° | 0.057 | 0.108 | -9.648 | 0.073 | 0.176 | -7.533 |
| 165° | 0.190 | 1.192 | 0.764 | 0.148 | 0.725 | -1.394 | 345° | 0.086 | 0.244 | -6.134 | 0.095 | 0.297 | -5.272 |
| 170° | 0.159 | 0.836 | -0.777 | 0.132 | 0.572 | -2.429 | 350° | 0.149 | 0.729 | -1.373 | 0.137 | 0.619 | -2.085 |
| 175° | 0.128 | 0.542 | -2.658 | 0.116 | 0.442 | -3.542 | 355° | 0.224 | 1.661 | 2.205 | 0.190 | 1.189 | 0.753 |

Horizontal Polarization:

Maximum: 3.687 (5.667 dB)

Horizontal Plane: 3.687 (5.667 dB)

Maximum ERP: 33.000 kW

Vertical Polarization:

Maximum: 3.642 (5.614 dB)

Horizontal Plane: 3.642 (5.614 dB)

Maximum ERP: 32.600 kW

Total Input Power: 8.951 kW

Reference: KQKS1M.FIG

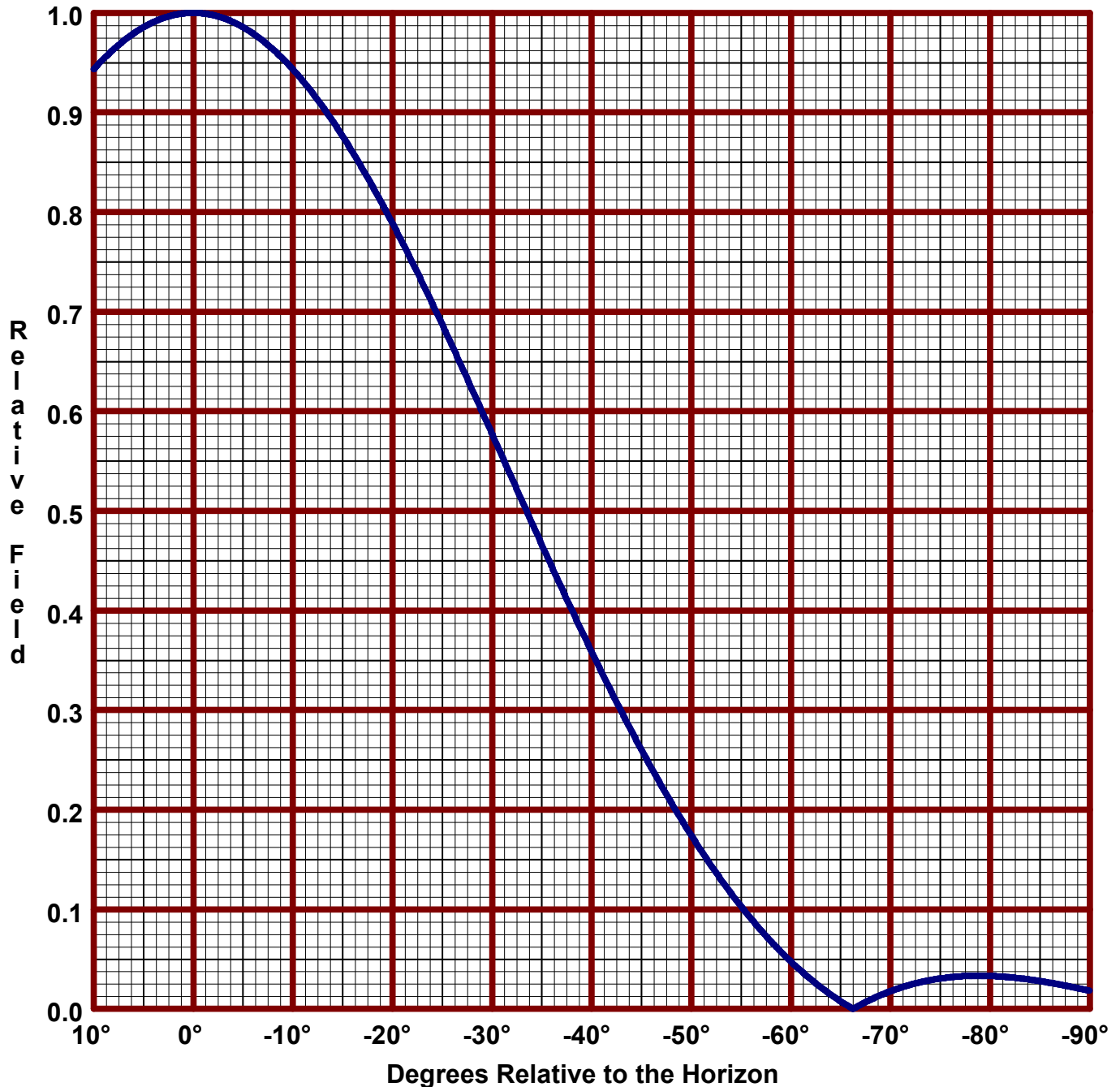
This list shows the azimuth values for the horizontal and vertical components.

ERI[®] Vertical Plane Relative Field Pattern

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Figure No: 3
Call Sign: KQKS
Location: Lakewood, CO.
Frequency: 107.5 MHz
Antenna: 2 bay 1051-2CP-DA

Date: 5/16/2017
H/V Power Ratio: 1
.548 Wave-length Spacing
0° Beam Tilt
0% First Null Fill



Horizontal Polarization:
Maximum: 3.687 (5.667 dB)
Horizontal Plane: 3.687 (5.667 dB)
Maximum ERP: 33.000 kW

Vertical Polarization:
Maximum: 3.642 (5.614 dB)
Horizontal Plane: 3.642 (5.614 dB)
Maximum ERP: 32.600 kW

Directional Antenna System for KQKS, Lakewood, Colorado

(Continued)

ANTENNA SPECIFICATIONS

Antenna Type: 1051-2C-DA-SP
Frequency: 107.5 MHz
Number of Bays: Two

MECHANICAL SPECIFICATIONS

Mounting: Custom
System length: 15 ft 5 in
Aperture length required: 25
Orientation: 70° true
Input flange to the antenna 6 1/8" female.

ELECTRICAL SPECIFICATIONS (For directional use)

| | |
|--------------------------------|------------------------|
| Maximum horizontal ERP: | 33.00 kW (15.185 dBk) |
| Horizontal maximum power gain: | 3.687 (5.667 dB) |
| Maximum vertical ERP: | 32.600 kW (15.132 dBk) |
| Vertical maximum power gain: | 3.642 (5.614 dB) |
| Total input power: | 8.951 kW (9.187 dBk) |