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**S.O. 29644**

**Report of Test SCALA CA-5CPRM**

**for**

**MBC GRAND BROADCASTING, INC.**

**KSTR 96.1 MHz MONTROSE, CO.**

## OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a SCALA CA-5CPRM to meet the needs of KSTR and to comply with the requirements of the FCC construction permit, file number BXPH-20110926AJP. This test characterizes only the radiation characteristics of the antenna when mounted on the tower as described. It does not represent or imply any guarantee of specific coverage which can be influenced by factors beyond the scope of this test.

## RESULTS:

The following Figures are the results of the measurements from our pattern range:

Figure 1A - Measured Azimuth Pattern with the FCC Composite
Figure 1B - Measured Composite Azimuth Pattern with the FCC Composite
Figure 1C - Tabulation of the Horizontal Polarization for the Measured Azimuth Pattern
Figure 1D - Tabulation of the Vertical Polarization for the Measured Azimuth Pattern
Figure 1E - Tabulation of the Measured Composite Azimuth Pattern
Figure 1F - Tabulation of the FCC Composite

The calculated elevation pattern of the antenna is shown in Figure 3.

Construction permit file number BXPH-20110926AJP indicates that the Horizontal radiation component shall not exceed 1.65 kW at any azimuth and is restricted to the following values at the azimuths specified:

255 Degrees T: 0.025 kW

325 - 335 Degrees T: 0.025 kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 115 Degrees T. At the restricted azimuth of 255 Degrees T the Horizontal component is 19.45 dB down from the maximum of 1.65 kW, or 0.0187 kW and at the restricted azimuth of 325 TO 335 Degrees T the vertical component is 20.72 dB down from the maximum of 1.65 kW, or 0.014 kW.

The R.M.S. of the Horizontal component is 0.396. The total Horizontal power gain is 3.709. The R.M.S. of the Vertical component is 0.375. The total Vertical power gain is 2.648. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is .431. The R.M.S. of the measured composite pattern is .406. Eighty-five percent (85%) of the original authorized FCC composite pattern is .3665. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

**METHOD OF DIRECTIONALIZATION:**

One bay of the SCALA CA-5CPRM was mounted on a tower of precise scale to the 60inch face tower at the KSTR site. The spacing of the antenna to the tower was varied to achieve the Horizontal and vertical patterns shown in Figure 1A. See Figure 2 for mechanical details.

**METHOD OF MEASUREMENT:**

As allowed by the construction permit, file number BXPH-20110926AJP, a single level of the SCALA CA-5CPRM was set up on the Shively Labs scale model antenna pattern measuring range. A scale of 4.5:1 was used.

**SUPERVISION:**

Mr. Surette was graduated from Lowell Technological Institute, Lowell, Massachusetts in 1973 with the degree of Bachelor of Science in Electrical Engineering. He has been directly involved with design and development of broadcast antennas, filter systems and RF transmission components since 1974. As an RF Engineer for six years with the original Shively Labs in Raymond, ME and for a short period of time with Dielectric Communications.
He is currently an Associate Member of the AFCCE and a Senior Member of IEEE.

He has authored a chapter on filters and combining systems for the latest edition of the CRC Electronics Handbook and for the 9th and 10th Editions of the NAB Handbook.

**EQUIPMENT:**

The scale model pattern range consists of a wooden rotating pedestal equipped with a position indicator. The scale model bay is placed on the top of this pedestal and is used in the transmission mode at approximately 20 feet above ground level. The receiving corner reflector is spaced 50 feet away from the rotating pedestal at the same level above ground as the transmitting model. The transmitting and receiving signals are carried to a control building by means of RG-9/U double shielded coax cable.

The control building is equipped with:

Hewlett Packard Model 8753 Network Analyzer

PC Based Controller

Hewlett Packard 7550A Graphics Plotter

All testing is carried out in strict accordance with approved procedures under our ISO9001:2008.

**TEST PROCEDURES:**

The receiving antenna system is mounted so that the horizontal and vertical azimuth patterns are measured independently. The network analyzer was set to 432.45 MHz Calibrated pads are used to check the linearity of the measuring system. For example, 6 dB padding yields a scale reading of 50 from an unpadded reading of 100 in voltage. From the recorded patterns, the R.M.S. values are calculated and recorded as shown in Figure 1A.

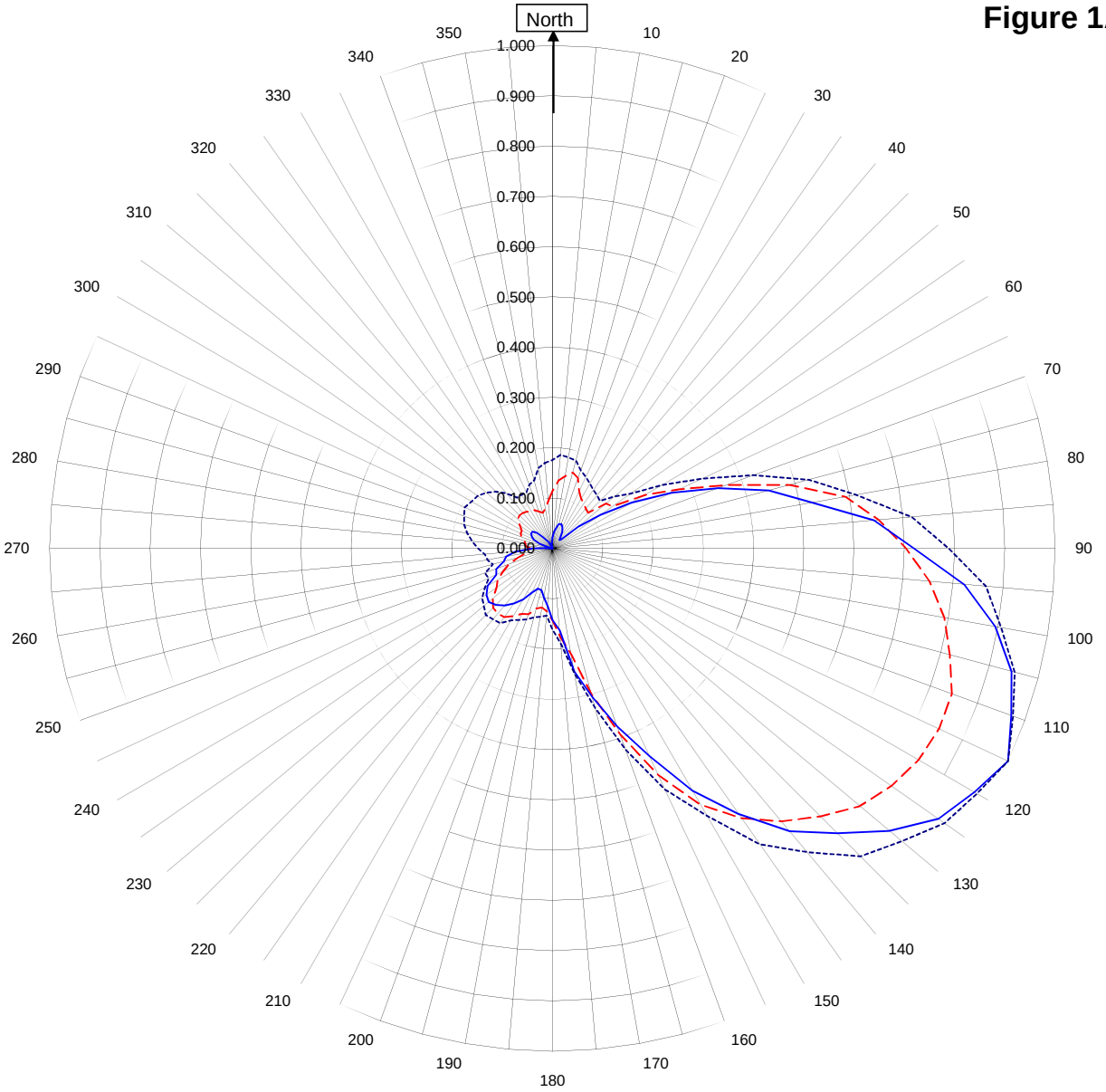
Respectfully submitted by:

Robert A. Surette
Director of Sales Engineering
S/O 29644
Date December 8, 2011

# Shively Labs

Shively Labs, a division of Howell Laboratories, Inc. Bridgton, ME (207)647-3327

**Figure 1A**




## KSTR MONTROSE, CO.

29644

December 7, 2011

| | |
|---|---|
| _____Horizontal RMS | 0.396 |
| _ _ _ _ _ _ _ _ _ Vertical RMS | 0.375 |
| H/V Composite RMS | 0.406 |
| .....FCC Composite RMS | 0.431 |

| | |
|---|---|
| Frequency | 96.1 / 432.45 mHz |
| Plot | Relative Field |
| Scale | 4.5 : 1 |
| | See Figure 2 for Mechanical Details |

| | |
|---|---|
| Antenna Model | SCALA CA-5CPRM |
| Pattern Type | Directional Azimuth |

# Shively Labs

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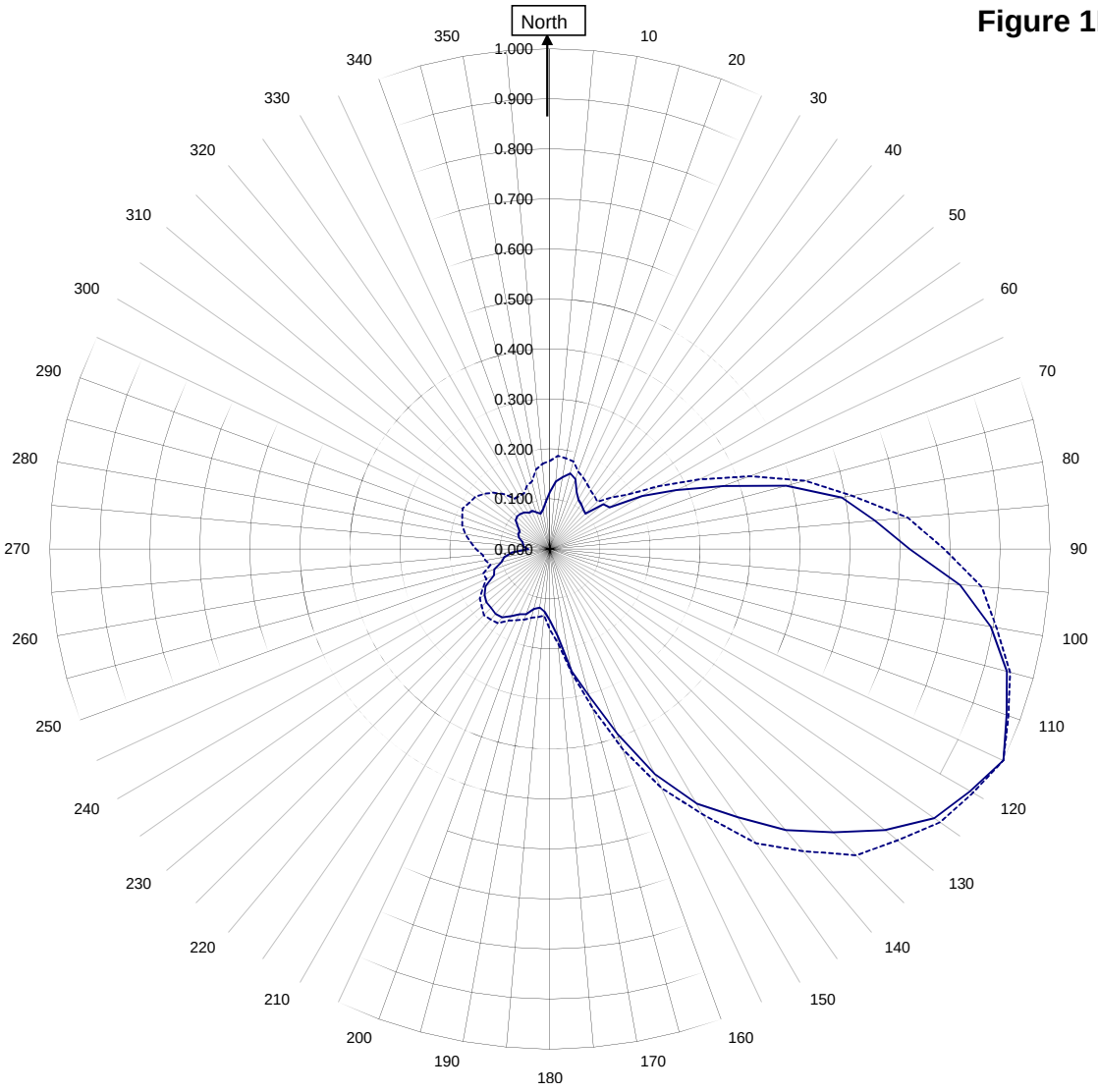
**Figure 1B**




## KSTR MONTROSE, CO.

29644

December 7, 2011

| | |
|---|---|
| _____H/VComposite RMS | 0.406 |
| ……FCC Composite RMS | 0.431 |

| | |
|---|---|
| Frequency | 96.1 / 432.45 mHz |
| Plot | Relative Field |
| Scale | 4.5 : 1 |
| | See Figure 2 for Mechanical Details |

| | |
|---|---|
| Antenna Model | SCALA CA-5CPRM |
| Pattern Type | Directional H/V Composite |

Figure 1C

Tabulation of Horizontal Azimuth Pattern
KSTR MONTROSE, CO.

| Azimuth | Rel Field | Azimuth | Rel Field |
|---|---|---|---|
| 0 | 0.022 | 180 | 0.142 |
| 10 | 0.042 | 190 | 0.098 |
| 20 | 0.052 | 200 | 0.085 |
| 30 | 0.039 | 210 | 0.117 |
| 40 | 0.022 | 220 | 0.148 |
| 45 | 0.027 | 225 | 0.159 |
| 50 | 0.067 | 230 | 0.166 |
| 60 | 0.182 | 240 | 0.149 |
| 70 | 0.351 | 250 | 0.119 |
| 80 | 0.525 | 260 | 0.094 |
| 90 | 0.719 | 270 | 0.041 |
| 100 | 0.895 | 280 | 0.000 |
| 110 | 0.971 | 290 | 0.027 |
| 120 | 0.969 | 300 | 0.047 |
| 130 | 0.874 | 310 | 0.052 |
| 135 | 0.801 | 315 | 0.044 |
| 140 | 0.734 | 320 | 0.029 |
| 150 | 0.556 | 330 | 0.015 |
| 160 | 0.376 | 340 | 0.000 |
| 170 | 0.248 | 350 | 0.010 |

Figure 1D

Tabulation of Vertical Azimuth Pattern
KSTR MONTROSE, CO.

| Azimuth | Rel Field | Azimuth | Rel Field |
|---|---|---|---|
| 0 | 0.114 | 180 | 0.143 |
| 10 | 0.146 | 190 | 0.119 |
| 20 | 0.149 | 200 | 0.139 |
| 30 | 0.114 | 210 | 0.155 |
| 40 | 0.104 | 220 | 0.169 |
| 45 | 0.100 | 225 | 0.167 |
| 50 | 0.139 | 230 | 0.155 |
| 60 | 0.212 | 240 | 0.126 |
| 70 | 0.369 | 250 | 0.093 |
| 80 | 0.592 | 260 | 0.055 |
| 90 | 0.704 | 270 | 0.044 |
| 100 | 0.792 | 280 | 0.054 |
| 110 | 0.845 | 290 | 0.066 |
| 120 | 0.841 | 300 | 0.070 |
| 130 | 0.797 | 310 | 0.090 |
| 135 | 0.754 | 315 | 0.093 |
| 140 | 0.708 | 320 | 0.092 |
| 150 | 0.588 | 330 | 0.084 |
| 160 | 0.393 | 340 | 0.078 |
| 170 | 0.213 | 350 | 0.080 |

Figure 1E

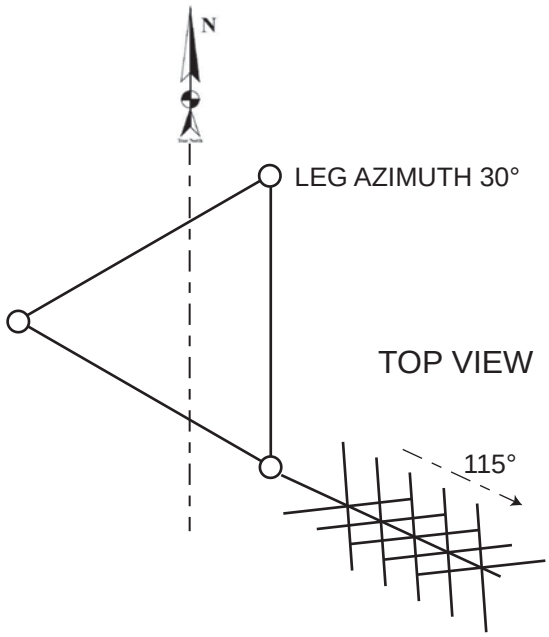
Tabulation of Composite Azimuth Pattern
KSTR MONTROSE, CO.

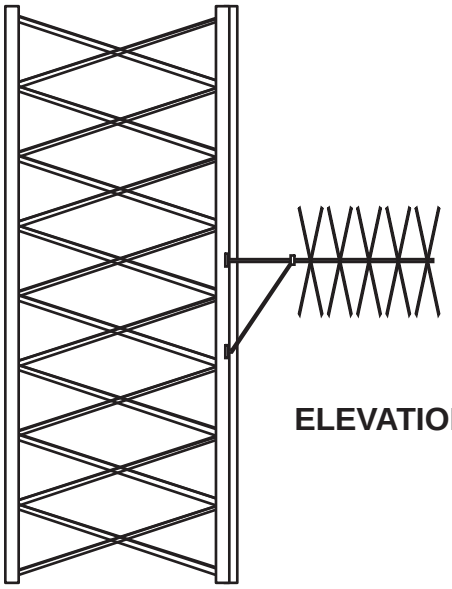
| Azimuth | Rel Field | Azimuth | Rel Field |
|---|---|---|---|
| 0 | 0.114 | 180 | 0.143 |
| 10 | 0.146 | 190 | 0.119 |
| 20 | 0.149 | 200 | 0.139 |
| 30 | 0.114 | 210 | 0.155 |
| 40 | 0.104 | 220 | 0.169 |
| 45 | 0.100 | 225 | 0.167 |
| 50 | 0.139 | 230 | 0.166 |
| 60 | 0.212 | 240 | 0.149 |
| 70 | 0.369 | 250 | 0.119 |
| 80 | 0.592 | 260 | 0.094 |
| 90 | 0.719 | 270 | 0.044 |
| 100 | 0.895 | 280 | 0.054 |
| 110 | 0.971 | 290 | 0.066 |
| 120 | 0.969 | 300 | 0.070 |
| 130 | 0.874 | 310 | 0.090 |
| 135 | 0.801 | 315 | 0.093 |
| 140 | 0.734 | 320 | 0.092 |
| 150 | 0.588 | 330 | 0.084 |
| 160 | 0.393 | 340 | 0.078 |
| 170 | 0.248 | 350 | 0.080 |

Figure 1F

Tabulation of FCC Directional Composite
KSTR MONTROSE, CO.

| Azimuth | Rel Field | Azimuth | Rel Field |
|---|---|---|---|
| 0 | 0.176 | 180 | 0.161 |
| 10 | 0.184 | 190 | 0.138 |
| 20 | 0.165 | 200 | 0.150 |
| 30 | 0.149 | 210 | 0.165 |
| 40 | 0.138 | 220 | 0.184 |
| 50 | 0.161 | 230 | 0.178 |
| 60 | 0.252 | 240 | 0.155 |
| 70 | 0.426 | 250 | 0.143 |
| 80 | 0.613 | 260 | 0.131 |
| 90 | 0.788 | 270 | 0.148 |
| 100 | 0.906 | 280 | 0.172 |
| 110 | 0.975 | 290 | 0.187 |
| 120 | 0.975 | 300 | 0.186 |
| 130 | 0.906 | 310 | 0.172 |
| 140 | 0.788 | 320 | 0.143 |
| 150 | 0.613 | 330 | 0.123 |
| 160 | 0.426 | 340 | 0.135 |
| 170 | 0.252 | 350 | 0.162 |



**ELEVATION VIEW**



# SHIVELY LABS

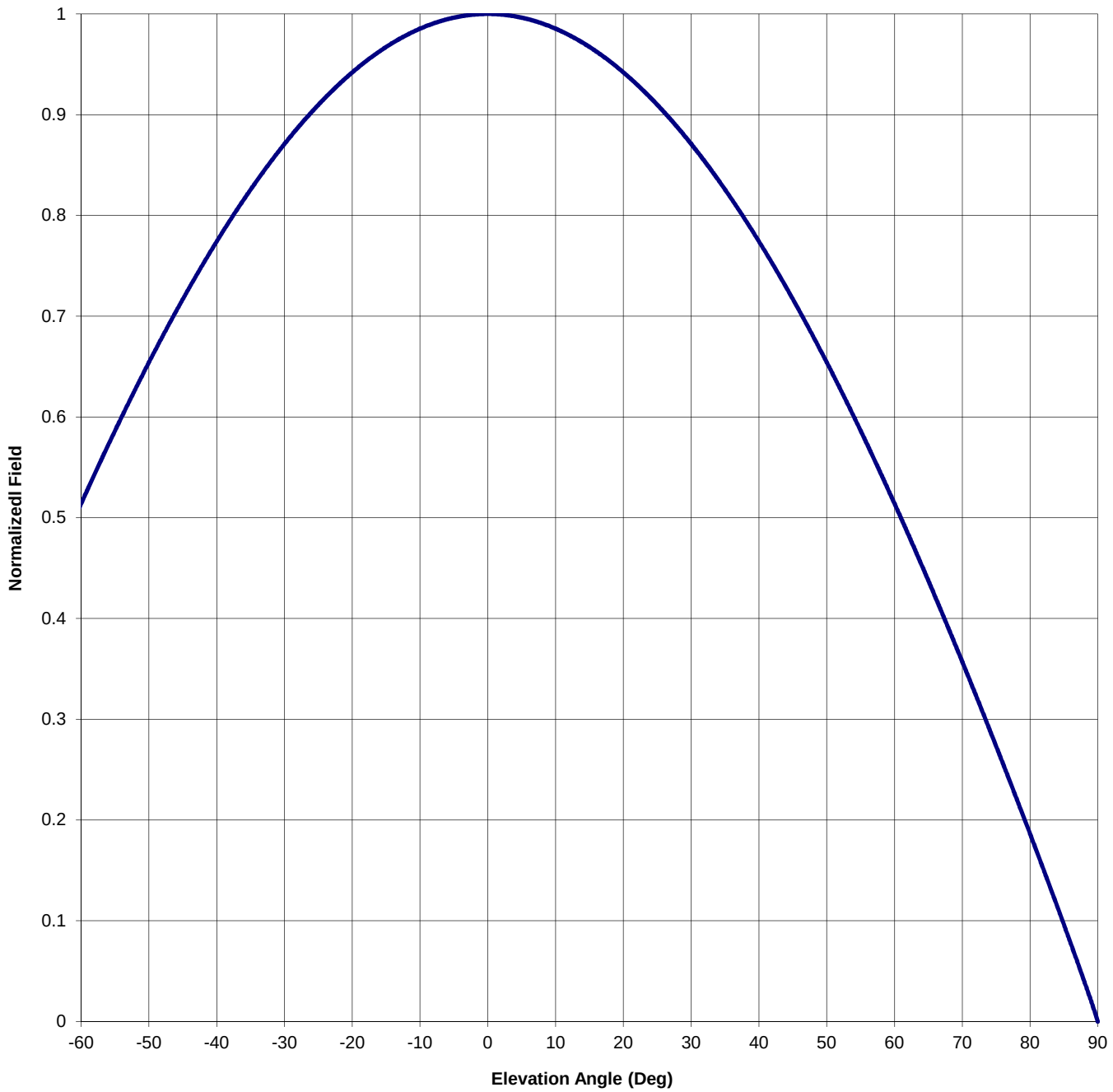
**DIV. HOWELL LABS** **BRIDGTON, MAINE USA**

FIGURE 2, SCALA CA-5CPRM,
96.1 MHz, KSTR, MONTROSE, CO

| SIZE | CODE IDENT. NO. | DRAWING NO. | REV |
|---|---|---|---|
| A | 26750 | AGF111208-001 | -- |

| SCALE | | SHEET |
|---|---|---|
| NONE | S/O 29644 | 1 OF 1 |

| | | | | | |
|---|---|---|---|---|---|
| **Antenna Mfg.:** | **Shively Labs** | | | | **Date: 12/8/2011** |
| **Antenna Type:** | **SCALA CA-5CPRM** | | | | |
| **Station:** | **KSTR** | **Beam Tilt** | **0** | | |
| **Frequency:** | **96.1** | **Gain (Max)** | **3.790** | **5.786 dB** | |
| **Channel #:** | **241** | **Gain (Horizon)** | **3.790** | **5.786 dB** | |
| **Figure:** | **Figure 3** | | | | |



**Antenna Mfg.:** Shively Labs **Date:** 12/8/2011

**Antenna Type:** SCALA CA-5CPRM

**Station:** KSTR **Beam Tilt** 0

**Frequency:** 96.1 **Gain (Max)** 3.790 5.786 dB

**Channel #:** 241 **Gain (Horizon)** 3.790 5.786 dB

**Figure:** Figure 3

| Angle of Depression (Deg) | Relative Field | Angle of Depression (Deg) | Relative Field | Angle of Depression (Deg) | Relative Field | Angle of Depression (Deg) | Relative Field |
|---|---|---|---|---|---|---|---|
| -90 | 0.000 | -44 | 0.729 | 0 | 1.000 | 46 | 0.705 |
| -89 | 0.021 | -43 | 0.741 | 1 | 1.000 | 47 | 0.693 |
| -88 | 0.040 | -42 | 0.752 | 2 | 0.999 | 48 | 0.680 |
| -87 | 0.059 | -41 | 0.763 | 3 | 0.999 | 49 | 0.667 |
| -86 | 0.078 | -40 | 0.774 | 4 | 0.998 | 50 | 0.654 |
| -85 | 0.096 | -39 | 0.785 | 5 | 0.996 | 51 | 0.641 |
| -84 | 0.114 | -38 | 0.796 | 6 | 0.995 | 52 | 0.628 |
| -83 | 0.133 | -37 | 0.806 | 7 | 0.993 | 53 | 0.614 |
| -82 | 0.151 | -36 | 0.816 | 8 | 0.991 | 54 | 0.600 |
| -81 | 0.168 | -35 | 0.826 | 9 | 0.988 | 55 | 0.586 |
| -80 | 0.186 | -34 | 0.835 | 10 | 0.985 | 56 | 0.572 |
| -79 | 0.204 | -33 | 0.845 | 11 | 0.982 | 57 | 0.558 |
| -78 | 0.221 | -32 | 0.854 | 12 | 0.979 | 58 | 0.544 |
| -77 | 0.239 | -31 | 0.862 | 13 | 0.975 | 59 | 0.529 |
| -76 | 0.256 | -30 | 0.871 | 14 | 0.971 | 60 | 0.514 |
| -75 | 0.273 | -29 | 0.879 | 15 | 0.967 | 61 | 0.499 |
| -74 | 0.290 | -28 | 0.887 | 16 | 0.963 | 62 | 0.484 |
| -73 | 0.307 | -27 | 0.895 | 17 | 0.958 | 63 | 0.469 |
| -72 | 0.324 | -26 | 0.903 | 18 | 0.953 | 64 | 0.453 |
| -71 | 0.341 | -25 | 0.910 | 19 | 0.948 | 65 | 0.437 |
| -70 | 0.357 | -24 | 0.917 | 20 | 0.942 | 66 | 0.422 |
| -69 | 0.373 | -23 | 0.924 | 21 | 0.936 | 67 | 0.406 |
| -68 | 0.390 | -22 | 0.930 | 22 | 0.930 | 68 | 0.390 |
| -67 | 0.406 | -21 | 0.936 | 23 | 0.924 | 69 | 0.373 |
| -66 | 0.422 | -20 | 0.942 | 24 | 0.917 | 70 | 0.357 |
| -65 | 0.437 | -19 | 0.948 | 25 | 0.910 | 71 | 0.341 |
| -64 | 0.453 | -18 | 0.953 | 26 | 0.903 | 72 | 0.324 |
| -63 | 0.469 | -17 | 0.958 | 27 | 0.895 | 73 | 0.307 |
| -62 | 0.484 | -16 | 0.963 | 28 | 0.887 | 74 | 0.290 |
| -61 | 0.499 | -15 | 0.967 | 29 | 0.879 | 75 | 0.273 |
| -60 | 0.514 | -14 | 0.971 | 30 | 0.871 | 76 | 0.256 |
| -59 | 0.529 | -13 | 0.975 | 31 | 0.862 | 77 | 0.239 |
| -58 | 0.544 | -12 | 0.979 | 32 | 0.854 | 78 | 0.221 |
| -57 | 0.558 | -11 | 0.982 | 33 | 0.845 | 79 | 0.204 |
| -56 | 0.572 | -10 | 0.985 | 34 | 0.835 | 80 | 0.186 |
| -55 | 0.586 | -9 | 0.988 | 35 | 0.826 | 81 | 0.168 |
| -54 | 0.600 | -8 | 0.991 | 36 | 0.816 | 82 | 0.151 |
| -53 | 0.614 | -7 | 0.993 | 37 | 0.806 | 83 | 0.133 |
| -52 | 0.628 | -6 | 0.995 | 38 | 0.796 | 84 | 0.114 |
| -51 | 0.641 | -5 | 0.996 | 39 | 0.785 | 85 | 0.096 |
| -50 | 0.654 | -4 | 0.998 | 40 | 0.774 | 86 | 0.078 |
| -49 | 0.667 | -3 | 0.999 | 41 | 0.763 | 87 | 0.059 |
| -48 | 0.680 | -2 | 0.999 | 42 | 0.752 | 88 | 0.040 |
| -47 | 0.693 | -1 | 1.000 | 43 | 0.741 | 89 | 0.021 |
| -46 | 0.705 | 0 | 1.000 | 44 | 0.729 | 90 | 0.000 |
| -45 | 0.717 | | | 45 | 0.717 | | |

S.O. 29644 Figure 4

VALIDATION OF TOTAL POWER GAIN CALCULATION

KSTR MONTROSE, CO.

MODEL SCALA CA-5CPRM

Elevation Gain of Antenna 0.55

Horizontal RMS value divided by the Vertical RMS value equals the Horiz. - Vert. Ratio

H RMS 0.3958 V RMS 0.37467 H/V Ratio 1.056

Elevation Gain of Horizontal Component 0.581

Elevation Gain of Vertical Component 0.521

Horizontal Azimuth Gain equals $1/(RMS)^2$. 6.383

Vertical Azimuth Gain equals $1/(RMS/Max\ Vert)^2$. 5.086

Max. Vertical 0.845

***Total Horizontal Power Gain is the Elevation Gain Times the Azimuth Gain**

Total Horizontal Power Gain = **3.709**

***Total Vertical Power Gain is the Elevation Gain Times the Azimuth Gain**

Total Vertical Power Gain = **2.648**

==========

ERP divided by Horizontal Power Gain equals Antenna Input Power

1.65 kW ERP Divided by H Gain 3.709 equals 0.445 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.445 kW Times V Gain 2.648 equals 1.178 kW V ERP

Maximum Value of the Vertical Component squared times the Maximum ERP equals the Vertical ERP

(0.845)^2 Times 1.65 Equals 1.178 kW Vertical ERP

NOTE: Calculating the ERP of the Vertical Component by two methods validates the total power gain calculations