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**S.O. 23333**

**Report of Test CA5-FM/CP/RM/50N**

**for**

**SANTA MONICA COMMUNITY COLLEGE DISTRICT**

**KCRU 89.1 MHz OXNARD, CA**

**OBJECTIVE:**

The objective of this test was to demonstrate the directional characteristics of a CA5-FM/CP/RM/50N to meet the needs of KCRU and to comply with the requirements of the FCC construction permit, file number BPED-19970127ID.

**RESULTS:**

The measured azimuth pattern for the CA5-FM/CP/RM/50N is shown in Figure 1. Figure 1A shows the Tabulation of the Horizontal Polarization. Figure 1B shows the Tabulation of the Vertical Polarization. The calculated elevation pattern of the antenna is shown in Figure 3. Construction permit file number BPED-19970127ID indicates that the Horizontal radiation component shall not exceed 0.850 kW at any azimuth and is restricted to the following values at the azimuths specified:

350 - 010 Degrees T: 0.478 kW
060 - 090 Degrees T: 0.240 kW
120 Degrees T: 0.085 kW

From Figure 1, the maximum radiation of the Horizontal component occurs at 297 Degrees T to 311 Degrees T. At the restricted azimuth of 350 - 010 Degrees T the Horizontal component is 3.16 dB down from the maximum of 0.850 kW, or 0.411 kW. At the restricted azimuth of 060 - 090 Degrees T the Horizontal component is 7.131 dB down from the maximum of 0.850 kW, or 0.164 kW. At the restricted azimuth of 120 Degrees T the Vertical component is 13.556 dB down from the maximum of 0.850 kW, or 0.037 kW.

The R.M.S. of the Horizontal component is 0.700. The total Horizontal power gain is 2.574. The R.M.S. of the Vertical component is 0.620. The total Vertical power gain is 2.524. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.820. Therefore this Pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

**METHOD OF DIRECTIONALIZATION:**

The CA5-FM/CP/RM/50N was mounted on a tower of exact scale to a Tri-X tower. The spacing of the antenna to the tower was varied to achieve the horizontal and vertical pattern shown in Figure 1. See Figure 2 for mechanical details.

**METHOD OF MEASUREMENT:**

As allowed by the construction permit, file number BPED-19970127ID, a single level of the CA5-FM/CP/RM/50N was set up on the Howell Laboratories 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 9$^{th}$ Edition 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

The test equipment is calibrated to ANSI/NCSL Z540-1-1994.

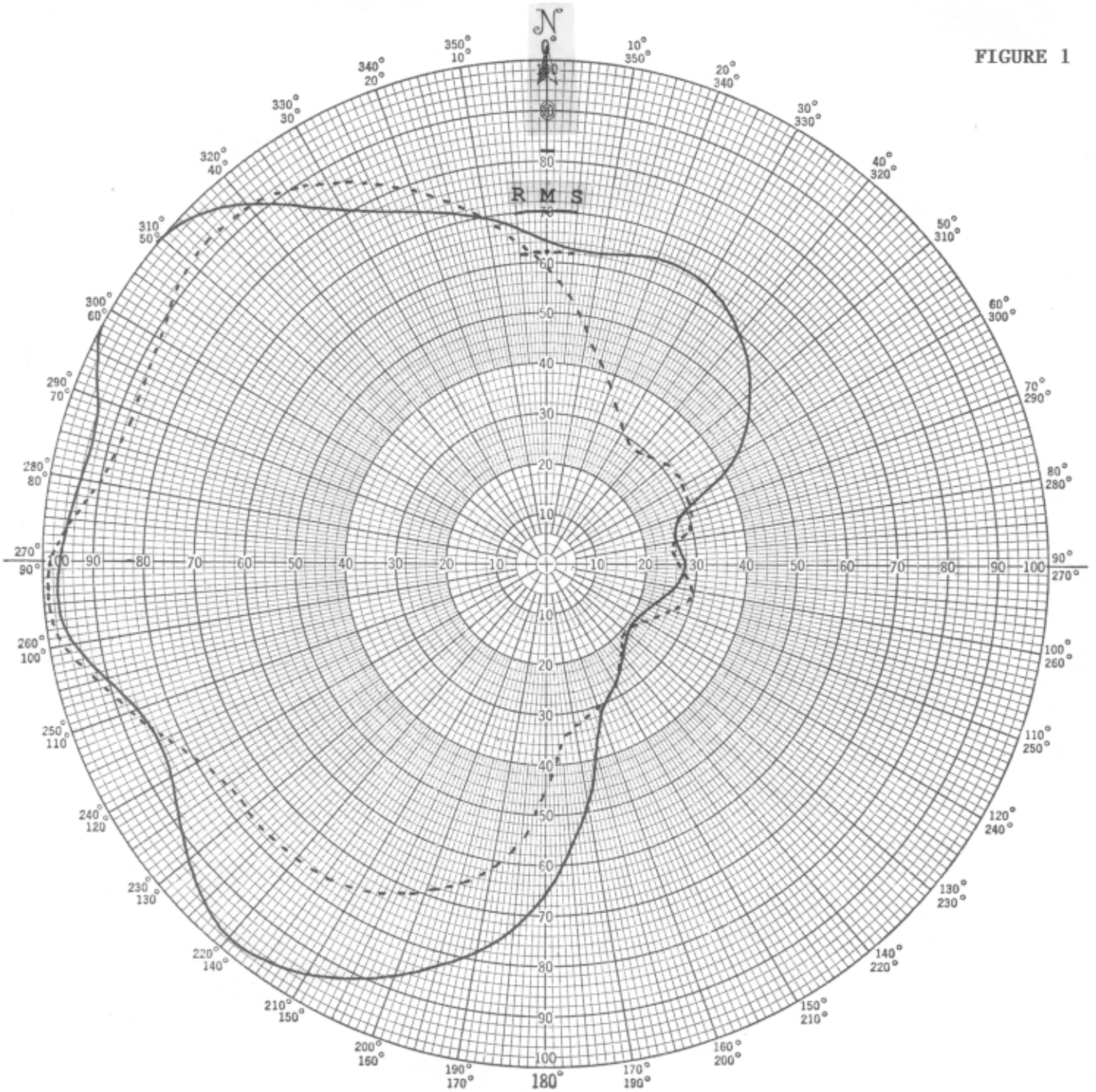
**TEST PROCEDURES:**

The corner reflector is mounted so that the horizontal and vertical azimuth patterns are measured independently by rotating the corner reflector by 90 degrees. The network analyzer was set to 400.95 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 1.

Respectfully submitted by:

Robert A. Surette
Manager of RF Engineering
S/O 23333
April 19, 2004

FIGURE 1




# Shively Labs

PROJECT NAME KCRU OXNARD, CA

PROJECT NUMBER 23333 DATE 3/31/04

MODEL ( X ) FULL SCALE ( ) FREQUENCY 400.95/89.1 MHz

POLARIZATION HORIZ (——); VERT (----)

CURVE PLOTTED IN: VOLTAGE ( X ) POWER( ) DB( )

OBSERVER RAS

ANTENNA TYPE CA5-FM/CP/RM/50N

PATTERN TYPE DIRECTIONAL AZIMUTH

REMARKS: SEE FIGURE 2 FOR MECHANICAL DETAILS

**Figure 1A**

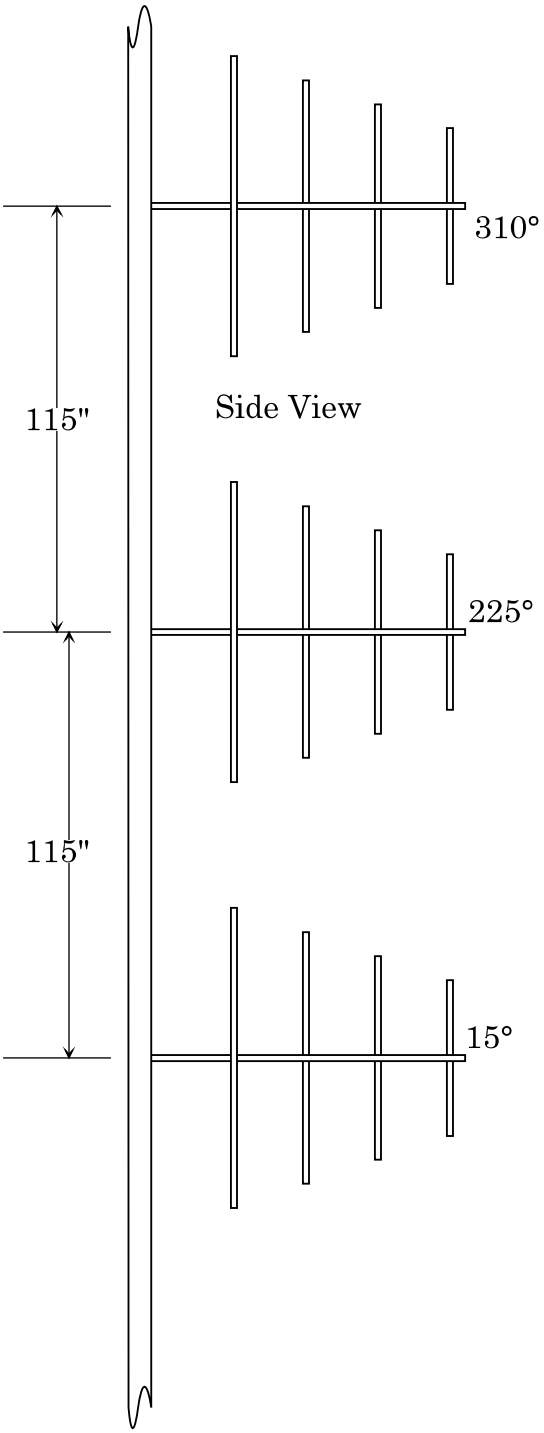
**S/O 23333**
**TABULATION OF HORIZONTAL POLARIZATION**
**KCRU OXNARD, CA**

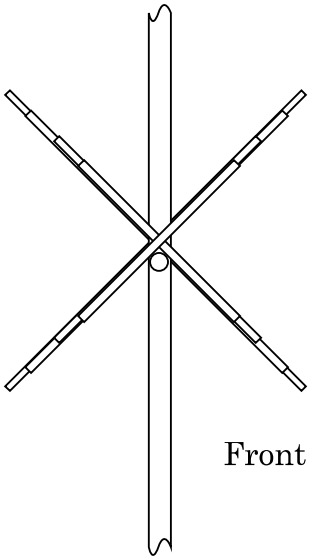
| DEGREE | RELATIVE FIELD | DEGREE | RELATIVE FIELD |
|---|---|---|---|
| 0 | 0.645 | 180 | 0.660 |
| 10 | 0.630 | 190 | 0.785 |
| 20 | 0.650 | 200 | 0.870 |
| 30 | 0.640 | 210 | 0.945 |
| 40 | 0.600 | 220 | 0.975 |
| 45 | 0.570 | 225 | 0.955 |
| 50 | 0.530 | 230 | 0.925 |
| 60 | 0.440 | 240 | 0.860 |
| 70 | 0.290 | 250 | 0.860 |
| 80 | 0.265 | 260 | 0.950 |
| 90 | 0.280 | 270 | 0.970 |
| 100 | 0.260 | 280 | 0.940 |
| 110 | 0.230 | 290 | 0.950 |
| 120 | 0.210 | 300 | 1.000 |
| 130 | 0.210 | 310 | 1.000 |
| 135 | 0.220 | 315 | 0.980 |
| 140 | 0.240 | 320 | 0.930 |
| 150 | 0.280 | 330 | 0.810 |
| 160 | 0.320 | 340 | 0.740 |
| 170 | 0.490 | 350 | 0.695 |

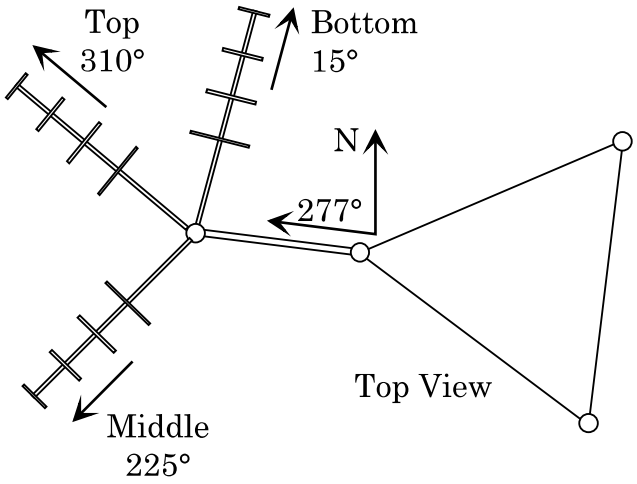
**Figure 1B**

**S/O 23333**
**TABULATION OF VERTICAL POLARIZATION**
**KCRU OXNARD, CA**

| DEGREE | RELATIVE FIELD | DEGREE | RELATIVE FIELD |
|---|---|---|---|
| 0 | 0.590 | 180 | 0.450 |
| 10 | 0.470 | 190 | 0.610 |
| 20 | 0.380 | 200 | 0.690 |
| 30 | 0.310 | 210 | 0.750 |
| 40 | 0.290 | 220 | 0.770 |
| 45 | 0.300 | 225 | 0.770 |
| 50 | 0.310 | 230 | 0.770 |
| 60 | 0.310 | 240 | 0.795 |
| 70 | 0.310 | 250 | 0.880 |
| 80 | 0.270 | 260 | 0.970 |
| 90 | 0.265 | 270 | 0.985 |
| 100 | 0.295 | 280 | 0.900 |
| 110 | 0.270 | 290 | 0.870 |
| 120 | 0.230 | 300 | 0.890 |
| 130 | 0.210 | 310 | 0.920 |
| 135 | 0.210 | 315 | 0.930 |
| 140 | 0.235 | 320 | 0.920 |
| 150 | 0.280 | 330 | 0.870 |
| 160 | 0.305 | 340 | 0.790 |
| 170 | 0.325 | 350 | 0.695 |



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## Figure 2 for KCRU, 89.1 MHz Scala Yagi Array

| SIZE | CODE IDENT. NO. | DRAWING NO. | REV |
|---|---|---|---|
| A | 26750 | AGF040419-002 | |
| SCALE | 23333 | SHEET | |

| | | | | |
|---|---|---|---|---|
| Antenna Mfg.: | Shively Labs | | | Date: 4/14/2004 |
| Antenna Type: | Scala CA5-FM/CP/RM/50N-DA | | | |
| Station: | KCRU | Beam Tilt | 0 | |
| Frequency: | 89.1 | Gain (Max) | 2.574 | 4.106 dB |
| Channel #: | 206 | Gain (Horizon) | 2.574 | 4.106 dB |
| Figure: | 3 | | | |

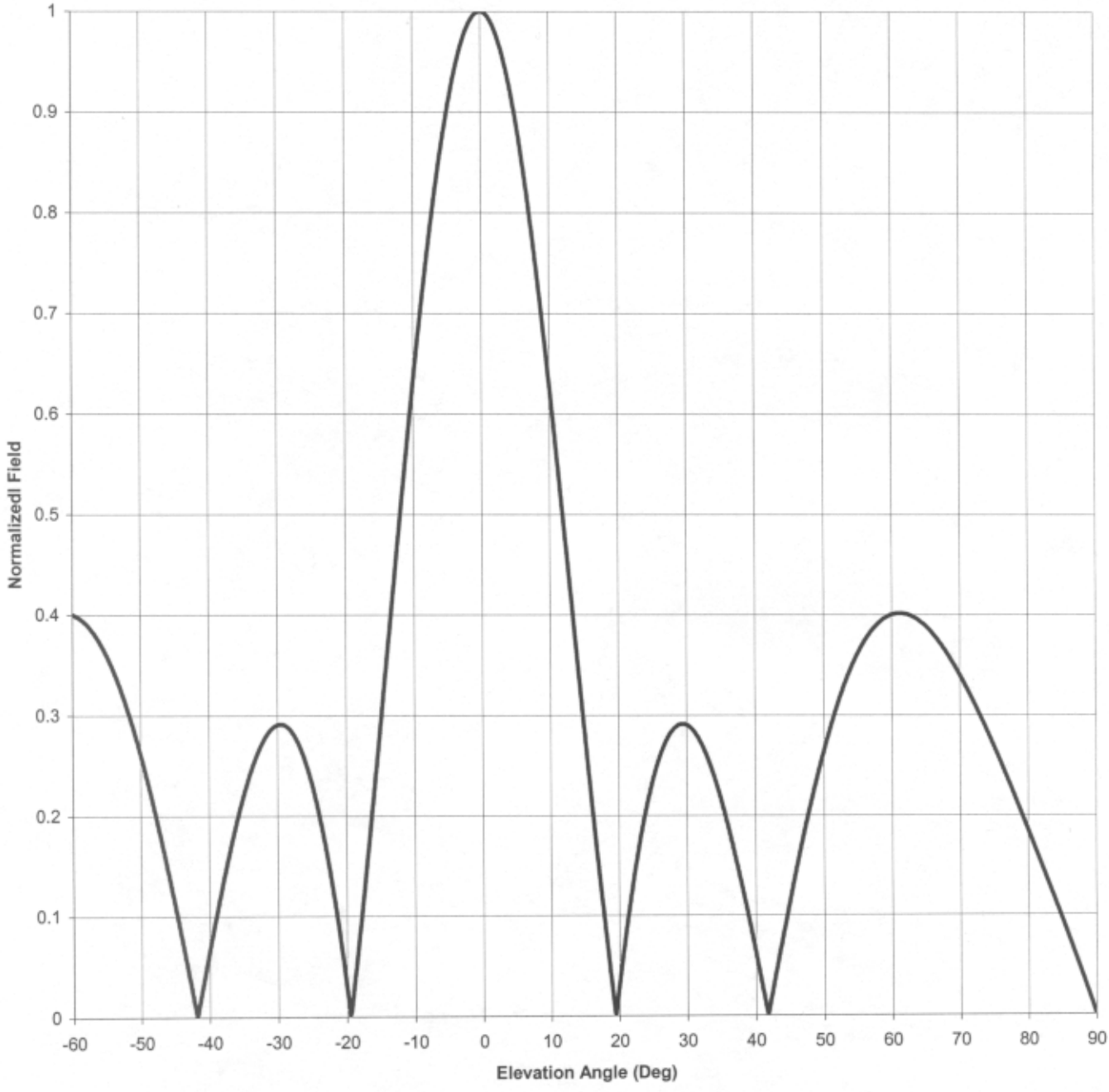

**FIGURE 4**

**S.O. 23333**

**VALIDATION OF GAIN CALCULATION**

**KCRU OXNARD, CA**

**MODEL CA5-FM/CP/RM/50N**

Elevation Gain of CA5-FM/CP/RM/50N equals 1.117

**The RMS values are calculated utilizing the data of a planimeter.**

Horizontal RMS divided by Vertical RMS equals
$0.70 \div 0.62 = 1.129$

Elevation Gain of Horizontal Component equals
$1.117 \times 1.129 = 1.261$

Elevation Gain of Vertical Component equals
$1.117 \times 0.886 = 0.990$

Horizontal Azimuth Gain equals $1/(RMS)^2$
$1/(0.70)^2 = 2.041$

Vertical Azimuth Gain equals $1/(RMS \div Max\ Vert)^2$
$1/(0.62 \div 0.99)^2 = 2.550$

*** Total Horizontal Gain is Elevation Gain times Azimuth Gain**
**$1.261 \times 2.041 = 2.574$**

*** Total Vertical Gain is Elevation Gain times Azimuth Gain**
**$0.99 \times 2.55 = 2.524$**

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ERP divided by Horizontal Gain equals Antenna Input Power
$0.85\ kW \div 2.574 = 0.330\ kW$

Antenna Input Power times Vertical Gain equals Vertical ERP
$0.330 \times 2.524 = 0.833\ kW$

Maximum Value of the Vertical Component squared times the Maximum ERP equals the Vertical ERP
$(0.99)^2 \times 0.85\ kW = 0.833\ kW$

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