

S.O. 28090

Report of Test Scala Yagi CA5-FM/CP

for

Community Radio for Northern Colorado

KENC 90.7 MHz Estes Park, CO

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a Scala Yagi CA5-FM/CP to meet the needs of KENC and to comply with the requirements of the FCC construction permit, file number BNPED-20071018ADV.

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 BNPED-20071018ADV indicates that the Horizontal radiation component shall not exceed 0.200 kW at any azimuth and is restricted to the following values at the azimuths specified:

70 - 210 Degrees T: 0.0063 kW

From Figure 1A, the maximum radiation of the Horizontal component occurs at 315 Degrees T. At the restricted azimuth of 70 - 210 Degrees T the Vertical component is 17.72 dB down from the maximum of 0.200 kW, or 0.0034 kW.

The R.M.S. of the Horizontal component is 0.421. The total Horizontal power gain is 2.872. The R.M.S. of the Vertical component is 0.421. The total Vertical power gain is 1.978. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.489. The R.M.S. of the measured composite pattern is 0.460. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.416. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

The Scala Yagi CA5-FM/CP was mounted on a tower of precise scale to the Rohn-45 tower at the KENC 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 BNPED-20071018ADV, a single level of the Scala Yagi CA5-FM/CP 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 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

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 408.15 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:

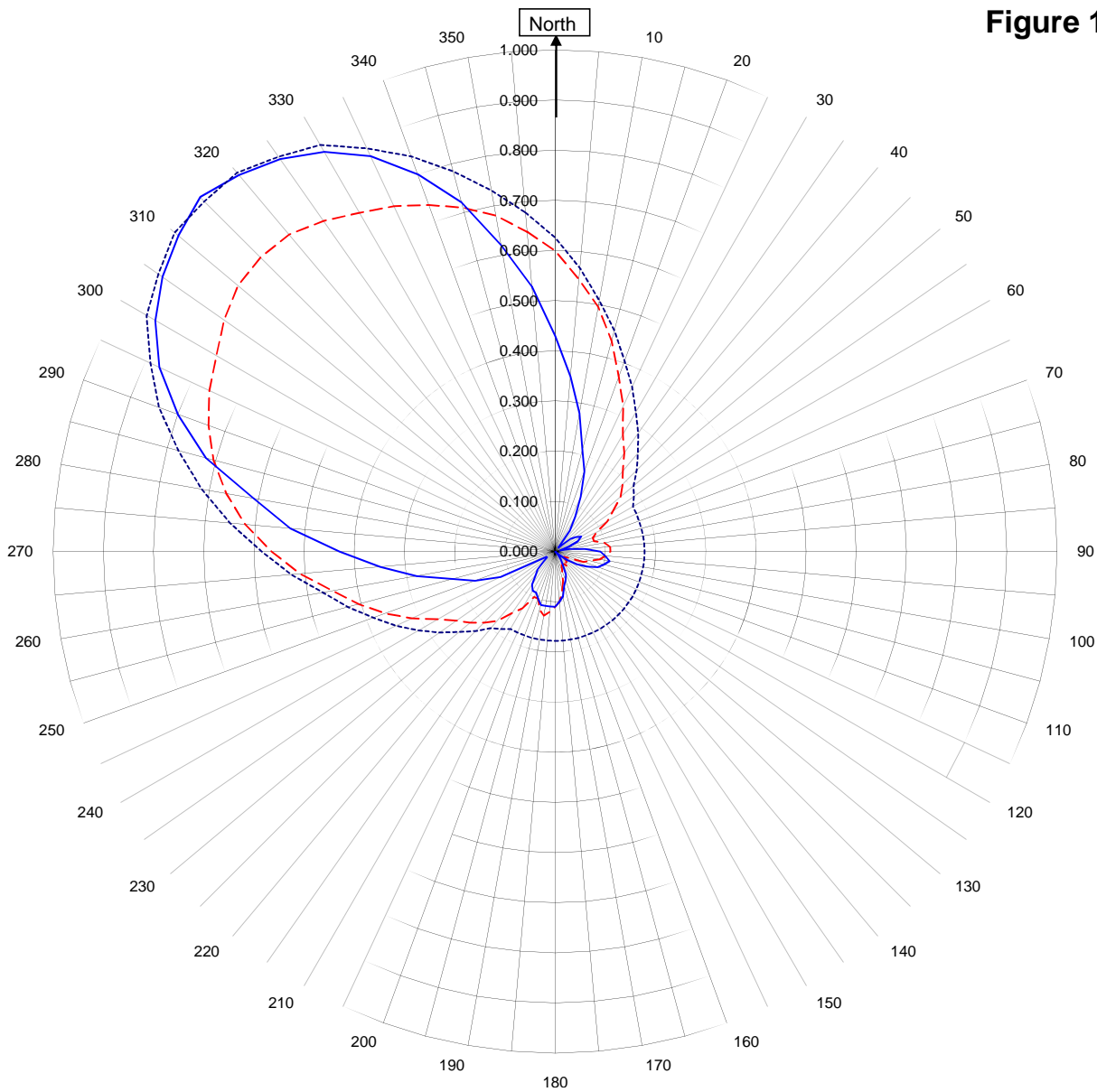


Robert A. Surette
Director of Sales Engineering
S/O 28090
January 9, 2013

Shively Labs

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

Figure 1A



KENC Estes Park, CO

28090

January 9, 2013

Horizontal RMS	0.421
Vertical RMS	0.421
H/V Composite RMS	0.460
FCC Composite RMS	0.489

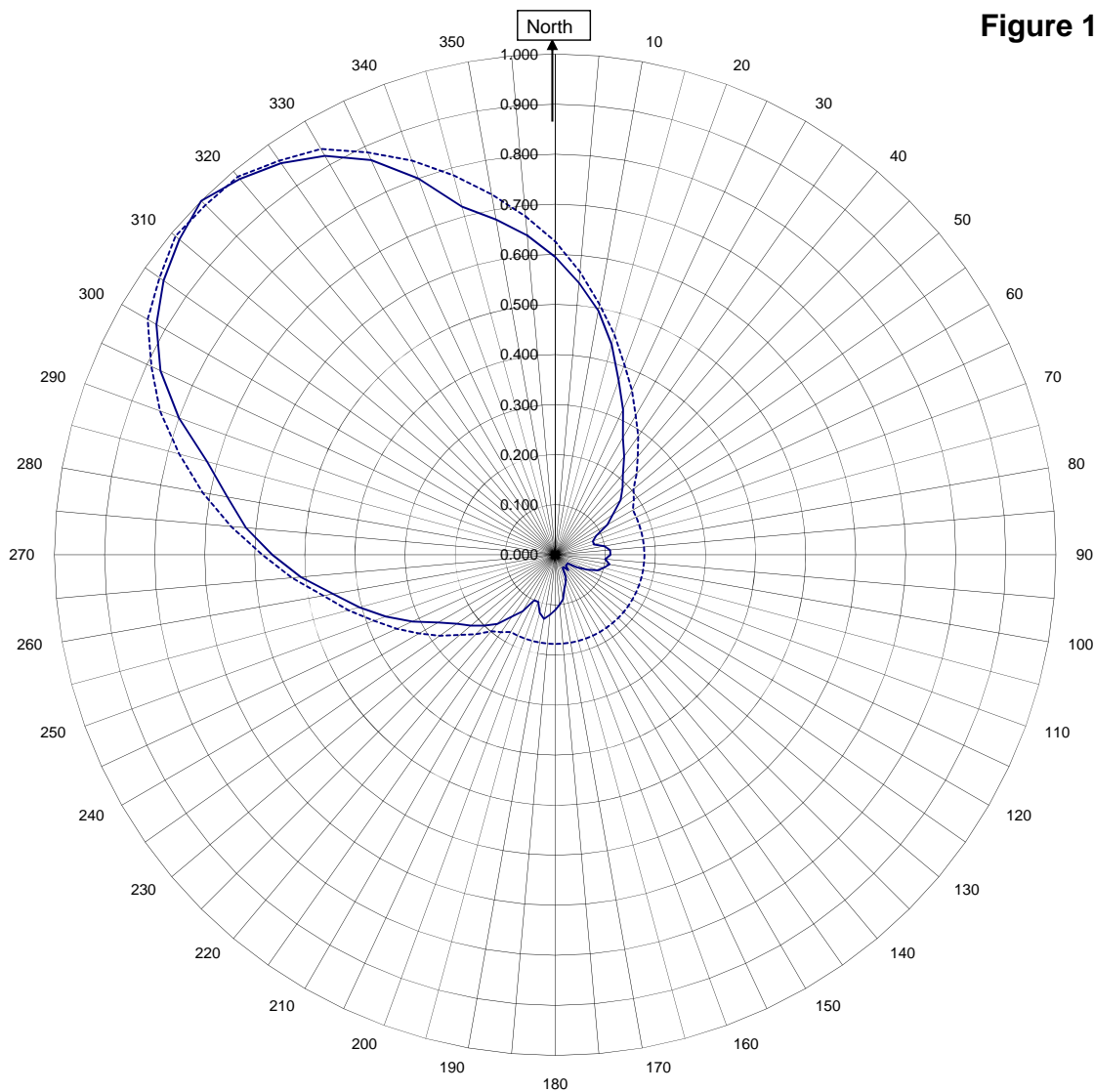
Frequency	90.7 / 408.15 MHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

Antenna Model	Scala Yagi CA5-FM/CP
Pattern Type	Directional Azimuth

Shively Labs

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Figure 1B



KENC Estes Park, CO

28090
January 9, 2013

 H/V Composite RMS	0.460
 FCC Composite RMS	0.489

Frequency	90.7 / 408.15 MHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

Antenna Model	Scala Yagi CA5-FM/CP
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern
KENC Estes Park, CO

Azimuth	Rel Field	Azimuth	Rel Field
0	0.430	180	0.110
10	0.280	190	0.110
20	0.170	200	0.100
30	0.080	210	0.090
40	0.010	220	0.060
45	0.020	225	0.050
50	0.040	230	0.030
60	0.060	240	0.020
70	0.030	250	0.170
80	0.030	260	0.280
90	0.090	270	0.430
100	0.110	280	0.610
110	0.090	290	0.800
120	0.050	300	0.920
130	0.010	310	0.980
135	0.000	315	1.000
140	0.010	320	0.980
150	0.030	330	0.920
160	0.060	340	0.800
170	0.090	350	0.620

Figure 1D

Tabulation of Vertical Azimuth Pattern
KENC Estes Park, CO

Azimuth	Rel Field	Azimuth	Rel Field
0	0.600	180	0.110
10	0.495	190	0.130
20	0.370	200	0.100
30	0.270	210	0.130
40	0.210	220	0.180
45	0.190	225	0.200
50	0.170	230	0.220
60	0.120	240	0.270
70	0.080	250	0.360
80	0.100	260	0.450
90	0.110	270	0.565
100	0.090	280	0.665
110	0.060	290	0.735
120	0.020	300	0.780
130	0.030	310	0.825
135	0.030	315	0.830
140	0.040	320	0.825
150	0.030	330	0.780
160	0.040	340	0.735
170	0.080	350	0.680

Figure 1E

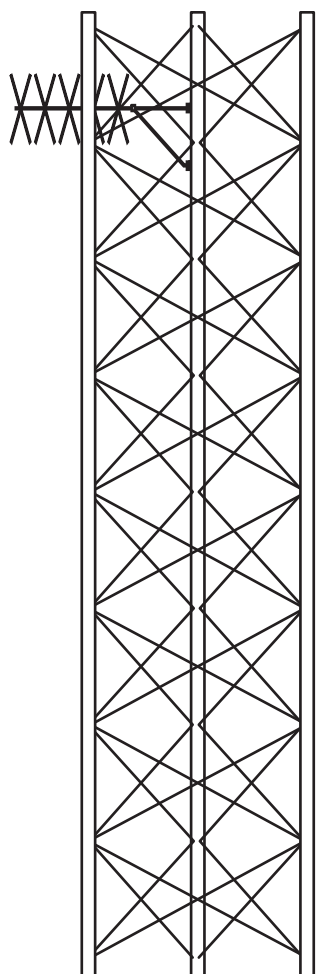
Tabulation of Composite Azimuth Pattern
KENC Estes Park, CO

Azimuth	Rel Field	Azimuth	Rel Field
0	0.595	180	0.110
10	0.495	190	0.130
20	0.370	200	0.100
30	0.270	210	0.130
40	0.210	220	0.180
45	0.190	225	0.200
50	0.170	230	0.220
60	0.120	240	0.270
70	0.080	250	0.360
80	0.100	260	0.450
90	0.110	270	0.565
100	0.110	280	0.665
110	0.090	290	0.800
120	0.050	300	0.920
130	0.030	310	0.980
135	0.030	315	1.000
140	0.040	320	0.980
150	0.030	330	0.920
160	0.060	340	0.800
170	0.090	350	0.680

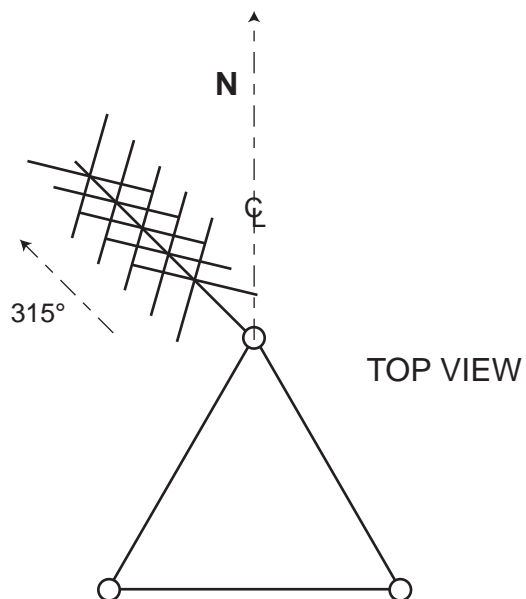
Figure 1F

Tabulation of FCC Directional Composite
KENC Estes Park, CO

Azimuth	Rel Field	Azimuth	Rel Field
0	0.626	180	0.178
10	0.508	190	0.178
20	0.404	200	0.178
30	0.321	210	0.178
40	0.256	220	0.199
50	0.204	230	0.249
60	0.179	240	0.314
70	0.178	250	0.385
80	0.178	260	0.470
90	0.178	270	0.585
100	0.178	280	0.715
110	0.178	290	0.840
120	0.178	300	0.940
130	0.178	310	0.990
140	0.178	320	0.986
150	0.178	330	0.936
160	0.178	340	0.838
170	0.178	350	0.731



ELEVATION VIEW



TOP VIEW

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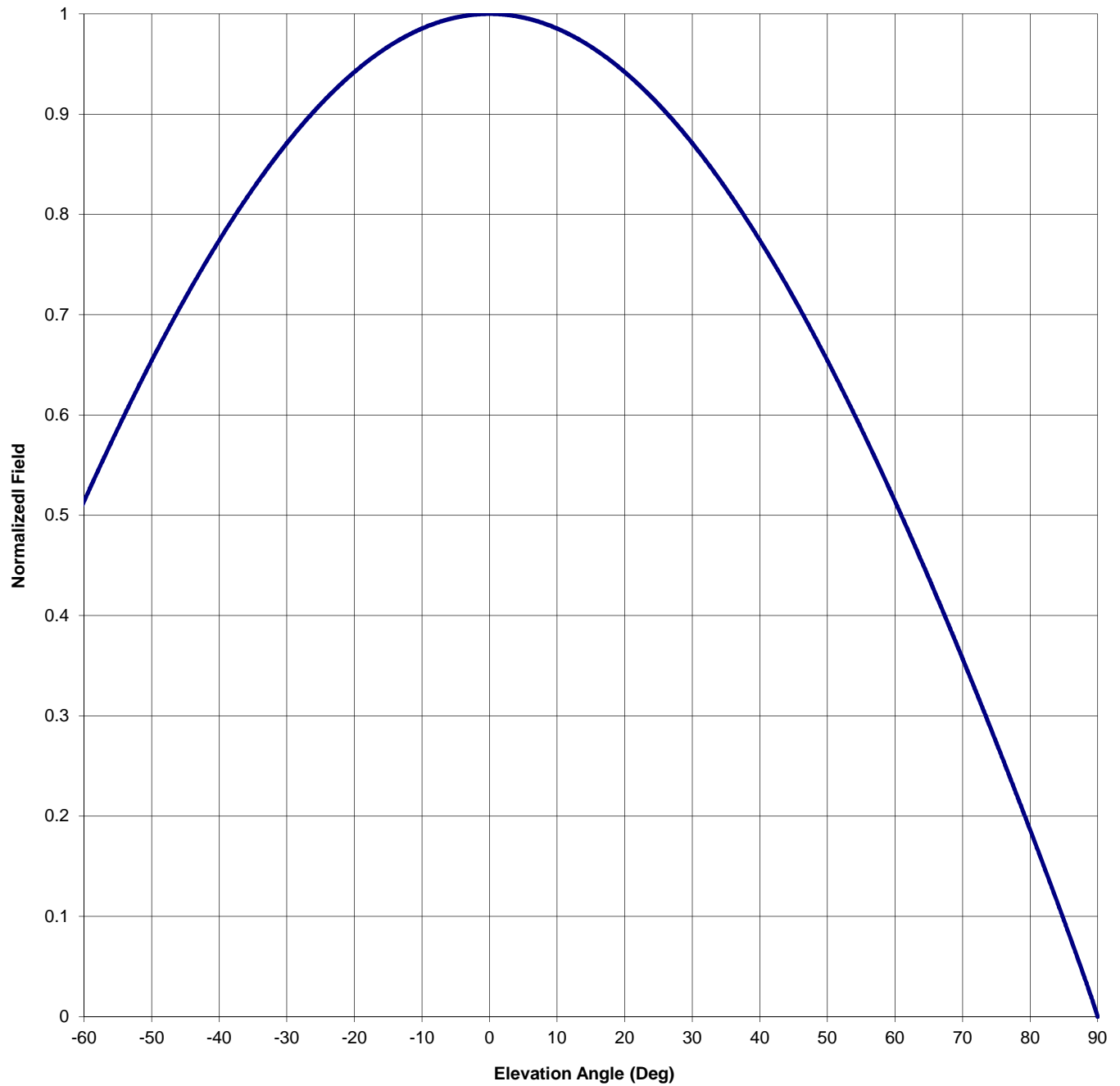
FIGURE 2 CIRCULARLY POLARIZED SCALA CAFM/CP, KENC, ESTES PARK, CO

SIZE	CODE IDENT. NO.	DRAWING NO.	REV
A	26750	AGF100303-001	--
SCALE	NONE	S/O 28090	SHEET 1 OF 1

Antenna Mfg.: Shively Labs
Antenna Type: Scala Yagi CA5-FM/CP
Station: KENC
Frequency: 90.7
Channel #: 214
Figure: 3

Date: 1/9/2013

Beam Tilt	0	
Gain (Max)	2.872	4.582 dB
Gain (Horizon)	2.872	4.582 dB



Antenna Mfg.: Shively Labs
 Antenna Type: Scala Yagi CA5-FM/CP
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Beam Tilt 0
 Gain (Max) 2.872 4.582 dB
 Gain (Horizon) 2.872 4.582 dB

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		

VALIDATION OF TOTAL POWER GAIN CALCULATION

KENC 90.7 MHz Estes Park, CO

Scala Yagi CA5-FM/CP

Elevation Gain of Antenna 0.509

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

H RMS	0.421	V RMS	0.421	H/V Ratio	1.000
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Elevation Gain of Horizontal Component	0.509
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Elevation Gain of Vertical Component	0.509
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Horizontal Azimuth Gain equals $1/(\text{RMS})^2$.	5.642
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Vertical Azimuth Gain equals $1/(\text{RMS}/\text{Max Vert})^2$.	3.887
Max. Vertical	0.83

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

Total Horizontal Power Gain = 2.872

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

Total Vertical Power Gain = 1.978

ERP divided by Horizontal Power Gain equals Antenna Input Power

0.2	kW ERP	Divided by H Gain	2.872	equals	0.07	kW H Antenna Input Power
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Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.07	kW	Times V Gain	1.978	equals	0.14	kW V ERP
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Maximum Value of the Vertical Component squared times the Maximum ERP equals the Vertical ERP

$(0.83)^2$	Times	0.20	Equals	0.14	kW Vertical ERP
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NOTE: Calculating the ERP of the Vertical Component by two methods validates the total power gain calculations