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S.O. 23032

Report of Test SCALA HDCA-5CP/RM

for

WESTERN CAROLINA UNIVERSITY

WWCU 90.5 MHz CULLOWHEE, NC

OBJECTIVE:

The objective of this test was to demonstrate the directional characteristics of a Scala HDCA-5CP/RM to meet the needs of WWCU and to comply with the requirements of the FCC construction permit, file number BPED-20010509AAU.

RESULTS:

The measured azimuth pattern for the Scala HDCA-5CP/RM 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-20010509AAU indicates that the Horizontal radiation component shall not exceed 0.24 kW at any azimuth and is restricted to the following values at the azimuths specified:

60 Degrees T: 0.0365 kW
240 Degrees T: 0.0216 kW
300 Degrees T: 0.0076 kW

From Figure 1, the maximum radiation of the Horizontal component occurs at 135 Degrees T to 150 Degrees T. At the restricted azimuth of 60 Degrees T the Horizontal component is 11.06 dB down from the maximum of 0.24 kW, or 0.020 kW. At the restricted azimuth of 240 Degrees T the Horizontal component is 11.37 dB down from the maximum of 0.24 kW, or 0.018 kW. At the restricted azimuth of 300 Degrees T the Horizontal component is 16.48 dB down from the maximum of 0.24 kW, or 0.005 kW.

The R.M.S. of the Horizontal component is 0.520. The total Horizontal power gain is 7.47. The R.M.S. of the Vertical component is 0.515. The total Vertical power gain is 7.14. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.61. Therefore this Pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

METHOD OF DIRECTIONALIZATION:

The Scala HDCA-5CP/RM was mounted on a tower of exact scale to the self-supported tower at the WWCU transmission site. The rotation of the Yagi antennas was varied to achieve the horizontal and vertical patterns shown in Figure 1. See Figure 2 for mechanical details.

METHOD OF MEASUREMENT:

As allowed by the construction permit, file number BPED-20010509AAU, the Scala HDCA-5CP/RM 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 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.

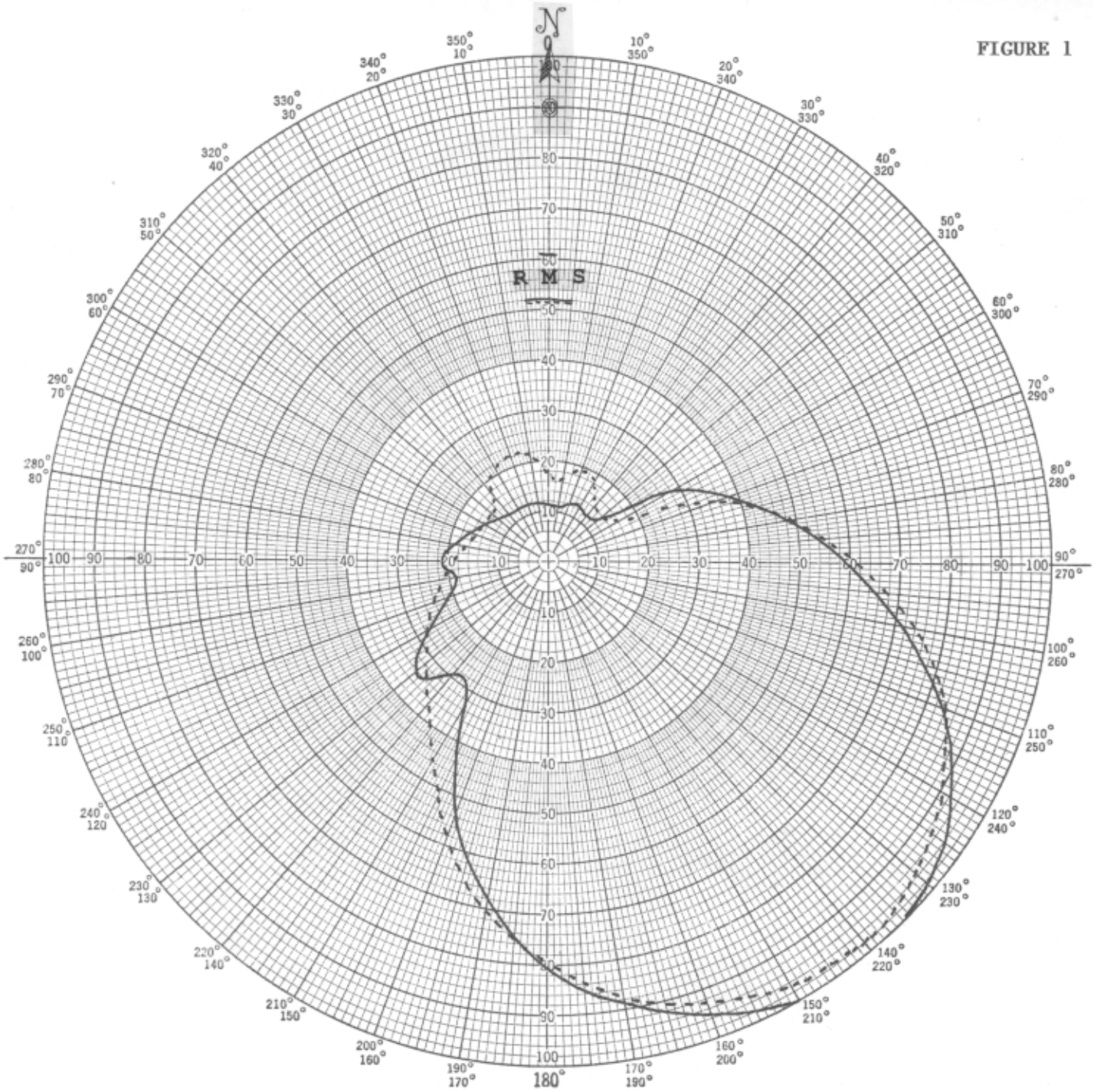
TEST PROCEDURES:

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 407.25 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 23032
June 28, 2004

FIGURE 1



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PROJECT NAME WWCU CULLOWHEE, NC

PROJECT NUMBER 23032 DATE 6/28/04

MODEL (X) FULL SCALE ( ) FREQUENCY 407.25/90.5 MHz

POLARIZATION HORIZ (——); VERT (----)

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

OBSERVER RAS

ANTENNA TYPE HDCA-5CP/RM

PATTERN TYPE DIRECTIONAL AZIMUTH

REMARKS: SEE FIGURE 2 FOR MECHANICAL DETAILS

Figure 1A

S/O 23032
TABULATION OF HORIZONTAL POLARIZATION
WWCU CULLOWHEE, NC

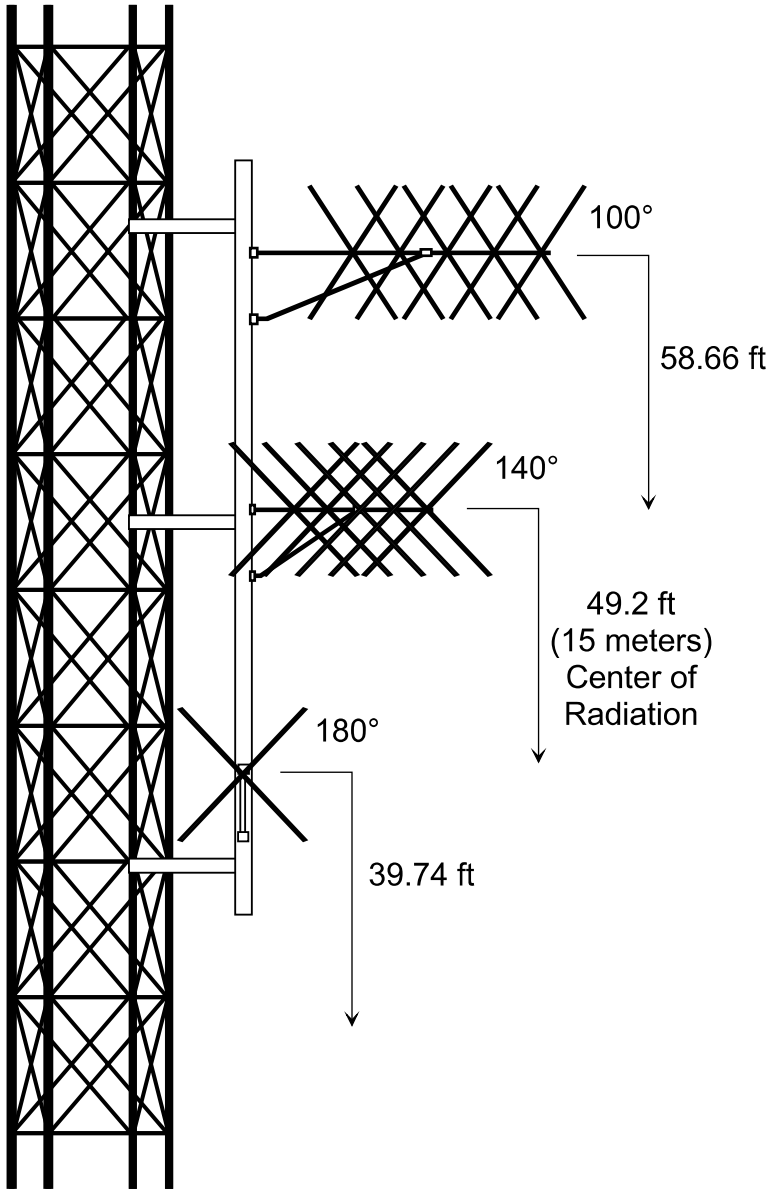
DEGREE	RELATIVE FIELD	DEGREE	RELATIVE FIELD
0	0.115	180	0.810
10	0.110	190	0.680
20	0.120	200	0.540
30	0.125	210	0.330
40	0.120	220	0.290
45	0.120	225	0.340
50	0.130	230	0.340
60	0.280	240	0.270
70	0.380	250	0.210
80	0.485	260	0.190
90	0.590	270	0.210
100	0.715	280	0.195
110	0.835	290	0.165
120	0.925	300	0.150
130	0.985	310	0.130
135	1.000	315	0.125
140	1.000	320	0.120
150	1.000	330	0.120
160	0.955	340	0.120
170	0.890	350	0.120

Figure 1B

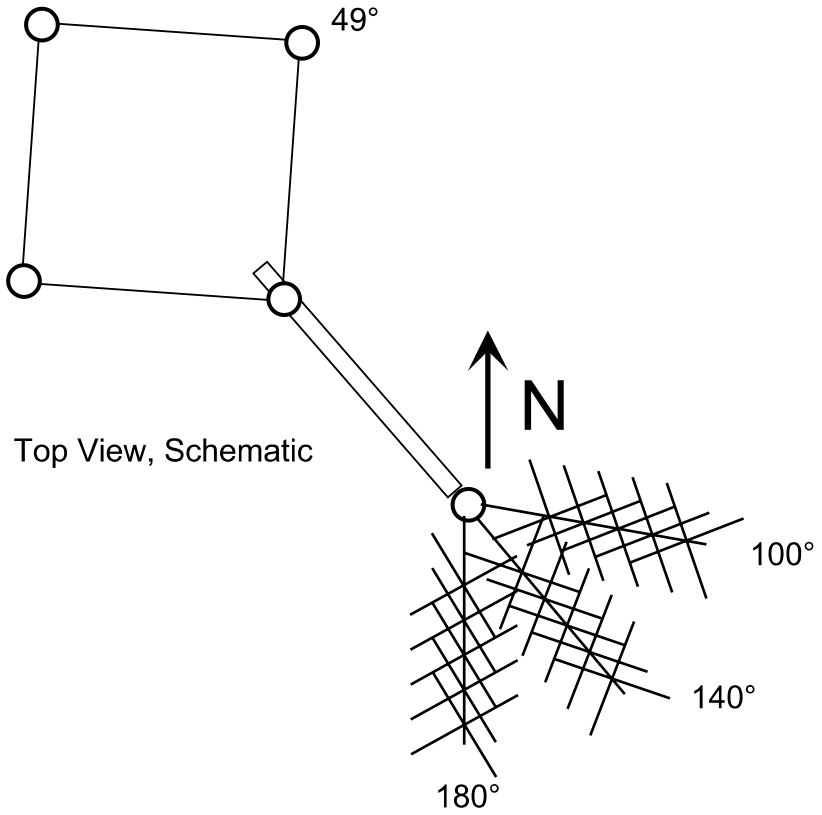
S/O 23032
TABULATION OF VERTICAL POLARIZATION
WWCU CULLOWHEE, NC

DEGREE	RELATIVE FIELD	DEGREE	RELATIVE FIELD
0	0.170	180	0.800
10	0.165	190	0.705
20	0.190	200	0.580
30	0.180	210	0.460
40	0.145	220	0.370
45	0.140	225	0.340
50	0.140	230	0.320
60	0.160	240	0.270
70	0.350	250	0.240
80	0.490	260	0.210
90	0.620	270	0.185
100	0.740	280	0.170
110	0.840	290	0.155
120	0.900	300	0.150
130	0.950	310	0.145
135	0.970	315	0.150
140	0.980	320	0.170
150	0.970	330	0.210
160	0.930	340	0.220
170	0.875	350	0.220

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



Side View, Schematic



Top View, Schematic

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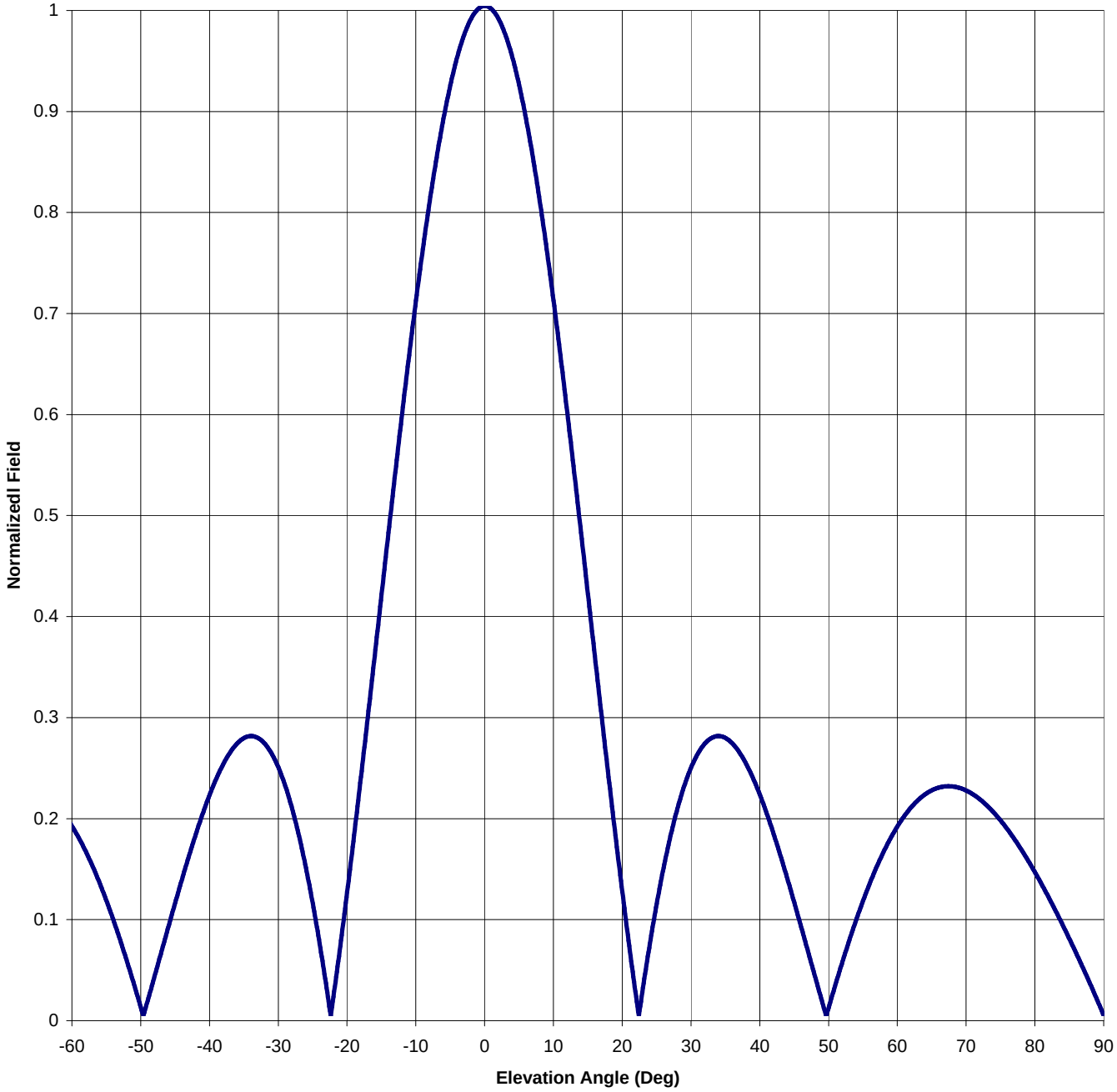
SHOP ORDER:	FREQUENCY:	SCALE:	DRAWN BY: AGF
23032	90.5 MHz	none	APPROVED BY:

TITLE: Antenna Layout for WWCU
Figure 2

DATE:		
6/28/04	AGF040628-001	1

Antenna Mfg.:	**Shively Labs**			**Date: 6/25/2004**
Antenna Type:	**Scala HDCA-5CP/RM**			
Station:	**WWCU**	**Beam Tilt**	**0**	
Frequency:	**90.5**	**Gain (Max)**	**7.470**	**8.733 dB**
Channel #:	**213**	**Gain (Horizon)**	**7.470**	**8.733 dB**
Figure:	**3**			



Antenna Mfg.: Shively Labs **Date:** 6/25/2004

Antenna Type: Scala HDCA-5CP/RM

Station: WWCU **Beam Tilt** 0

Frequency: 90.5 **Gain (Max)** 7.470 8.733 dB

Channel #: 213 **Gain (Horizon)** 7.470 8.733 dB

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	0.136	0	1.000	46	0.088
-89	0.016	-43	0.159	1	0.997	47	0.064
-88	0.032	-42	0.180	2	0.987	48	0.039
-87	0.047	-41	0.200	3	0.971	49	0.015
-86	0.062	-40	0.219	4	0.949	50	0.008
-85	0.076	-39	0.235	5	0.922	51	0.031
-84	0.090	-38	0.250	6	0.888	52	0.054
-83	0.104	-37	0.261	7	0.850	53	0.075
-82	0.117	-36	0.270	8	0.807	54	0.095
-81	0.130	-35	0.275	9	0.759	55	0.114
-80	0.142	-34	0.277	10	0.708	56	0.132
-79	0.154	-33	0.275	11	0.654	57	0.148
-78	0.165	-32	0.270	12	0.597	58	0.163
-77	0.175	-31	0.260	13	0.538	59	0.176
-76	0.185	-30	0.246	14	0.478	60	0.188
-75	0.194	-29	0.228	15	0.418	61	0.198
-74	0.201	-28	0.205	16	0.357	62	0.207
-73	0.208	-27	0.178	17	0.296	63	0.214
-72	0.214	-26	0.147	18	0.237	64	0.219
-71	0.219	-25	0.111	19	0.179	65	0.223
-70	0.223	-24	0.072	20	0.123	66	0.226
-69	0.226	-23	0.028	21	0.069	67	0.227
-68	0.227	-22	0.019	22	0.019	68	0.227
-67	0.227	-21	0.069	23	0.028	69	0.226
-66	0.226	-20	0.123	24	0.072	70	0.223
-65	0.223	-19	0.179	25	0.111	71	0.219
-64	0.219	-18	0.237	26	0.147	72	0.214
-63	0.214	-17	0.296	27	0.178	73	0.208
-62	0.207	-16	0.357	28	0.205	74	0.201
-61	0.198	-15	0.418	29	0.228	75	0.194
-60	0.188	-14	0.478	30	0.246	76	0.185
-59	0.176	-13	0.538	31	0.260	77	0.175
-58	0.163	-12	0.597	32	0.270	78	0.165
-57	0.148	-11	0.654	33	0.275	79	0.154
-56	0.132	-10	0.708	34	0.277	80	0.142
-55	0.114	-9	0.759	35	0.275	81	0.130
-54	0.095	-8	0.807	36	0.270	82	0.117
-53	0.075	-7	0.850	37	0.261	83	0.104
-52	0.054	-6	0.888	38	0.250	84	0.090
-51	0.031	-5	0.922	39	0.235	85	0.076
-50	0.008	-4	0.949	40	0.219	86	0.062
-49	0.015	-3	0.971	41	0.200	87	0.047
-48	0.039	-2	0.987	42	0.180	88	0.032
-47	0.064	-1	0.997	43	0.159	89	0.016
-46	0.088	0	1.000	44	0.136	90	0.000
-45	0.112			45	0.112		

FIGURE 4

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VALIDATION OF GAIN CALCULATION

WWCU CULLOWHEE, NC

MODEL SCALA HDCA-5CP/RM

Elevation Gain of Scala HDCA-5CP/RM equals 2.0

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

Horizontal RMS divided by Vertical RMS equals
$0.520 \div 0.515 = 1.01$

Elevation Gain of Horizontal Component equals
$2.0 \times 1.01 = 2.02$

Elevation Gain of Vertical Component equals
$2.0 \times 0.99 = 1.98$

Horizontal Azimuth Gain equals $1/(RMS)^2$
$1/(0.52)^2 = 3.698$

Vertical Azimuth Gain equals $1/(RMS \div Max\ Vert)^2$
$1/(0.515 \div 0.98)^2 = 3.621$

*** Total Horizontal Gain is Elevation Gain times Azimuth Gain**
$2.02 \times 3.698 = 7.47$

*** Total Vertical Gain is Elevation Gain times Azimuth Gain**
$1.98 \times 3.621 = 7.17$

ERP divided by Horizontal Gain equals Antenna Input Power
$0.24\ kW \div 7.47 = 0.032\ kW$

Antenna Input Power times Vertical Gain equals Vertical ERP
$0.032 \times 7.17 = 0.229\ kW$

Maximum Value of the Vertical Component squared times the Maximum ERP equals the Vertical ERP
$(0.98)^2 \times 0.24\ kW = 0.23\ kW$

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