

**S.O. 31291**  
**Report of Test 6810-4R-DA**  
**for**  
**Holy Family Communications**  
**WMIH 89.5 MHz Geneva, OH**

**OBJECTIVE:**

The objective of this test was to demonstrate the directional characteristics of a 6810-4R-DA to meet the needs of WMIH and to comply with the requirements of the FCC construction permit, file number BNPED-20071022AUP. 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 BNPED-20071022AUP indicates that the Horizontal radiation component shall not exceed 21.0 kW at any azimuth and is restricted to the following values at the azimuths specified:

130 to 140 Degrees True: 1.044 kilowatts

From Figure 1A, the maximum radiation of the Horizontal component occurs at 313 Degrees True to 330 Degrees True. At the restricted azimuth of 130 to 140 Degrees True the Horizontal component is 14.023 dB down from the maximum of 21.0 kW, or 0.832 kW

The R.M.S. of the Horizontal component is 0.712. The total Horizontal power gain is 4.563. The R.M.S. of the Vertical component is 0.653. The total Vertical power gain is 3.614. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.819. The R.M.S. of the measured composite pattern is 0.732. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.696. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

#### **METHOD OF DIRECTIONALIZATION:**

One bay of the 6810-4R-DA was mounted on a tower of precise scale to the ERI 36" tower at the WMIH site. The spacing of the antenna to the tower was varied to achieve the vertical pattern shown in Figure 1A. A horizontal parasitic element was placed directly under the bay. The position of this horizontal parasitic element was changed until the horizontal pattern shown in Figure 1A was achieved. See Figure 2 for mechanical details.

#### **METHOD OF MEASUREMENT:**

As allowed by the construction permit, file number BNPED-20071022AUP, a single level of the 6810-4R-DA 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 9<sup>th</sup> and 10<sup>th</sup> 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 402.75 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:

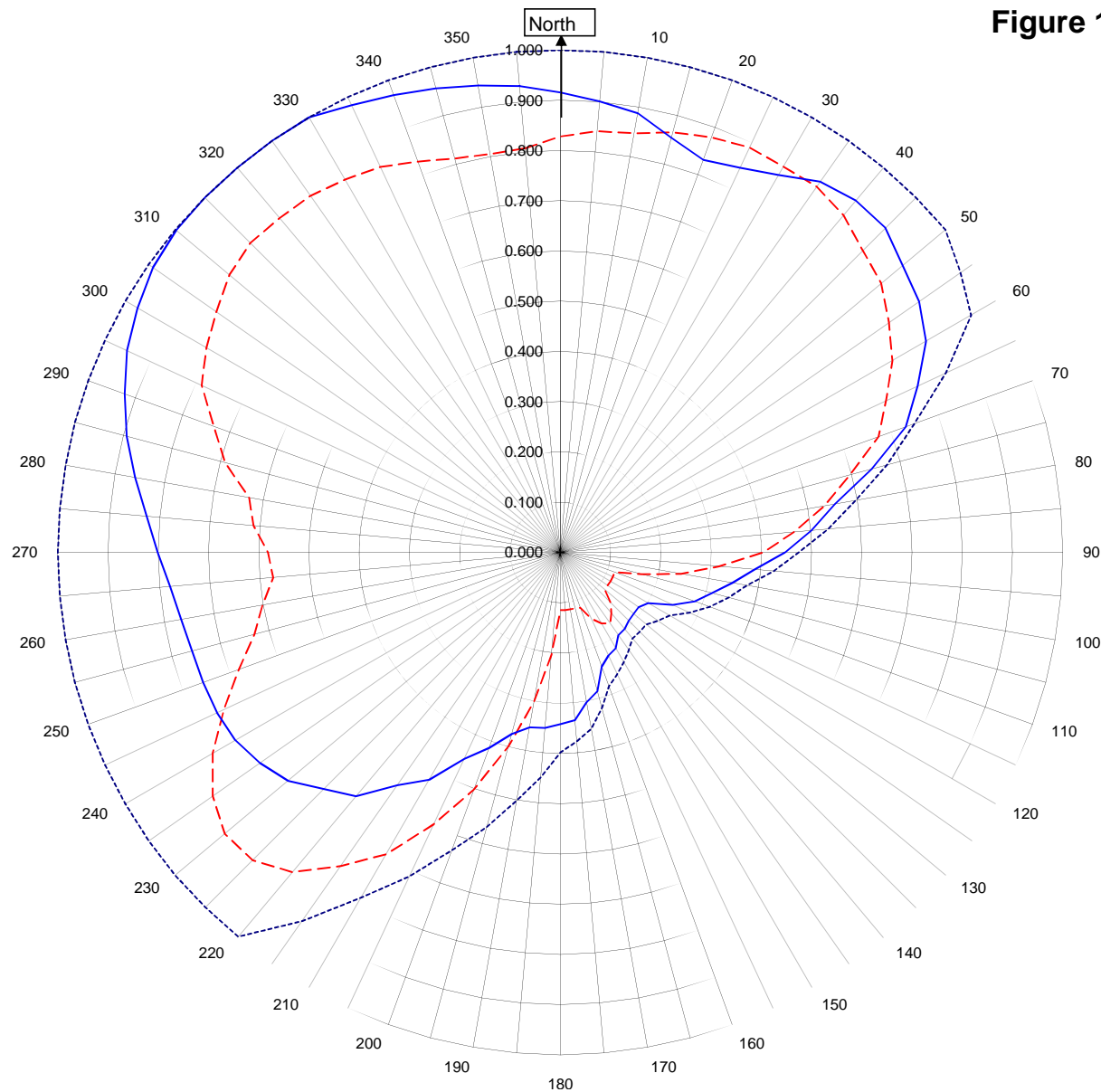


Robert A. Surette  
Director of Sales Engineering  
S/O 31291  
November 19, 2013

# Shively Labs

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

Figure 1A



WMIH

GENEVA, OH.

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November 19, 2013

Horizontal RMS	0.712
Vertical RMS	0.653
H/V Composite RMS	0.732
FCC Composite RMS	0.819

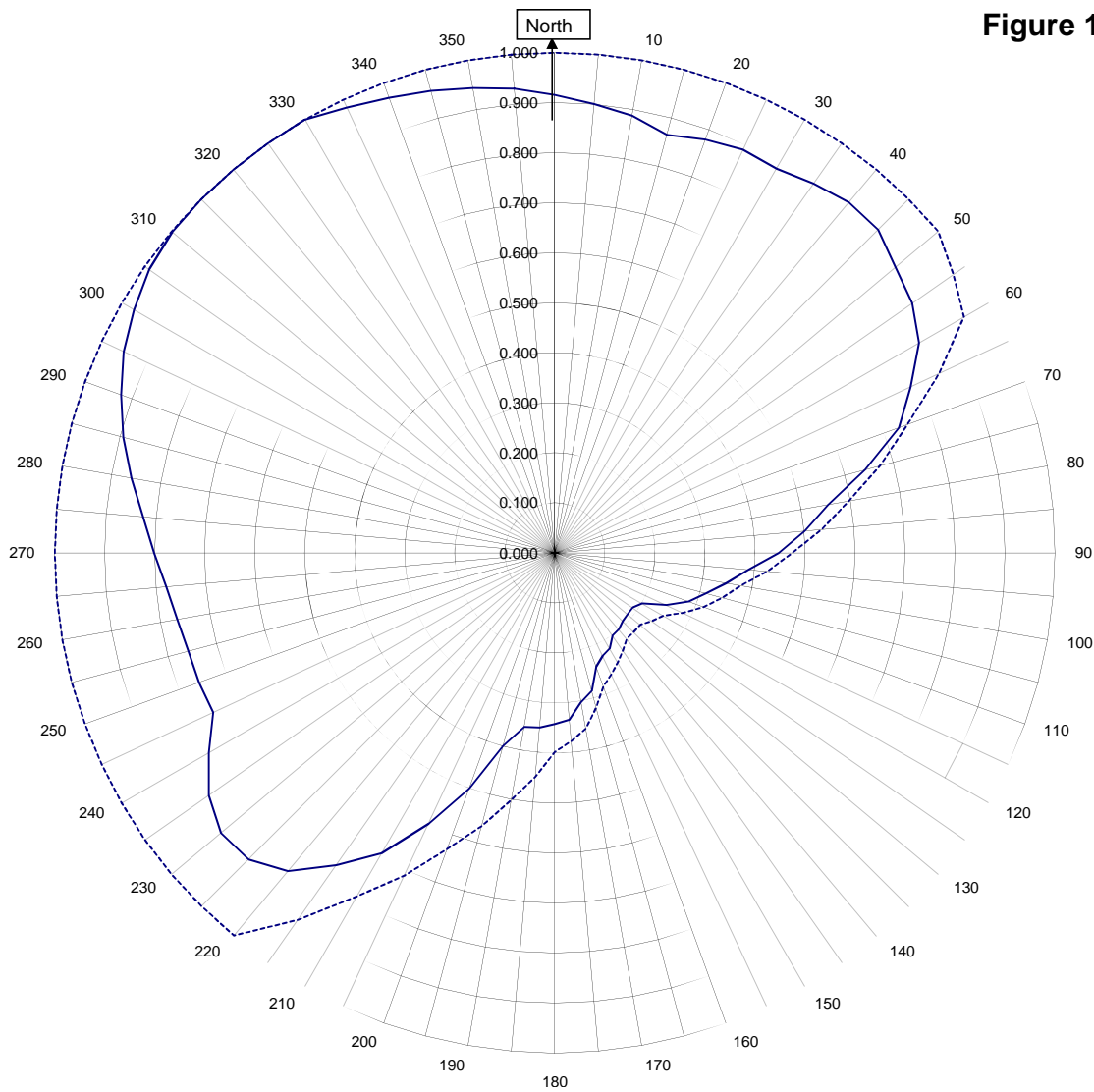
Frequency	89.5 / 402.75 MHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

Antenna Model	6810-4R-DA
Pattern Type	Directional Azimuth

# Shively Labs

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Figure 1B



## WMIH GENEVA, OH.

31291  
November 19, 2013

—————H/V Composite RMS	0.732	Frequency	89.5 / 402.75 mHz
.....FCC Composite RMS	0.819	Plot	Relative Field
		Scale	4.5 : 1
			See Figure 2 for Mechanical Details

Antenna Model	6810-4R-DA
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern  
WMIH GENEVA, OH.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.915	180	0.342
10	0.888	190	0.353
20	0.832	200	0.414
30	0.868	210	0.522
40	0.915	220	0.633
45	0.914	225	0.665
50	0.889	230	0.707
60	0.840	240	0.747
70	0.732	250	0.757
80	0.555	260	0.766
90	0.447	270	0.801
100	0.347	280	0.860
110	0.284	290	0.923
120	0.201	300	0.972
130	0.190	310	0.998
135	0.193	315	1.000
140	0.199	320	1.000
150	0.220	330	1.000
160	0.242	340	0.969
170	0.302	350	0.944

Figure 1D

Tabulation of Vertical Azimuth Pattern  
WMIH GENEVA, OH.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.828	180	0.115
10	0.848	190	0.301
20	0.880	200	0.501
30	0.887	210	0.693
40	0.877	220	0.830
45	0.851	225	0.866
50	0.834	230	0.872
60	0.763	240	0.799
70	0.674	250	0.681
80	0.533	260	0.602
90	0.403	270	0.582
100	0.244	280	0.629
110	0.115	290	0.734
120	0.115	300	0.813
130	0.115	310	0.860
135	0.141	315	0.872
140	0.158	320	0.869
150	0.163	330	0.857
160	0.117	340	0.828
170	0.115	350	0.805

Figure 1E

Tabulation of Composite Azimuth Pattern  
WMIH GENEVA, OH.

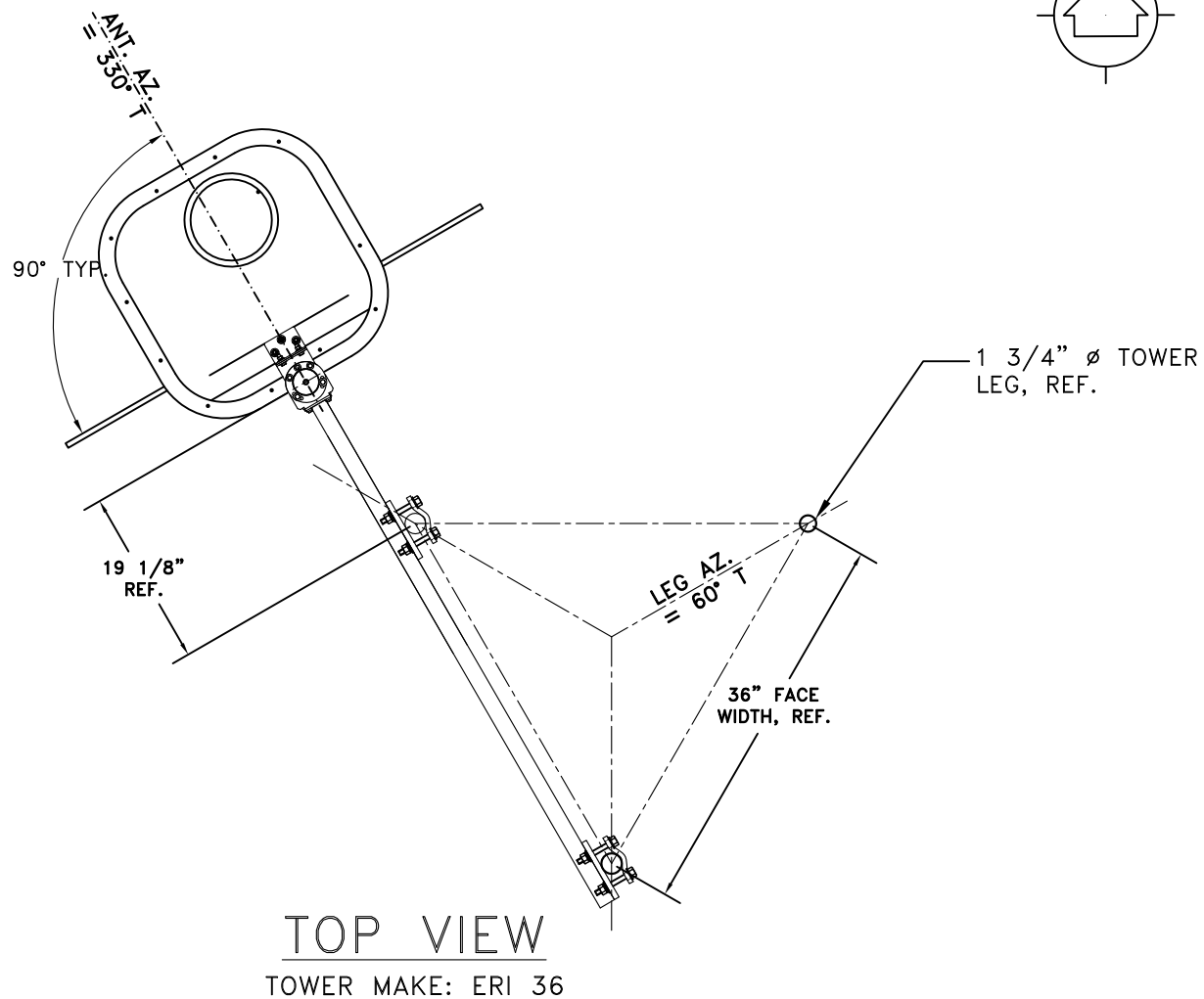
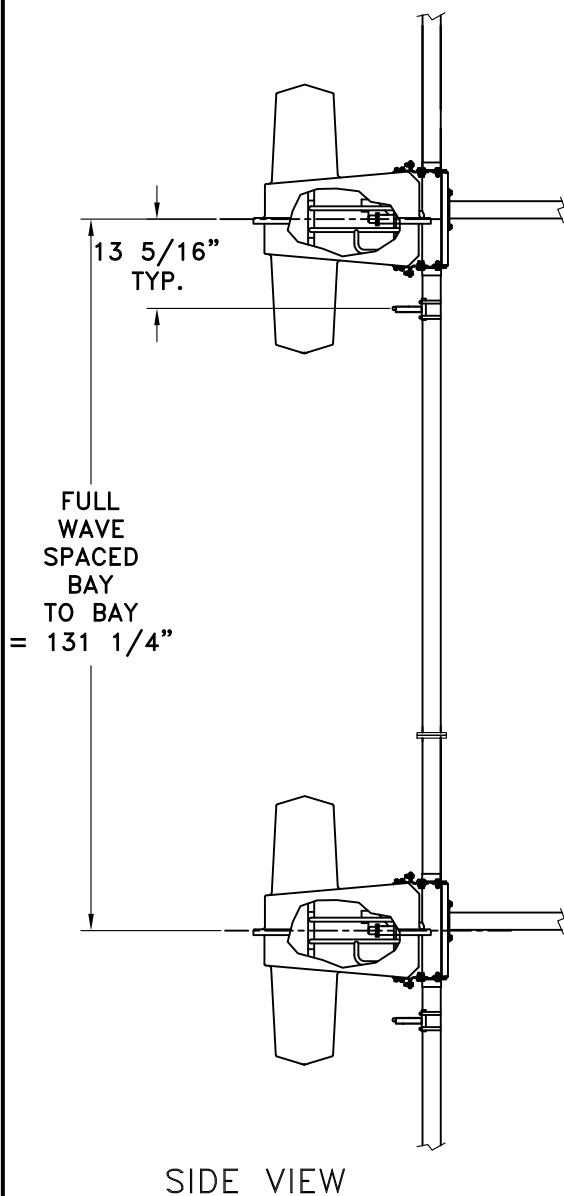
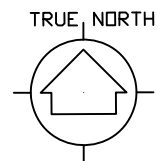
Azimuth	Rel Field	Azimuth	Rel Field
0	0.915	180	0.342
10	0.888	190	0.353
20	0.880	200	0.501
30	0.887	210	0.693
40	0.915	220	0.830
45	0.914	225	0.866
50	0.889	230	0.872
60	0.840	240	0.799
70	0.732	250	0.757
80	0.555	260	0.766
90	0.447	270	0.801
100	0.347	280	0.860
110	0.284	290	0.923
120	0.201	300	0.972
130	0.190	310	0.998
135	0.193	315	1.000
140	0.199	320	1.000
150	0.220	330	1.000
160	0.242	340	0.969
170	0.302	350	0.944



Figure 1F

Tabulation of FCC Directional Composite  
WMIH GENEVA, OH.

Azimuth	Rel Field	Azimuth	Rel Field
0	1.000	180	0.398
10	1.000	190	0.501
20	1.000	200	0.630
30	1.000	210	0.793
40	1.000	220	0.998
50	1.000	230	1.000
60	0.944	240	1.000
70	0.750	250	1.000
80	0.596	260	1.000
90	0.474	270	1.000
100	0.377	280	1.000
110	0.316	290	1.000
120	0.251	300	1.000
130	0.223	310	1.000
140	0.223	320	1.000
150	0.252	330	1.000
160	0.283	340	1.000
170	0.356	350	1.000



ANTENNA HEADING 330° TRUE NORTH

SHIVELY LABS			
A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER:	FREQUENCY:	SCALE:	DRAWN BY:
31291	89.5	N.T.S.	ASP
TITLE:			
MODEL-6810-4R-DIRECTIONAL ANTENNA			
DATE:	APPROVED BY:		
12-2-13	DAB		

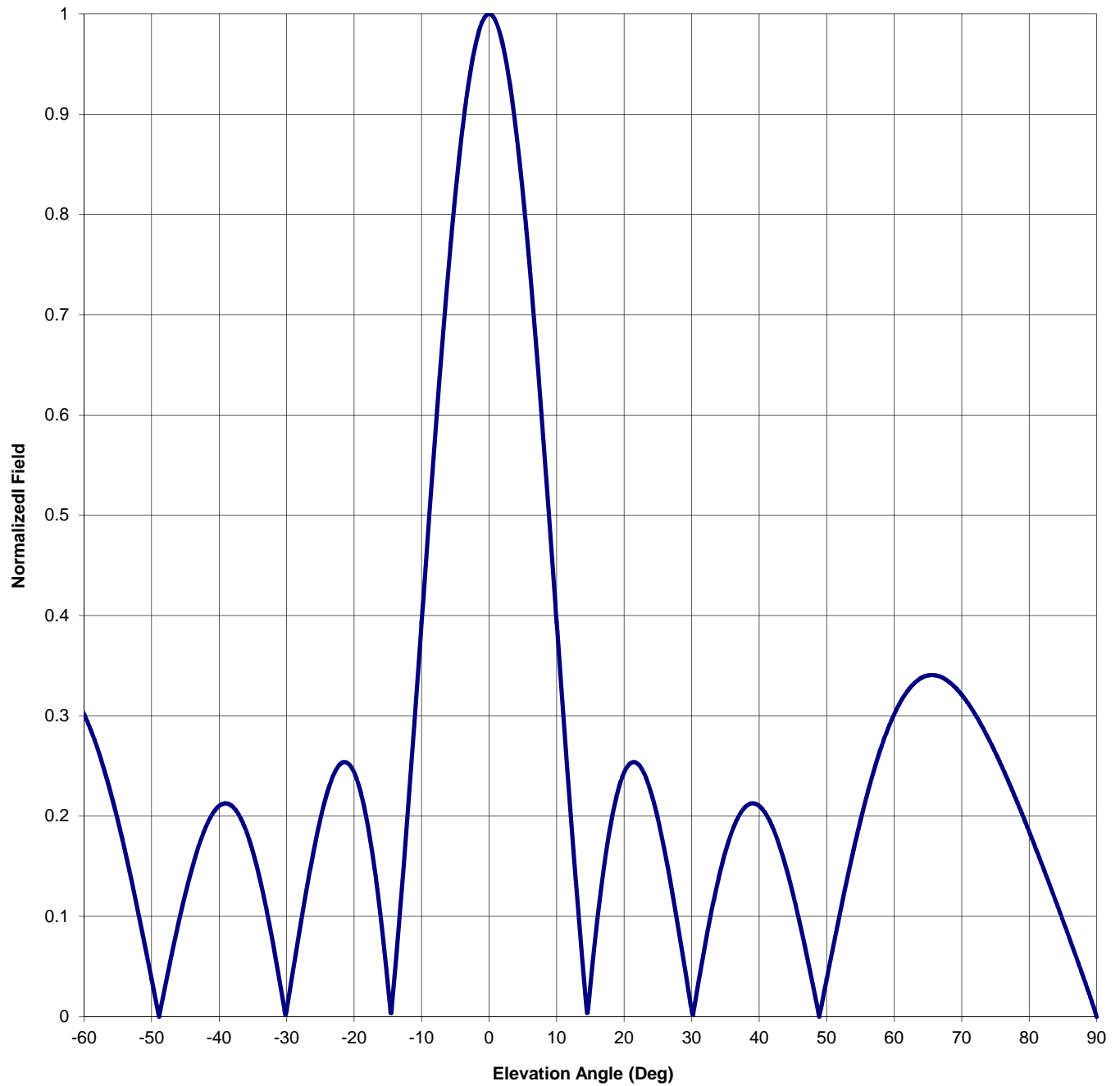
FIGURE 2

Antenna Mfg.: Shively Labs  
Antenna Type: 6810-4R-DA

Date: 11/19/2013

Station: WMIH  
Frequency: 89.5  
Channel #: 208  
Figure: Figure 3

Beam Tilt	0	
Gain (Max)	4.563	6.592 dB
Gain (Horizon)	4.563	6.592 dB



Antenna Mfg.: Shively Labs

Date: 11/19/2013

Antenna Type: 6810-4R-DA

Station: WMIH

Beam Tilt 0

Frequency: 89.5

Gain (Max) 4.563

6.592 dB

Channel #: 208

Gain (Horizon) 4.563

6.592 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	0.148	0	1.000	46	0.094
-89	0.021	-43	0.171	1	0.992	47	0.063
-88	0.040	-42	0.189	2	0.970	48	0.030
-87	0.059	-41	0.202	3	0.933	49	0.003
-86	0.077	-40	0.210	4	0.883	50	0.037
-85	0.096	-39	0.213	5	0.821	51	0.071
-84	0.114	-38	0.210	6	0.748	52	0.104
-83	0.132	-37	0.200	7	0.667	53	0.137
-82	0.150	-36	0.185	8	0.579	54	0.167
-81	0.167	-35	0.165	9	0.487	55	0.196
-80	0.184	-34	0.138	10	0.393	56	0.222
-79	0.201	-33	0.107	11	0.300	57	0.246
-78	0.218	-32	0.072	12	0.208	58	0.267
-77	0.233	-31	0.034	13	0.122	59	0.286
-76	0.249	-30	0.006	14	0.041	60	0.302
-75	0.263	-29	0.048	15	0.032	61	0.315
-74	0.277	-28	0.089	16	0.095	62	0.325
-73	0.290	-27	0.129	17	0.149	63	0.333
-72	0.301	-26	0.165	18	0.192	64	0.338
-71	0.312	-25	0.197	19	0.223	65	0.340
-70	0.321	-24	0.223	20	0.244	66	0.341
-69	0.329	-23	0.242	21	0.253	67	0.339
-68	0.335	-22	0.252	22	0.252	68	0.335
-67	0.339	-21	0.253	23	0.242	69	0.329
-66	0.341	-20	0.244	24	0.223	70	0.321
-65	0.340	-19	0.223	25	0.197	71	0.312
-64	0.338	-18	0.192	26	0.165	72	0.301
-63	0.333	-17	0.149	27	0.129	73	0.290
-62	0.325	-16	0.095	28	0.089	74	0.277
-61	0.315	-15	0.032	29	0.048	75	0.263
-60	0.302	-14	0.041	30	0.006	76	0.249
-59	0.286	-13	0.122	31	0.034	77	0.233
-58	0.267	-12	0.208	32	0.072	78	0.218
-57	0.246	-11	0.300	33	0.107	79	0.201
-56	0.222	-10	0.393	34	0.138	80	0.184
-55	0.196	-9	0.487	35	0.165	81	0.167
-54	0.167	-8	0.579	36	0.185	82	0.150
-53	0.137	-7	0.667	37	0.200	83	0.132
-52	0.104	-6	0.748	38	0.210	84	0.114
-51	0.071	-5	0.821	39	0.213	85	0.096
-50	0.037	-4	0.883	40	0.210	86	0.077
-49	0.003	-3	0.933	41	0.202	87	0.059
-48	0.030	-2	0.970	42	0.189	88	0.040
-47	0.063	-1	0.992	43	0.171	89	0.021
-46	0.094	0	1.000	44	0.148	90	0.000
-45	0.123			45	0.123		

## VALIDATION OF TOTAL POWER GAIN CALCULATION

WMIH GENEVA, OH.

MODEL 6810-4R-DA

Elevation Gain of Antenna

2.12

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

H RMS

0.712035

V RMS

0.652509

H/V Ratio

1.091

Elevation Gain of Horizontal Component

2.313

Elevation Gain of Vertical Component

1.943

Horizontal Azimuth Gain equals  $1/(\text{RMS})^2$ .

1.972

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

1.860

Max. Vertical

0.89

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

Total Horizontal Power Gain =

4.563

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

Total Vertical Power Gain =

3.614

ERP divided by Horizontal Power Gain equals Antenna Input Power

21.0

kW ERP

Divided by H Gain

4.563

equals

4.602

kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

4.602 kW

Times V Gain

3.614

equals

16.634 kW V ERP

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

 $(0.89)^2$ 

Times

21.00

Equals

16.634

kW Vertical ERP

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