

**S.O. 34578**

**Report of Test 6810-2R-DA**

**for**

**REGENTS OF THE UNIVERSITY OF MICHIGAN**

**WCBN-FM 88.3 MHz ANN ARBOR, MI.**

**OBJECTIVE:**

The objective of this test was to demonstrate the directional characteristics of a 6810-2R-DA to meet the needs of WCBN-FM and to comply with the requirements of the FCC construction permit, file number BPED-20151116ADW. 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 BPED-20151116ADW indicates that the Horizontal radiation component shall not exceed 1.40 kW at any azimuth and is restricted to the following values at the azimuths specified:

80 Degrees True: 0.044 kilowatts

From Figure 1A, the maximum radiation of the Horizontal component occurs at 246 Degrees True to 254 Degrees True.. At the restricted azimuth of 80 Degrees True the Vertical component is 19.74 dB down from the maximum of 1.40 kW, or 0.015 kW.

The R.M.S. of the Horizontal component is 0.707. The total Horizontal power gain is 2.238. The R.M.S. of the Vertical component is 0.625. The total Vertical power gain is 2.123. See Figure 4 for calculations. The R.M.S. of the FCC composite pattern is 0.801. The R.M.S. of the measured composite pattern is 0.708. Eighty-five percent (85%) of the original authorized FCC composite pattern is 0.681. Therefore this pattern complies with the FCC requirement of 73.316(c)(2)(ix)(A).

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

One bay of the 6810-2R-DA was mounted on a tower of precise scale to the Rohn-80 tower at the WCBN-FM 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 BPED-20151116ADW, a single level of the 6810-2R-DA was set up on the Shively Labs scale model antenna pattern measuring range. A scale of 4.5:1 was used.

#### **EQUIPMENT:**

The 4.5:1 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.

Test Report 6810-2R-DA

WCBN-FM

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The control building is equipped with:

Hewlett Packard Model 4395-A Network Analyzer

PC Based Controller

Output Standard Printer or 'pdf'

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 397.35 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:

A handwritten signature in blue ink, appearing to read 'Martyn Gregory', with a stylized flourish at the end.

Martyn Gregory

Vice President, Shively Labs

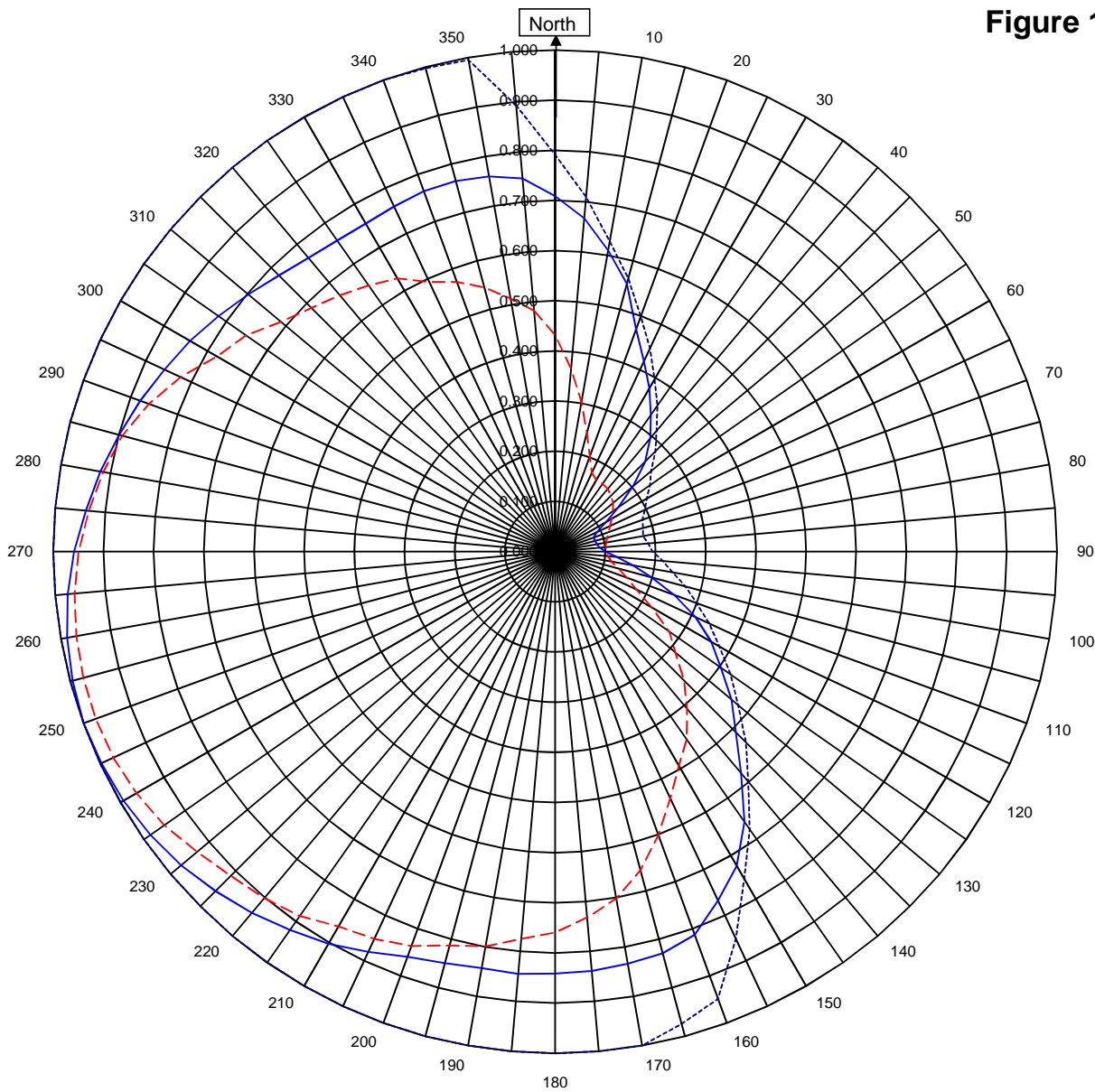
S/O 34578

Date May 24, 2017

# Shively Labs

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

Figure 1A



**WCBN-FM      ANN ARBOR , MI.**

34578  
May 25, 2017

Horizontal RMS	0.707
Vertical RMS	0.625
H/V Composite RMS	0.708
FCC Composite RMS	0.801

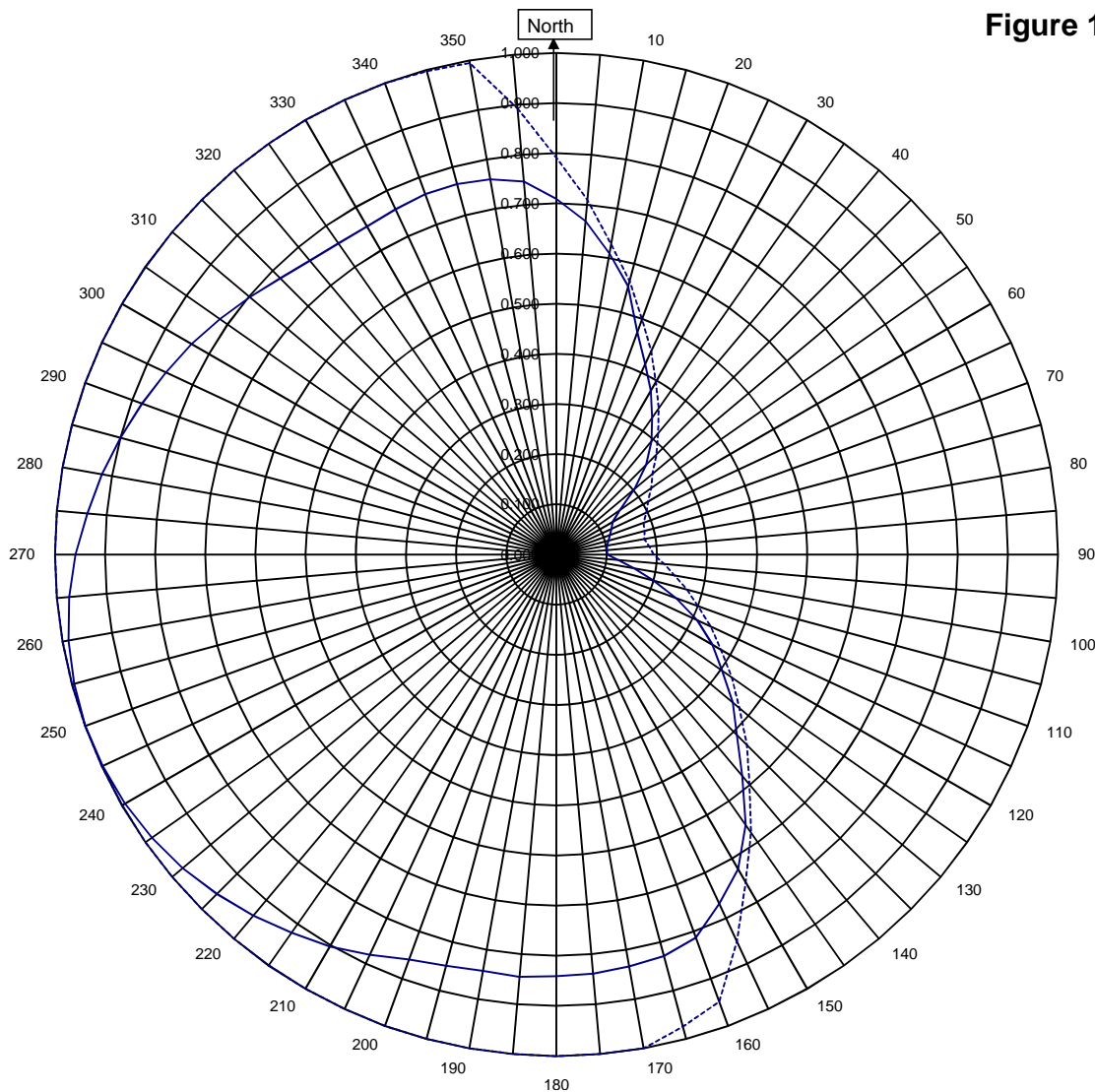
Frequency	88.3 / 397.35    mHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

Antenna Model	6810-2R-DA
Pattern Type	Directional Azimuth

# Shively Labs

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Figure 1B



**WCBN-FM ANN ARBOR , MI.**

34578  
May 25, 2017

—————H/V Composite RMS	0.708
.....FCC Composite RMS	0.801

Frequency	88.3 / 397.35 mHz
Plot	Relative Field
Scale	4.5 : 1
See Figure 2 for Mechanical Details	

Antenna Model	6810-2R-DA
Pattern Type	Directional H/V Composite

Figure 1C

Tabulation of Horizontal Azimuth Pattern  
WCBN-FM ANN ARBOR , MI.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.709	180	0.841
10	0.609	190	0.843
20	0.472	200	0.859
30	0.376	210	0.903
40	0.295	220	0.940
45	0.253	225	0.957
50	0.203	230	0.973
60	0.116	240	0.993
70	0.082	250	1.000
80	0.085	260	0.988
90	0.100	270	0.959
100	0.157	280	0.920
110	0.253	290	0.880
120	0.359	300	0.840
130	0.459	310	0.798
135	0.509	315	0.779
140	0.576	320	0.765
150	0.724	330	0.755
160	0.813	340	0.765
170	0.834	350	0.760

Figure 1D

Tabulation of Vertical Azimuth Pattern  
WCBN-FM ANN ARBOR , MI.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.432	180	0.759
10	0.303	190	0.799
20	0.202	200	0.837
30	0.165	210	0.863
40	0.163	220	0.902
45	0.158	225	0.914
50	0.150	230	0.931
60	0.130	240	0.964
70	0.114	250	0.974
80	0.103	260	0.969
90	0.101	270	0.949
100	0.114	280	0.914
110	0.153	290	0.861
120	0.223	300	0.779
130	0.313	310	0.713
135	0.363	315	0.687
140	0.409	320	0.667
150	0.493	330	0.629
160	0.602	340	0.572
170	0.702	350	0.513

Figure 1E

Tabulation of Composite Azimuth Pattern  
WCBN-FM ANN ARBOR , MI.

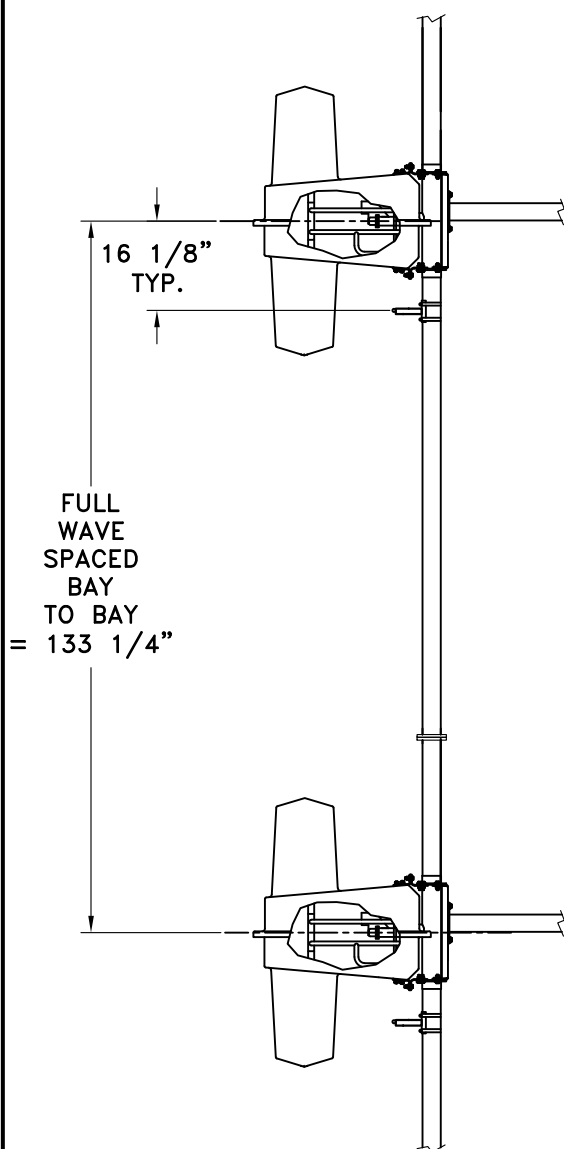
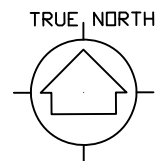
Azimuth	Rel Field	Azimuth	Rel Field
0	0.709	180	0.841
10	0.609	190	0.843
20	0.472	200	0.859
30	0.376	210	0.903
40	0.295	220	0.940
45	0.253	225	0.957
50	0.203	230	0.973
60	0.130	240	0.993
70	0.114	250	1.000
80	0.103	260	0.988
90	0.101	270	0.959
100	0.157	280	0.920
110	0.253	290	0.880
120	0.359	300	0.840
130	0.459	310	0.798
135	0.509	315	0.779
140	0.576	320	0.765
150	0.724	330	0.755
160	0.813	340	0.765
170	0.834	350	0.760



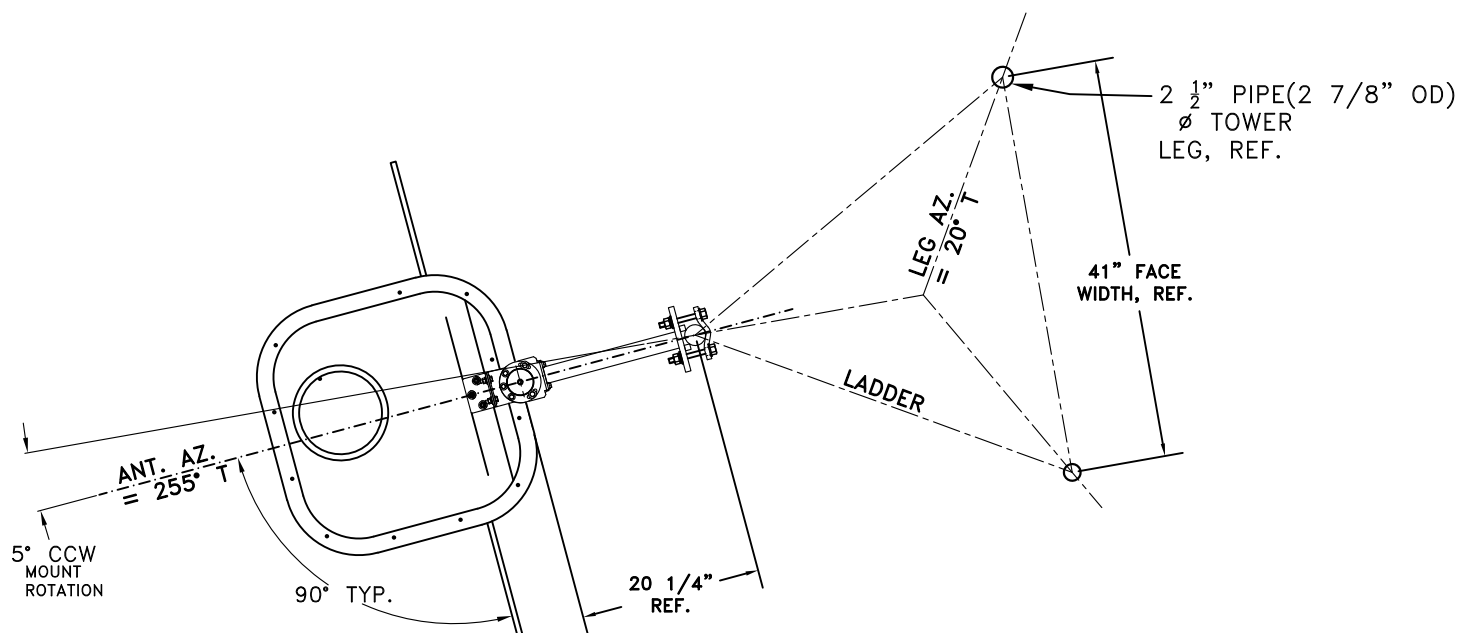
Figure 1F

Tabulation of FCC Directional Composite  
WCBN-FM ANN ARBOR , MI.

Azimuth	Rel Field	Azimuth	Rel Field
0	0.791	180	1.000
10	0.628	190	1.000
20	0.499	200	1.000
30	0.396	210	1.000
40	0.315	220	1.000
50	0.250	230	1.000
60	0.211	240	1.000
70	0.185	250	1.000
80	0.178	260	1.000
90	0.194	270	1.000
100	0.238	280	1.000
110	0.300	290	1.000
120	0.378	300	1.000
130	0.476	310	1.000
140	0.599	320	1.000
150	0.754	330	1.000
160	0.949	340	1.000
170	1.000	350	0.995



SIDE VIEW



TOP VIEW

TOWER MAKE:  
ROHN 80, 41" FACE

ANTENNA HEADING 255° TRUE NORTH

SHIVELY LABS			
A DIVISION OF HOWELL LABORATORIES INC., BRIDGTON, MAINE			
SHOP ORDER:	FREQUENCY:	SCALE:	DRAWN BY:
34578	88.3	N.T.S.	ASP
TITLE:			
MODEL-6810-2R-DIRECTIONAL ANTENNA			
DATE:	APPROVED BY:		
5-26-17	DAB		

FIGURE 2

Antenna Mfg.: Shively Labs

Antenna Type: 6810-2R-DA

Station: WCBN-FM

Frequency: 88.3

Channel #: 202

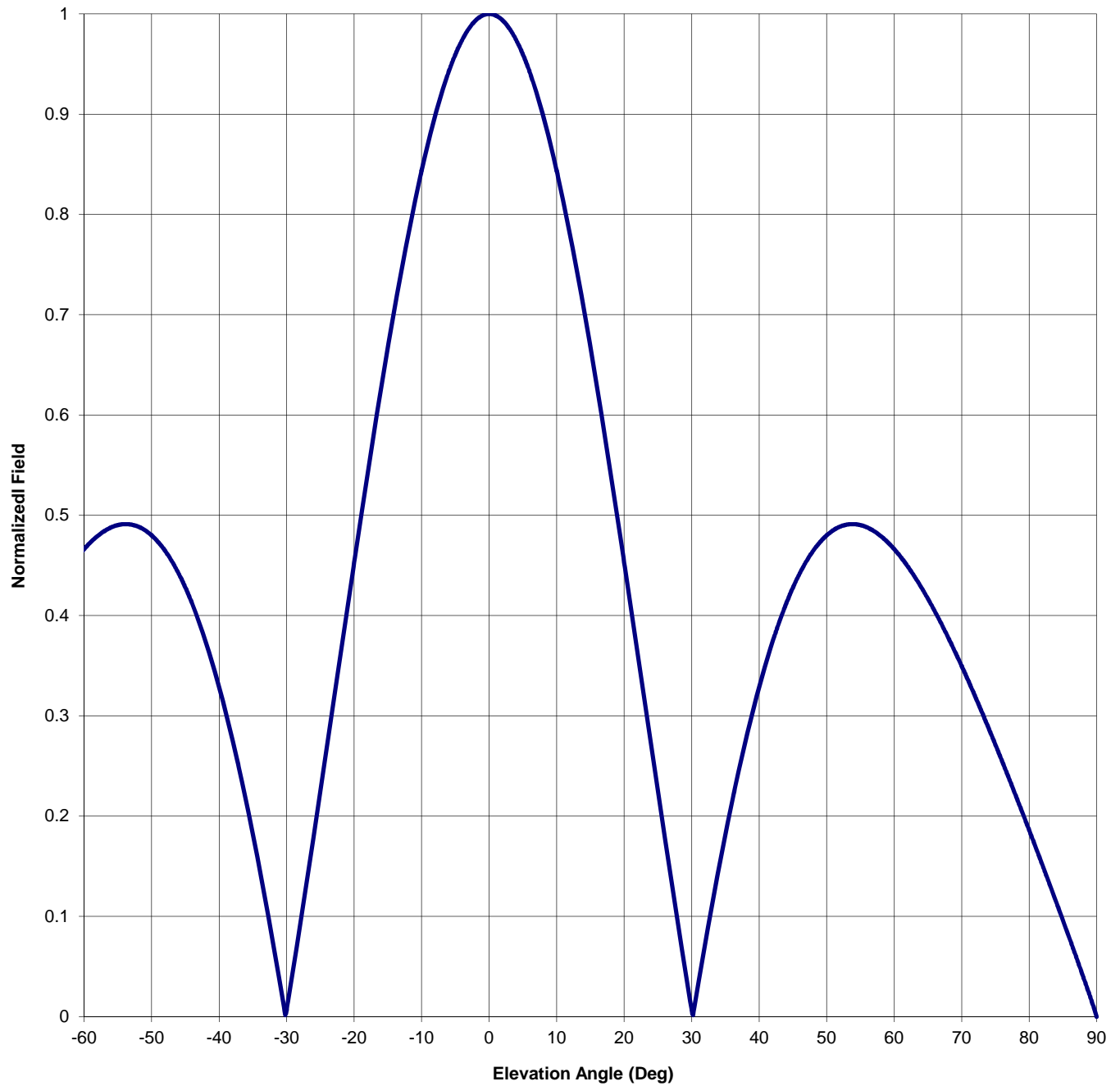
Figure: Figure 3

Date: 5/26/2017

Beam Tilt 0

Gain (Max) 2.238 3.499 dB

Gain (Horizon) 2.238 3.499 dB



Antenna Mfg.: Shively Labs

Date: 5/26/2017

Antenna Type: 6810-2R-DA

Station: WCBN-FM

Beam Tilt 0

Frequency: 88.3

Gain (Max) 2.238

3.499 dB

Channel #: 202

Gain (Horizon) 2.238

3.499 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	0.412	0	1.000	46	0.442
-89	0.021	-43	0.394	1	0.998	47	0.454
-88	0.040	-42	0.374	2	0.993	48	0.465
-87	0.059	-41	0.352	3	0.985	49	0.473
-86	0.078	-40	0.329	4	0.974	50	0.480
-85	0.096	-39	0.303	5	0.960	51	0.485
-84	0.114	-38	0.276	6	0.942	52	0.489
-83	0.132	-37	0.246	7	0.922	53	0.491
-82	0.150	-36	0.215	8	0.898	54	0.491
-81	0.168	-35	0.182	9	0.872	55	0.490
-80	0.186	-34	0.147	10	0.844	56	0.488
-79	0.203	-33	0.111	11	0.813	57	0.484
-78	0.221	-32	0.073	12	0.779	58	0.479
-77	0.238	-31	0.034	13	0.744	59	0.473
-76	0.255	-30	0.007	14	0.707	60	0.466
-75	0.271	-29	0.049	15	0.668	61	0.458
-74	0.288	-28	0.091	16	0.627	62	0.449
-73	0.304	-27	0.135	17	0.585	63	0.439
-72	0.319	-26	0.180	18	0.542	64	0.428
-71	0.335	-25	0.225	19	0.498	65	0.417
-70	0.350	-24	0.270	20	0.453	66	0.405
-69	0.364	-23	0.316	21	0.408	67	0.392
-68	0.378	-22	0.362	22	0.362	68	0.378
-67	0.392	-21	0.408	23	0.316	69	0.364
-66	0.405	-20	0.453	24	0.270	70	0.350
-65	0.417	-19	0.498	25	0.225	71	0.335
-64	0.428	-18	0.542	26	0.180	72	0.319
-63	0.439	-17	0.585	27	0.135	73	0.304
-62	0.449	-16	0.627	28	0.091	74	0.288
-61	0.458	-15	0.668	29	0.049	75	0.271
-60	0.466	-14	0.707	30	0.007	76	0.255
-59	0.473	-13	0.744	31	0.034	77	0.238
-58	0.479	-12	0.779	32	0.073	78	0.221
-57	0.484	-11	0.813	33	0.111	79	0.203
-56	0.488	-10	0.844	34	0.147	80	0.186
-55	0.490	-9	0.872	35	0.182	81	0.168
-54	0.491	-8	0.898	36	0.215	82	0.150
-53	0.491	-7	0.922	37	0.246	83	0.132
-52	0.489	-6	0.942	38	0.276	84	0.114
-51	0.485	-5	0.960	39	0.303	85	0.096
-50	0.480	-4	0.974	40	0.329	86	0.078
-49	0.473	-3	0.985	41	0.352	87	0.059
-48	0.465	-2	0.993	42	0.374	88	0.040
-47	0.454	-1	0.998	43	0.394	89	0.021
-46	0.442	0	1.000	44	0.412	90	0.000
-45	0.428			45	0.428		

## VALIDATION OF TOTAL POWER GAIN CALCULATION

WCBN-FM ANN ARBOR , MI.

MODEL 6810-2R-DA

Elevation Gain of Antenna

0.99

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

H RMS 0.707296 V RMS 0.625418 H/V Ratio 1.131

Elevation Gain of Horizontal Component 1.120

Elevation Gain of Vertical Component 0.875

Horizontal Azimuth Gain equals  $1/(\text{RMS})^2$ . 1.999Vertical Azimuth Gain equals  $1/(\text{RMS}/\text{Max Vert})^2$ . 2.425

Max. Vertical 0.974

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

Total Horizontal Power Gain = 2.238

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

Total Vertical Power Gain = 2.123

ERP divided by Horizontal Power Gain equals Antenna Input Power

1.4 kW ERP Divided by H Gain 2.238 equals 0.626 kW H Antenna Input Power

Antenna Input Power times Vertical Power Gain equals Vertical ERP

0.626 kW Times V Gain 2.123 equals 1.328 kW V ERP

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

(0.974)<sup>2</sup> Times 1.40 Equals 1.328 kW Vertical ERP

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