



# Propagation Systems, Inc.

Quality Broadcast Antenna Systems

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**Directional FM Antenna  
WIAB  
Interlochen Center for the Arts  
Mackinaw City, MI**

A standard model PSIFMR antenna with parasitic elements was used in conjunction with the customer's 36" face triangular tower to create the necessary directional radiation pattern. The final antenna consists of eight radiating elements each secured to the tower face with custom mounting brackets and support mast. The antenna bays are full-wave spaced and there are a total of two horizontal parasitic elements per bay. The antenna array is center fed from an existing flexible transmission line. Each radiating element receives equal power and the correct phase.

Pattern testing was performed using a 1/3 scale model element and tower. The azimuth plane measurements were taken on a ground reflection test range. This type of test range utilizes the reflected signal and direct signal from the source antenna to form an interference pattern on the antenna under test. The antenna and tower under test was mounted to a turntable that allowed the structure to be rotated 360° in the azimuth plane. The source antenna was located approximately 75 ft. from the antenna under test. The source height above ground was adjusted to peak the first lobe of the interference pattern at the antenna under test.

The test antenna was mounted in the center of rotation of the turntable. The antenna and mounting structure were rotated clockwise while data was recorded in a counter clockwise direction. All feed cables to the antenna were secured and grounded during pattern measurements. A Hewlett Packard 8753E-network analyzer operating at 265.5 MHz was used as both the source and receiver. The level of the received signal was compared with a standard dipole to establish the directivity of the final pattern. The final pattern measured does not exceed the envelope pattern and is 85.8% of the envelope RMS.

The antenna is to be mounted 113 meters (373 ft.) +2/-4 meters above ground level on a the east tower face and positioned 66° True. Any guy wire that passes within 20 ft. of a radiating element must be changed to the appropriate non-metallic substitute. It is recommended that a broadcast engineer be present to supervise the installation of the antenna and that he or she certifies that the antenna has been installed according to the enclosed instructions.

The measured principal minimum at 220 degrees is 2.06 kW, below the approved level of 10.125 kW. An input power level of 7.70 kW will be required at the antenna input in order to reach the approved 50 kW ERP. The transmitter output power requirements are dependent upon the transmission line size and length used to feed the antenna. The final length of transmission line must be determined after installation.

### Antenna Specifications

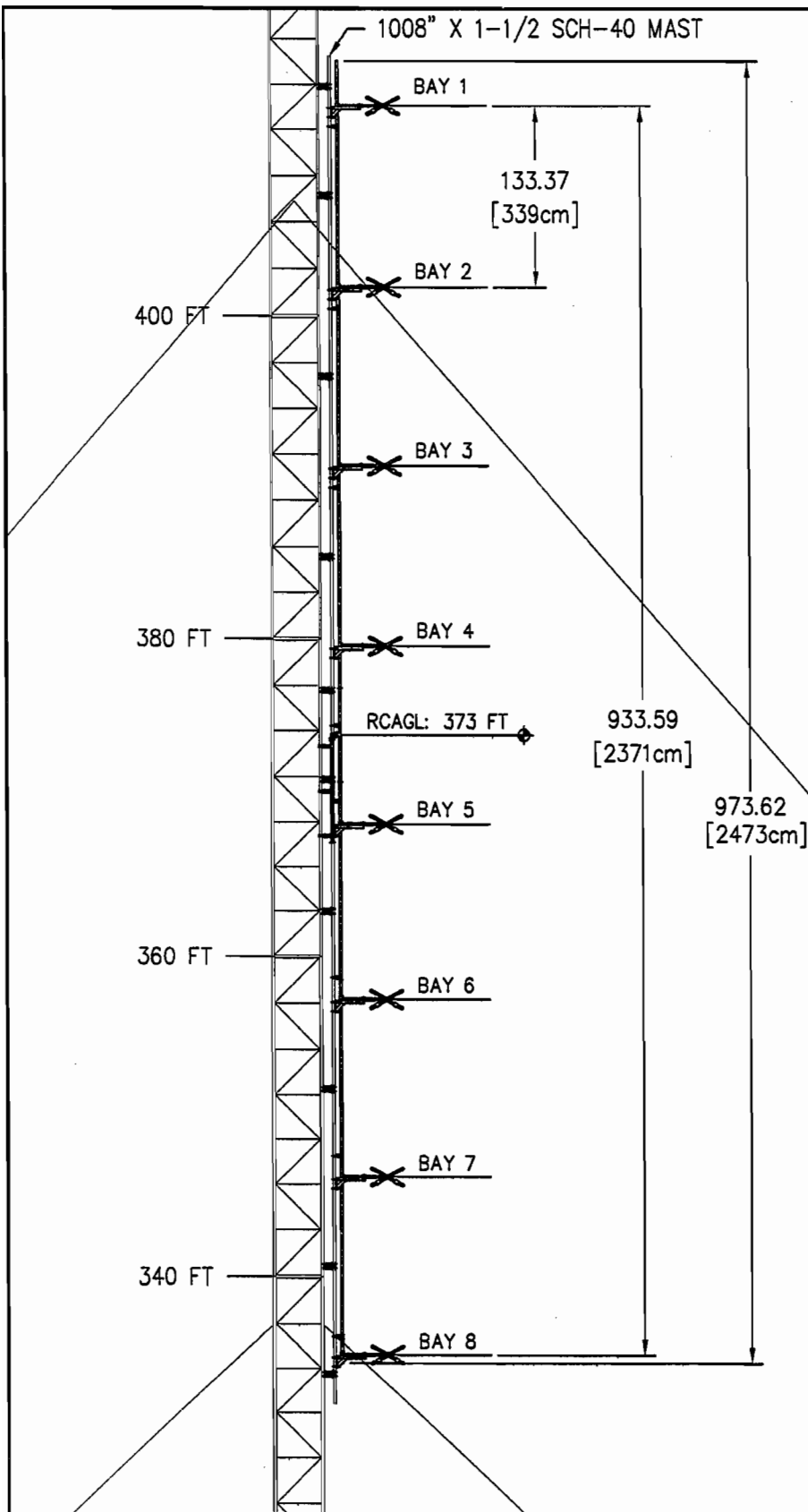
Antenna Model	PSIFMR-8C-DA
Type	8-bay directional FM antenna
Bay Spacing	Full-wave spaced elements
Frequency	88.5 MHz
Polarization	Circular
Envelope RMS	.931
Composite RMS	.799
Gain (h-pol)	6.49 (8.12 dB)
Gain (v-pol)	6.49 (8.12 dB)
ERP	50 kW
Antenna input power	7.70 kW
Input	1-5/8" EIA center fed input
Power rating	12 kW
Length	84 ft.
Weight	966.5 lbs.
Wind Area	81.3 sq. ft.

### Statement of Certification

This is to certify the antenna has been designed, fabricated and tested under my supervision and it meets the required envelope pattern limitations set forth in the stations construction permit.

 8/22/2016

Douglas A. Ross  
President  
Propagation Systems Inc.



SPECIFICATIONS	
SPACING:	1.0λ
LENGTH:	84 FT [25.6m]
APERTURE:	77.8 FT [23.71m]
RATING:	12 kW
GAIN:	6.49 (8.12dB)
WEIGHT:	966.5 LB [438.39 Kg]
WINDAREA:	81.3 FT <sup>2</sup>
TIA-222-F	(NO ICE)

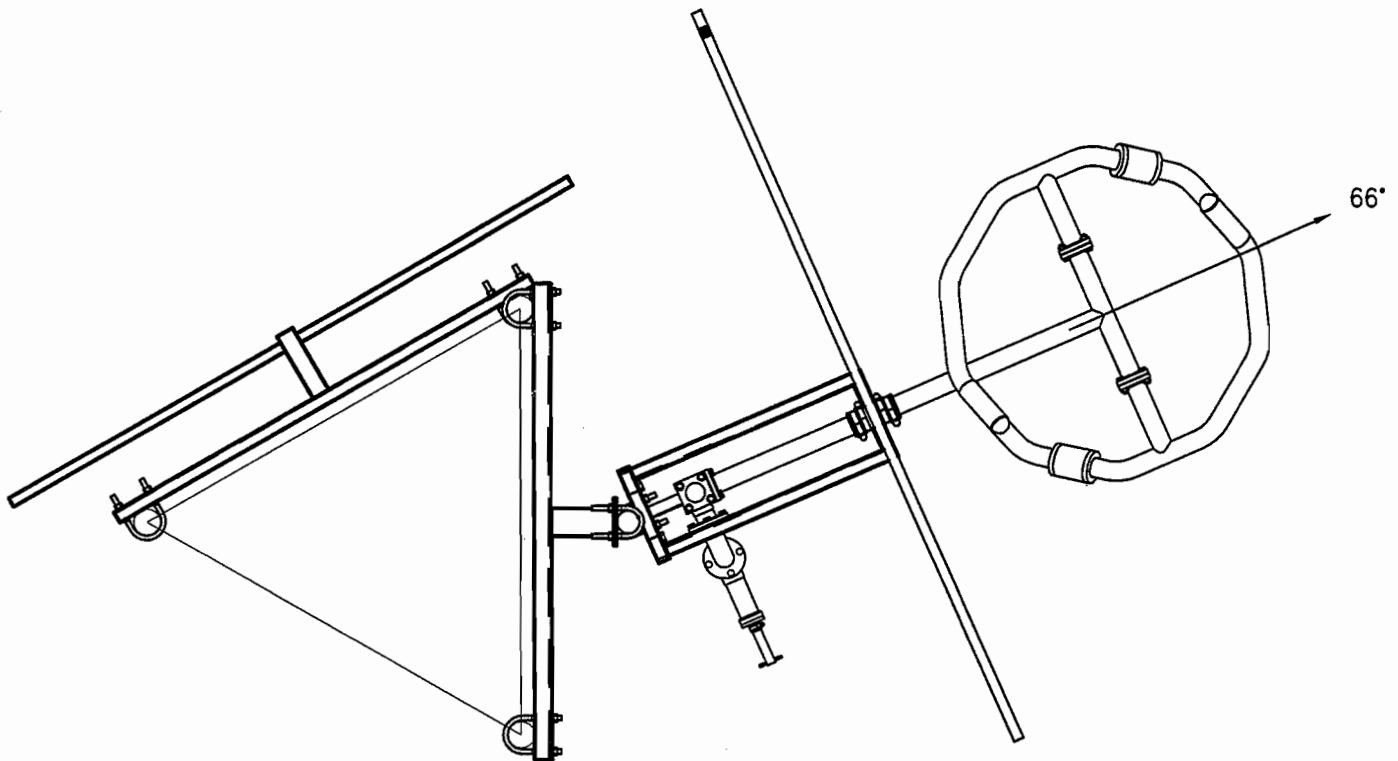
REV.	MADE BY	CHECKED BY	DATE	CHANGE	SIZE
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## PROPAGATION SYSTEMS, INC.

Ebensburg, Pennsylvania USA 814-472-5540

### ANTENNA ELEVATION AND SPECIFICATIONS

MODEL:	PSIFMR-8C-DA	DRAWN BY:	B.K.SCHILLING	DATE:	8/18/16
CHANNEL/FREQUENCY:	88.5 MHz	APPROVED BY:		DATE:	
SCALE:		DRAWING NO.:	1601-001	REV.	



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## ANTENNA ORIENTATION AND PLAN VIEW

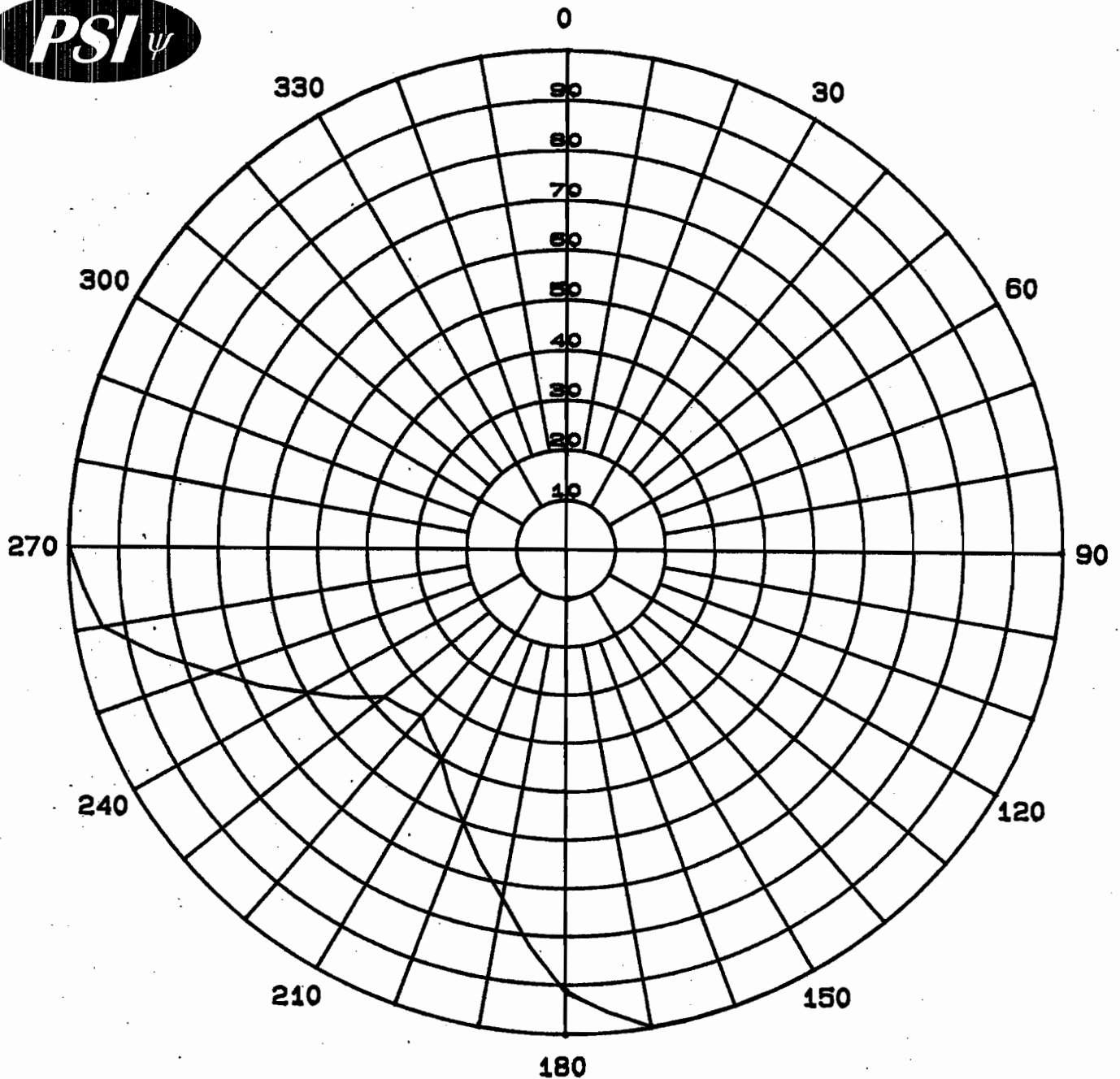
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SIZE

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MODEL: PSIFMR-8C-DA	DRAWN BY: B.K.SCHILLING	DATE: 8/18/16
CHANNEL/FREQUENCY: 88.5 MHz	APPROVED BY:	DATE:
SCALE:	DRAWING NO.: 1601-002	REV.



Maximum Envelope  
Azimuth Plane Pattern  
Antenna: PSIFMR-8C-DA  
Type: 8-Bay Directional FM Antenna  
ERP: 50 kW (16.99 dBk)  
RMS Envelope: .931  
Frequency: 88.5 MHz  
WIAB Mackinaw City, MI

**Propagation Systems Inc.**  
**PO Box 113**  
**Ebensburg, PA 15931**

## Maximum Envelope Tabulation

Antenna: PSIFMR-8C-DA

Interlochen Center for the Arts

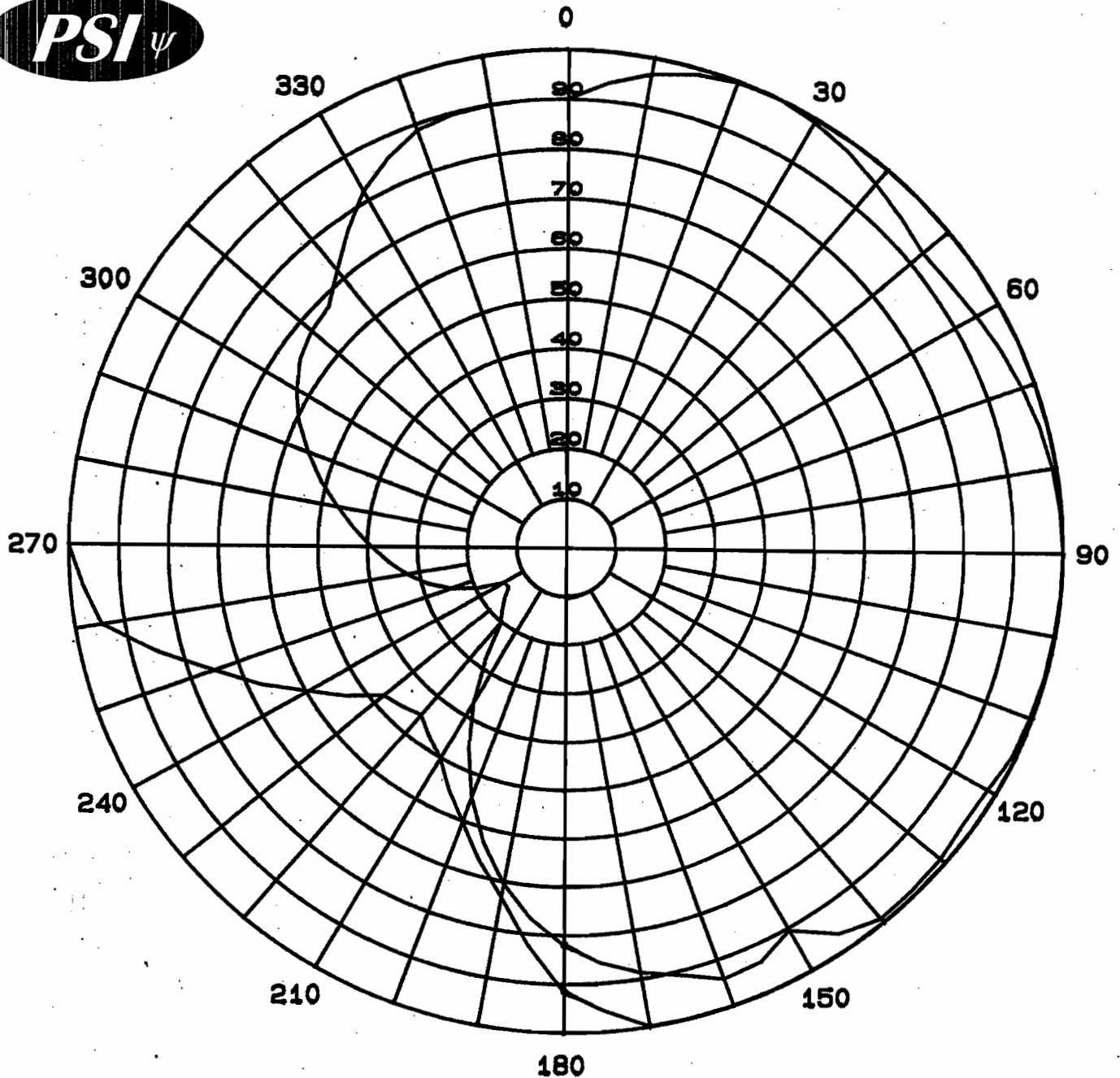
Station: WIAB

Frequency: 88.5 MHz

Location: Mackinaw City, MI

Maximum ERP: 50 kW (16.99 dBk)

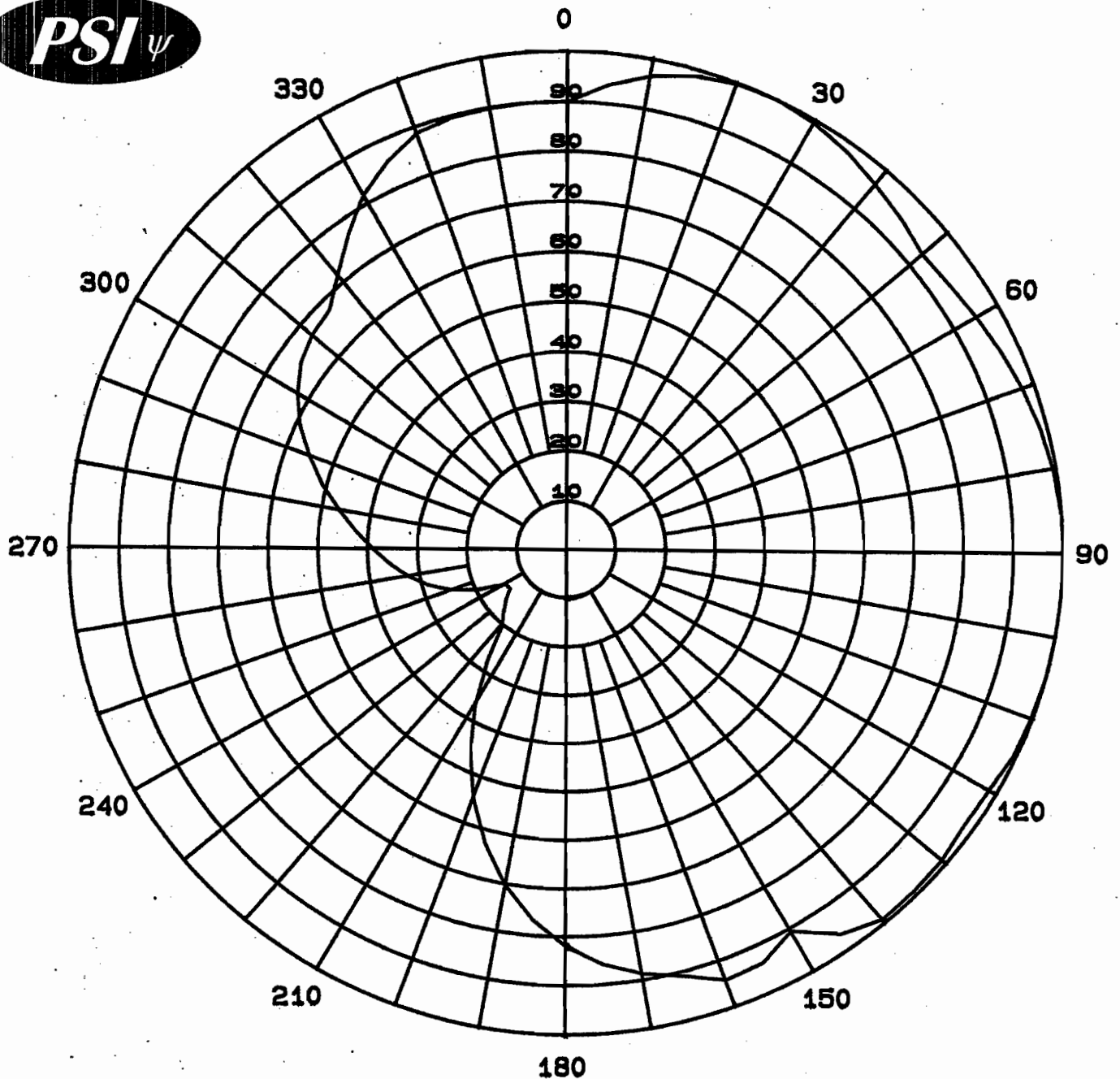
Angle	Relative Field	ERP (kW)	ERP (dBk)
0	1.000	50.00	16.99
10	1.000	50.00	16.99
20	1.000	50.00	16.99
30	1.000	50.00	16.99
40	1.000	50.00	16.99
50	1.000	50.00	16.99
60	1.000	50.00	16.99
70	1.000	50.00	16.99
80	1.000	50.00	16.99
90	1.000	50.00	16.99
100	1.000	50.00	16.99
110	1.000	50.00	16.99
120	1.000	50.00	16.99
130	1.000	50.00	16.99
140	1.000	50.00	16.99
150	1.000	50.00	16.99
160	1.000	50.00	16.99
170	1.000	50.00	16.99
180	0.915	41.86	16.22
190	0.730	26.65	14.26
200	0.600	18.00	12.55
210	0.500	12.50	10.97
220	0.450	10.13	10.05
230	0.475	11.28	10.52
240	0.595	17.70	12.48
250	0.750	28.13	14.49
260	0.945	44.65	16.50
270	1.000	50.00	16.99
280	1.000	50.00	16.99
290	1.000	50.00	16.99
300	1.000	50.00	16.99
310	1.000	50.00	16.99
320	1.000	50.00	16.99
330	1.000	50.00	16.99
340	1.000	50.00	16.99
350	1.000	50.00	16.99



Maximum Envelope and  
Composite Pattern  
Antenna: PSIFMR-8C-DA  
Type: 8-Bay Directional FM Antenna  
ERP: 50 kW (16.99 dBk)  
RMS Envelope: .931  
RMS Composite: .799  
Frequency: 88.5 MHz

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**Ebensburg, PA 15931**

WIAB Mackinaw City, MI



Measured Composite  
Azimuth Plane Pattern  
Antenna: PSIFMR-8C-DA  
Type: 8-Bay Directional FM Antenna  
ERP: 50 kW (16.99 dBk)  
RMS Composite: .799  
Frequency: 88.5 MHz  
WIAB Mackinaw City, MI

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## Composite Pattern Tabulation

Antenna: PSIFMR-8C-DA

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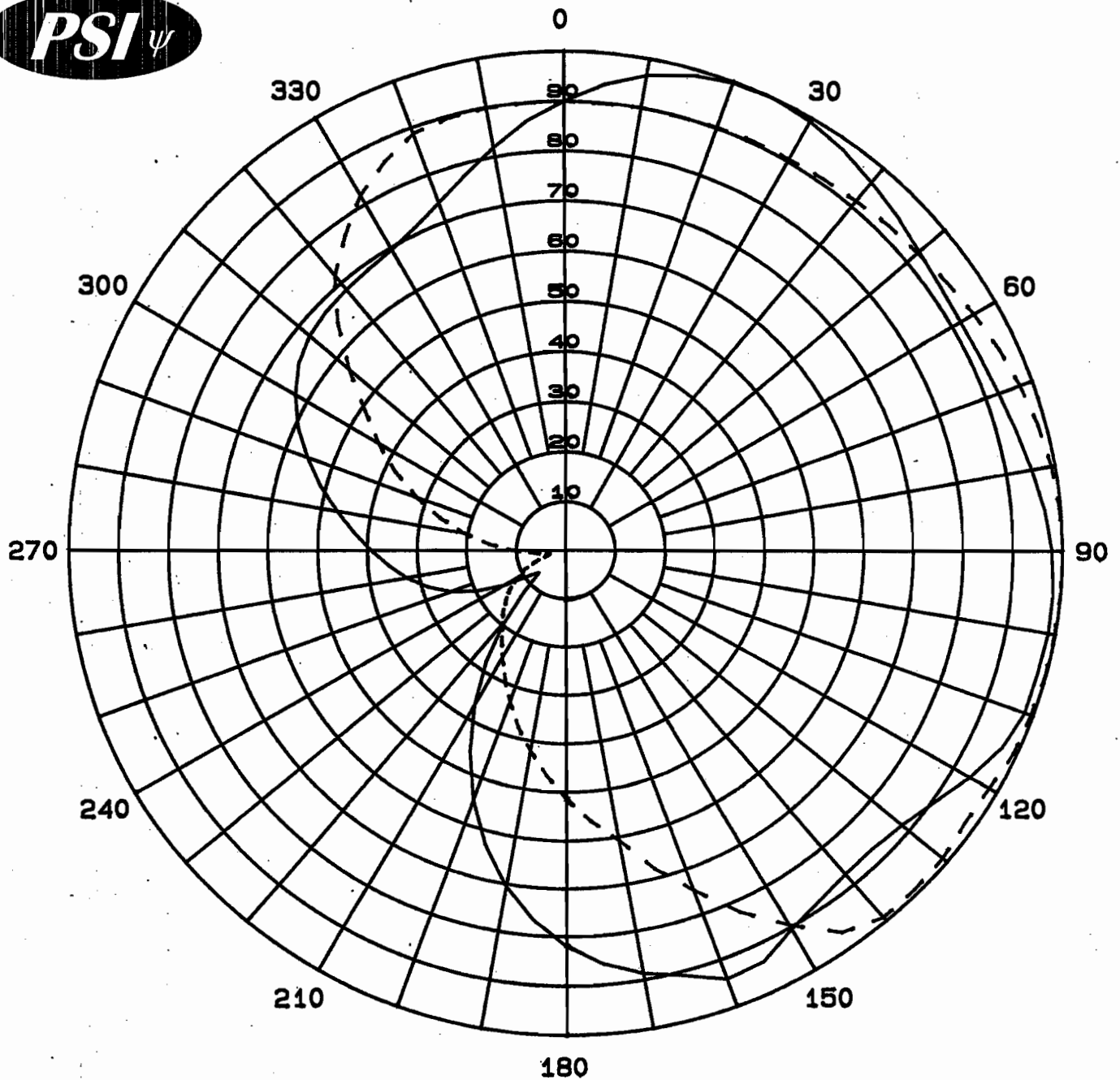
Station: WIAB

Frequency: 88.5 MHz

Location: Mackinaw City, MI

Maximum ERP: 50 kW (16.99 dBk)

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.900	40.50	16.07
10	0.967	46.75	16.70
20	0.998	49.80	16.97
30	0.993	49.30	16.93
40	0.963	46.37	16.66
50	0.933	43.52	16.39
60	0.950	45.13	16.54
70	0.973	47.34	16.75
80	0.992	49.20	16.92
90	1.000	50.00	16.99
100	0.998	49.80	16.97
110	0.995	49.50	16.95
120	0.982	48.22	16.83
130	0.988	48.81	16.88
140	0.991	49.10	16.91
150	0.906	41.04	16.13
160	0.943	44.46	16.48
170	0.888	39.43	15.96
180	0.820	33.62	15.27
190	0.703	24.71	13.93
200	0.547	14.96	11.75
210	0.370	6.85	8.35
220	0.203	2.06	3.14
230	0.160	1.28	1.07
240	0.142	1.01	0.04
250	0.246	3.03	4.81
260	0.324	5.25	7.20
270	0.390	7.61	8.81
280	0.466	10.86	10.36
290	0.552	15.24	11.83
300	0.627	19.66	12.94
310	0.671	22.51	13.52
320	0.721	25.99	14.15
330	0.821	33.70	15.28
340	0.888	39.43	15.96
350	0.899	40.41	16.06



Measured Relative Field  
Azimuth Plane Pattern  
Antenna: PSIFMR-8C-DA  
Type: 8-Bay Directional FM Antenna  
Gain H-pol (solid): 6.49 (8.12 dB)  
Gain V-pol (dash): 6.49 (8.12 dB)  
Frequency: 88.5 MHz  
WIAB Mackinaw City, MI

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**Ebensburg, PA 15931**

# Measured Relative Field Tabulation

Antenna: PSIFMR-8C-DA

Interlochen Center for the Arts

Station: WIAB

Frequency: 88.5 MHz

Location: Mackinaw City, MI

## Horizontal Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.899	5.245	7.20
10	0.967	6.069	7.83
20	0.998	6.464	8.11
30	0.993	6.399	8.06
40	0.963	6.019	7.79
50	0.933	5.649	7.52
60	0.920	5.493	7.40
70	0.928	5.589	7.47
80	0.953	5.894	7.70
90	0.979	6.220	7.94
100	0.986	6.310	8.00
110	0.983	6.271	7.97
120	0.938	5.710	7.57
130	0.882	5.049	7.03
140	0.873	4.946	6.94
150	0.906	5.327	7.27
160	0.943	5.771	7.61
170	0.888	5.118	7.09
180	0.820	4.364	6.40
190	0.703	3.207	5.06
200	0.547	1.942	2.88
210	0.370	0.888	-0.51
220	0.196	0.249	-6.03
230	0.070	0.032	-14.98
240	0.142	0.131	-8.83
250	0.246	0.393	-4.06
260	0.324	0.681	-1.67
270	0.390	0.987	-0.06
280	0.466	1.409	1.49
290	0.552	1.978	2.96
300	0.627	2.551	4.07
310	0.671	2.922	4.66
320	0.683	3.028	4.81
330	0.696	3.144	4.97
340	0.740	3.554	5.51
350	0.818	4.343	6.38

### Maximum Value

Field 1.00  
Gain 6.49 (8.12 dB)

Azimuth Bearing 25 degrees

### Minimum Field

Field 0.070  
Gain .032 (-14.98 dB)

Azimuth Bearing 230 degrees

## Vertical Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.900	5.257	7.21
10	0.901	5.269	7.22
20	0.902	5.280	7.23
30	0.905	5.315	7.26
40	0.914	5.422	7.34
50	0.928	5.589	7.47
60	0.950	5.857	7.68
70	0.973	6.144	7.88
80	0.992	6.387	8.05
90	1.000	6.490	8.12
100	0.998	6.464	8.11
110	0.995	6.425	8.08
120	0.982	6.258	7.96
130	0.988	6.335	8.02
140	0.991	6.374	8.04
150	0.895	5.199	7.16
160	0.748	3.631	5.60
170	0.609	2.407	3.81
180	0.515	1.721	2.36
190	0.420	1.145	0.59
200	0.333	0.720	-1.43
210	0.259	0.435	-3.61
220	0.203	0.267	-5.73
230	0.160	0.166	-7.80
240	0.117	0.089	-10.51
250	0.066	0.028	-15.49
260	0.033	0.007	-21.51
270	0.105	0.072	-11.45
280	0.208	0.281	-5.52
290	0.319	0.660	-1.80
300	0.434	1.222	0.87
310	0.567	2.086	3.19
320	0.721	3.374	5.28
330	0.821	4.375	6.41
340	0.888	5.118	7.09
350	0.899	5.245	7.20

### Maximum Value

Field 1.00  
Gain 6.49 (8.12 dB)

Azimuth Bearing 90 degrees

### Minimum Field

Field 0.033  
Gain .007 (-21.51 dB)

Azimuth Bearing 260 degrees

# ERP Tabulation

Antenna: PSIFMR-8C-DA

Interlochen Center for the Arts

Station: WIAB

Frequency: 88.5 MHz

Location: Mackinaw City, MI

Maximum ERP: 50 kW (16.99 dBk)

## Horizontal Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.899	40.41	16.06
10	0.967	46.75	16.70
20	0.998	49.80	16.97
30	0.993	49.30	16.93
40	0.963	46.37	16.66
50	0.933	43.52	16.39
60	0.920	42.32	16.27
70	0.928	43.06	16.34
80	0.953	45.41	16.57
90	0.979	47.92	16.81
100	0.986	48.61	16.87
110	0.983	48.31	16.84
120	0.938	43.99	16.43
130	0.882	38.90	15.90
140	0.873	38.11	15.81
150	0.906	41.04	16.13
160	0.943	44.46	16.48
170	0.888	39.43	15.96
180	0.820	33.62	15.27
190	0.703	24.71	13.93
200	0.547	14.96	11.75
210	0.370	6.85	8.35
220	0.196	1.92	2.83
230	0.070	0.25	-6.11
240	0.142	1.01	0.04
250	0.246	3.03	4.81
260	0.324	5.25	7.20
270	0.390	7.61	8.81
280	0.466	10.86	10.36
290	0.552	15.24	11.83
300	0.627	19.66	12.94
310	0.671	22.51	13.52
320	0.683	23.32	13.68
330	0.696	24.22	13.84
340	0.740	27.38	14.37
350	0.818	33.46	15.24

### Maximum Value (H-pol)

Field 1.00  
ERP 50 kW (16.99 dBk)  
Azimuth Bearing 25 degrees

### Minimum Field (H-pol)

Field 0.070  
ERP .25 kW (-6.11 dBk)  
Azimuth Bearing 230 degrees

## Vertical Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.900	40.50	16.07
10	0.901	40.59	16.08
20	0.902	40.68	16.09
30	0.905	40.95	16.12
40	0.914	41.77	16.21
50	0.928	43.06	16.34
60	0.950	45.13	16.54
70	0.973	47.34	16.75
80	0.992	49.20	16.92
90	1.000	50.00	16.99
100	0.998	49.80	16.97
110	0.995	49.50	16.95
120	0.982	48.22	16.83
130	0.988	48.81	16.88
140	0.991	49.10	16.91
150	0.895	40.05	16.03
160	0.748	27.98	14.47
170	0.609	18.54	12.68
180	0.515	13.26	11.23
190	0.420	8.82	9.45
200	0.333	5.54	7.44
210	0.259	3.35	5.26
220	0.203	2.06	3.14
230	0.160	1.28	1.07
240	0.117	0.68	-1.65
250	0.066	0.22	-6.62
260	0.033	0.05	-12.64
270	0.105	0.55	-2.59
280	0.208	2.16	3.35
290	0.319	5.09	7.07
300	0.434	9.42	9.74
310	0.567	16.07	12.06
320	0.721	25.99	14.15
330	0.821	33.70	15.28
340	0.888	39.43	15.96
350	0.899	40.41	16.06

### Maximum Value (V-pol)

Field 1.00  
ERP 50 kW (16.99 dBk)  
Azimuth Bearing 90 degrees

### Minimum Field (V-pol)

Field 0.033  
ERP .05 kW (-12.64 dBk)  
Azimuth Bearing 260 degrees



Relative Field Elevation Pattern  
Model: PSIFMR-8C-DA  
Type: Directional FM Antenna  
Polarization: Circular  
Bay Spacing: Full-wave  
Gain: 6.49 (8.12 dB)  
WIAB Mackinaw City, MI

