



Propagation Systems, Inc.

Quality Broadcast Antenna Systems

**Directional FM Antenna
WWHI
Ball State University
Muncie, IN**

A standard model PSIFML antenna with parasitic elements was used in conjunction with the customer's support mast to create the necessary directional radiation pattern. The final antenna consists of two half-wave spaced radiating elements with horizontal and vertical parasitic elements.

Pattern testing was performed using a 1/3 scale model element and mast. 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 273.9 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 94% of the envelope RMS.

The antenna is to be mounted to a support mast extending above the penthouse 40.6 meters (133.2 ft.) above ground level. The antenna is to be installed on the south wall of the east building corner and positioned 190° True. At this elevation the antenna will be within the allowed +2m/-4m tolerance. No other antenna can be installed within 3 meters from the radiating element. 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.

An input power level of .302 kW will be necessary at the antenna input in order to reach the required .380 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

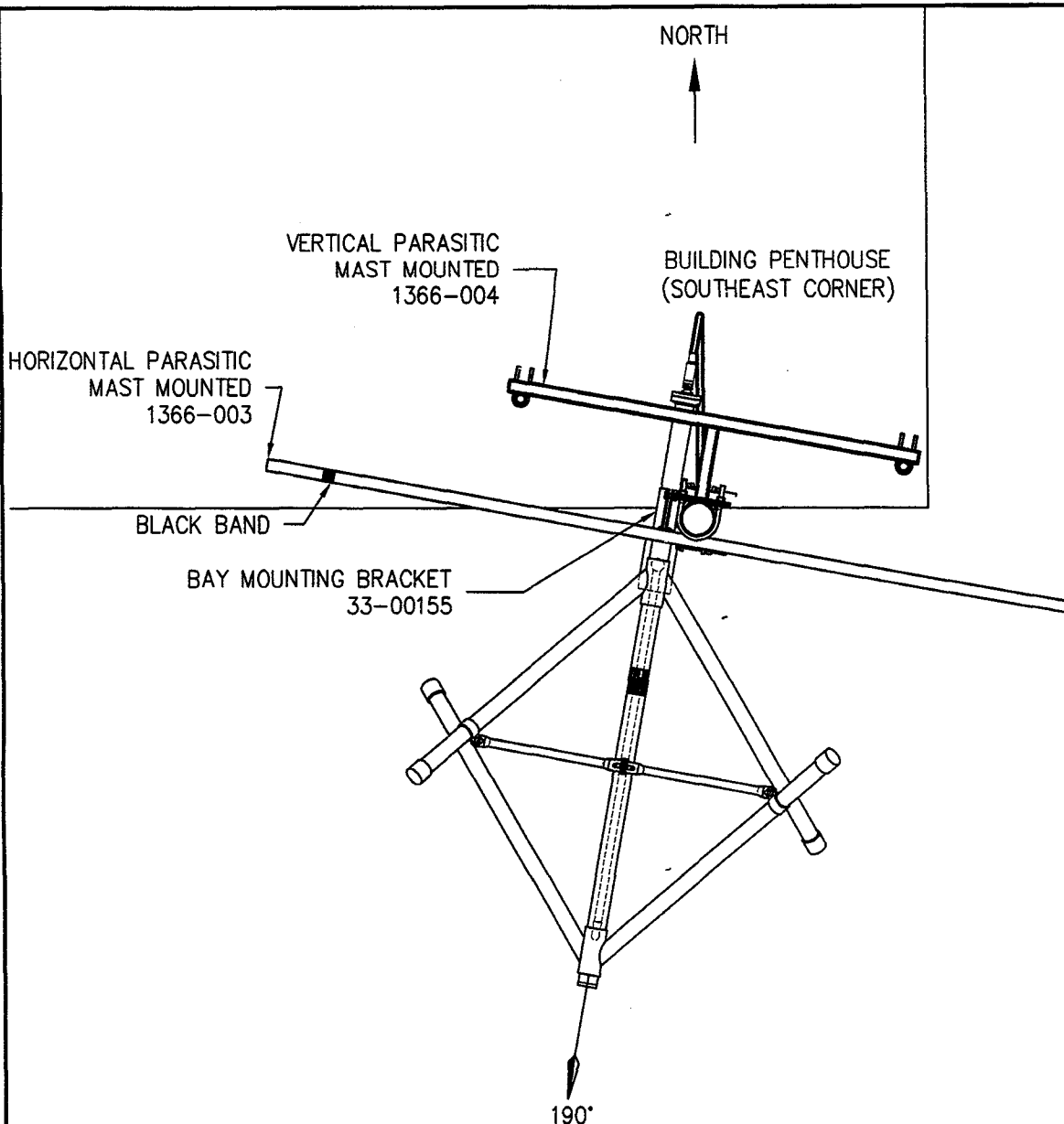
Antenna Model	PSIFML-2A-50WS-H-DA
Type	2-bay directional FM antenna
Frequency	91.3 MHz
Polarization	Circular
Envelope RMS	.799
Composite RMS	.751
Gain (h-pol)	1.26 (1.00 dB)
Gain (v-pol)	1.23 (.908 dB)
ERP	.380 kW
Antenna input power	.302 kW
Input	7/8" EIA
Power rating	1.5 kW
Length	10.58 ft.
Weight	97.4 lbs.
Wind Area	9.54 sq. ft.

Statement of Certification

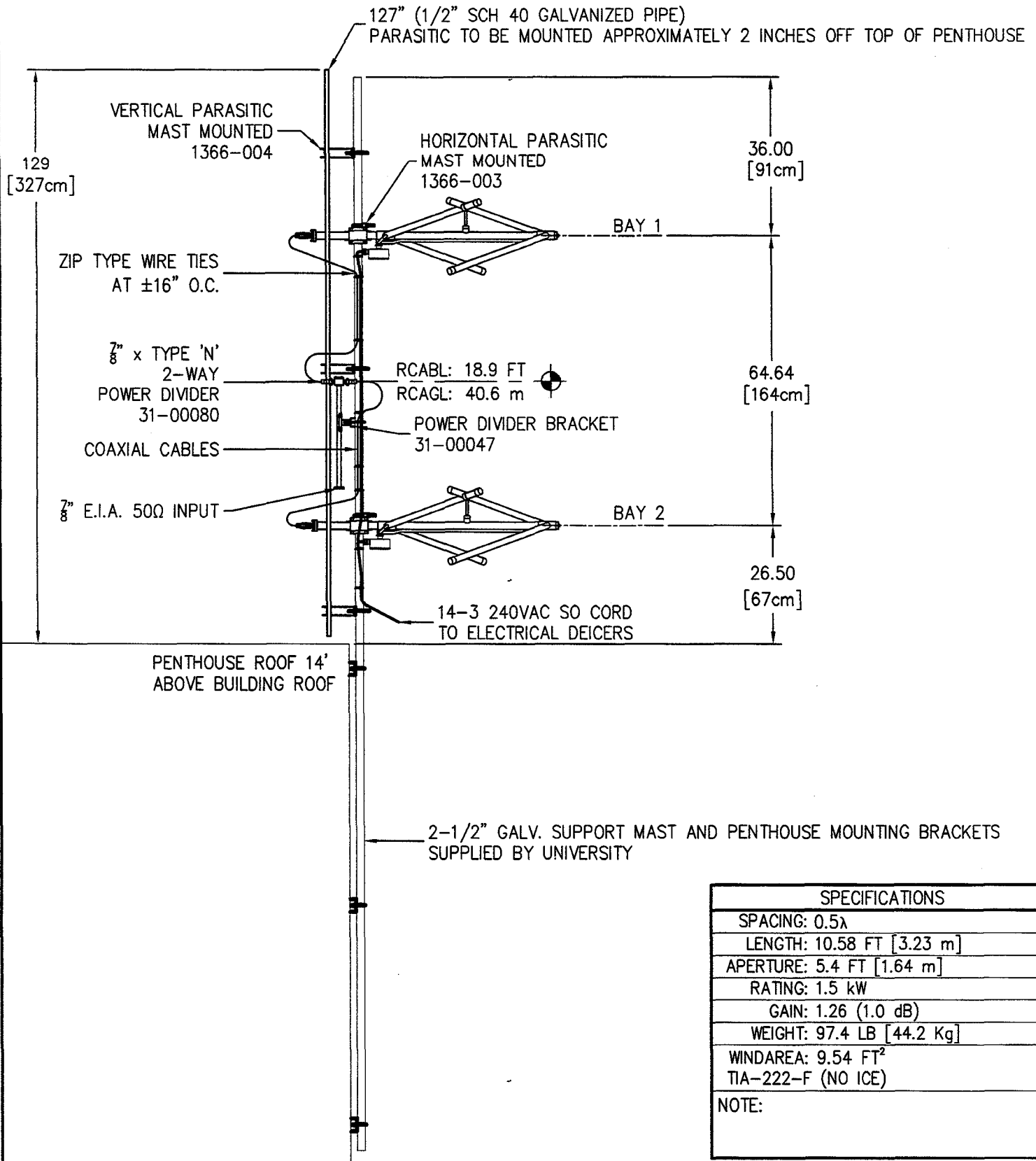
This is to certify the antenna has been designed, fabricated and tested under my supervision and it meets the required envelope pattern limitations set forth in the stations construction permit.

 2/4/2015

Douglas A. Ross
President
Propagation Systems Inc.

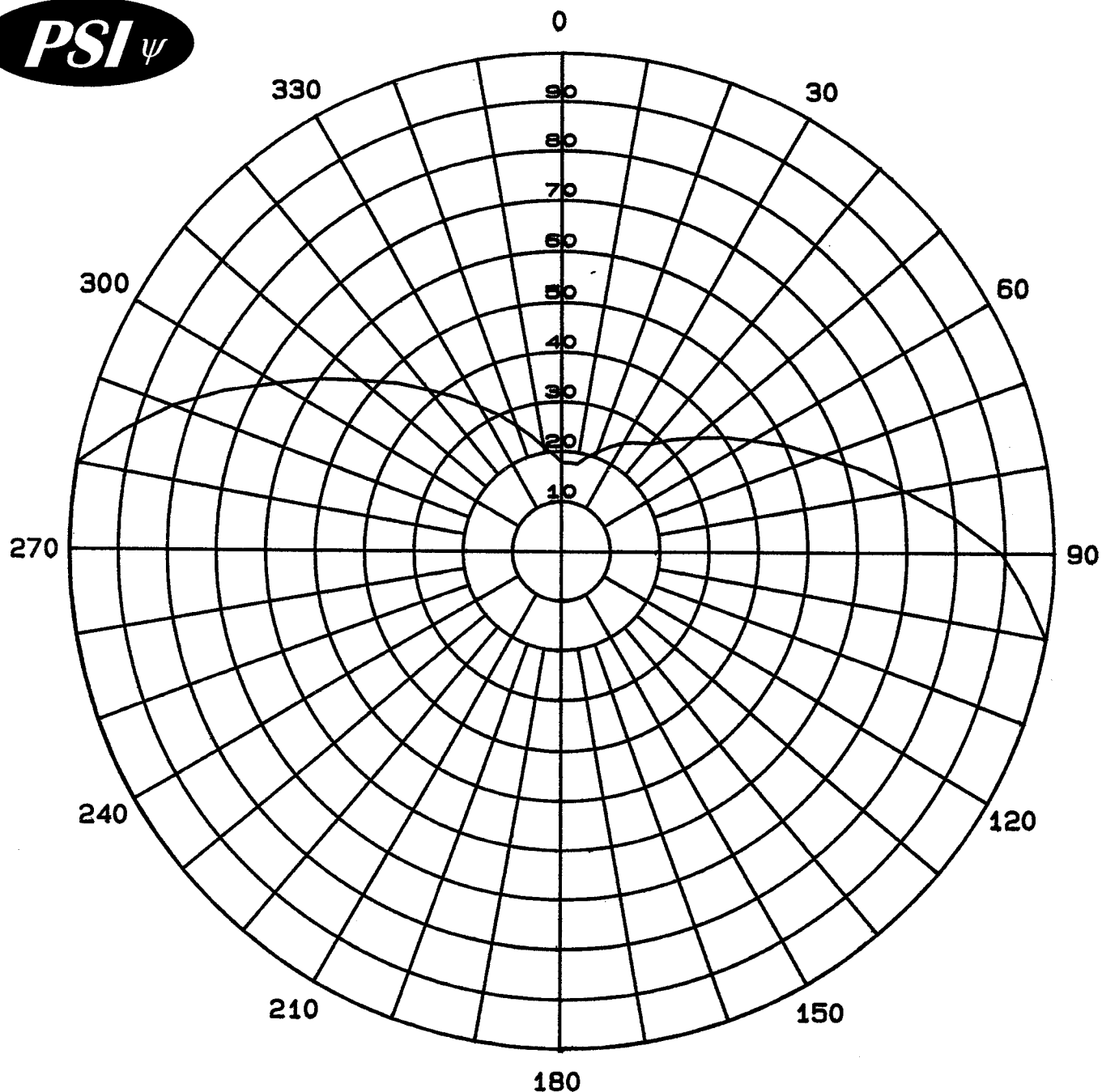


				PROPAGATION SYSTEMS, INC.			
				Ebensburg, Pennsylvania USA 814-472-5540			
				ANTENNA ORIENTATION			
REV.		MADE BY CHECKED BY		DATE		CHANGE	
This drawing is loaned subject to the express understanding and agreement that the drawing and information therein contained are, and shall remain the property of PSI, and will not be otherwise utilized or disposed of, directly or indirectly, and will not be used in whole or in part or assist in making or finish any information for the making of drawings, prints or other reproductions hereof, or for the design or making of any item, parts, object, apparatus or parts thereof, except upon the written permissions of PSI first obtained. The acceptance of this drawing will be construed as an acceptance of the forgoing agreement.				MODEL: PSIFML-2A-50WS-H-DA			
				CHANNEL/FREQUENCY: 91.3 MHz			
				SCALE: 1:10			
				DRAWING NO.: 1366-002			
SIZE: A				DATE: 5/18/15			
				APPROVED BY: B.K.SCHILLING			
				DATE:			
				REV.			



SPECIFICATIONS	
SPACING:	0.5λ
LENGTH:	10.58 FT [3.23 m]
APERTURE:	5.4 FT [1.64 m]
RATING:	1.5 kW
GAIN:	1.26 (1.0 dB)
WEIGHT:	97.4 LB [44.2 Kg]
WINDAREA:	9.54 FT ²
TIA-222-F (NO ICE)	
NOTE:	

PROPAGATION SYSTEMS, INC.			
Ebensburg, Pennsylvania USA 814-472-5540			
ANTENNA ELEVATION, AND SPECIFICATIONS			
REV.	MADE BY CHECKED BY	DATE	CHANGE
This drawing is loaned subject to the express understanding and agreement that the drawing and information therein contained are, and shall remain the property of PSI, and will not be otherwise utilized or disposed of, directly or indirectly, and will not be used in whole or in part or assist in making or finish any information for the making of drawings, prints or other reproductions hereof, or for the design or making of any item, parts, object, apparatus or parts thereof, except upon the written permissions of PSI first obtained. The acceptance of this drawing will be construed as an acceptance of the foregoing agreement.			
SIZE A	MODEL PSIFML-2A-50WS-H-DA	DRAWN BY B.K.SCHILLING	DATE 11/19/14
	CHANNEL/ FREQUENCY: 91.3 MHz	APPROVED BY:	DATE:
	SCALE: 1:30	DRAWING NO.: 1366-001	REV.



Maximum Envelope
Azimuth Plane Pattern
Antenna: PSIFML-2A-50WS-H-DA
Type: 2-Bay Directional FM Antenna
ERP: .38 kW (-4.20 dBk)
RMS Envelope: .799
Frequency: 91.3 MHz
WWHI Muncie, IN

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Envelope Pattern

Antenna: PSIFML-2A-50WS-H-DA

Ball State University

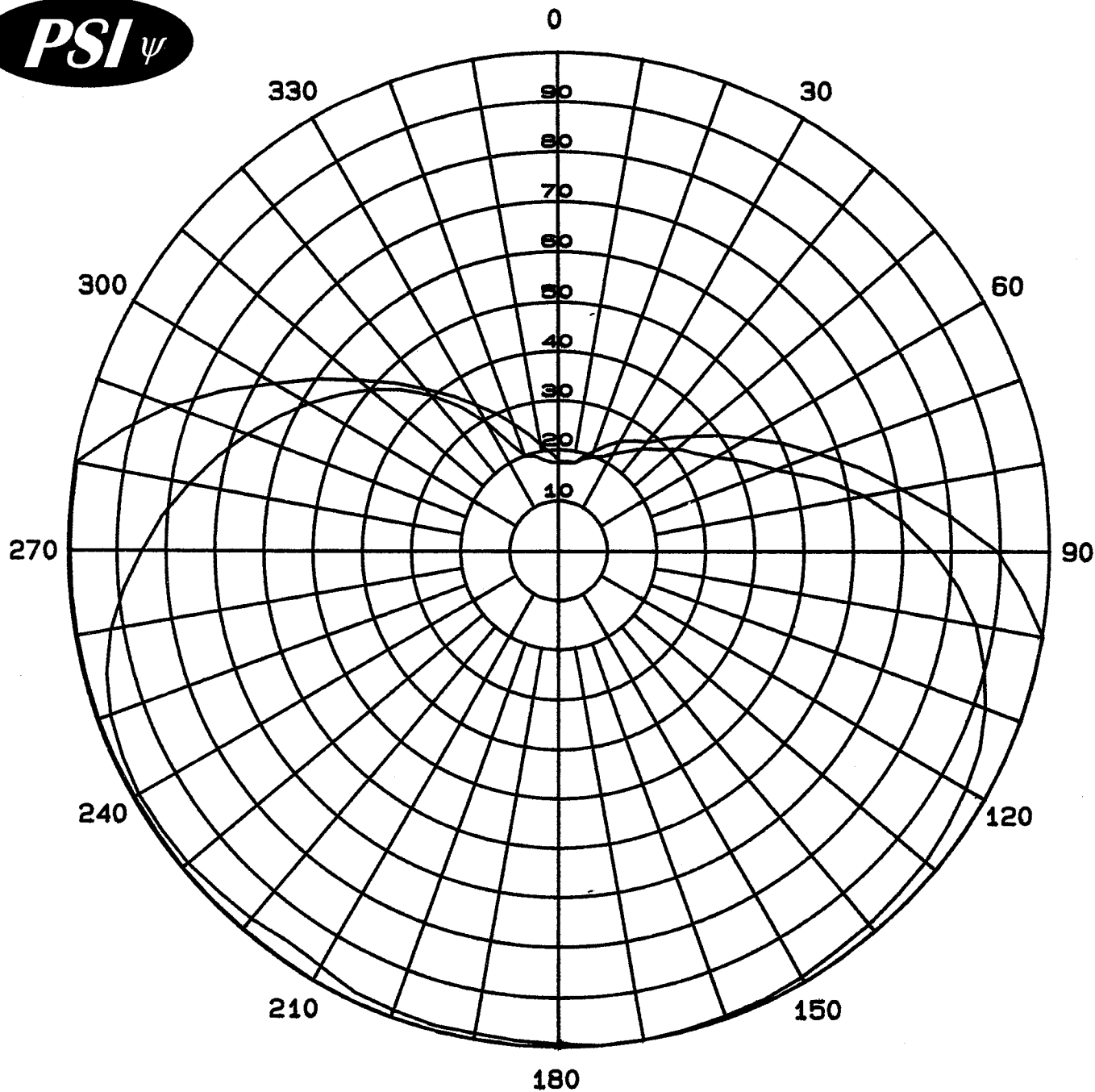
Station: WWHI

Frequency: 91.3 MHz

Location: Muncie, IN

Maximum ERP: .38 kW (-4.20 dBk)

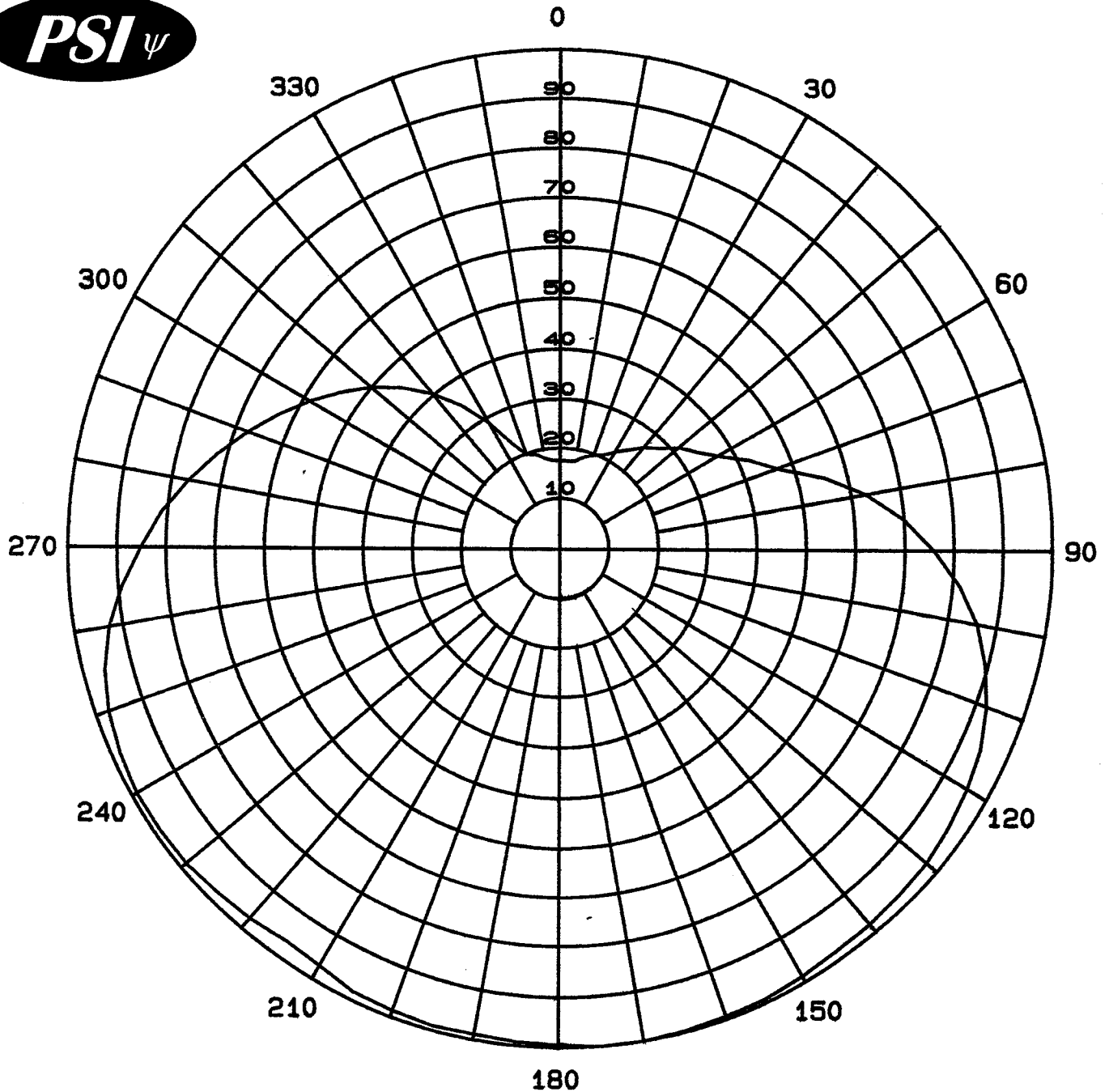
Angle	Relative Field	ERP kW	ERP dBK
0	0.177	0.012	-19.24
10	0.177	0.012	-19.24
20	0.211	0.017	-17.72
30	0.251	0.024	-16.21
40	0.281	0.030	-15.23
50	0.354	0.048	-13.22
60	0.446	0.076	-11.22
70	0.562	0.120	-9.21
80	0.707	0.190	-7.21
90	0.891	0.302	-5.20
100	0.999	0.379	-4.21
110	0.999	0.379	-4.21
120	1.000	0.380	-4.20
130	1.000	0.380	-4.20
140	1.000	0.380	-4.20
150	1.000	0.380	-4.20
160	1.000	0.380	-4.20
170	1.000	0.380	-4.20
180	1.000	0.380	-4.20
190	1.000	0.380	-4.20
200	1.000	0.380	-4.20
210	1.000	0.380	-4.20
220	1.000	0.380	-4.20
230	1.000	0.380	-4.20
240	0.999	0.379	-4.21
250	0.999	0.379	-4.21
260	0.999	0.379	-4.21
270	0.999	0.379	-4.21
280	0.999	0.379	-4.21
290	0.841	0.269	-5.71
300	0.668	0.170	-7.71
310	0.530	0.107	-9.72
320	0.421	0.067	-11.72
330	0.334	0.042	-13.73
340	0.266	0.027	-15.70
350	0.211	0.017	-17.72



Maximum Envelope and
Composite Pattern
Antenna: PSIFML-2A-50WS-H-DA
Type: 2-Bay Directional FM Antenna
ERP: .38 kW (-4.20 dBk)
RMS Envelope: .799
RMS Composite: .751
Frequency: 91.3 MHz

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

WWHI Muncie, IN



Measured Composite
Azimuth Plane Pattern
Antenna: PSIFML-2A-50WS-H-DA
Type: 2-Bay Directional FM Antenna
ERP: .38 kW (-4.20 dBk)
RMS Composite: .751
Frequency: 91.3 MHz
WWHI Muncie, IN

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Composite Pattern

Maximum of H-pol or V-pol

Antenna: PSIFML-2A-50WS-H-DA

Ball State University

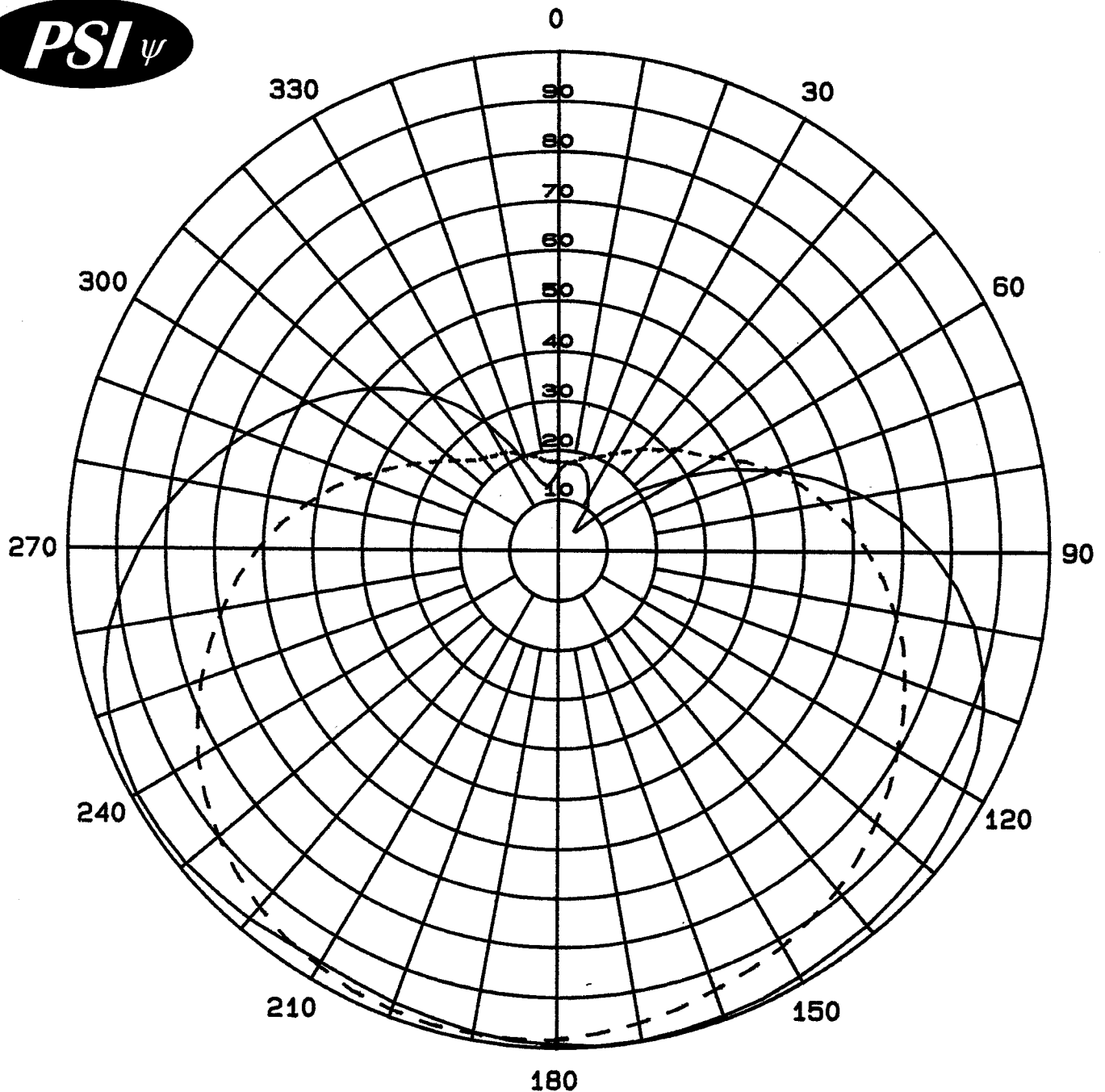
Station: WWHI

Frequency: 91.3 MHz

Location: Muncie, IN

Maximum ERP: .38 kW (-4.20 dBk)

Angle	Relative Field	ERP kW	ERP dBK
0	0.175	0.012	-19.34
10	0.177	0.012	-19.24
20	0.198	0.015	-18.27
30	0.223	0.019	-17.24
40	0.265	0.027	-15.74
50	0.315	0.038	-14.24
60	0.371	0.052	-12.81
70	0.471	0.084	-10.74
80	0.631	0.151	-8.20
90	0.759	0.219	-6.60
100	0.861	0.282	-5.50
110	0.923	0.324	-4.90
120	0.956	0.347	-4.59
130	0.973	0.360	-4.44
140	0.981	0.366	-4.37
150	0.988	0.371	-4.31
160	0.994	0.375	-4.25
170	1.000	0.380	-4.20
180	0.994	0.375	-4.25
190	0.987	0.370	-4.32
200	0.985	0.369	-4.33
210	0.969	0.357	-4.48
220	0.973	0.360	-4.44
230	0.985	0.369	-4.33
240	0.988	0.371	-4.31
250	0.973	0.360	-4.44
260	0.929	0.328	-4.84
270	0.851	0.275	-5.60
280	0.765	0.222	-6.53
290	0.674	0.173	-7.63
300	0.587	0.131	-8.83
310	0.502	0.096	-10.19
320	0.406	0.063	-12.03
330	0.293	0.033	-14.86
340	0.200	0.015	-18.18
350	0.183	0.013	-18.95



Measured Relative Field
Azimuth Plane Pattern
Antenna: PSIFML-2A-50WS-H-DA
Type: 2-Bay Directional FM Antenna
Gain H-pol (solid): 1.26 (1.00 dB)
Gain V-pol (dash): 1.23 (.908 dB)
Frequency: 91.3 MHz
WWHI Muncie, IN

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Measured Relative Field Tabulation

Antenna: PSIFML-2A-50WS-H-DA

Ball State University

Station: WWHL

Frequency: 91.3 MHz

Location: Muncie, IN

Horizontal Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.156	0.031	-15.13
10	0.176	0.039	-14.09
20	0.165	0.034	-14.65
30	0.123	0.019	-17.20
40	0.049	0.003	-25.19
50	0.124	0.019	-17.13
60	0.295	0.110	-9.60
70	0.471	0.280	-5.54
80	0.631	0.502	-3.00
90	0.759	0.726	-1.39
100	0.861	0.934	-0.30
110	0.923	1.073	0.31
120	0.956	1.152	0.61
130	0.973	1.193	0.77
140	0.981	1.213	0.84
150	0.988	1.230	0.90
160	0.994	1.245	0.95
170	1.000	1.260	1.00
180	0.994	1.245	0.95
190	0.984	1.220	0.86
200	0.970	1.186	0.74
210	0.961	1.164	0.66
220	0.973	1.193	0.77
230	0.985	1.222	0.87
240	0.988	1.230	0.90
250	0.973	1.193	0.77
260	0.929	1.087	0.36
270	0.851	0.912	-0.40
280	0.765	0.737	-1.32
290	0.674	0.572	-2.42
300	0.587	0.434	-3.62
310	0.502	0.318	-4.98
320	0.406	0.208	-6.83
330	0.293	0.108	-9.66
340	0.177	0.039	-14.04
350	0.128	0.021	-16.85

Maximum Value

Field 1.000
Gain 1.26 (1.00 dB)
Azimuth Bearing 170-175 degrees

Minimum Field

Field 0.049
Gain .003 (-25.19 dB)
Azimuth Bearing 40 degrees

Vertical Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.175	0.039	-14.14
10	0.177	0.039	-14.04
20	0.198	0.049	-13.06
30	0.223	0.063	-12.03
40	0.265	0.088	-10.53
50	0.315	0.125	-9.03
60	0.371	0.173	-7.61
70	0.465	0.272	-5.65
80	0.550	0.381	-4.19
90	0.629	0.499	-3.02
100	0.695	0.609	-2.16
110	0.752	0.713	-1.47
120	0.800	0.806	-0.93
130	0.846	0.902	-0.45
140	0.888	0.994	-0.03
150	0.919	1.064	0.27
160	0.941	1.116	0.48
170	0.965	1.173	0.69
180	0.985	1.222	0.87
190	0.987	1.227	0.89
200	0.985	1.222	0.87
210	0.969	1.183	0.73
220	0.941	1.116	0.48
230	0.898	1.016	0.07
240	0.844	0.898	-0.47
250	0.772	0.751	-1.24
260	0.692	0.603	-2.19
270	0.610	0.469	-3.29
280	0.517	0.337	-4.73
290	0.423	0.225	-6.47
300	0.340	0.146	-8.37
310	0.275	0.095	-10.21
320	0.237	0.071	-11.50
330	0.224	0.063	-11.99
340	0.200	0.050	-12.98
350	0.183	0.042	-13.75

Maximum Value

Field 0.989
Gain 1.23 (.908 dB)
Azimuth Bearing 195 degrees

Minimum Field

Field 0.175
Gain .039 (-14.14 dB)
Azimuth Bearing 0-5 degrees

ERP Tabulation

Antenna: PSIFML-2A-50WS-H-DA

Ball State University

Station: WWHI

Frequency: 91.3 MHz

Location: Muncie, IN

Horizontal Polarization

Angle	Relative Field	ERP kW	ERP (dBk)
0	0.156	0.009	-20.34
10	0.176	0.012	-19.29
20	0.165	0.010	-19.85
30	0.123	0.006	-22.40
40	0.049	0.001	-30.40
50	0.124	0.006	-22.33
60	0.295	0.033	-14.81
70	0.471	0.084	-10.74
80	0.631	0.151	-8.20
90	0.759	0.219	-6.60
100	0.861	0.282	-5.50
110	0.923	0.324	-4.90
120	0.956	0.347	-4.59
130	0.973	0.360	-4.44
140	0.981	0.366	-4.37
150	0.988	0.371	-4.31
160	0.994	0.375	-4.25
170	1.000	0.380	-4.20
180	0.994	0.375	-4.25
190	0.984	0.368	-4.34
200	0.970	0.358	-4.47
210	0.961	0.351	-4.55
220	0.973	0.360	-4.44
230	0.985	0.369	-4.33
240	0.988	0.371	-4.31
250	0.973	0.360	-4.44
260	0.929	0.328	-4.84
270	0.851	0.275	-5.60
280	0.765	0.222	-6.53
290	0.674	0.173	-7.63
300	0.587	0.131	-8.83
310	0.502	0.096	-10.19
320	0.406	0.063	-12.03
330	0.293	0.033	-14.86
340	0.177	0.012	-19.24
350	0.128	0.006	-22.06

Maximum Value

Field 1.000
ERP .380 kW (-4.20 dBk)
Azimuth Bearing 170-175 degrees

Minimum Field

Field 0.049
ERP .001 (-30.40 dBk)
Azimuth Bearing 40 degrees

Vertical Polarization

Angle	Relative Field	ERP kW	ERP (dBk)
0	0.175	0.012	-19.34
10	0.177	0.012	-19.24
20	0.198	0.015	-18.27
30	0.223	0.019	-17.24
40	0.265	0.027	-15.74
50	0.315	0.038	-14.24
60	0.371	0.052	-12.81
70	0.465	0.082	-10.85
80	0.550	0.115	-9.39
90	0.629	0.150	-8.23
100	0.695	0.184	-7.36
110	0.752	0.215	-6.68
120	0.800	0.243	-6.14
130	0.846	0.272	-5.65
140	0.888	0.300	-5.23
150	0.919	0.321	-4.94
160	0.941	0.336	-4.73
170	0.965	0.354	-4.51
180	0.985	0.369	-4.33
190	0.987	0.370	-4.32
200	0.985	0.369	-4.33
210	0.969	0.357	-4.48
220	0.941	0.336	-4.73
230	0.898	0.306	-5.14
240	0.844	0.271	-5.68
250	0.772	0.226	-6.45
260	0.692	0.182	-7.40
270	0.610	0.141	-8.50
280	0.517	0.102	-9.93
290	0.423	0.068	-11.68
300	0.340	0.044	-13.57
310	0.275	0.029	-15.42
320	0.237	0.021	-16.71
330	0.224	0.019	-17.20
340	0.200	0.015	-18.18
350	0.183	0.013	-18.95

Maximum Value

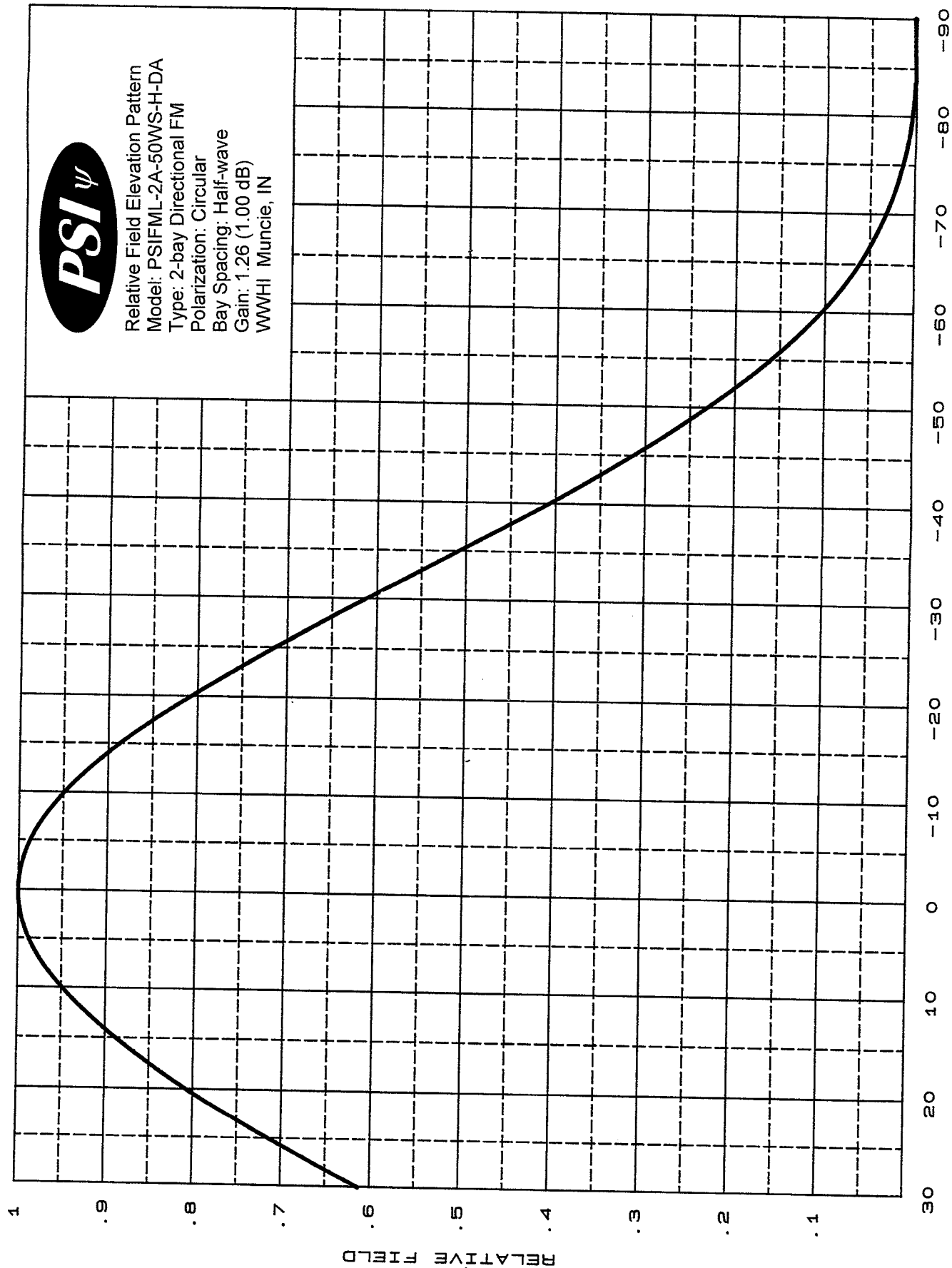
Field 0.989
ERP .372 kW (-4.30 dBk)
Azimuth Bearing 195 degrees

Minimum Field

Field 0.175
ERP .012 (-19.34 dBk)
Azimuth Bearing 0-5 degrees



Relative Field Elevation Pattern
Model: PSIFML-2A-50WS-H-DA
Type: 2-bay Directional FM
Polarization: Circular
Bay Spacing: Half-wave
Gain: 1.26 (1.00 dB)
WWHI Muncie, IN



DEGREES BELOW HORIZONTAL