



Propagation Systems, Inc.

Quality Broadcast Antenna Systems

Directional FM Antenna

WORQ

Lakeshore Communications, Inc.

Green Bay, WI

A standard model PSIFMR antenna with parasitic elements was used in conjunction with the customer's 60" face triangular tower to create the necessary directional radiation pattern. The final antenna consists of three radiating elements each secured to the tower with a custom-mounting bracket. The antenna bays are full wave spaced and there are two vertical and two horizontal parasitic elements per bay. The antenna array is end fed from an existing 1-5/8" flexible transmission line. Each radiating element receives equal power and 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 270.3 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 89.9% of the envelope RMS.

The antenna is to be mounted 146 meters (479 ft.) above ground level on the northeast tower leg and positioned 35° True. At this elevation the antenna will be within the allowed +2m/-4m tolerance. No other antenna can be installed within 10 ft of any radiating element. Any guy wires that pass within 15 ft. of any radiating element must be replaced with a non-metallic substitute. Pattern measurements were taken with and without three future transmission lines present on the tower. It was determined that placement of the

transmission lines on the southwest tower face adjacent to the existing 4" line as shown in the attached drawing will have no impact on the antenna pattern. 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 6.59 kW will be necessary at the antenna input in order to reach the required 18 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-3E-R-DA
Type	3-bay directional FM antenna
Bay Spacing	Full wave spaced elements, radomes
Frequency	90.1 MHz
Polarization	Circular
Envelope RMS	.888
Composite RMS	.798
Gain (h-pol)	2.73 (4.36 dB)
Gain (v-pol)	2.73 (4.36 dB)
ERP	18 kW
Antenna input power	6.59 kW
Input	1-5/8" EIA end fed input
Power rating	9 kW
Length	33.77 ft.
Weight	366 lbs.
Wind Area	26.86 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.

 9/1/15

Douglas A. Ross
President
Propagation Systems, Inc.

VERTICAL PARASITIC
LEG MOUNTED
1454-006

VERTICAL PARASITIC
LEG MOUNTED
1454-005

SHORTING STUB
34-00007
BAY 1

BAY MOUNTING BRACKET
33-00106

HORIZONTAL PARASITIC
BOOM MOUNTED
1454-003

BAY 2
RCAGL
479 FT
(146 M)

HORIZONTAL PARASITIC
BLOCK MOUNTED
1454-004

BAY 3
468.1 FT

INPUT SECTION
33-00028

3-PROBE TUNER
33-00019

1-5/8 SUPPORT BRACKET
33-00180

1-5/8 EIA INPUT

492.7 FT

489.9 FT

131.00
[333cm]

262.00
[665cm]

405.25
[1029cm]

459 FT

APPROXIMATE SPECIFICATIONS

SPACING: 1.0 λ

LENGTH: 33.77 FT (10.29m)

APERTURE: 21.83 Ft (6.65m)

RATING: 9 kW

GAIN: 2.73 (4.36 dB)

WEIGHT: 366 LB (166.02 Kg)

WINDAREA: 26.86 FT²

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.

SIZE

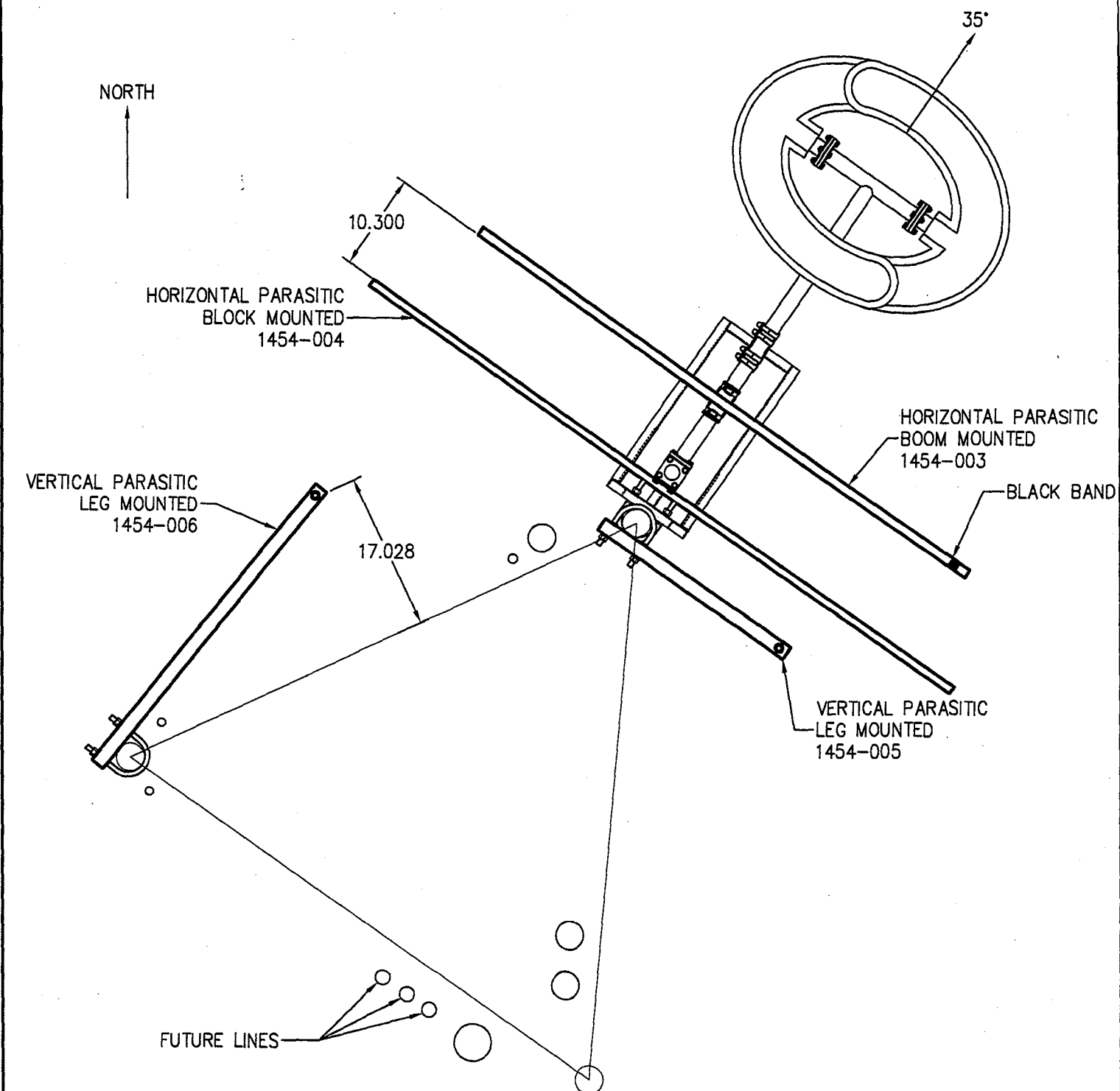
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PROPAGATION SYSTEMS, INC.

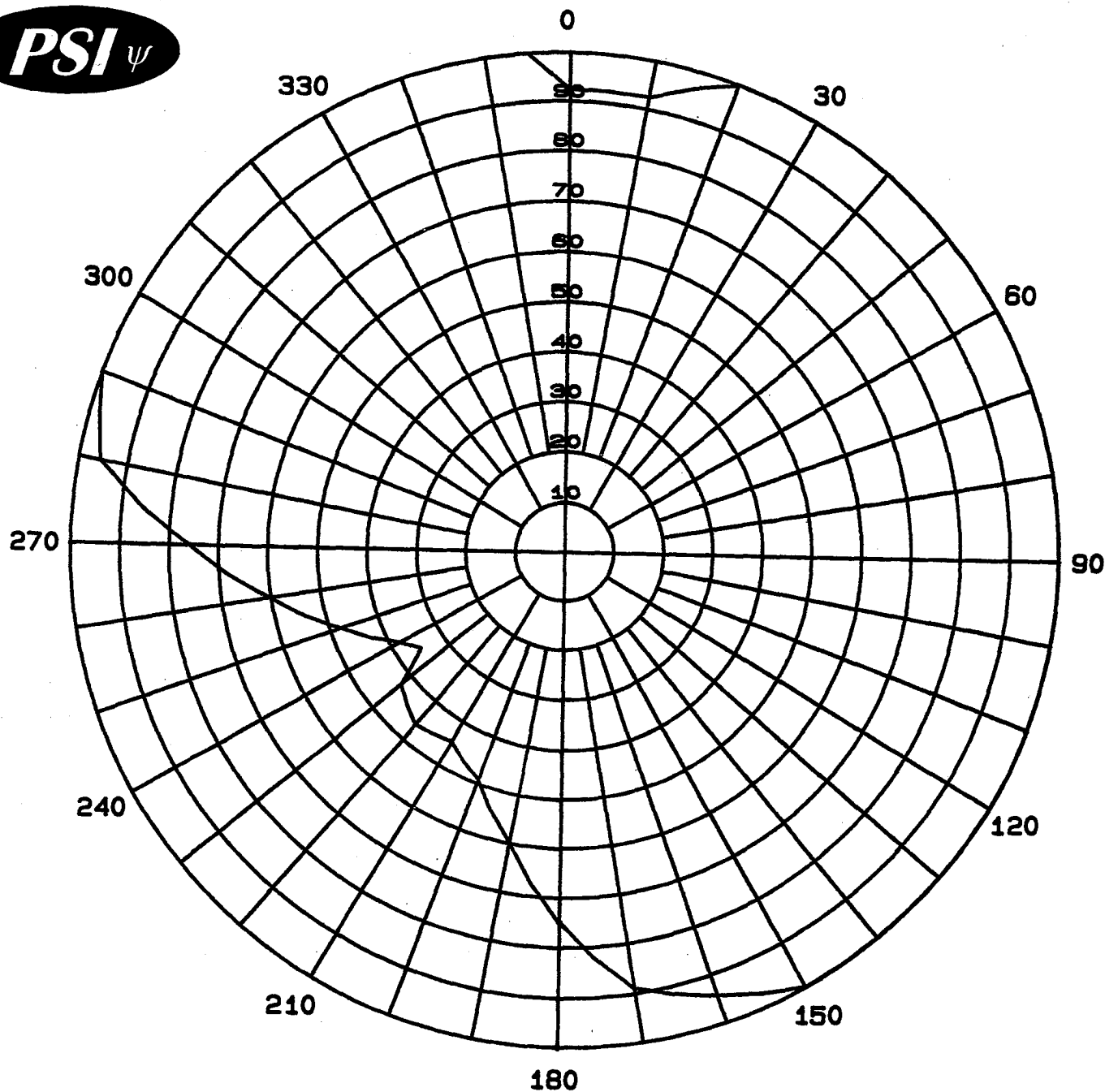
Ebensburg, Pennsylvania USA 814-472-5540

ANTENNA ELEVATION AND SPECIFICATION

MODEL: PSIFMR-3E-R-DA	DRAWN BY: B.K.SCHILLING	DATE: 7/27/15
CHANNEL/FREQUENCY: 90.1 MHz	APPROVED BY:	DATE:
SCALE: 1:70	DRAWING NO.: 1454-001	REV.



PROPAGATION SYSTEMS, INC. Ebensburg, Pennsylvania USA 814-472-5540			
PLAN VIEW AND ORIENTATION			
REV.	MADE 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.			SIZE A
MODEL: PSIFMR-3E-R-DA		DRAWN BY: B.K.SCHILLING	DATE: 7/27/15
CHANNEL/FREQUENCY: 90.1 MHz		APPROVED BY:	DATE:
SCALE: 1:15		DRAWING NO.: 1454-002	REV.



Maximum Envelope
Azimuth Plane Pattern
Antenna: PSIFMR-3E-R-DA
Type: 3-Bay Directional FM Antenna
ERP: 18 kW (12.55 dBk)
RMS Envelope: .888
Frequency: 90.1 MHz
WORQ Green Bay, WI

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Maximum Envelope Tabulation

Antenna: PSIFMR-3E-R-DA

Lakeshore Communications, Inc.

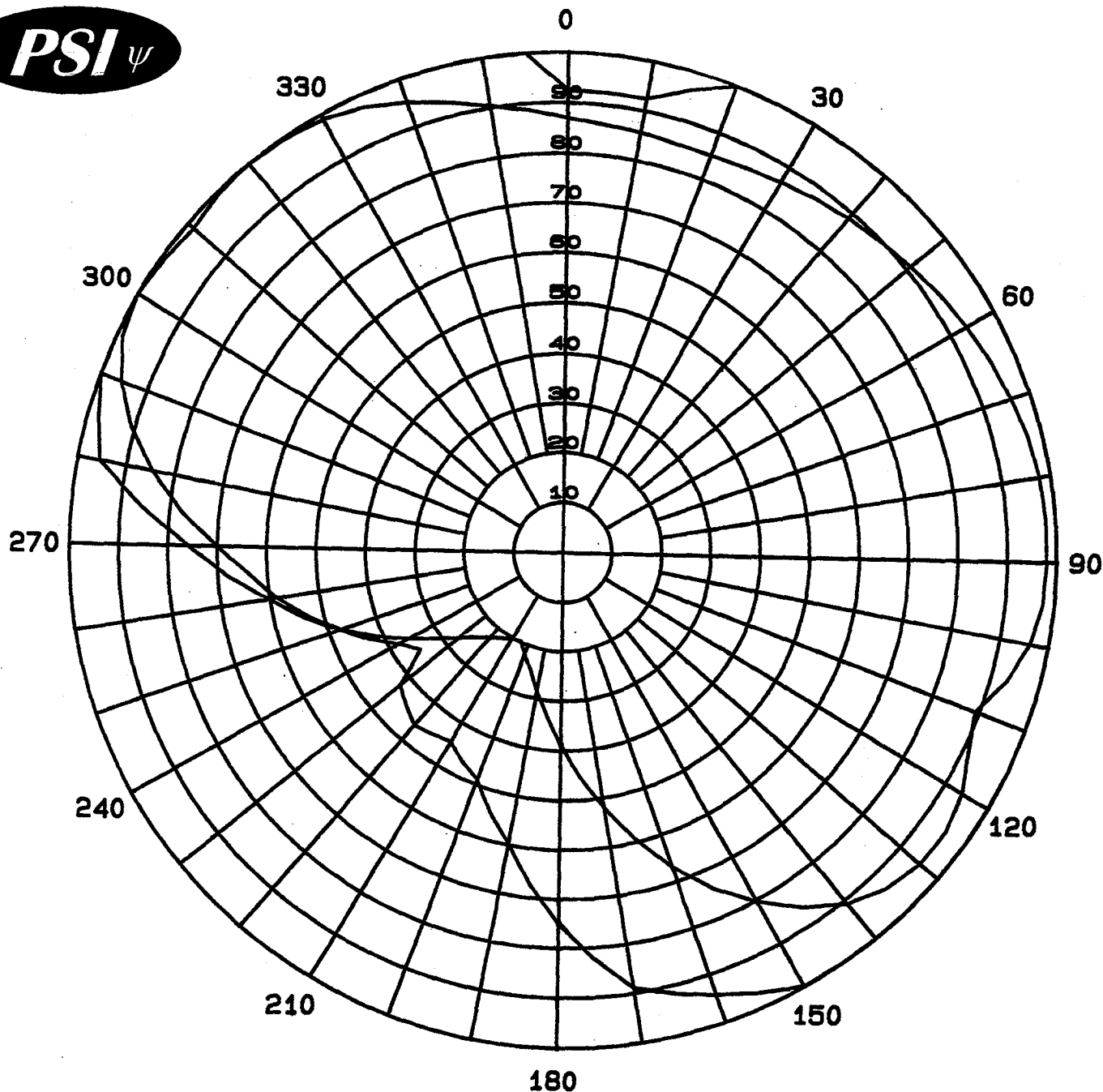
Station: WORQ

Frequency: 90.1 MHz

Location: Green Bay, WI

Maximum ERP: 18 kW (12.55 dBk)

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.925	15.40	11.88
10	0.925	15.40	11.88
20	1.000	18.00	12.55
30	1.000	18.00	12.55
40	1.000	18.00	12.55
50	1.000	18.00	12.55
60	1.000	18.00	12.55
70	1.000	18.00	12.55
80	1.000	18.00	12.55
90	1.000	18.00	12.55
100	1.000	18.00	12.55
110	1.000	18.00	12.55
120	1.000	18.00	12.55
130	1.000	18.00	12.55
140	1.000	18.00	12.55
150	1.000	18.00	12.55
160	0.944	16.04	12.05
170	0.891	14.29	11.55
180	0.750	10.13	10.05
190	0.596	6.39	8.06
200	0.490	4.32	6.36
210	0.445	3.56	5.52
220	0.461	3.83	5.83
230	0.426	3.27	5.14
235	0.350	2.21	3.43
240	0.380	2.60	4.15
250	0.478	4.11	6.14
260	0.602	6.52	8.14
270	0.758	10.34	10.15
280	0.955	16.42	12.15
290	1.000	18.00	12.55
300	1.000	18.00	12.55
310	1.000	18.00	12.55
320	1.000	18.00	12.55
330	1.000	18.00	12.55
340	1.000	18.00	12.55
350	1.000	18.00	12.55



Maximum Envelope and
Composite Pattern

Antenna: PSIFMR-3E-R-DA

Type: 3-Bay Directional FM Antenna

ERP: 18 kW (12.55 dBk)

RMS Envelope: .888

RMS Composite: .798

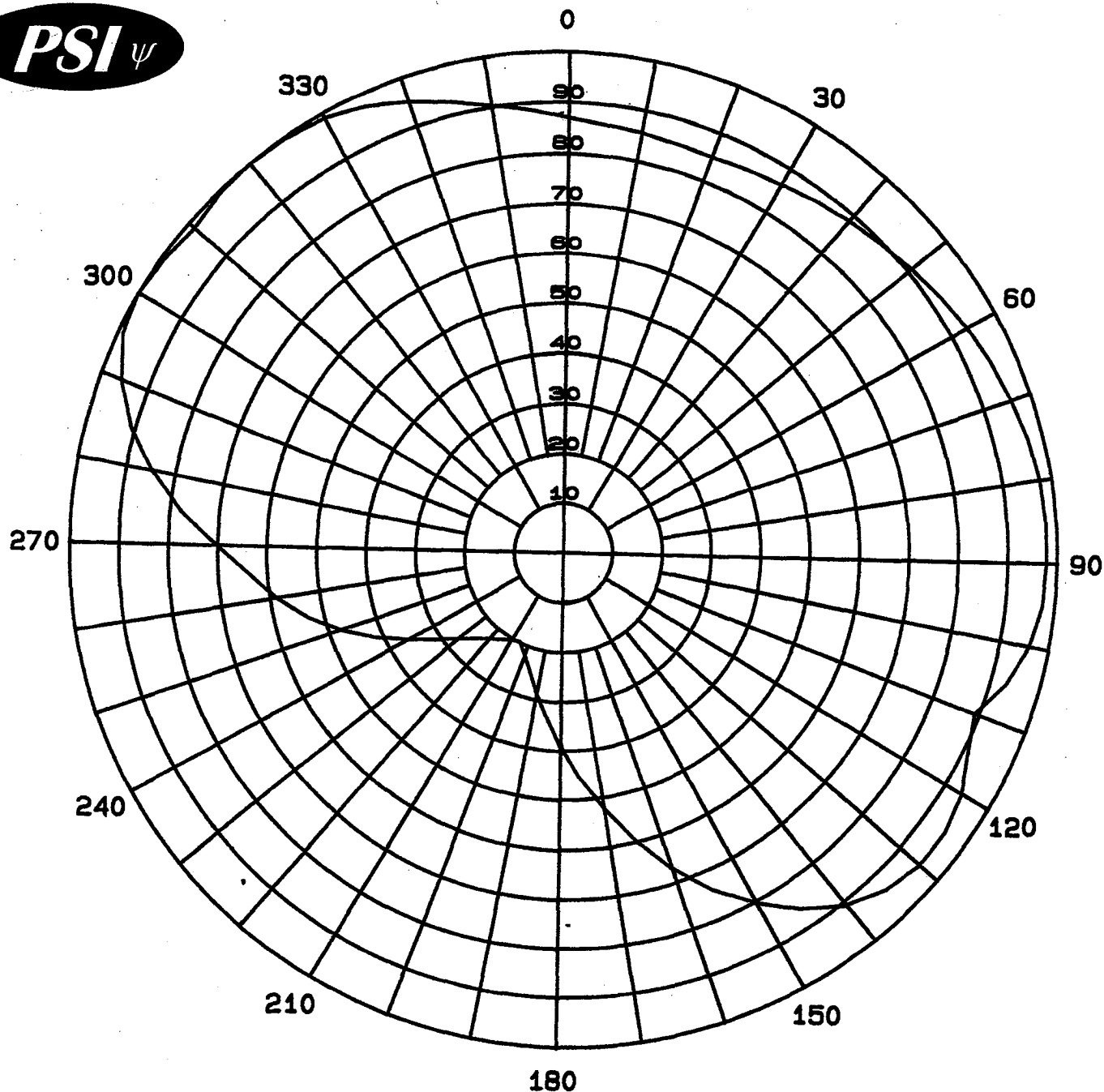
Frequency: 90.1 MHz

Propagation Systems Inc.

PO Box 113

Ebensburg, PA 15931

WORQ Green Bay, WI



Measured Composite
Azimuth Plane Pattern
Antenna: PSIFMR-3E-R-DA
Type: 3-Bay Directional FM Antenna
ERP: 18 kW (12.55 dBk)
RMS Composite: .798
Frequency: 90.1 MHz
WORQ Green Bay, WI

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Composite Pattern Tabulation

Antenna: PSIFMR-3E-R-DA

Lakeshore Communications, Inc.

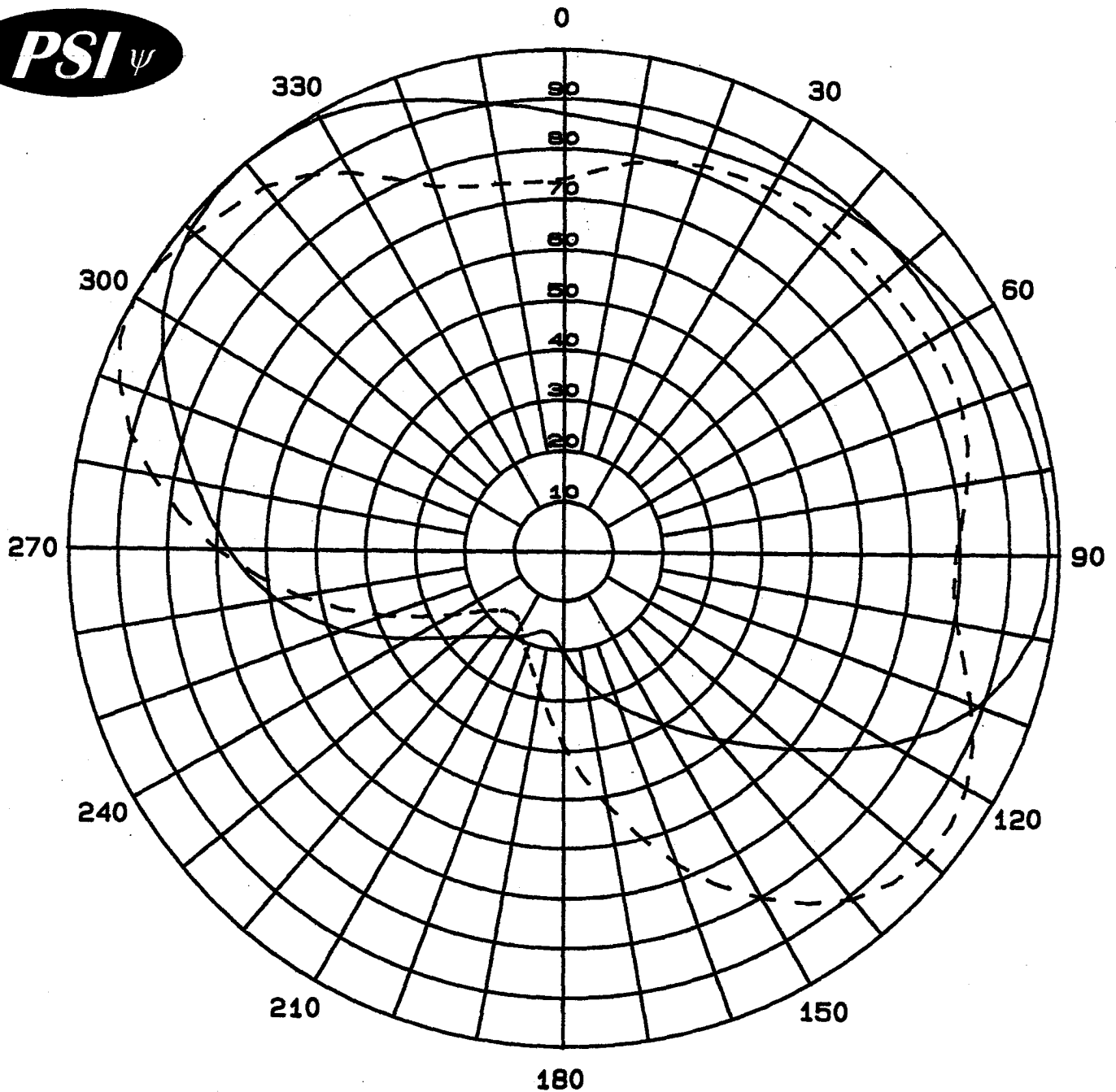
Station: WORQ

Frequency: 90.1 MHz

Location: Green Bay, WI

Maximum ERP: 18 kW (12.55 dBk)

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.870	13.62	11.34
10	0.857	13.22	11.21
20	0.852	13.07	11.16
30	0.865	13.47	11.29
40	0.887	14.16	11.51
50	0.910	14.91	11.73
60	0.937	15.80	11.99
70	0.960	16.59	12.20
80	0.977	17.18	12.35
90	0.980	17.29	12.38
100	0.962	16.66	12.22
110	0.892	14.32	11.56
120	0.940	15.90	12.02
130	0.954	16.38	12.14
140	0.909	14.87	11.72
150	0.804	11.64	10.66
160	0.671	8.10	9.09
170	0.521	4.89	6.89
180	0.390	2.74	4.37
190	0.284	1.45	1.62
200	0.218	0.86	-0.68
210	0.202	0.73	-1.34
220	0.225	0.91	-0.40
230	0.272	1.33	1.24
235	0.245	1.08	0.34
240	0.358	2.31	3.63
250	0.475	4.06	6.09
260	0.586	6.18	7.91
270	0.700	8.82	9.45
280	0.845	12.85	11.09
290	0.955	16.42	12.15
300	1.000	18.00	12.55
310	0.985	17.46	12.42
320	1.000	18.00	12.55
330	0.990	17.64	12.47
340	0.952	16.31	12.13
350	0.904	14.71	11.68



Measured Relative Field
Azimuth Plane Pattern
Antenna: PSIFMR-3E-R-DA
Type: 3-Bay Directional FM Antenna
Gain H-pol (solid): 2.73 (4.36 dB)
Gain V-pol (dash): 2.73 (4.36 dB)
Frequency: 90.1 MHz
WORQ Green Bay, WI

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Measured Relative Field Tabulation

Antenna: PSIFMR-3E-R-DA
Lakeshore Communications, Inc.
Station: WORQ
Frequency: 90.1 MHz
Location: Green Bay, WI

Horizontal Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.870	2.066	3.15
10	0.857	2.005	3.02
20	0.852	1.982	2.97
30	0.865	2.043	3.10
40	0.887	2.148	3.32
50	0.910	2.261	3.54
60	0.937	2.397	3.80
70	0.960	2.516	4.01
80	0.977	2.606	4.16
90	0.980	2.622	4.19
100	0.962	2.526	4.03
110	0.892	2.172	3.37
120	0.762	1.585	2.00
130	0.612	1.023	0.10
140	0.488	0.650	-1.87
150	0.397	0.430	-3.66
160	0.330	0.297	-5.27
170	0.269	0.198	-7.04
180	0.204	0.114	-9.45
190	0.166	0.075	-11.24
200	0.177	0.086	-10.68
210	0.202	0.111	-9.53
220	0.225	0.138	-8.59
230	0.272	0.202	-6.95
235	0.245	0.164	-7.86
240	0.358	0.350	-4.56
250	0.475	0.616	-2.10
260	0.586	0.937	-0.28
270	0.675	1.244	0.95
280	0.755	1.556	1.92
290	0.846	1.954	2.91
300	0.935	2.387	3.78
310	0.985	2.649	4.23
320	1.000	2.730	4.36
330	0.990	2.676	4.27
340	0.952	2.474	3.93
350	0.904	2.231	3.48

Maximum Value

Field 1.00
Gain 2.73 (4.36 dB)
Azimuth Bearing 320 degrees

Minimum Field

Field 0.166
Gain .075 (-11.24 dB)
Azimuth Bearing 190 degrees

Vertical Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.739	1.491	1.73
10	0.785	1.682	2.26
20	0.817	1.822	2.61
30	0.834	1.899	2.78
40	0.839	1.922	2.84
50	0.841	1.931	2.86
60	0.851	1.977	2.96
70	0.853	1.986	2.98
80	0.827	1.867	2.71
90	0.791	1.708	2.33
100	0.805	1.769	2.48
110	0.874	2.085	3.19
120	0.940	2.412	3.82
130	0.954	2.485	3.95
140	0.909	2.256	3.53
150	0.804	1.765	2.47
160	0.671	1.229	0.90
170	0.521	0.741	-1.30
180	0.390	0.415	-3.82
190	0.284	0.220	-6.57
200	0.218	0.130	-8.87
210	0.173	0.082	-10.88
220	0.162	0.072	-11.45
230	0.185	0.093	-10.29
235	0.169	0.078	-11.08
240	0.258	0.182	-7.41
250	0.385	0.405	-3.93
260	0.542	0.802	-0.96
270	0.700	1.338	1.26
280	0.845	1.949	2.90
290	0.955	2.490	3.96
300	1.000	2.730	4.36
310	0.973	2.585	4.12
320	0.938	2.402	3.81
330	0.864	2.038	3.09
340	0.768	1.610	2.07
350	0.739	1.491	1.73

Maximum Value

Field 1.00
Gain 2.73 (4.36 dB)
Azimuth Bearing 300 degrees

Minimum Field

Field 0.162
Gain .072 (-11.45 dB)
Azimuth Bearing 220 degrees

ERP Tabulation

Antenna: PSIFMR-3E-R-DA
Lakeshore Communications, Inc.
Station: WORQ
Frequency: 90.1 MHz
Location: Green Bay, WI
Maximum ERP: 18 kW (12.55 dBk)

Horizontal Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.870	13.62	11.34
10	0.857	13.22	11.21
20	0.852	13.07	11.16
30	0.865	13.47	11.29
40	0.887	14.16	11.51
50	0.910	14.91	11.73
60	0.937	15.80	11.99
70	0.960	16.59	12.20
80	0.977	17.18	12.35
90	0.980	17.29	12.38
100	0.962	16.66	12.22
110	0.892	14.32	11.56
120	0.762	10.45	10.19
130	0.612	6.74	8.29
140	0.488	4.29	6.32
150	0.397	2.84	4.53
160	0.330	1.96	2.92
170	0.269	1.30	1.15
180	0.204	0.75	-1.25
190	0.166	0.50	-3.05
200	0.177	0.56	-2.49
210	0.202	0.73	-1.34
220	0.225	0.91	-0.40
230	0.272	1.33	1.24
235	0.245	1.08	0.34
240	0.358	2.31	3.63
250	0.475	4.06	6.09
260	0.586	6.18	7.91
270	0.675	8.20	9.14
280	0.755	10.26	10.11
290	0.846	12.88	11.10
300	0.935	15.74	11.97
310	0.985	17.46	12.42
320	1.000	18.00	12.55
330	0.990	17.64	12.47
340	0.952	16.31	12.13
350	0.904	14.71	11.68

Maximum Value (H-pol)

Field 1.00
ERP 18 kW (12.55 dBk)
Azimuth Bearing 320 degrees

Minimum Field (H-pol)

Field 0.166
ERP .50 kW (-3.05 dBk)
Azimuth Bearing 190 degrees

Vertical Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.739	9.83	9.93
10	0.785	11.09	10.45
20	0.817	12.01	10.80
30	0.834	12.52	10.98
40	0.839	12.67	11.03
50	0.841	12.73	11.05
60	0.851	13.04	11.15
70	0.853	13.10	11.17
80	0.827	12.31	10.90
90	0.791	11.26	10.52
100	0.805	11.66	10.67
110	0.874	13.75	11.38
120	0.940	15.90	12.02
130	0.954	16.38	12.14
140	0.909	14.87	11.72
150	0.804	11.64	10.66
160	0.671	8.10	9.09
170	0.521	4.89	6.89
180	0.390	2.74	4.37
190	0.284	1.45	1.62
200	0.218	0.86	-0.68
210	0.173	0.54	-2.69
220	0.162	0.47	-3.26
230	0.185	0.62	-2.10
235	0.169	0.51	-2.89
240	0.258	1.20	0.79
250	0.385	2.67	4.26
260	0.542	5.29	7.23
270	0.700	8.82	9.45
280	0.845	12.85	11.09
290	0.955	16.42	12.15
300	1.000	18.00	12.55
310	0.973	17.04	12.31
320	0.938	15.84	12.00
330	0.864	13.44	11.28
340	0.768	10.62	10.26
350	0.739	9.83	9.93

Maximum Value (V-pol)

Field 1.00
ERP 18 kW (12.55 dBk)
Azimuth Bearing 300 degrees

Minimum Field (V-pol)

Field 0.162
ERP .47 kW (-3.26 dBk)
Azimuth Bearing 220 degrees



Relative Field Elevation Pattern
Model: PSIFMR-3E-R-DA
Type: Directional FM Antenna
Polarization: Circular
Number of Bays: Three
Gain: 2.73 (4.36 dB)
WORQ Green Bay, WI

