



Propagation Systems, Inc.

Quality Broadcast Antenna Systems

**Directional FM Antenna
Avondale School District
WAHS
Auburn Hills, MI**

A standard model PSIFML antenna was used in conjunction with the customer's 24" triangular face tower to create the necessary directional radiation pattern. The final antenna consists of three radiating elements each secured to the tower with a standard mounting bracket. There is one horizontal and one vertical parasitic element per bay. The antenna bays are 8/10-wave spaced and 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 268.5 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 85.4% of the envelope RMS.

The antenna is to be mounted on the tower with the center of radiation at 127 ft. above the roof top. The resulting elevation above ground level is 43 meters. At this elevation the antenna is within +2/-4 meters of the approved 42 meters above ground. No other antenna can be installed within 10 ft of any radiating element. The antenna is to be positioned 40° True and certified by a licensed surveyor. It is recommended that a broadcast engineer is present to supervise the installation of the antenna and that he or she

certifies the antenna has been installed according to the enclosed instructions. It is also recommended any metallic guy wire that passes with 15 ft. of any radiating element be replaced with the appropriate non-metallic guy substitute.

An input power level of .774 kW will be required at the antenna input in order to reach the licensed 2.4 kW ERP. The transmitter output power requirements are dependent upon the transmission line size and length used to feed the antenna.

Antenna Specifications

Antenna Model	PSIFML-3A-8WS-DA
Type	3-bay directional FM antenna
Bay Spacing	8/10-wave spaced elements
Frequency	89.5 MHz
Polarization	Circular
Envelope RMS	.719
Composite RMS	.614
Gain (h-pol)	3.10 (4.92 dB)
Gain (V-pol)	2.62 (4.19 dB)
Antenna input power	.774 kW
Input	7/8" EIA center fed input
Power rating	2.25 kW
Aperture	17.58 ft.
Antenna Weight	79.5 lbs.
Antenna Wind Area	8.4 sq. ft.

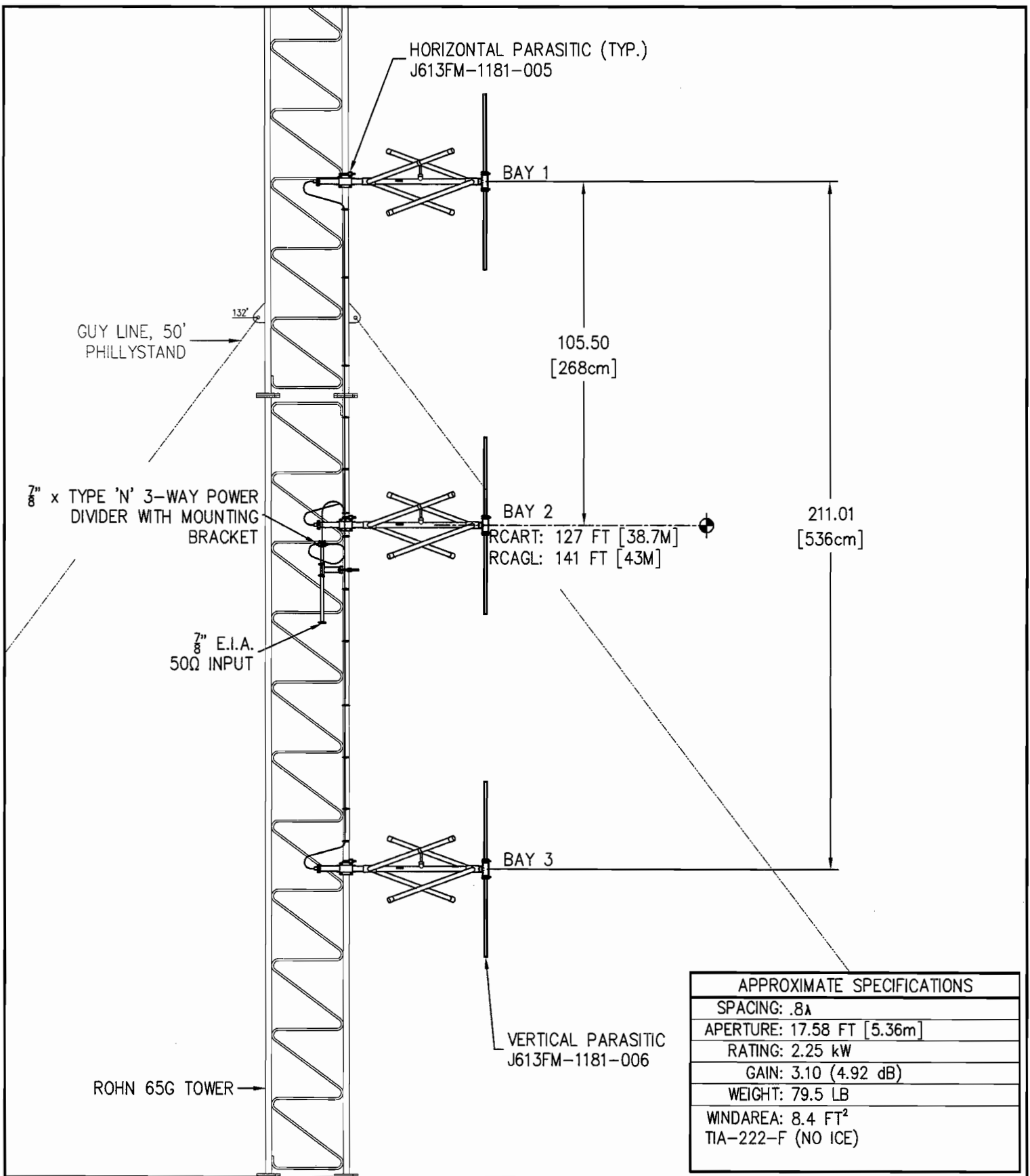
Statement of Certification

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.



9/10/2013

Douglas A. Ross
President
Propagation Systems Inc.



REV.	MADE BY CHECKED BY	DATE	CHANGE

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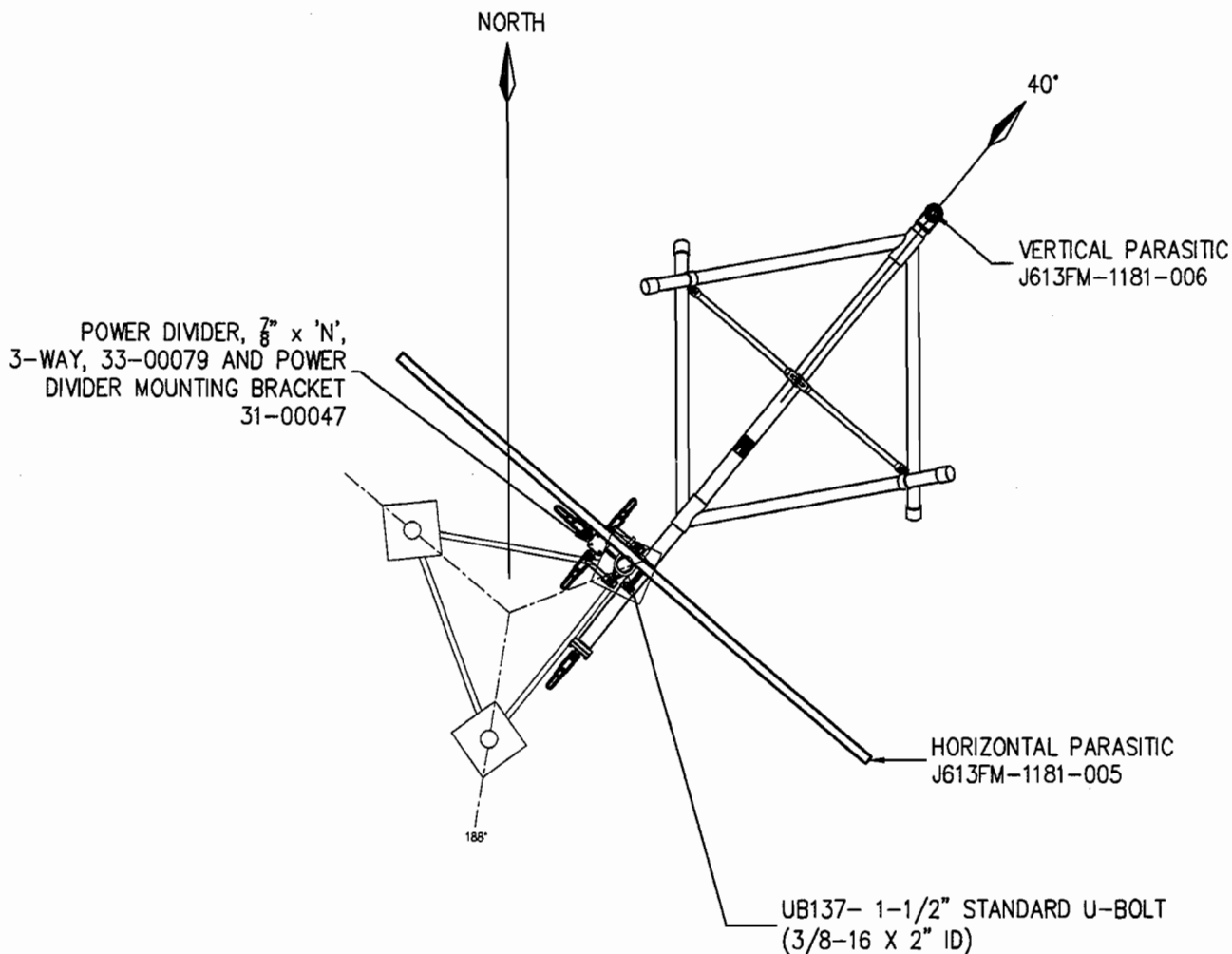
SIZE
A

PROPAGATION SYSTEMS, INC.

Ebensburg, Pennsylvania USA 814-472-5540

ELEVATIONS AND SPECIFICATIONS

MODEL: PSIFML-3A-8WS-DA	DRAWN BY: D.G. Kellar	DATE: 6/24/13
CHANNEL/ FREQUENCY: 89.5 MHz	APPROVED BY:	DATE:
SCALE: 1:40	DRAWING NO.: J613FM-1181-001	REV.



A	D.G. Kellar	D	C
REV.	MADE BY CHECKED BY	DATE	CHANGE

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SIZE

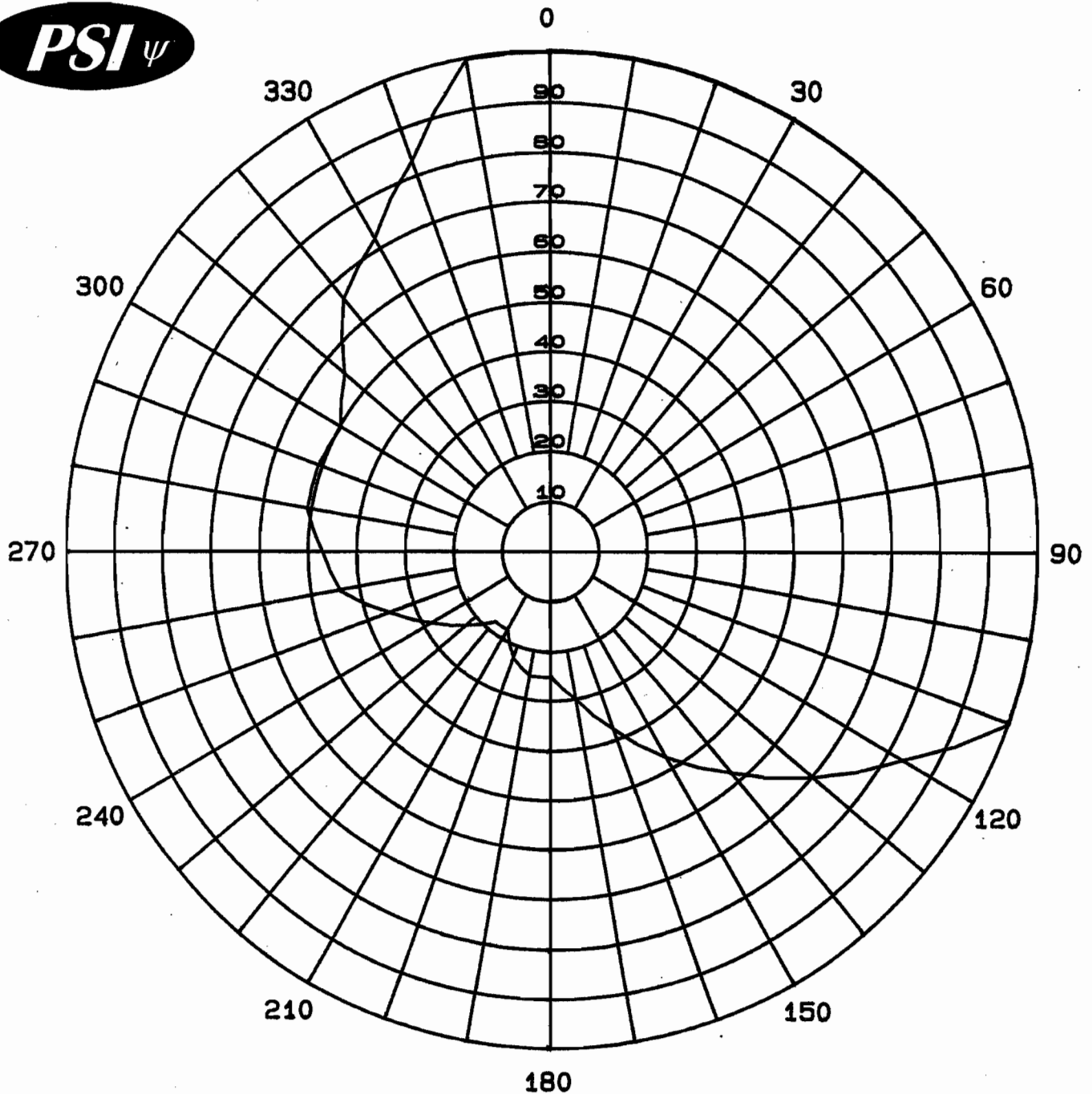
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PROPAGATION SYSTEMS, INC.

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PLAN VIEW AND ORIENTATION

MODEL: PSIFML-3A-8WS-DA	DRAWN BY: D.G. Kellar	DATE: 6/24/13
CHANNEL/ FREQUENCY: 89.5 MHz	APPROVED BY:	DATE:
SCALE: 1:20	DRAWING NO.: J613FM-1181-002	REV. A



Maximum Envelope
Azimuth Plane Pattern
Antenna: PSIFML-3A-8WS-DA
Type: 3-Bay Directional FM Antenna
ERP: 2.4 kW (3.80 dBk)
RMS Envelope: .719
Frequency: 89.5 MHz
WAHS Auburn Hills, MI

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Maximum Envelope Tabulation

Antenna: PSIFML-3A-8WS-DA

Avondale School District

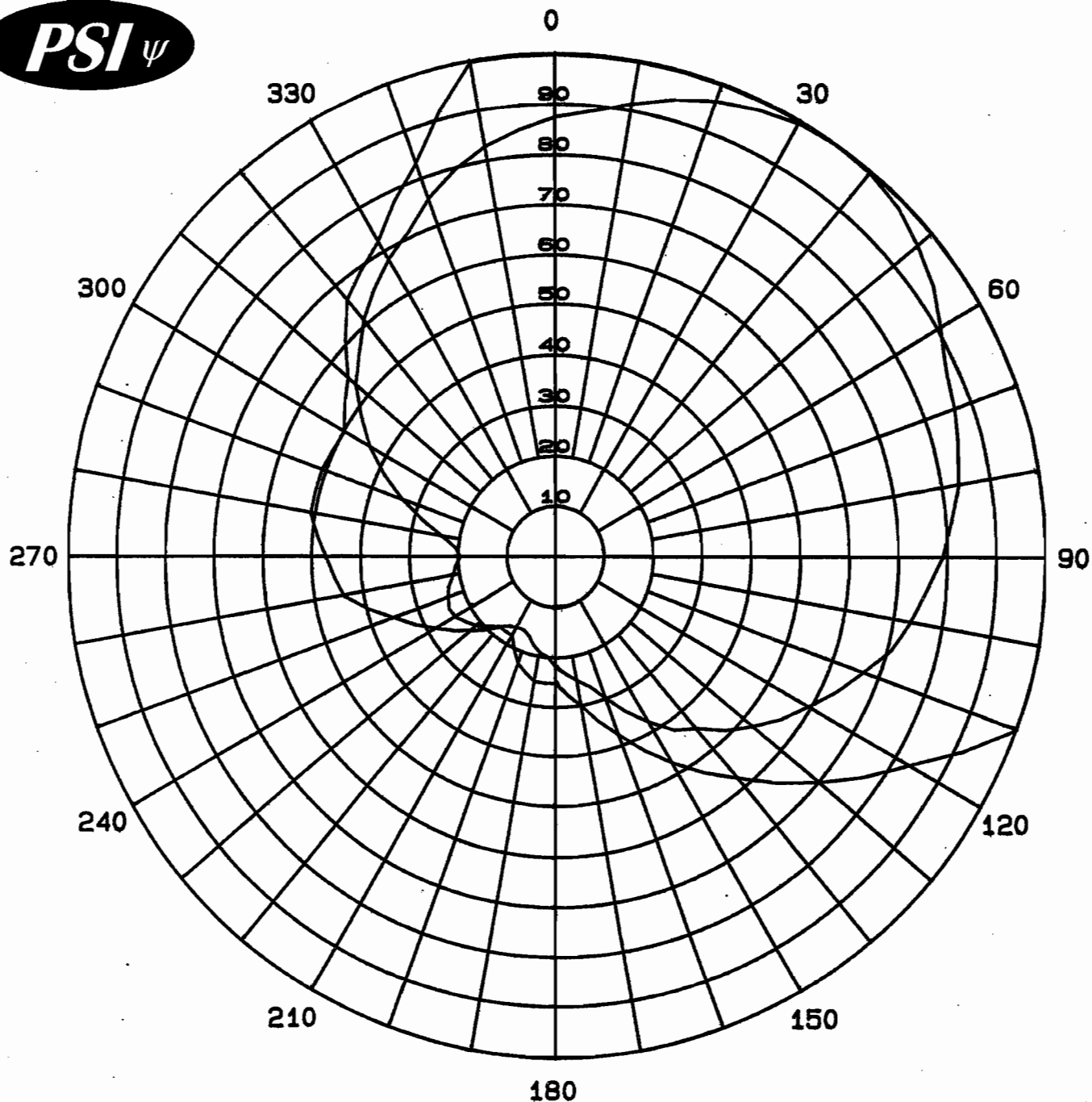
Station: WAHS

Frequency: 89.5 MHz

Location: Auburn Hills, MI

Maximum ERP: 2.4 kW (3.80 dBk)

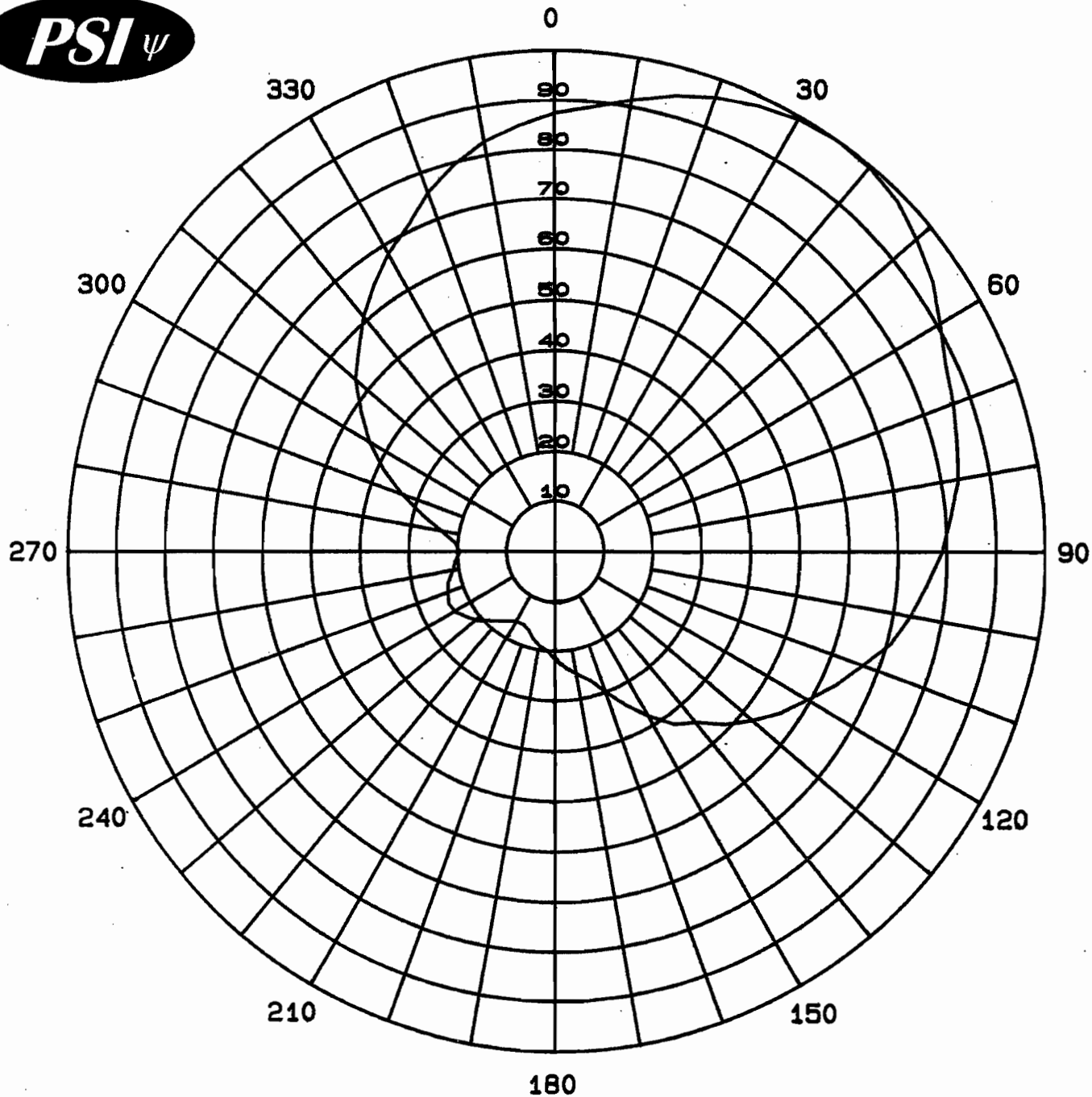
Angle	Relative Field	ERP (kW)	ERP (dBk)
0	1.000	2.40	3.80
10	1.000	2.40	3.80
20	1.000	2.40	3.80
30	1.000	2.40	3.80
40	1.000	2.40	3.80
50	1.000	2.40	3.80
60	1.000	2.40	3.80
70	1.000	2.40	3.80
80	1.000	2.40	3.80
90	1.000	2.40	3.80
100	1.000	2.40	3.80
110	1.000	2.40	3.80
120	0.830	1.65	2.18
130	0.700	1.18	0.70
140	0.576	0.80	-0.99
150	0.474	0.54	-2.68
160	0.377	0.34	-4.67
170	0.300	0.22	-6.66
180	0.250	0.15	-8.24
190	0.250	0.15	-8.24
200	0.224	0.12	-9.19
210	0.178	0.08	-11.19
220	0.178	0.08	-11.19
230	0.224	0.12	-9.19
240	0.280	0.19	-7.25
250	0.350	0.29	-5.32
260	0.440	0.46	-3.33
270	0.470	0.53	-2.76
280	0.510	0.62	-2.05
290	0.510	0.62	-2.05
300	0.500	0.60	-2.22
310	0.555	0.74	-1.31
320	0.665	1.06	0.26
330	0.725	1.26	1.01
340	0.835	1.67	2.24
350	1.000	2.40	3.80



Maximum Envelope and
Composite Pattern
Antenna: PSIFML-3A-8WS-DA
Type: 3-Bay Directional FM Antenna
ERP: 2.4 kW (3.80 dBk)
RMS Envelope: .719
RMS Composite: .614
Frequency: 89.5 MHz

Propagation Systems Inc.
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Ebensburg, PA 15931

WAHS Auburn Hills, MI



Measured Composite
Azimuth Plane Pattern
Antenna: PSIFML-3A-8WS-DA
Type: 3-Bay Directional FM Antenna
ERP: 2.4 kW (3.80 dBk)
RMS Composite: .614
Frequency: 89.5 MHz
WAHS Auburn Hills, MI

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Composite Pattern Tabulation

Antenna: PSIFML-3A-8WS-DA

Avondale School District

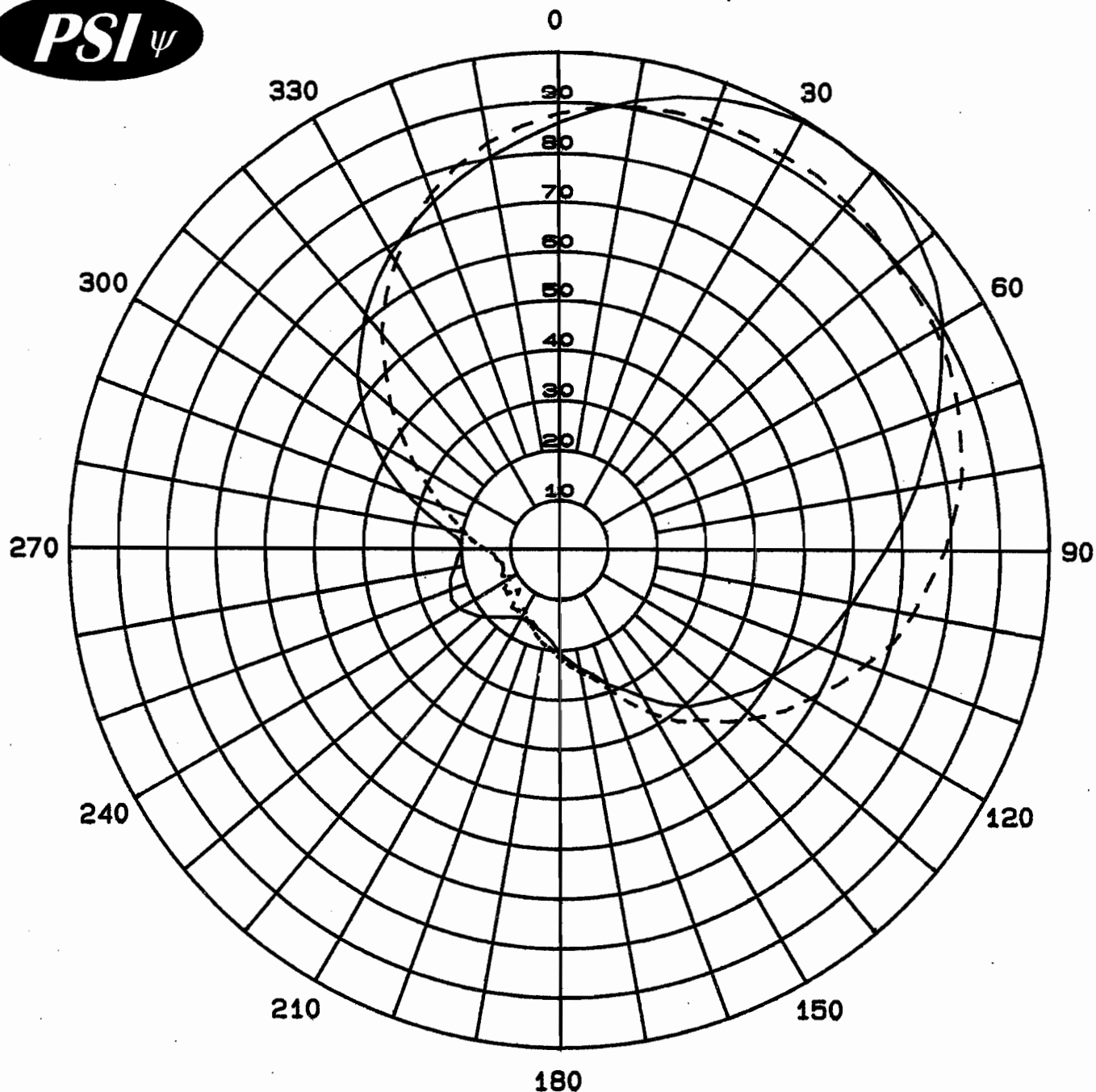
Station: WAHS

Frequency: 89.5 MHz

Location: Auburn Hills, MI

Maximum ERP: 2.4 kW (3.80 dBk)

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.875	1.84	2.64
10	0.915	2.01	3.03
20	0.964	2.23	3.48
30	0.995	2.38	3.76
40	0.996	2.38	3.77
50	0.961	2.22	3.46
60	0.905	1.97	2.94
70	0.863	1.79	2.52
80	0.834	1.67	2.23
90	0.788	1.49	1.73
100	0.733	1.29	1.10
110	0.665	1.06	0.26
120	0.592	0.84	-0.75
130	0.524	0.66	-1.81
140	0.445	0.48	-3.23
150	0.380	0.35	-4.60
160	0.300	0.22	-6.66
170	0.250	0.15	-8.24
180	0.218	0.11	-9.43
190	0.191	0.09	-10.58
200	0.164	0.06	-11.90
210	0.159	0.06	-12.17
220	0.178	0.08	-11.19
230	0.211	0.11	-9.71
240	0.237	0.13	-8.70
250	0.236	0.13	-8.74
260	0.215	0.11	-9.55
270	0.197	0.09	-10.31
280	0.236	0.13	-8.74
290	0.334	0.27	-5.72
300	0.440	0.46	-3.33
310	0.536	0.69	-1.61
320	0.613	0.90	-0.45
330	0.684	1.12	0.50
340	0.760	1.39	1.42
350	0.830	1.65	2.18



Measured Relative Field
Azimuth Plane Pattern
Antenna: PSIFML-3A-8WS-DA
Type: 3-Bay Directional FM Antenna
Gain H-pol (solid): 3.10 (4.92 dB)
Gain V-pol (dash): 2.62 (4.19 dB)
Frequency: 89.5 MHz
WAHS Auburn Hills, MI

Propagation Systems Inc.
PO Box 113
Ebensburg, PA 15931

Measured Relative Field Tabulation

Antenna: PSIFML-3A-8WS-DA

Avondale School District

Station: WAHS

Frequency: 89.5 MHz

Location: Auburn Hills, MI

Horizontal Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.856	2.271	3.56
10	0.915	2.595	4.14
20	0.964	2.881	4.60
30	0.995	3.069	4.87
40	0.996	3.075	4.88
50	0.961	2.863	4.57
60	0.905	2.539	4.05
70	0.822	2.095	3.21
80	0.742	1.707	2.32
90	0.668	1.383	1.41
100	0.608	1.146	0.59
110	0.561	0.976	-0.11
120	0.503	0.784	-1.06
130	0.457	0.647	-1.89
140	0.411	0.524	-2.81
150	0.342	0.363	-4.41
160	0.288	0.257	-5.90
170	0.242	0.182	-7.41
180	0.207	0.133	-8.77
190	0.172	0.092	-10.38
200	0.155	0.074	-11.28
210	0.159	0.078	-11.06
220	0.178	0.098	-10.08
230	0.211	0.138	-8.60
240	0.237	0.174	-7.59
250	0.236	0.173	-7.63
260	0.215	0.143	-8.44
270	0.197	0.120	-9.20
280	0.236	0.173	-7.63
290	0.334	0.346	-4.61
300	0.440	0.600	-2.22
310	0.536	0.891	-0.50
320	0.613	1.165	0.66
330	0.684	1.450	1.61
340	0.743	1.711	2.33
350	0.802	1.994	3.00

Maximum Value

Field 1.00
Gain 3.10 (4.92 dB)
Azimuth Bearing 34 degrees

Minimum Field

Field 0.154
Gain .073 (-11.33 dB)
Azimuth Bearing 201 degrees

Vertical Polarization

Angle	Relative Field	Power Gain	Gain (dB)
0	0.875	2.373	3.75
10	0.903	2.528	4.03
20	0.916	2.601	4.15
30	0.918	2.612	4.17
40	0.911	2.573	4.10
50	0.894	2.478	3.94
60	0.886	2.433	3.86
70	0.863	2.309	3.63
80	0.834	2.156	3.34
90	0.788	1.925	2.84
100	0.733	1.666	2.22
110	0.665	1.371	1.37
120	0.592	1.086	0.36
130	0.524	0.851	-0.70
140	0.445	0.614	-2.12
150	0.380	0.448	-3.49
160	0.300	0.279	-5.54
170	0.250	0.194	-7.13
180	0.218	0.147	-8.32
190	0.191	0.113	-9.47
200	0.164	0.083	-10.79
210	0.139	0.060	-12.23
220	0.152	0.072	-11.45
230	0.139	0.060	-12.23
240	0.114	0.040	-13.95
250	0.121	0.045	-13.43
260	0.129	0.052	-12.87
270	0.153	0.073	-11.39
280	0.197	0.120	-9.20
290	0.258	0.206	-6.85
300	0.341	0.360	-4.43
310	0.448	0.622	-2.06
320	0.563	0.983	-0.08
330	0.666	1.375	1.38
340	0.760	1.791	2.53
350	0.830	2.136	3.30

Maximum Value

Field 0.920
Gain 2.62 (4.19 dB)
Azimuth Bearing 26 degrees

Minimum Field

Field 0.114
Gain .040 (-13.95 dB)
Azimuth Bearing 240 degrees

ERP Tabulation

Antenna: PSIFML-3A-8WS-DA

Avondale School District

Station: WAHS

Frequency: 89.5 MHz

Location: Auburn Hills, MI

Maximum ERP: 2.4 kW (3.80 dBk)

Horizontal Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.856	1.76	2.45
10	0.915	2.01	3.03
20	0.964	2.23	3.48
30	0.995	2.38	3.76
40	0.996	2.38	3.77
50	0.961	2.22	3.46
60	0.905	1.97	2.94
70	0.822	1.62	2.10
80	0.742	1.32	1.21
90	0.668	1.07	0.30
100	0.608	0.89	-0.52
110	0.561	0.76	-1.22
120	0.503	0.61	-2.17
130	0.457	0.50	-3.00
140	0.411	0.41	-3.92
150	0.342	0.28	-5.52
160	0.288	0.20	-7.01
170	0.242	0.14	-8.52
180	0.207	0.10	-9.88
190	0.172	0.07	-11.49
200	0.155	0.06	-12.39
210	0.159	0.06	-12.17
220	0.178	0.08	-11.19
230	0.211	0.11	-9.71
240	0.237	0.13	-8.70
250	0.236	0.13	-8.74
260	0.215	0.11	-9.55
270	0.197	0.09	-10.31
280	0.236	0.13	-8.74
290	0.334	0.27	-5.72
300	0.440	0.46	-3.33
310	0.536	0.69	-1.61
320	0.613	0.90	-0.45
330	0.684	1.12	0.50
340	0.743	1.32	1.22
350	0.802	1.54	1.89

Maximum Value (H-pol)

Field 1.00
ERP 2.4 kW (3.80 dBk)
Azimuth Bearing 34 degrees

Minimum Field (H-pol)

Field 0.154
ERP .057 kW (-12.45 dBk)
Azimuth Bearing 201 degrees

Vertical Polarization

Angle	Relative Field	ERP (kW)	ERP (dBk)
0	0.875	1.84	2.64
10	0.903	1.96	2.92
20	0.916	2.01	3.04
30	0.918	2.02	3.06
40	0.911	1.99	2.99
50	0.894	1.92	2.83
60	0.886	1.88	2.75
70	0.863	1.79	2.52
80	0.834	1.67	2.23
90	0.788	1.49	1.73
100	0.733	1.29	1.10
110	0.665	1.06	0.26
120	0.592	0.84	-0.75
130	0.524	0.66	-1.81
140	0.445	0.48	-3.23
150	0.380	0.35	-4.60
160	0.300	0.22	-6.66
170	0.250	0.15	-8.24
180	0.218	0.11	-9.43
190	0.191	0.09	-10.58
200	0.164	0.06	-11.90
210	0.139	0.05	-13.34
220	0.152	0.06	-12.56
230	0.139	0.05	-13.34
240	0.114	0.03	-15.06
250	0.121	0.04	-14.54
260	0.129	0.04	-13.99
270	0.153	0.06	-12.50
280	0.197	0.09	-10.31
290	0.258	0.16	-7.97
300	0.341	0.28	-5.54
310	0.448	0.48	-3.17
320	0.563	0.76	-1.19
330	0.666	1.06	0.27
340	0.760	1.39	1.42
350	0.830	1.65	2.18

Maximum Value (V-pol)

Field 0.920
ERP 2.03 kW (3.08 dBk)
Azimuth Bearing 26 degrees

Minimum Field (V-pol)

Field 0.114
ERP .031 kW (-15.06 dBk)
Azimuth Bearing 240 degrees



Relative Field Elevation Pattern
Model: PSIFML-3A-8WS-DA
Type: 3-Bay Directional FM
Polarization: Circular
Bay Spacing: 8/10-wave
Gain: 3.10 (4.92 dB)
Station: WAHS

