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## The Sea Swift Experiments October 1974 : Parts 1-4

Källström, Claes

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LUND UNIVERSITY

PO Box 117  
221 00 Lund  
+46 46-222 00 00

THE SEA SWIFT EXPERIMENTS  
OCTOBER 1974.

PART II

C. KÄLLSTRÖM

Report 7516(C) June 1975  
Department of Automatic Control  
Lund Institute of Technology

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THE SEA SWIFT EXPERIMENTS,  
OCTOBER 1974 - PART II

Claes Källström

## EXPERIMENT A17

Date 1974-10-14  
 Time 19.06  
 Duration 27 min  
 Position N 09° 07' E 53° 26'  
 Water depth deep  
 Forward draught 20.2 m  
 Aft draught 20.2 m  
 Wind direction SW (1; see Appendix A)  
 Wind velocity 1 Beaufort (1-1.5 m/s, light air)  
 Wave height 1 m (rollings)  
 PSIREF 208°  
 Rudder limit Not active

Regulator structure

NA = 3      NB = 1      NC = 1      K = 8  
 IREG = 10    IRDIF = 0    RL = 0.98    IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -15.448 \\ 25.557 \\ -9.928 \\ 0.845 \\ -3.271 \end{bmatrix} \quad P = \begin{bmatrix} 4.372 & & & & \\ -6.843 & 12.163 & & & \\ 2.867 & -5.735 & 3.129 & & \\ -0.059 & 0.079 & -0.017 & 0.015 & \\ 9.035 & -8.878 & -0.767 & -0.109 & 97.368 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = 0.181$$

Statistics (mean value and standard deviation)

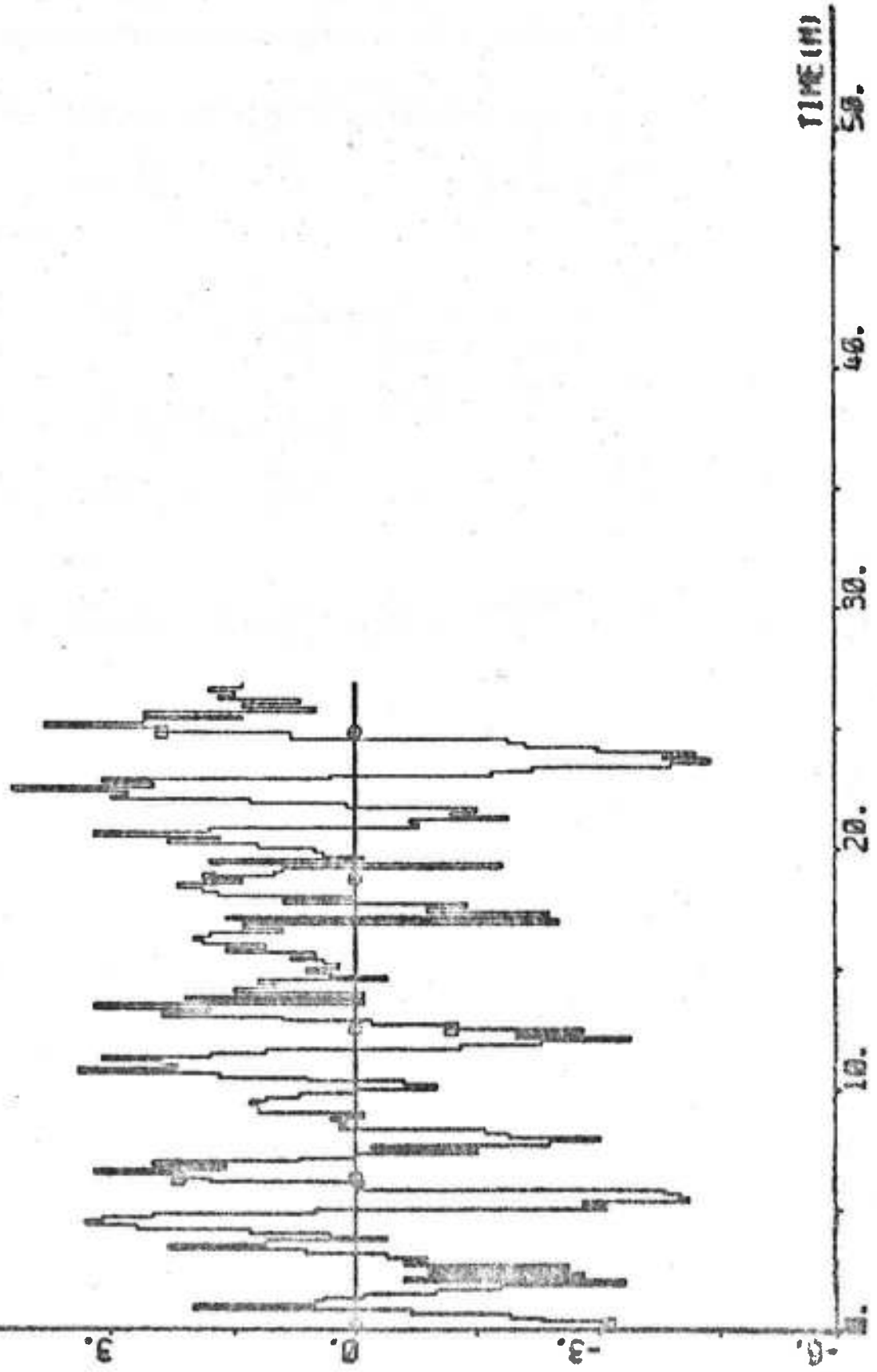
DELTA	1.21 ± 1.98 deg
PSI-PSIREF	-0.017 ± 0.544 deg
AN	85.65 ± 0.58 rpm
U	15.29 ± 0.25 knots

$$V_1 = 0.835$$

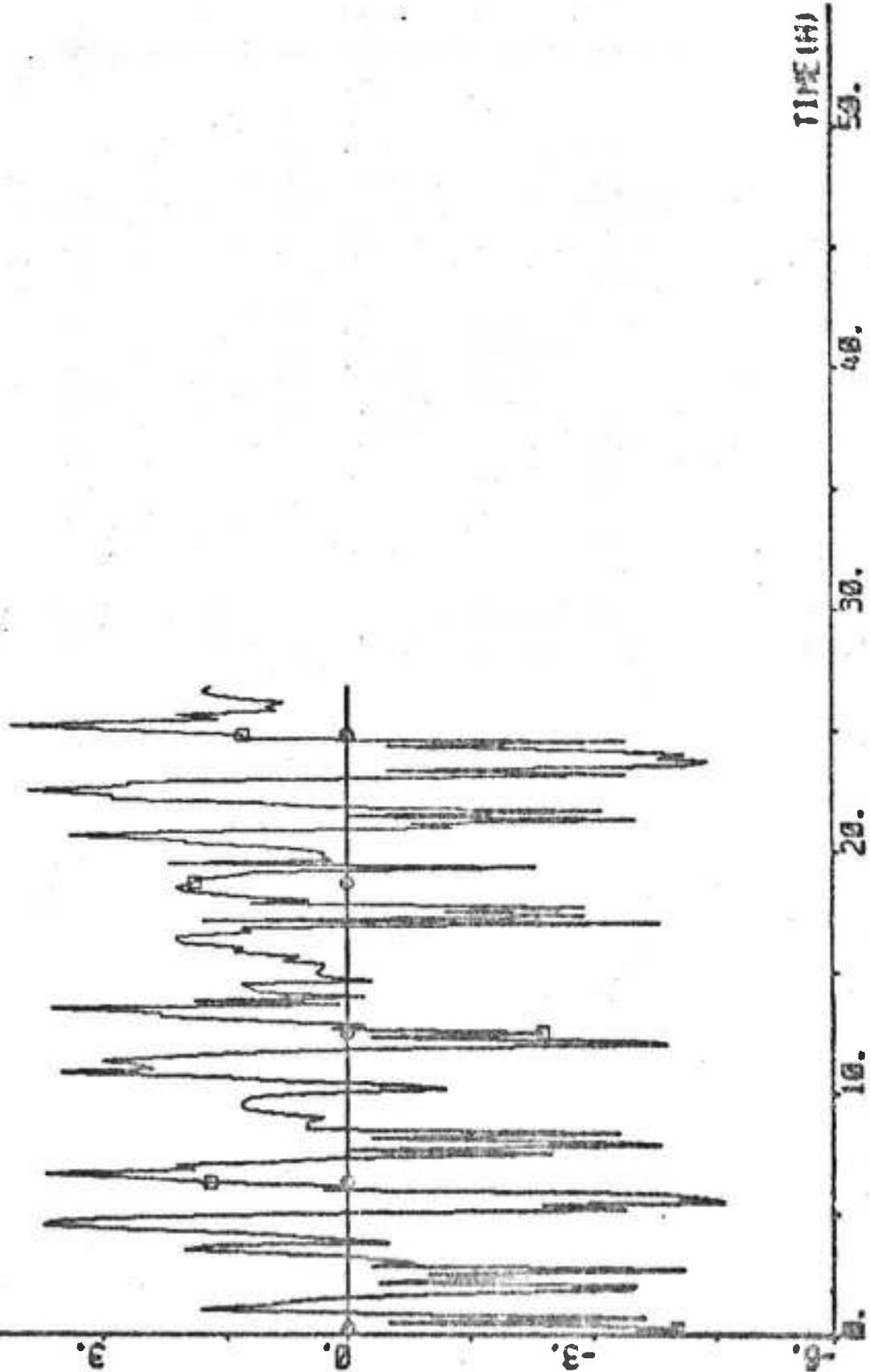
$$V_2 = 0.688$$



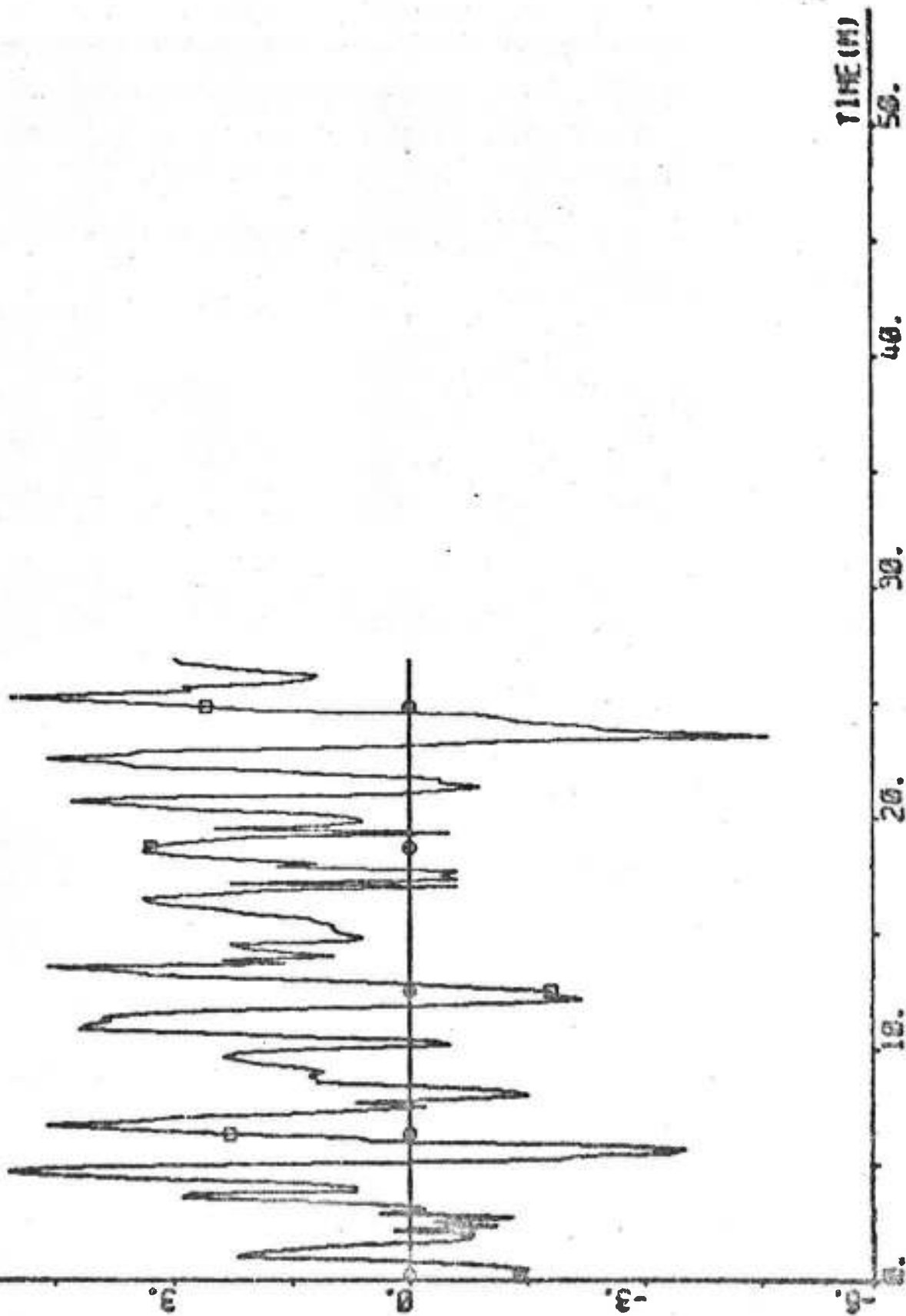
PLOT HP A17P1(1) ZERO -5 7 DELCOC DEG



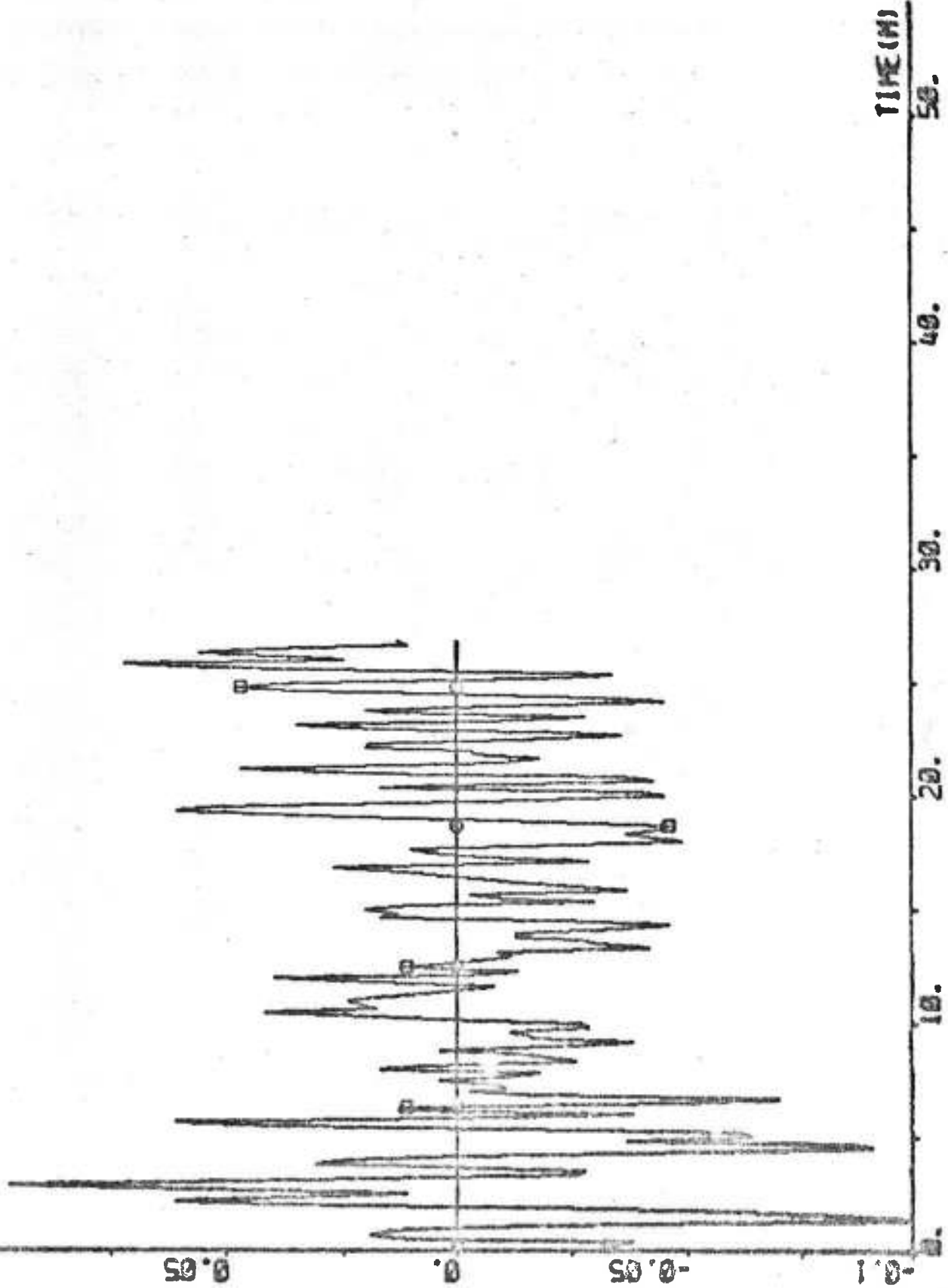
PLOT A17P1(3) ZERO -5 7 ° DELTAS DEG



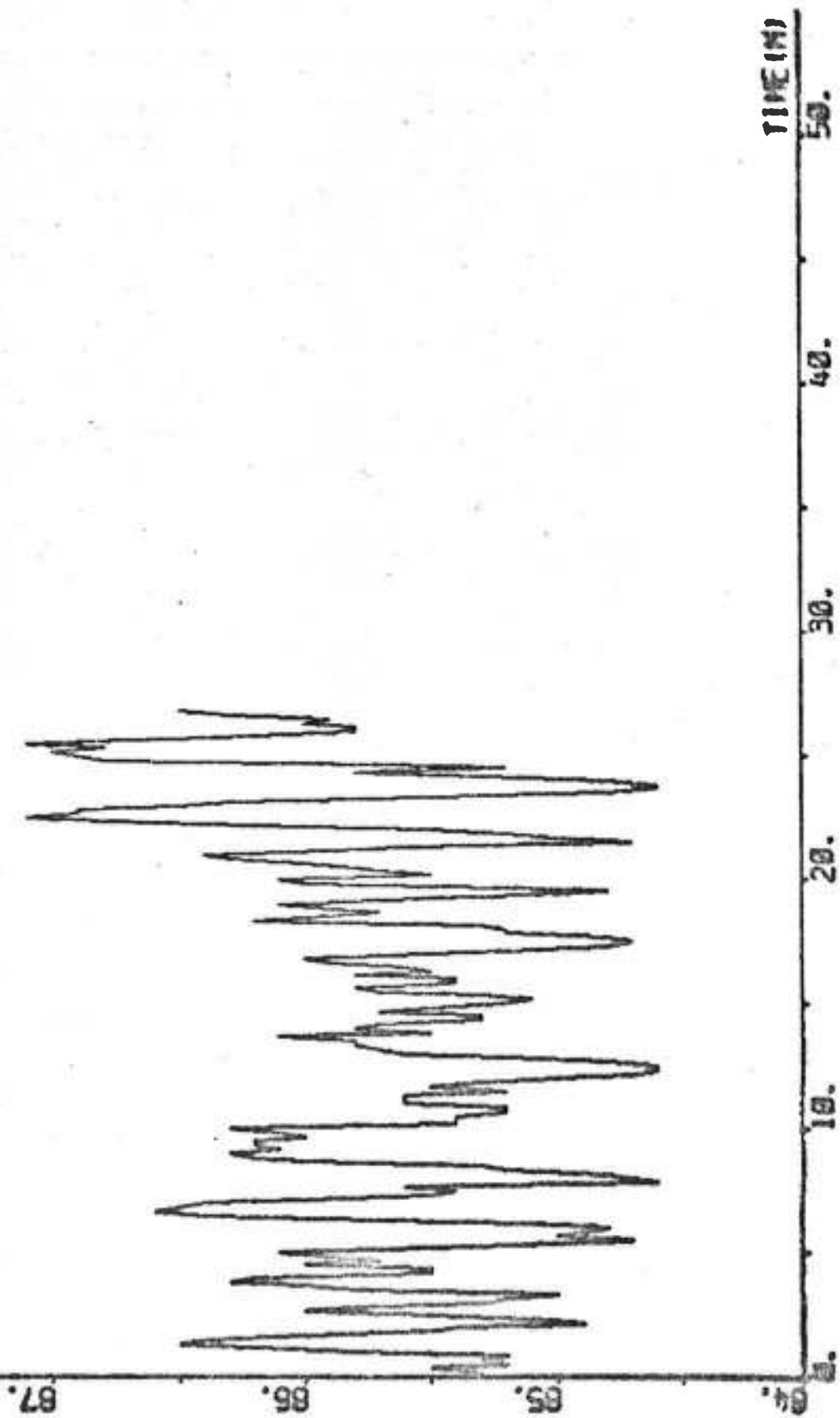
PLOT A17P1(4) ZERO -5 7 °DELTA DEG



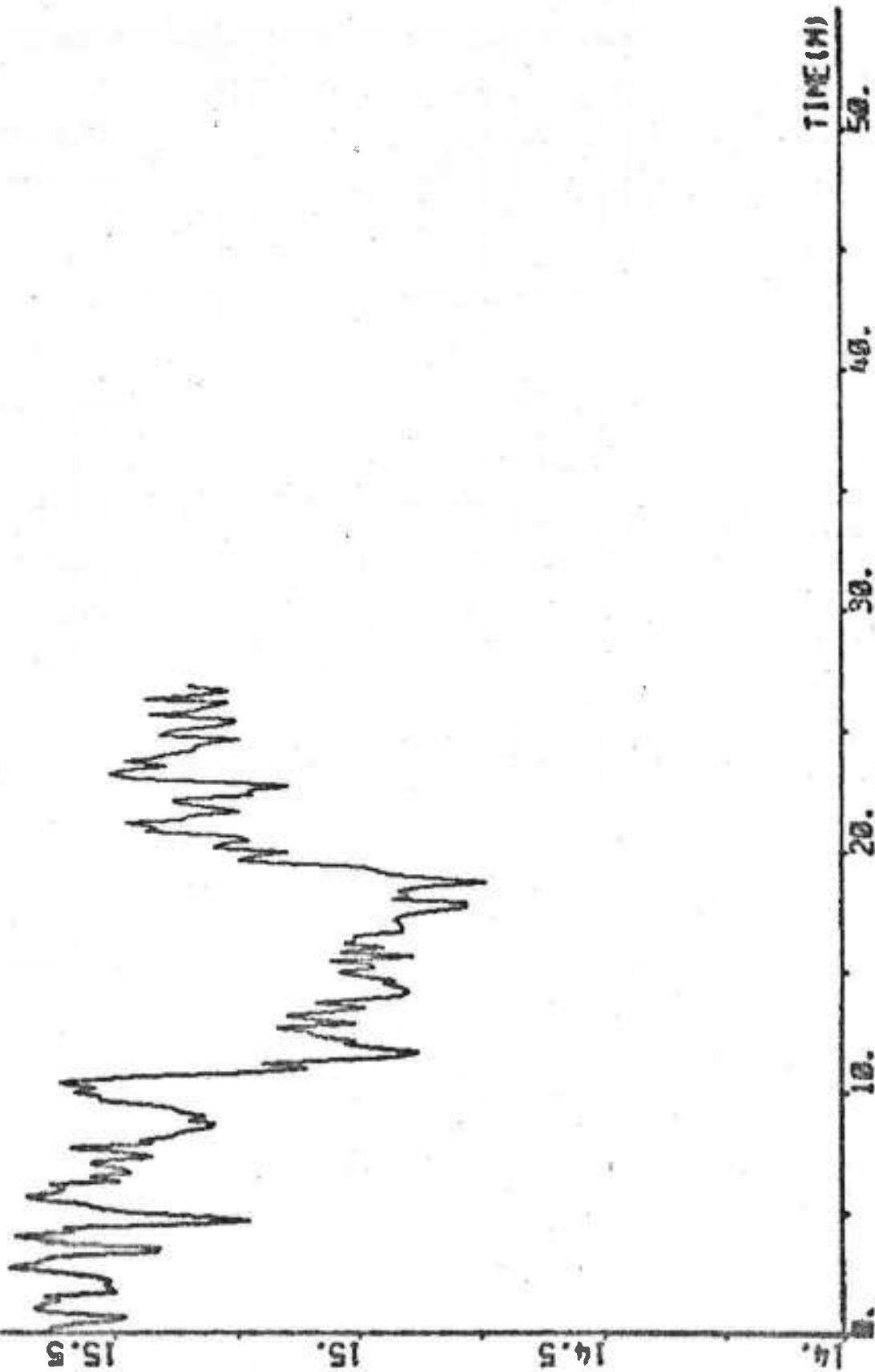
PLOT R17P1(S) ZERO -0.1 0.1 -PP DEG/S



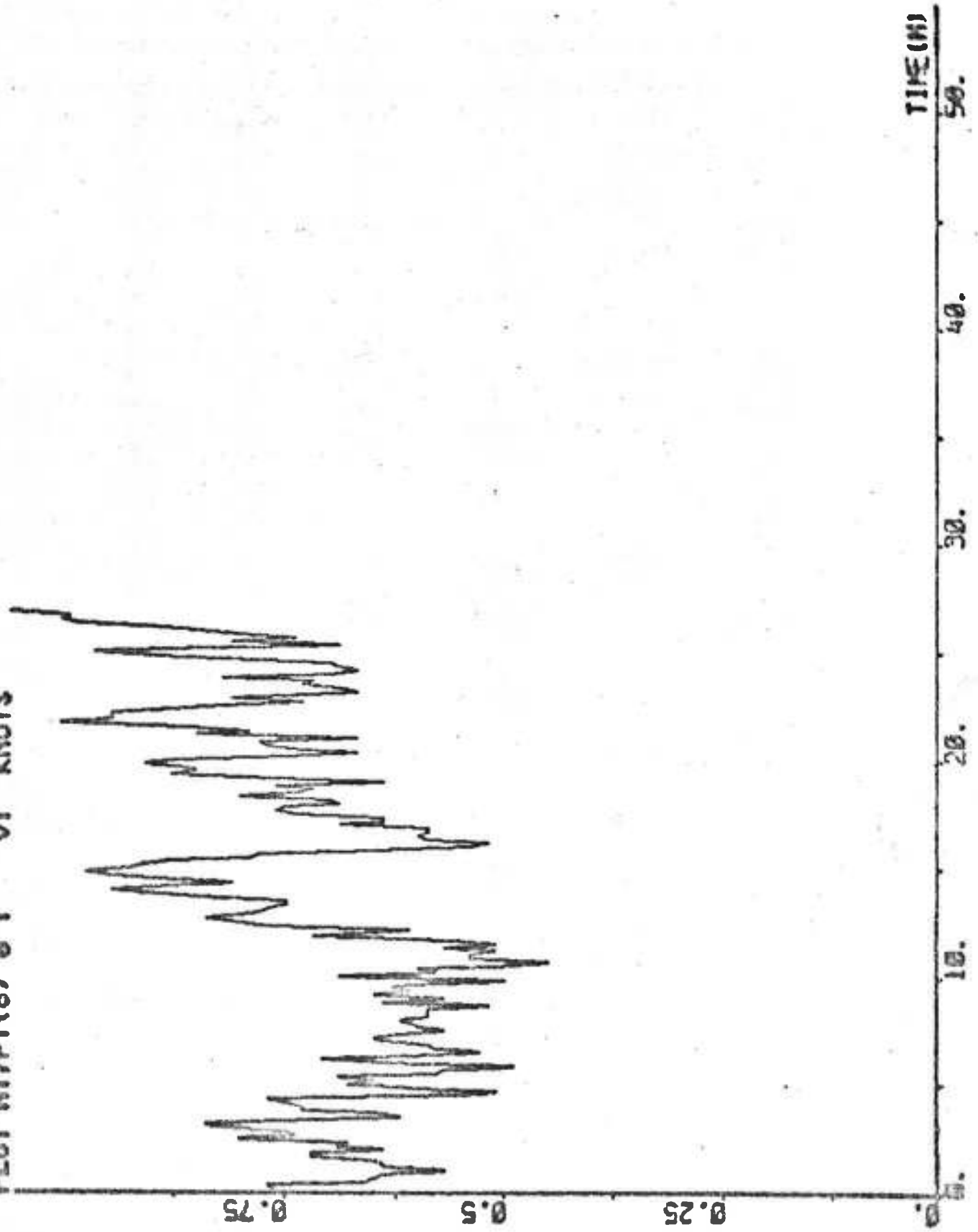
PLOT A17P1(6) 04 00 "RN RPM



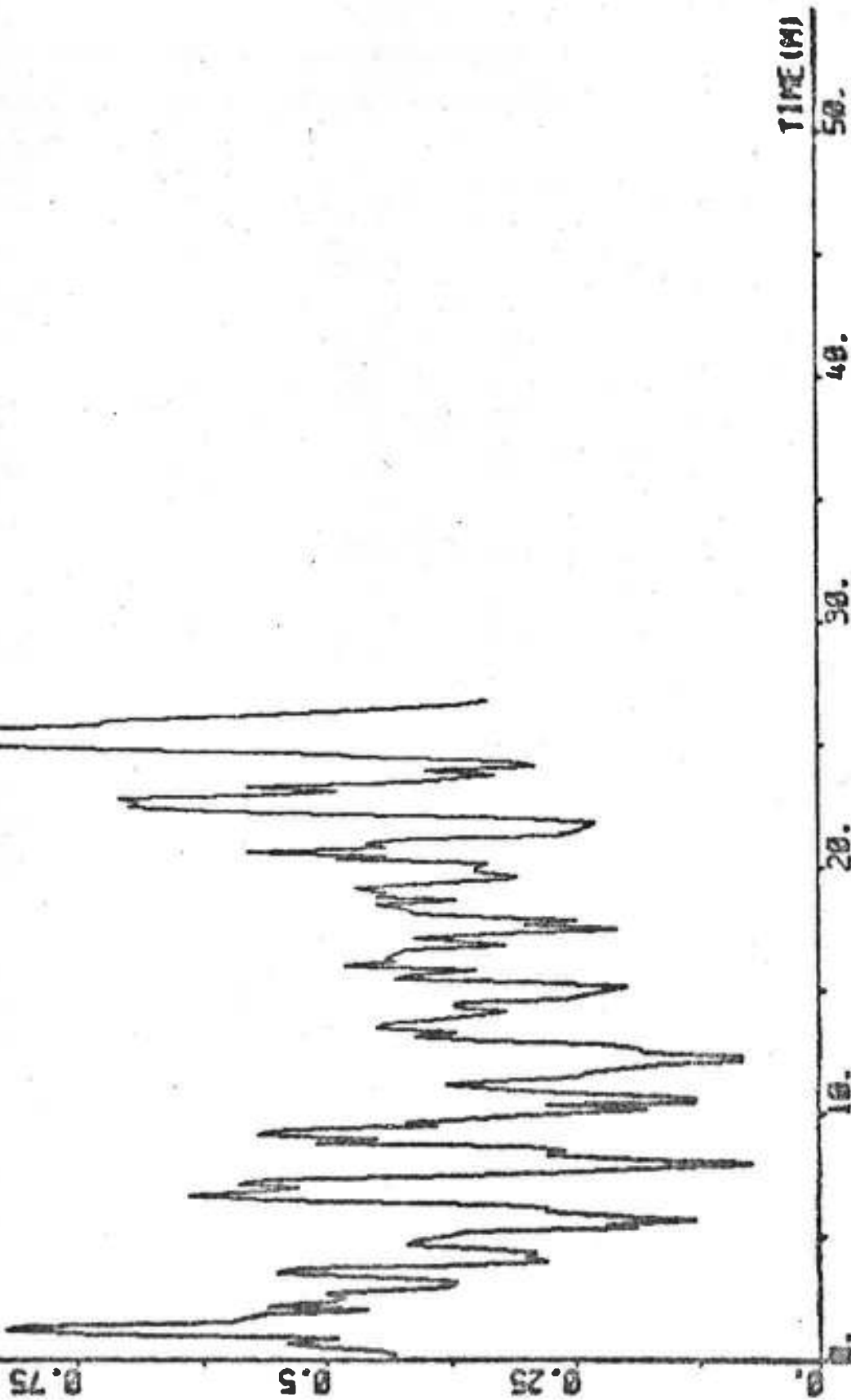
PL0T R17P1(7) 14 16 "U KNOTS



PLOT R17P1(8) @ 1 -VI KNOTS

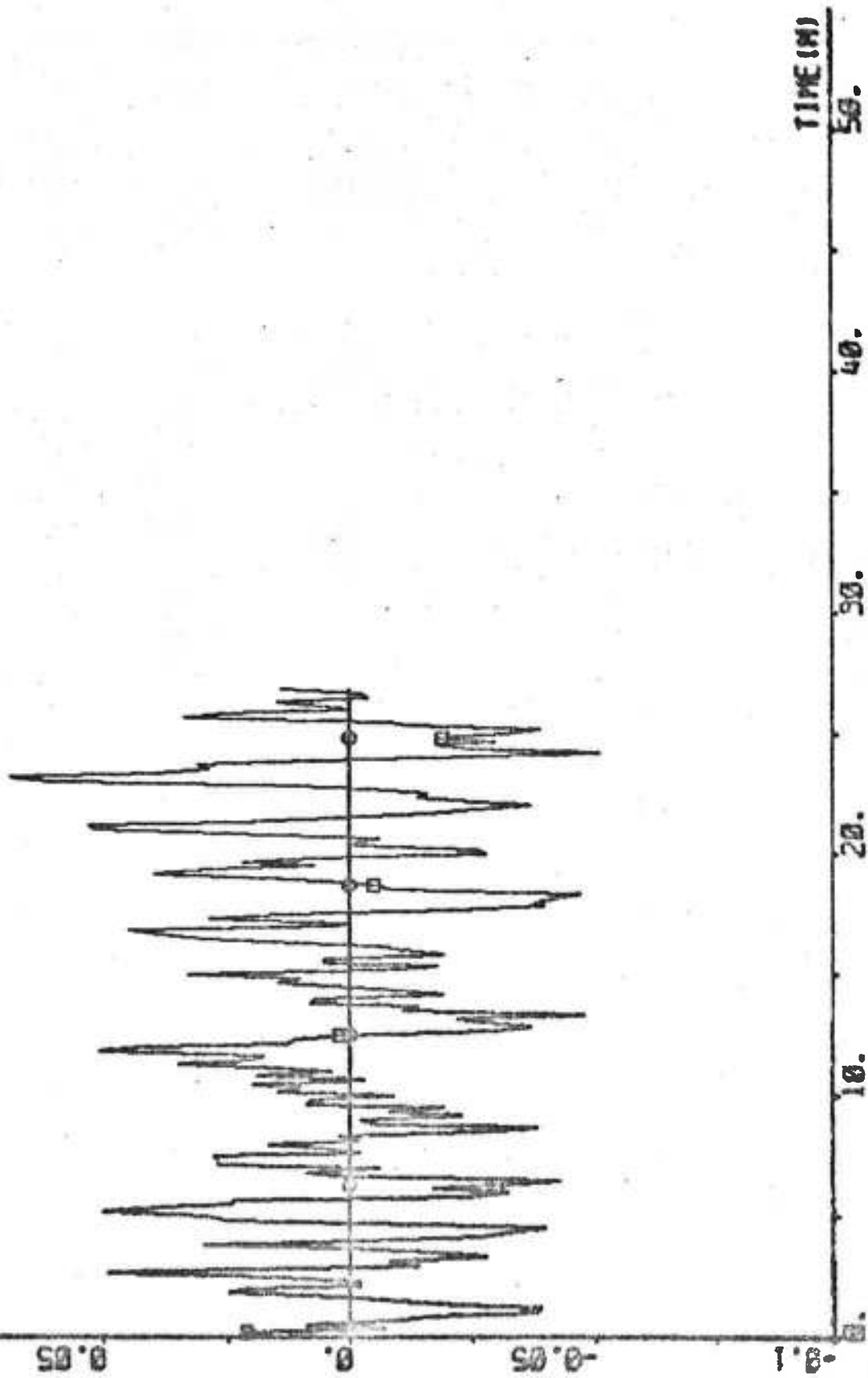


PL0T A17P1(8) 0 1 -V2 KIOTS

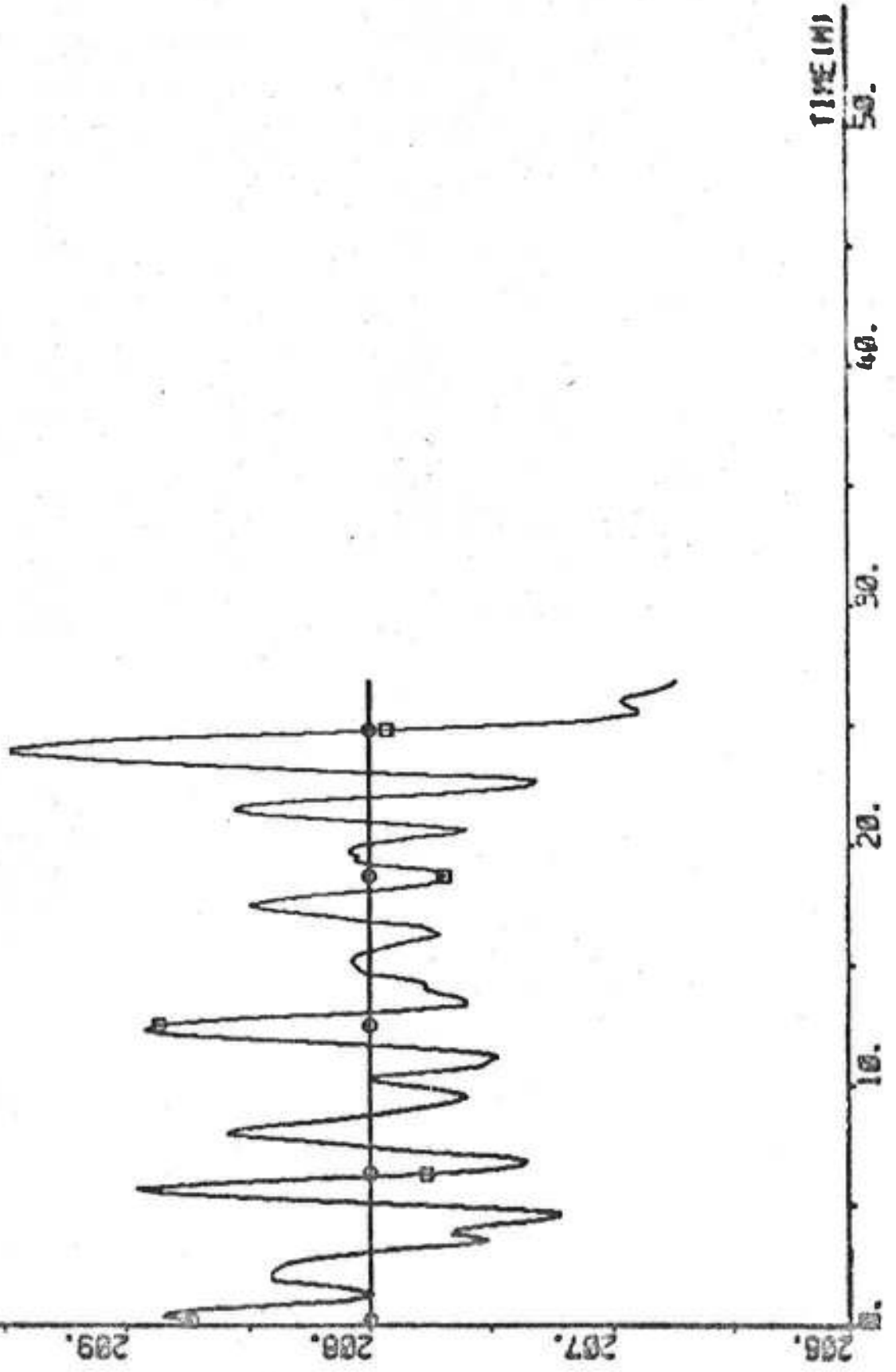




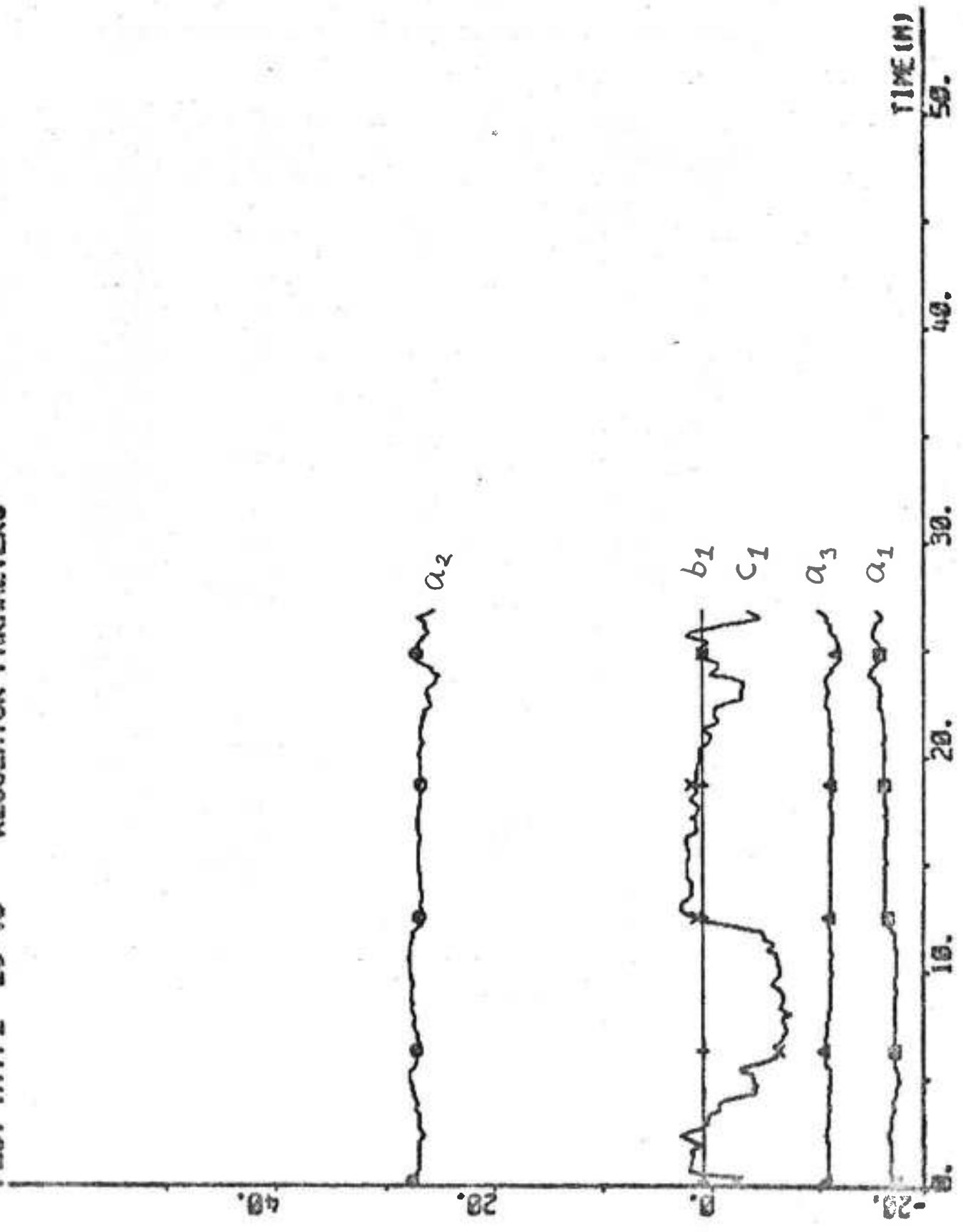
PLOT R17P1(10) ZERO -0.1 0.1 °R DEG/S



PLOT R17P1(13 14) 206 210 °PSI PSIREF DEG



PLOT R17P2 -20 40 °REGULATOR PARAMETERS



## EXPERIMENT A18

Date 1974-10-14  
 Time 22.04  
 Duration 27 min  
 Position N 08° 18' E 53° 12'  
 Water depth deep  
 Forward draught 20.2 m  
 Aft draught 20.2 m  
 Wind direction SW (1; see Appendix A)  
 Wind velocity 2 Beaufort (2-3.5 m/s, light breeze)  
 Wave height 2 - 3 m (rollings)  
 PSIREF 207.5° (Sailmaster)  
 Rudder limit Not active

Regulator structure

NA = 3      NB = 1      NC = 1      K = 5  
 IREG = 15    IRDIF = 0    RL = 0.98    IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -16.325 \\ 26.380 \\ -10.022 \\ 1.034 \\ -1.195 \end{bmatrix} \quad P = \begin{bmatrix} 2.566 & & & & \\ -3.199 & 5.634 & & & \\ 1.077 & -2.671 & 2.096 & & \\ -0.021 & 0.027 & -0.006 & 0.001 & \\ 4.247 & -6.009 & 0.880 & 0.063 & 55.943 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = 0.033$$

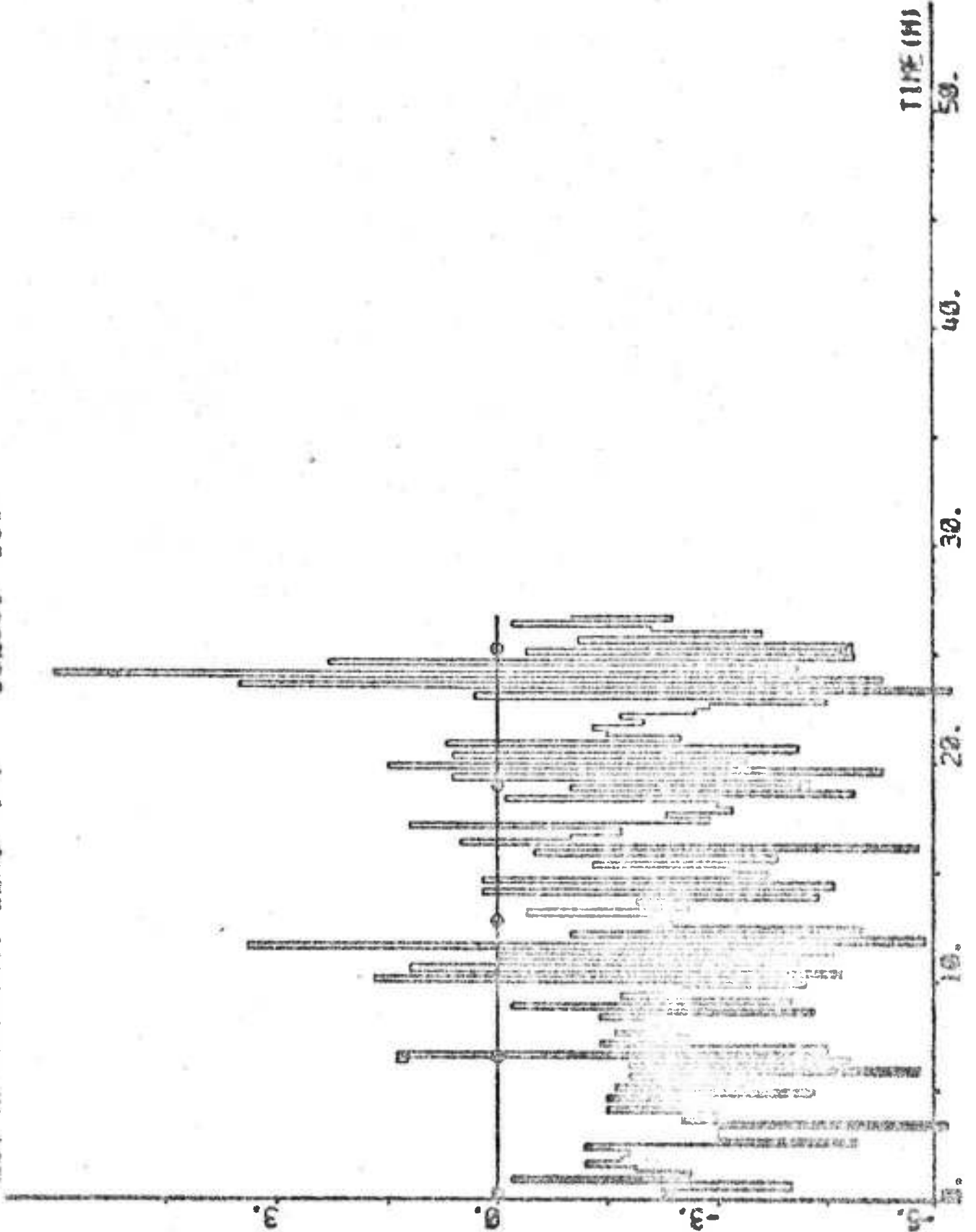
Statistics (mean value and standard deviation)

DELTA	-1.06 ± 1.87 deg
PSI-PSIREF	-0.059 ± 0.167 deg
AN	86.13 ± 0.28 rpm
U	16.20 ± 0.11 knots

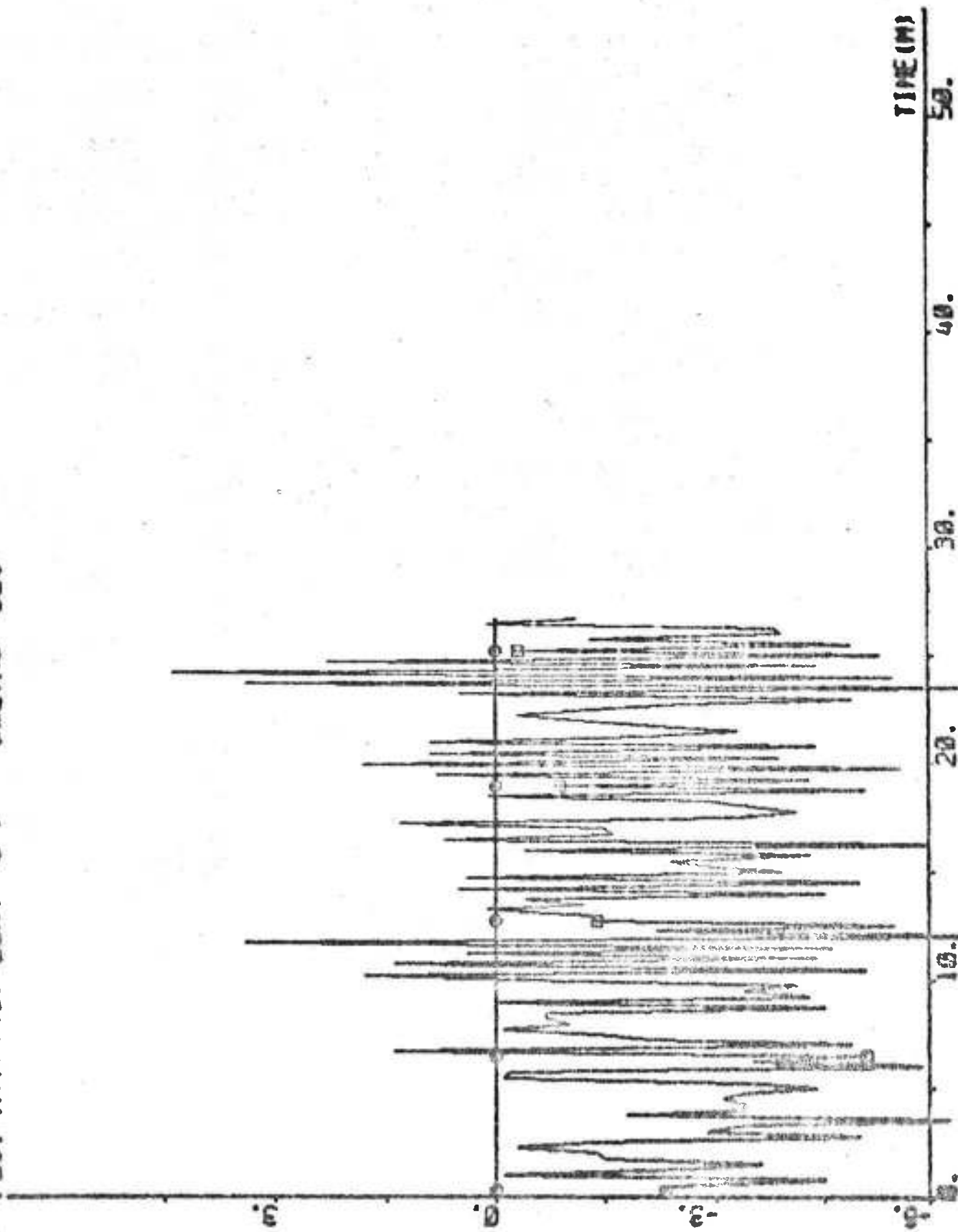
$$V_1 = 0.493$$

$$V_2 = 0.381$$

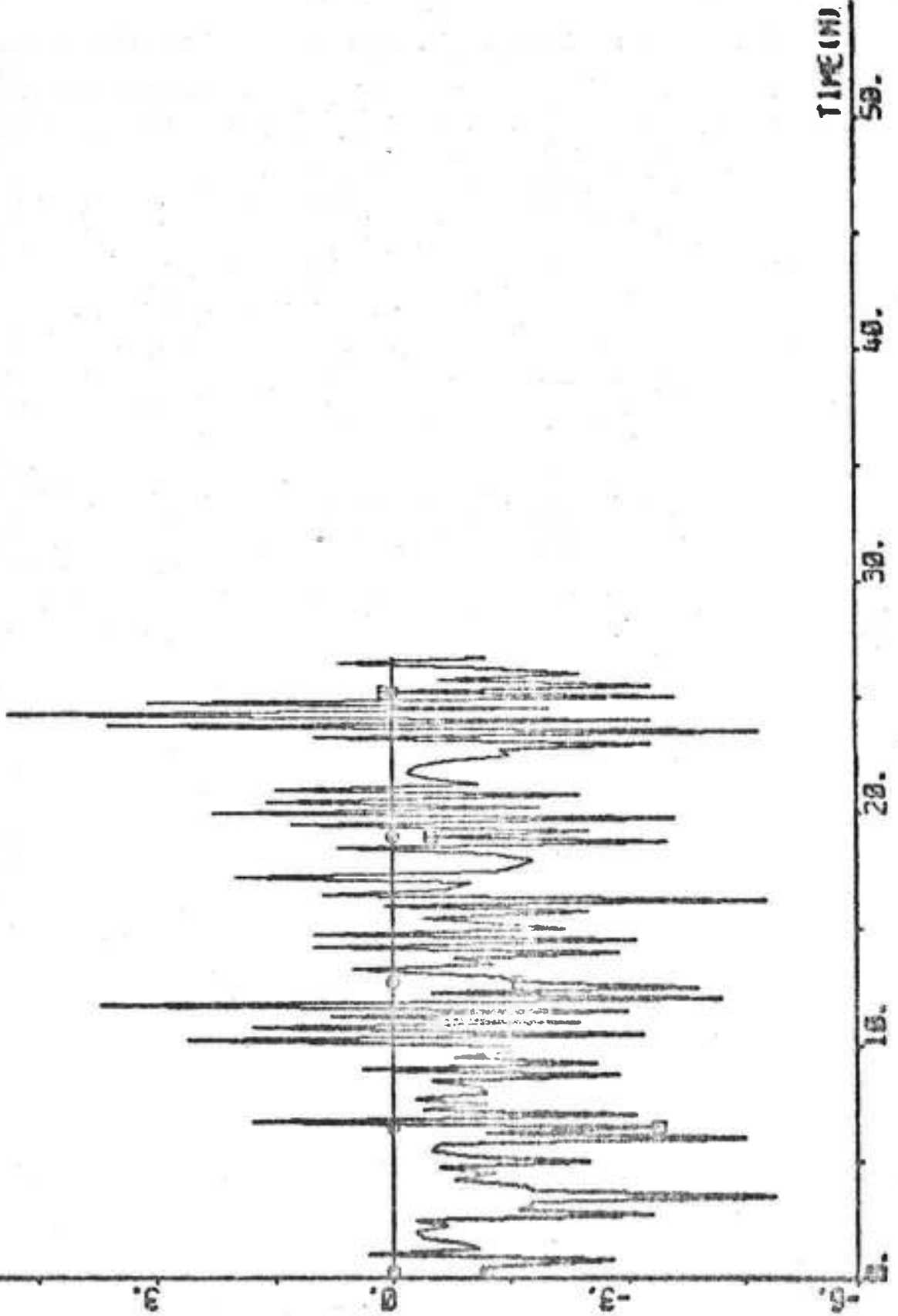
PILOT HP A18P(1) ZERO -5 7 DELCOC DEG



PLOT R10P1(3) ZERO -5 7 "DELTA" DEG

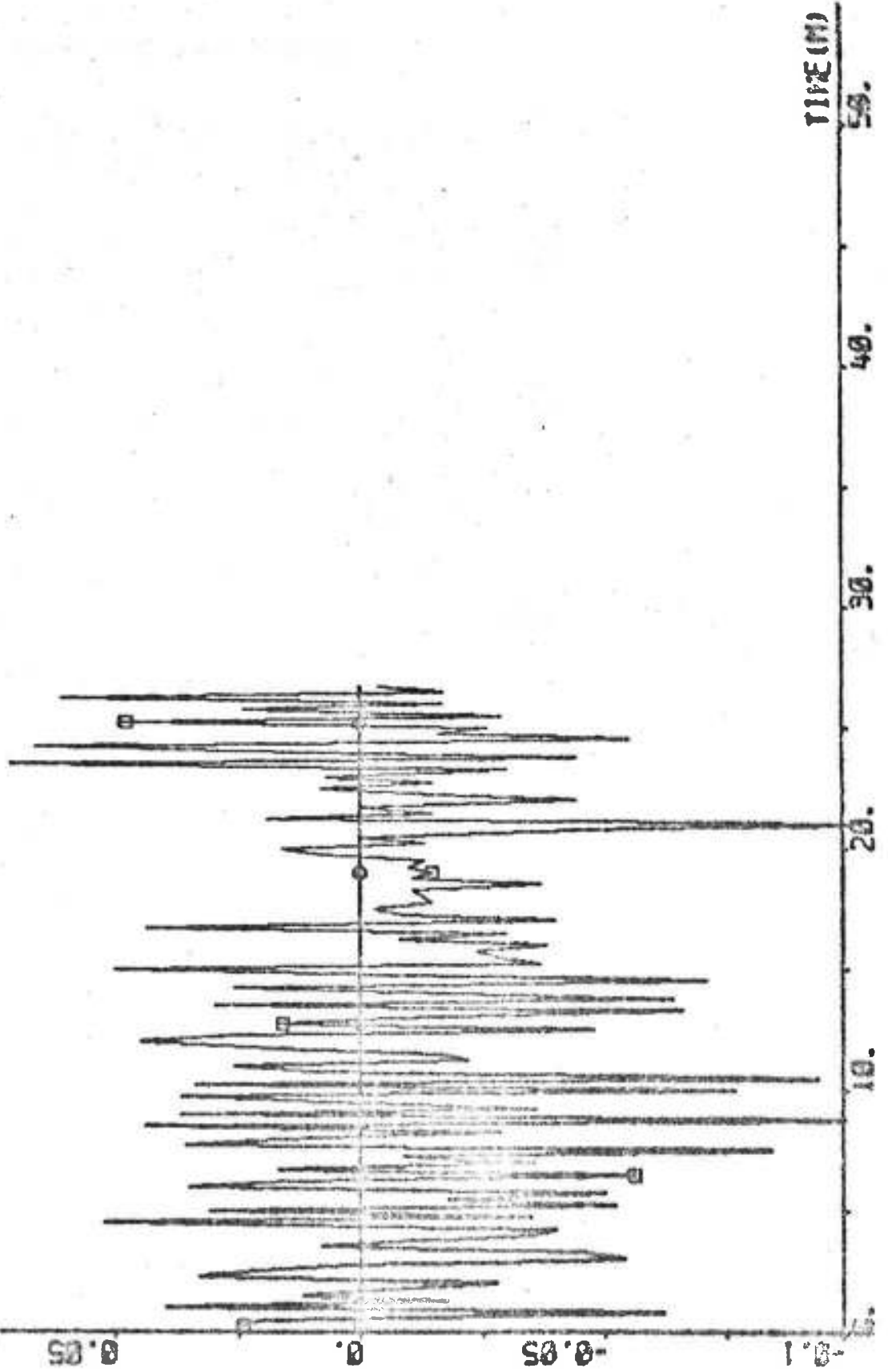


PLOT A18P1(4) ZERO -5 7 °DELTA DEG

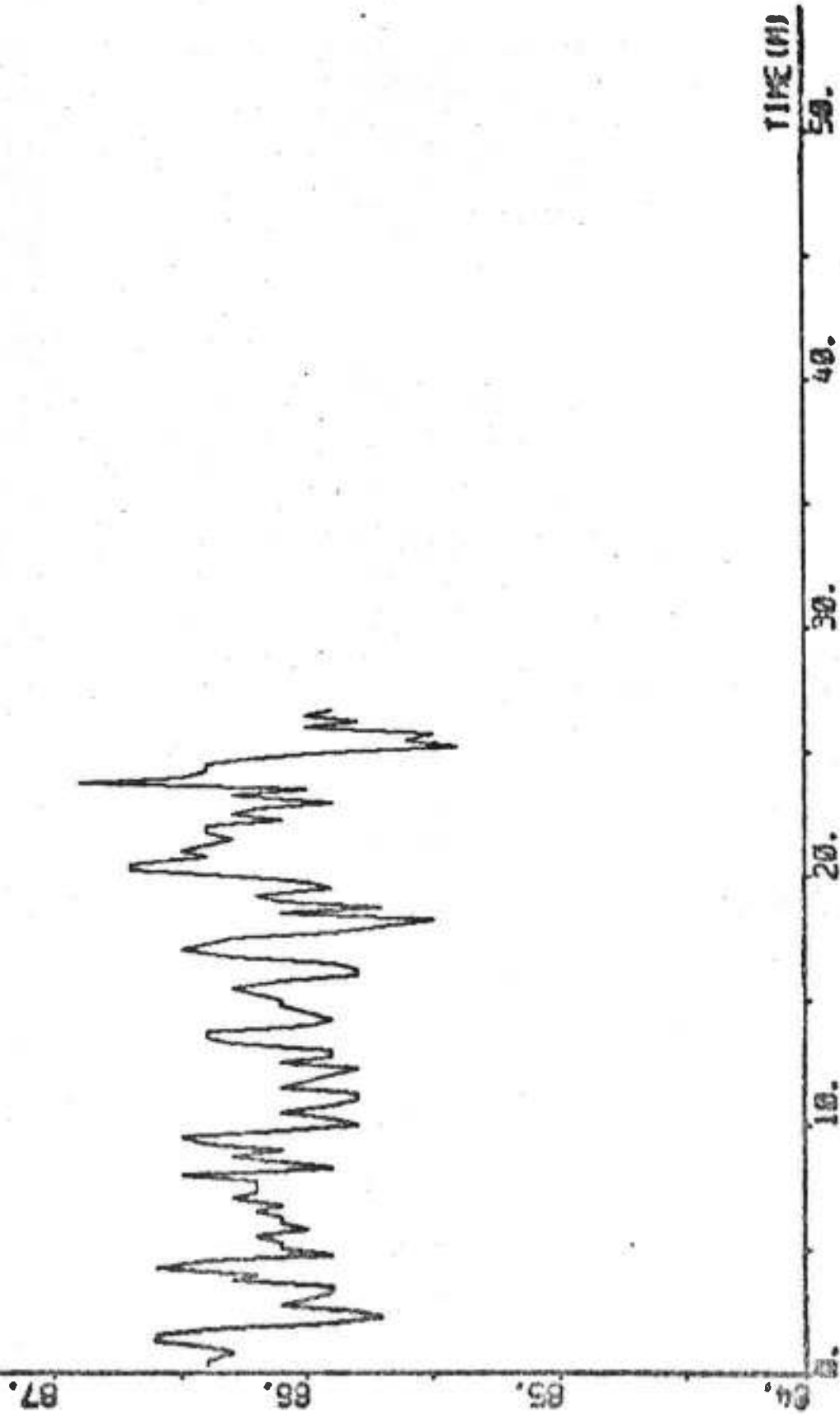




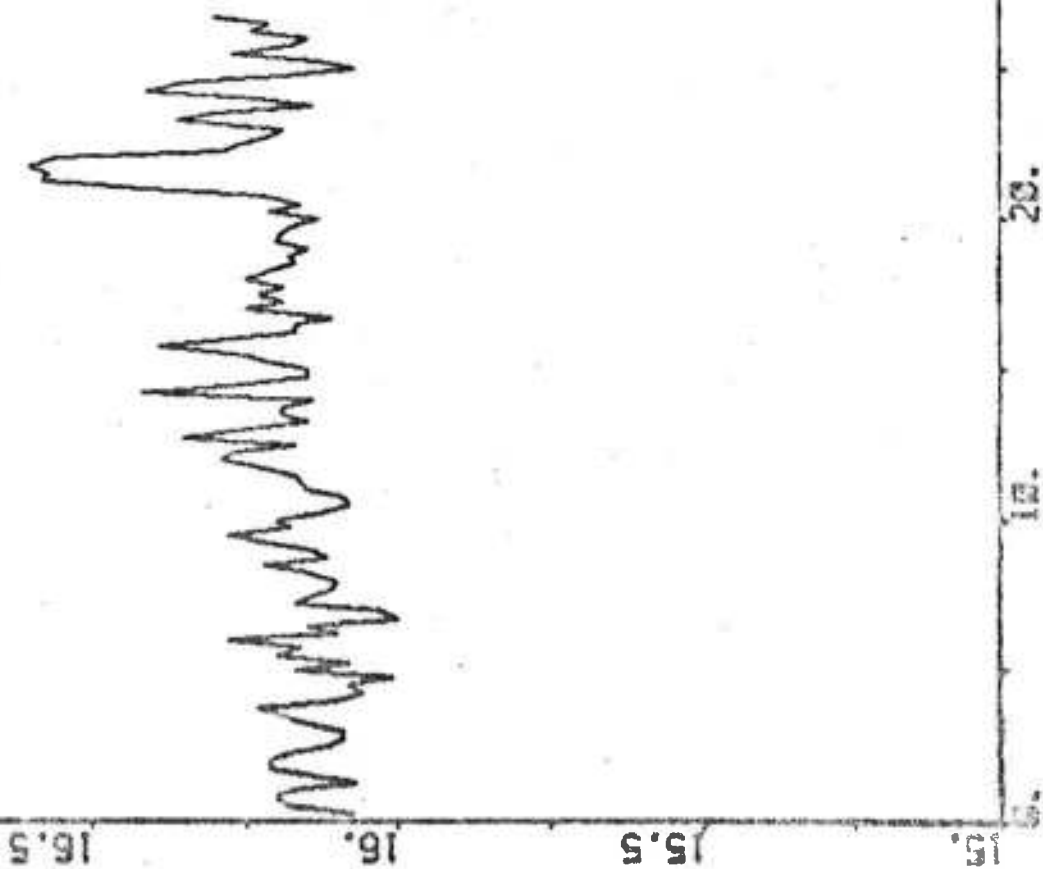
PLUT #10P1(S) ZERO -0.1 0.1 -PP DEG/S



PL0T R1CP1(6) 84 88 -AN RPM



FLOY A10:1(7) 15 17 -U KNOTS



PLOT RIOP1(8) @ 1 -VI KNOTS



TIME (H)

50.

40.

30.

20.

10.

0.

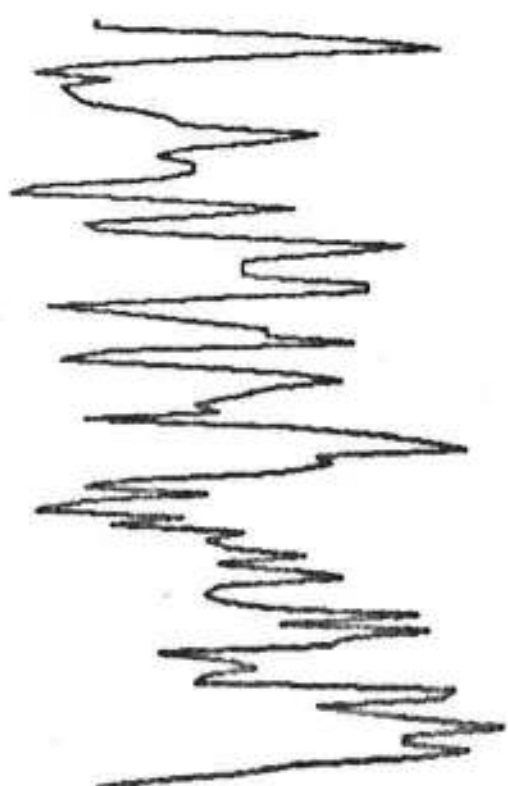
PLOT A18P1(S) 9 1 -V2 KNOTS

0.75

0.5

0.25

0.



TIME (M)

50.

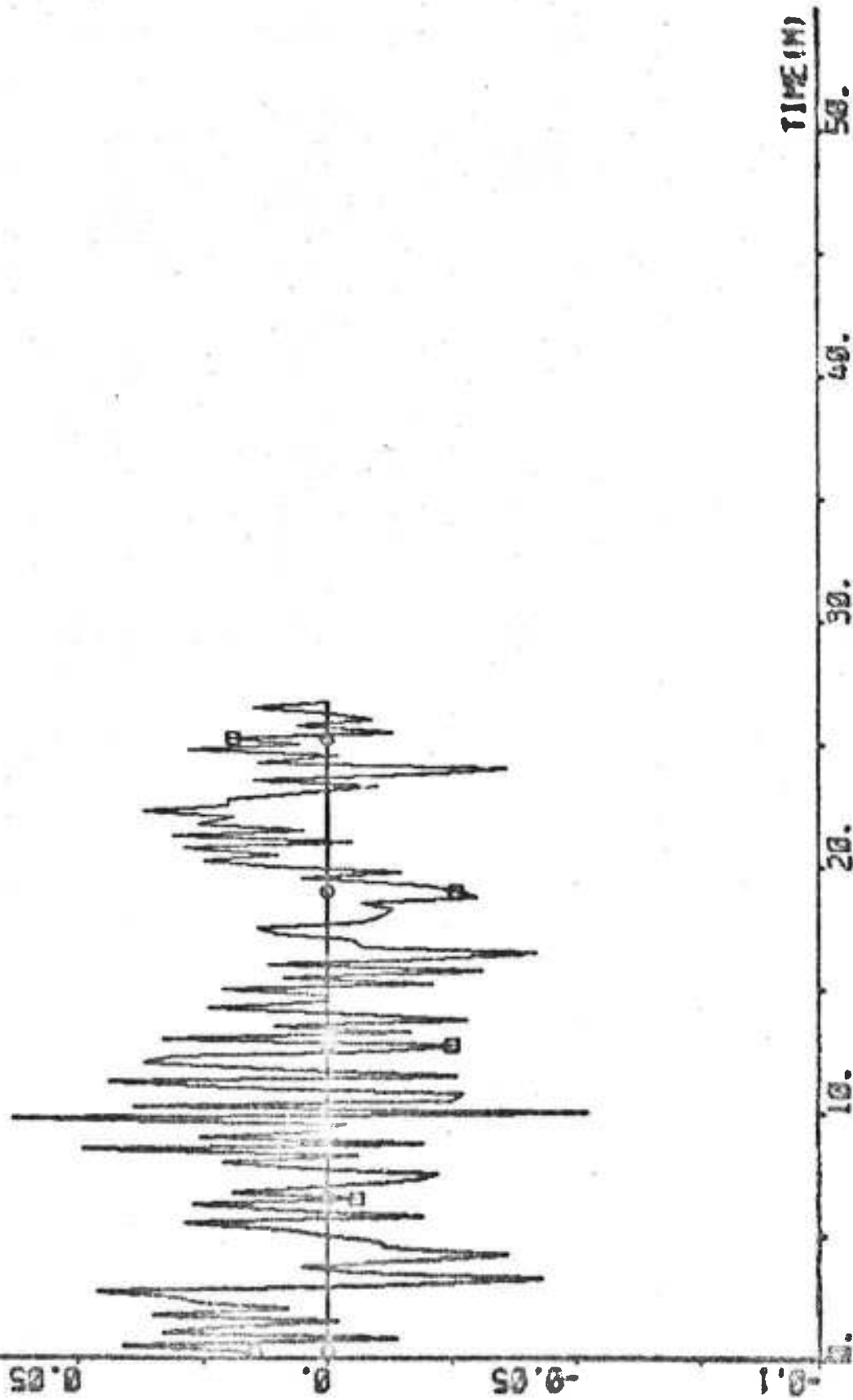
40.

30.

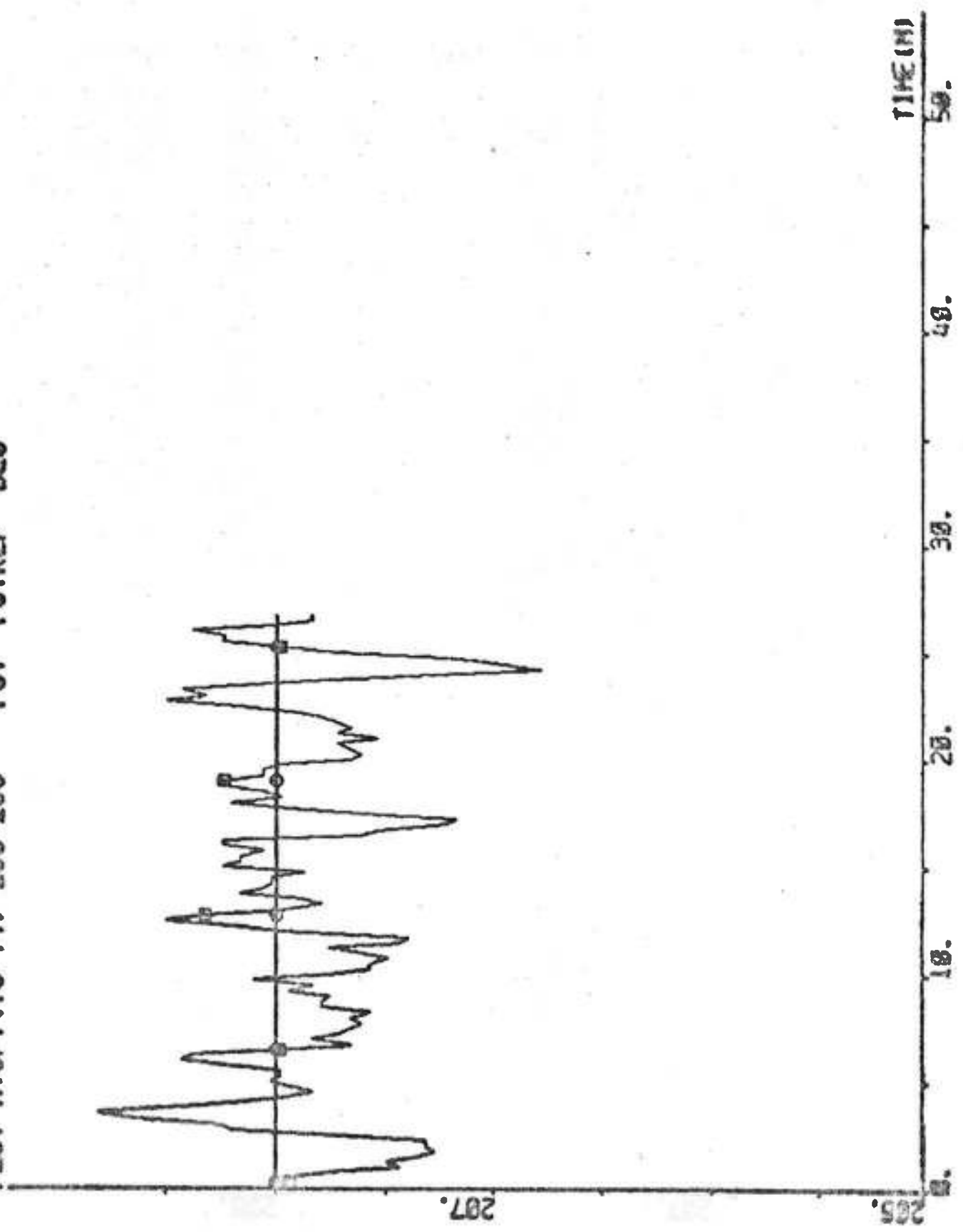
20.

10.

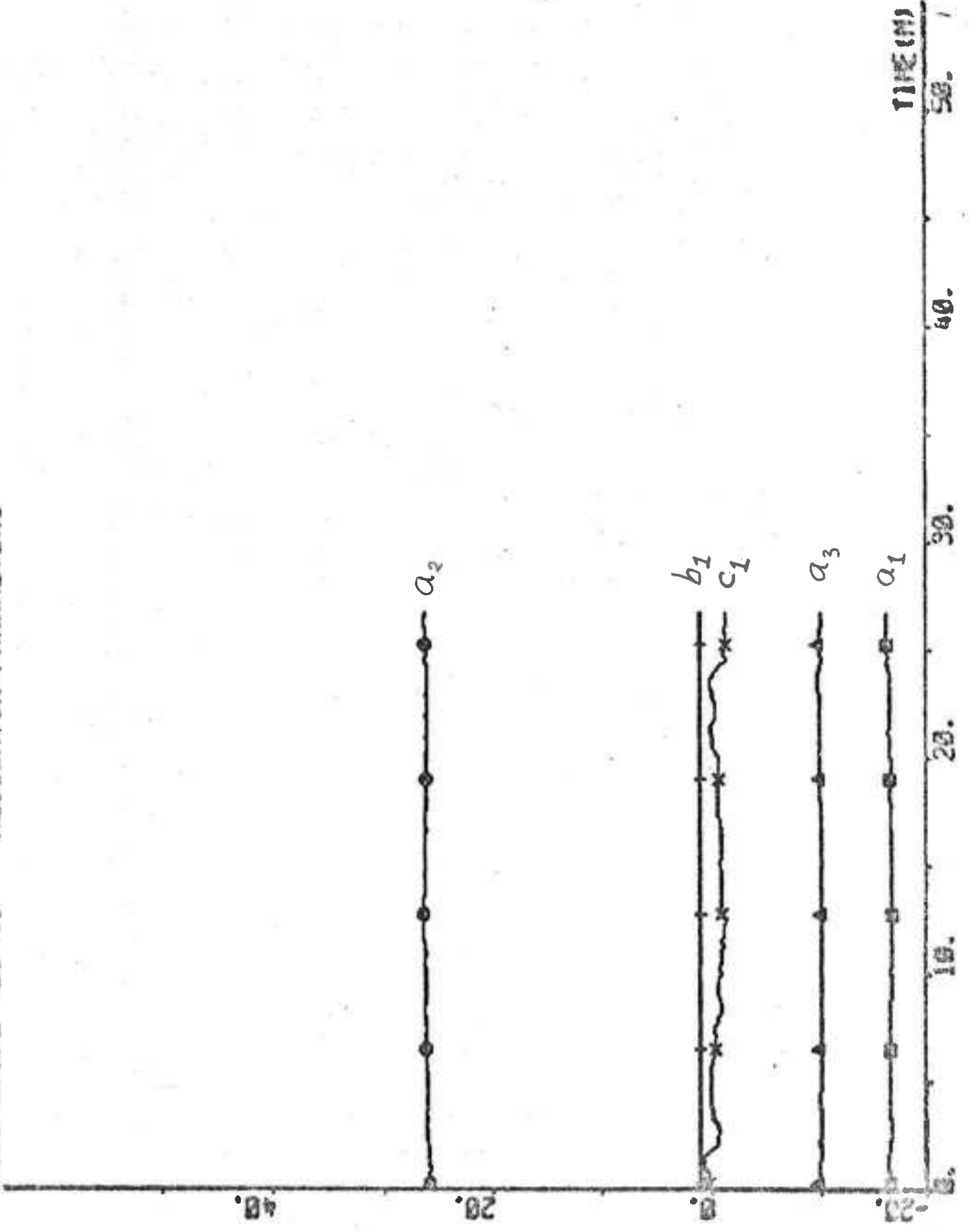
PLOT A16P1(16) ZERO -0.1 0.1 "R DEC/S



FLOT A16P1 (13 14) 286 208 °PSI PSIREF DEG



PLOT A10P2 -20 40 REGULATOR PARAMETERS





## EXPERIMENT A19

Date	1974-10-14
Time	23.00
Duration	30 min
Position	N 08° 04', E 53° 06'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	2 Beaufort (2-3.5 m/s, light breeze)
Wave height	2 - 3 m (rollings)
PSIREF	207.6° (Sailmaster)
Rudder limit	Not active

Regulator structure

NA = 3	NB = 1	NC = 1	K = 5
IREG = 15	IRDIF = 0	RL = 0.98	IRR = 2    BR = 0.2

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -17.159 \\ 28.051 \\ -10.999 \\ 1.036 \\ -0.560 \end{bmatrix} \quad P = \begin{bmatrix} 4.178 & & & & \\ -5.070 & 7.545 & & & \\ 1.146 & -2.741 & 1.855 & & \\ -0.020 & 0.024 & -0.004 & 0.001 & \\ 31.256 & -34.852 & 5.513 & -0.086 & 413.370 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.107$$

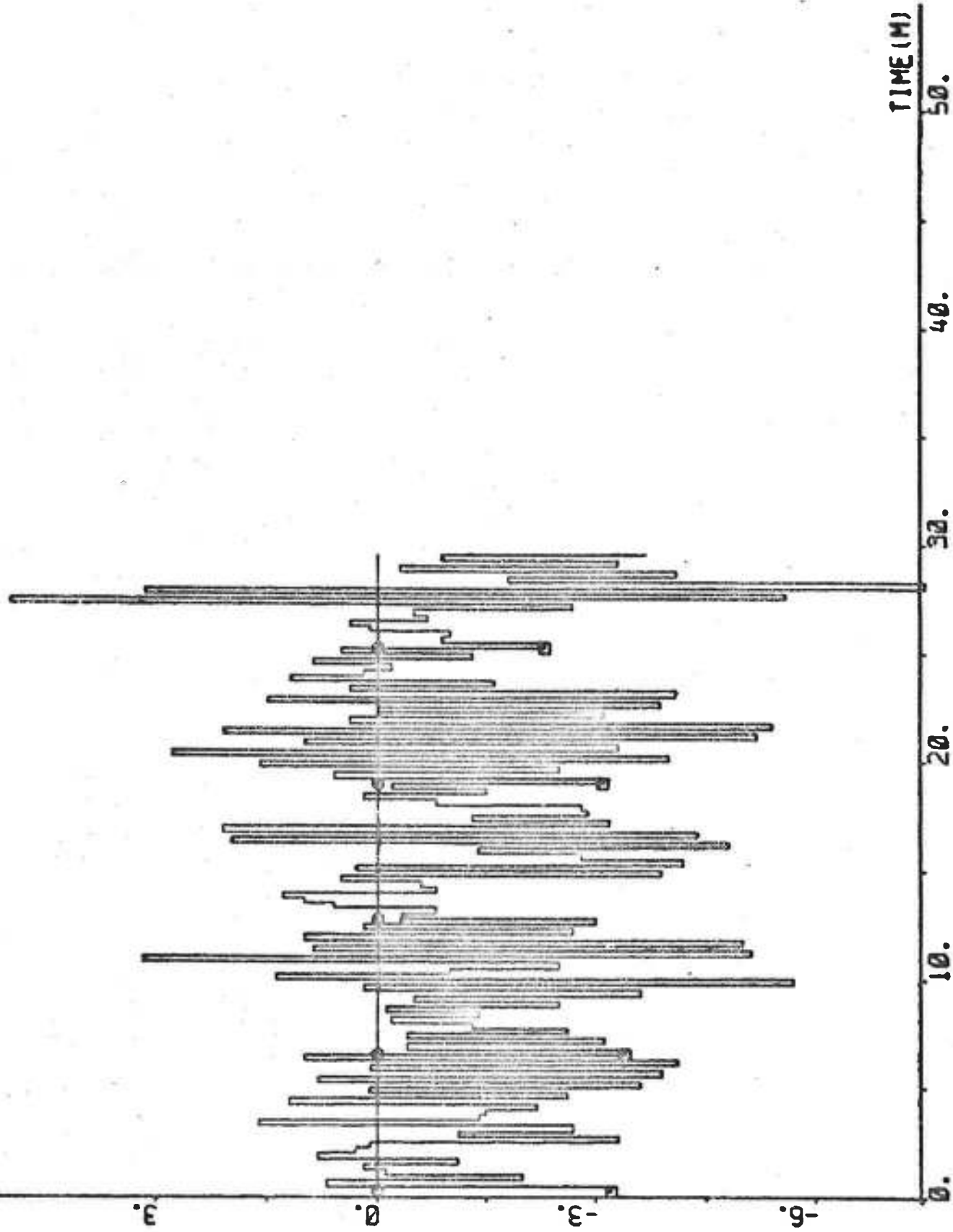
Statistics (mean value and standard deviation)

DELTA	-0.23 ± 1.86 deg
PSI-PSIREF	0.054 ± 0.247 deg
AN	85.78 ± 0.25 rpm
U	16.17 ± 0.06 knots

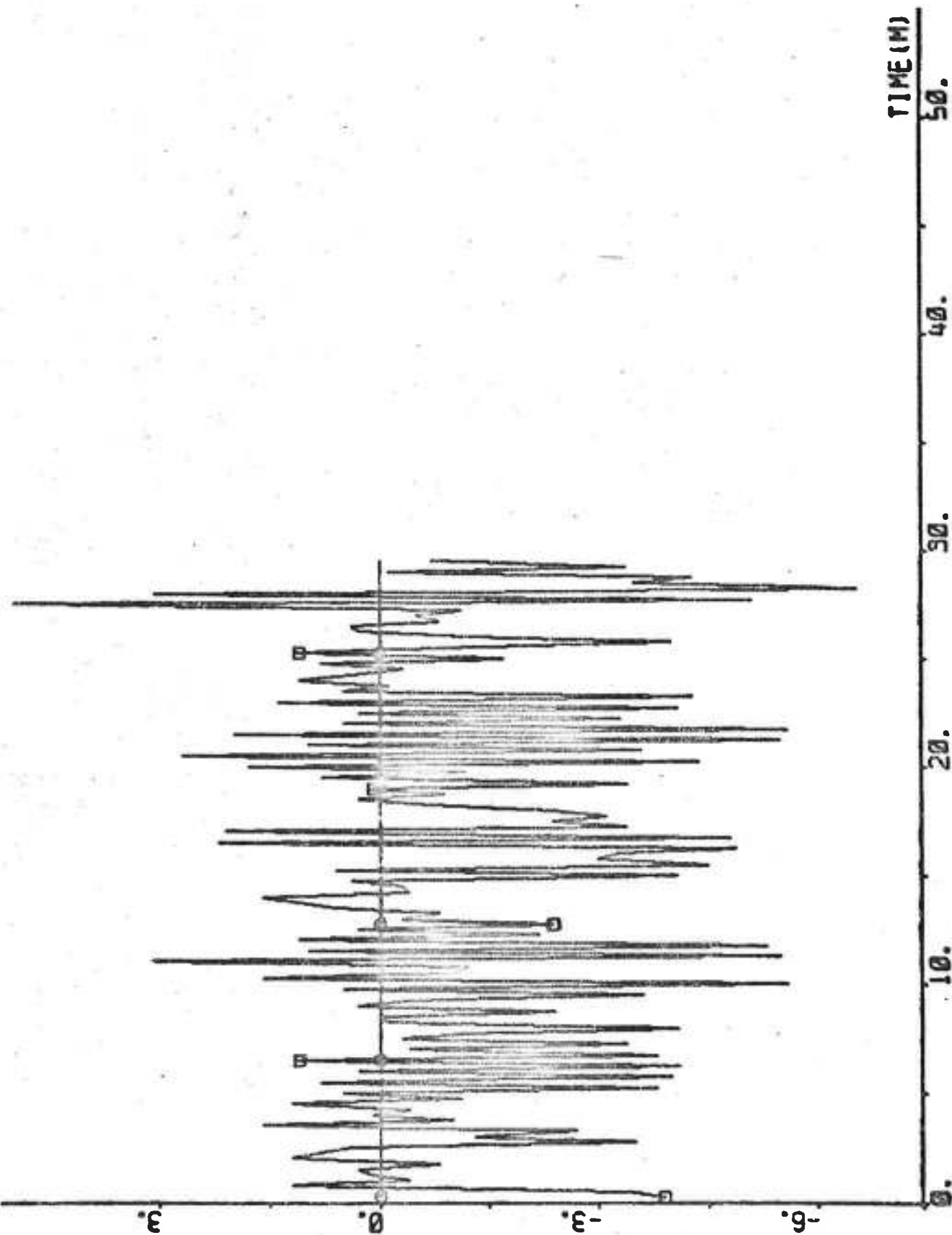
$$V_1 = 0.415$$

$$V_2 = 0.410$$

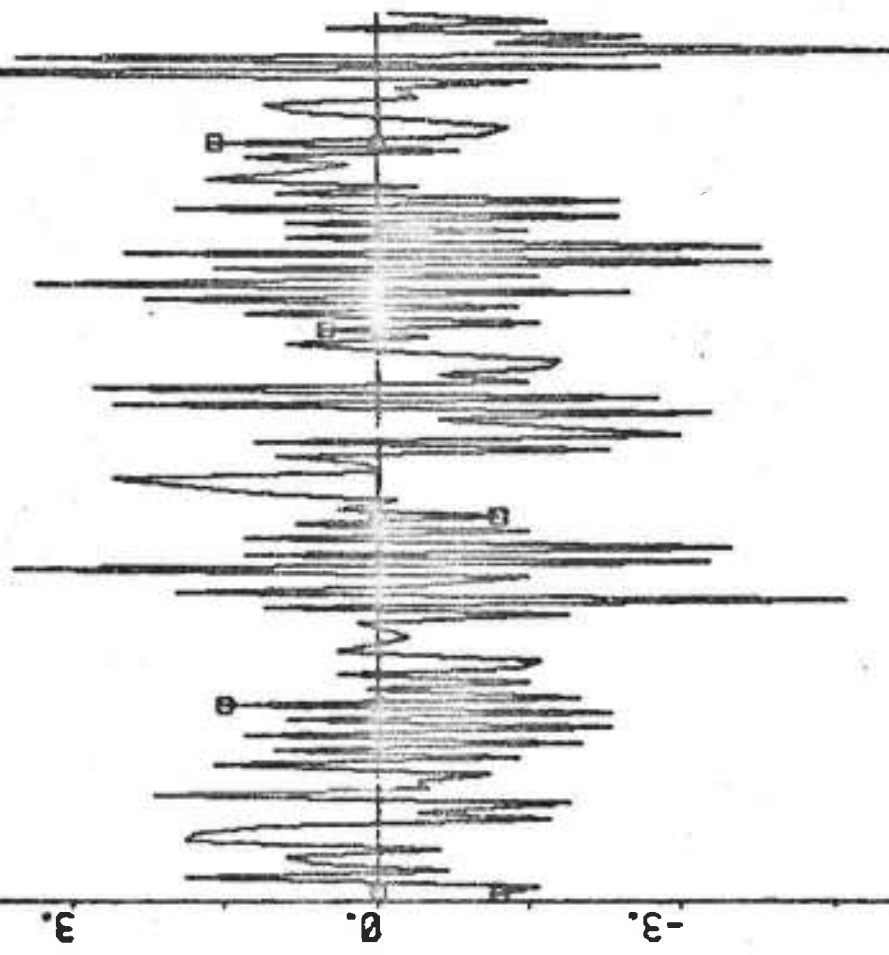
PLOT HP A19P1(1) ZERO -7 5 "DELCOC DEG



PLOT AISP1(3) ZERO -7 6 "DELTA" DEG



PLOT R1SP1(4) ZERO -7 5 °DELTA DEG



TIME (M)  
50.

40.

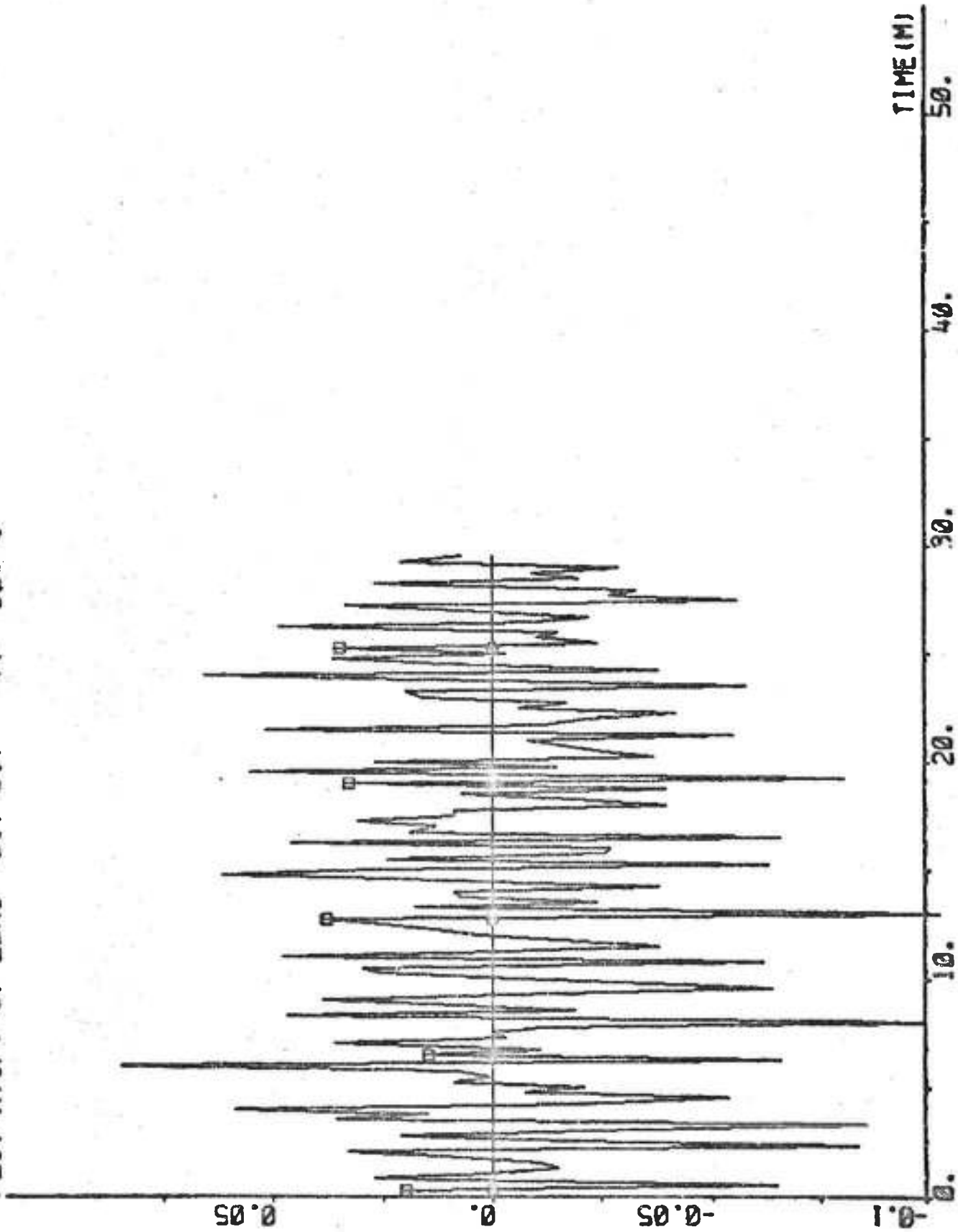
30.

20.

10.

0.

PLOT A19P1(S) ZERO -0.1 0.1 "PP DEG/S



PLOT A1SP1(7) 15 17 -U KNOTS

16.5

16.

15.5

15.



0.

10.

20.

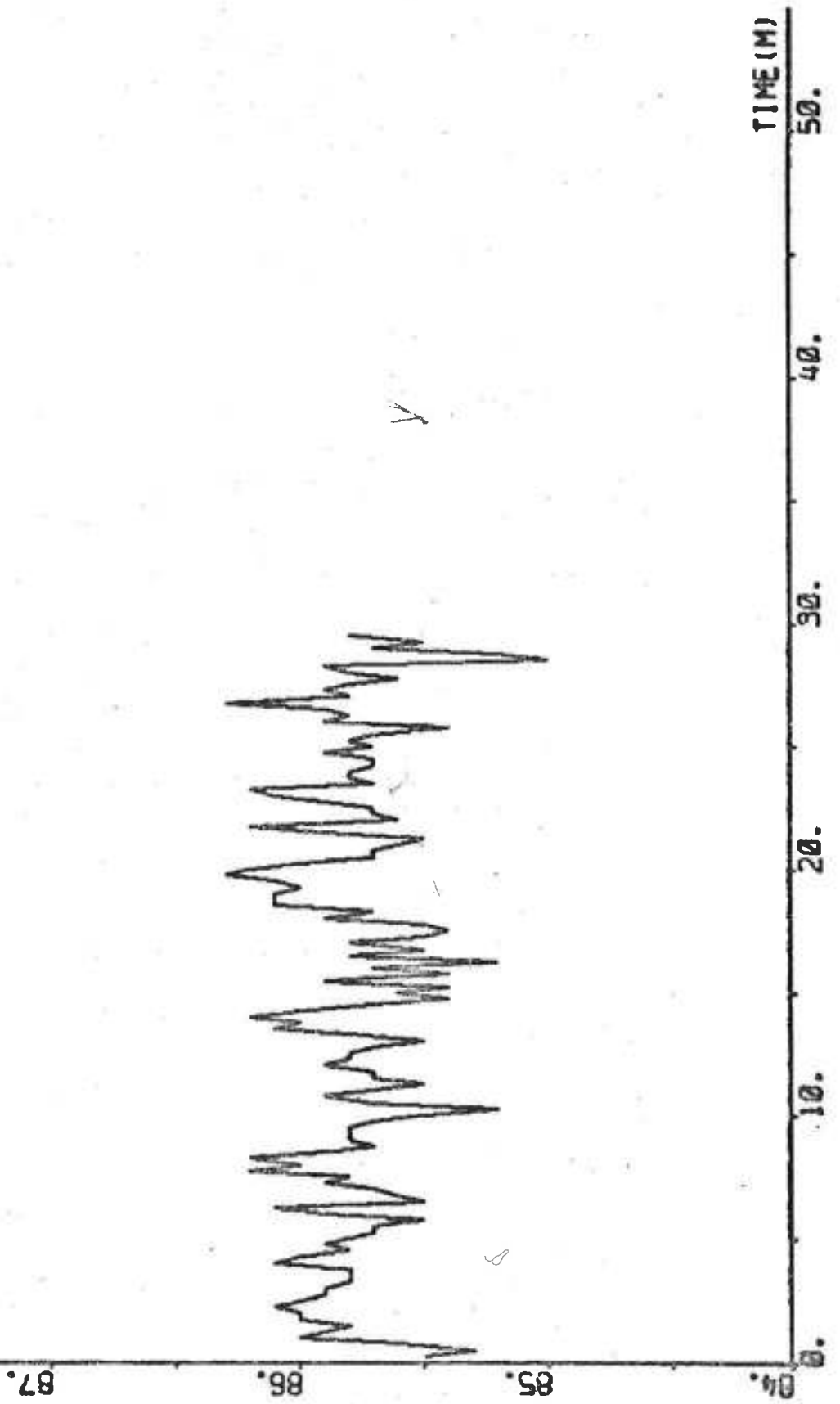
30.

40.

50.

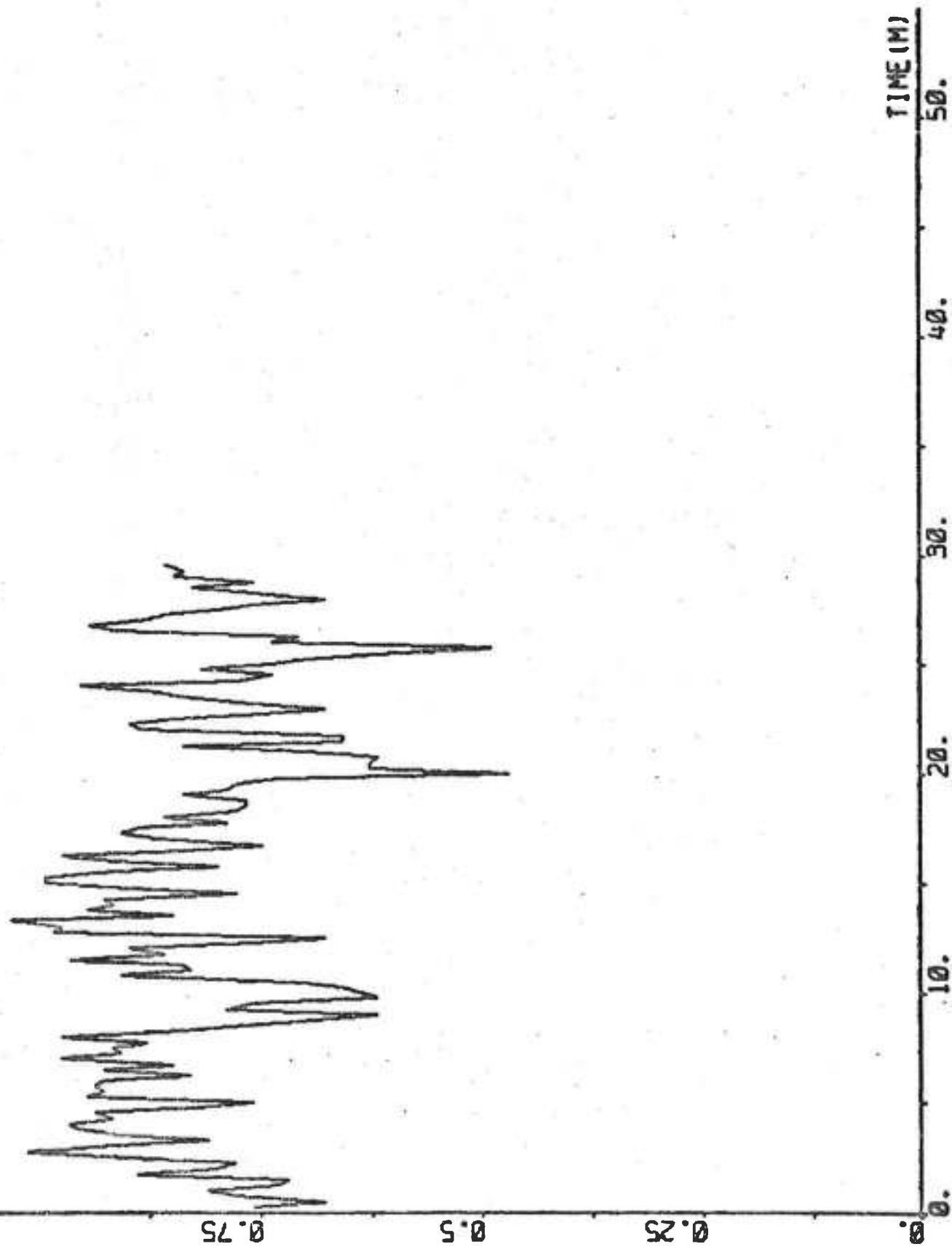
TIME (M)

PLOT R1SP1(S) S4 E3 "AN RPM

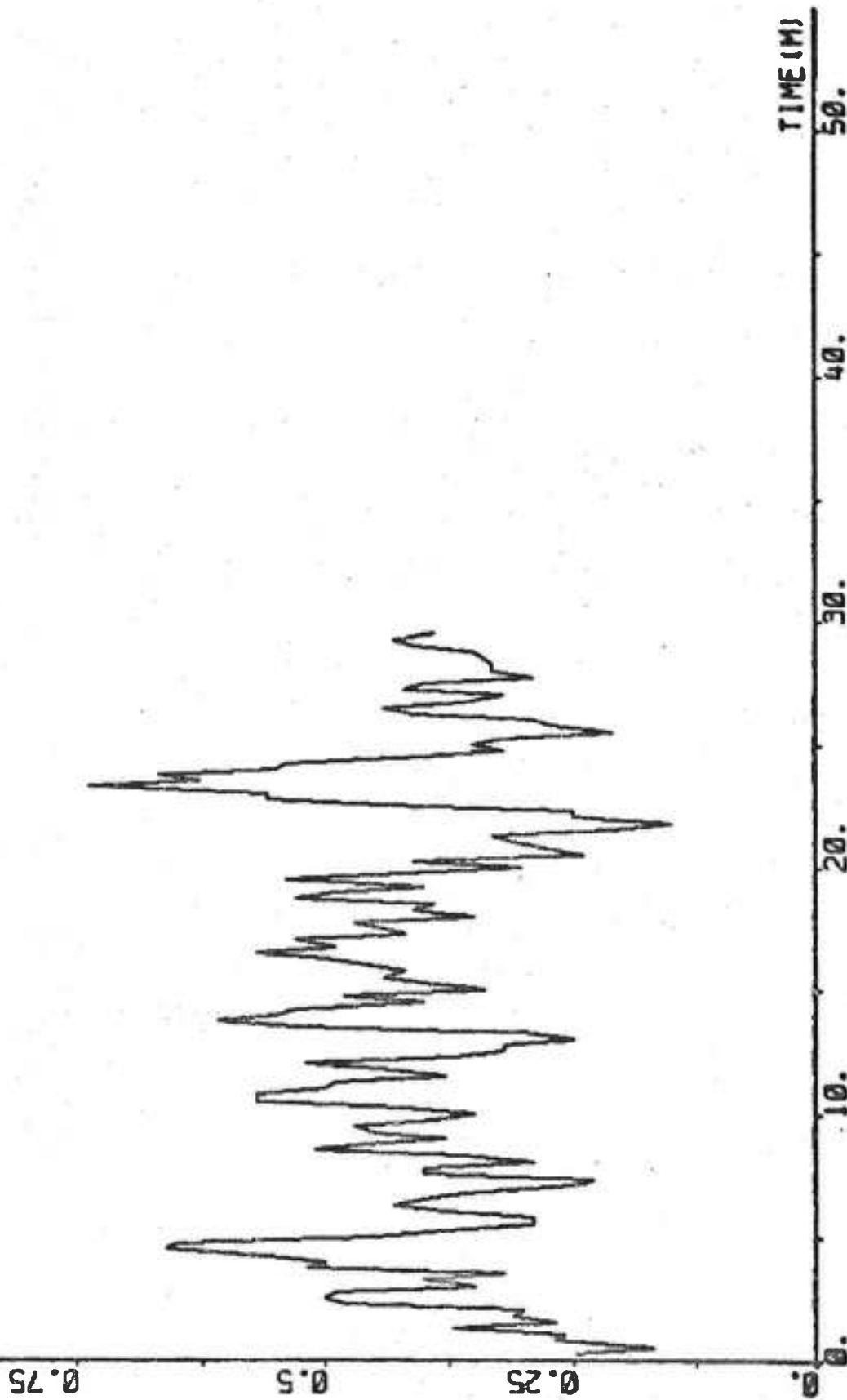




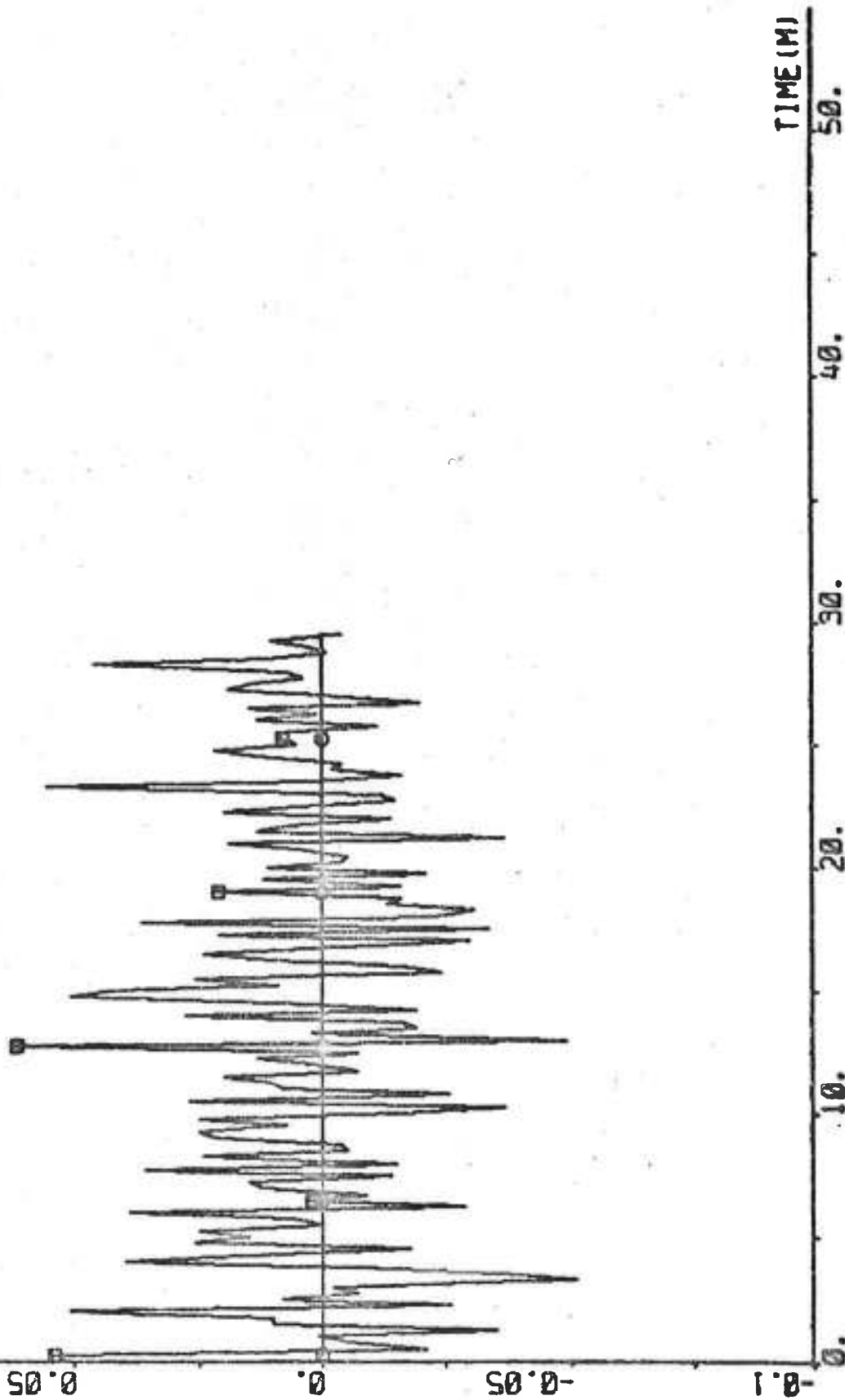
PLOT #19P1 (e) 1 "V1 KNOTS



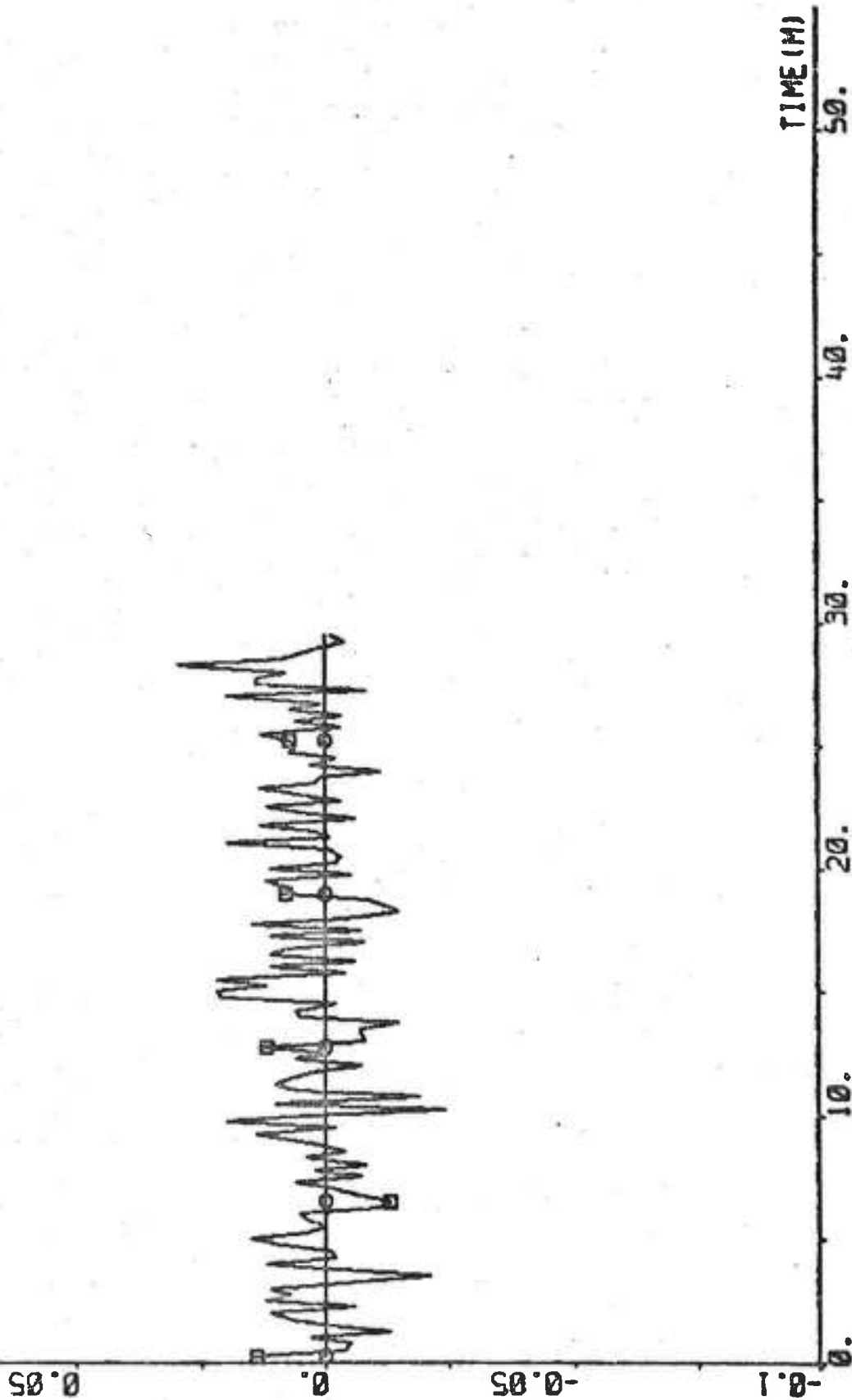
PLOT A1SP1(S) @ 1 -V2 KNOTS



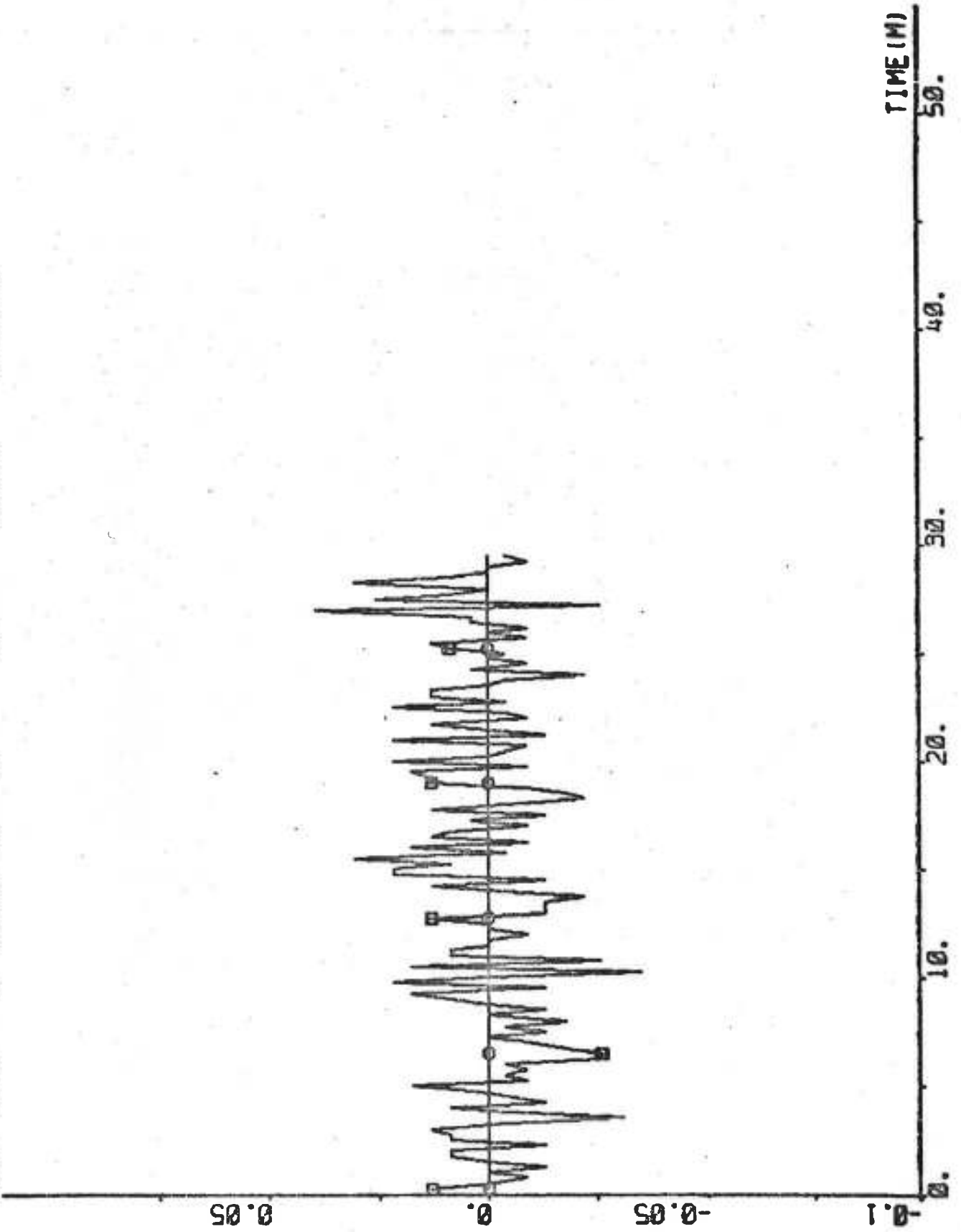
PLOT A18P1(16) ZERO -0.1 0.1 °R DEG/S



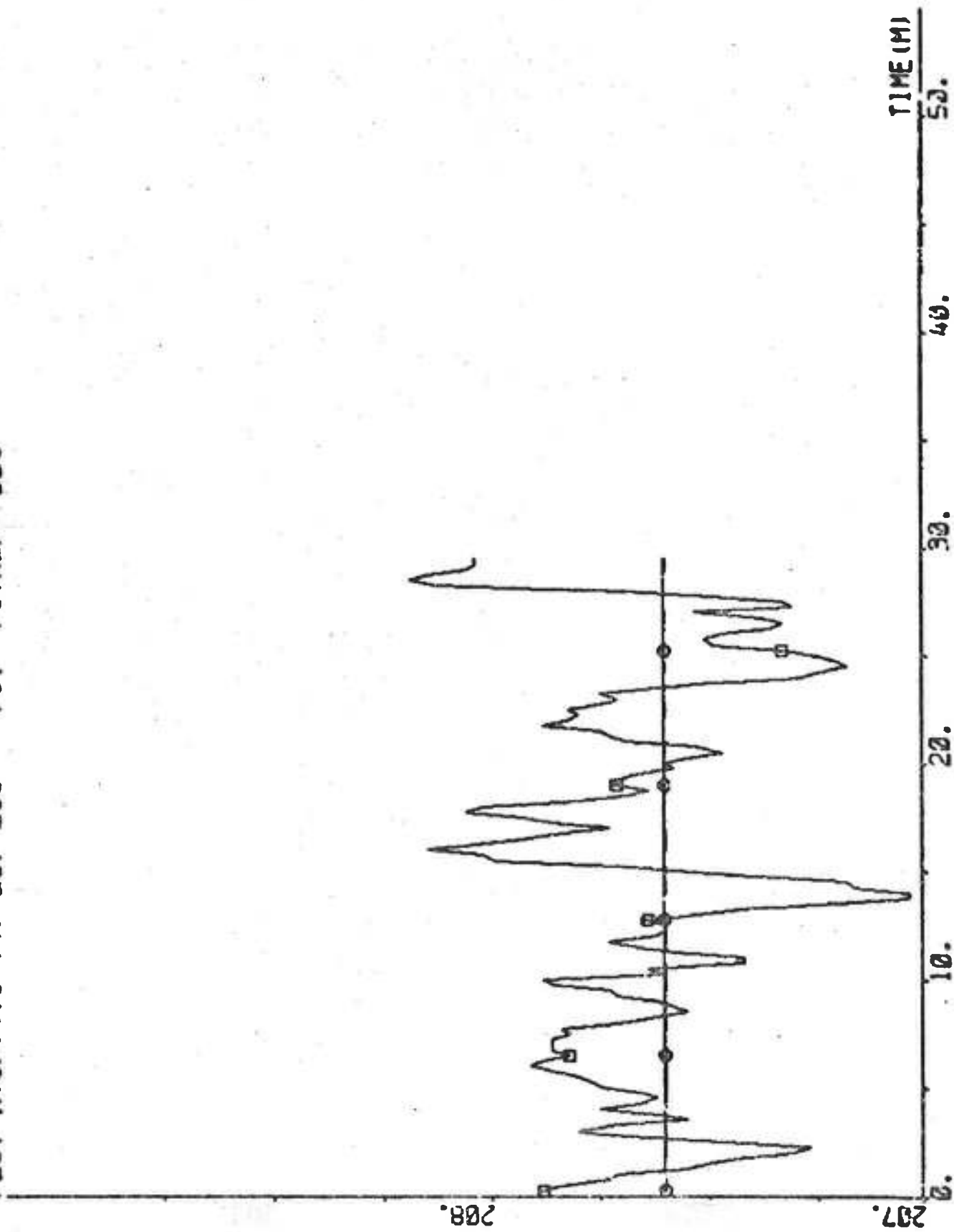
PLOT R18P1(11) ZERO -0.1 0.1 "AVR DEG/S (BR-0.2)



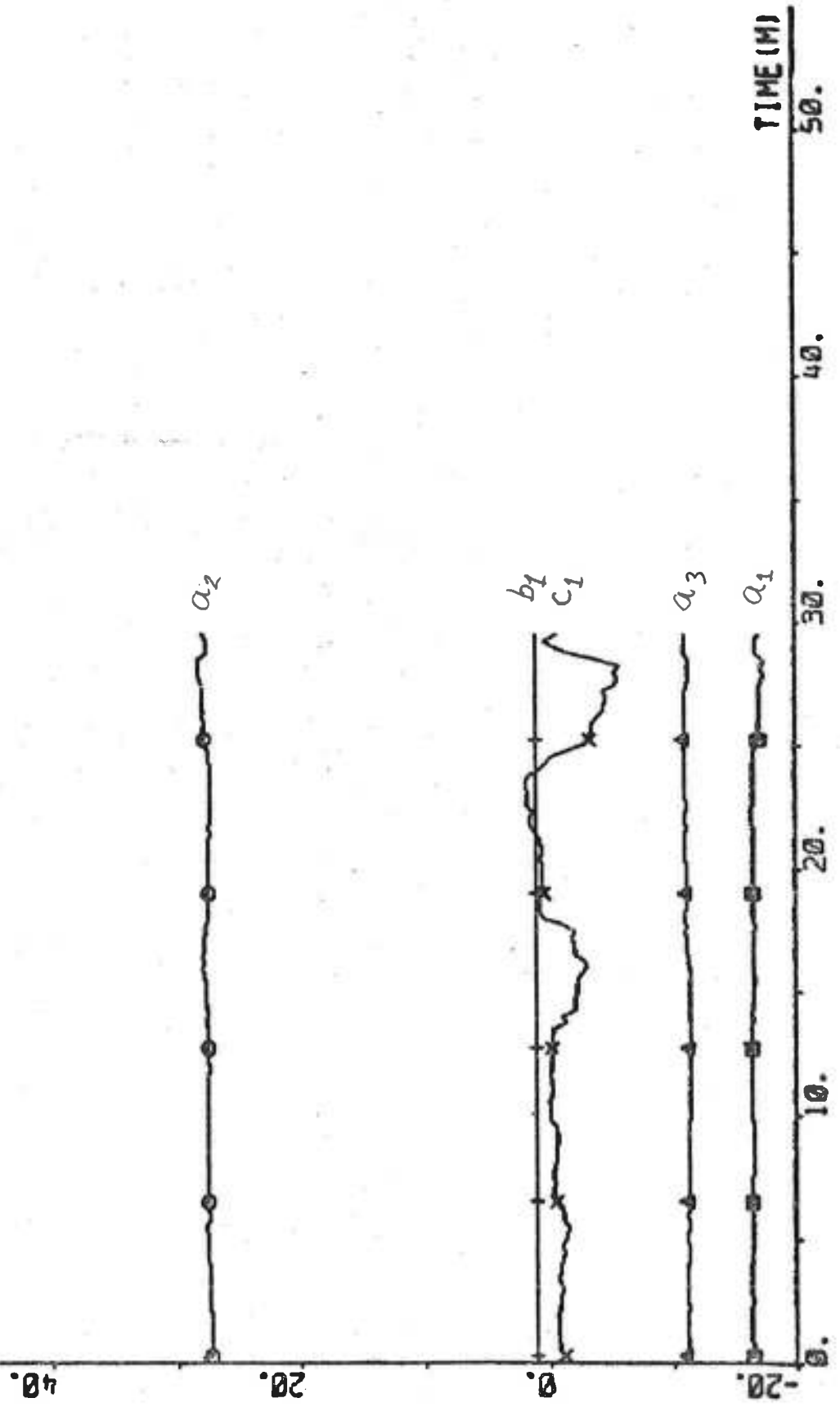
PLOT A19P1(12) ZERO -0.1 0.1 -DPSIDT DEG/S (IDPSI=5)



PLOT A1SP1(13 14) 207 208 °PSI PSIREF DEG



PLOT A19P2 - 20 40 REGULATOR PARAMETERS



## EXPERIMENT A20

Date 1974-10-15  
 Time 01.13  
 Duration 32 min  
 Position N 07° 30' E 53° 00'  
 Water depth deep  
 Forward draught 20.2 m  
 Aft draught 20.2 m  
 Wind direction SW (1; see Appendix A)  
 Wind velocity 2 Beaufort (2-3.5 m/s, light breeze)  
 Wave height 2 - 3 m  
 PSIREF 208.1°, 208.2° (Sailmaster)  
 Rudder limit Not active (0-15 min)  
 ±10° (15-32 min)

Regulator structure

0 - 15 min: Kockums' PID-regulator

$$k_P = 1.0 \quad k_D = 123 \text{ s} \quad k_I = 1/123 \text{ s}^{-1} \quad T_s = 15 \text{ s}$$

15 - 32 min: AUTP1

$$\begin{array}{llll}
 \text{NA} = 3 & \text{NB} = 1 & \text{NC} = 1 & \text{K} = 5 \\
 \text{IREG} = 15 & \text{IRDIF} = 0 & \text{RL} = 0.98 & \text{IRR} = 1
 \end{array}$$

Final values (AUTP1)

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -14.171 \\ 20.518 \\ -7.202 \\ 0.837 \\ -11.302 \end{bmatrix}$$

P unknown

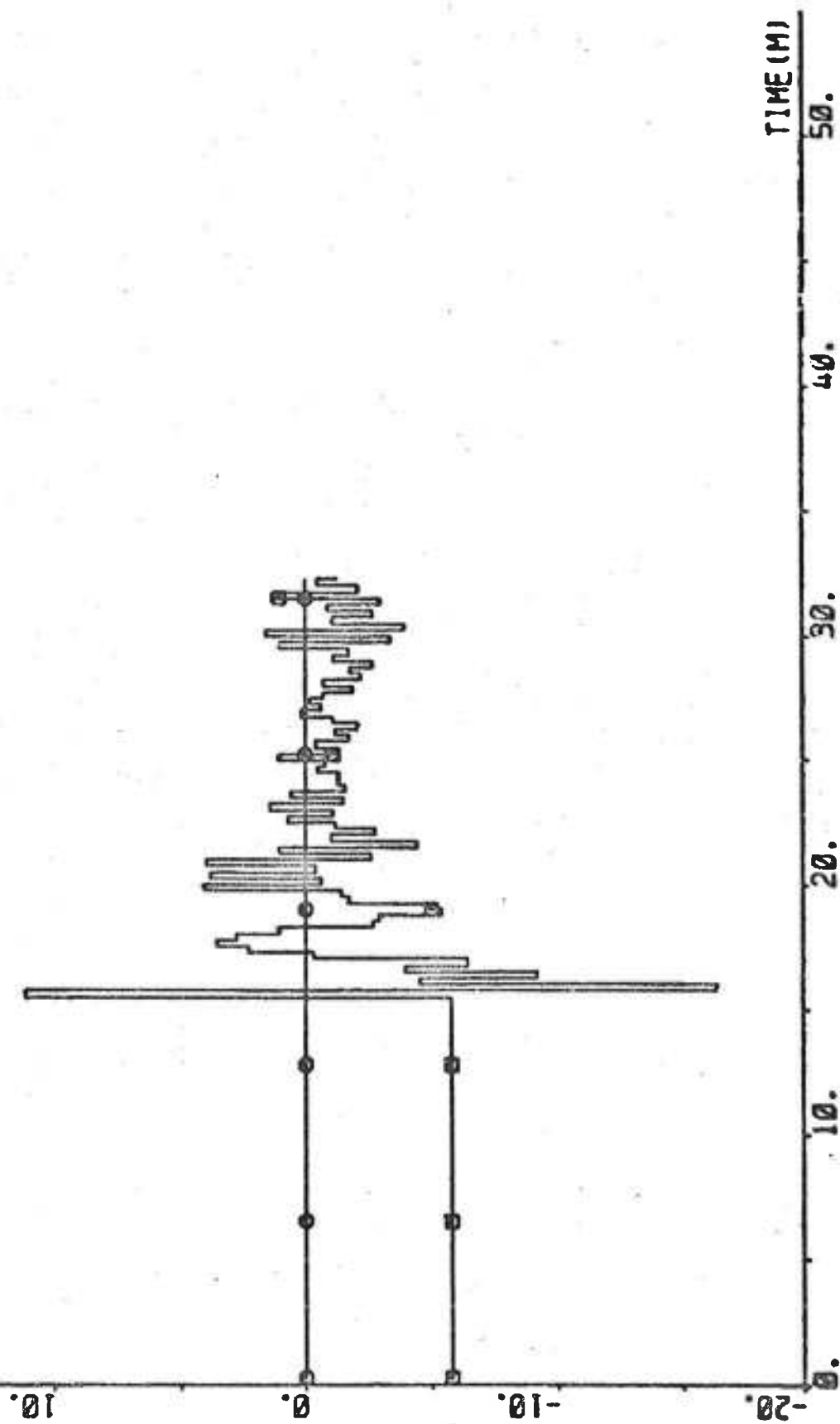
$$a_1 + a_2 + a_3 = -0.855$$



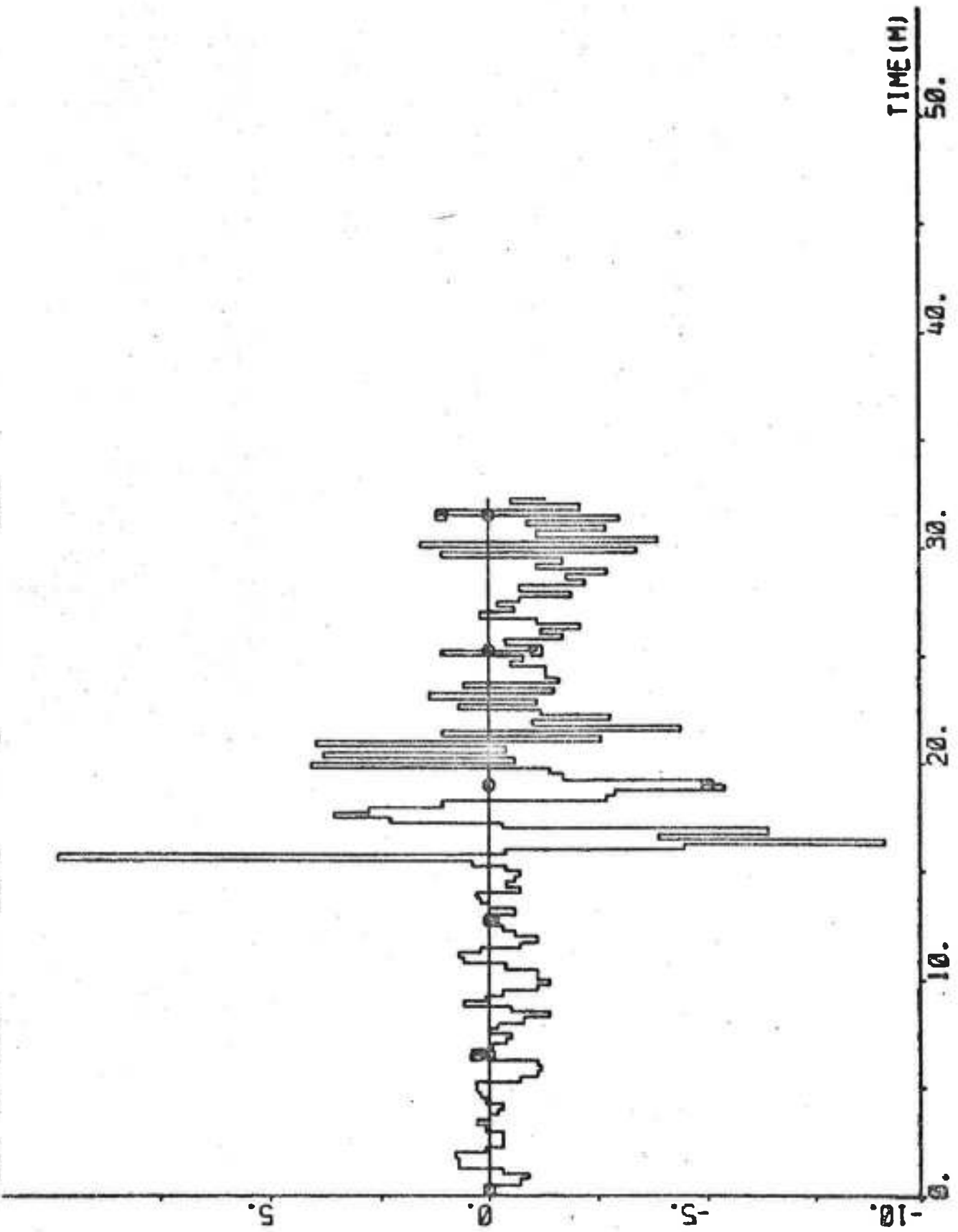
Statistics (mean value and standard deviation)

	<u>0-15 min (PID)</u>	<u>15-32 min (AUTP1)</u>
DELTA	0.32 ± 0.63 deg	-0.01 ± 2.61 deg
PSI-PSIREF	0.033 ± 0.140 deg	0.509 ± 0.771 deg
AN	85.87 ± 0.20 rpm	85.87 ± 0.46 rpm
U	16.46 ± 0.20 knots	16.40 ± 0.11 knots
V <sub>1</sub>	0.071	1.535
V <sub>2</sub>	0.060	1.535

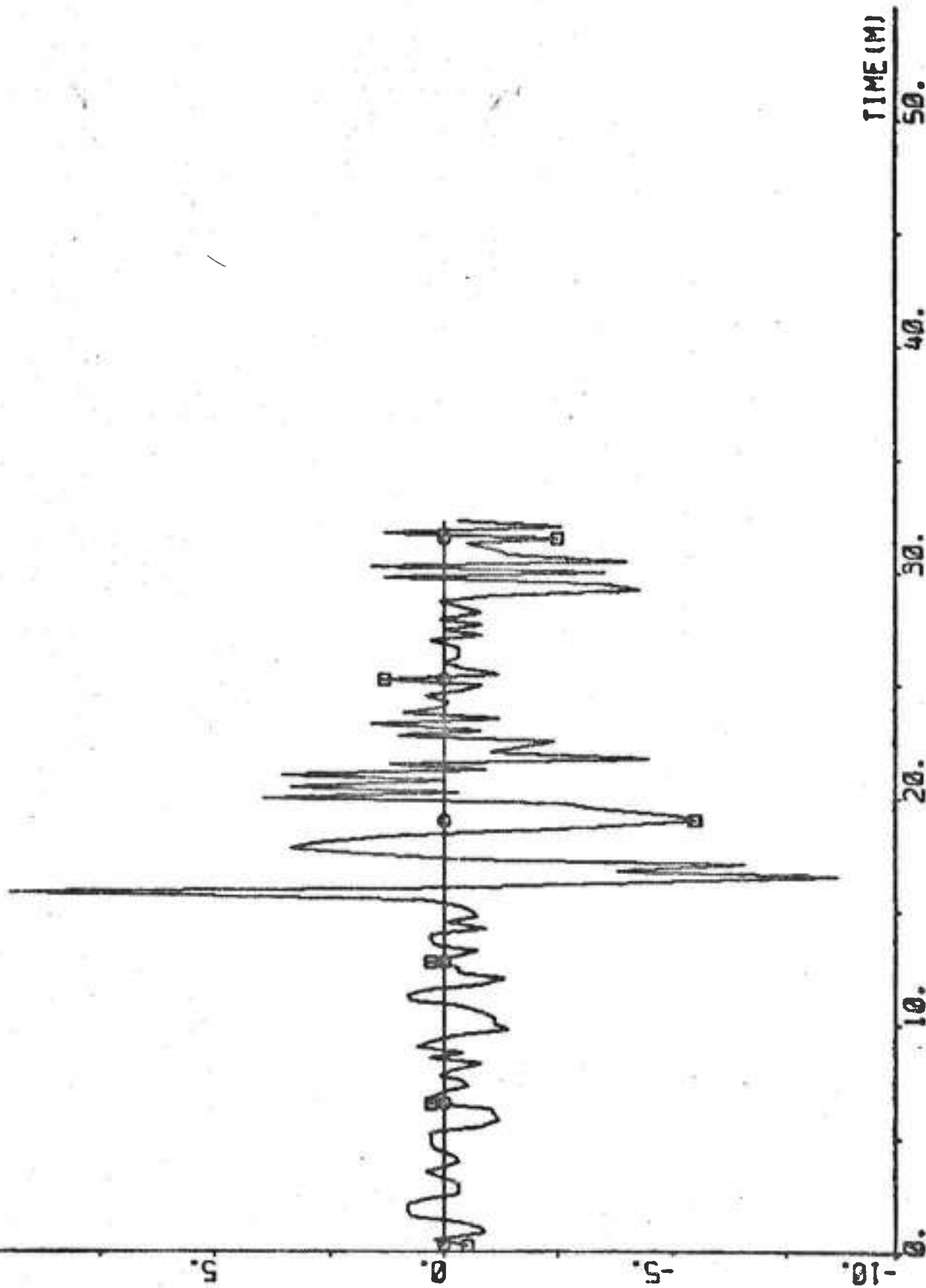
PLOT MP A20P1(1) ZERO -20 20 "DELCOC DEG



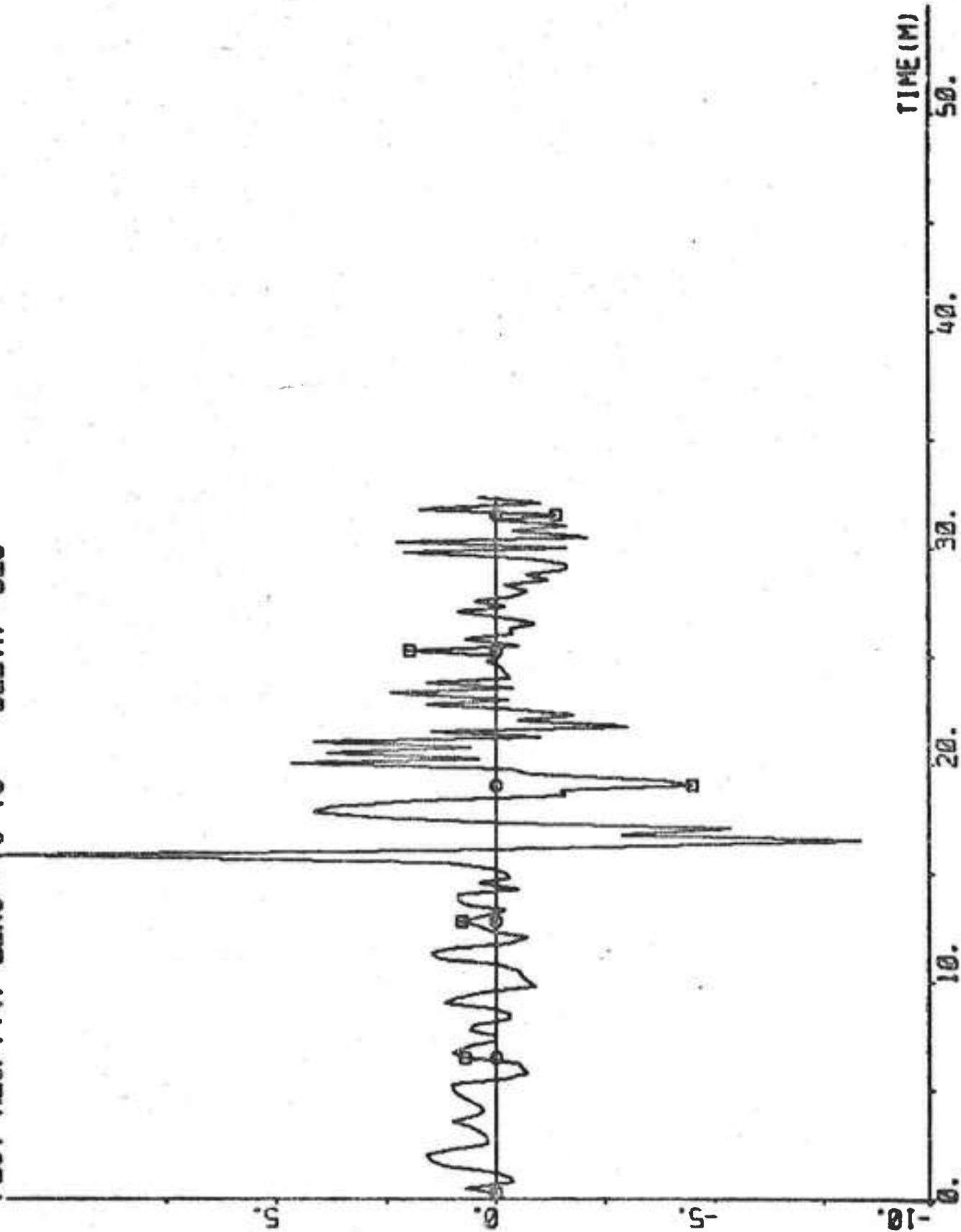
PLOT HP A20P1(2) ZERO -10 10 "DELCON DEG



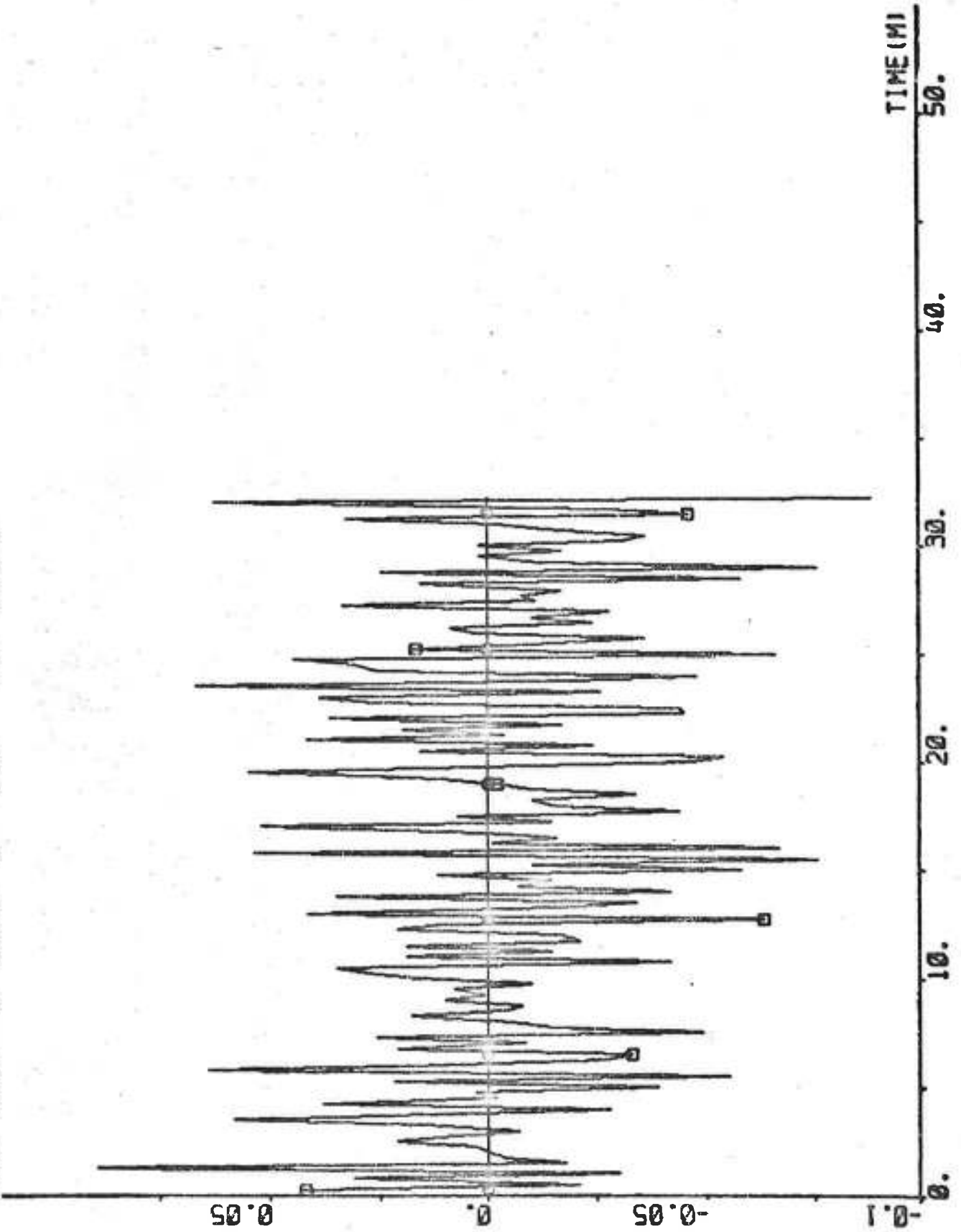
PLOT A20P1(3) ZERO -10 10 "DELTA" DEG



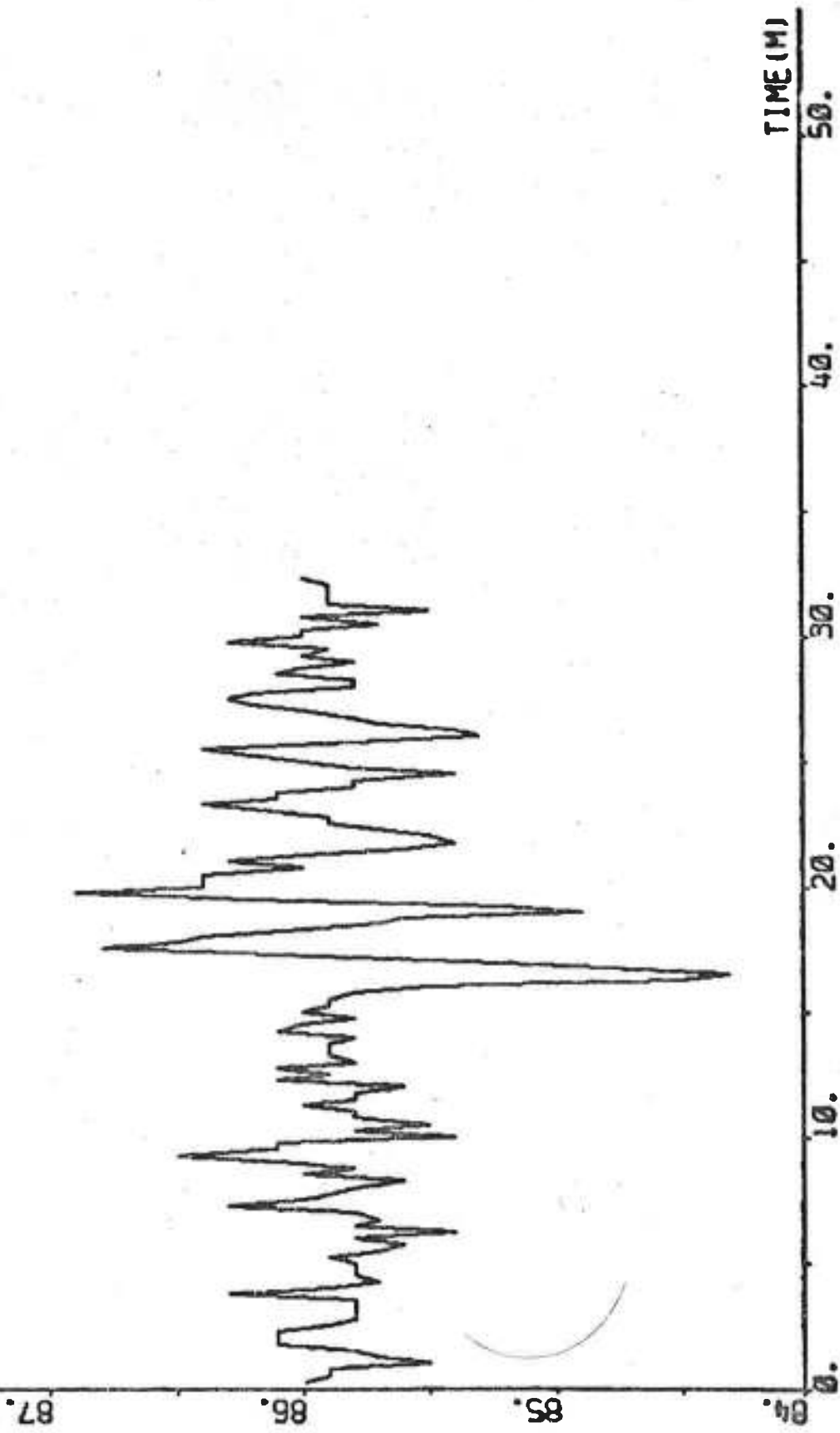
PLOT RZSP1(4) ZERO -10 10 "DELTA DEG



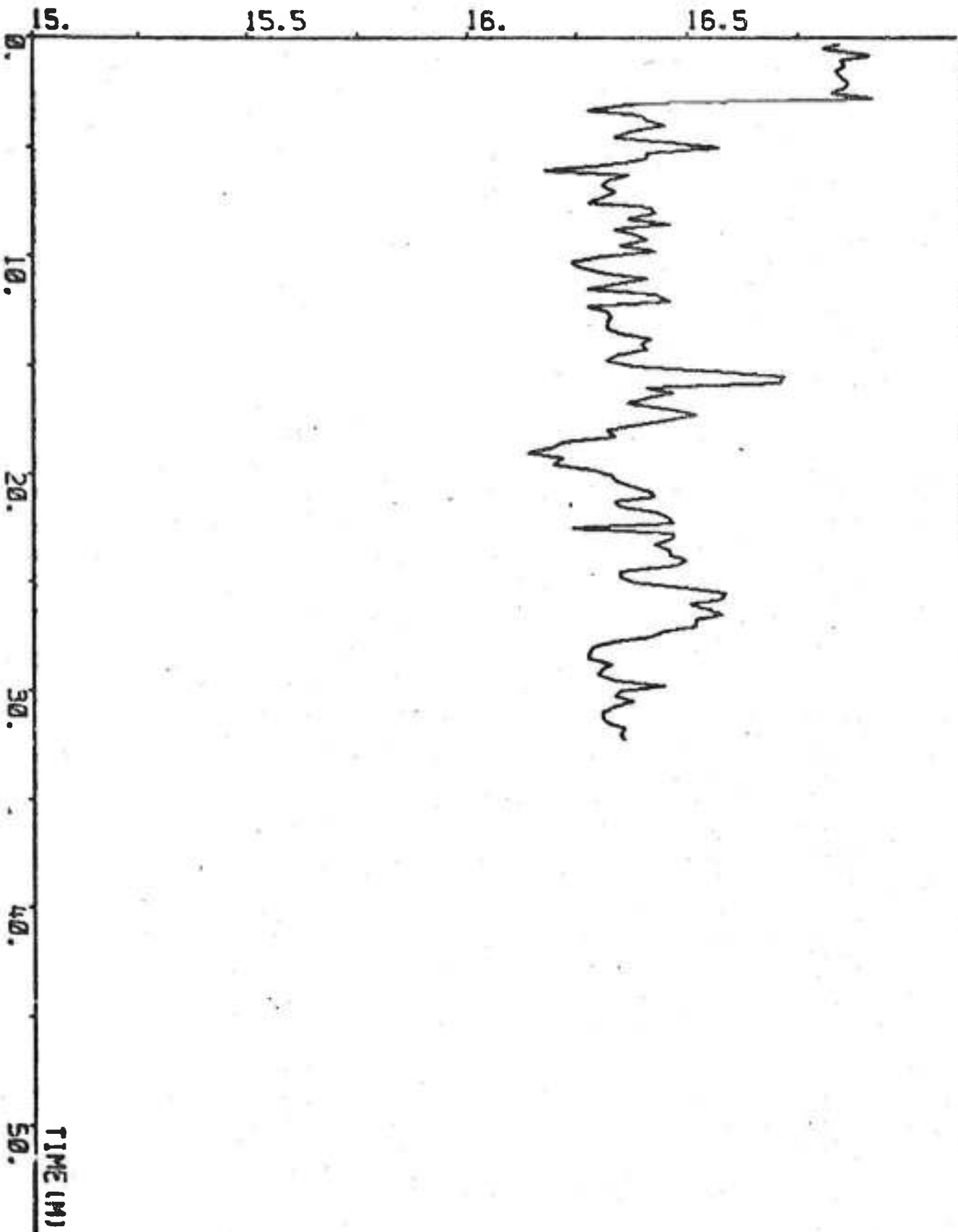
PLOT A20P1(5) ZERO -0.1 0.1 "PP DEG/S



PLOT R20P1 (6) 04 09 "RN RPM

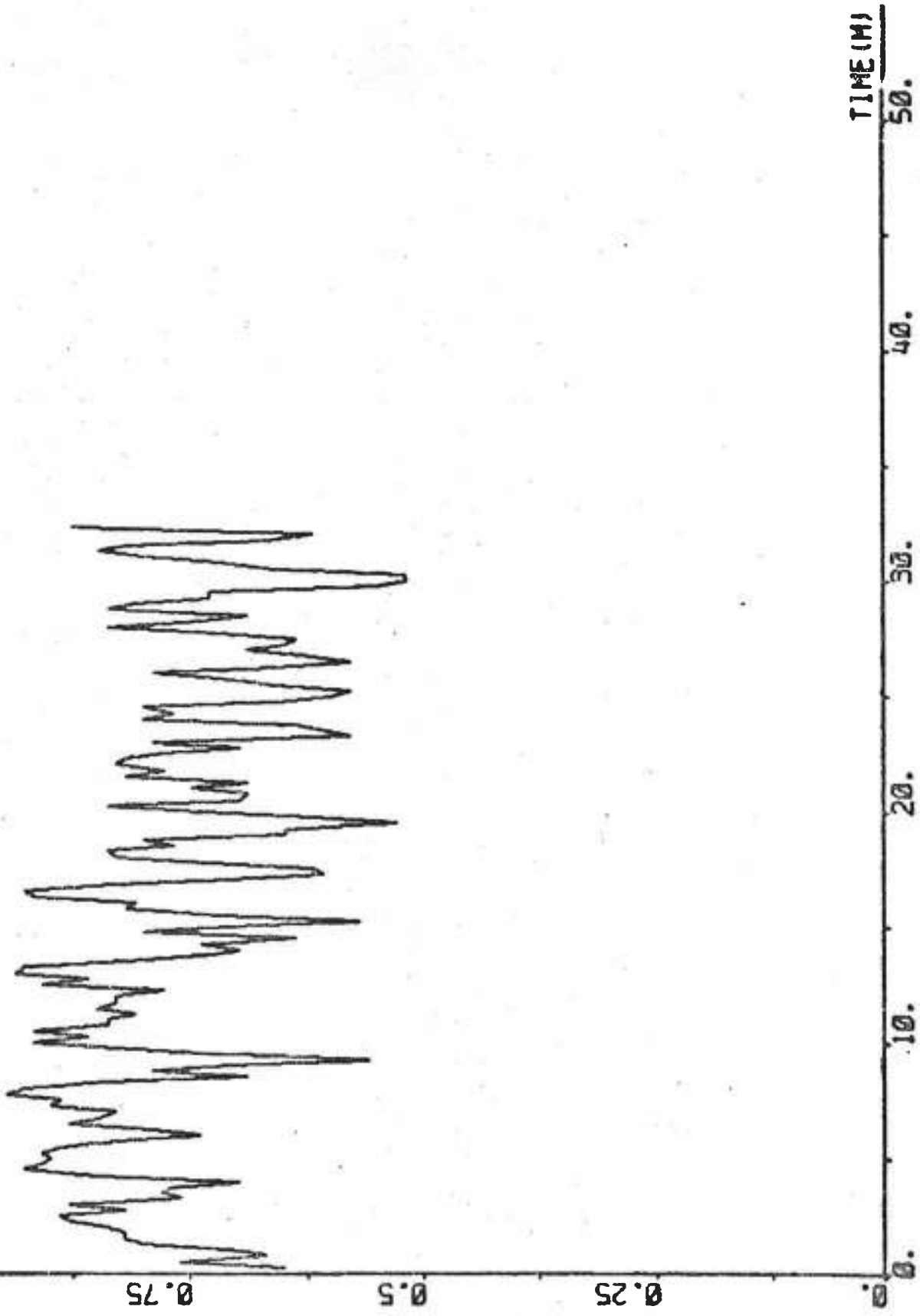


PLOT RZGP1(7) 16 17 "U KNOTS



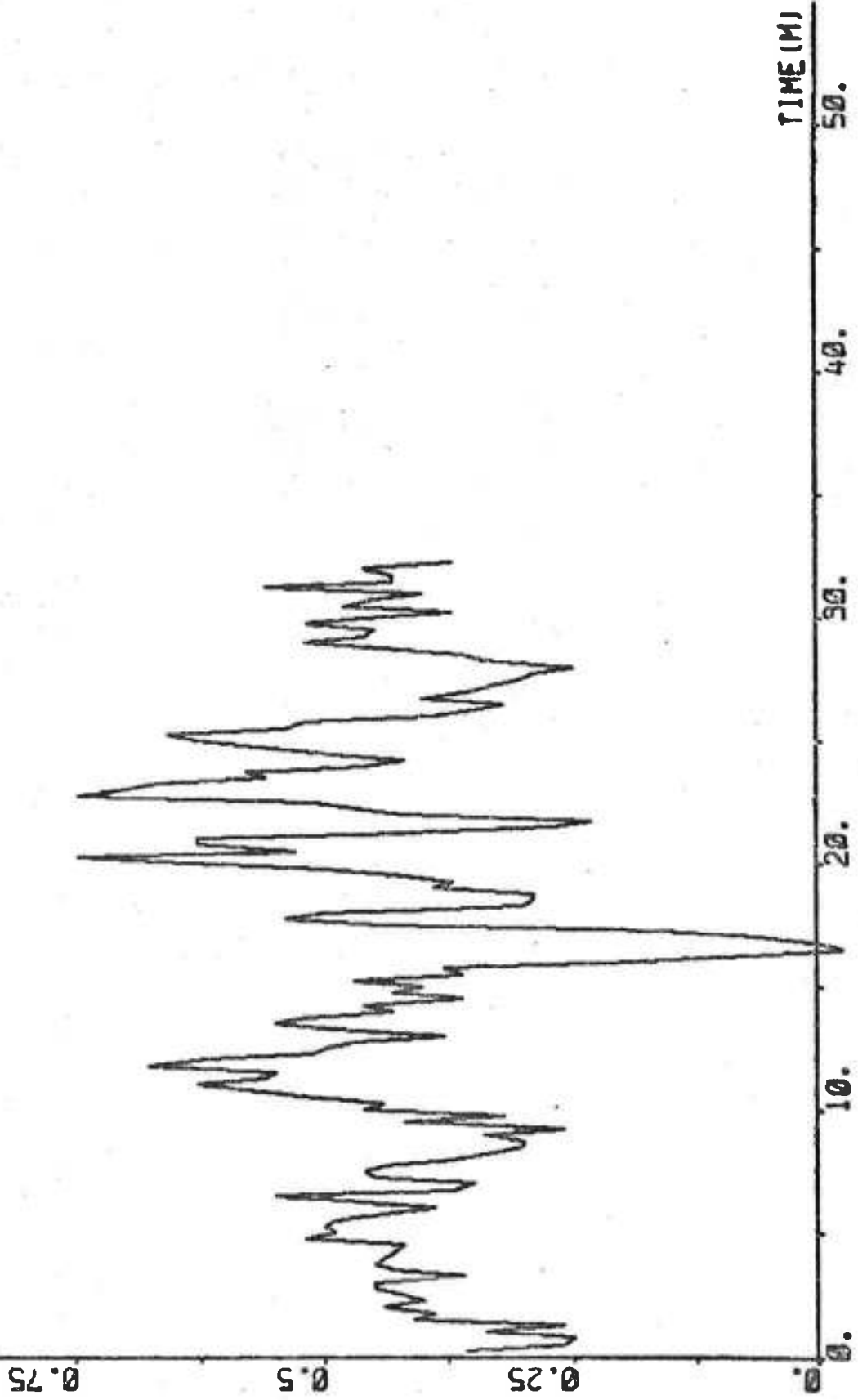


PLOT RZEP1 (8) 0 1 -V1 KNOTS

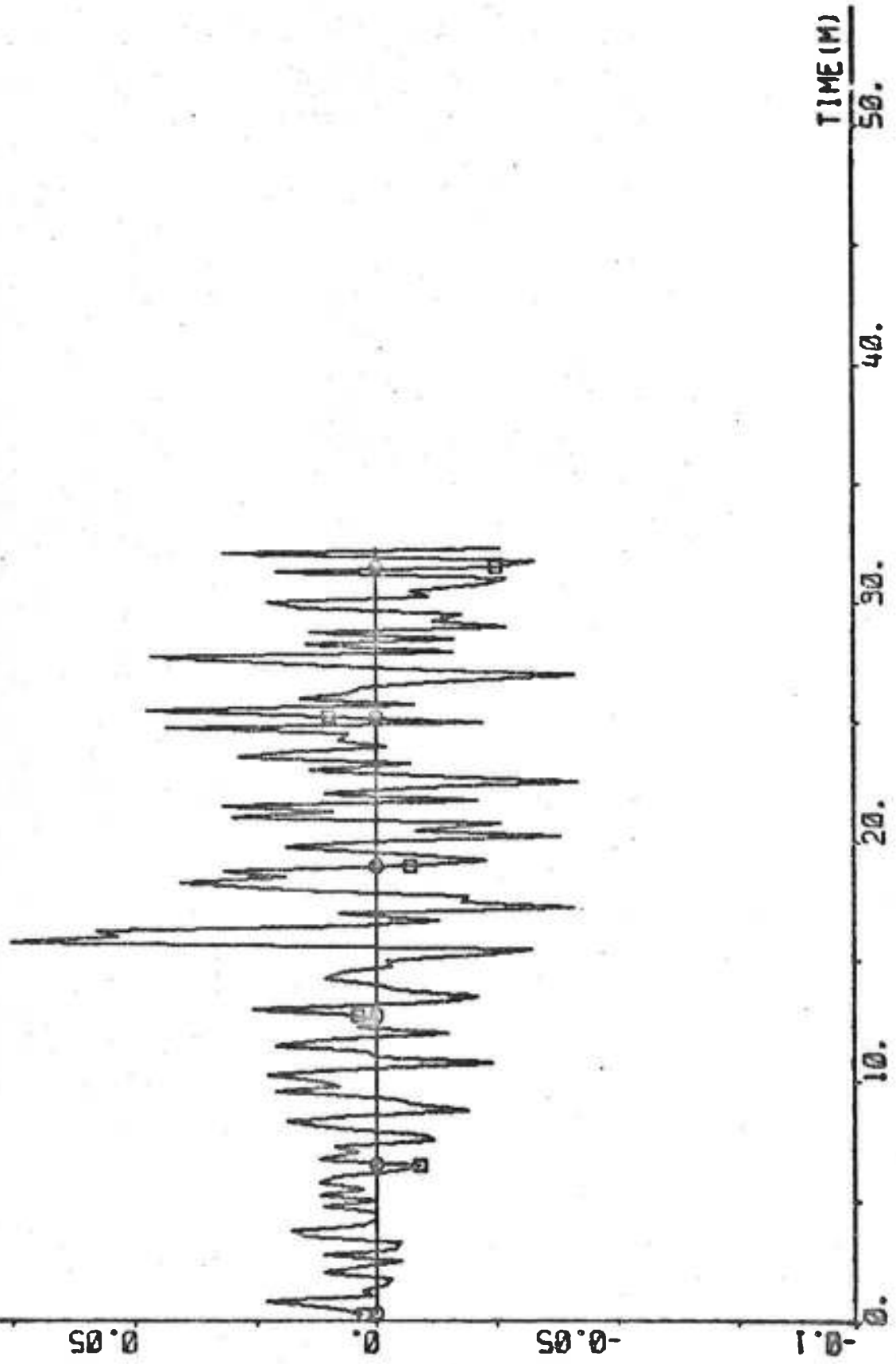


TIME (H)

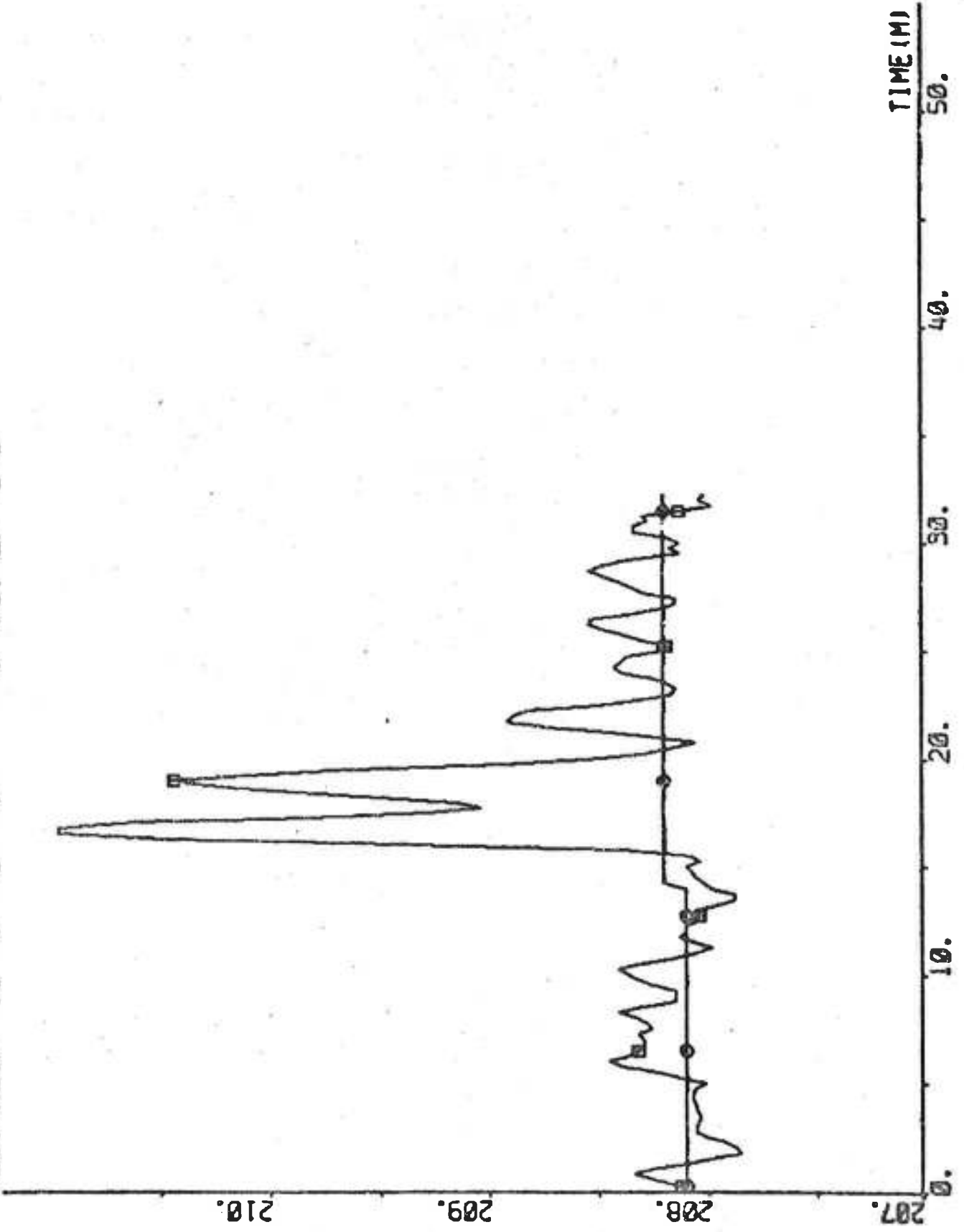
PLOT R26P1(8) @ 1 -V2 KNOTS



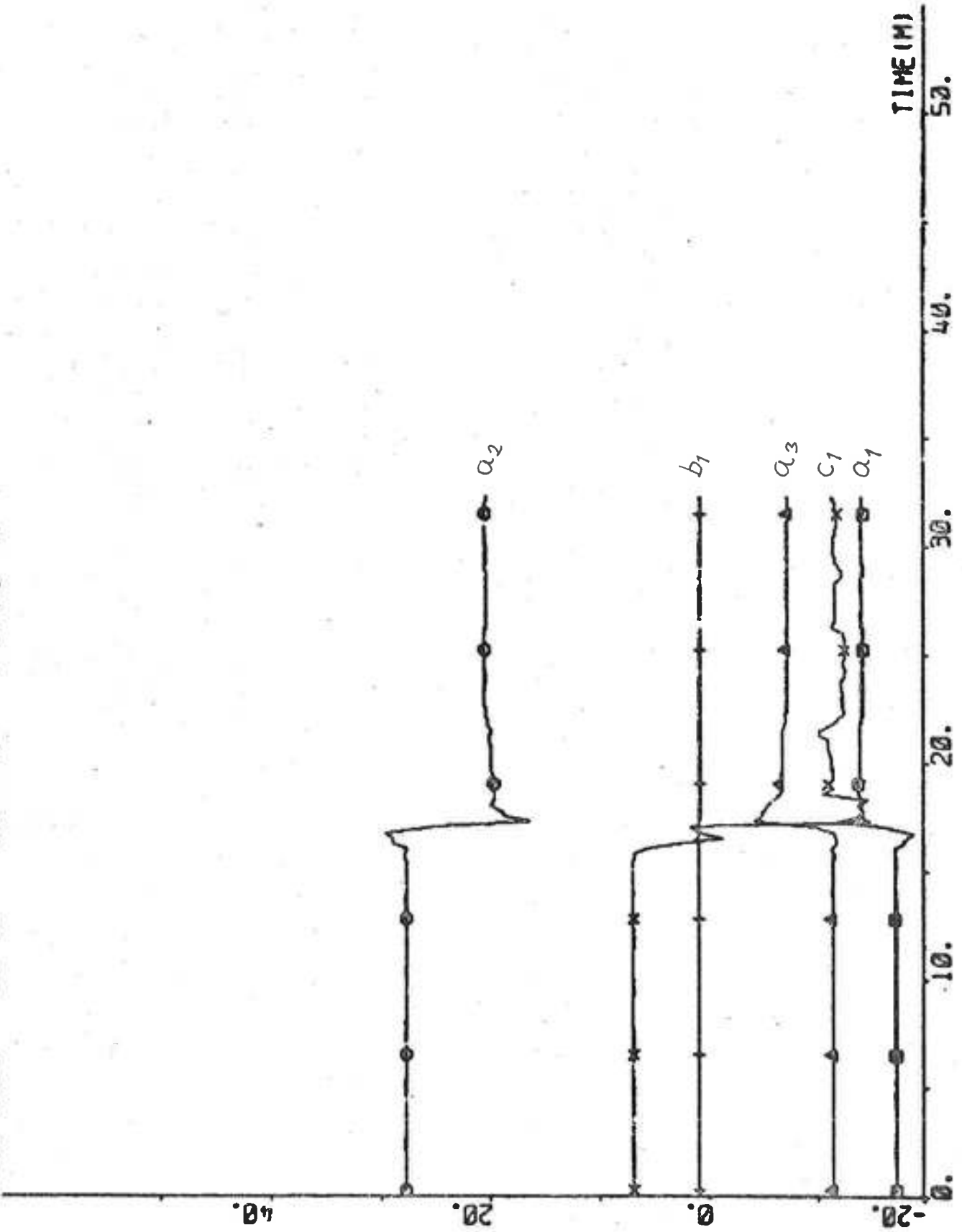
PLOT AZOP1(10) ZERO -0.1 0.1 "R DEG/S



PLOT A26P1(13 14) 207 211 -PSI PSIREF DEG



PLOT A20P2 -20 40 "REGULATOR PARAMETERS



## EXPERIMENT A21

Date	1974-10-15
Time	08.54
Duration	40 min
Position	N 05° 33' E 52° 14'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	2 Beaufort (2-3.5 m/s, light breeze)
Wave height	1 - 2 m (light sea from SW)
PSIREF	209°
Rudder limit	Not active

The aft doppler log was adjusted during the experiment, which affected the V2-measurement.

Regulator structure

NA = 3	NB = 1	NC = 1	K = 5
IREG = 15	IRDIF = 0	RL = 0.98	IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -10.640 \\ 15.967 \\ -5.930 \\ 0.679 \\ 16.434 \end{bmatrix} \quad P = \begin{bmatrix} 3.853 & & & & \\ -6.171 & 11.999 & & & \\ 2.595 & -6.314 & 4.116 & & \\ 0.021 & -0.132 & 0.112 & 0.018 & \\ 5.922 & -6.322 & -0.094 & -0.029 & 92.124 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.603$$

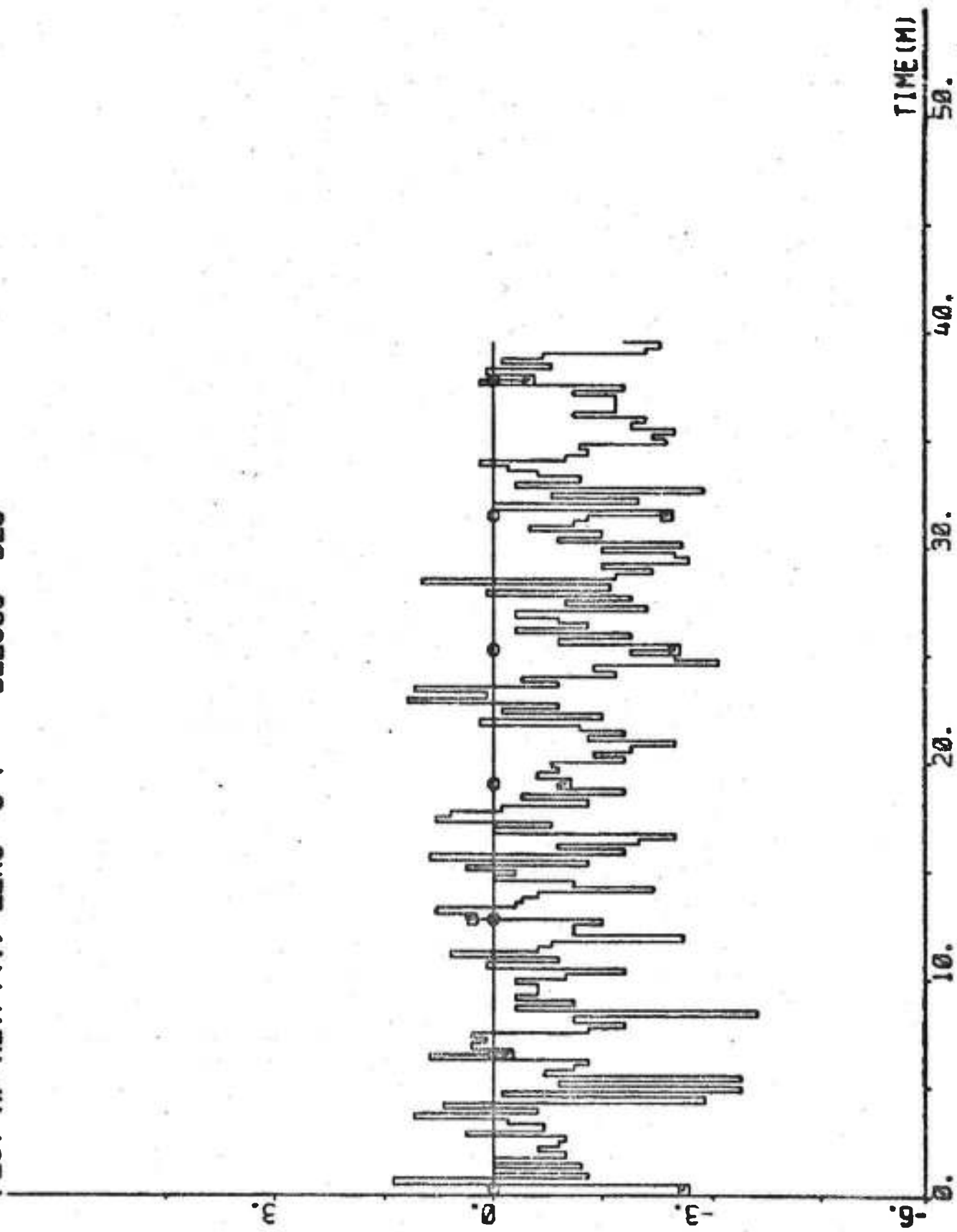
Statistics (mean value and standard deviation)

DELTA	-0.22 ± 0.91 deg
PSI-PSIREF	-0.122 ± 0.207 deg
AN	85.81 ± 0.27 rpm
U	16.04 ± 0.12 knots

$$V_1 = 0.145$$

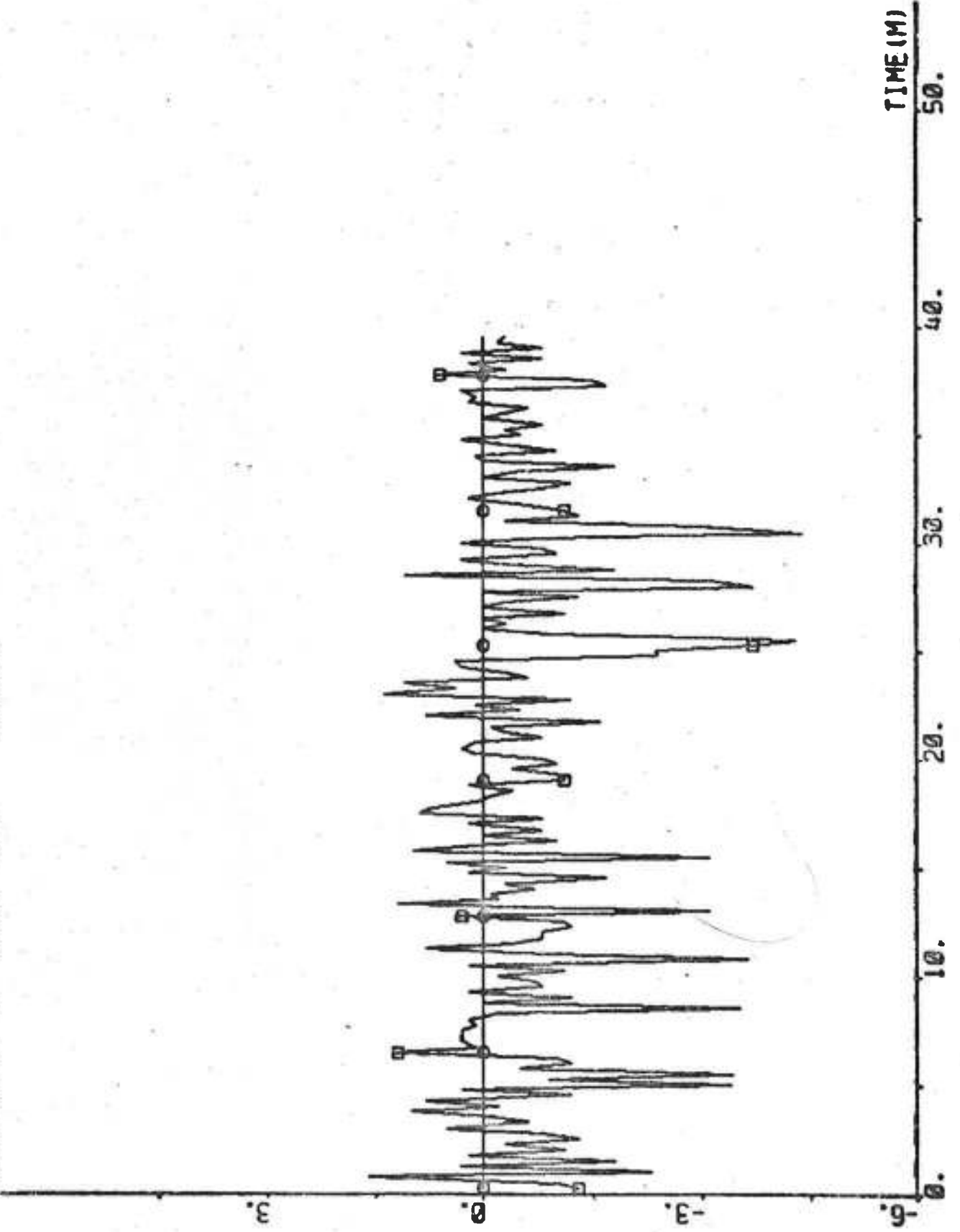
$$V_2 = 0.141$$

PLOT HP A21P1(1) ZERO -5 7 -DELCOC DEG

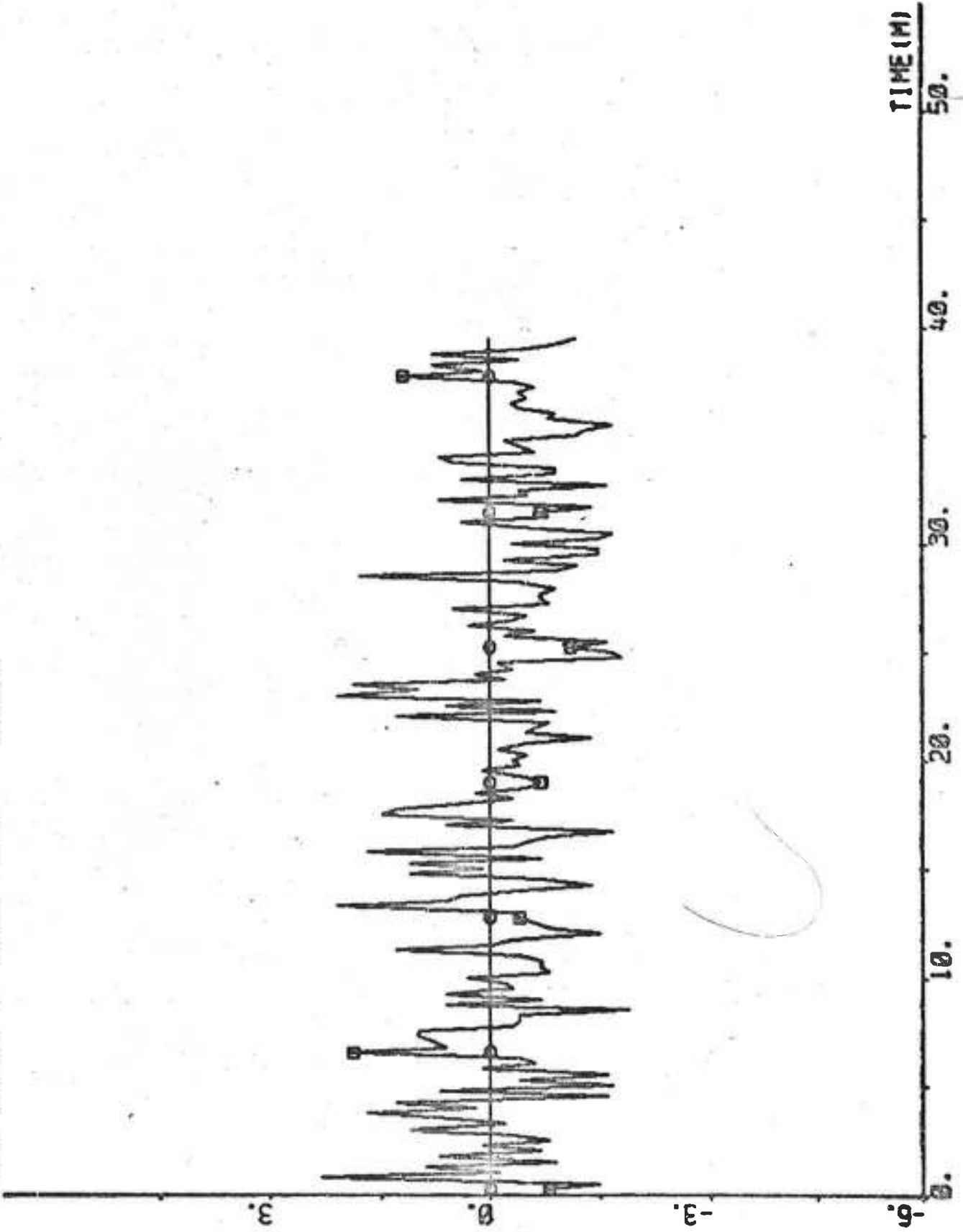




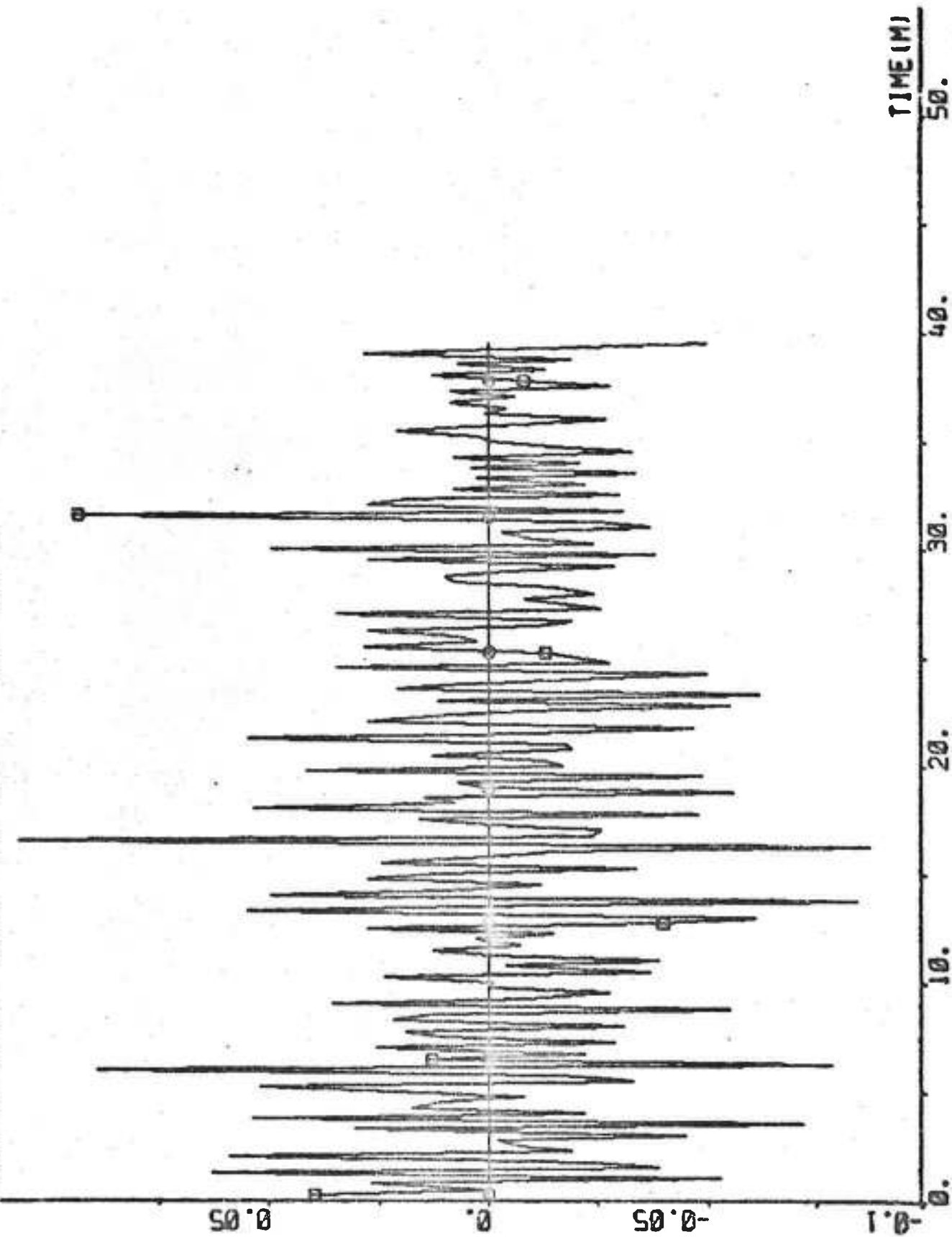
PLOT A2IP1(3) ZERO -5 7 "DELTAS DEC



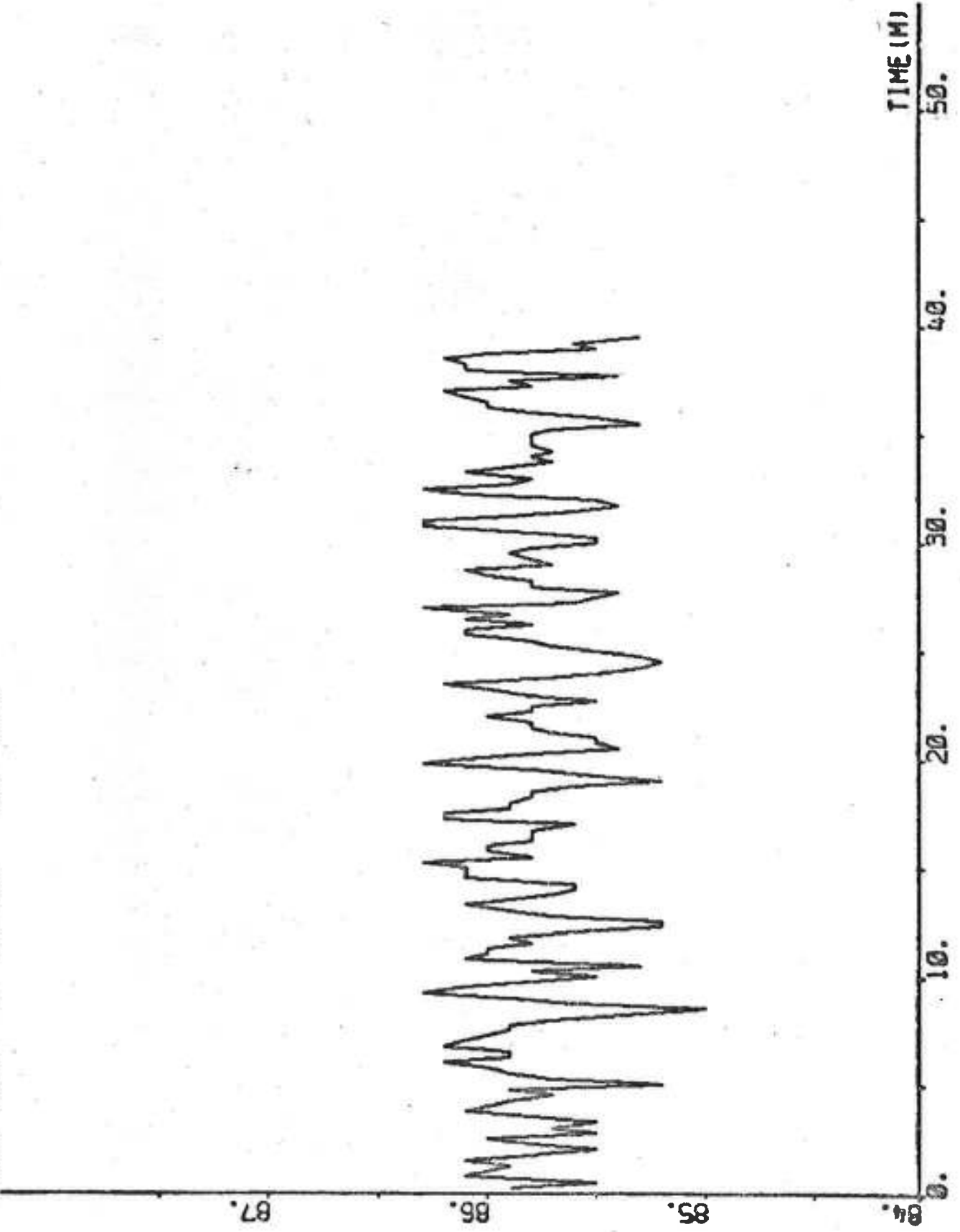
PLOT A21P1(4) ZERO -6 7 "DELTA DEG



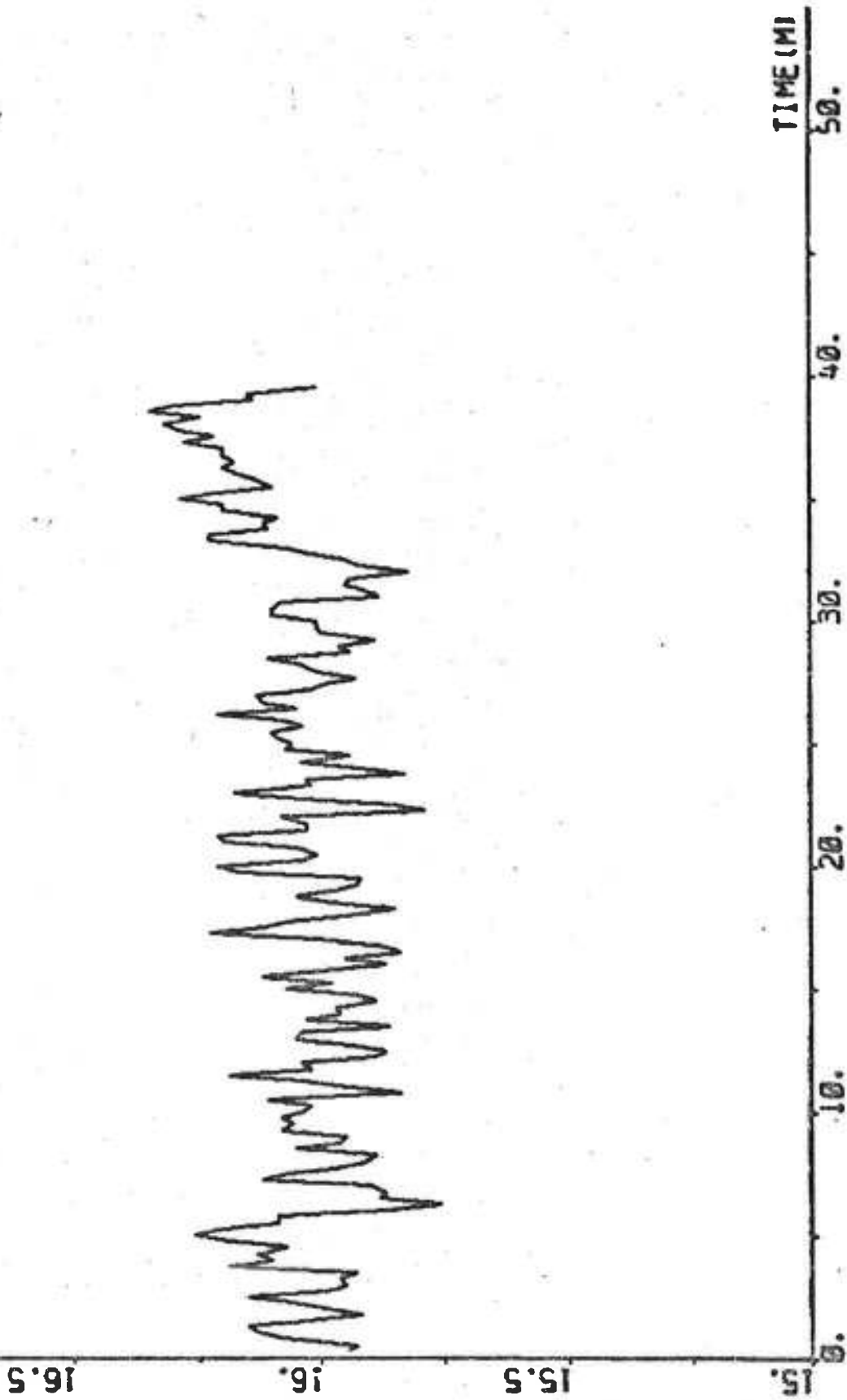
PLOT A21P1(5) ZERO -0.1 0.1 -PP DEG/S



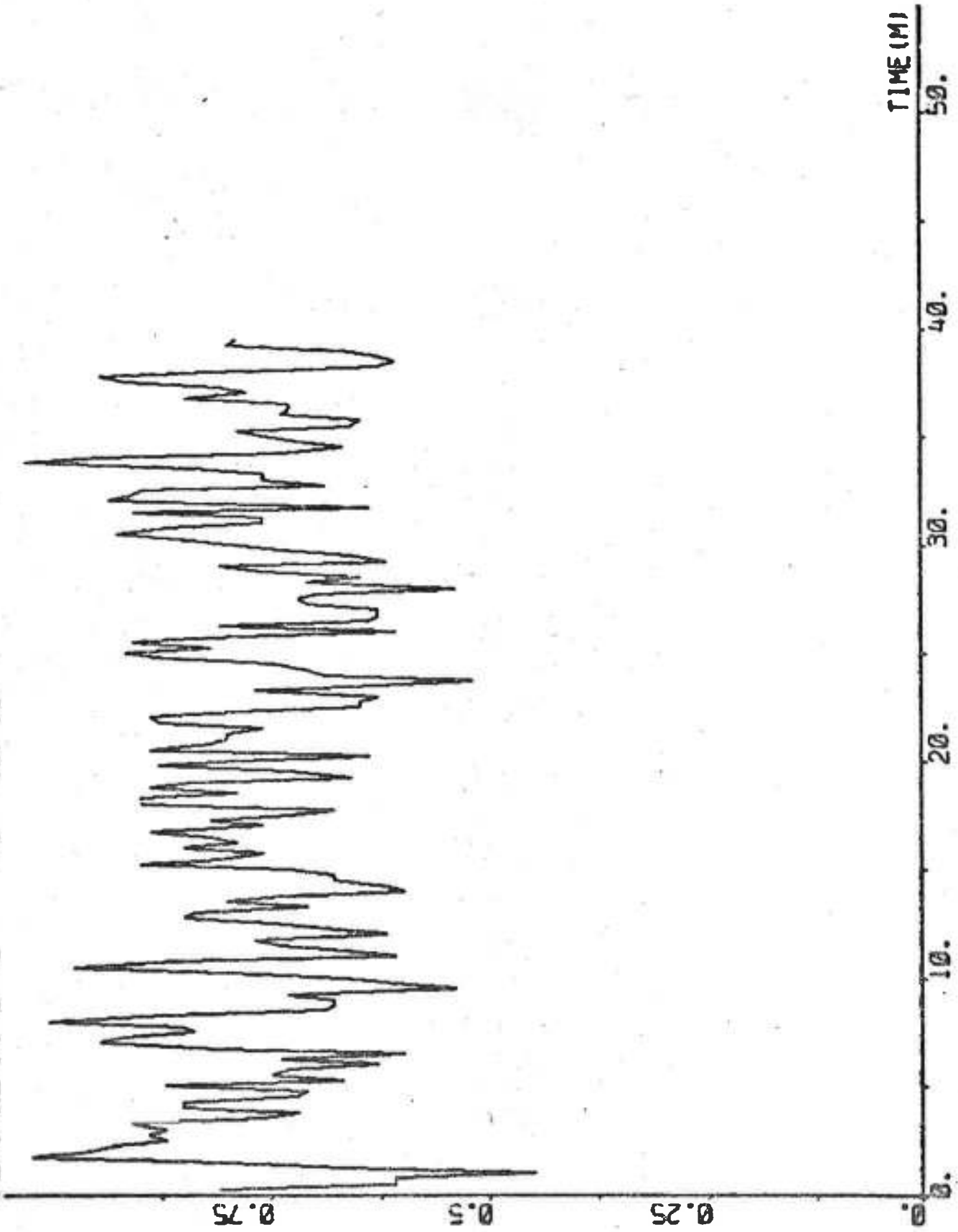
PLOT A21P1(6) 64 68 -AN RPH



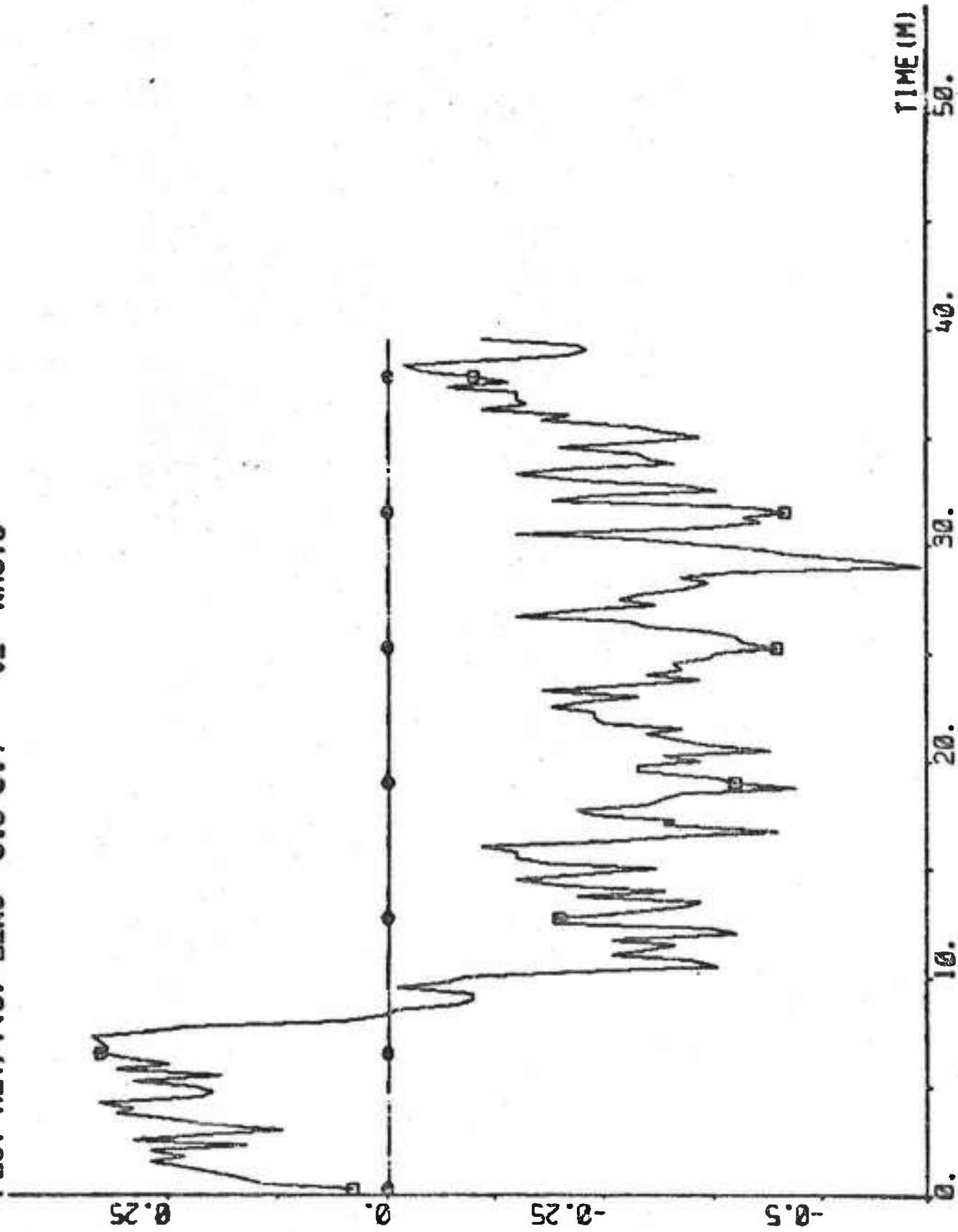
PLOT A21P1(7) 15 17 "U KNOTS



PLOT A21P1(8) Q 1 -V1 KNOTS

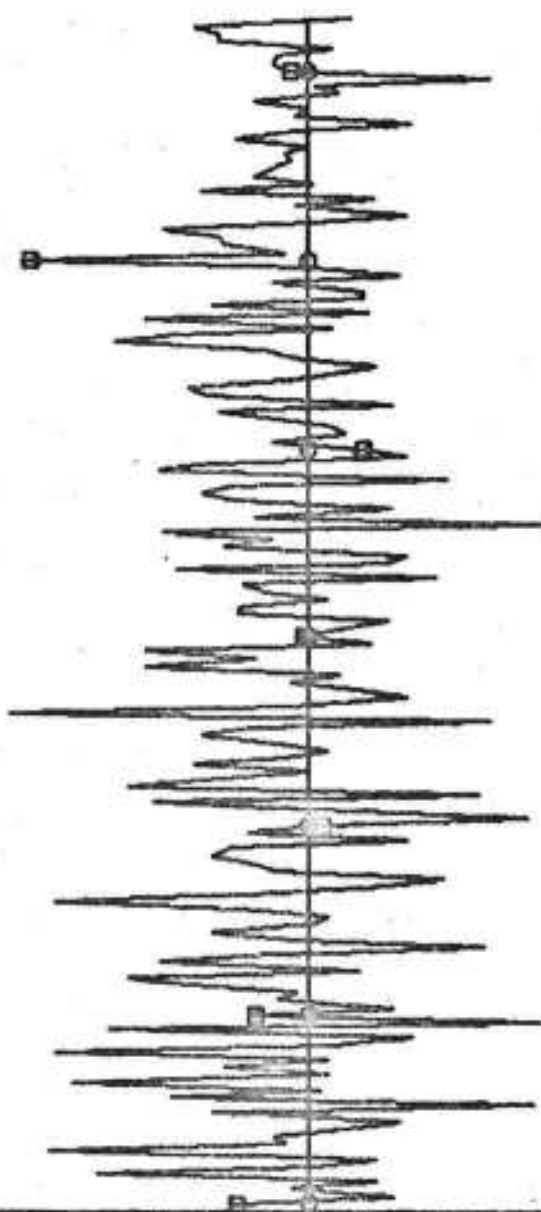


PLOT A21P1(9) ZERO -0.6 0.4 "V2 KNOTS



PLOT A21P1(10) ZERO -0.1 0.1 °R DEG/S

0.05 0.0 -0.05 -0.1

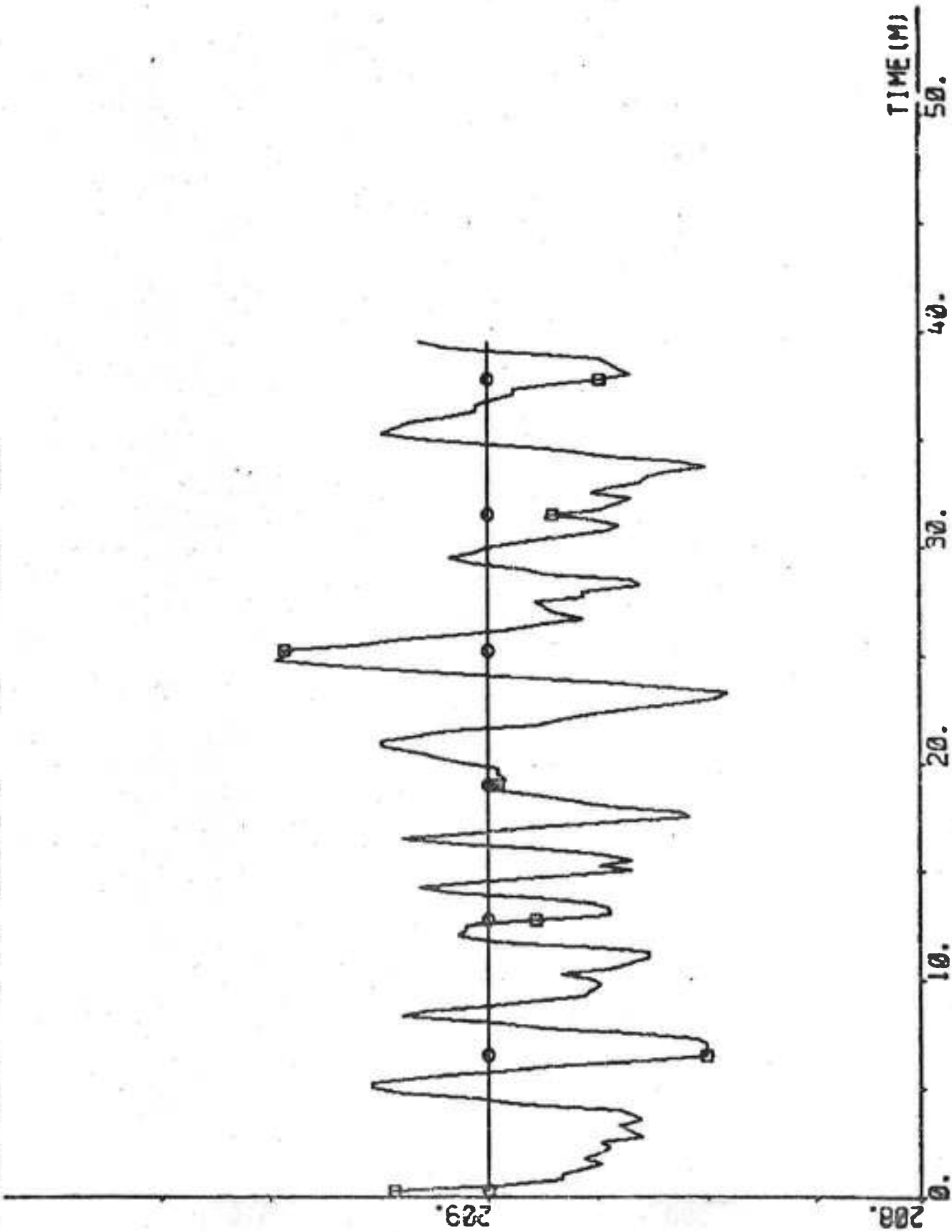


TIME (M)

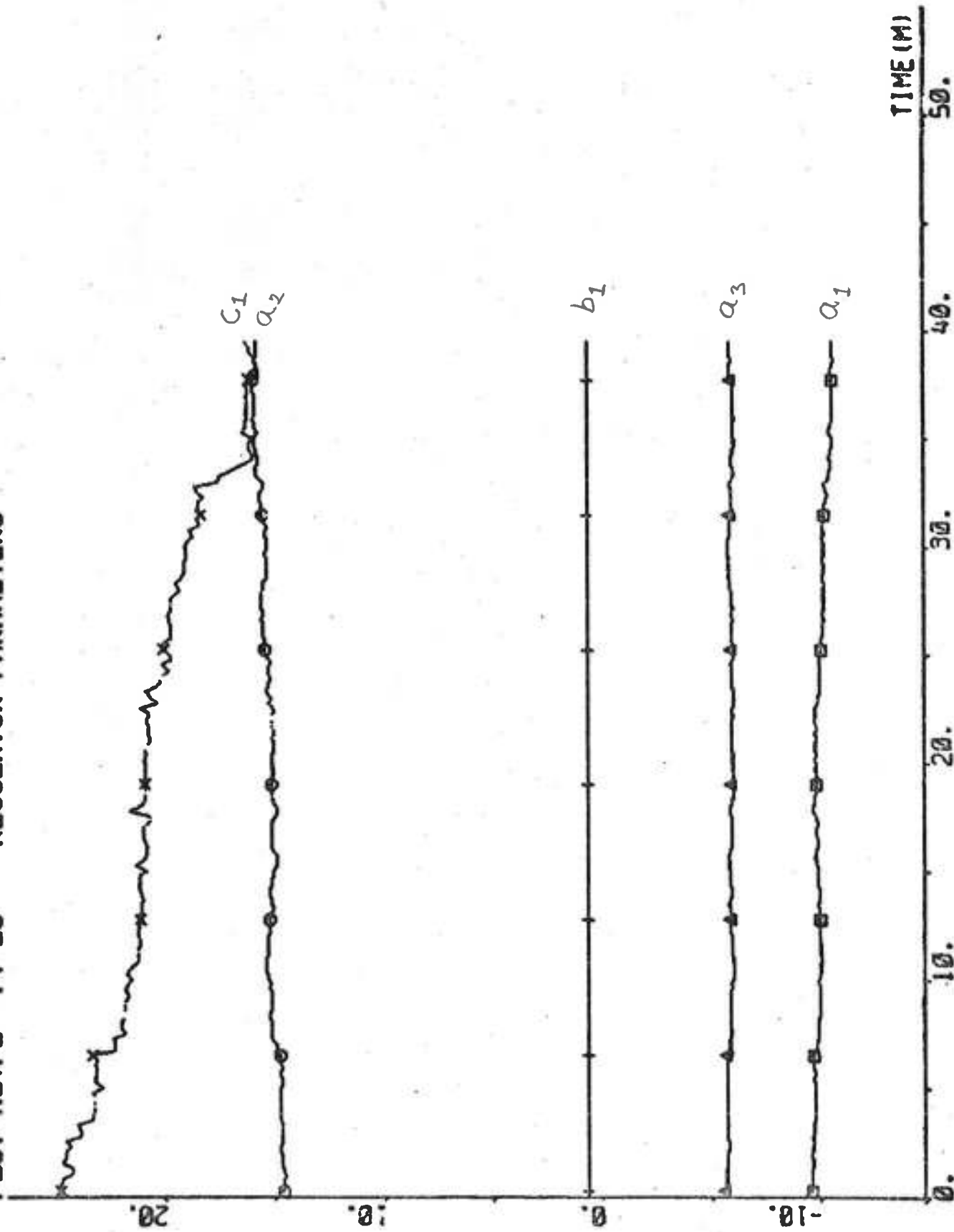
0. 10. 20. 30. 40. 50.



PLOT A21P1 (13 14) 200 210 "PSI PSIREF DEG



PLOT A21P2 -14 26 "REGULATOR PARAMETERS



## EXPERIMENT A22

Date	1974-10-15
Time	09.45
Duration	36 min
Position	N 05° 21' E 52° 07'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	2 Beaufort (2-3.5 m/s, light breeze)
Wave height	1 - 2 m
PSIREF	209°
Rudder limit	Not active

The aft doppler log was adjusted during the experiment, which affected the V2-measurement.

Regulator structure

NA = 3	NB = 1	NC = 1	K = 5
IREG = 15	IRDIF = 0	RL = 0.97	IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -12.708 \\ 19.647 \\ -7.066 \\ 0.670 \\ 3.836 \end{bmatrix} \quad P = \begin{bmatrix} 5.915 & & & & \\ -8.712 & 17.106 & & & \\ 3.641 & -9.595 & 6.928 & & \\ 0.035 & -0.161 & 0.150 & 0.020 & \\ 8.260 & -8.057 & -1.517 & 0.093 & 140.644 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.127$$

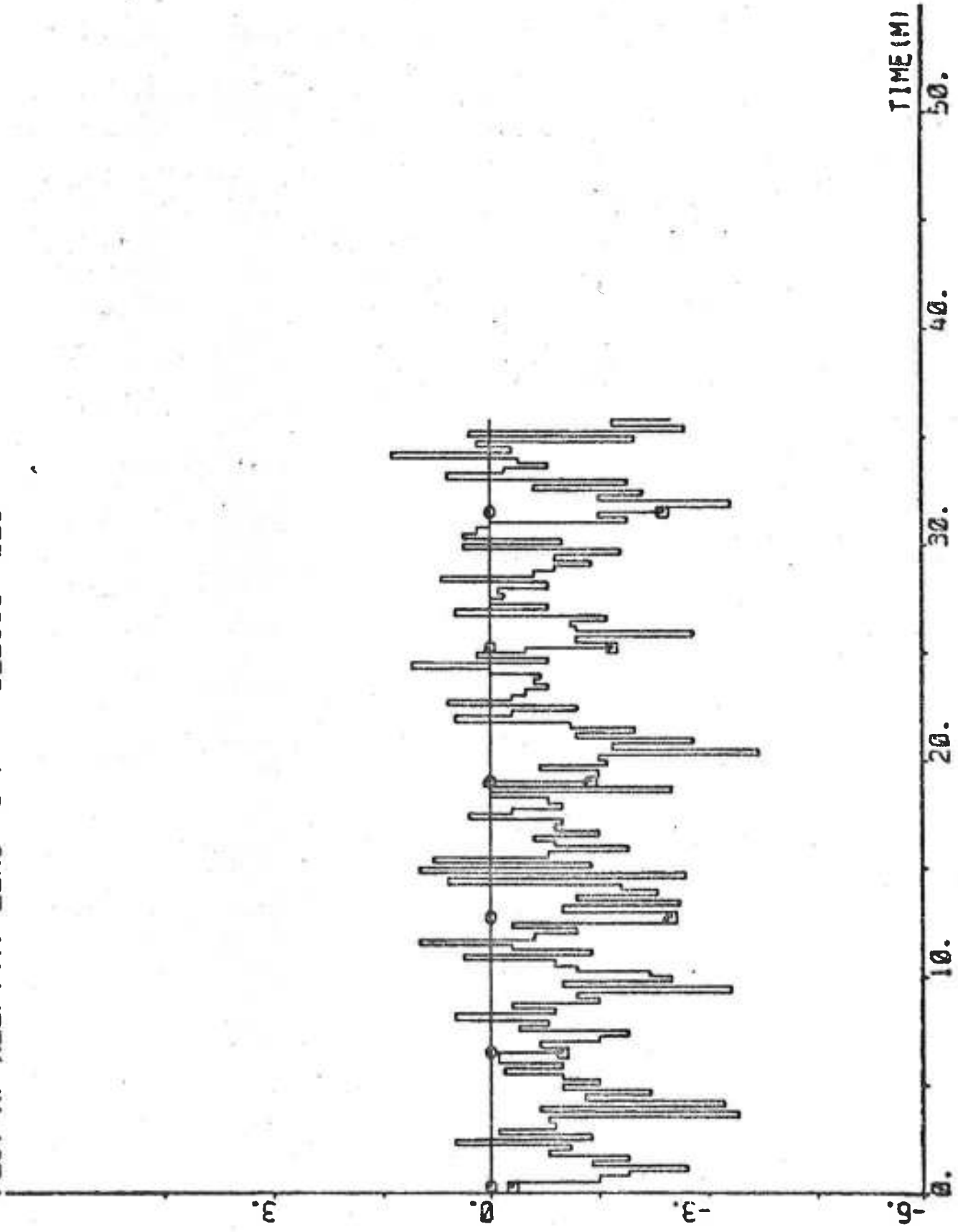
Statistics (mean value and standard deviation)

DELTA	-0.17 ± 0.85 deg
PSI-PSIREF	-0.091 ± 0.217 deg
AN	85.86 ± 0.27 rpm
U	16.29 ± 0.17 knots

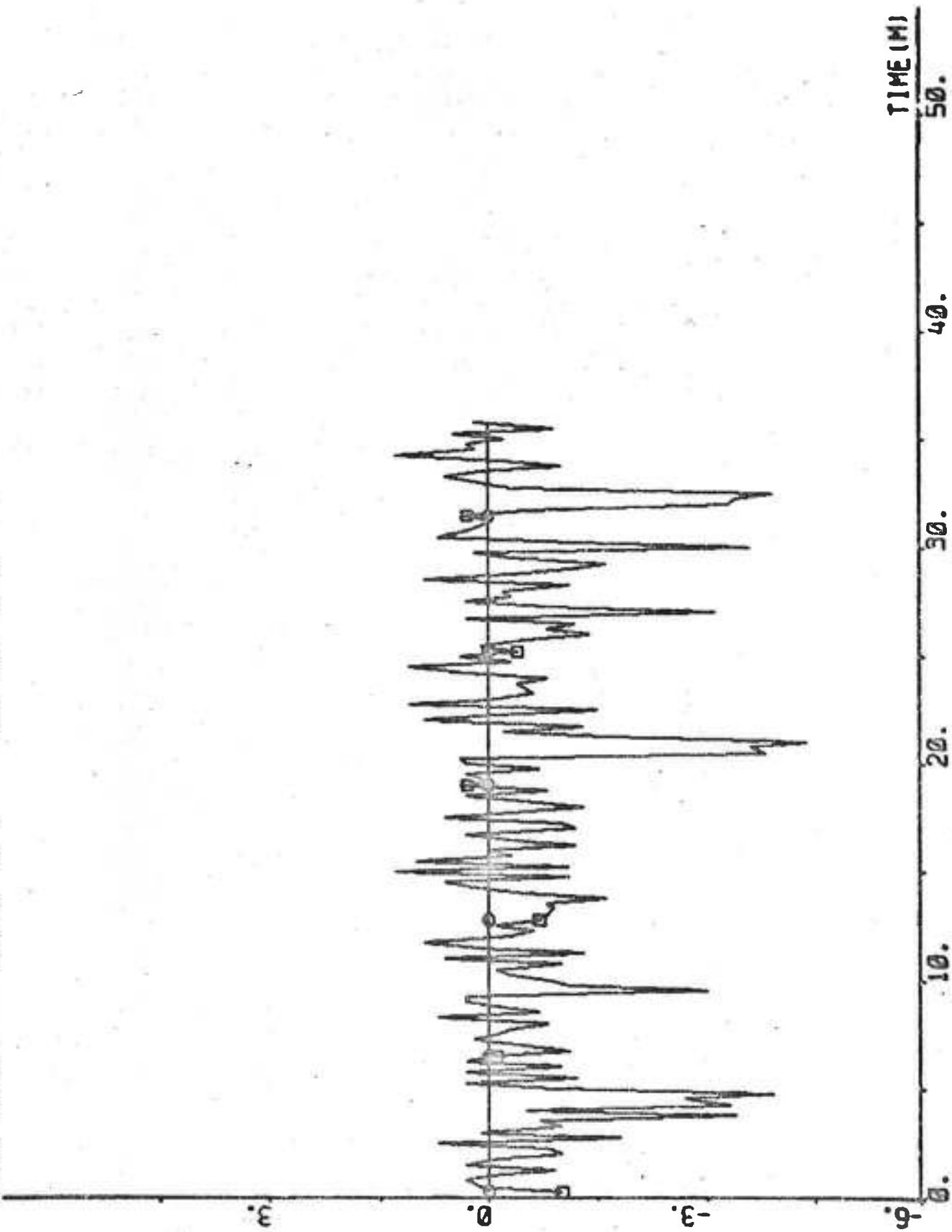
$$V_1 = 0.131$$

$$V_2 = 0.128$$

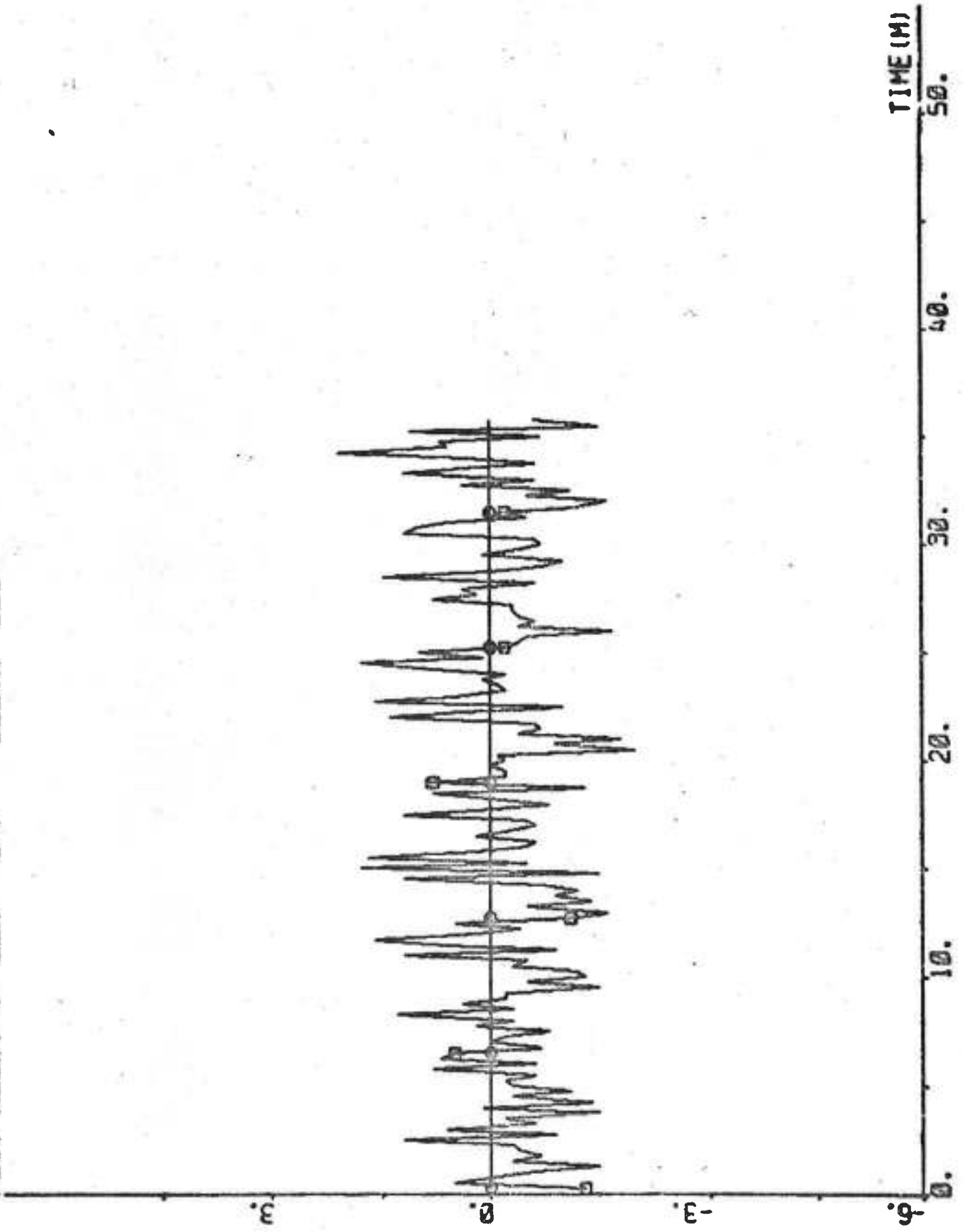
PLOT HP A22P1(1) ZERO -6 7 "DELCOC DEG



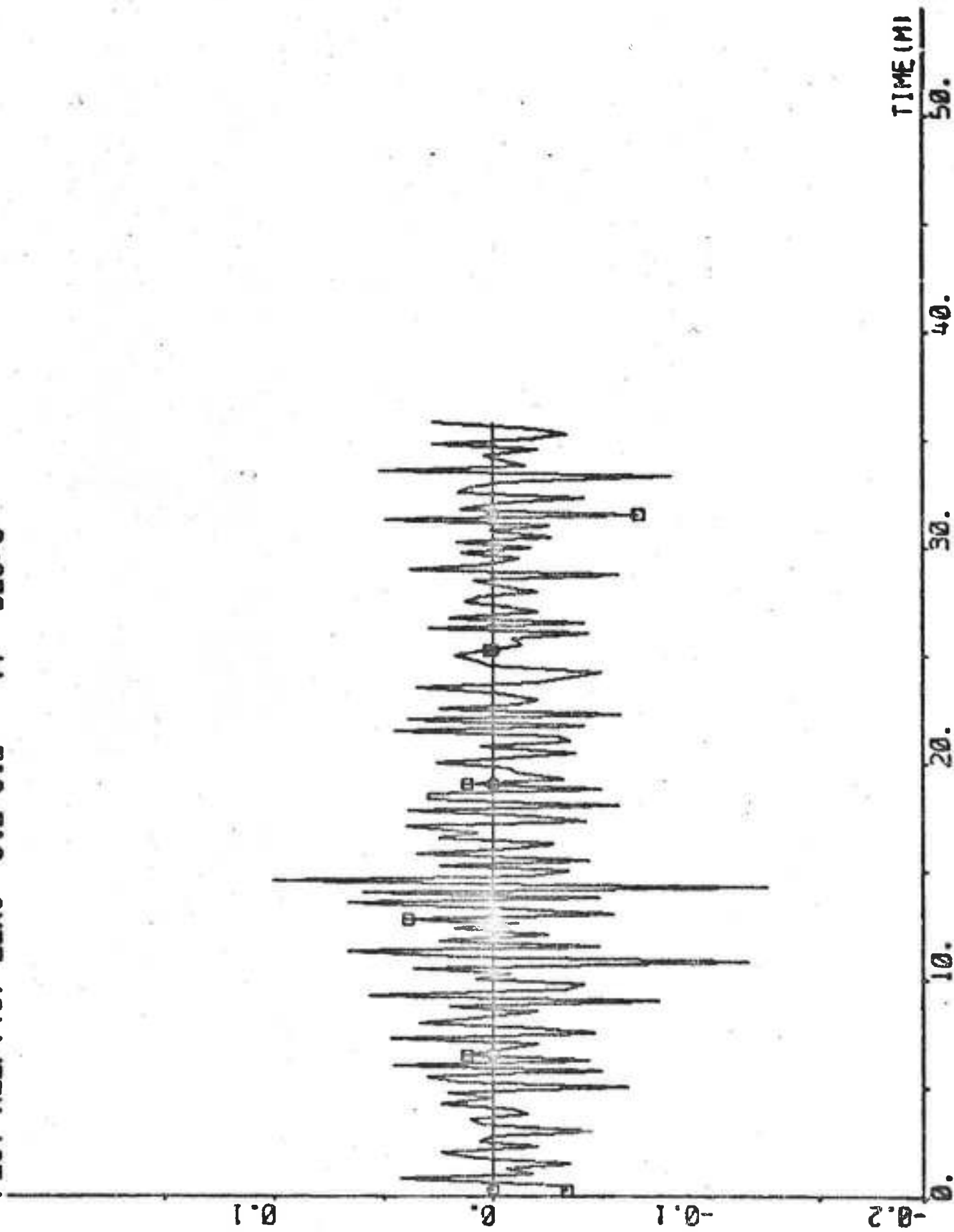
PLOT A22P1 (3) ZERO -5 7 "DELTA" DEG



PLOT A22P1(4) ZERO -5 7 "DELTA DEG



PLOT R22P1(5) ZERO -0.2 0.2 "PP DEG/S





PLOT A22P1(6) 04 00 "AN RPM

87.

86.

85.

84.



TIME (M)  
50.

40.

30.

20.

10.

0.

PLOT R22P1 (7) 15 17 "U KNOTS

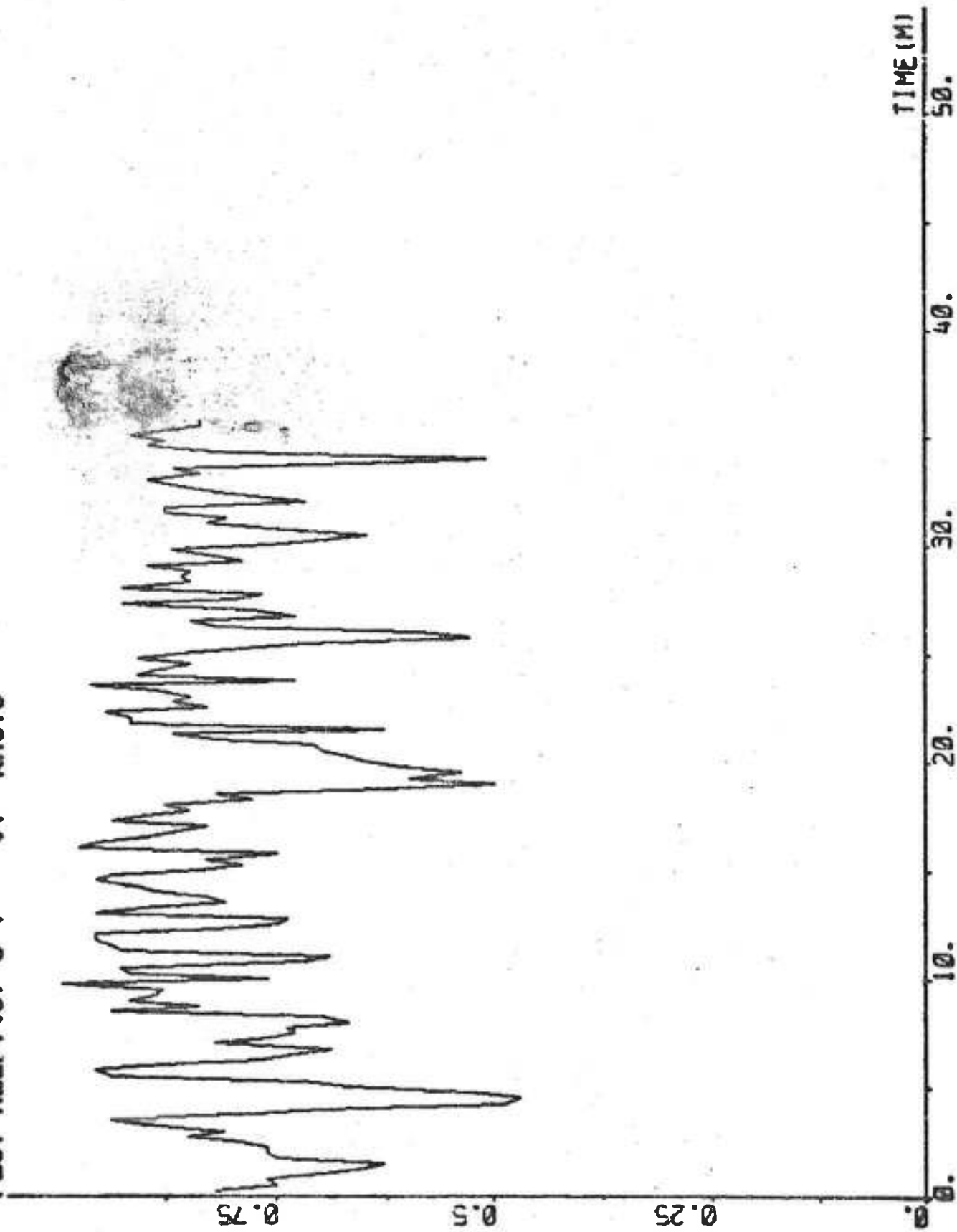


15.  
15.5  
16.  
16.5

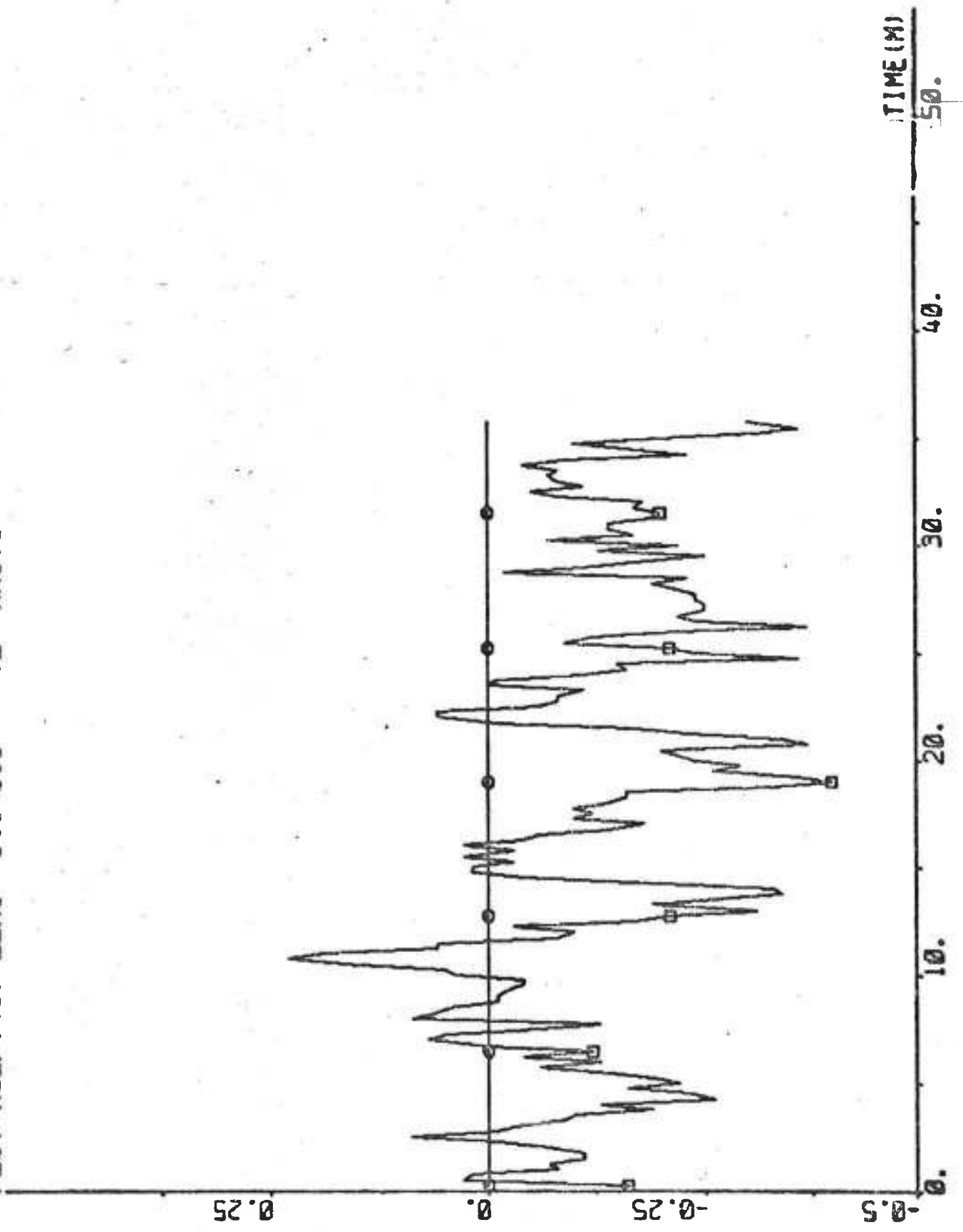
0. 10. 20. 30. 40. 50.

TIME (M)

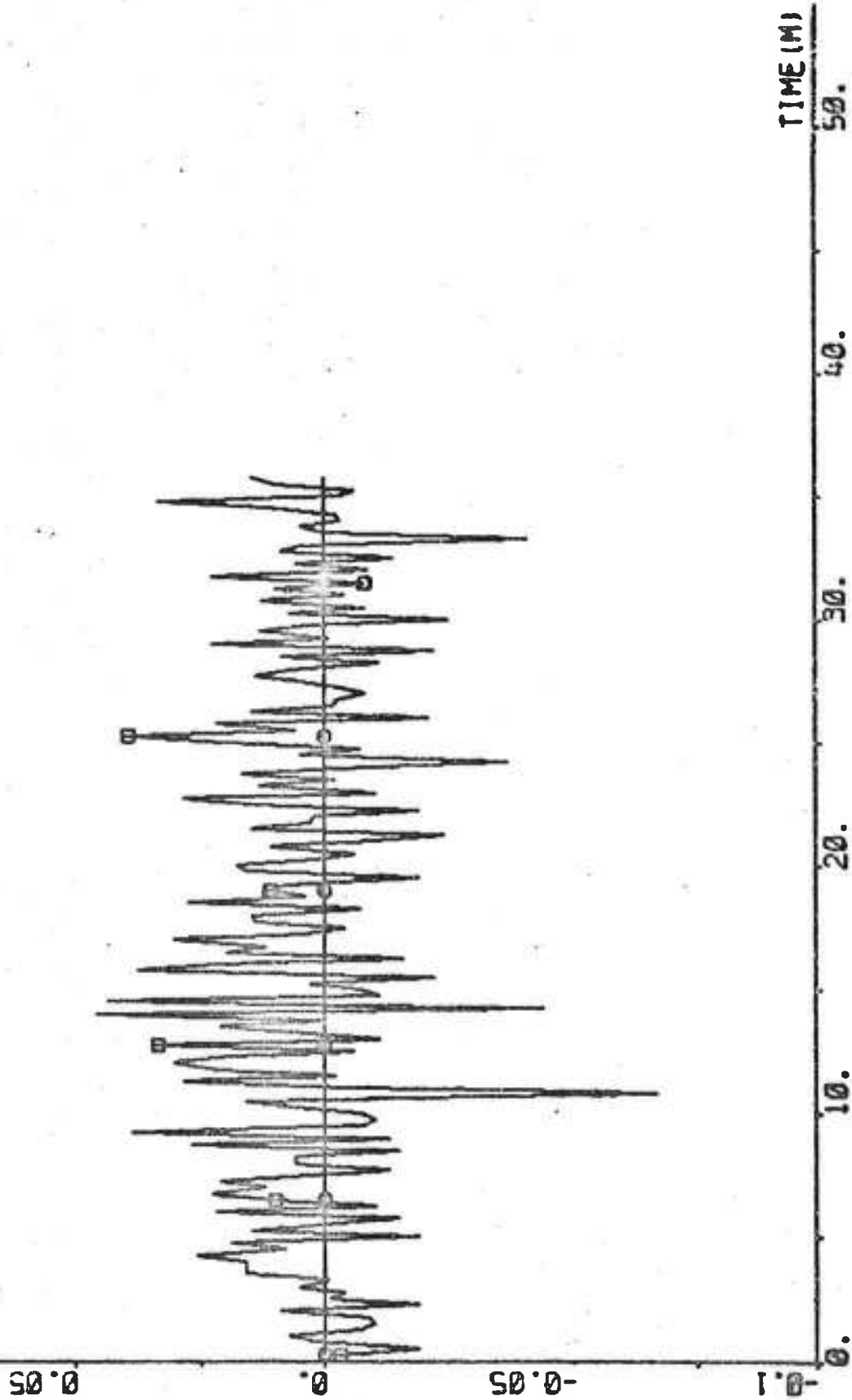
PLOT R22P1(8) 0 1 "V1 KNOTS



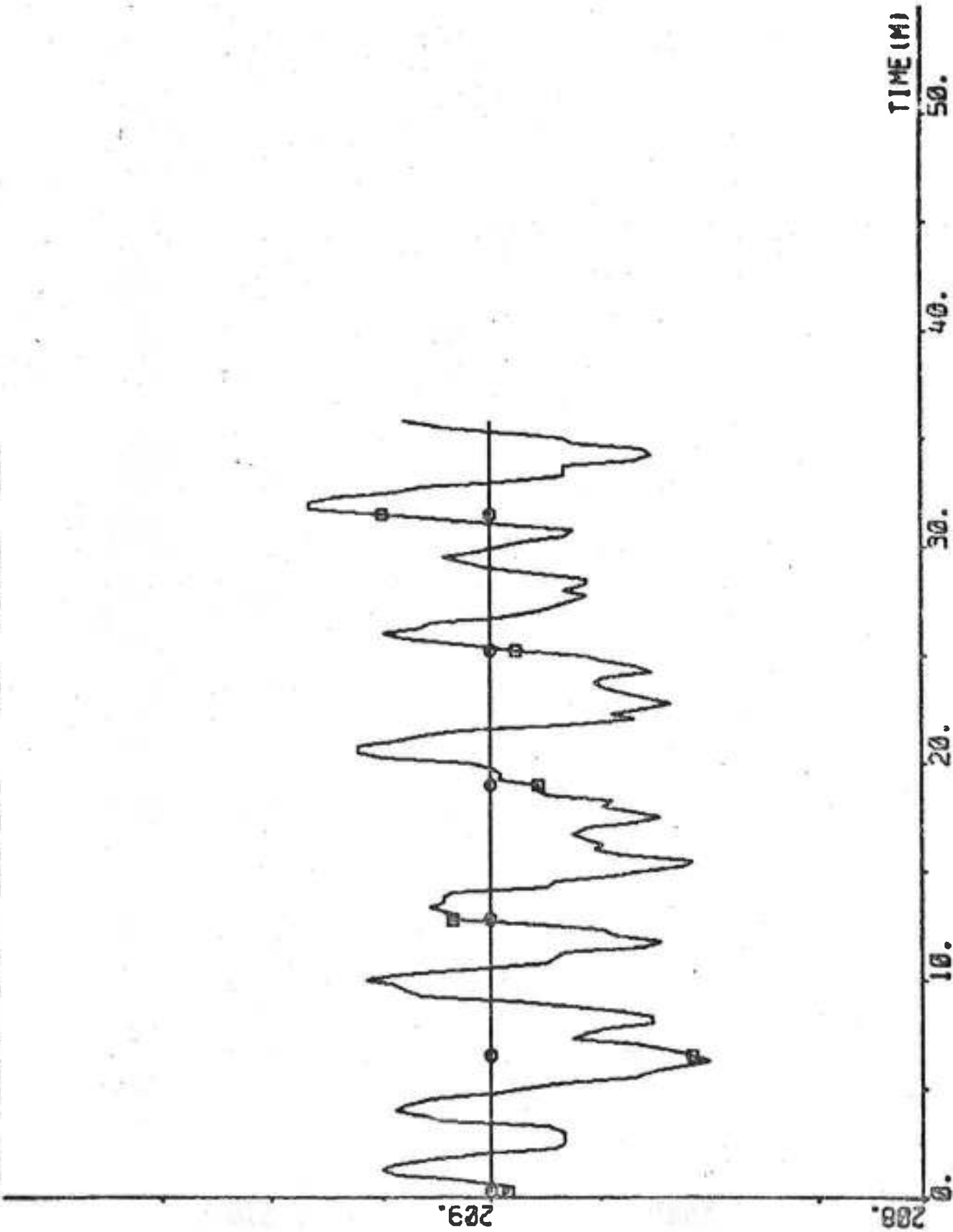
PLOT R22P1(9) ZERO -0.5 0.5 "V2 KNOTS



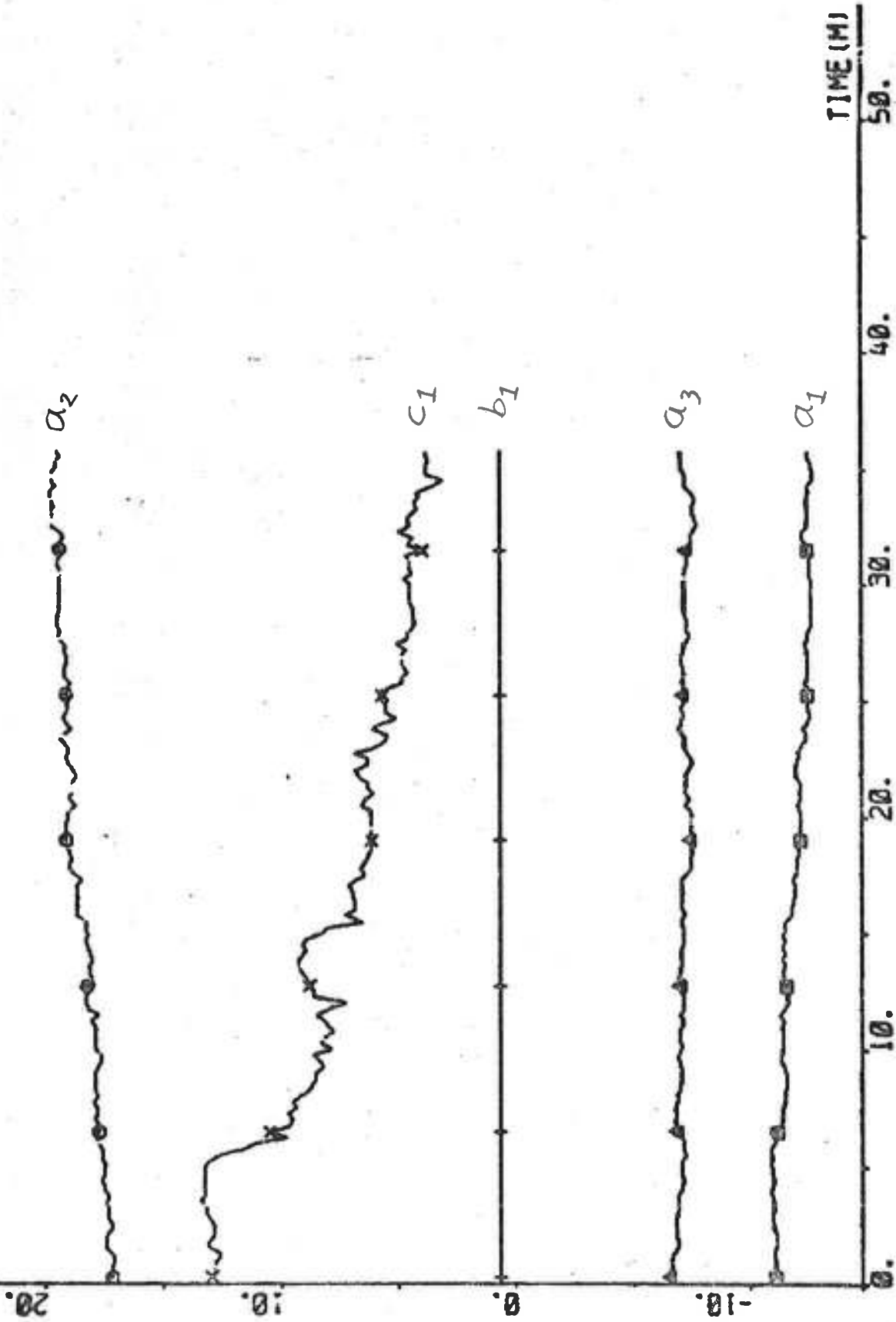
PLOT A22P1(10) ZERO -0.1 0.1 °R DEG/S



PLOT A22Pi (13 14) 208 210 "PSI PSIREF DEG



PLOT A22P2 - 14 26 "REGULATOR PARAMETERS



## EXPERIMENT A23

Date	1974-10-15
Time	10.54
Duration	17 min
Position	N 05° 02' E 51° 58'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	2 Beaufort (2-3.5 m/s, light breeze)
Wave height	1 - 2 m
PSIREF	209°
Rudder limit	Not active

Regulator structure

NA = 3	NB = 1	NC = 1	K = 5
IREG = 15	IRDIF = 0	RL = 0.99	IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -13.563 \\ 20.540 \\ -7.076 \\ 0.662 \\ 2.719 \end{bmatrix} \quad P = \begin{bmatrix} 2.400 & & & & \\ -3.215 & 6.306 & & & \\ 1.166 & -3.471 & 2.770 & & \\ 0.005 & -0.061 & 0.066 & 0.007 & \\ 3.654 & -4.871 & 0.901 & 0.026 & 43.533 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.099$$



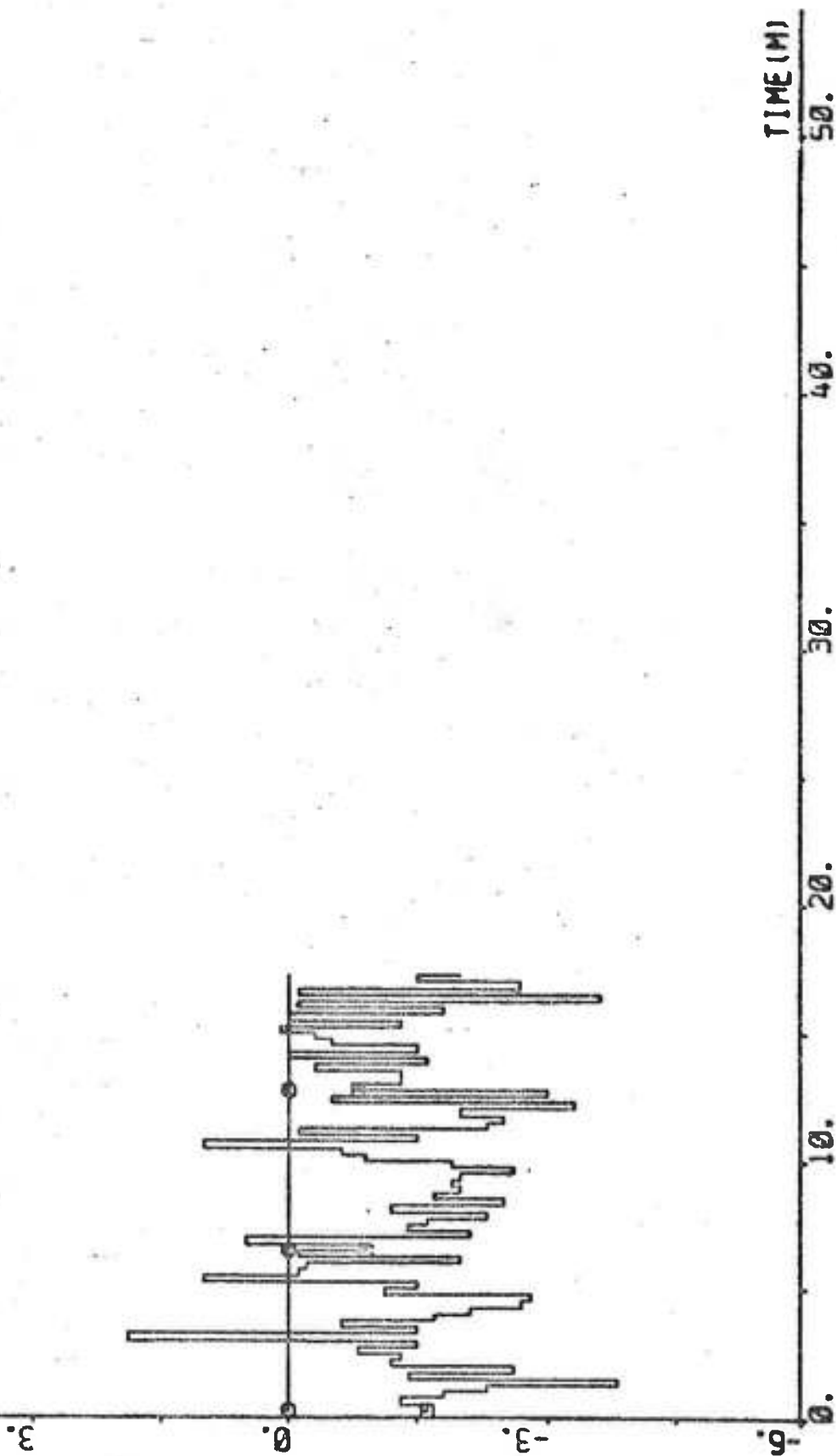
Statistics (mean value and standard deviation)

DELTA	-0.40 ± 0.91 deg
PSI-PSIREF	-0.034 ± 0.167 deg
AN	85.84 ± 0.26 rpm
U	16.33 ± 0.16 knots

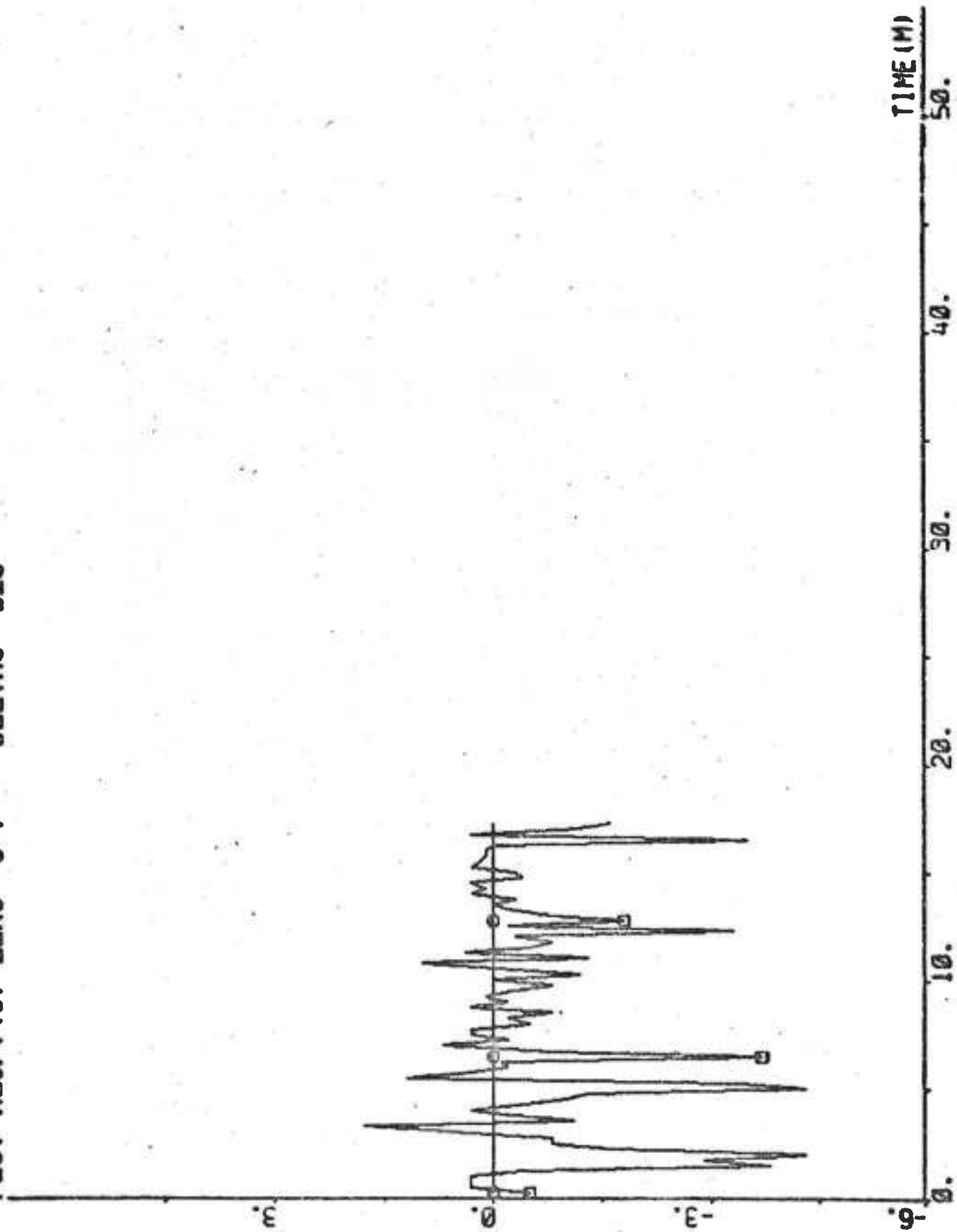
$$V_1 = 0.128$$

$$V_2 = 0.112$$

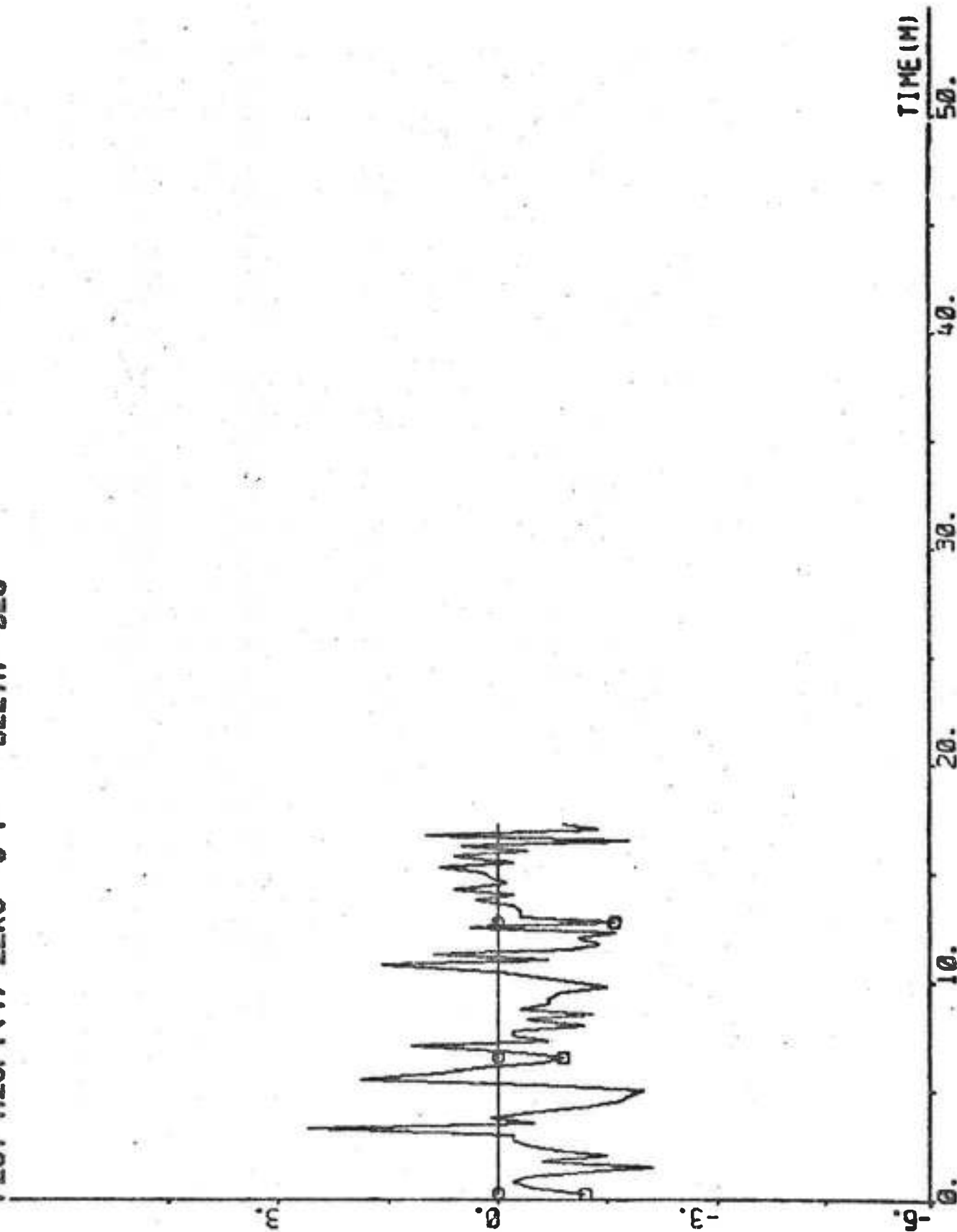
PLOT HP A23P1(1) ZERO -5 7 DELCOC DEG



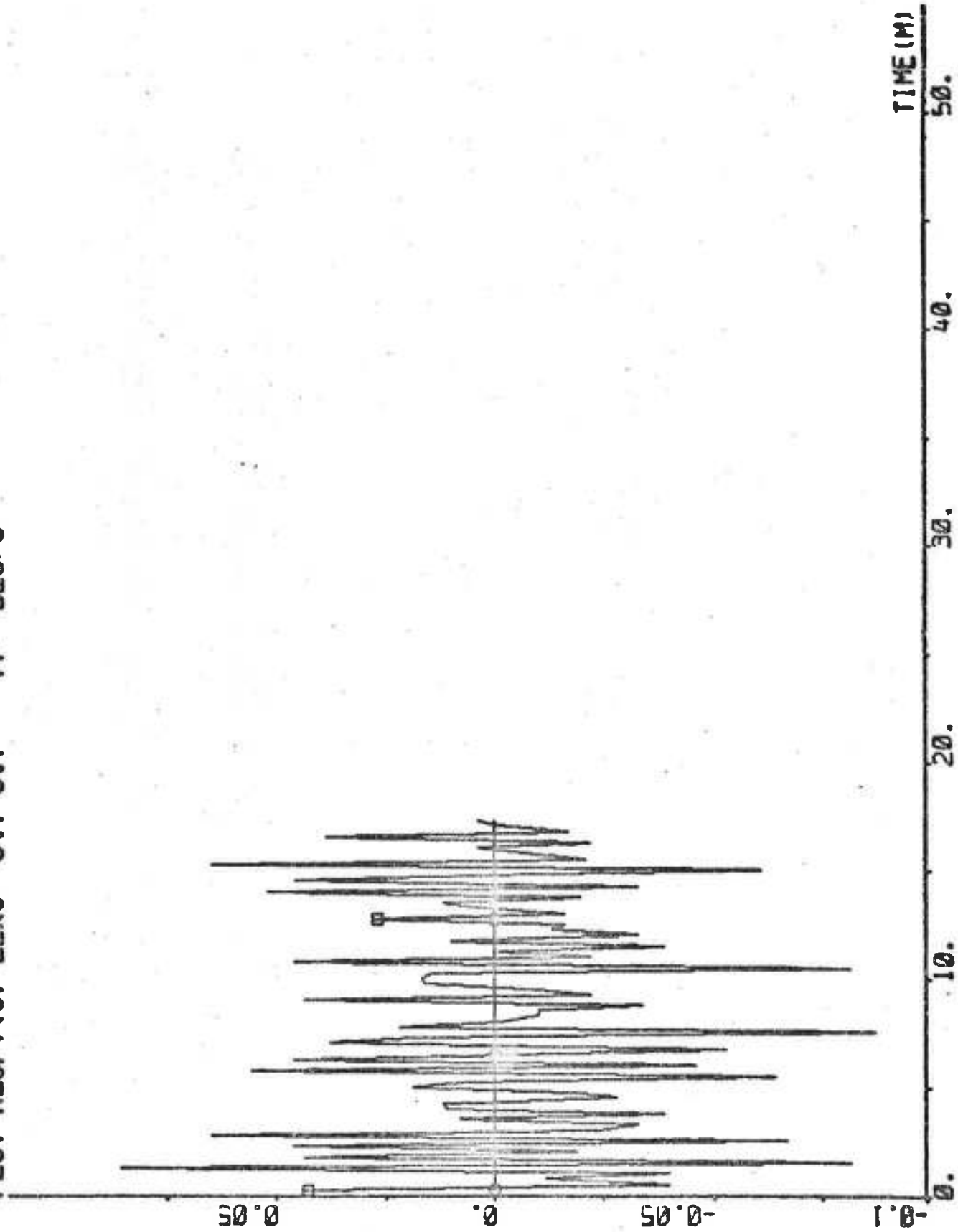
PLOT A23P1 (3) ZERO -5 7 °DELTAS DEG



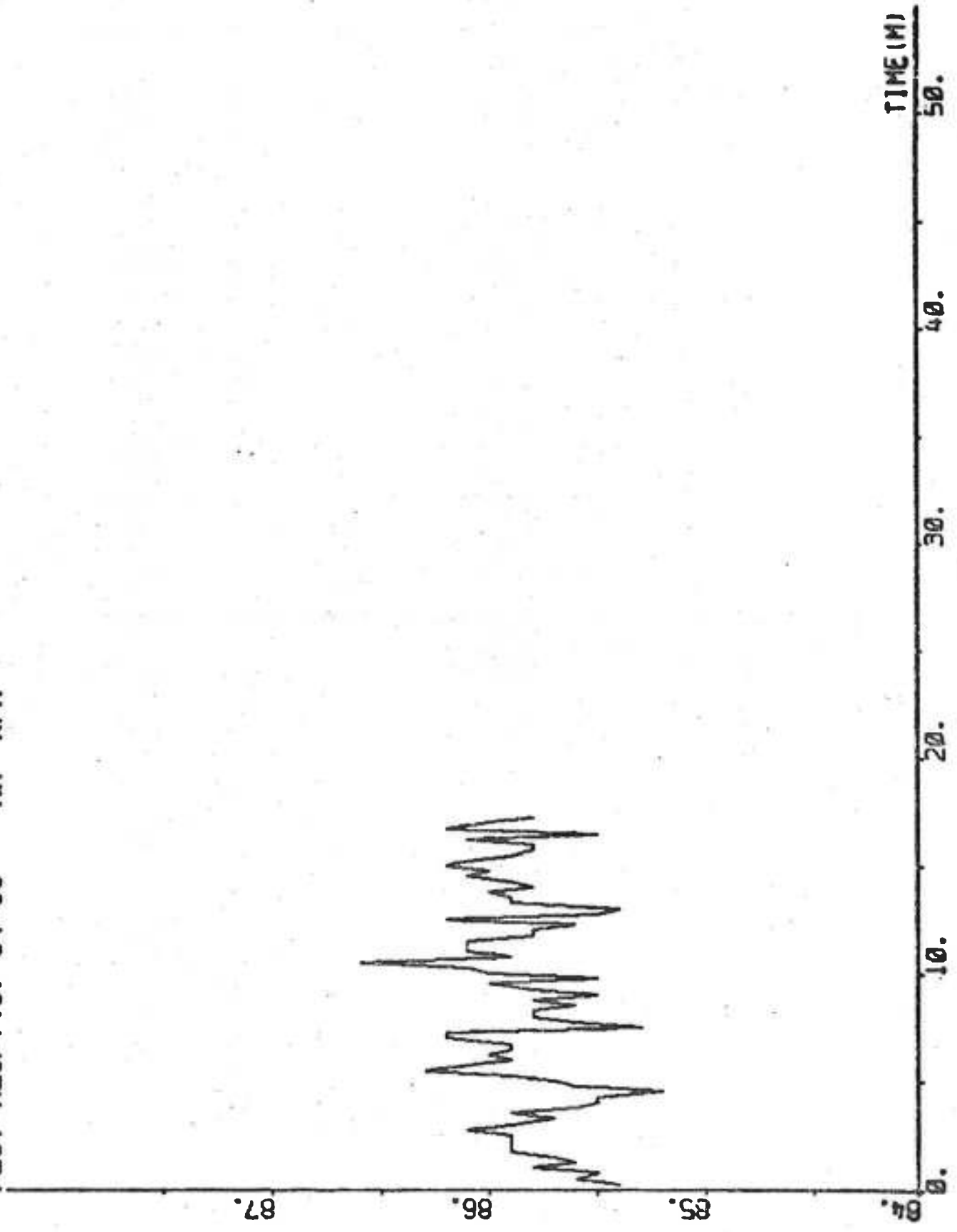
PLOT A23P1(4) ZERO -5 7 "DELTA DEG



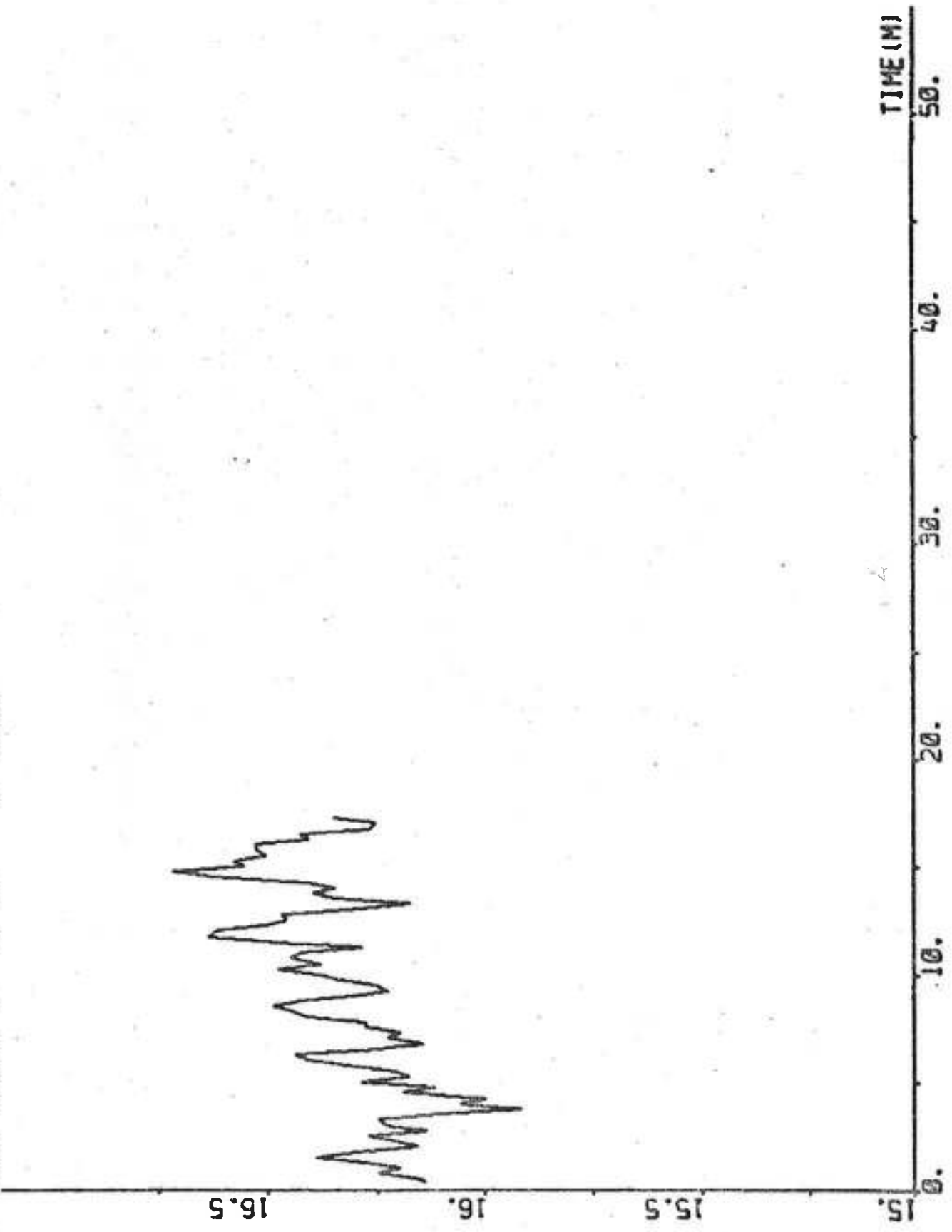
PLOT A23P1(6) ZERO -0.1 0.1 \*PP DEG/S



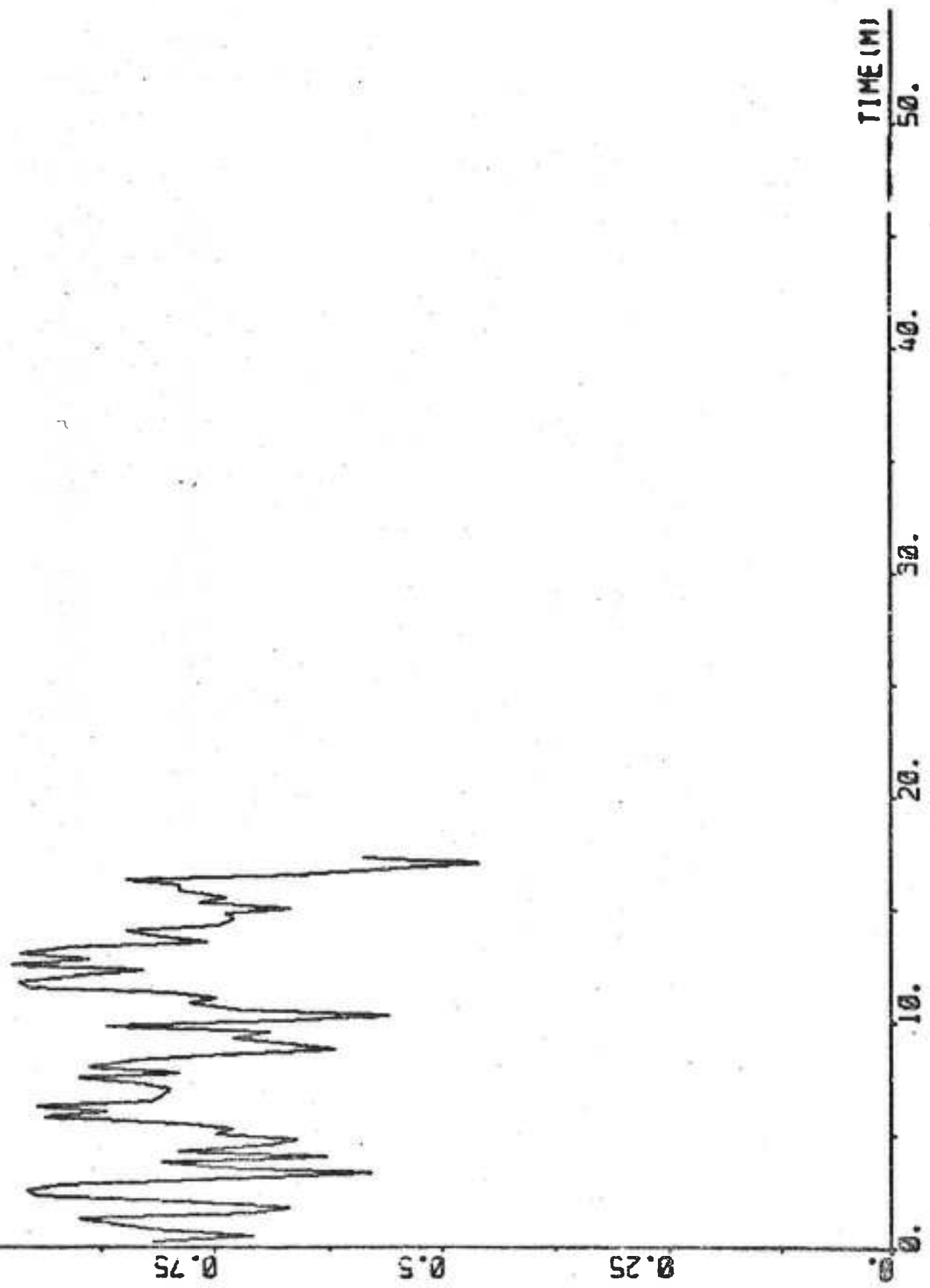
PLOT A23P1(6) 04 00 "AN RPM



PLOT R23P1(7) 15 17 °U KNOTS

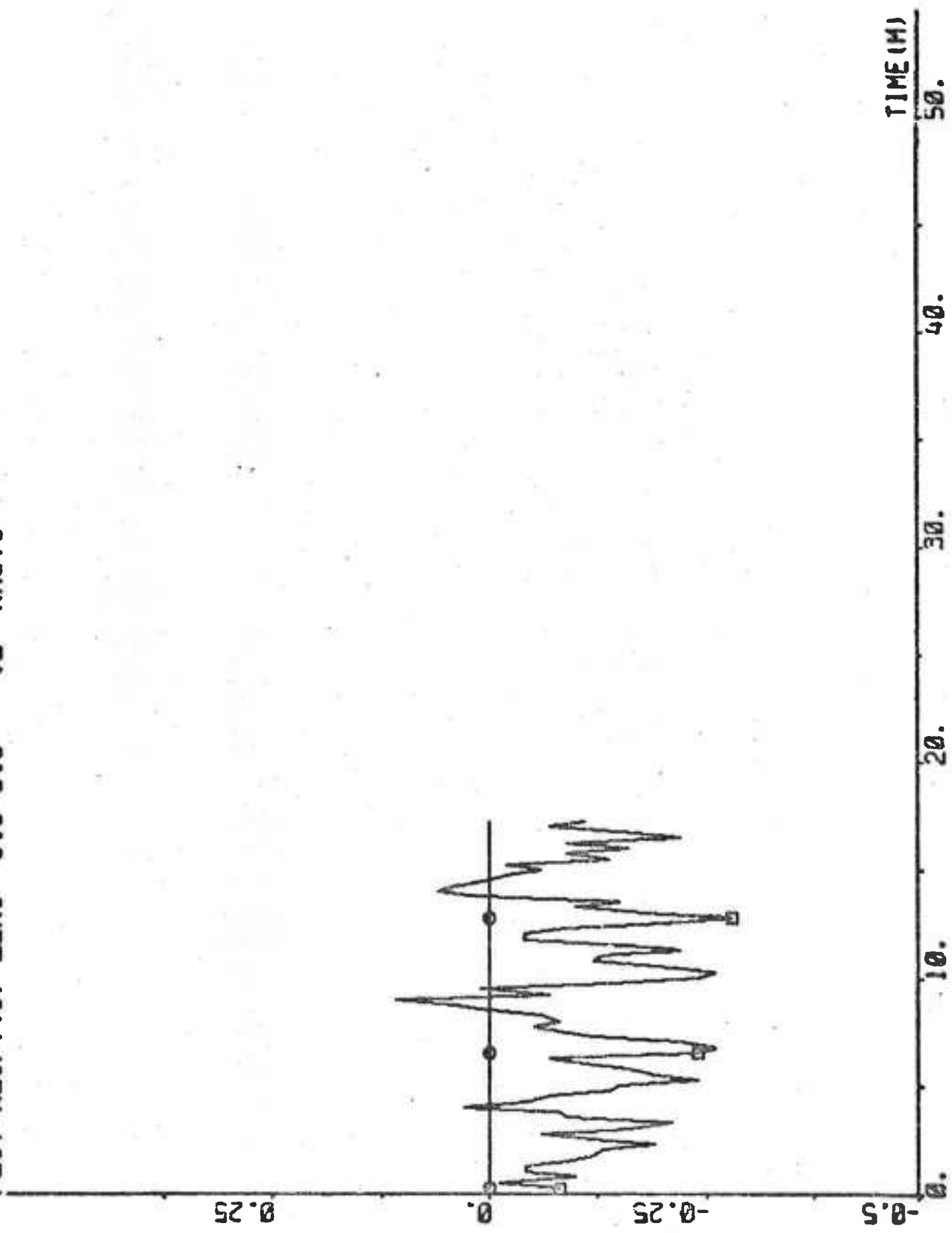


PL0T R23P1 (8) 8 1 "V1 KNOTS

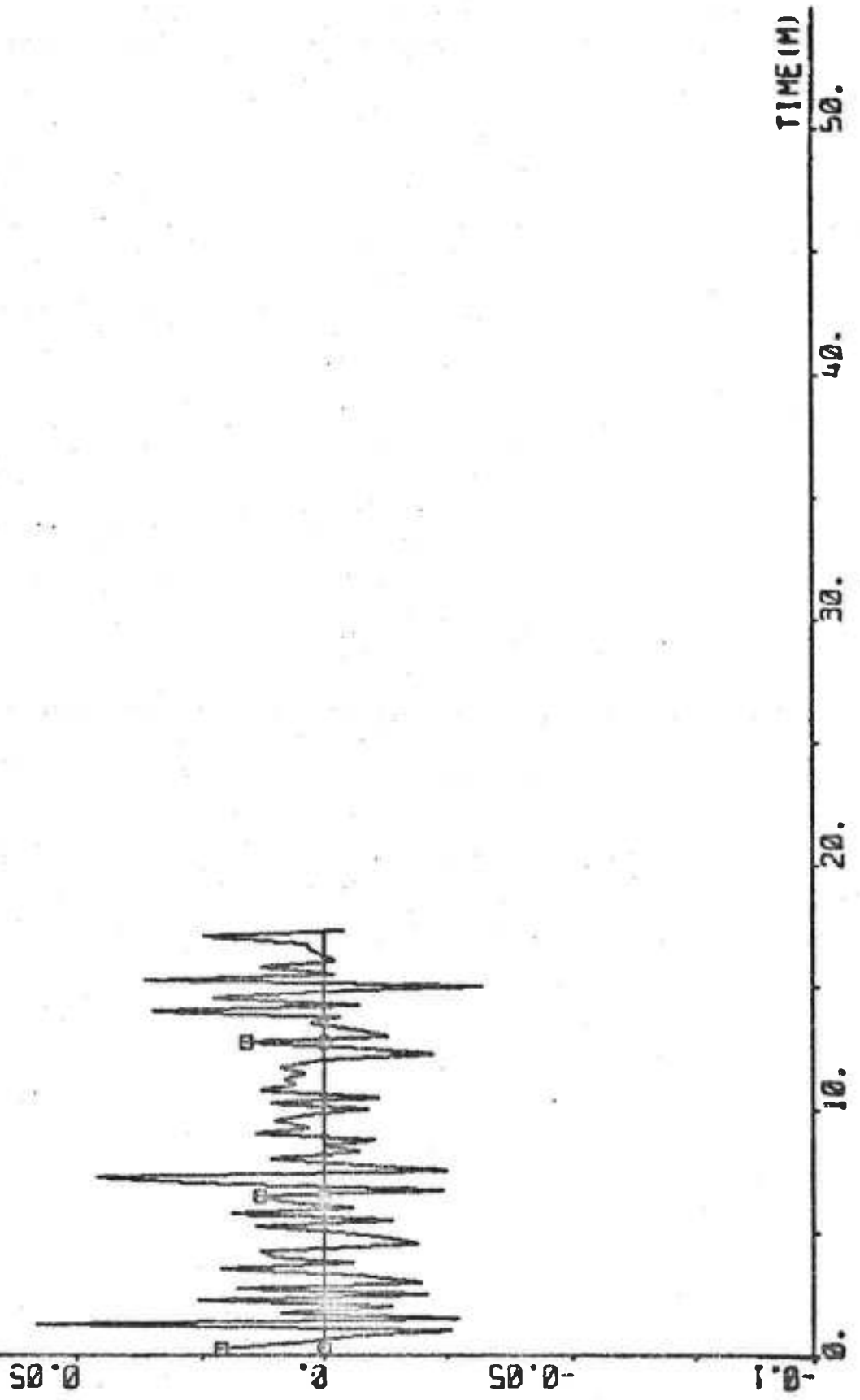




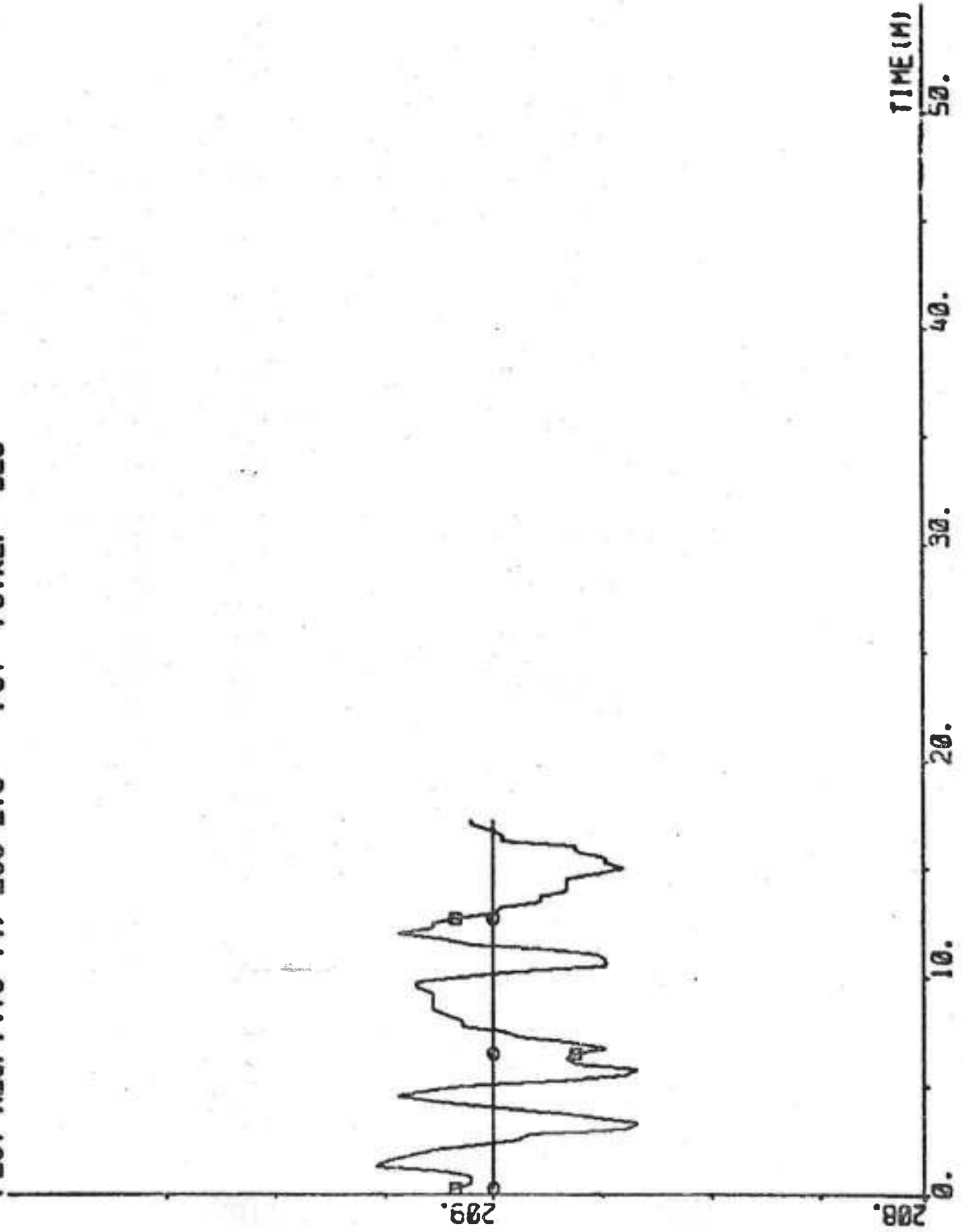
PL0T A23P1(9) ZERO -0.5 0.5 "V2 KNOTS



PLOT A23P1(10) ZERO -6.1 0.1 "R DEG/S



PLOT A23P1(13 14) 208 210 "PSI PSIREF DEG



## EXPERIMENT A24

Date	1974-10-15
Time	13.34
Duration	30 min
Position	N 04 <sup>o</sup> 26' E 51 <sup>o</sup> 38'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	2 Beaufort (2-3.5 m/s, light breeze)
Wave height	1 - 2 m
PSIREF	209 <sup>o</sup>
Rudder limit	Not active

Regulator structure

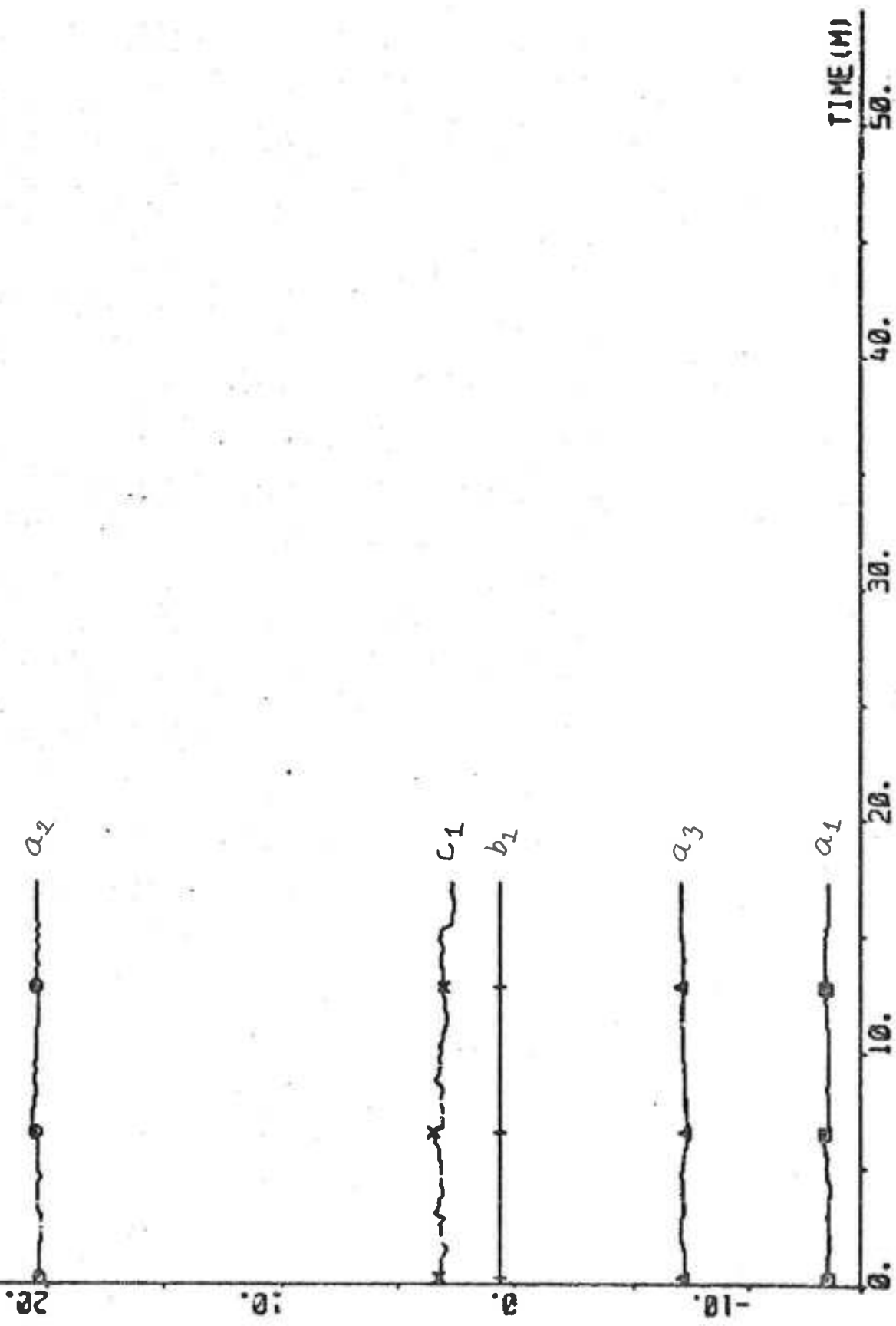
NA = 2	NB = 1	NC = 1	K = 5
IREG = 15	IRDIF = 0	RL = 0.98	IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -4.554 \\ 4.147 \\ 0.888 \\ 30.925 \end{bmatrix} \quad P = \begin{bmatrix} 0.789 & & & \\ -0.781 & 0.817 & & \\ -0.029 & 0.029 & 0.006 & \\ 4.425 & -4.862 & -0.118 & 61.401 \end{bmatrix}$$

$$a_1 + a_2 = -0.407$$

PLOT A23P2 -14 26 "REGULATOR PARAMETERS



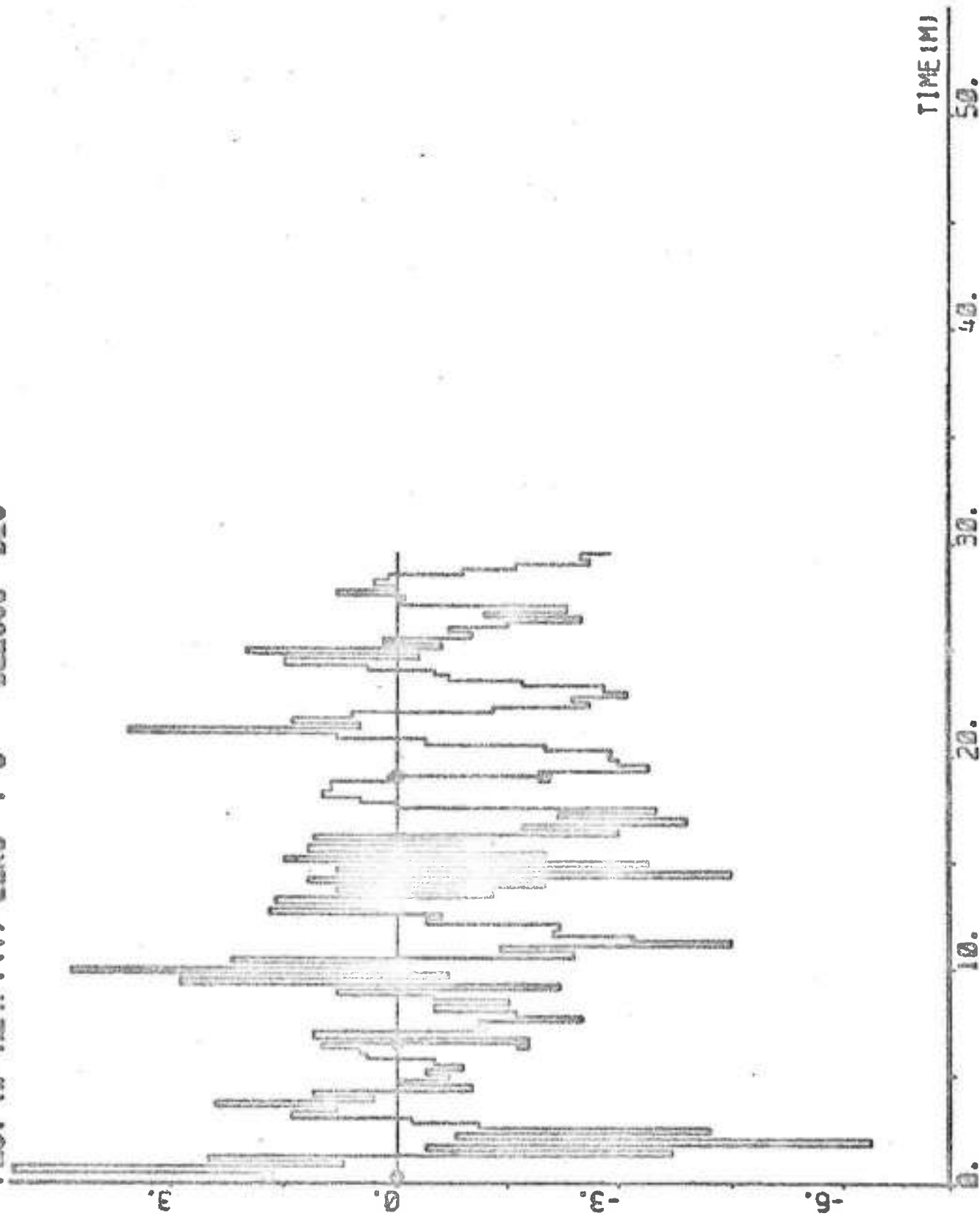
Statistics (mean value and standard deviation)

DELTA	0.29 ± 1.78 deg
PSI-PSIREF	-0.510 ± 0.555 deg
AN	85.59 ± 0.38 rpm
U	16.14 ± 0.11 knots

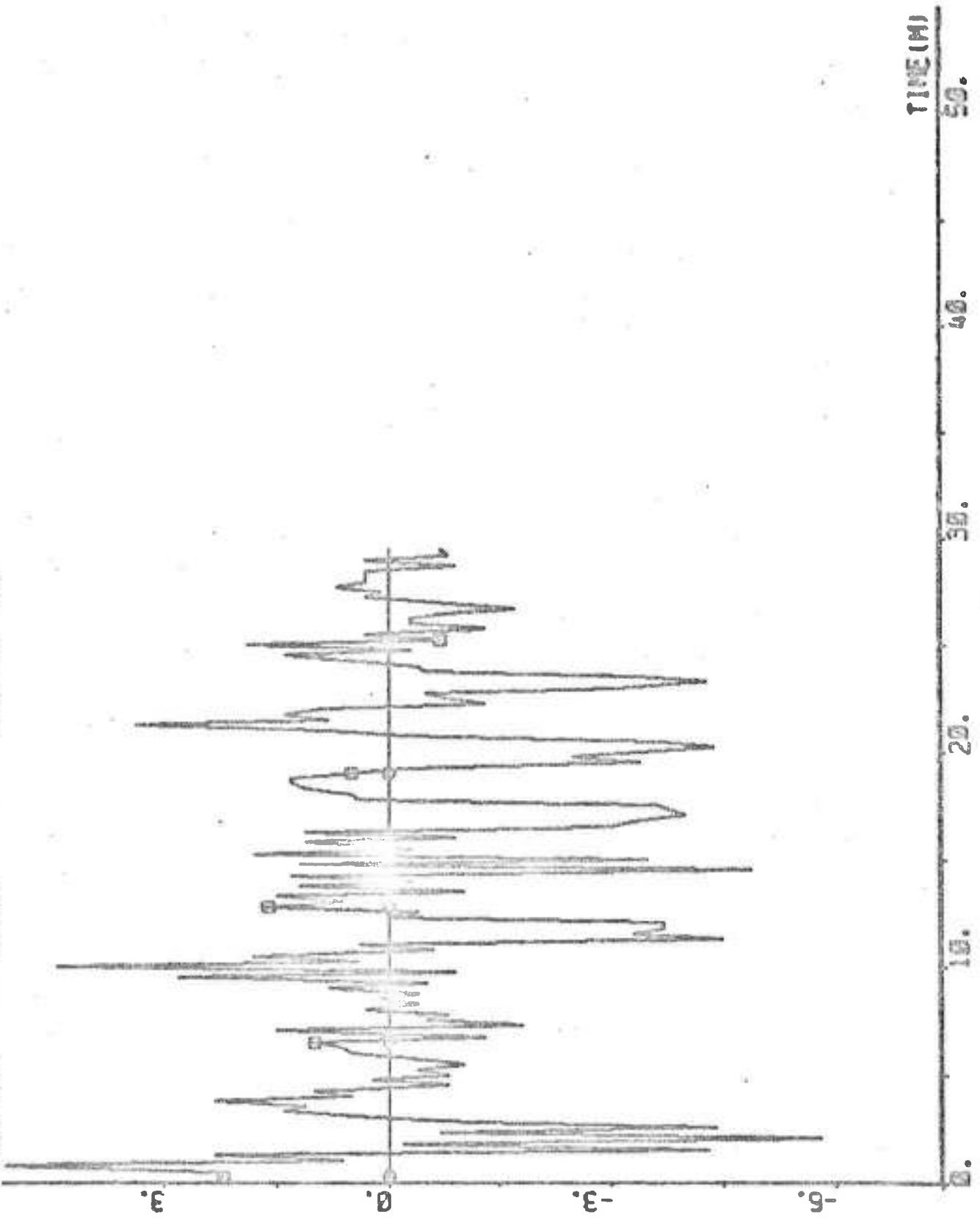
$$V_1 = 0.893$$

$$V_2 = 0.885$$

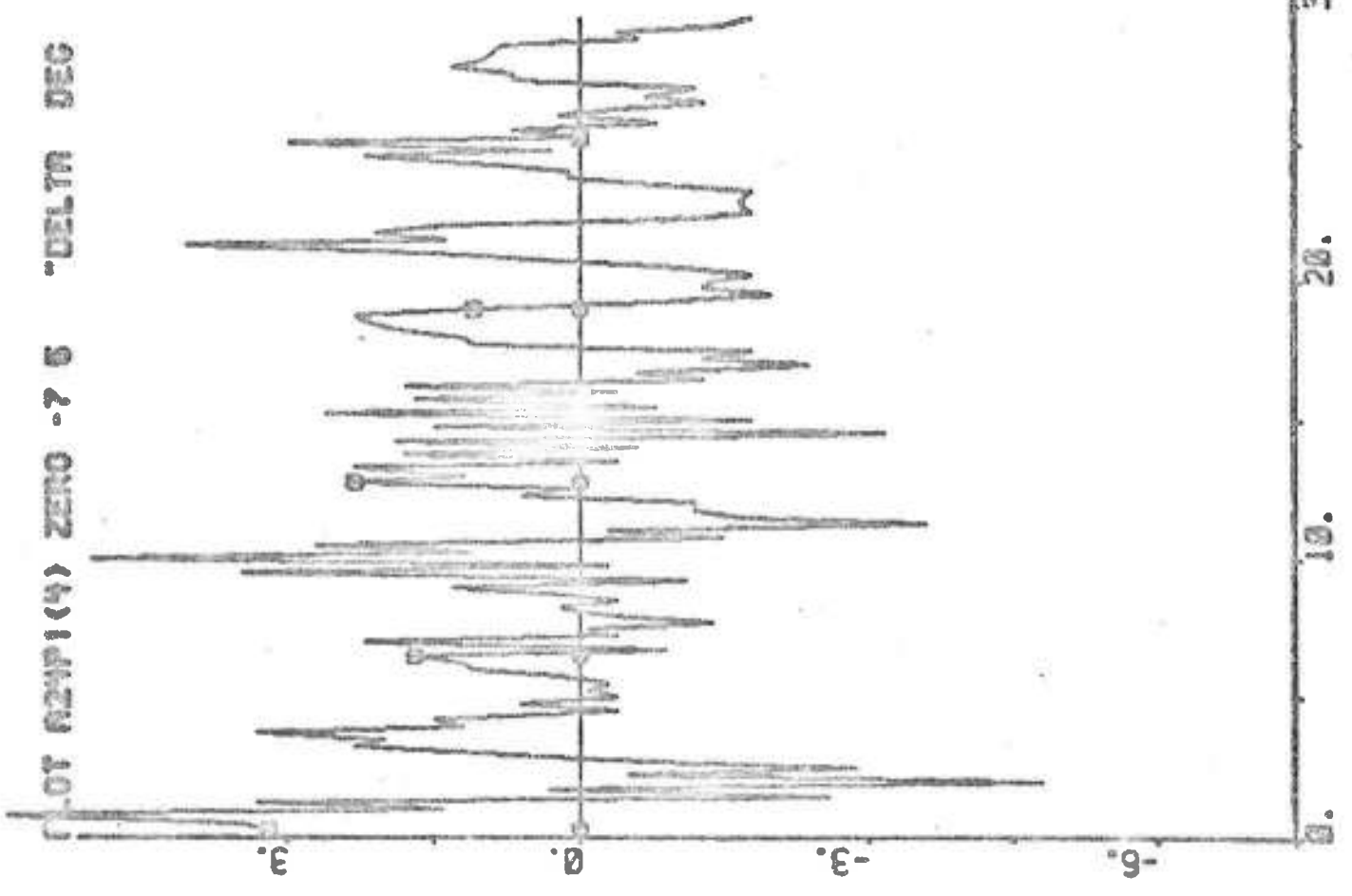
PLOT WP R24P1(1) ZERO -7 G "DELCOG DEG



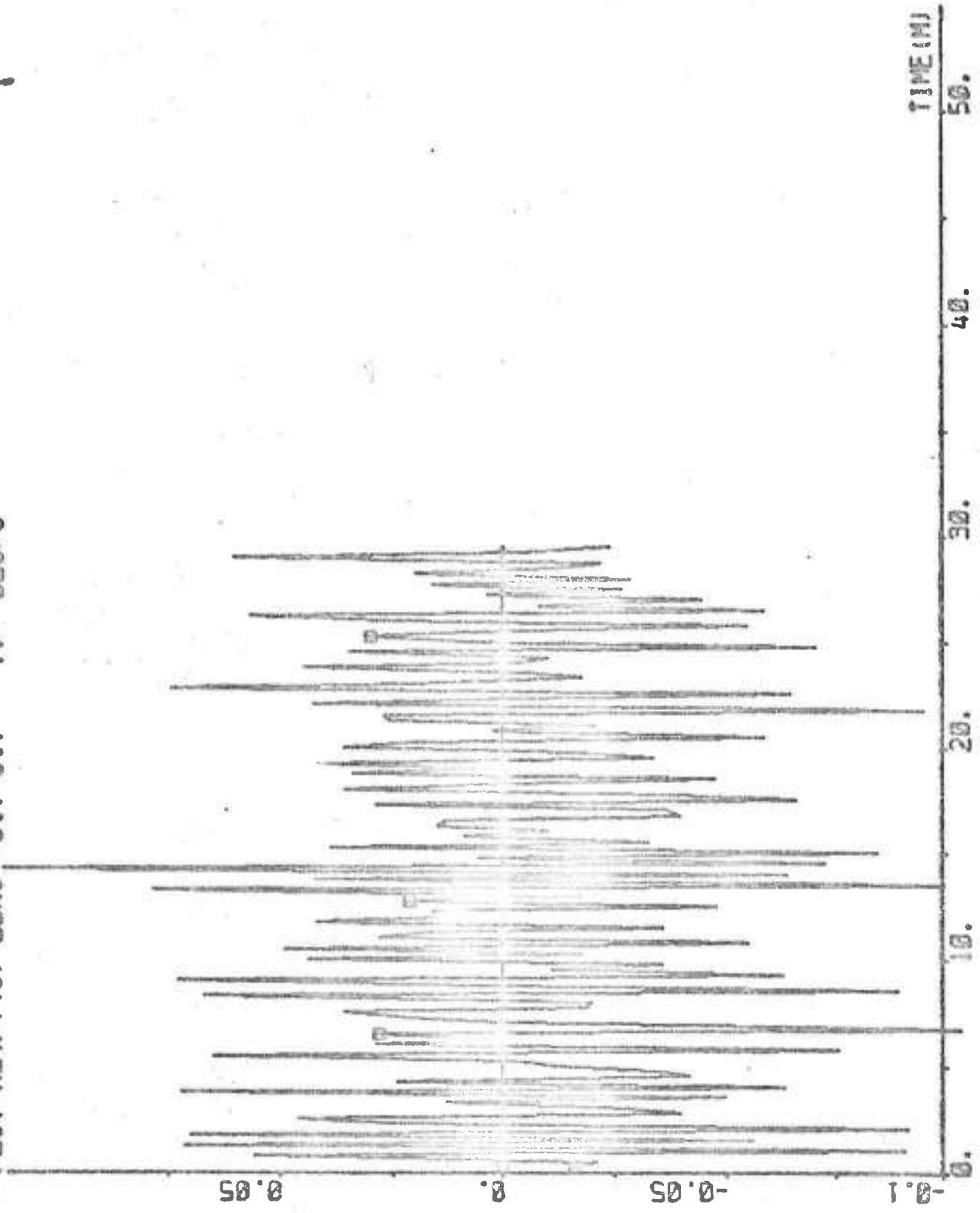
FLOT R24P1(3) ZERO -7 6 "DELTA" DEG



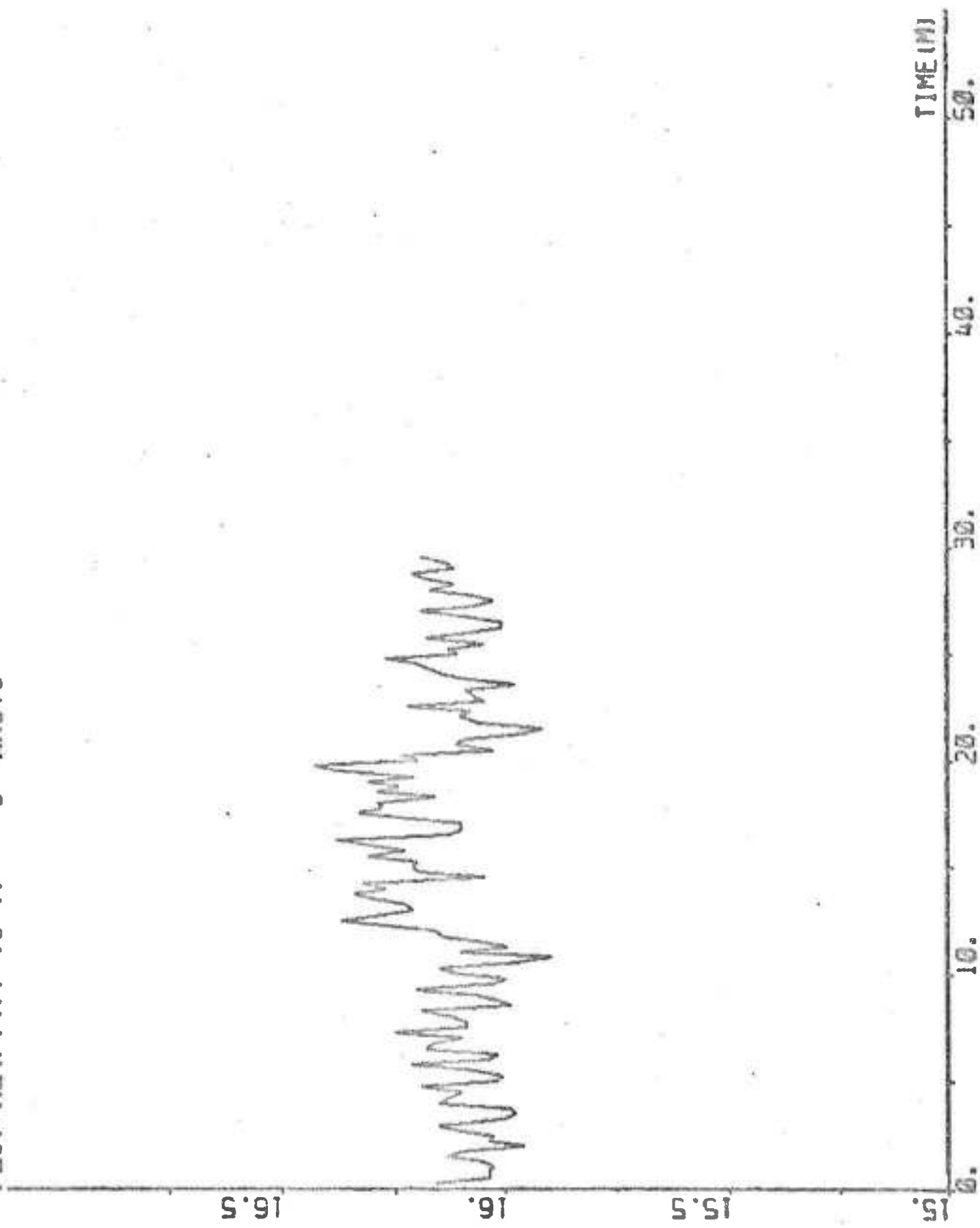




PLOT AZIP(6) ZERO -0.1 0.1 PP DEG/S

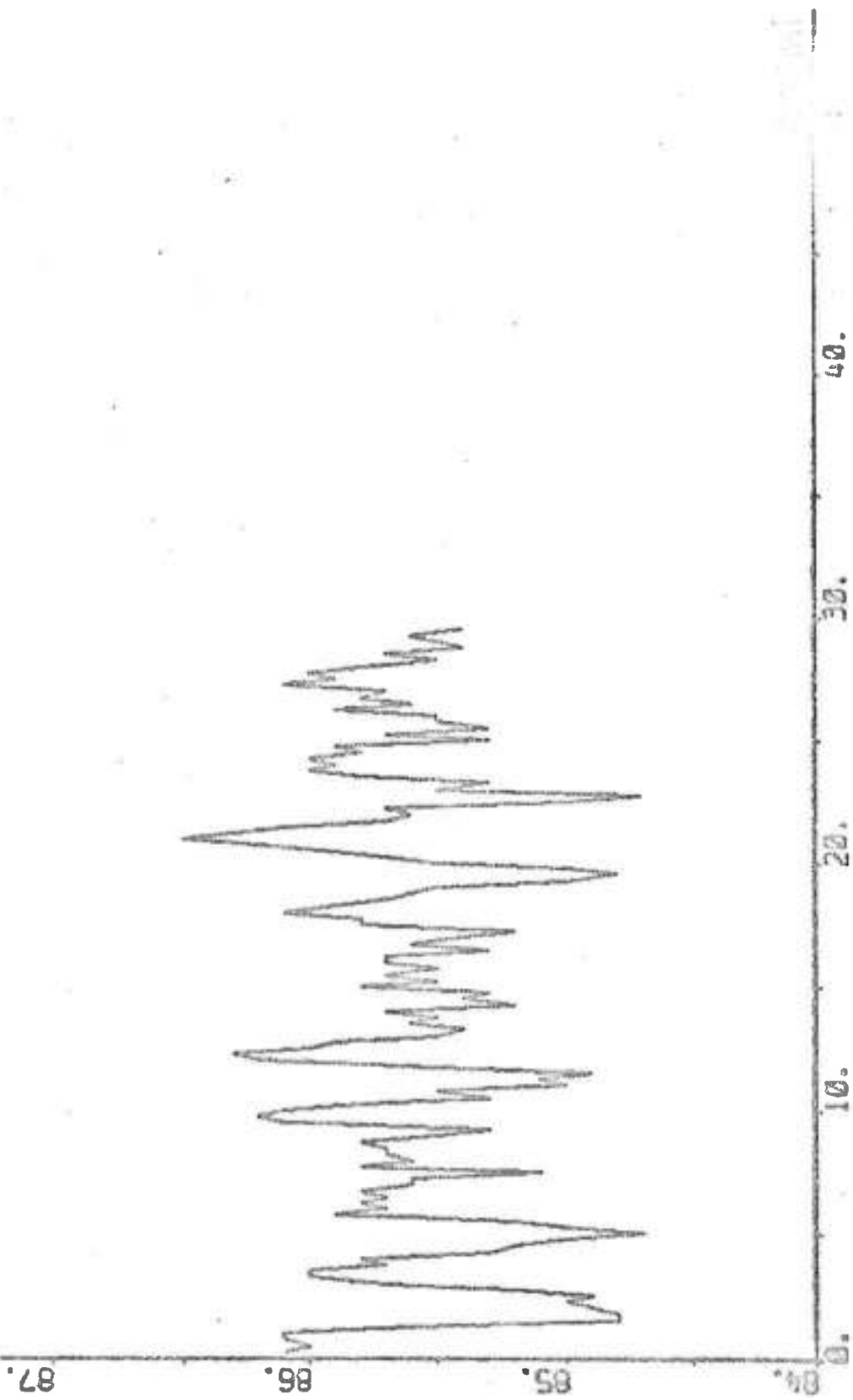


PLOT RZHP1(7) 15 17 ~U KNOTS

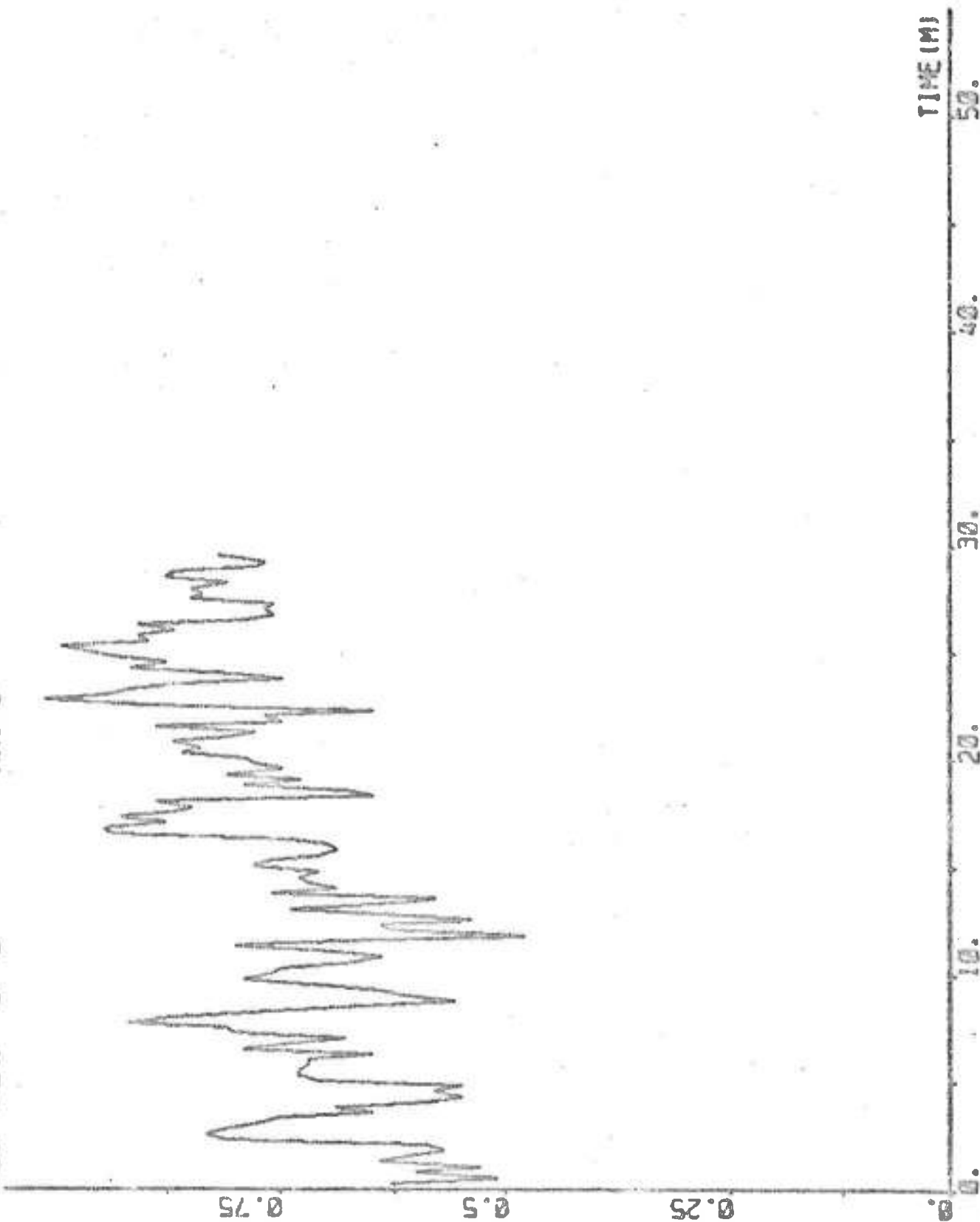


TIME (M)

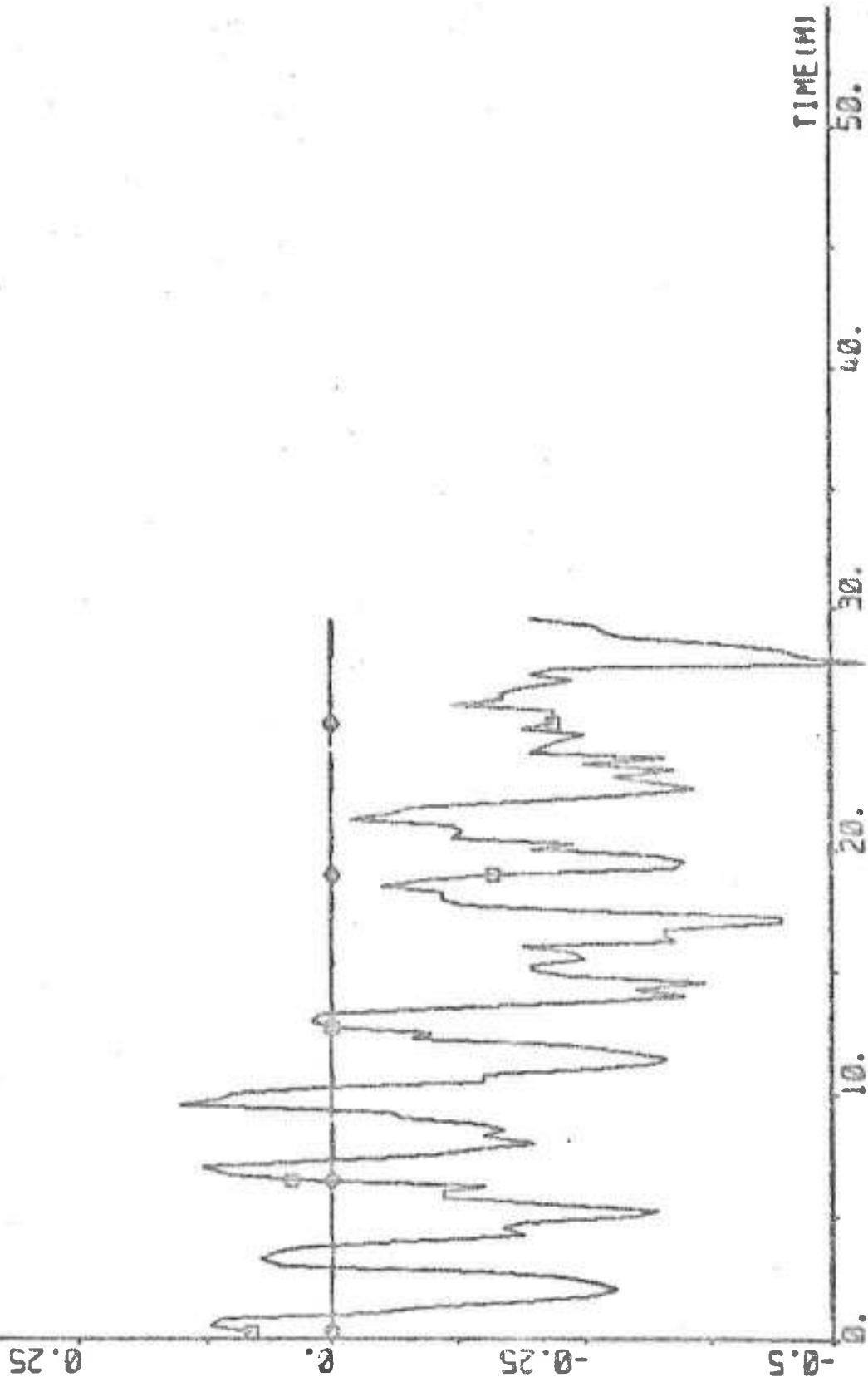
PLOT A24P1(6) 04 68 "DN RPN



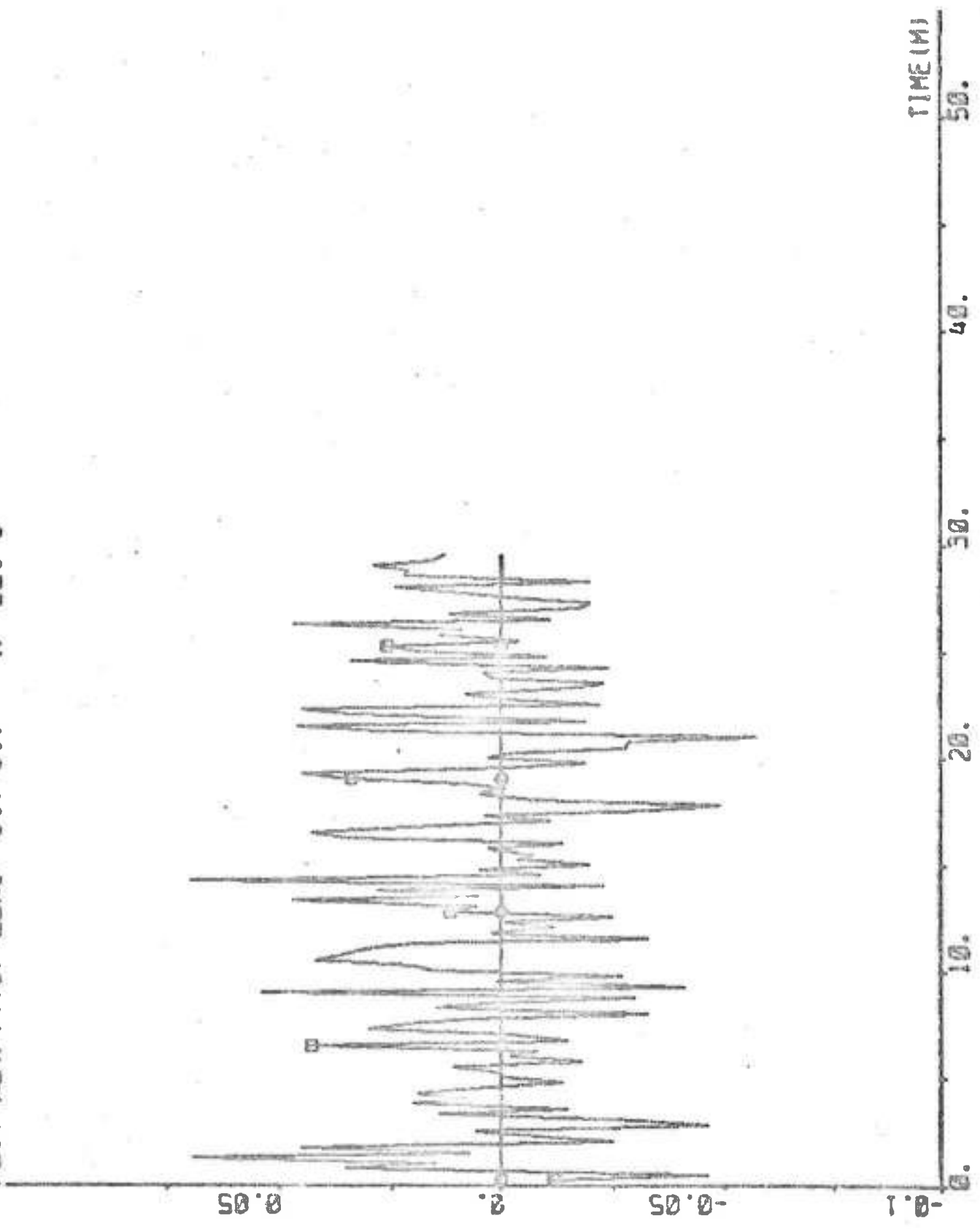
PLOT 024P1(0) 0 1 -VI KNOTS



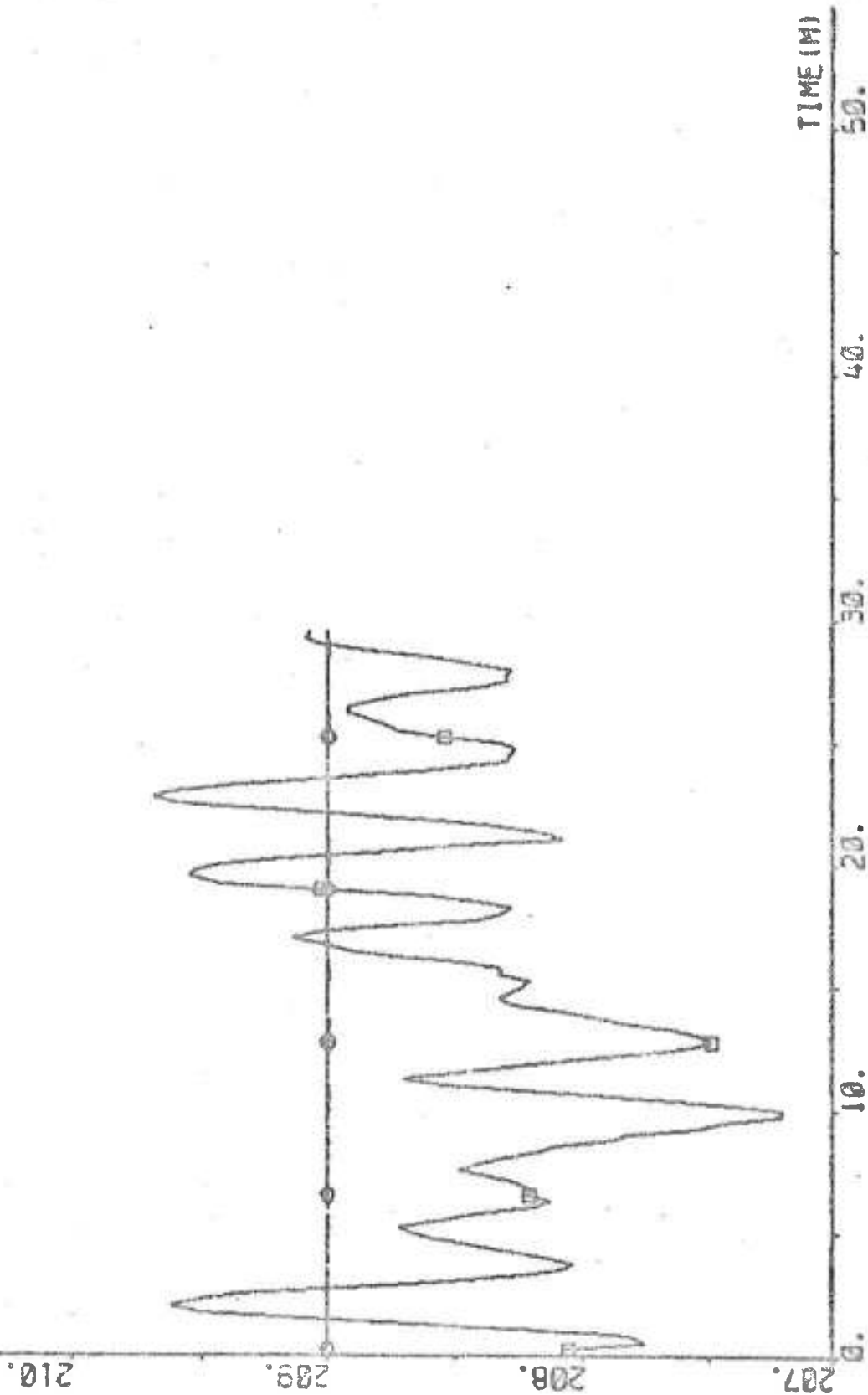
FLOT R24P1(8) ZERO -0.5 0.5 -V2 KNOTS



PLOT R24P1(10) ZERO -0.1 0.1 °R DEG/S



PLOT A24P1(13 14) 207 211 °PSI PSIPREF DEG





FLOT A24P2 -20 40 REGULATOR PARAMETERS



## EXPERIMENT A25

Date	1974-10-15
Time	14.31
Duration	26 min
Position	N 04° 13' E 51° 31'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	2 Beaufort (2-3.5 m/s, light breeze)
Wave height	1 - 2 m
PSIREF	209°
Rudder limit	Not active

Regulator structure

NA = 3	NB = 2	NC = 1	K = 5
IREG = 15	IRDIF = 0	RL = 0.98	IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \\ c_1 \end{bmatrix} = \begin{bmatrix} -14.112 \\ 21.221 \\ -7.715 \\ 0.654 \\ 0.025 \\ -0.588 \end{bmatrix} \quad P = \begin{bmatrix} 3.714 & & & & & \\ -3.107 & 10.445 & & & & \\ 0.241 & -7.804 & 8.124 & & & \\ -0.127 & -0.408 & 0.538 & 0.054 & & \\ -0.103 & -0.375 & 0.485 & 0.045 & 0.049 & \\ 1.914 & -3.132 & 1.465 & 0.133 & 0.237 & 53.165 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.606$$

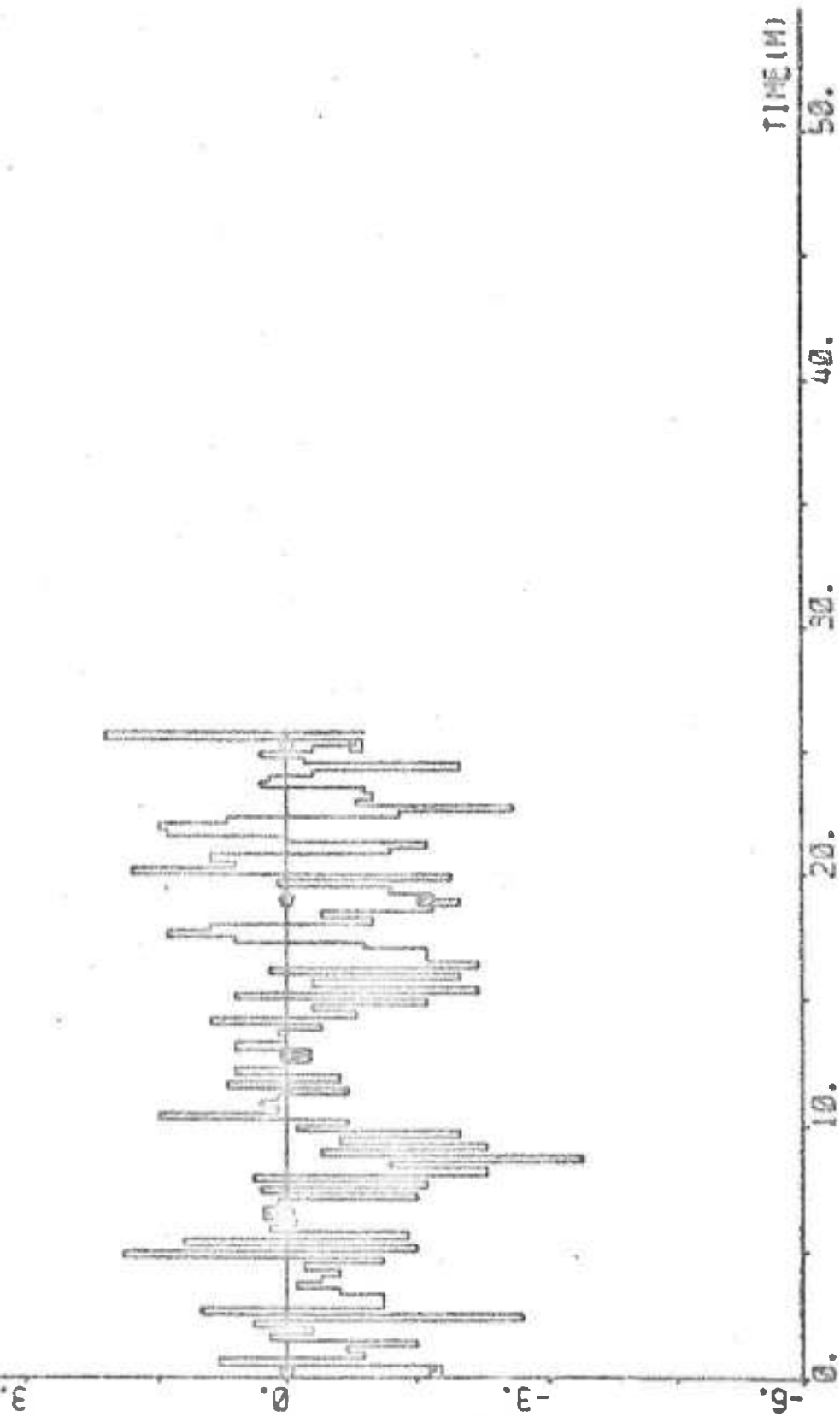
Statistics (mean value and standard deviation)

DELTA	0.21 ± 1.10 deg
PSI-PSIREF	-0.003 ± 0.171 deg
AN	85.55 ± 0.21 rpm
U	16.30 ± 0.08 knots

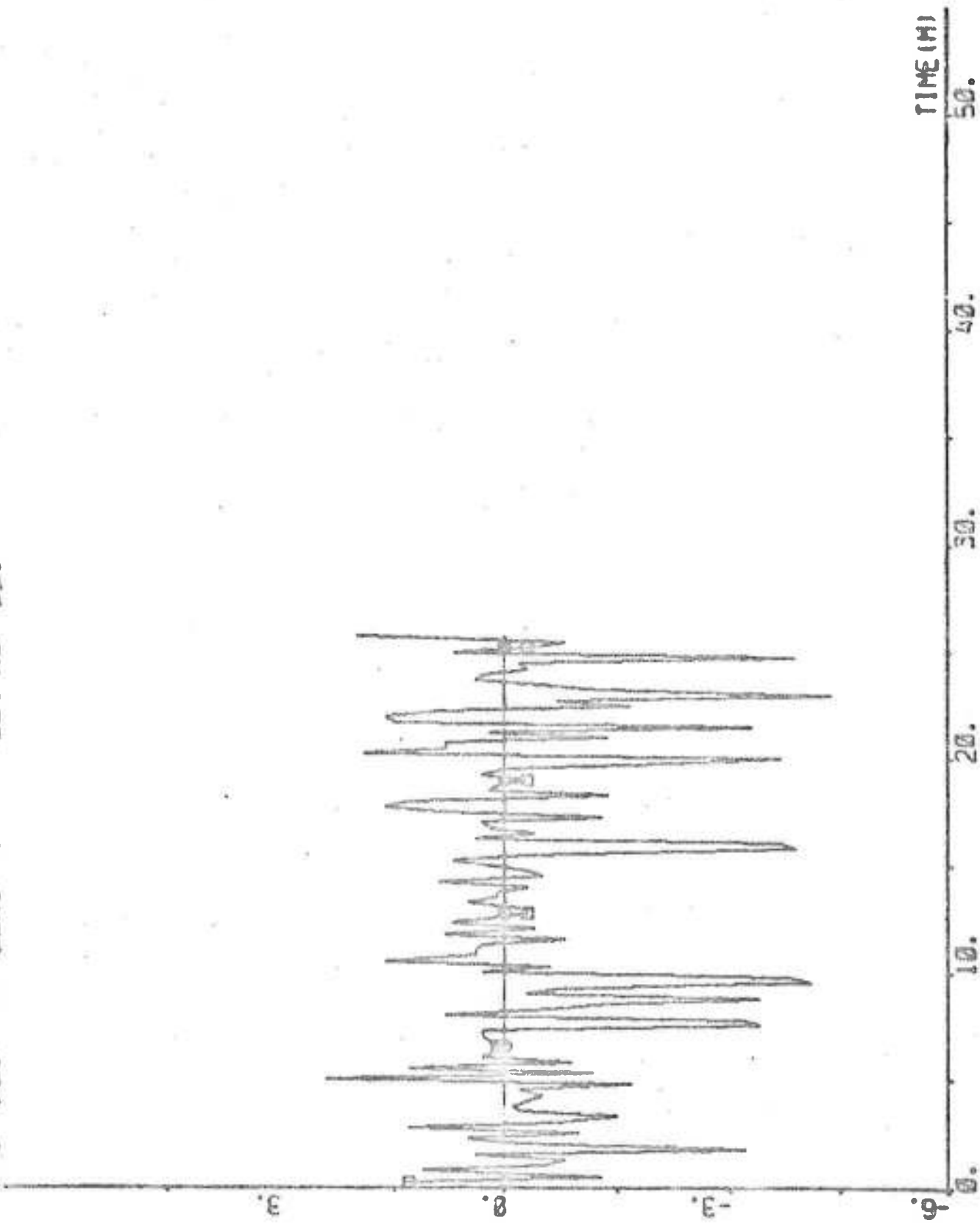
$$V_1 = 0.155$$

$$V_2 = 0.150$$

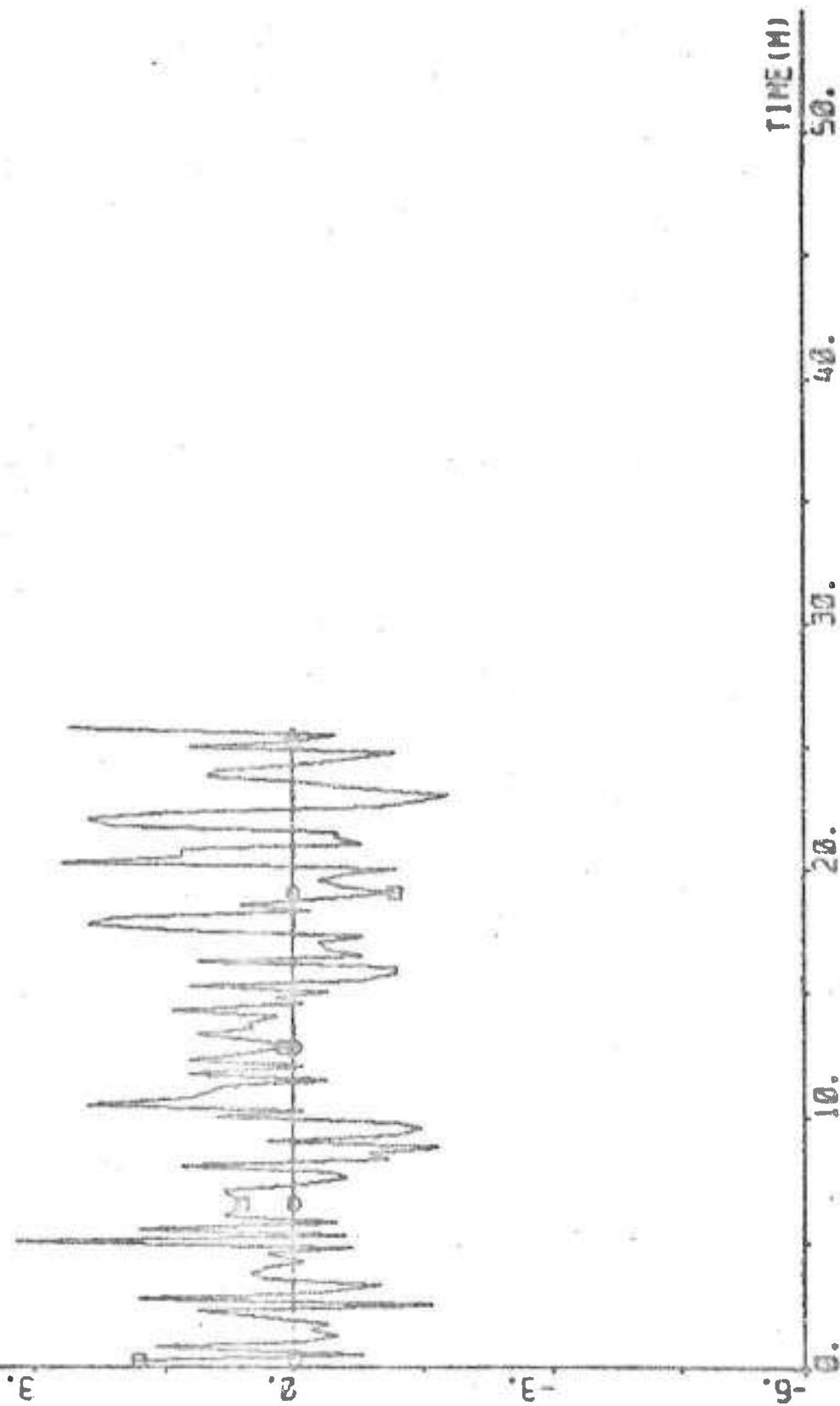
PLOT HP A26P1(1) ZERO -5 ? -DELCOG DEG

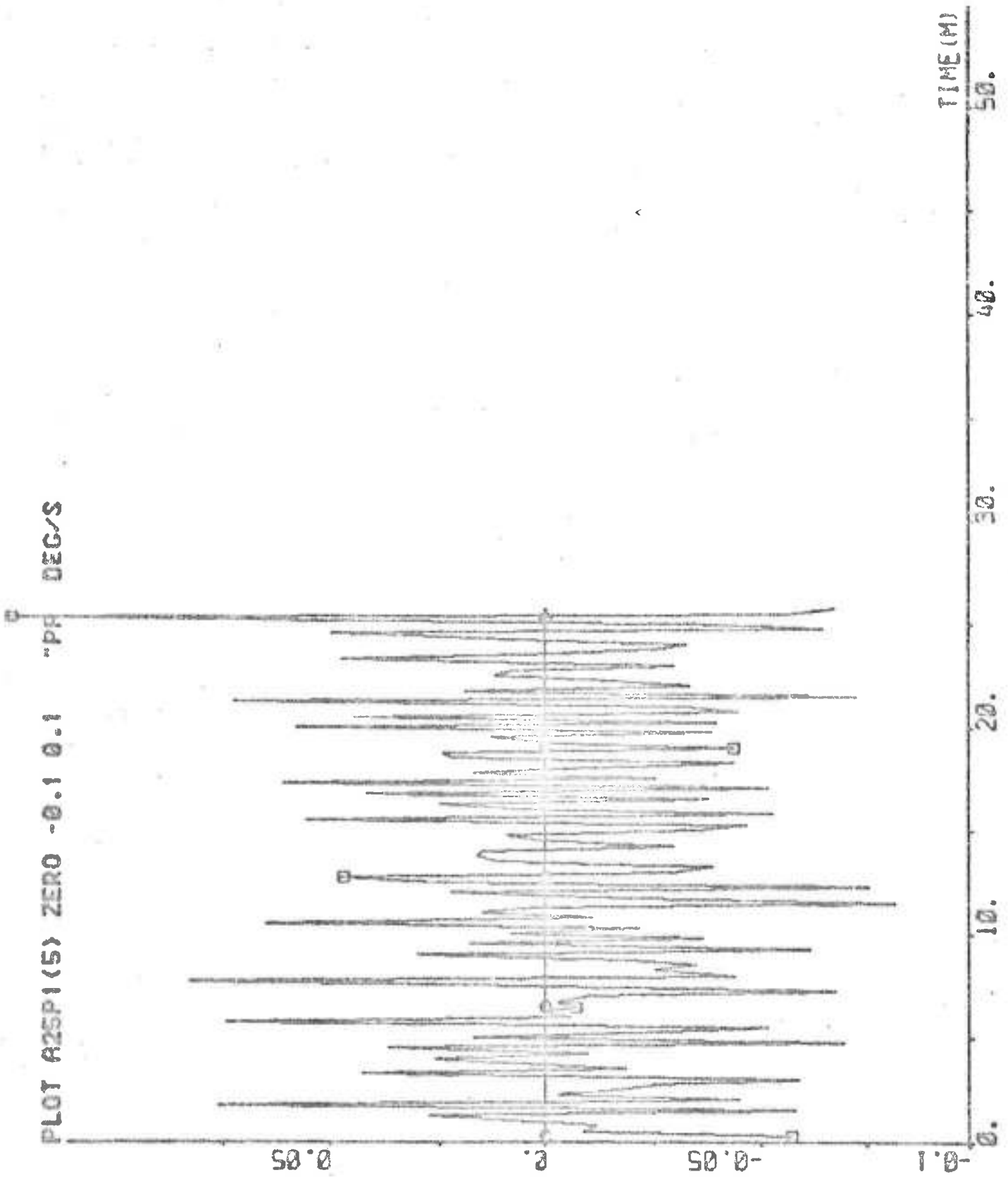


PLOT A25P1(3) ZERO -5 7 DELTAS DEG



PLOT A2SP1(4) ZERO -5 7 DELTA DEG





FLOT R125P1(6) 04 00 °PM RPH

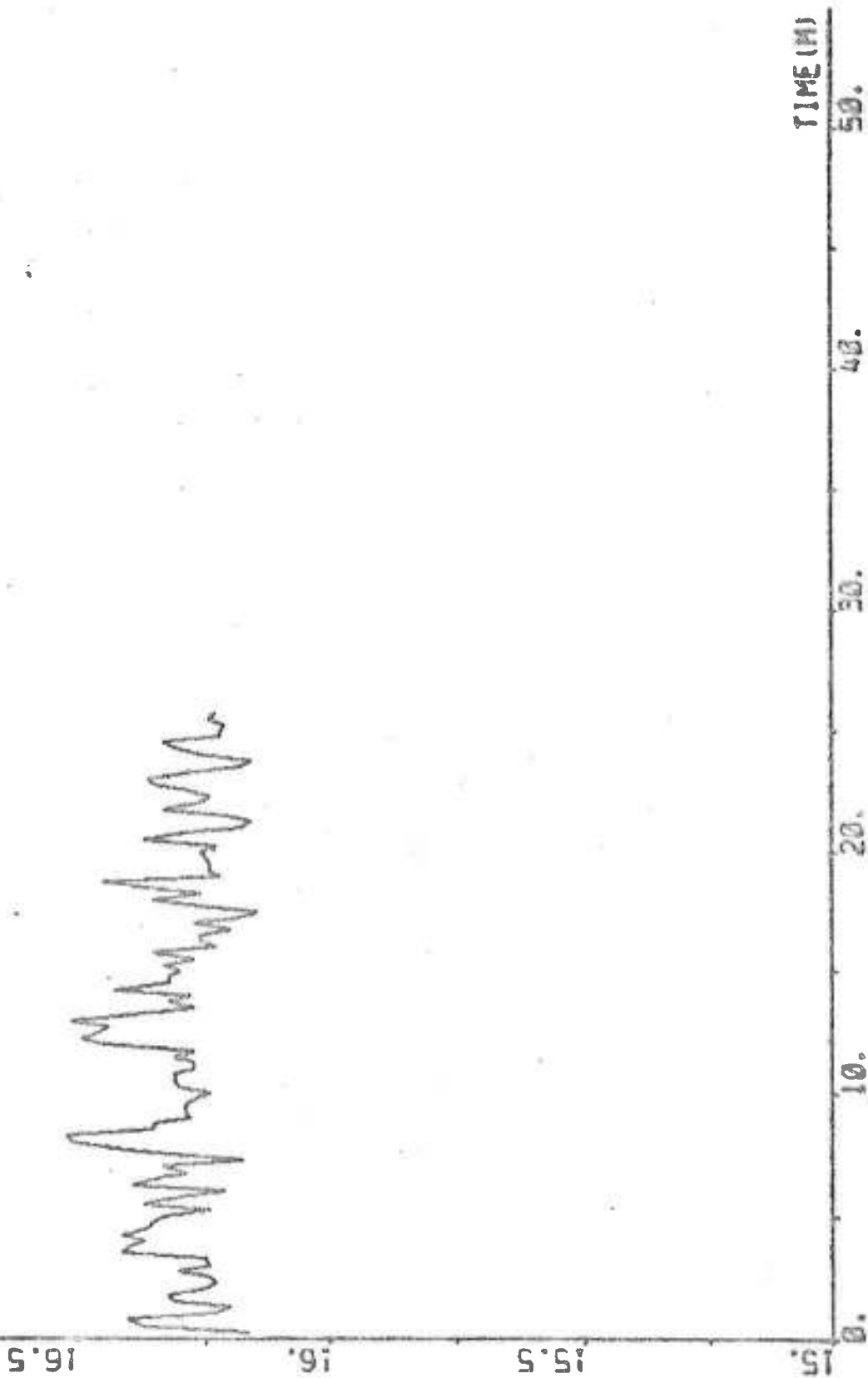
84.  
85.  
87.



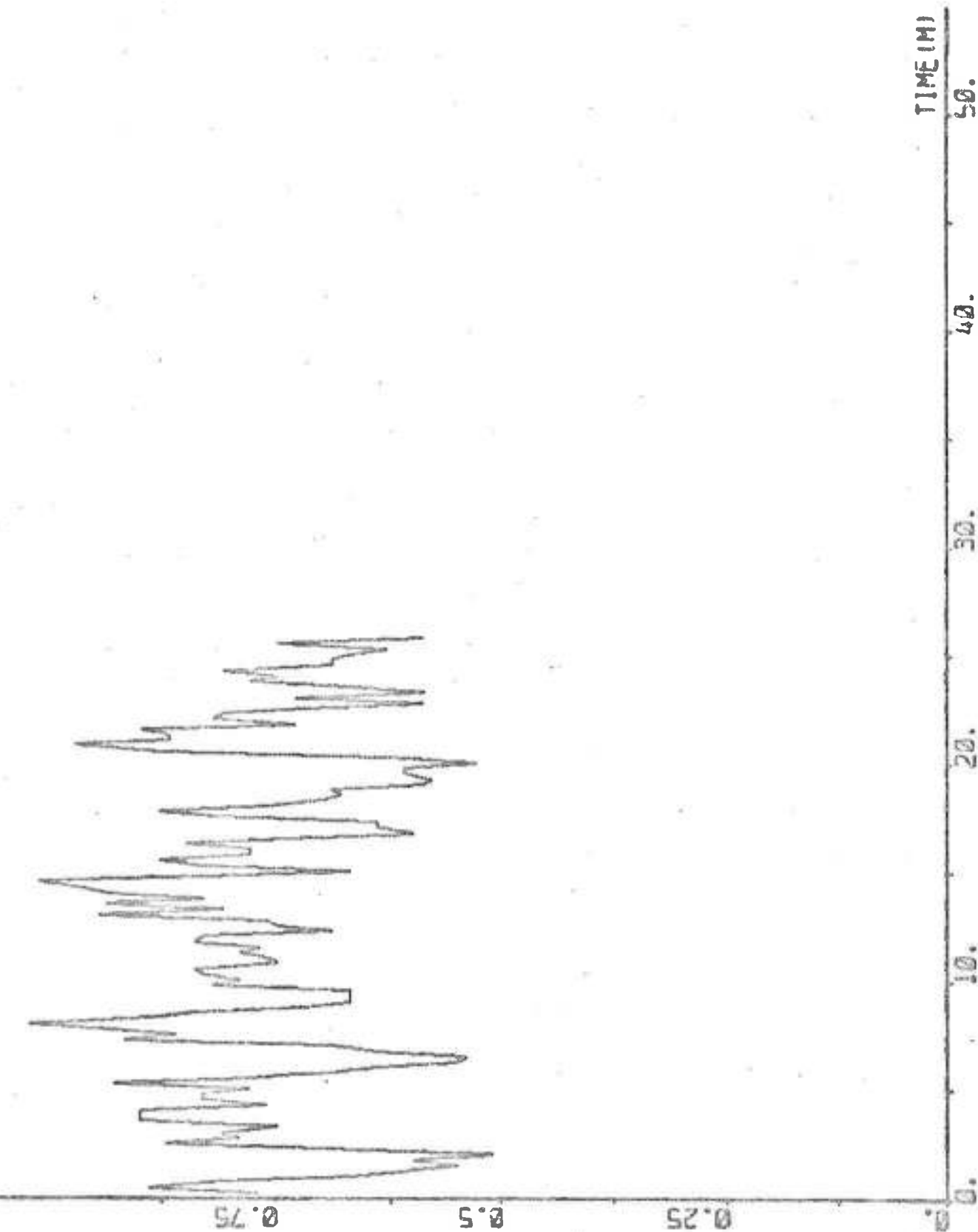
0. 10. 20. 30. 40. 50. TIME (M)



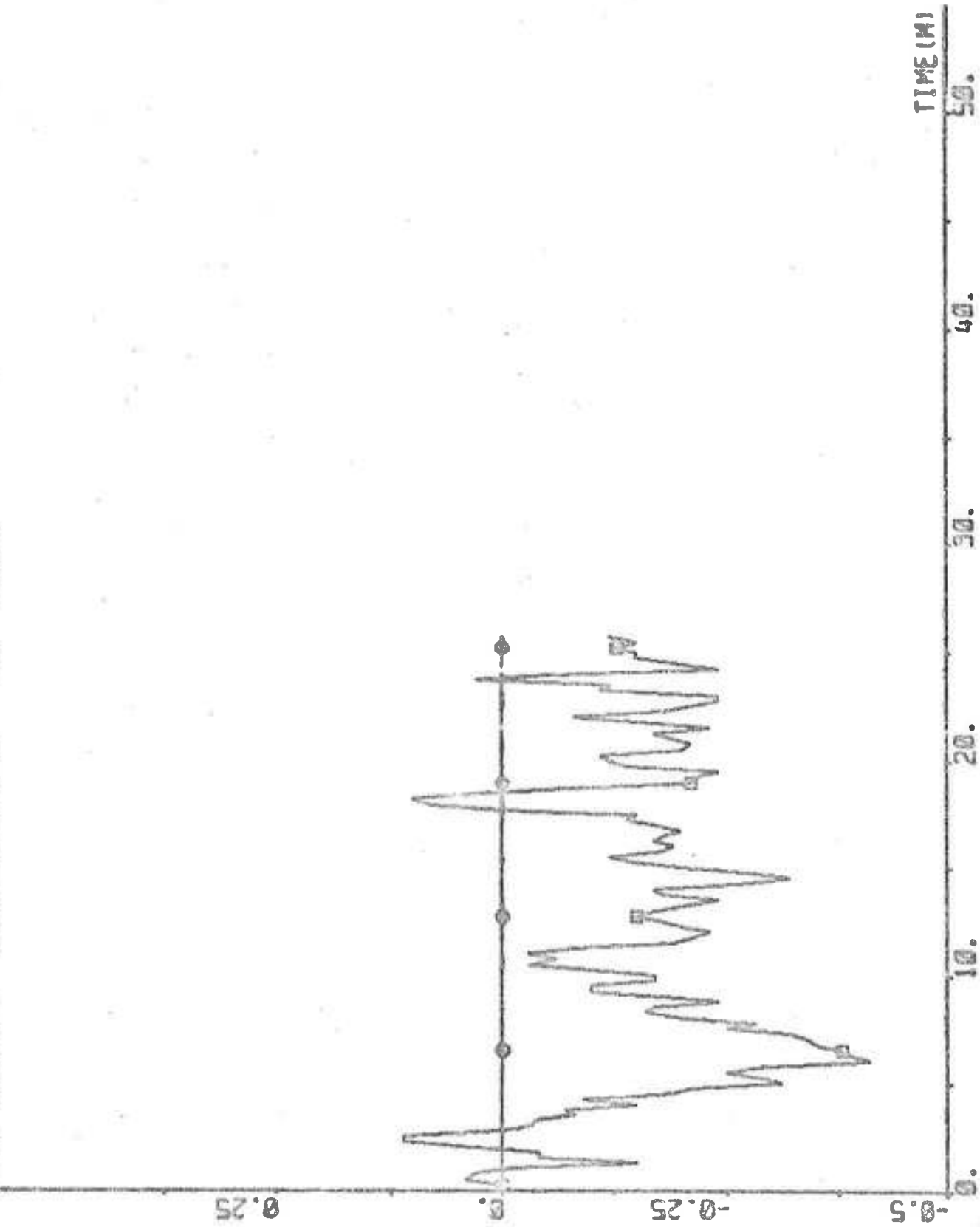
PLOT A2SP1(7) 16 17 "U KNOTS



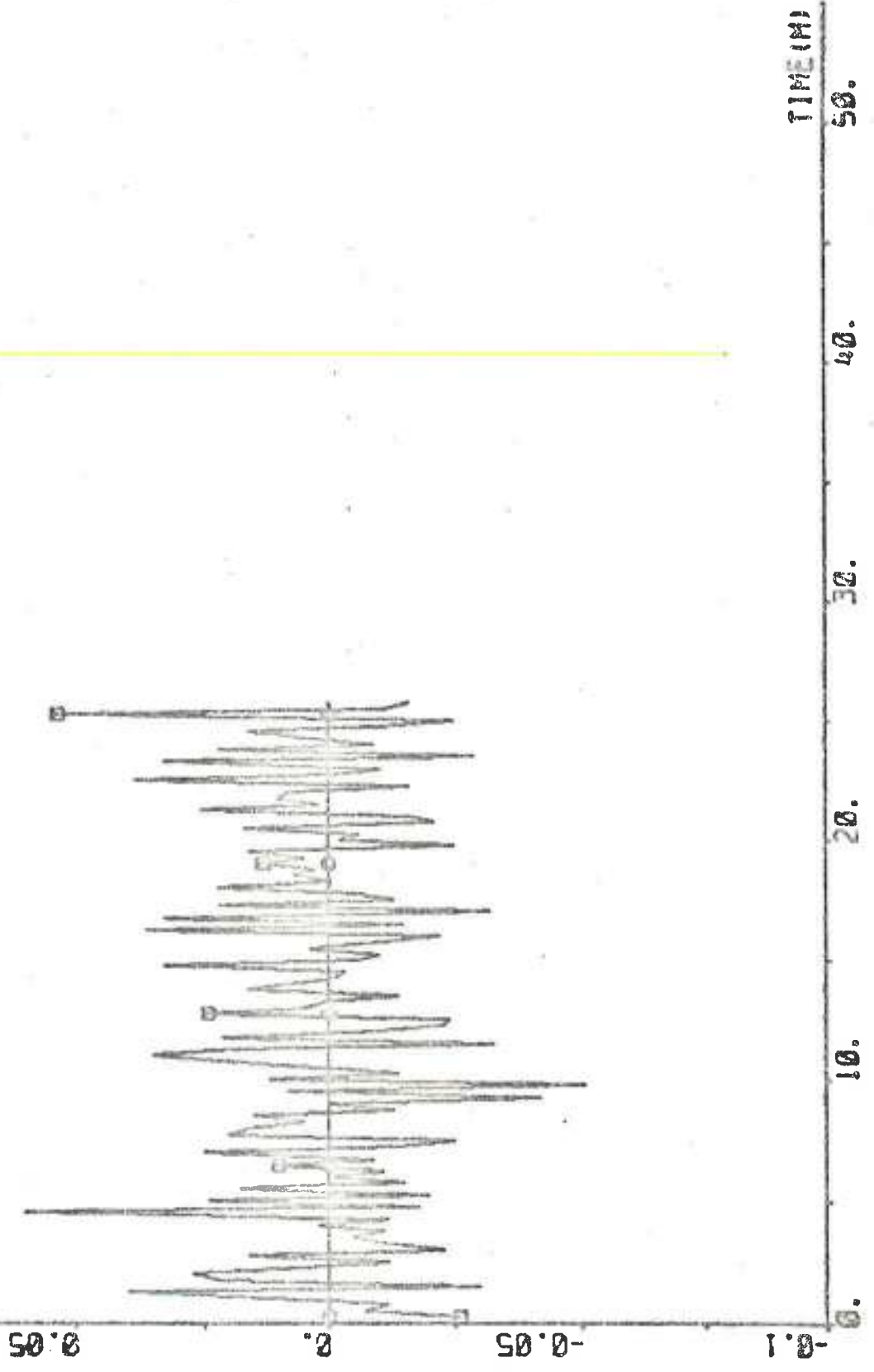
PLOT A28P1(9) 0 1 -V1 KNOTS



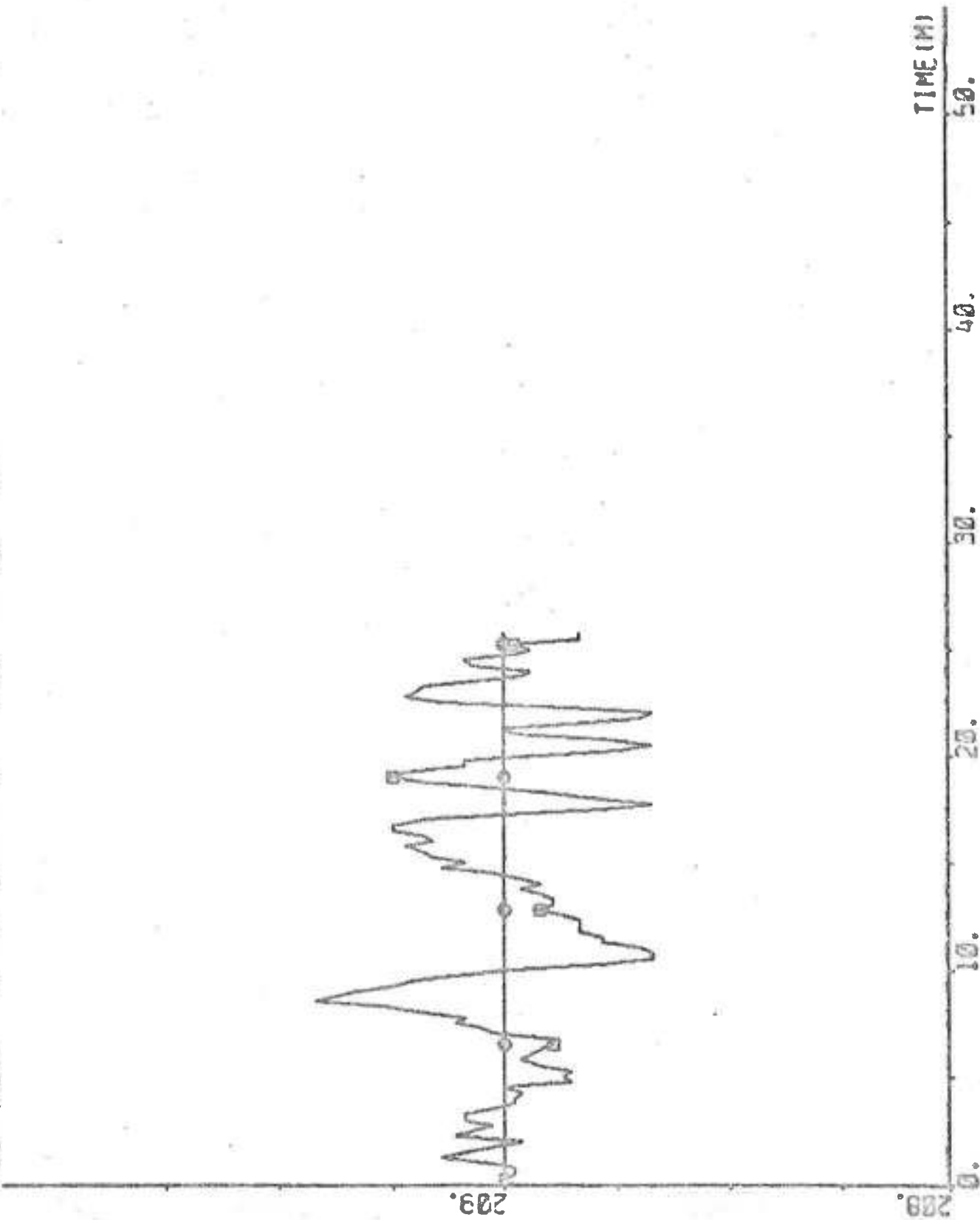
PLOT R2SP1(8) ZERO -0.5 0.5 ^V2 KNOTS



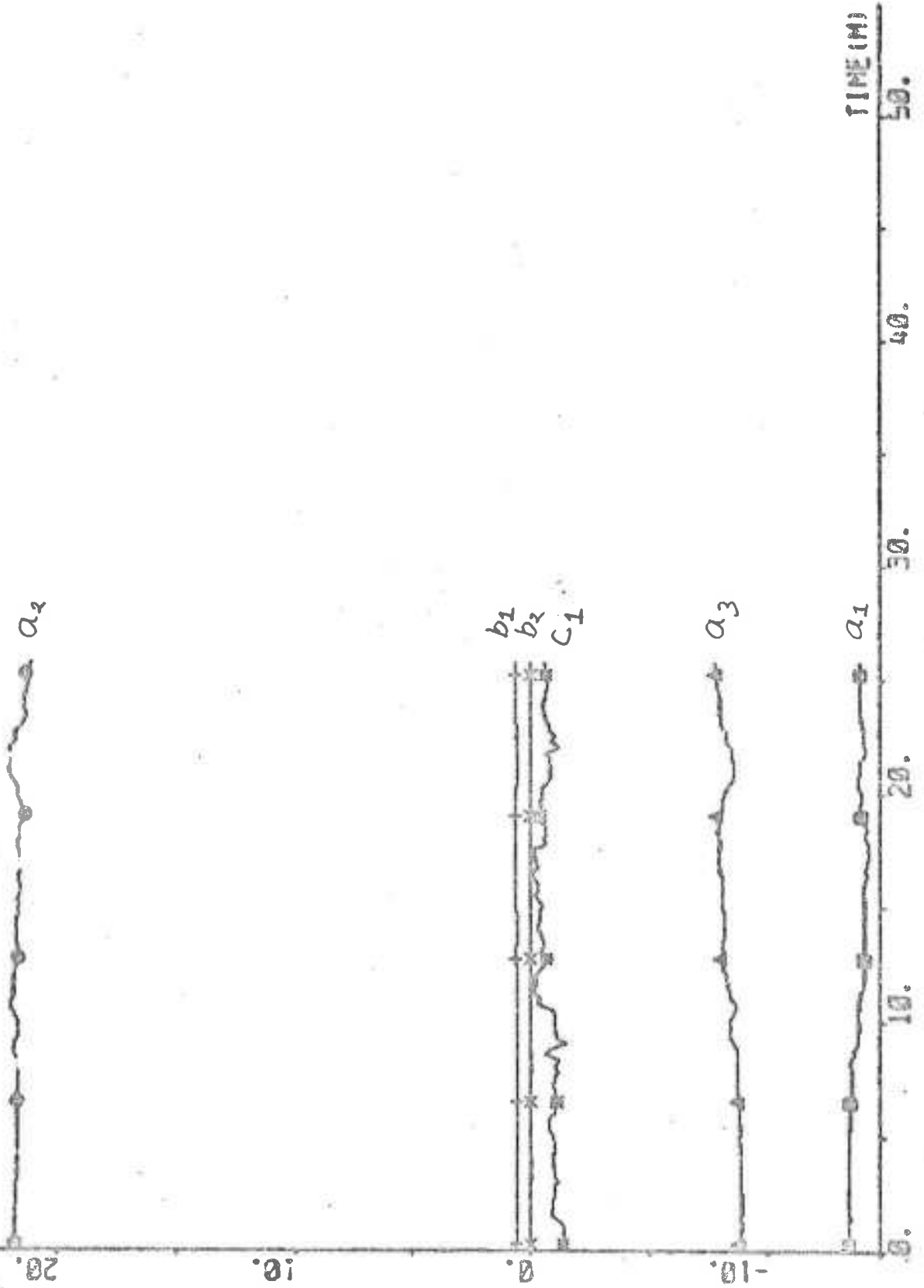
PLOT R2SP1(10) ZERO -0.1 0.1 -R DEG/S



PLOT A25P1(13 14) 208 210 -PSI PSIREF DEG



PLOT A25P2 -14 26 REGULATOR PARAMETERS



## EXPERIMENT A26

Date	1974-10-15
Time	16.20
Duration	26 min
Position	N 03 <sup>o</sup> 48' E 51 <sup>o</sup> 12'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	3 Beaufort (4-5.5 m/s, gentle breeze)
Wave height	2 m
PSIREF	209 <sup>o</sup>
Rudder limit	Not active

Regulator structure

NA = 3	NB = 2	NC = 2	K = 5
IREG = 15	IRDIF = 0	RL = 0.98	IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \\ c_1 \\ c_2 \end{bmatrix} = \begin{bmatrix} -13.790 \\ 21.190 \\ -7.316 \\ 0.686 \\ 0.018 \\ -2.277 \\ 0.112 \end{bmatrix} \quad P = \begin{bmatrix} 5.758 & & & & & & & \\ -8.857 & 27.467 & & & & & & \\ 4.861 & -22.273 & 20.833 & & & & & \\ 0.140 & -1.174 & 1.206 & 0.099 & & & & \\ 0.135 & -1.077 & 1.107 & 0.084 & 0.083 & & & \\ 4.980 & -7.260 & 2.224 & 0.283 & 0.163 & 75.302 & & \\ -2.338 & 7.221 & -5.993 & 0.041 & 0.075 & 12.069 & 63.850 & \end{bmatrix}$$

$$a_1 + a_2 + a_3 = 0.084$$

Statistics (mean value and standard deviation)

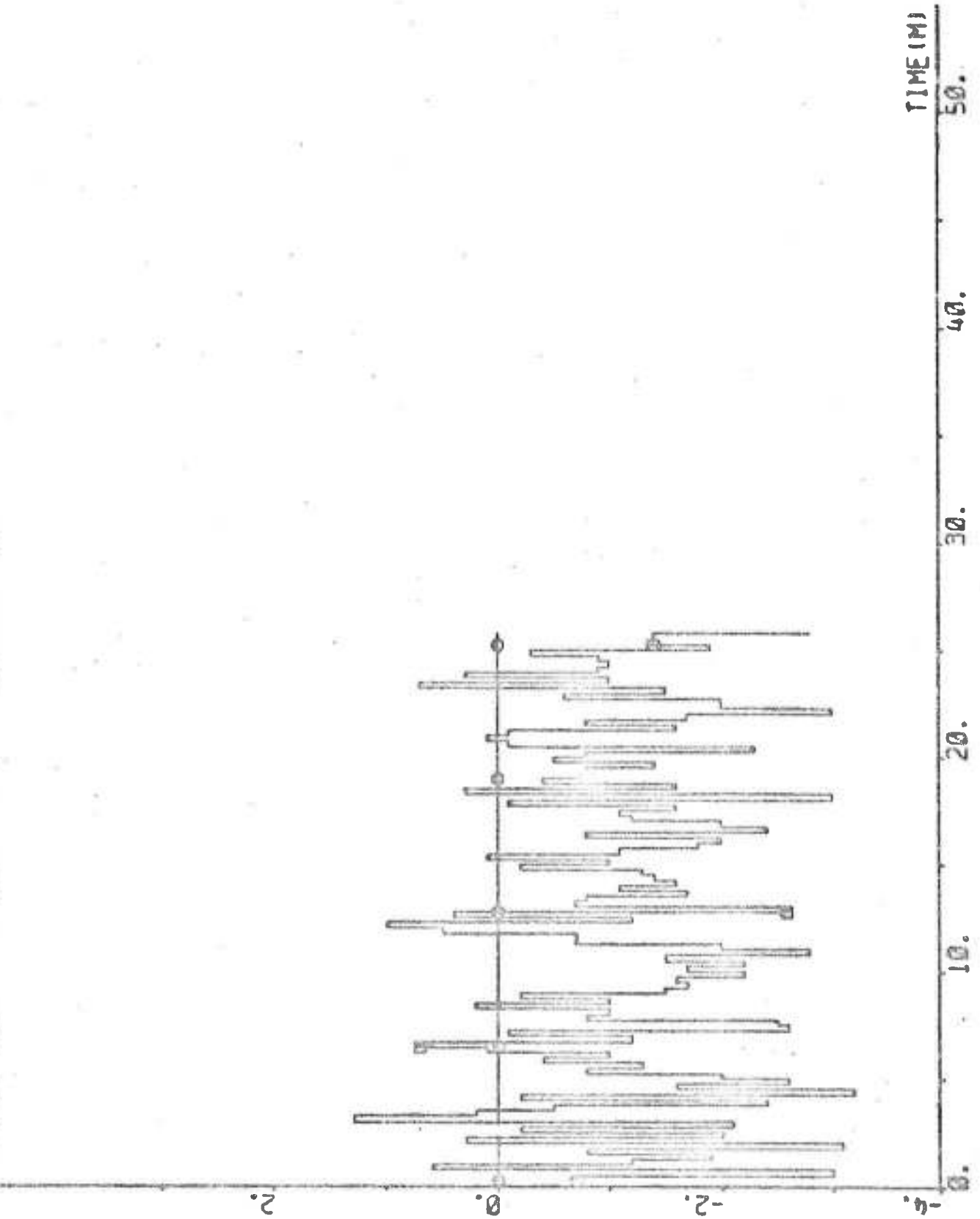
DELTA	-0.34 ± 0.89 deg
PSI-PSIREF	-0.001 ± 0.140 deg
AN	85.55 ± 0.24 rpm
U	16.32 ± 0.09 knots

$$V_1 = 0.110$$

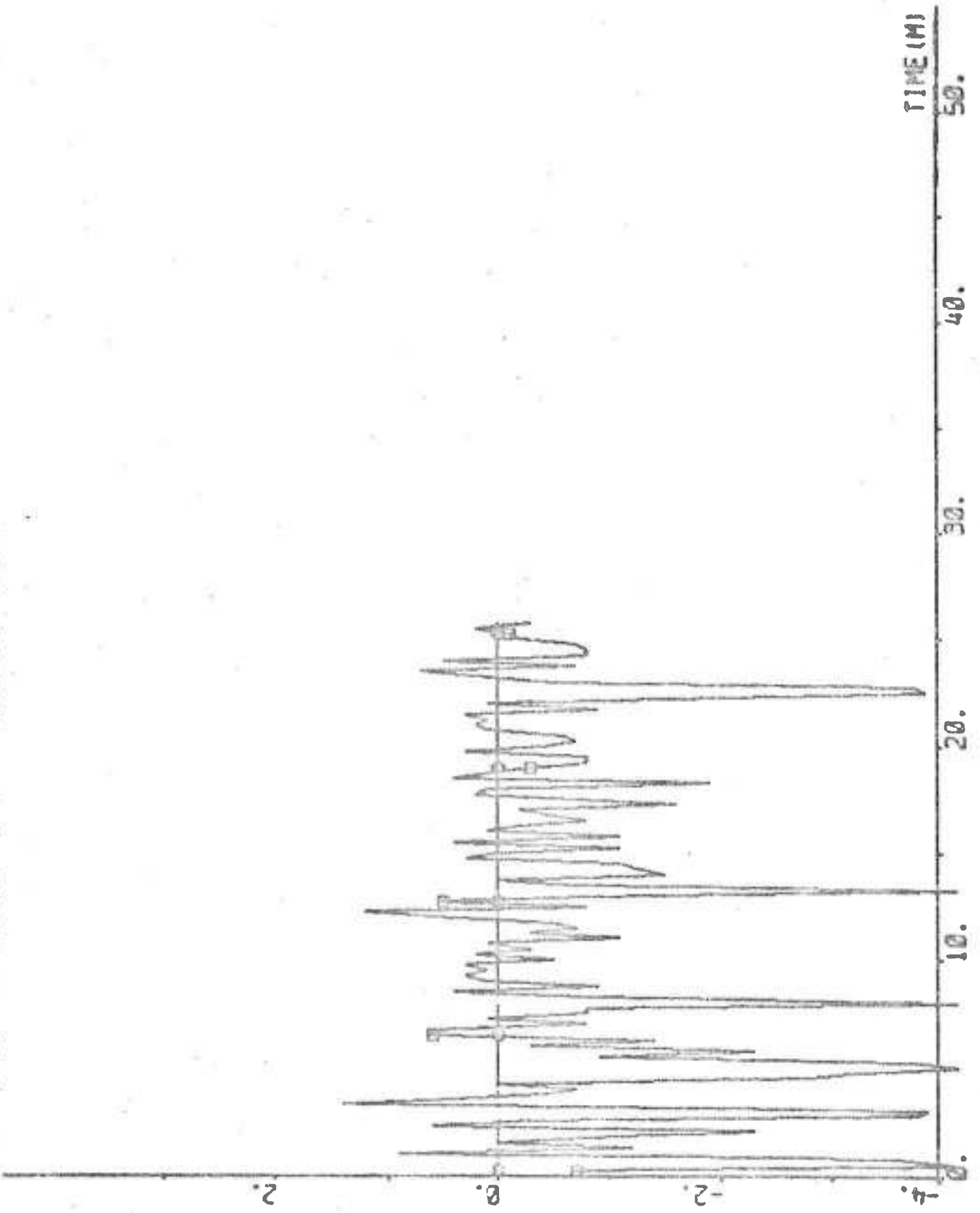
$$V_2 = 0.099$$



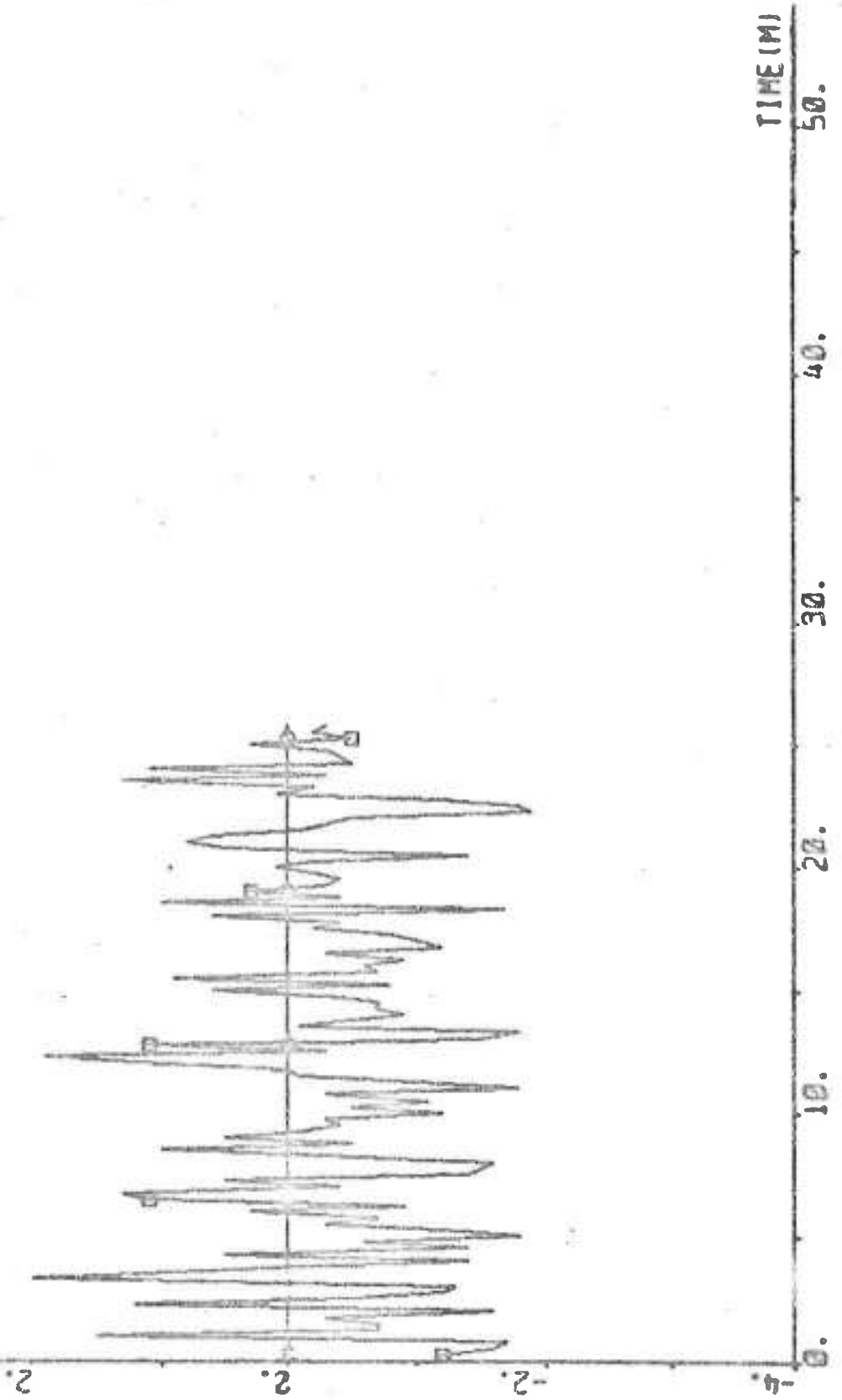
PLOT HP A2CP1(1) ZERO -4 4 DELCOC DEC



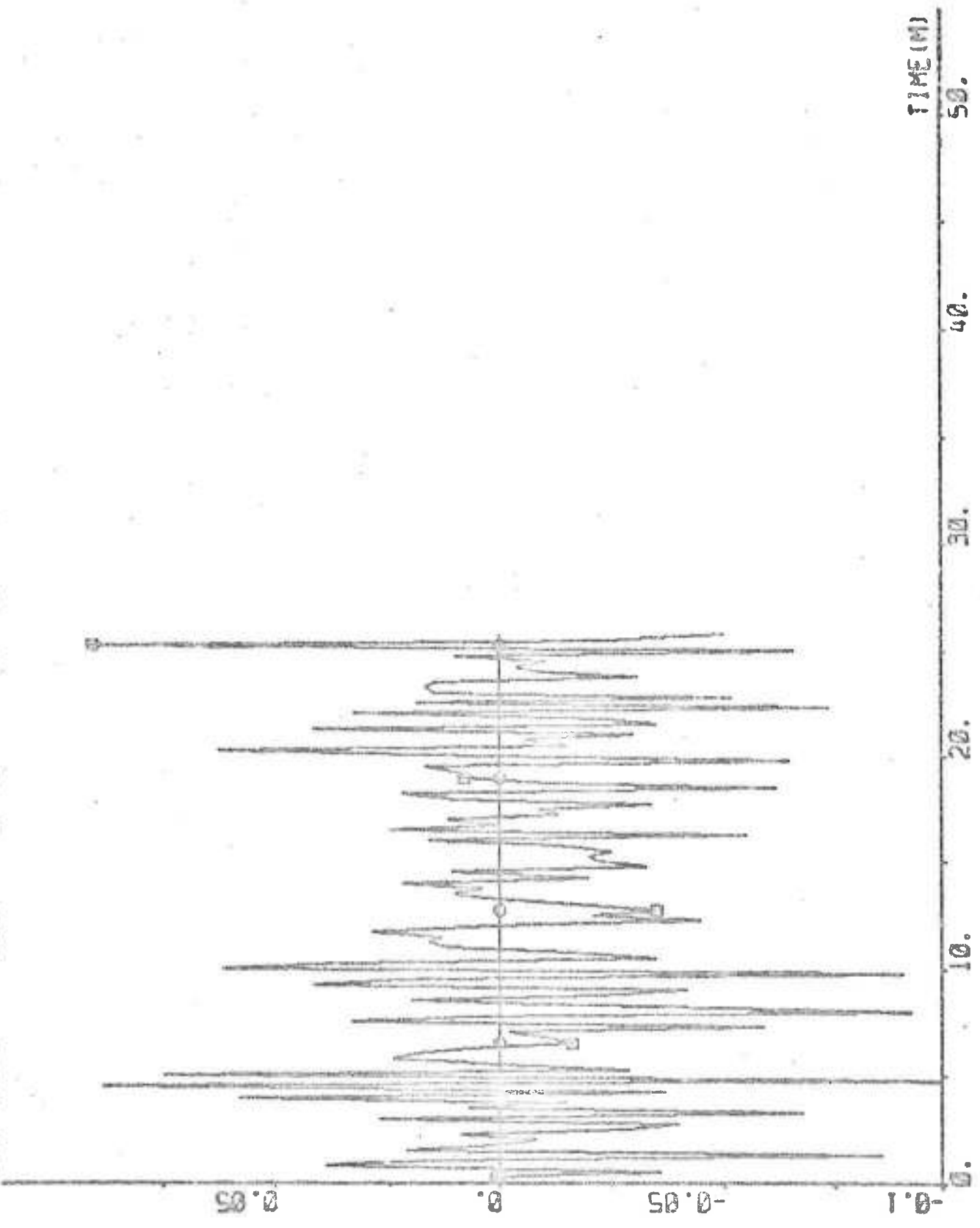
PLOT A2SP1(3) ZERO -4 4 "DELTA" DEG



PLOT R26P1(4) ZERO -4 4 "DELTA DEG



PLOT A2SP1(5) ZERO -0.1 0.1 "PP DEC/S



TIME (M)

50.

40.

30.

20.

10.

0.

FLOT R2SP1(6) 54 88 \*AN RPH

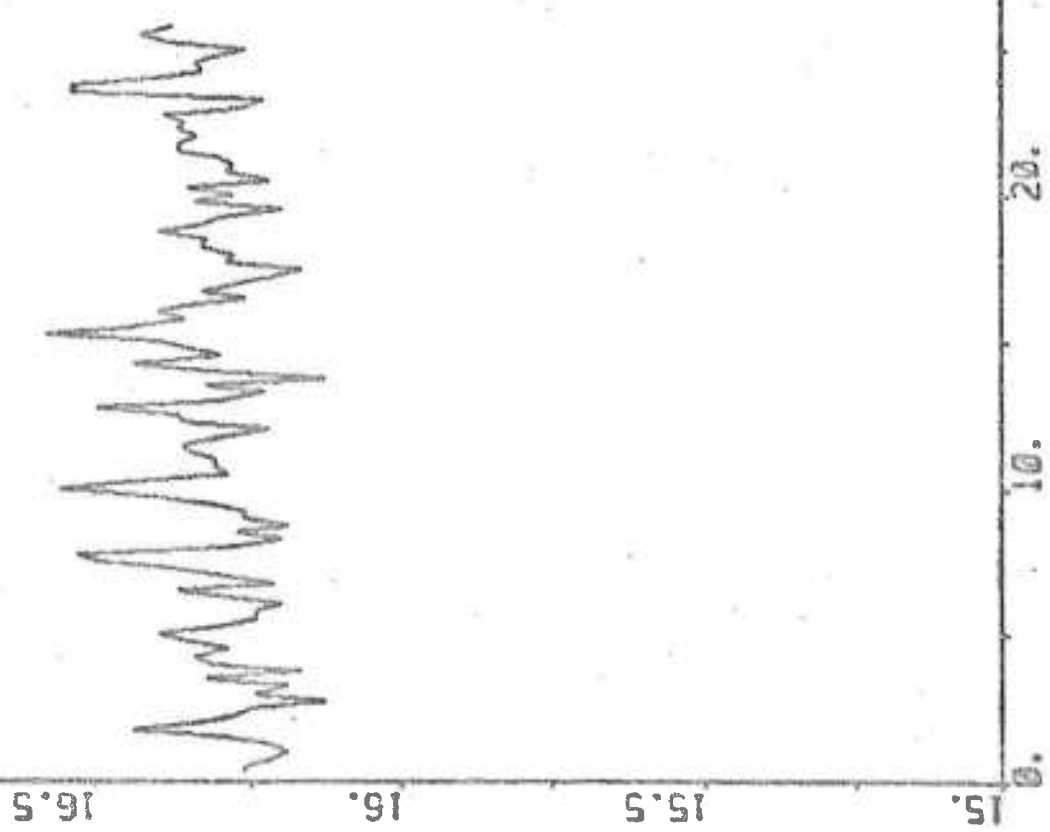
TIME (M)

0. 10. 20. 30. 40. 50.

84. 85. 86. 87.

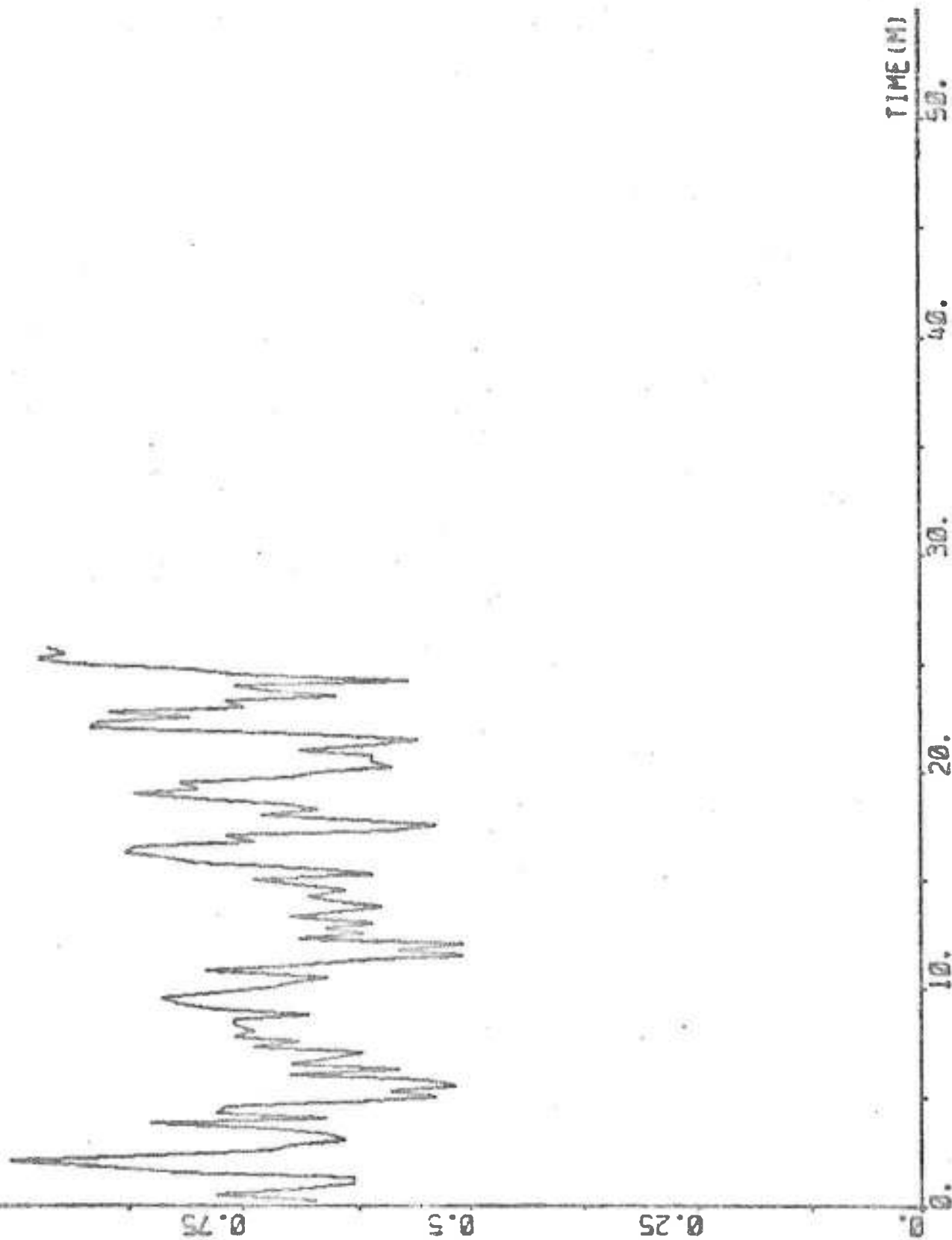


FL0T A20P1(7) 15 17 -U KNOTS

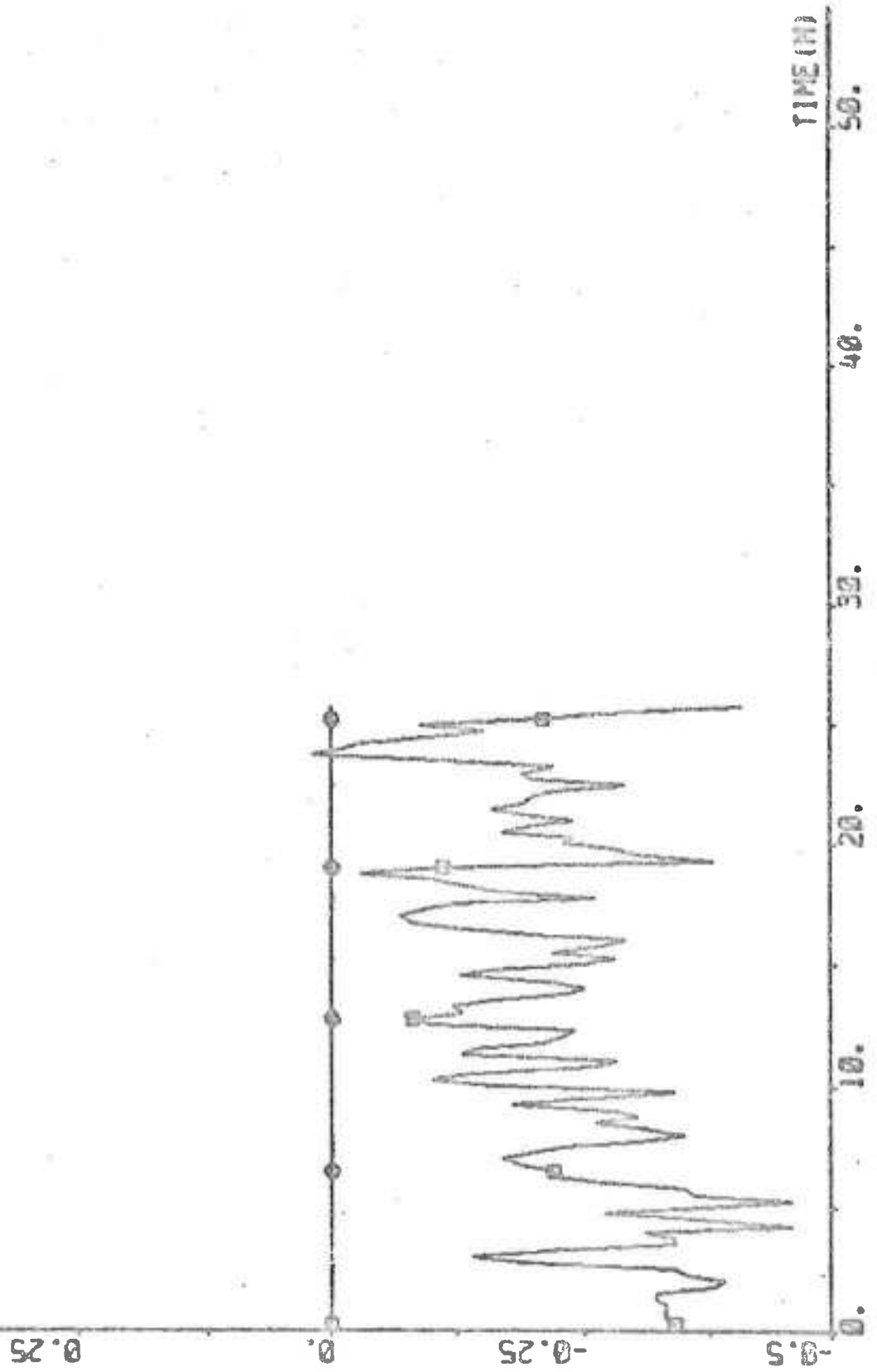


TIME(M)

PLOT A2SP1(0) 0 1 -V1 KNOTS

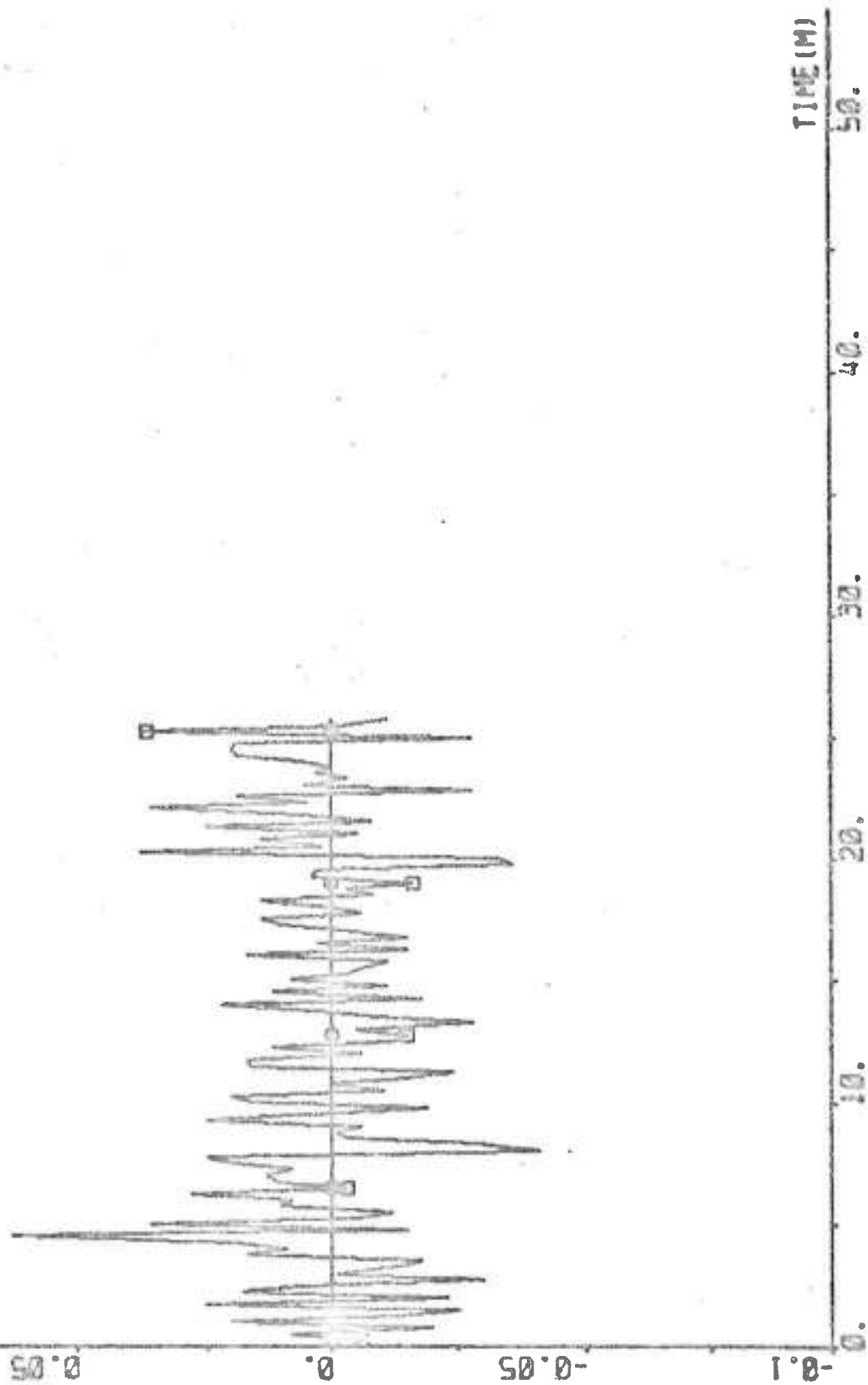


PLOT A2CP1(0) ZERO -0.5 0.6 \*V2 KNOTS

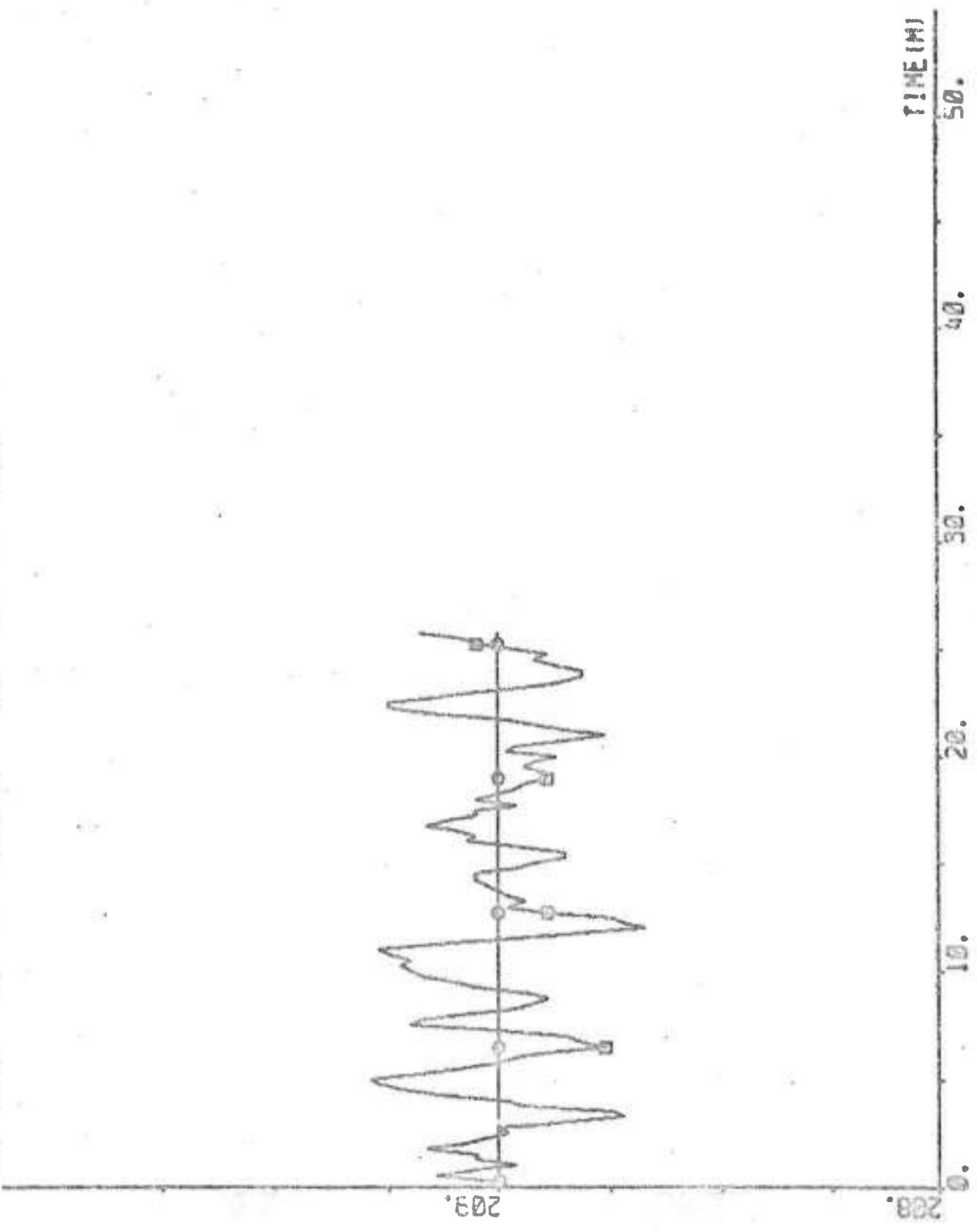




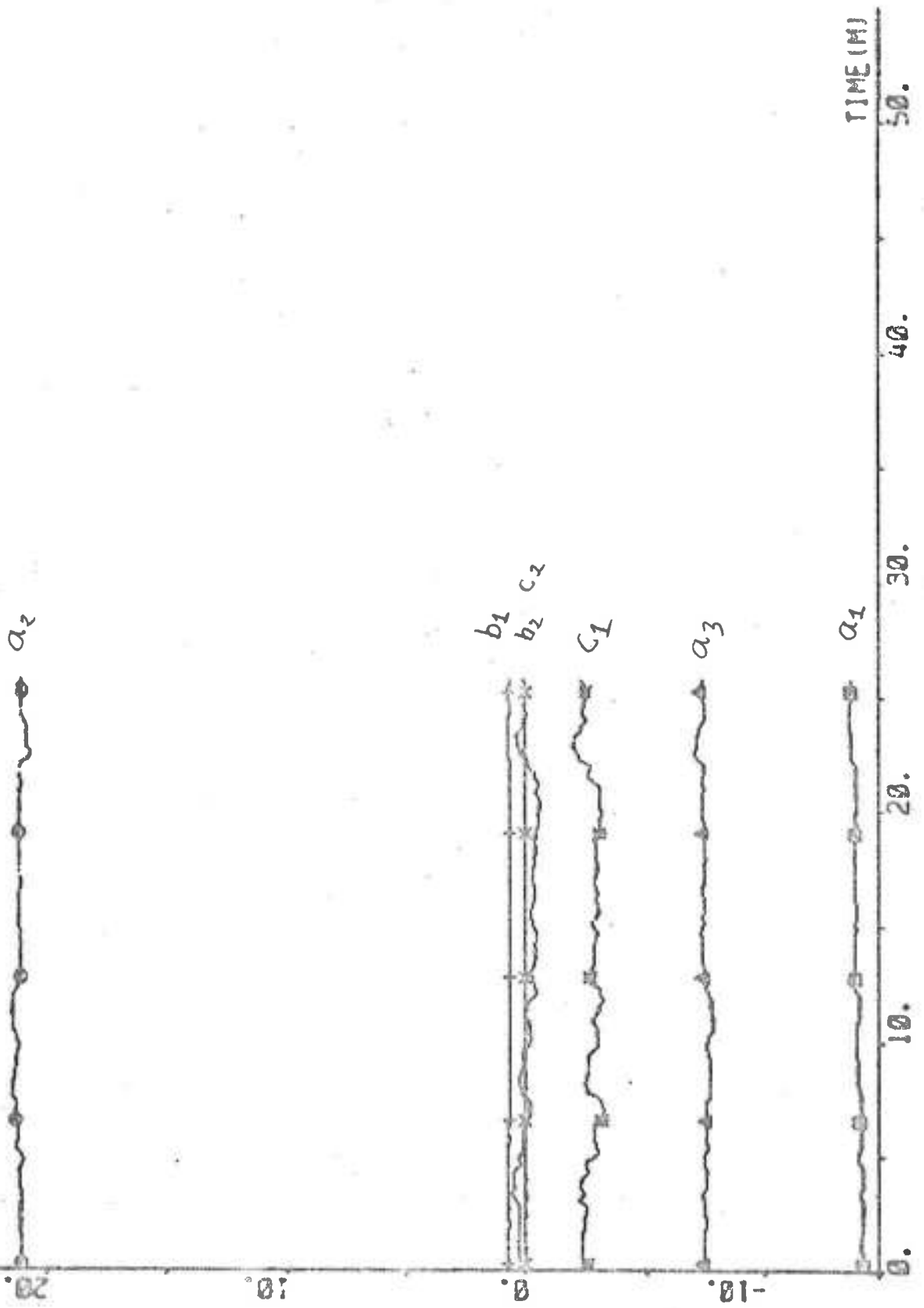
PLOT A2SP1(10) ZERO -0.1 0.1 °R DEC/S



PLOT A2SP1(13 14) 200 210 °PSI PSIREF DEG



## PLOT A26P2 -14 26 "REGULATOR PARAMETERS



## EXPERIMENT A27

Date	1974-10-15
Time	18.58
Duration	33 min
Position	N 03° 12' E 50° 51'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	2 - 3 Beaufort (2-5.5 m/s, light to gentle breeze)
Wave height	1 - 2 m
PSIREF	209°
Rudder limit	Not active

Regulator structure

NA = 4	NB = 1	NC = 1	K = 5
IREG = 15	IRDIF = 0	RL = 0.98	IRR = 1

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -12.034 \\ 17.518 \\ -4.728 \\ -1.337 \\ 0.467 \\ -3.039 \end{bmatrix} \quad P = \begin{bmatrix} 4.809 & & & & & & \\ -6.943 & 48.538 & & & & & \\ 3.299 & -70.648 & 118.547 & & & & \\ -0.356 & 30.878 & -55.218 & 27.190 & & & \\ 0.040 & -2.951 & 5.103 & -2.371 & 0.246 & & \\ 7.065 & -21.429 & 24.290 & -10.183 & 1.009 & 91.117 & \end{bmatrix}$$

$$a_1 + a_2 + a_3 + a_4 = -0.581$$

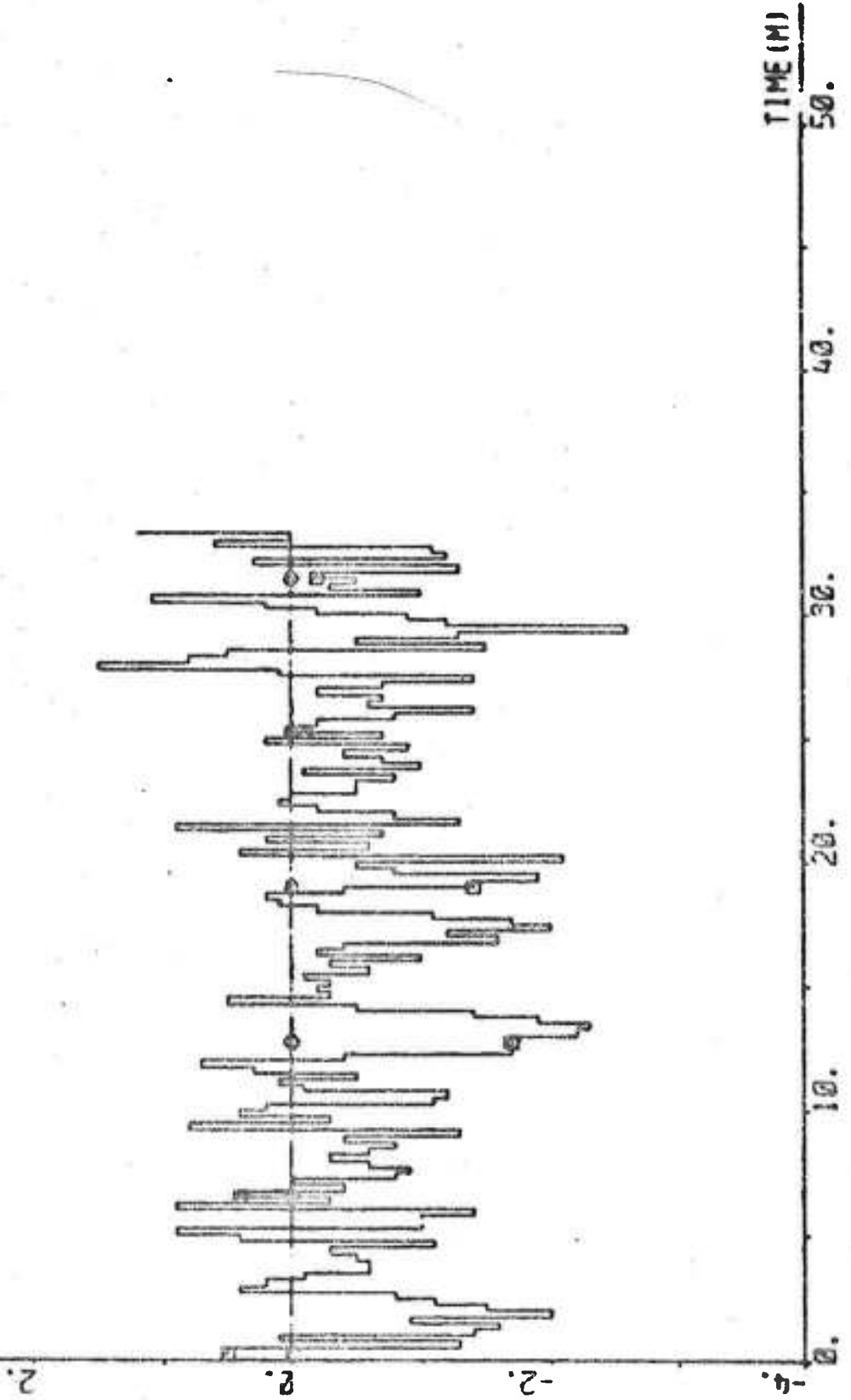
Statistics (mean value and standard deviation)

DELTA	$0.17 \pm 0.74$ deg
PSI-PSIREF	$0.005 \pm 0.153$ deg
AN	$85.52 \pm 0.26$ rpm
U	$15.92 \pm 0.09$ knots

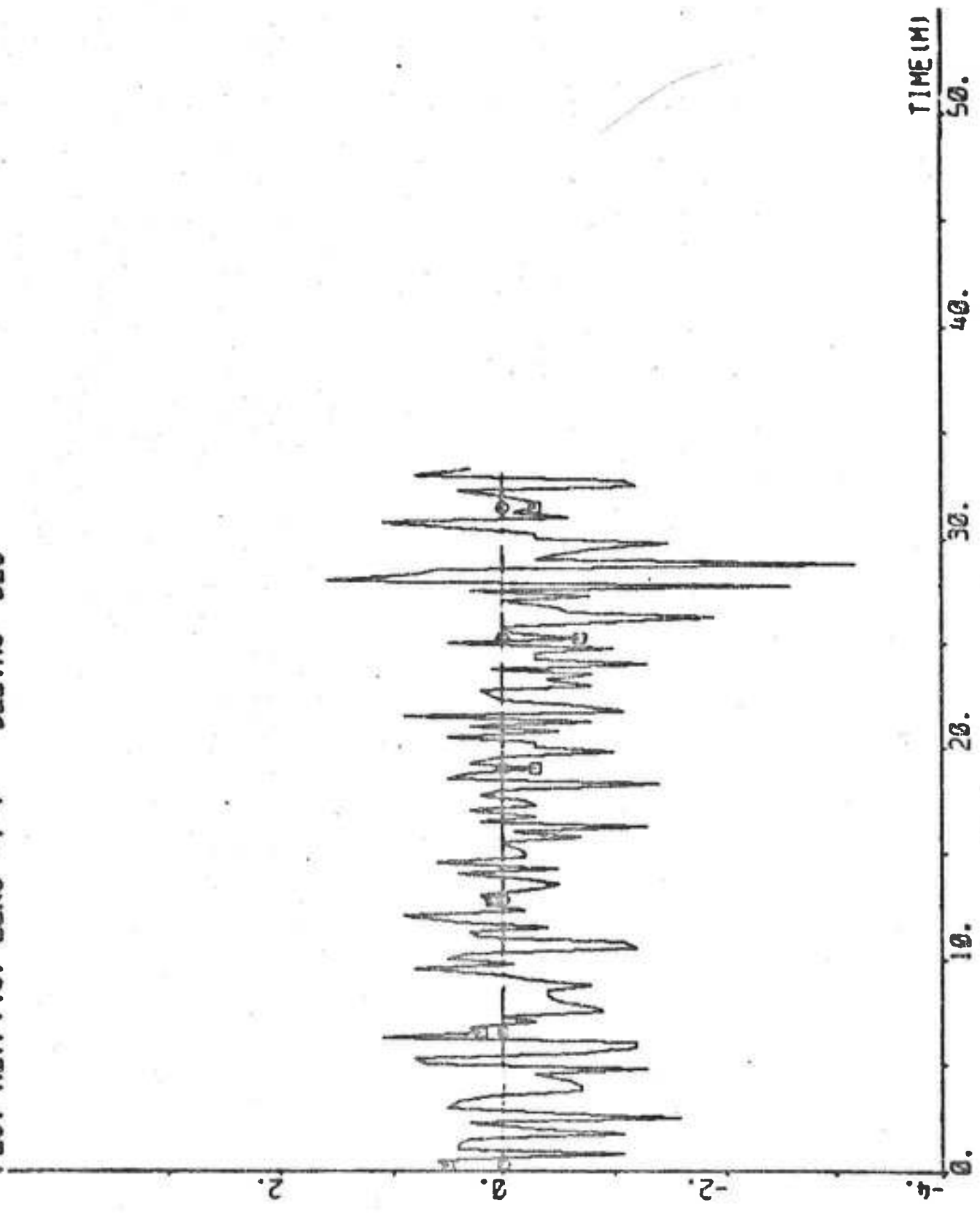
$$V_1 = 0.081$$

$$V_2 = 0.078$$

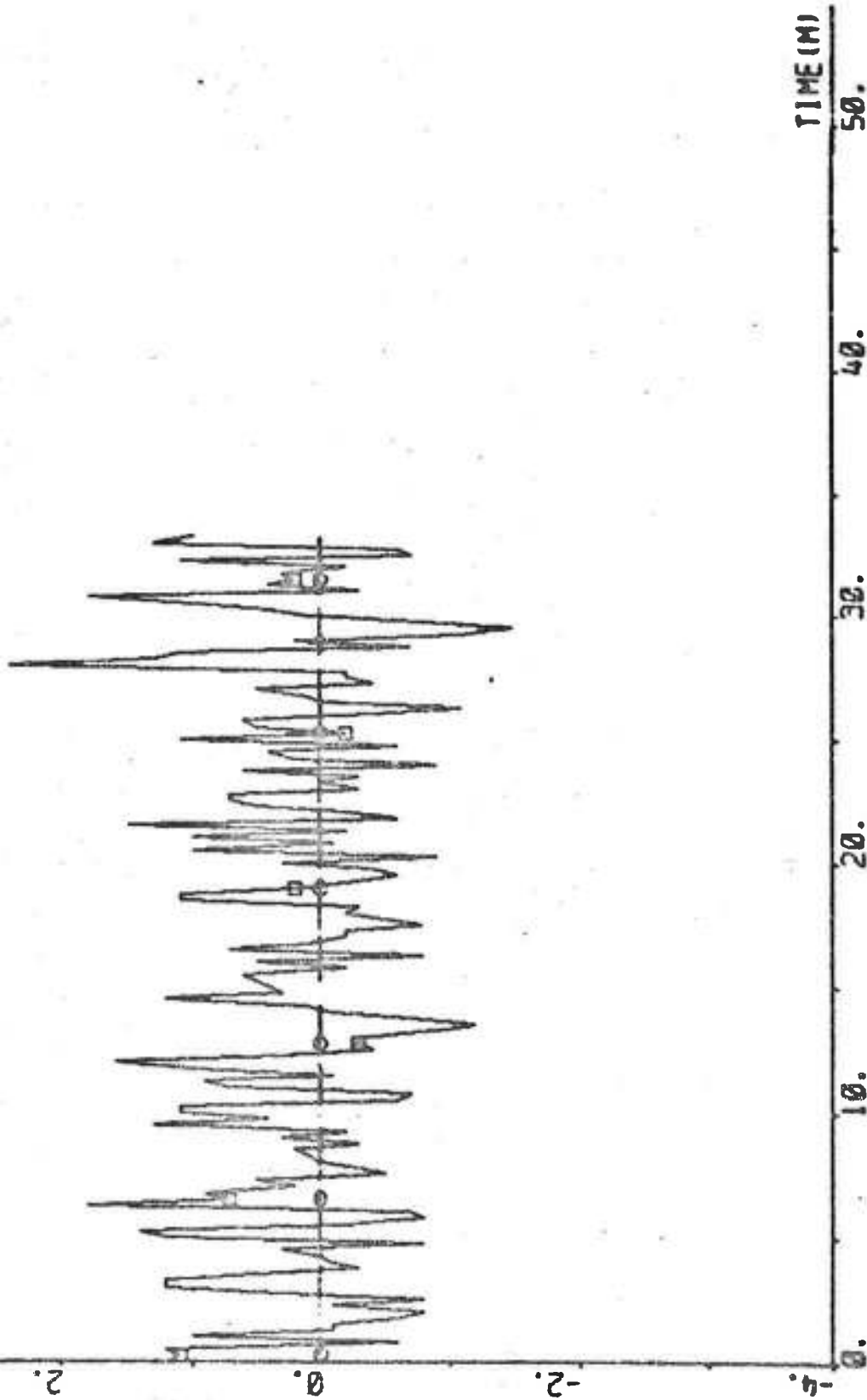
PLOT MP A27P1(1) ZERO -4 4 "DELCOG DEG



PLOT A27P1(3) ZERO -4 4 °DELTA DEG

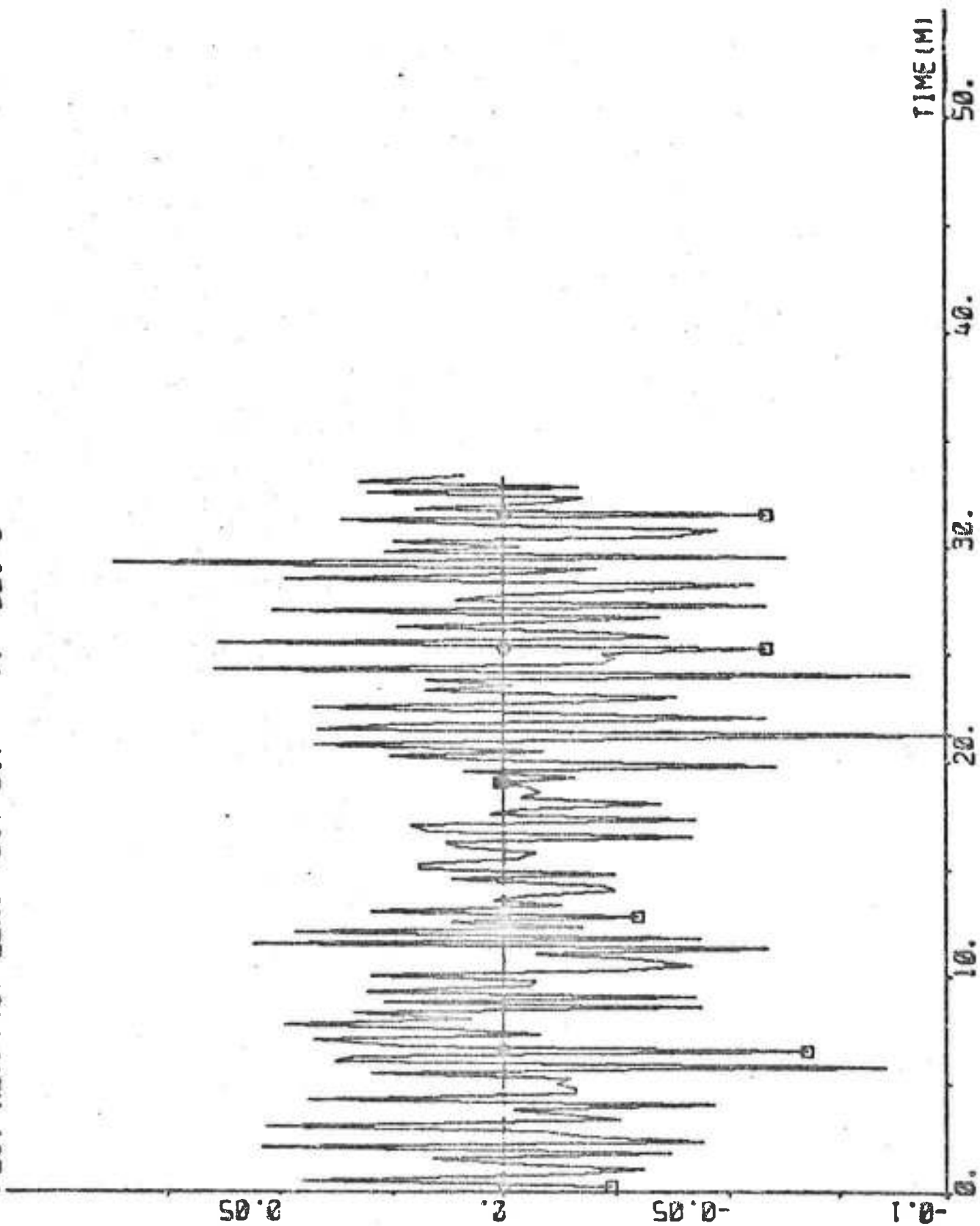


PLOT A27P1(4) ZERO -4 4 "DELTA DEG

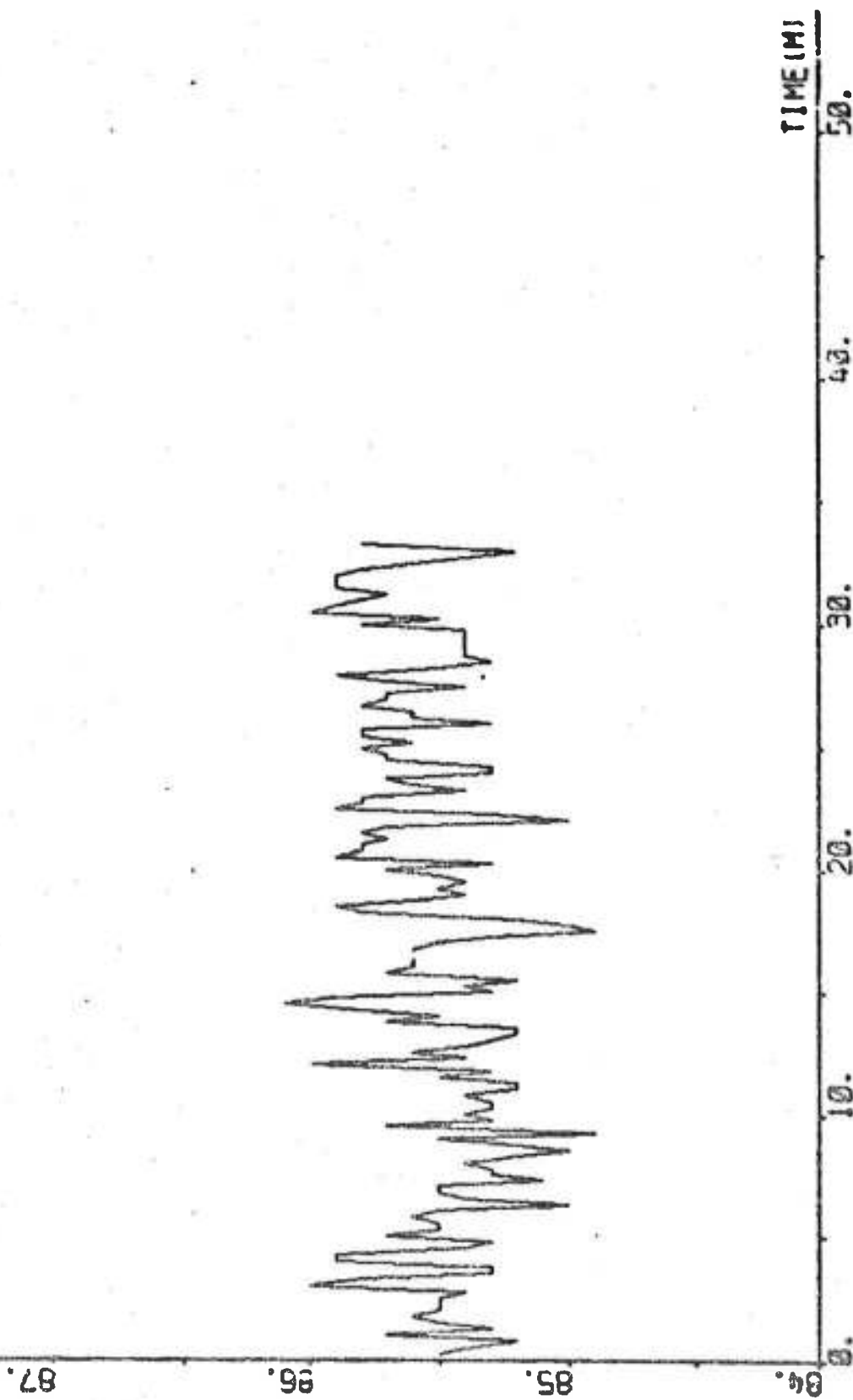




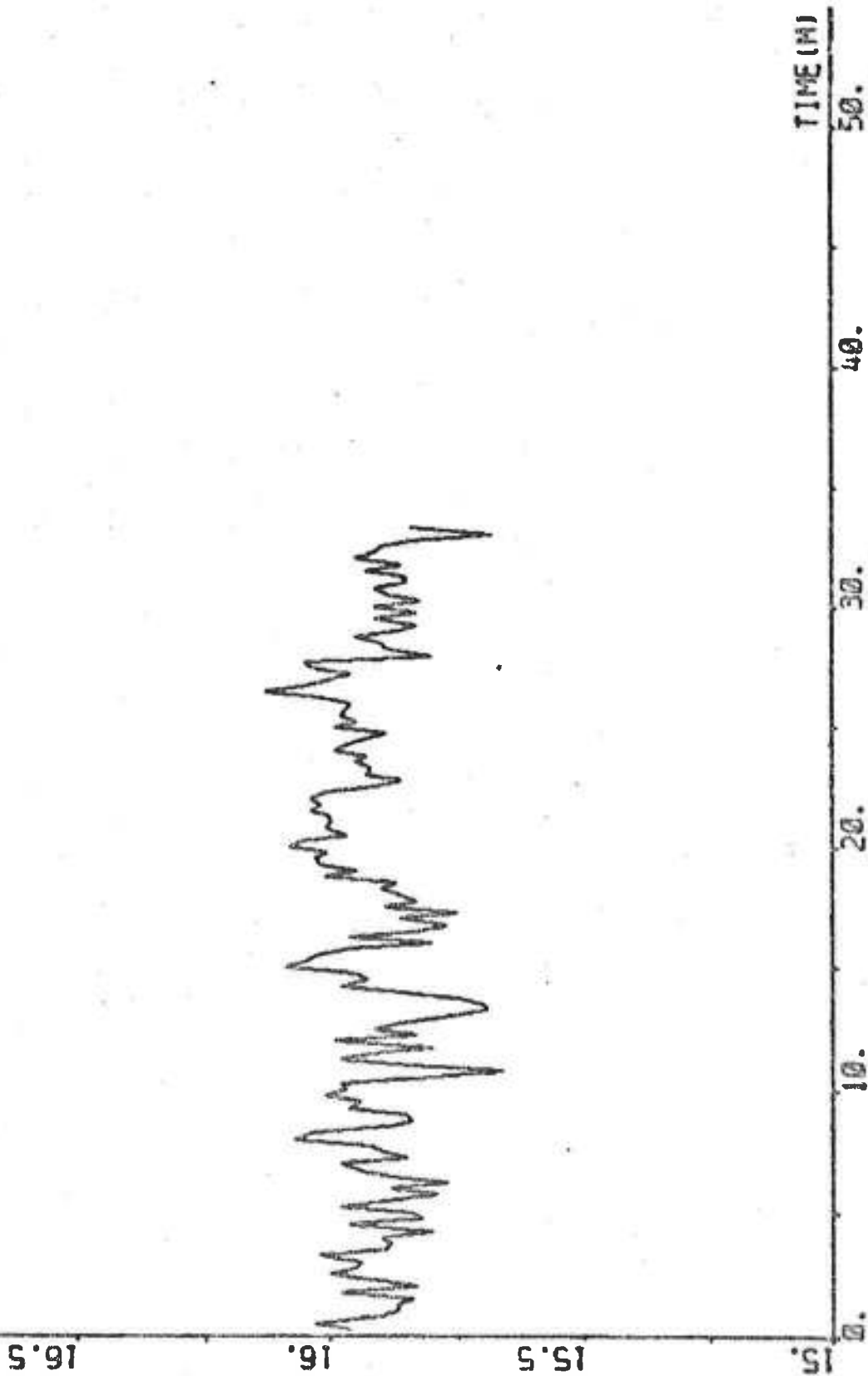
PLOT R27P1(5) ZERO -0.1 0.1 "PP DEG/S



PLOT R27P1(6) 54 60 -FM RPM



PLOT A27P1(7) 15 17 ~U KNOTS



PLOT A27P1(9) 0 1 "VI KNOTS



TIME (M)

50.

40.

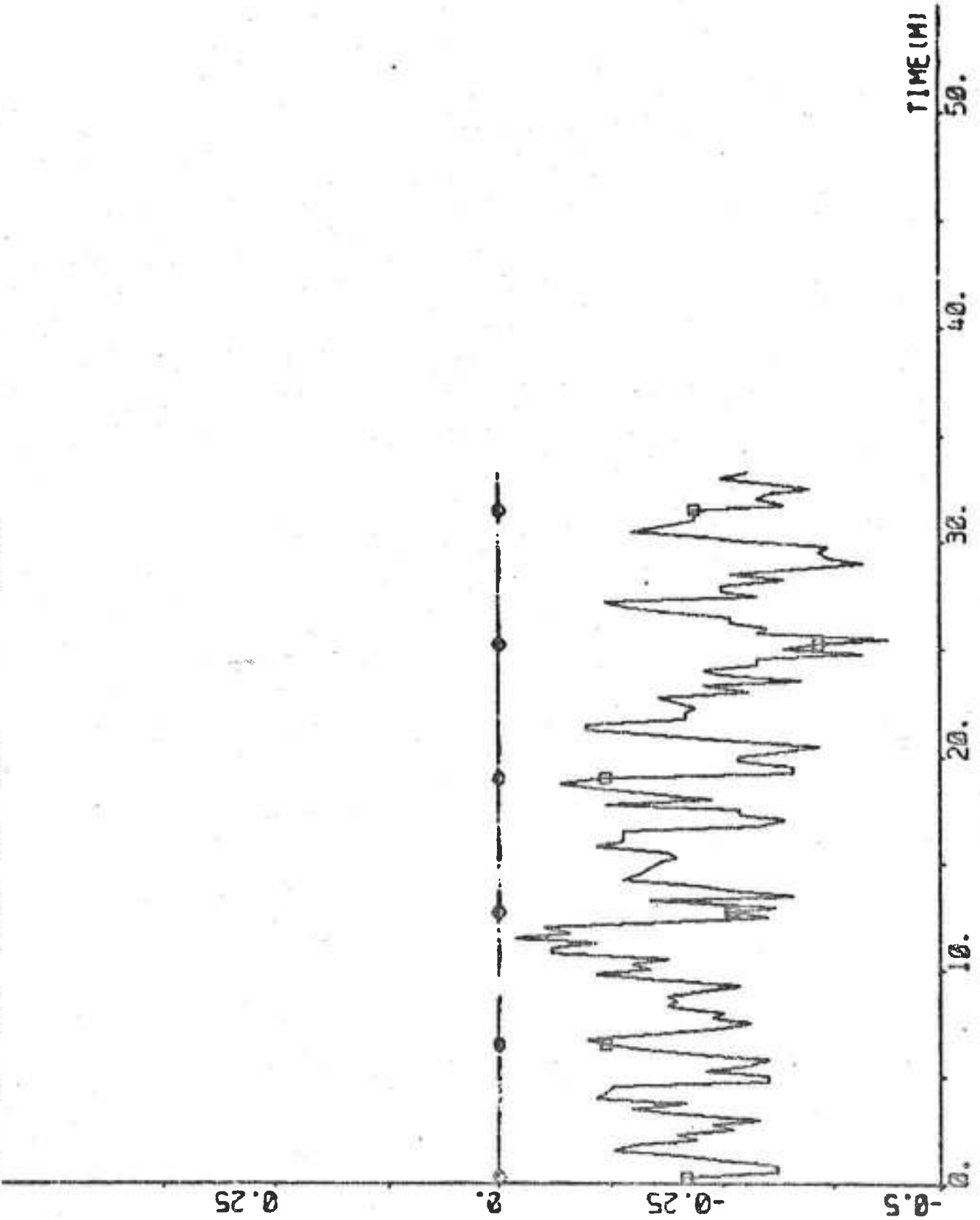
30.

20.

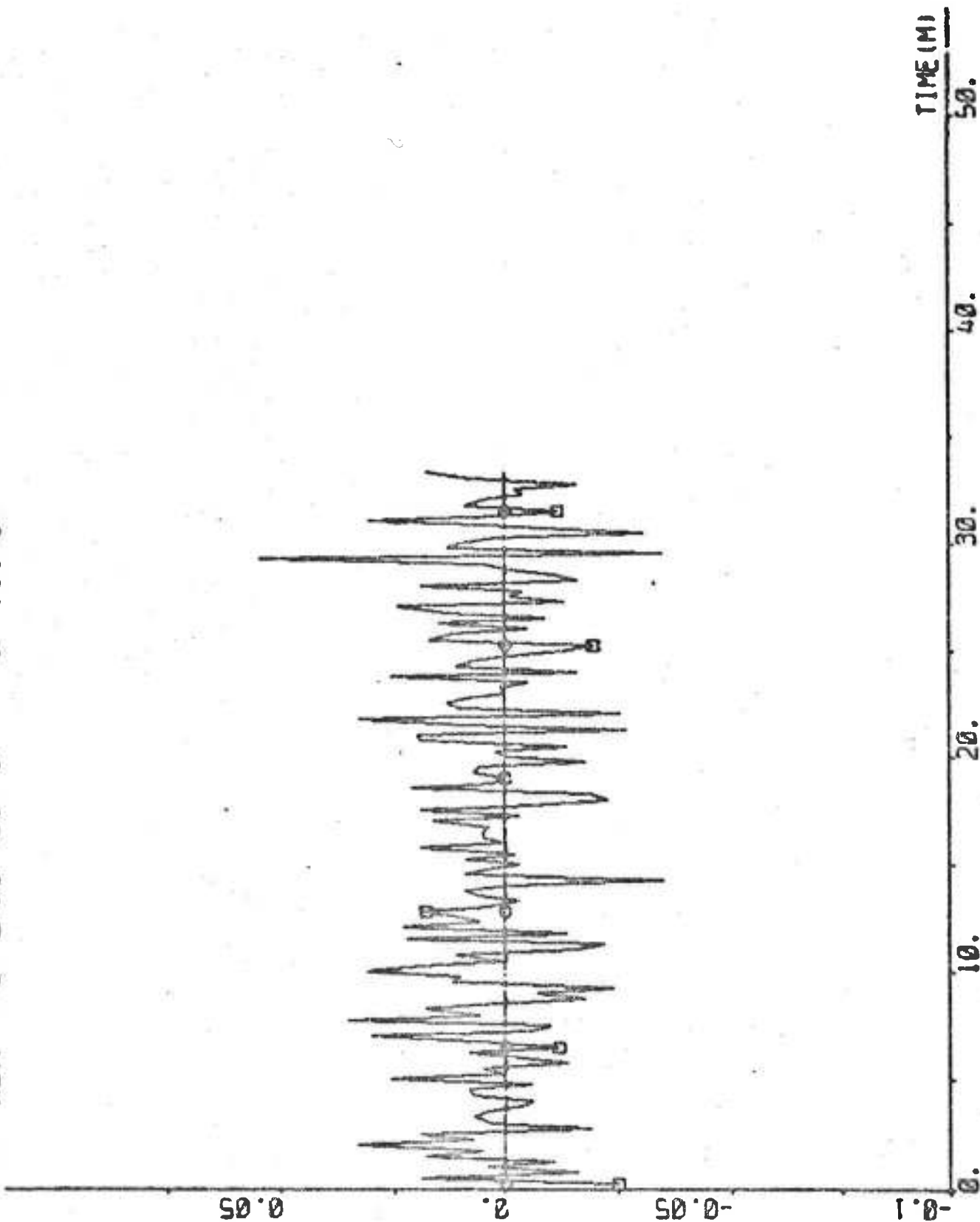
10.

0.

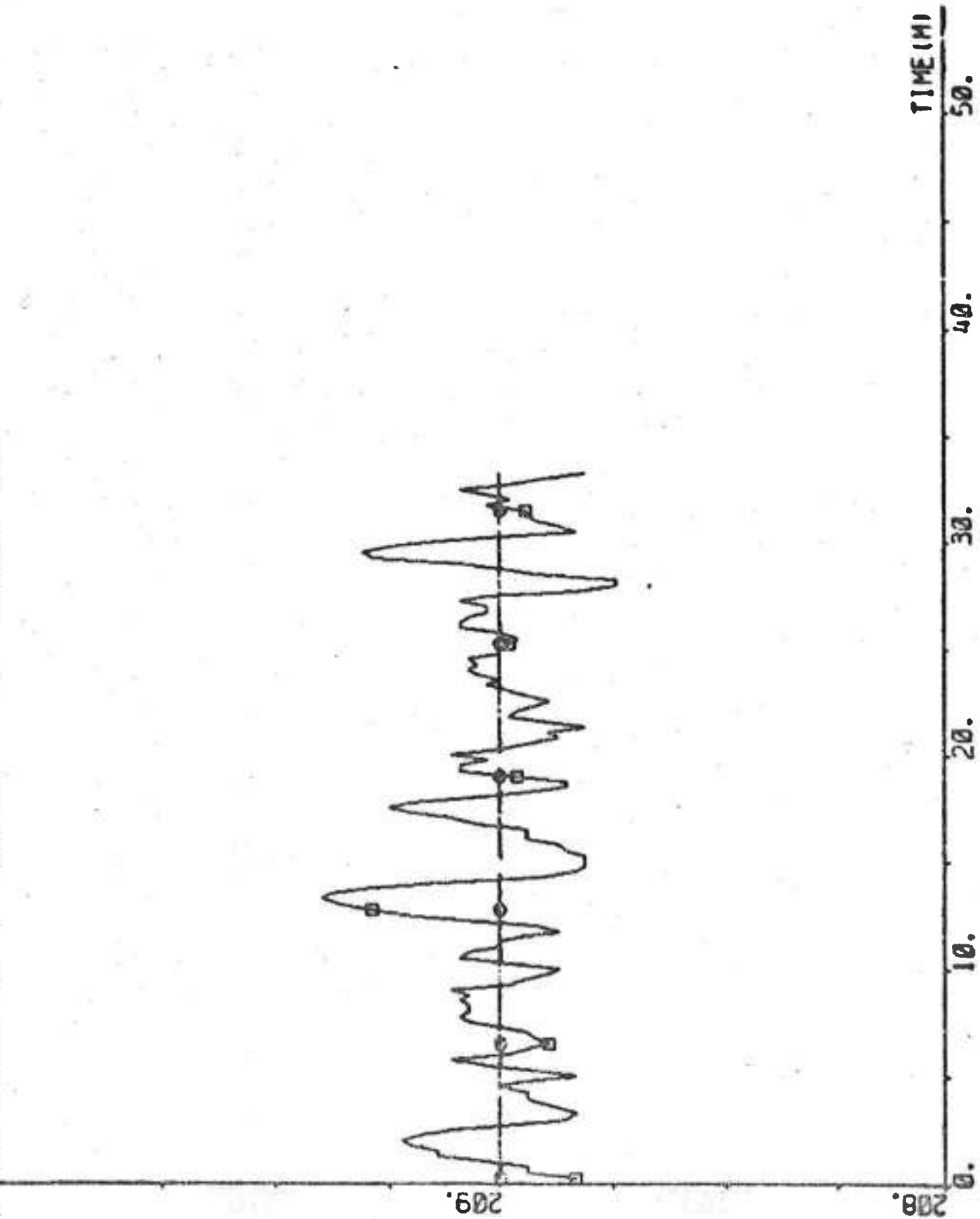
PLOT RZ7P1(9) ZERO -0.5 0.5 -V2 KNOTS



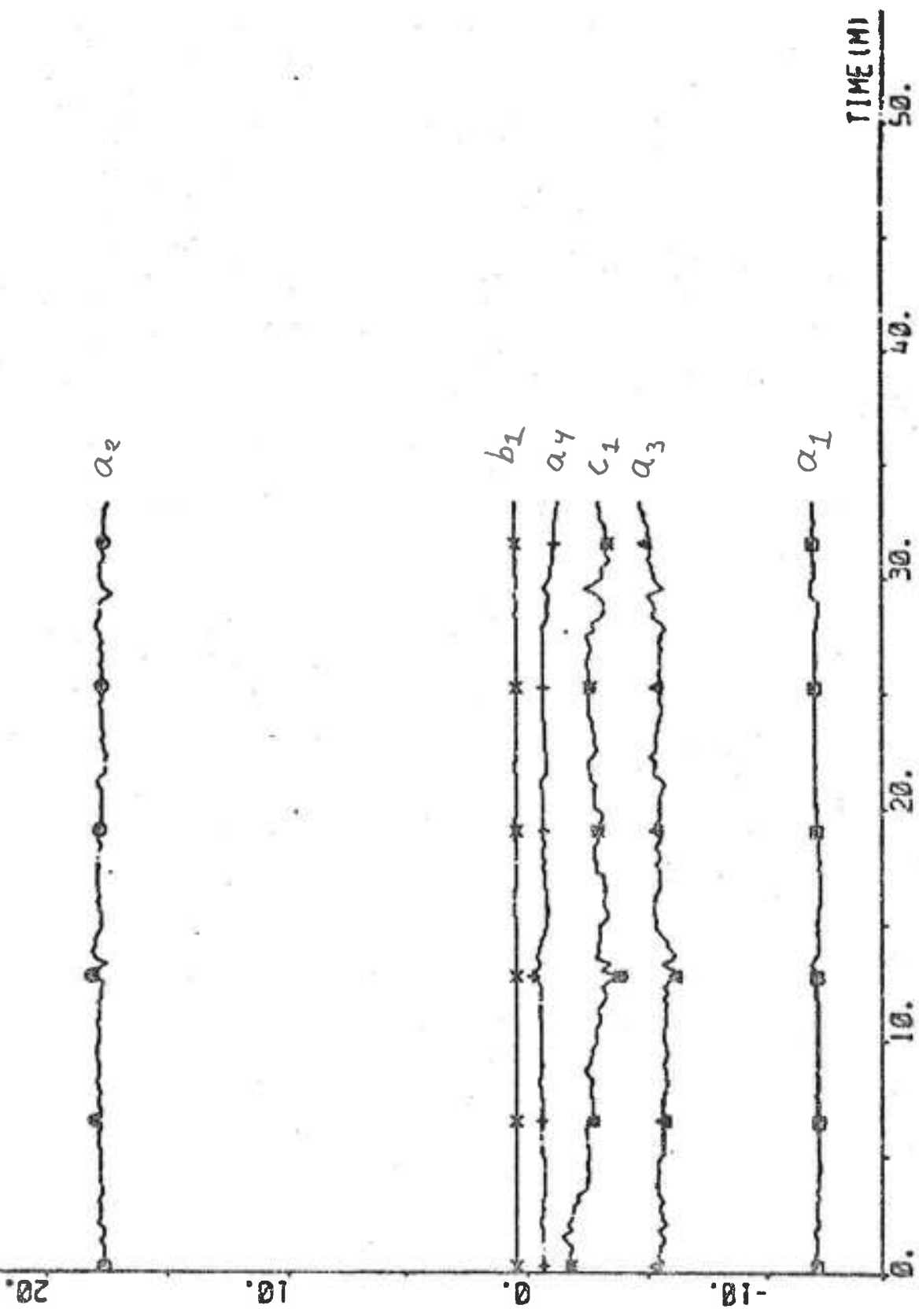
PLOT A27P1(10) ZERO -0.1 0.1 "R DEG/S



PLOT R27P1(13 14) 200 210 °PSI PSIREF DEG



PLOT A2773 -14 26 "REGULATOR PARAMETERS"





## EXPERIMENT A28

Date	1974-10-16
Time	07.57
Duration	21 min
Position	N 00 <sup>o</sup> 06' E 49 <sup>o</sup> 10'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SW (1; see Appendix A)
Wind velocity	3-4 Beaufort (4-8 m/s, gentle to moderate breeze)
Wave height	4 m
PSIREF	208 <sup>o</sup>
Rudder limit	Not active

Regulator structure

NA = 3	NB = 2	NC = 0	K = 4
IREG = 20	RL = 0.98		

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} -5.815 \\ 8.792 \\ -2.997 \\ 0.480 \\ 0.162 \end{bmatrix} \quad P = \begin{bmatrix} 2.316 & & & & \\ -2.846 & 6.999 & & & \\ 0.996 & -5.081 & 4.934 & & \\ -0.255 & -0.163 & 0.479 & 0.152 & \\ -0.009 & -0.599 & 0.683 & 0.080 & 0.152 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.020$$

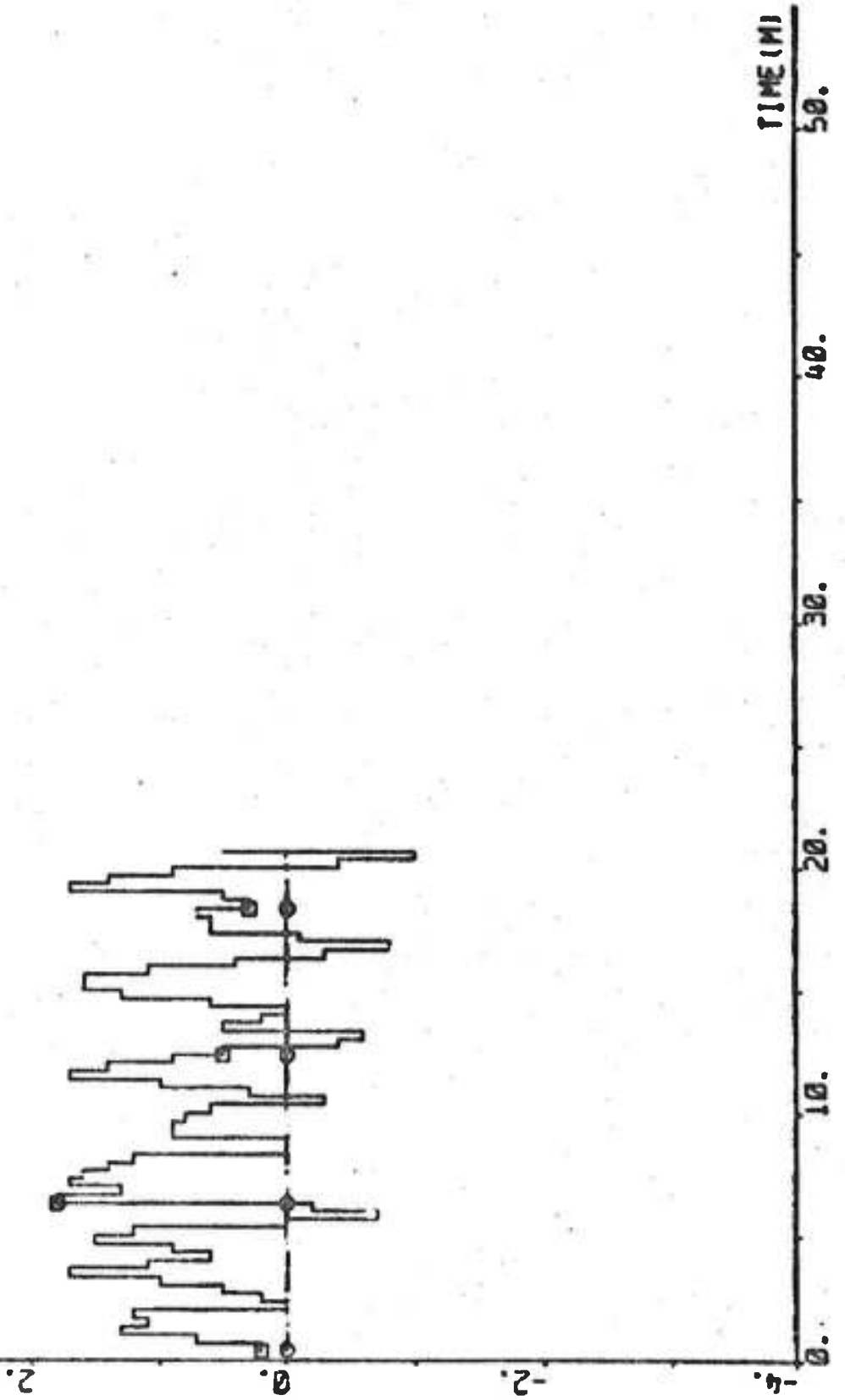
Statistics (mean value and standard deviation)

DELTA	1.55 ± 0.95 deg
PSI-PSIREF	0.033 ± 0.226 deg
AN	85.60 ± 0.25 rpm
U	15.67 ± 0.05 knots

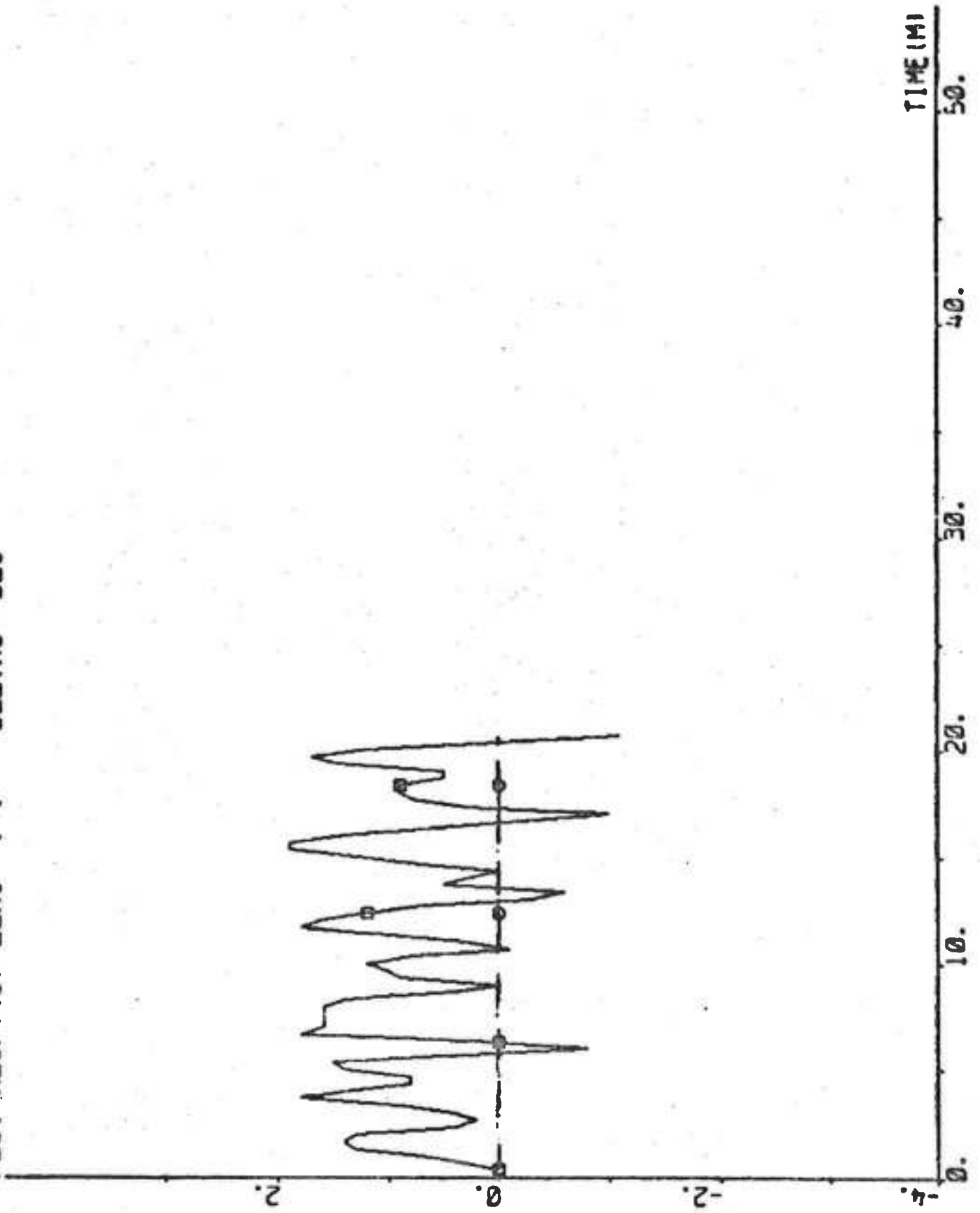
$$V_1 = 0.383$$

$$V_2 = 0.142$$

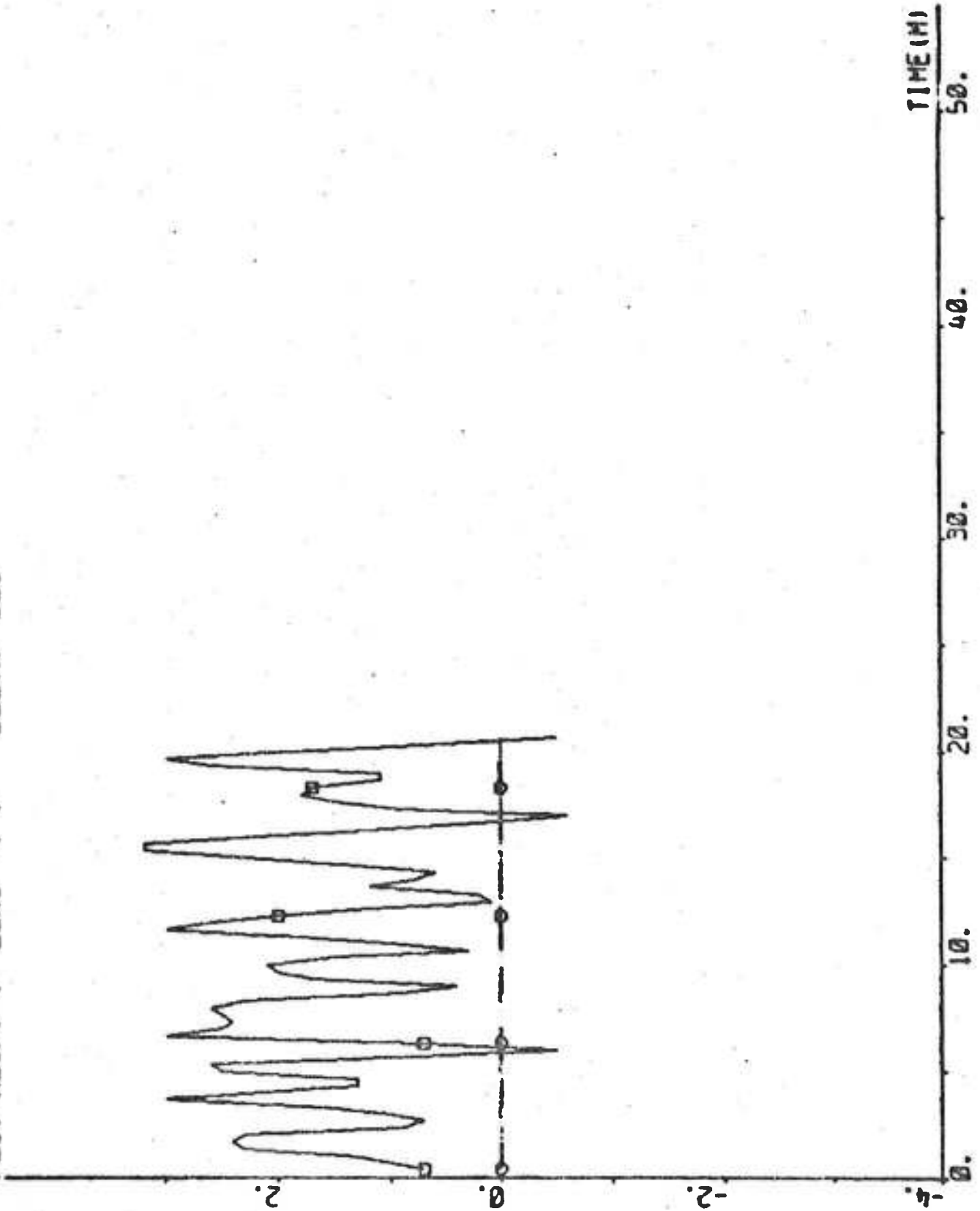
PLOT MP A26P1(1) ZERO -4 4 DELCOC DEG



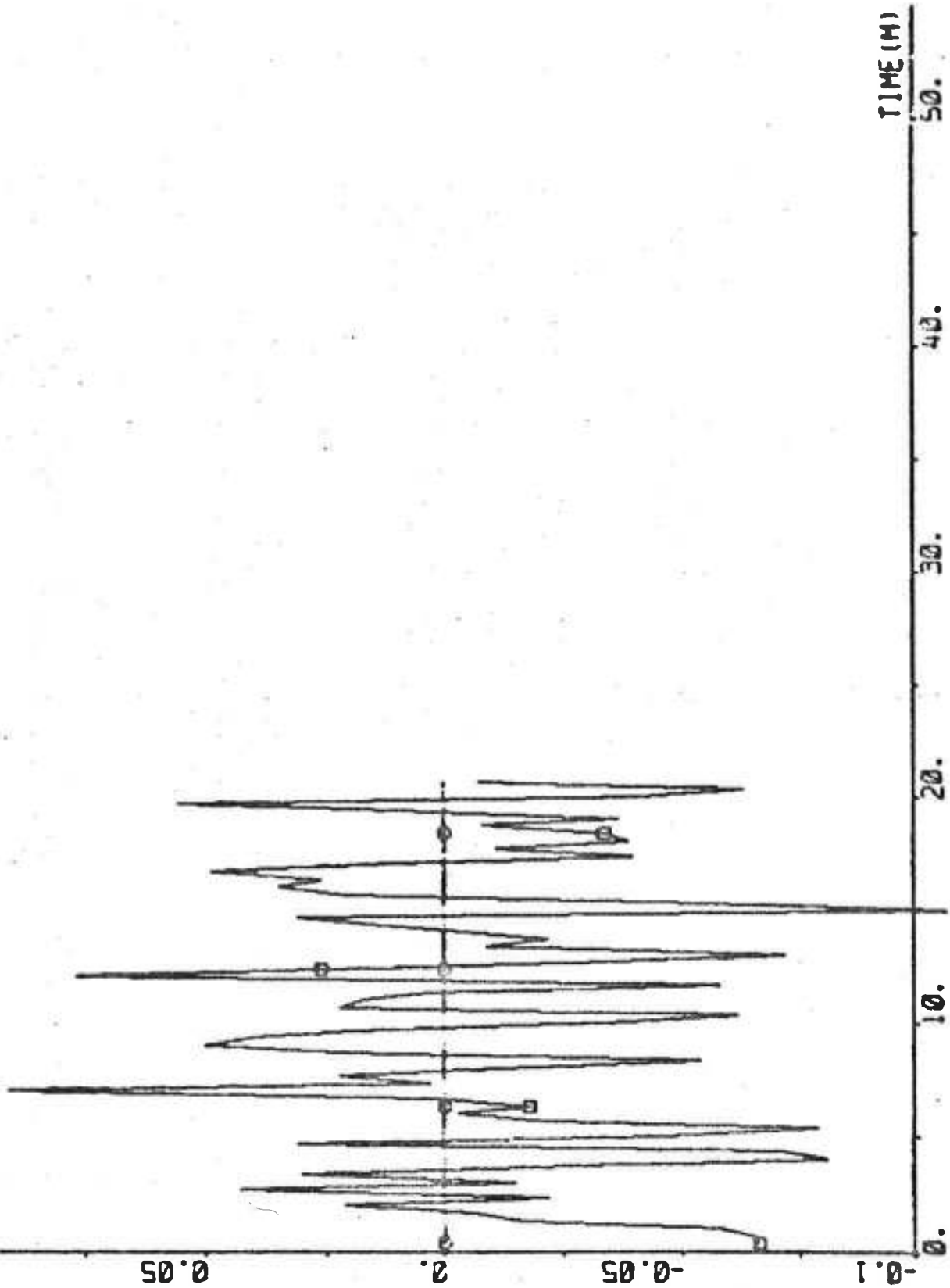
PLOT A28P1(3) ZERO -4 4 °DELTA DEG



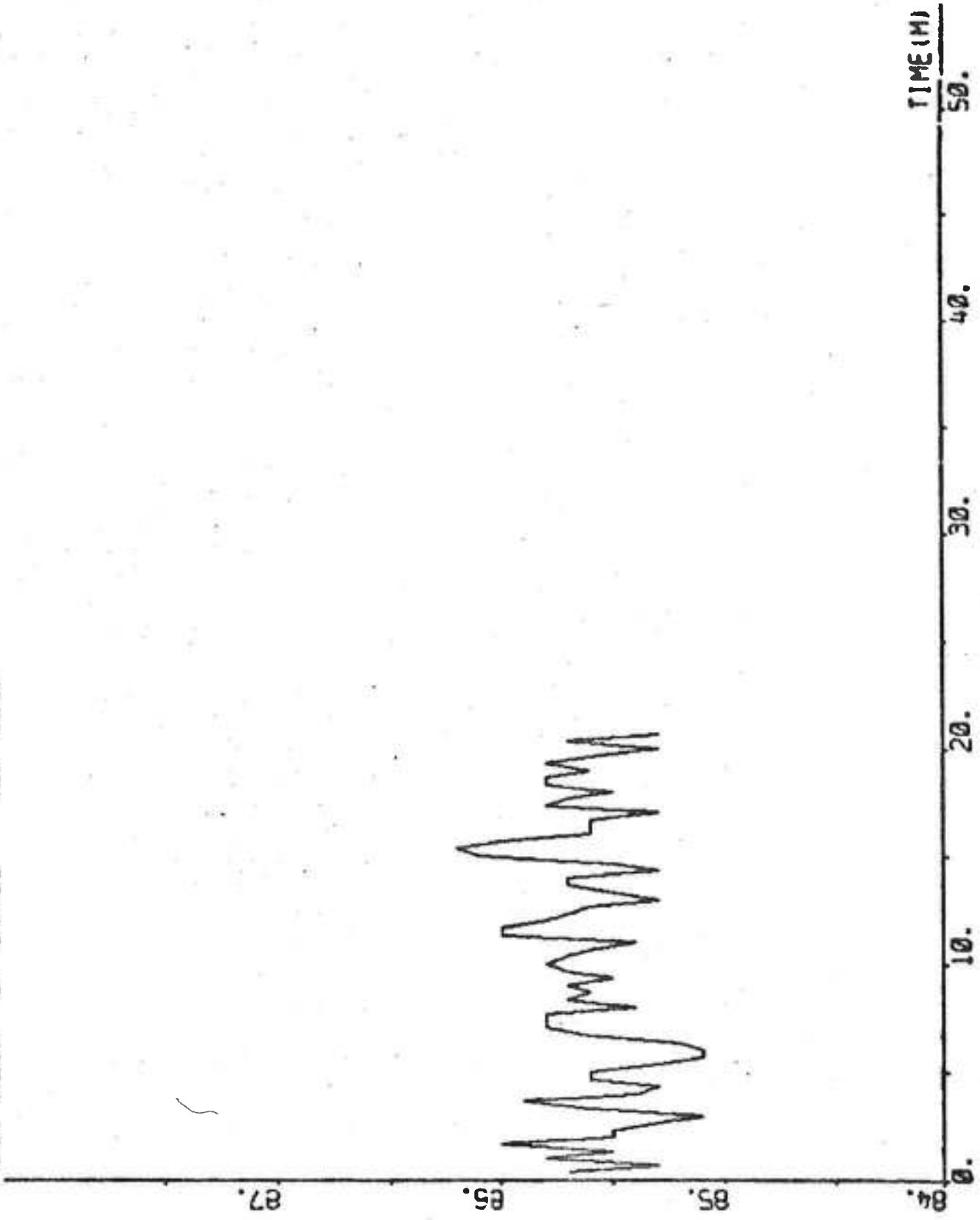
PLOT A26P1(4) ZERO -4 4 °DELTA DEG



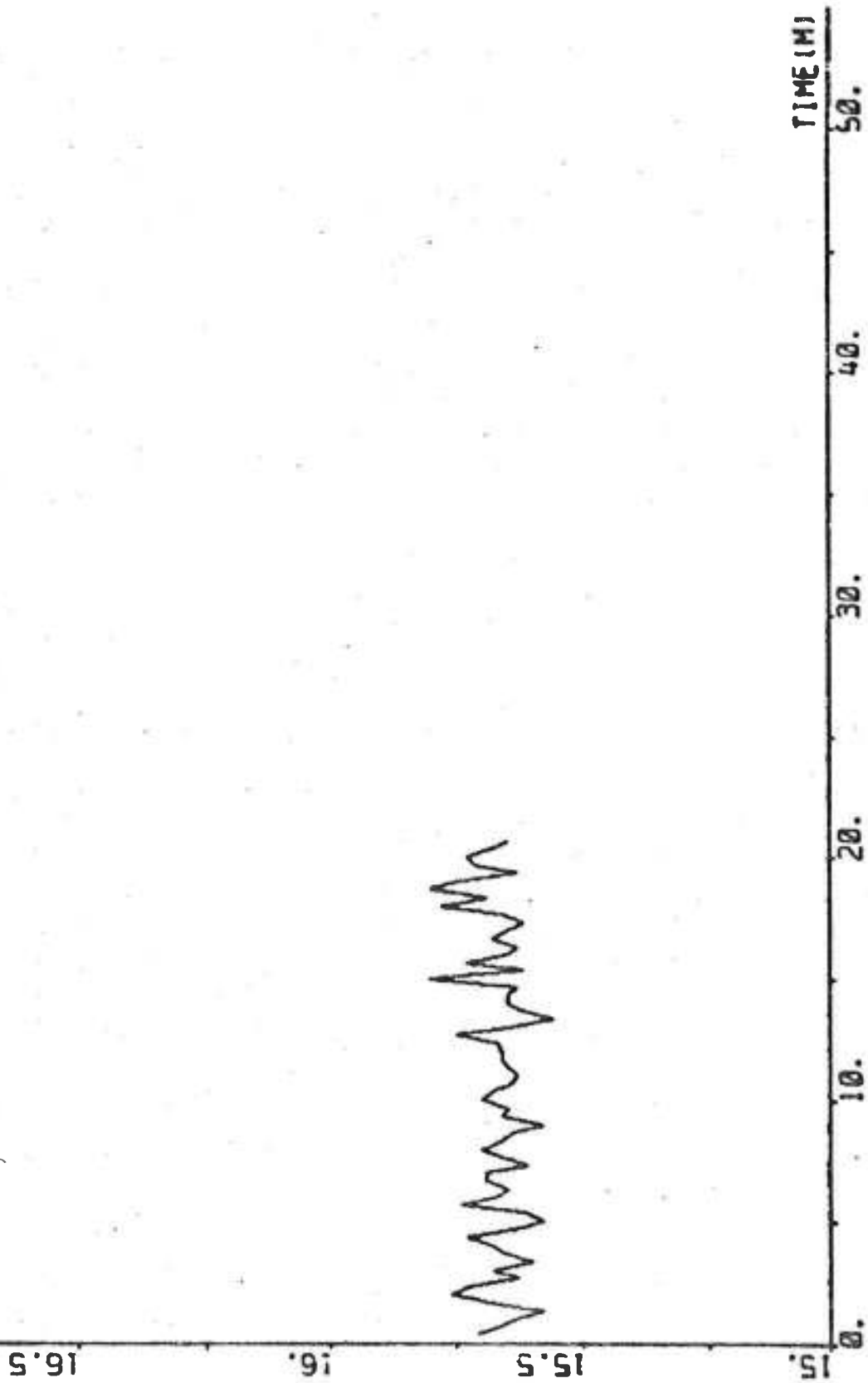
PLOT R28P1(5) ZERO -0.1 0.1 -PP DEG/S



PLOT R28P1(6) 84 88 -AN RPM

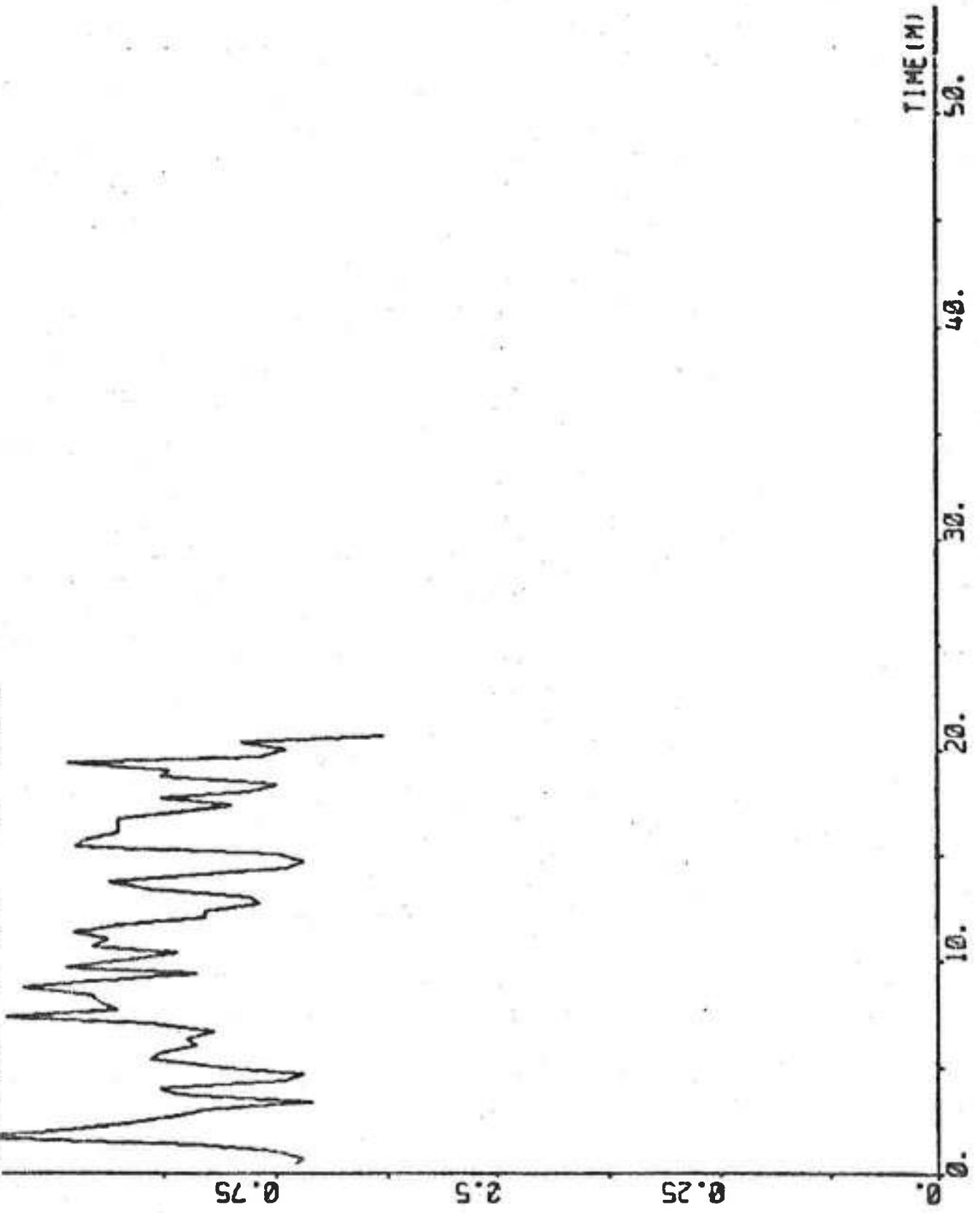


PLOT R26P1(7) 15 17 °U KNOTS

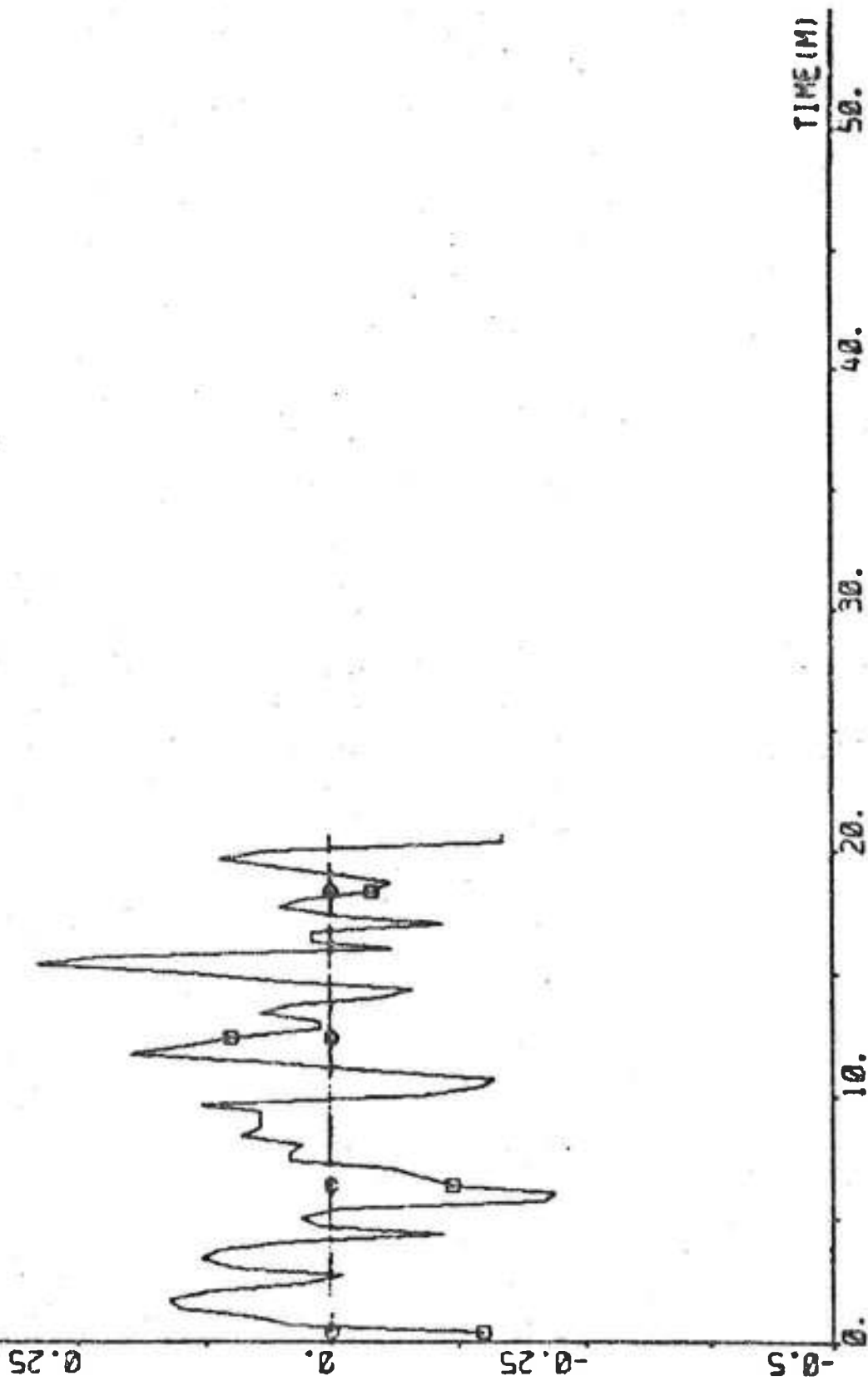




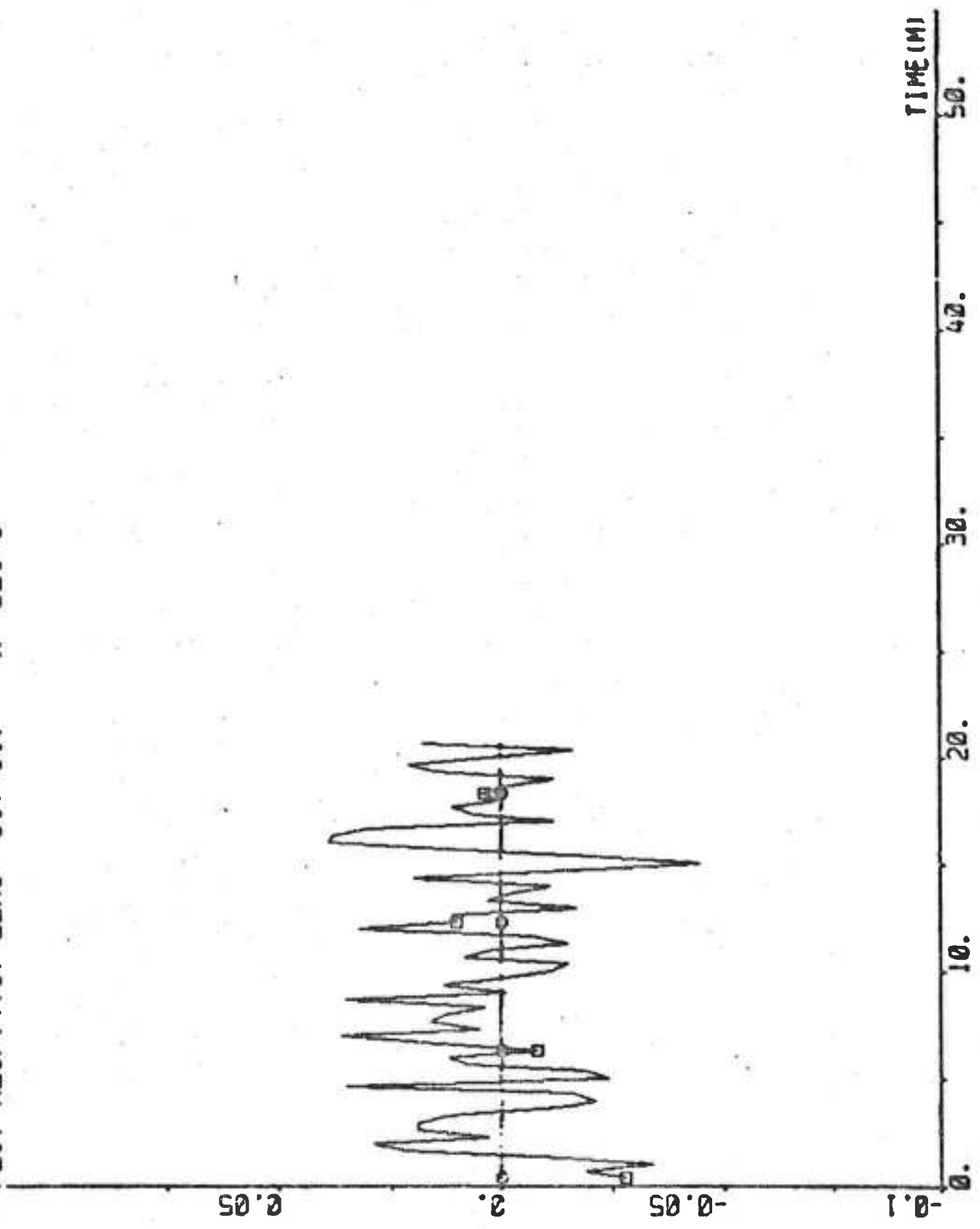
PLOT\_A28P1(8) @ 1 -V1 KNOTS



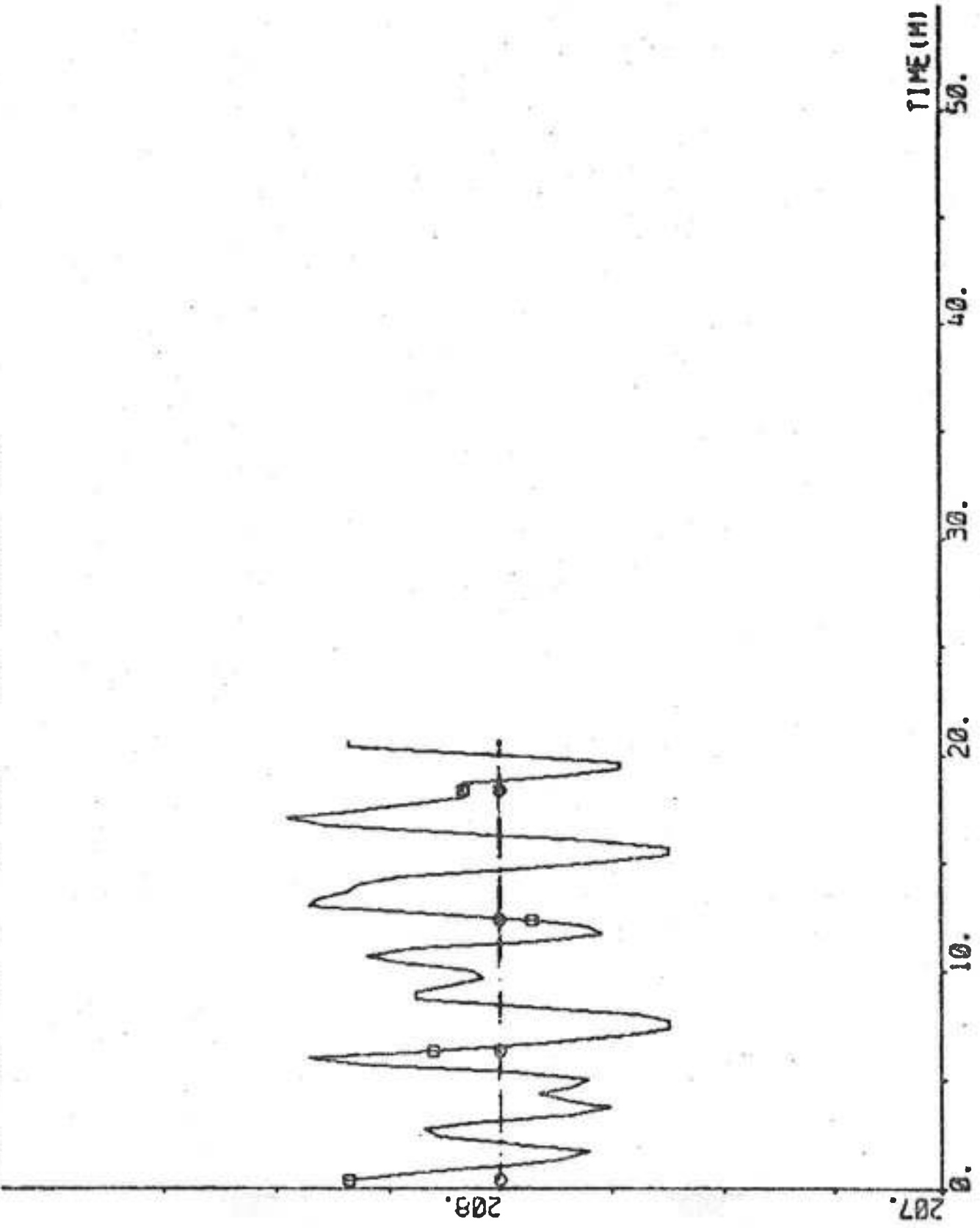
PLOT A20P1(9) ZERO -0.5 0.5 -U2 KNOTS



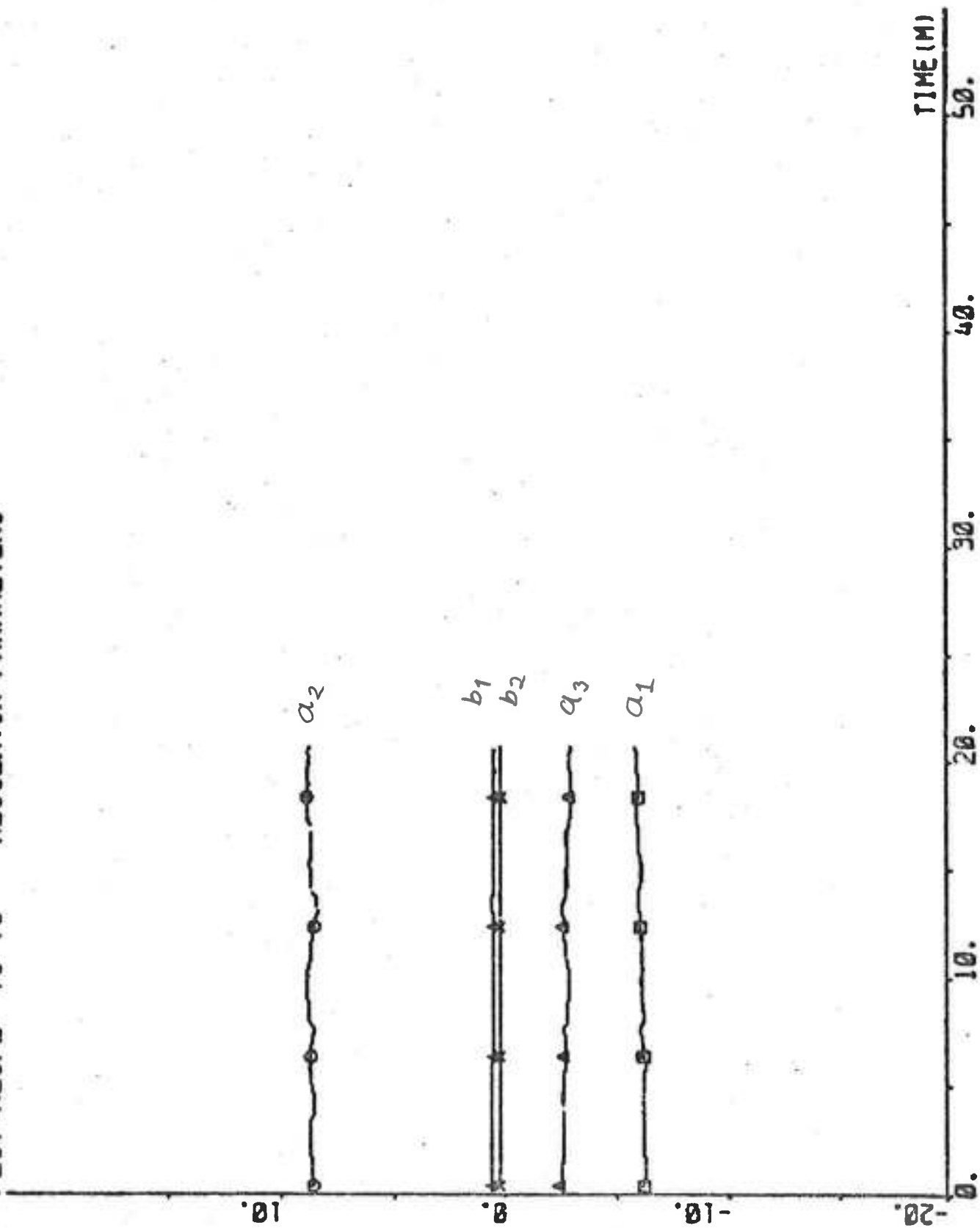
PLOT A26P1(10) ZERO -0.1 0.1 °R DEG/S



PLOT A28PI(13 14) 287 289 -PSI PSIREF DEG



PLOT A20P2 -15 15 REGULATOR PARAMETERS



## EXPERIMENT A29

Date	1974-10-16
Time	09.12
Duration	32 min
Position	S 00° 09' E 49° 02'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	S (8; see Appendix A)
Wind velocity	3-4 Beaufort (4-8 m/s, gentle to moderate breeze)
Wave height	4 m
PSIREF	208°
Rudder limit	Not active

Probably misleading measurements of U, V1 and V2 due to air-bubbles below the doppler logs.

Regulator structure

NA = 3      NB = 2      NC = 0      K = 5  
 IREG = 15      RL = 0.98

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} -9.280 \\ 13.473 \\ -4.185 \\ 0.966 \\ 0.562 \end{bmatrix} \quad P = \begin{bmatrix} 2.540 & & & & \\ -3.550 & 7.286 & & & \\ 1.533 & -4.426 & 3.621 & & \\ -0.021 & -0.127 & 0.177 & 0.032 & \\ -0.002 & -0.153 & 0.177 & 0.022 & 0.030 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = 0.008$$

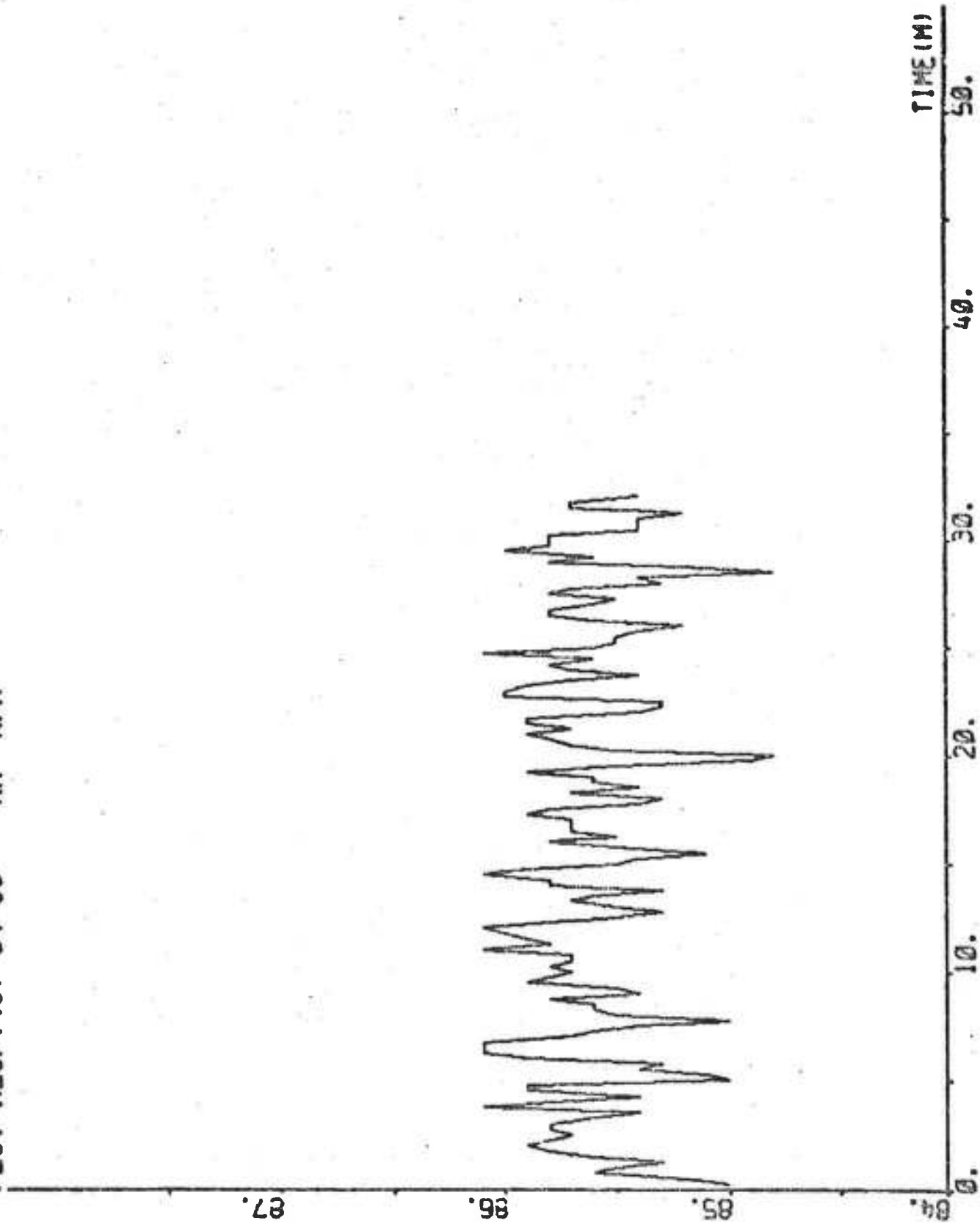
Statistics (mean value and standard deviation)

DELTA	1.48 ± 1.03 deg
PSI-PSIREF	0.001 ± 0.260 deg
AN	85.62 ± 0.28 rpm
U	6.36 ± 0.36 knots

$$V_1 = 0.393$$

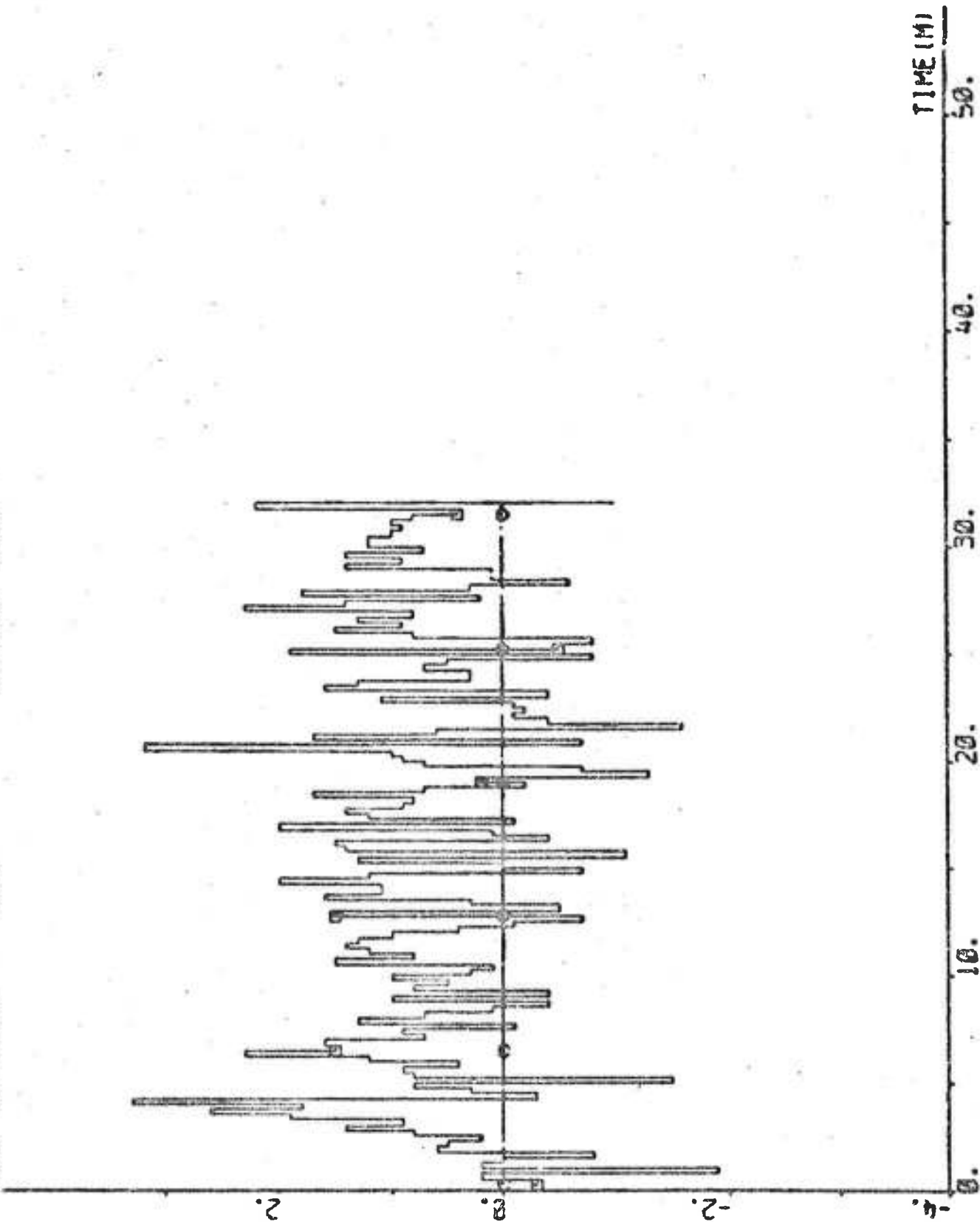
$$V_2 = 0.174$$

PLOT R29P1(6) 64 88 "RM RPM

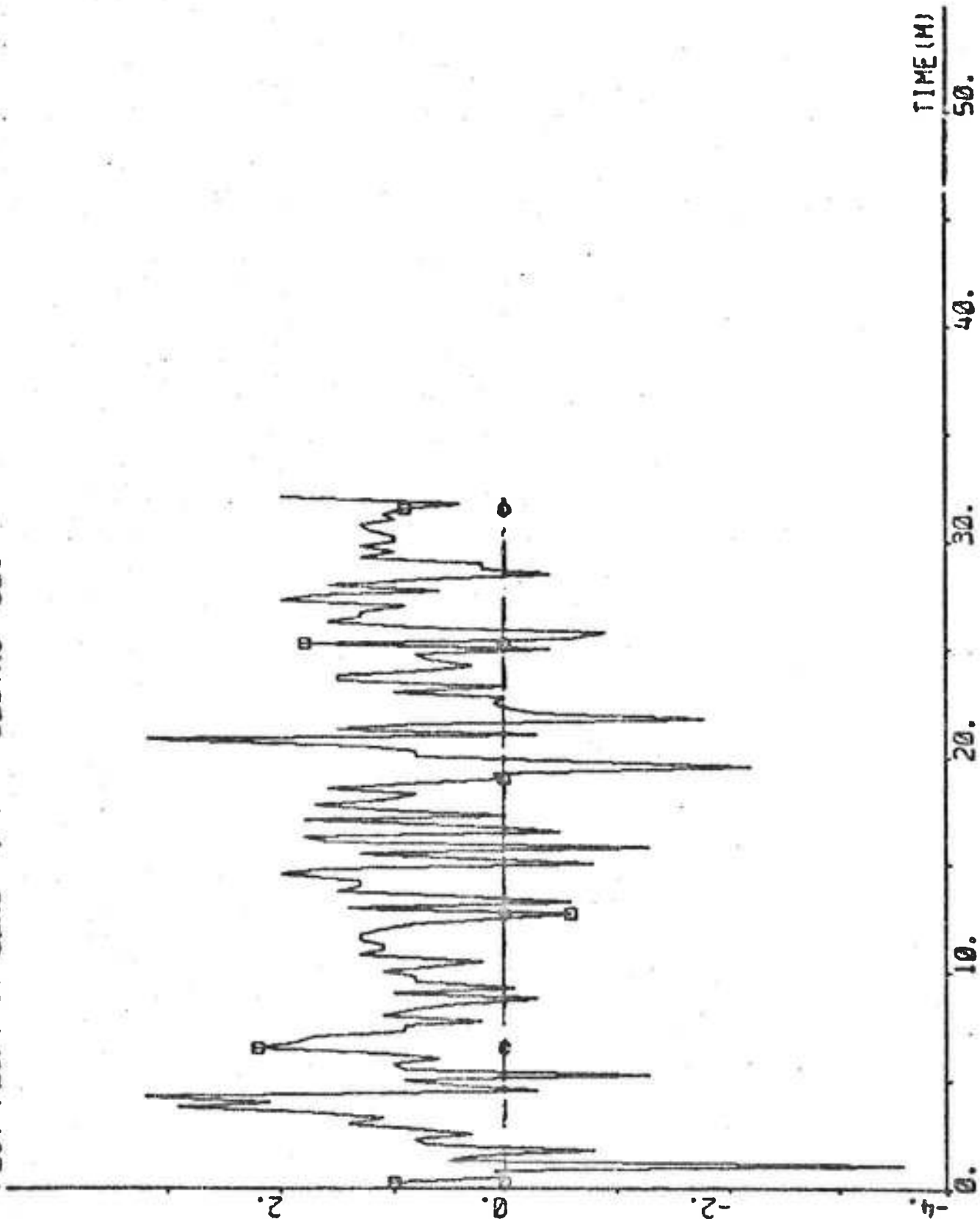




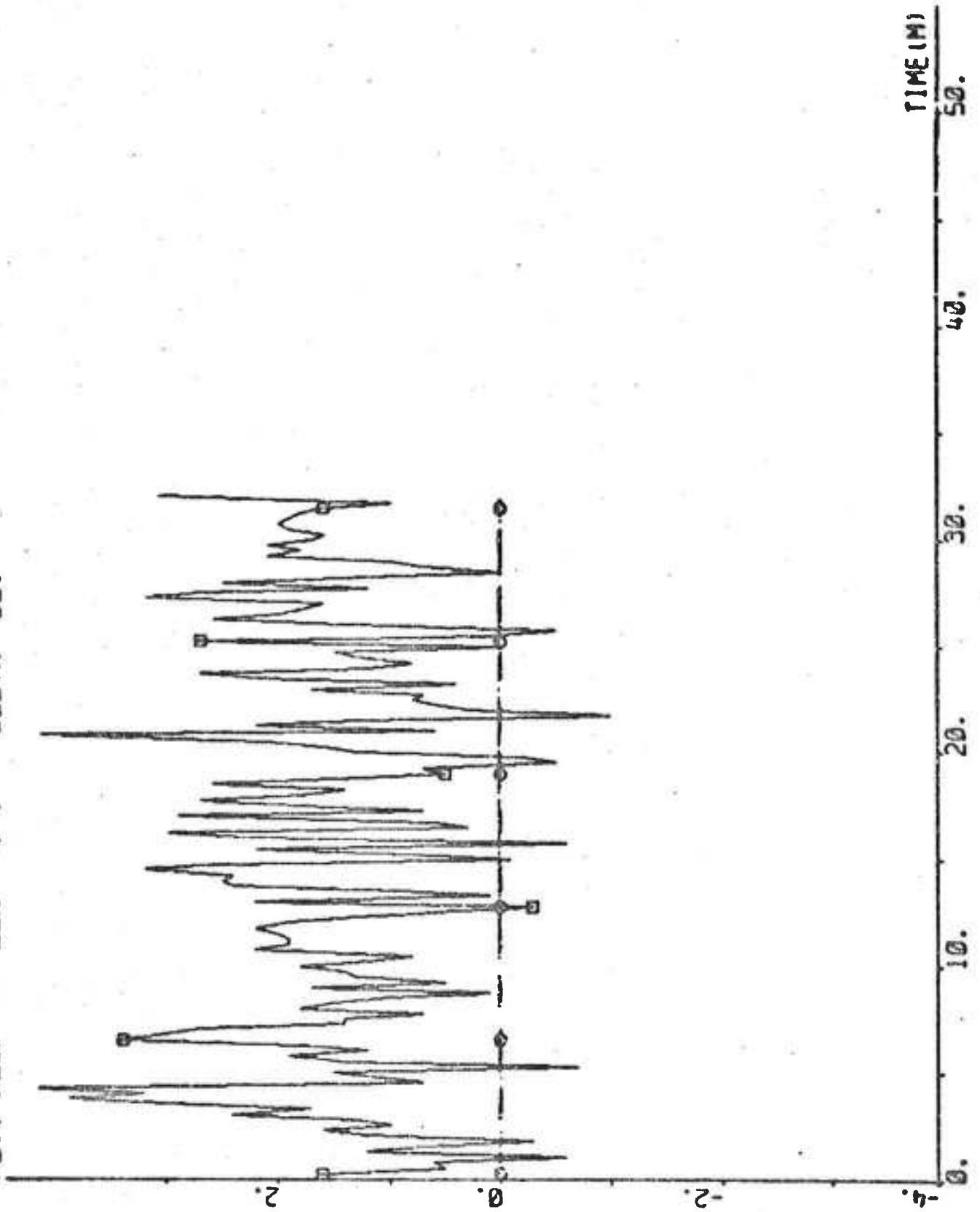
PLOT HP R23P1(1) ZERO -4 4 DELCOC DEG



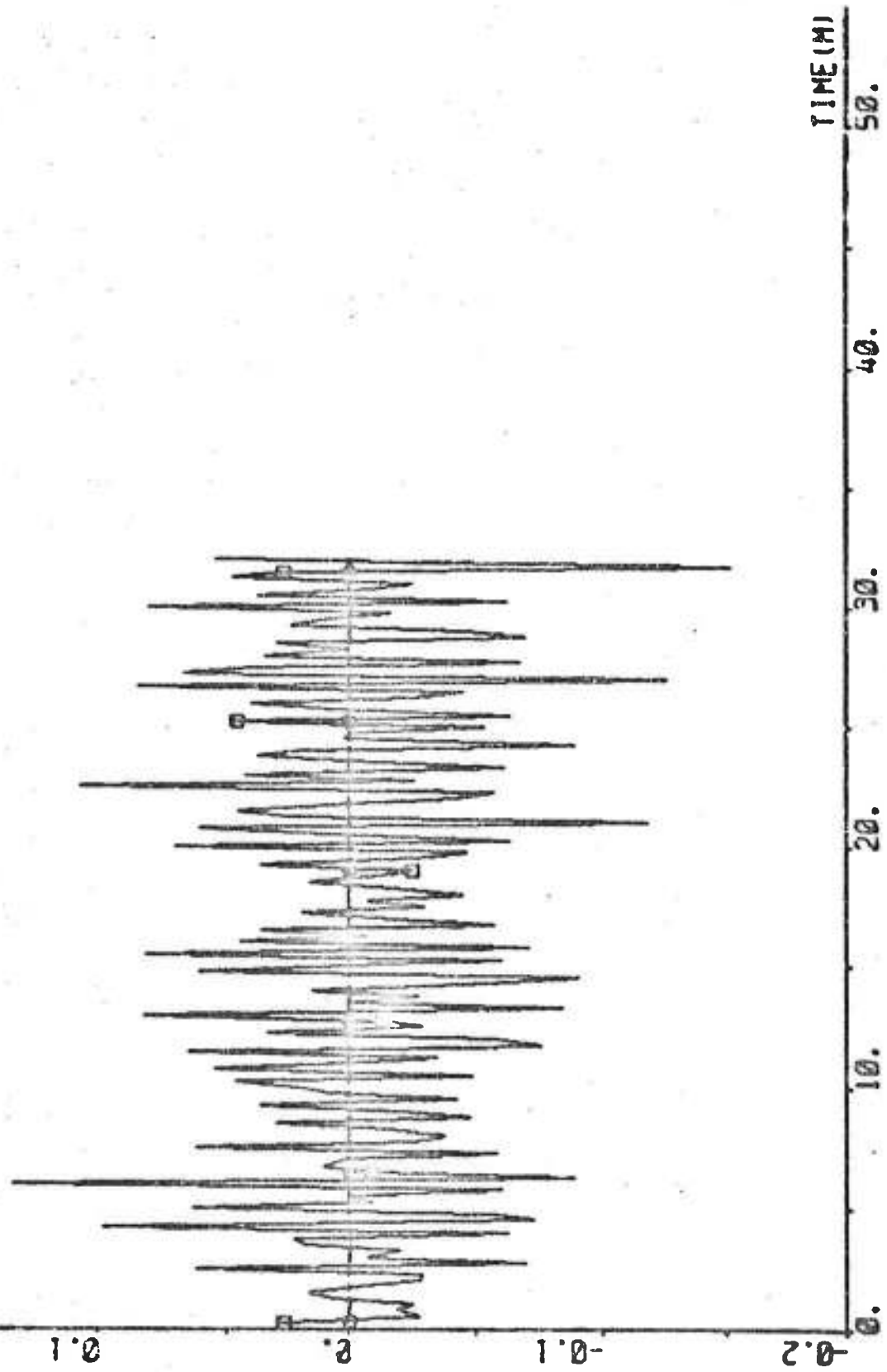
PLOT R29P1(3) ZERO -4 4 "DELTA" DEG



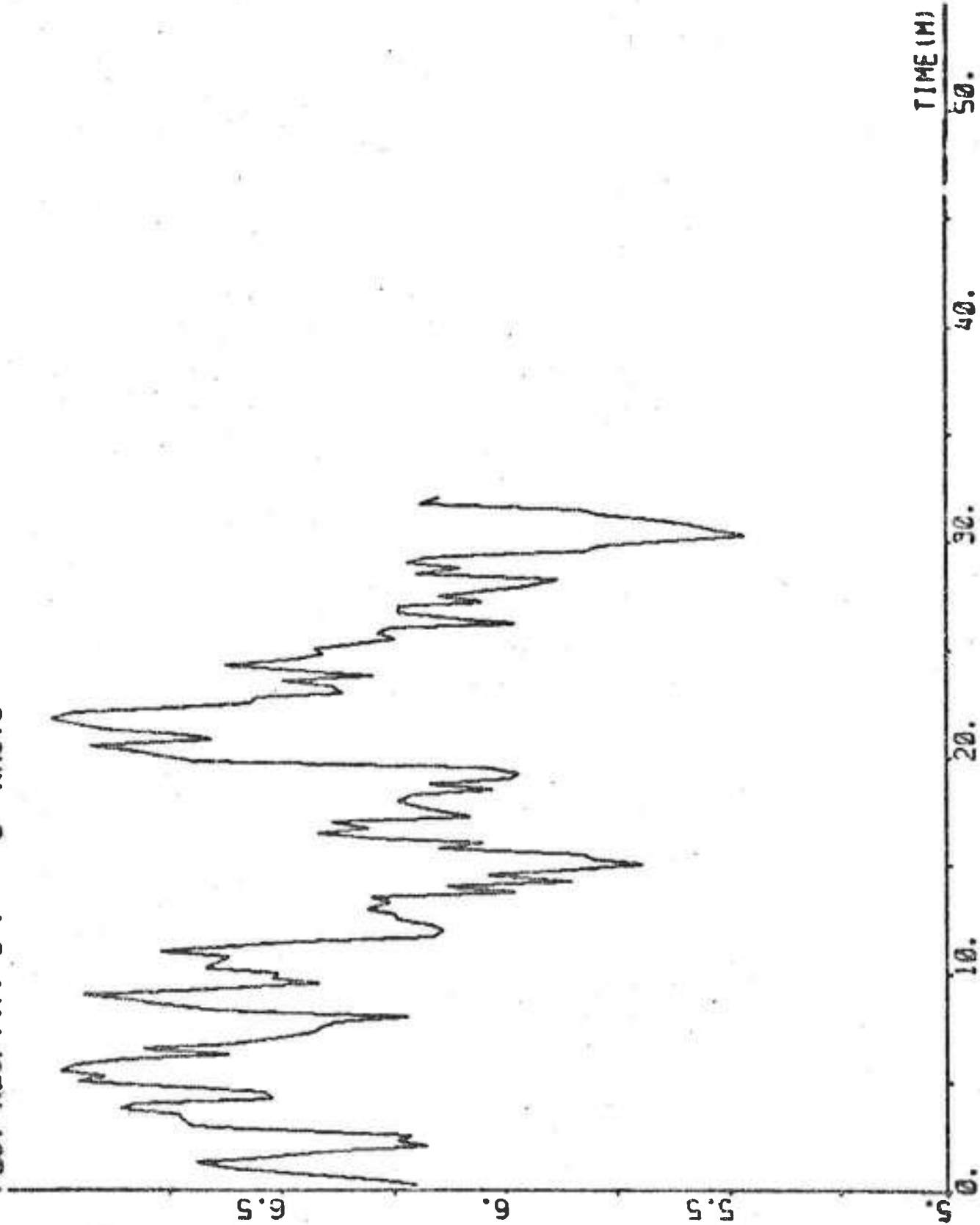
PLOT A29P1(4) ZERO -4 4 DELTA DEC

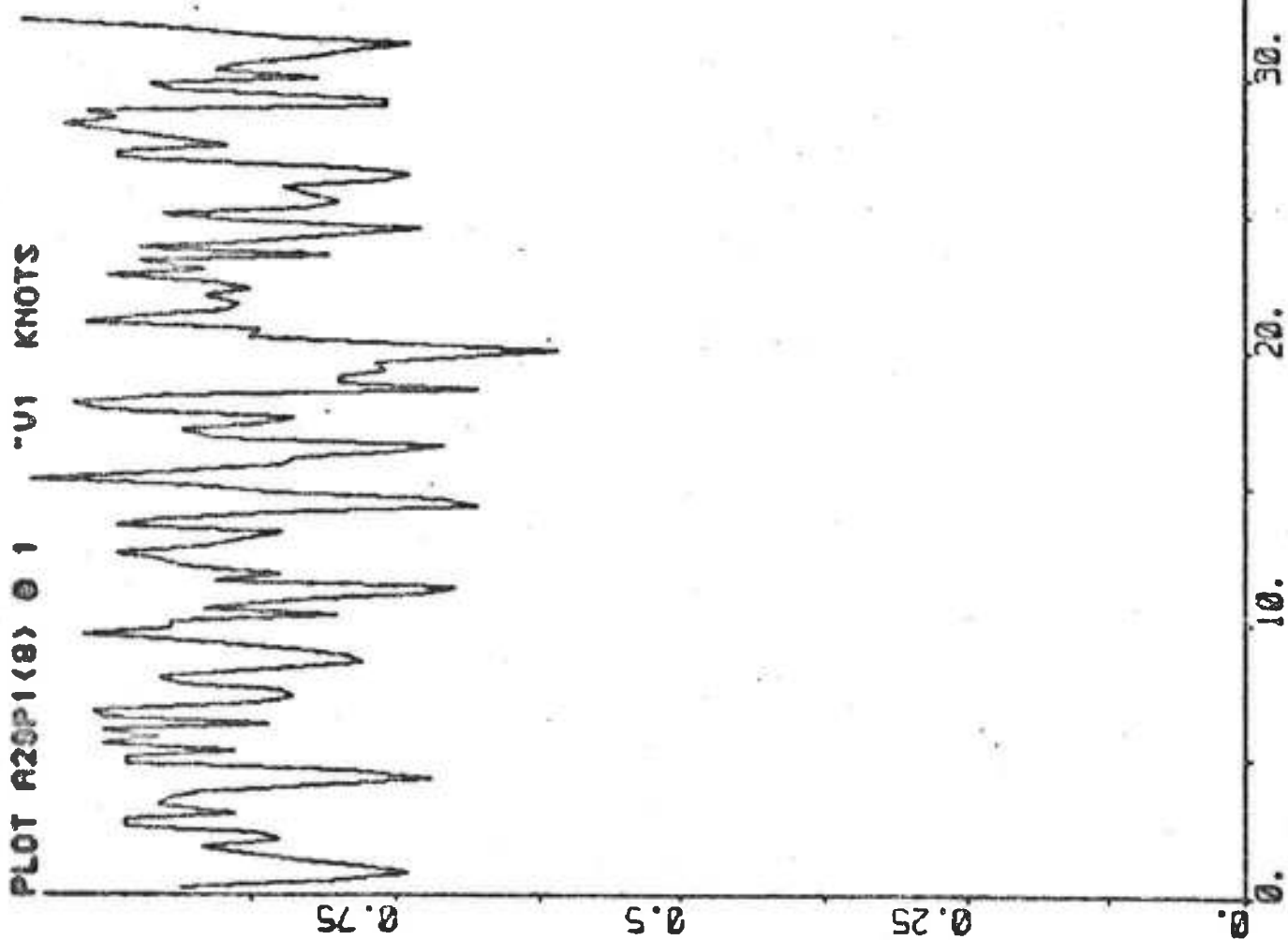


PLOT A2SP1(6) ZERO -0.2 G.2 -PP DEG/S

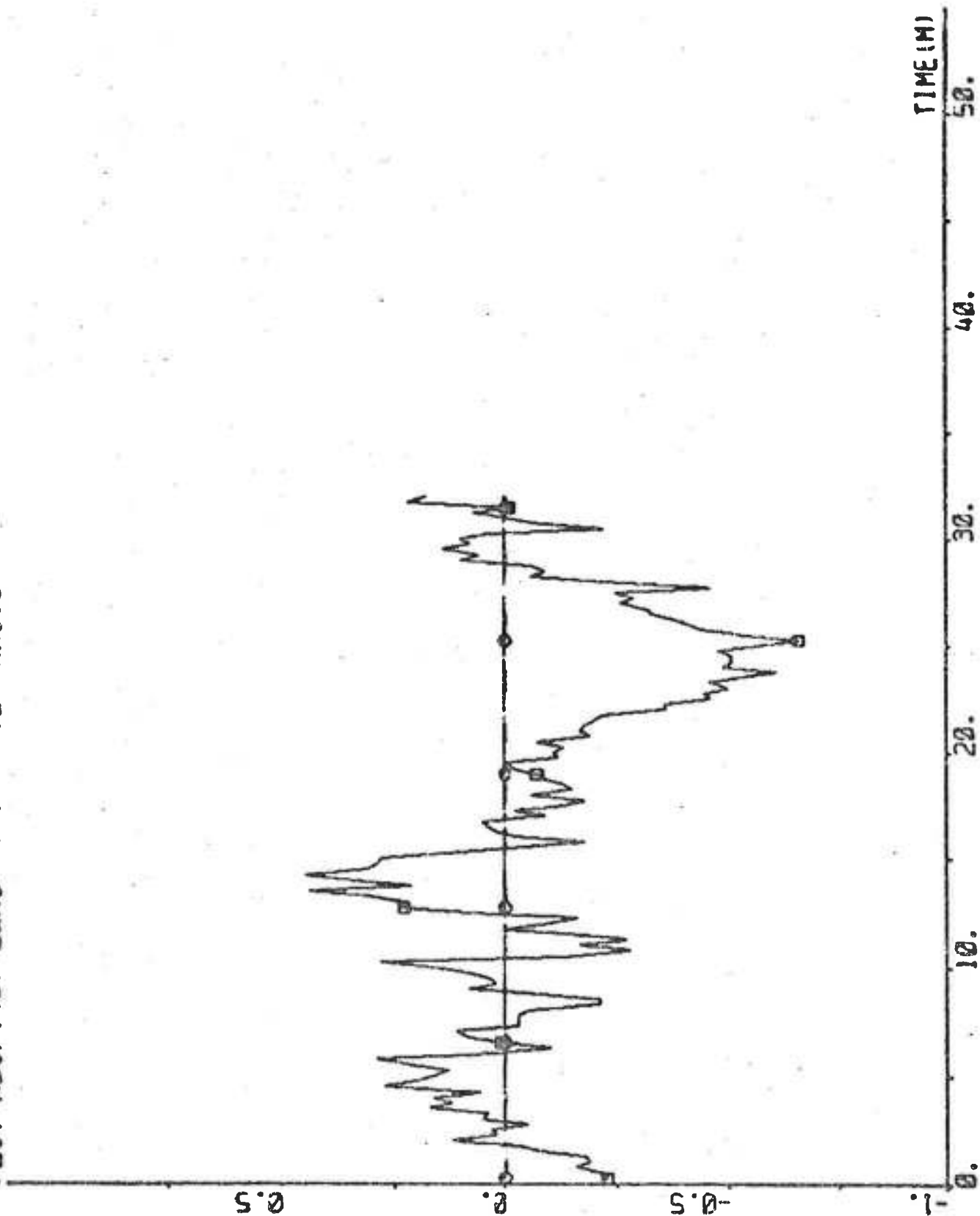


PLOT A29P1(7) 6 7 "U KNOTS

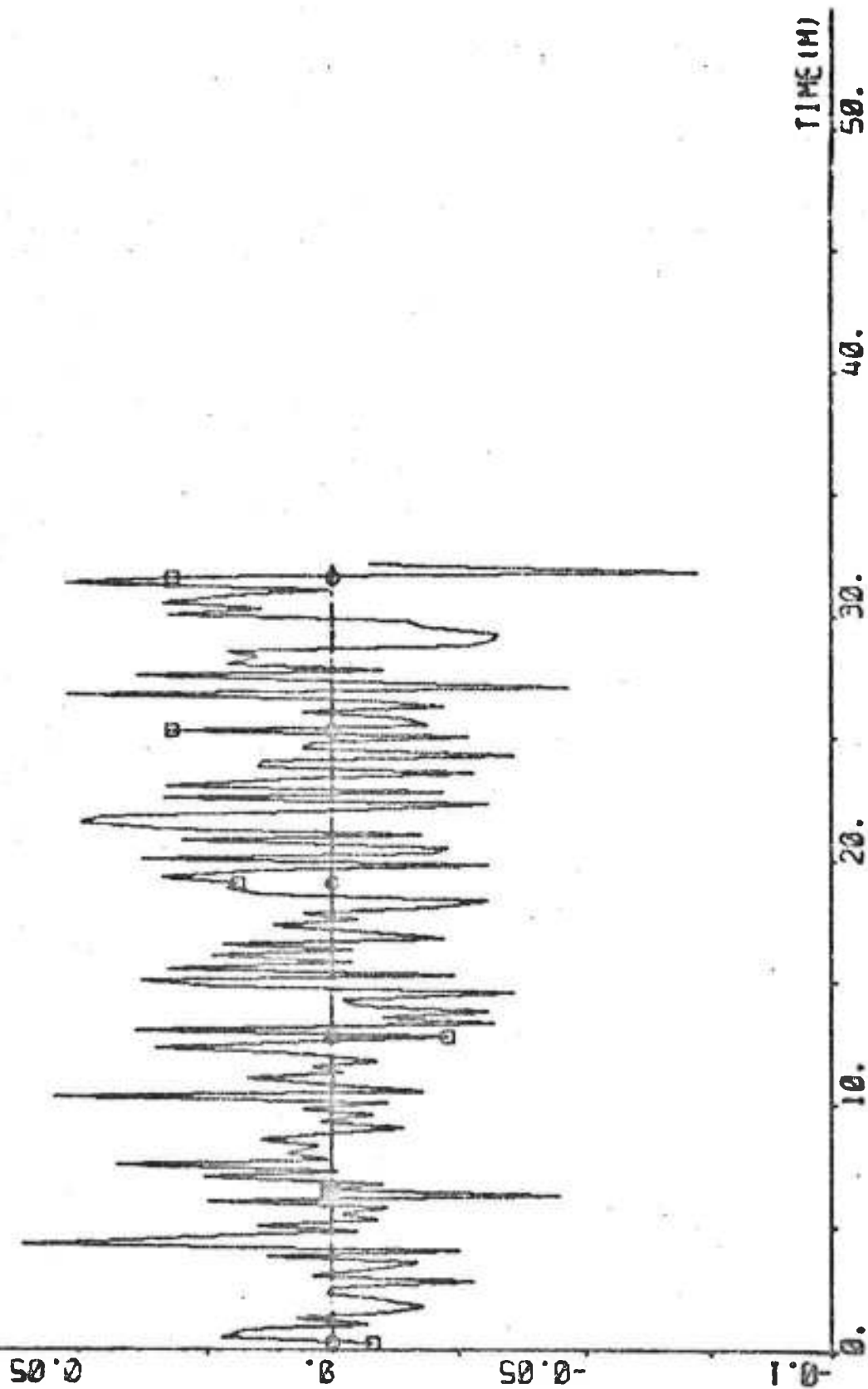




PLOT R29P1(9) ZERO -1 : -VZ KNOTS

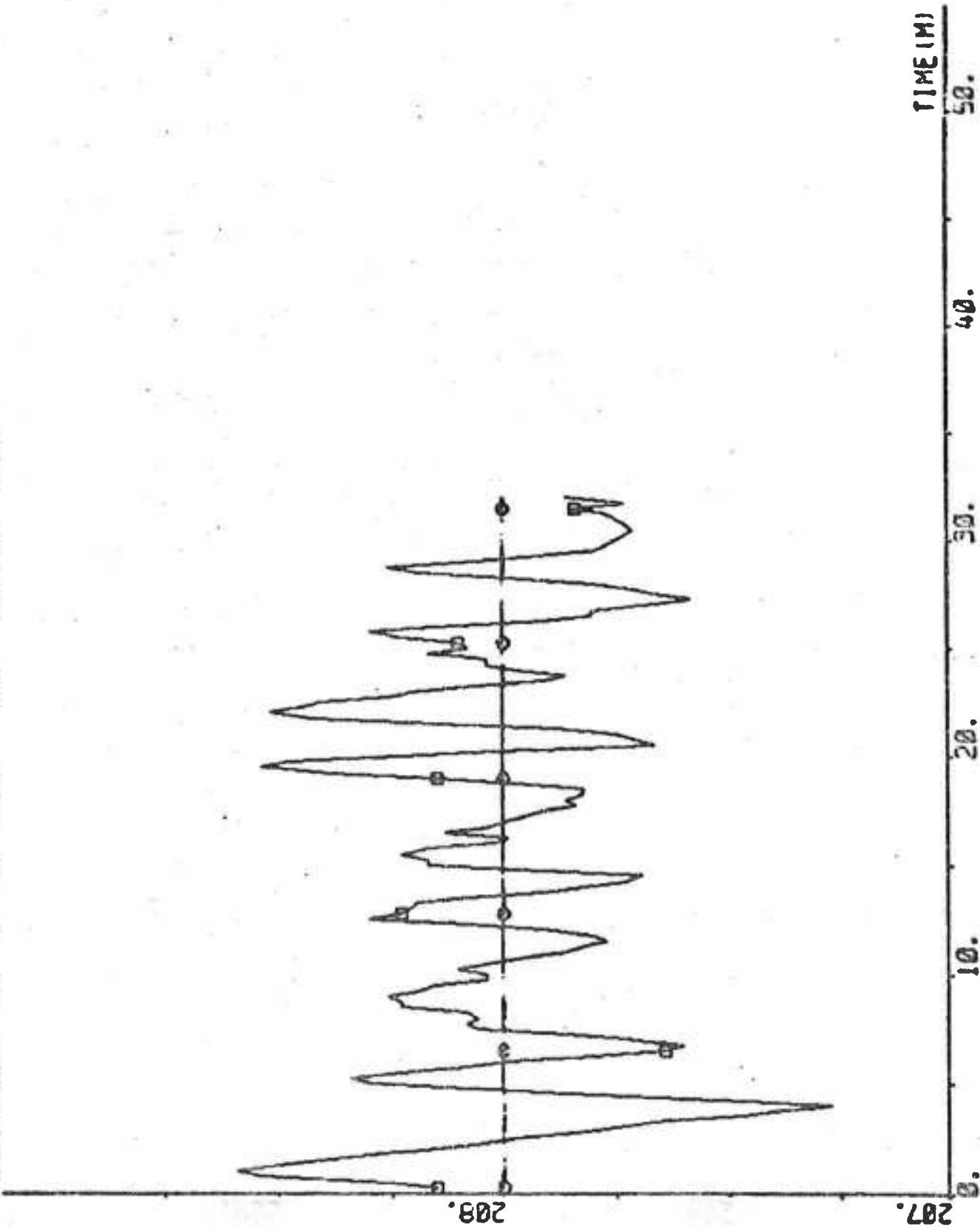


PLOT A29P1(10) ZERO -0.1 0.1 "R DEC/S

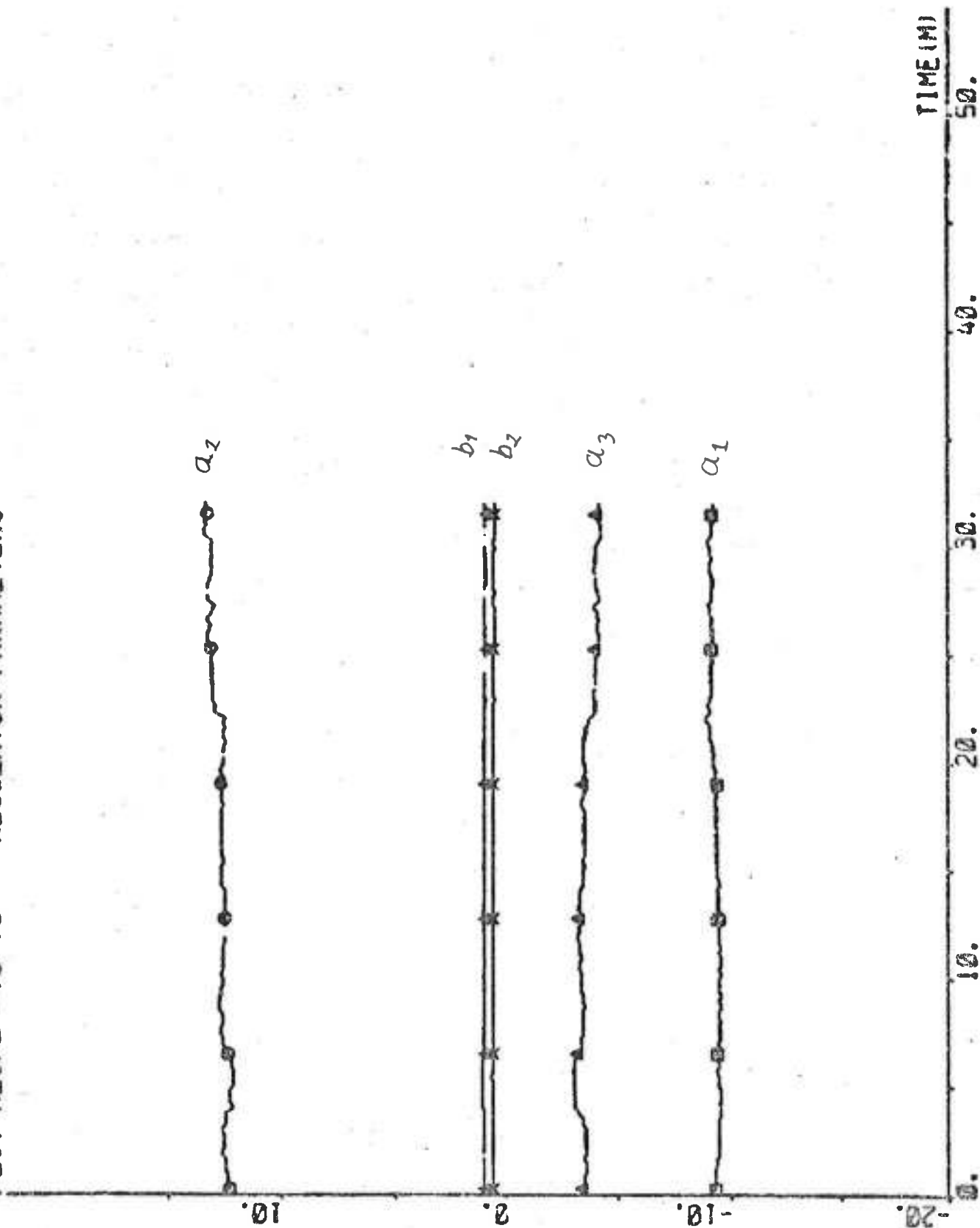




PLOT A29P1(13 14) 297 299 "PSI PSIREF DEC



PLOT A29P2 -15 15 REGULATOR PARAMETERS



## EXPERIMENT A30

Date	1974-10-16
Time	14.06
Duration	31 min
Position	S 01 <sup>o</sup> 20' E 48 <sup>o</sup> 23'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SSW (1; see Appendix A)
Wind velocity	3-4 Beaufort (4-8 m/s, gentle to moderate breeze)
Wave height	3 - 4 m
PSIREF	208 <sup>o</sup>
Rudder limit	Not active

Regulator structure

NA = 3	NB = 1	NC = 0	K = 5
IREG = 15	RL = 0.98		

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \end{bmatrix} = \begin{bmatrix} -12.381 \\ 18.843 \\ -6.589 \\ 1.079 \end{bmatrix} \quad P = \begin{bmatrix} 2.842 & & & & \\ -4.235 & 7.573 & & & \\ 1.900 & -3.935 & 2.532 & & \\ -0.031 & 0.044 & -0.016 & 0.004 & \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.127$$

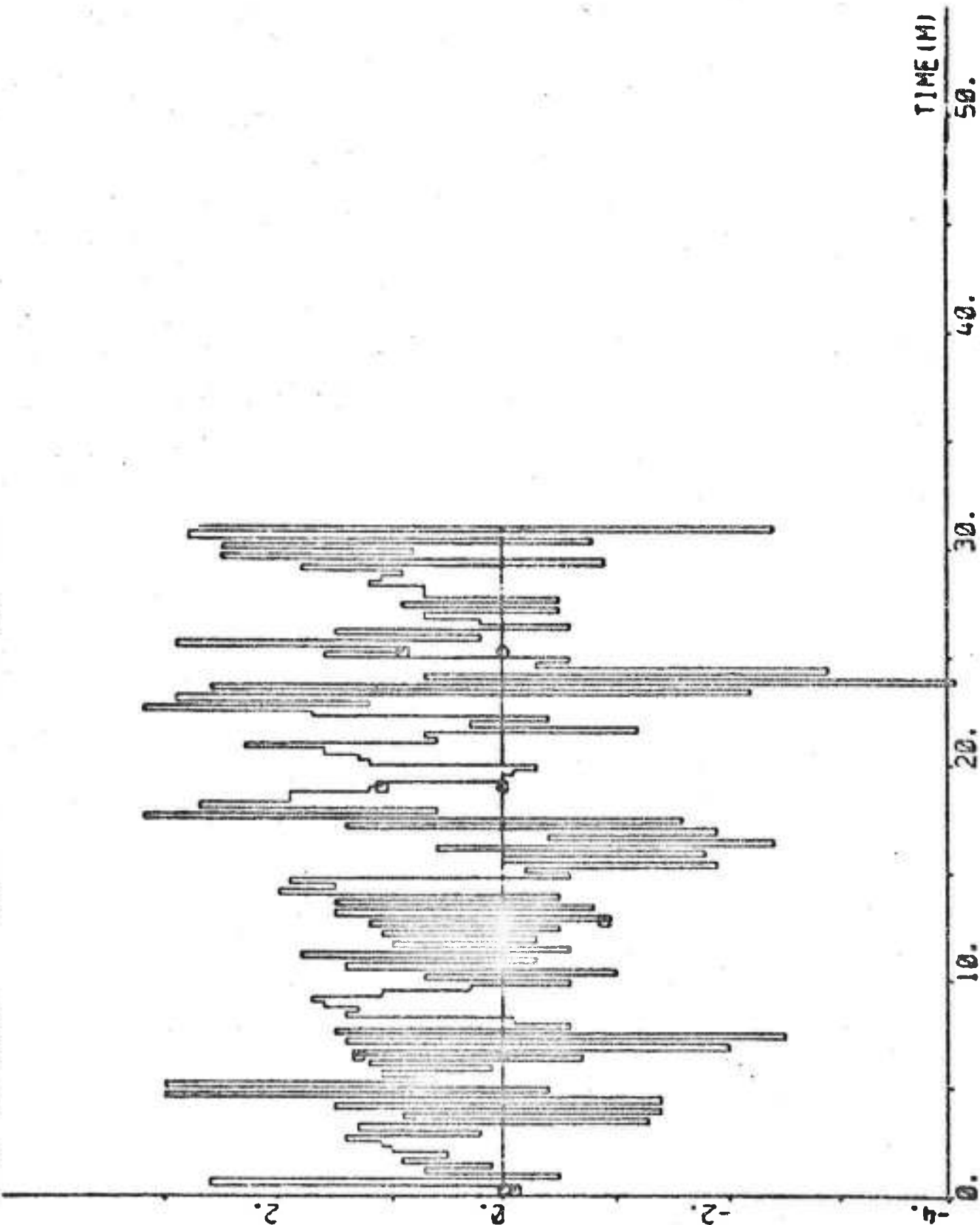
Statistics (mean value and standard deviation)

DELTA	1.38 ± 1.37 deg
PSI-PSIREF	-0.024 ± 0.253 deg
AN	85.67 ± 0.26 rpm
U	20.24 ± 0.09 knots

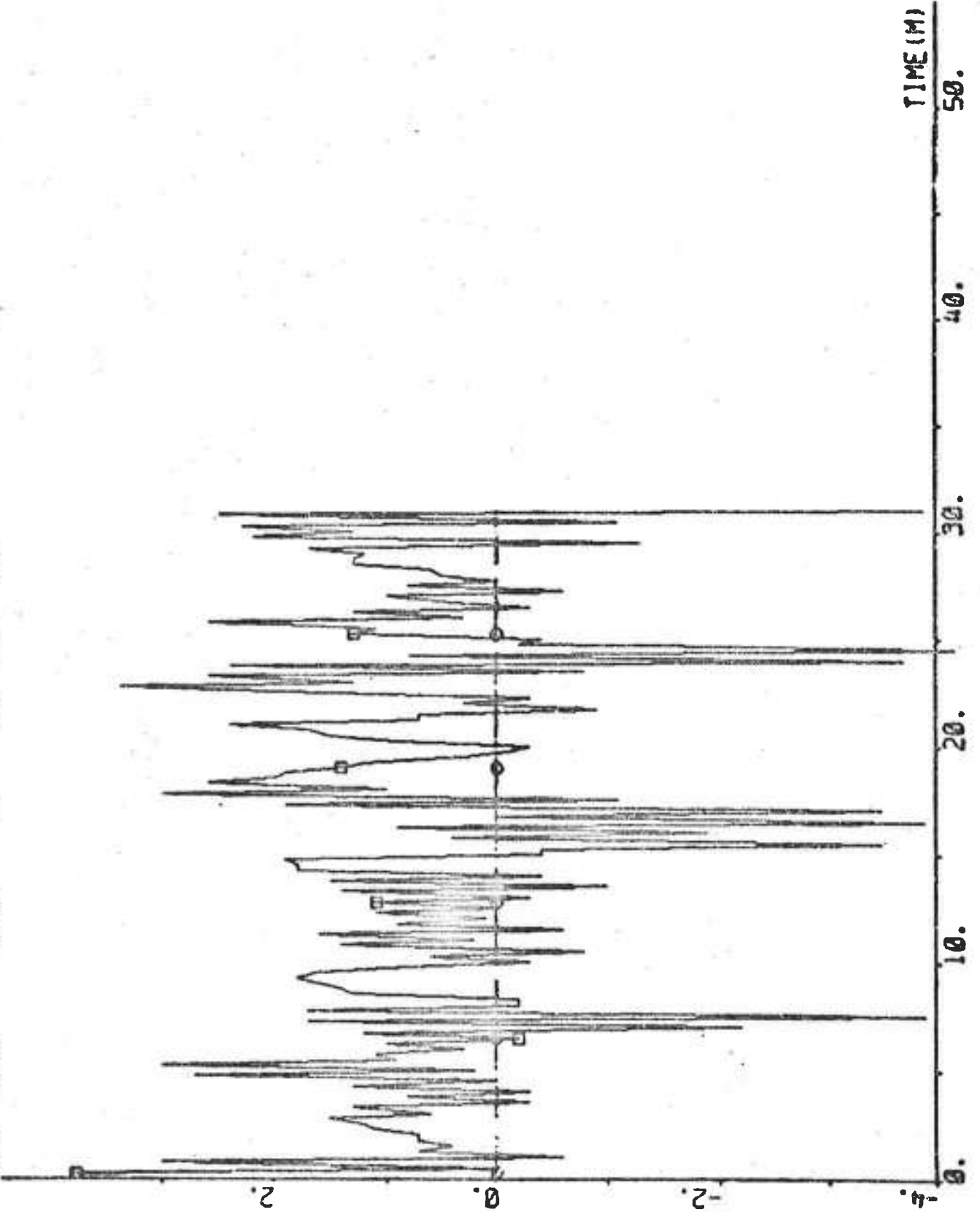
$$V_1 = 0.443$$

$$V_2 = 0.252$$

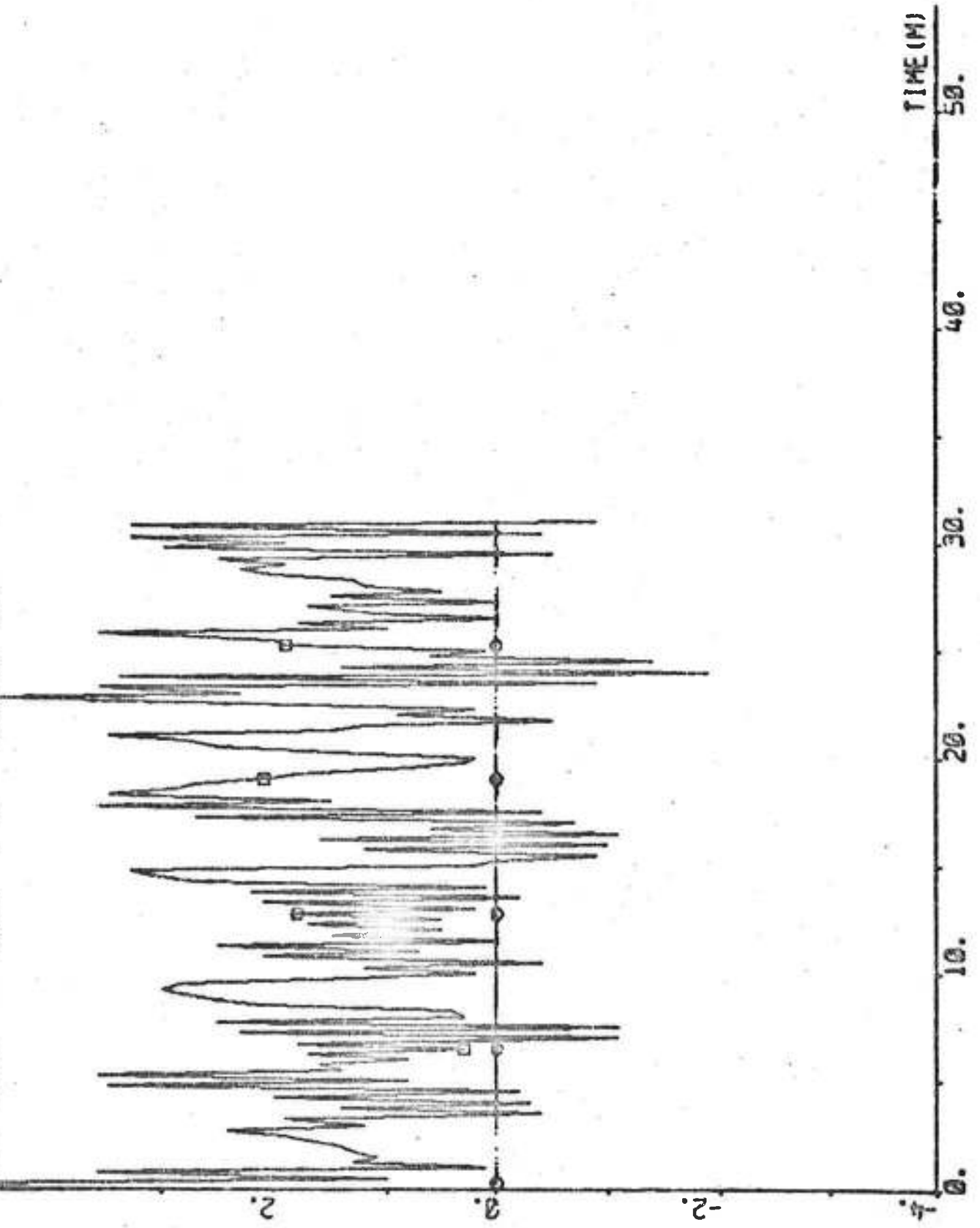
PLOT HP R3SP1(1) ZERO -4 4 "DELCOG DEC



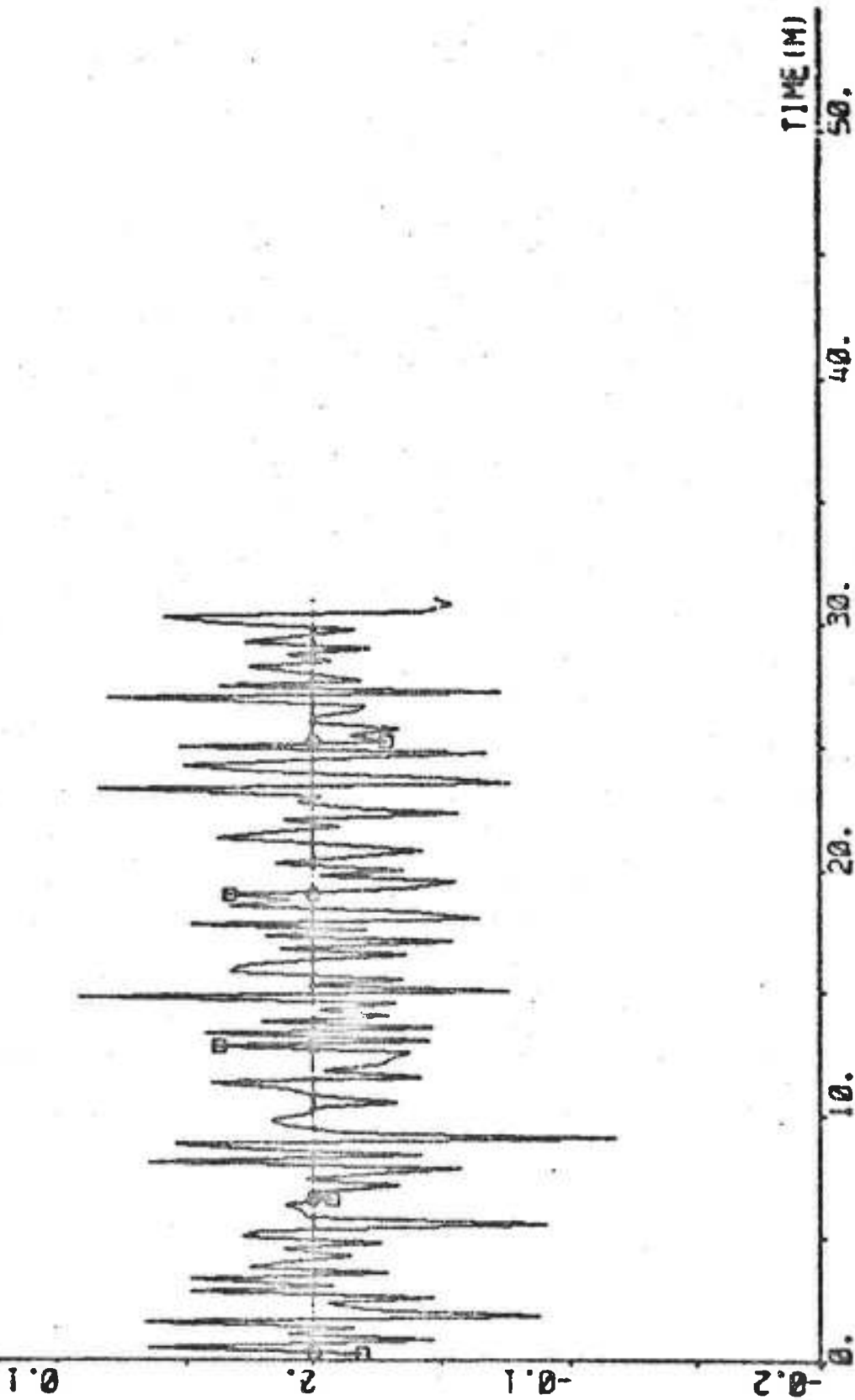
PLOT AOSP1(3) ZERO -4 4 "DELTA" DEG



FLOT R30P1(4) ZERO -4 4 "DELTA DEG

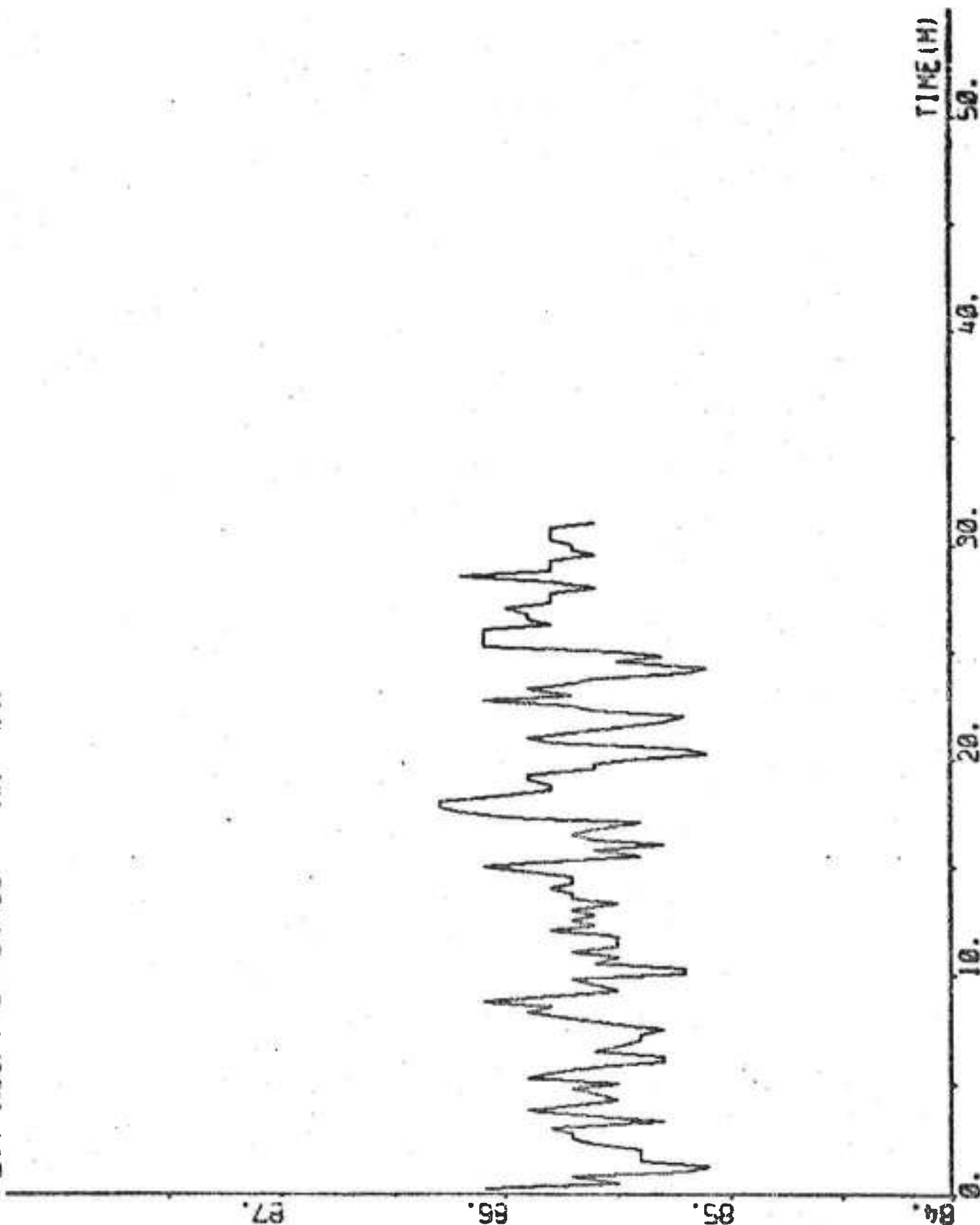


PLOT R30P1(5) ZERO -0.2 0.2 °PP DEG/S

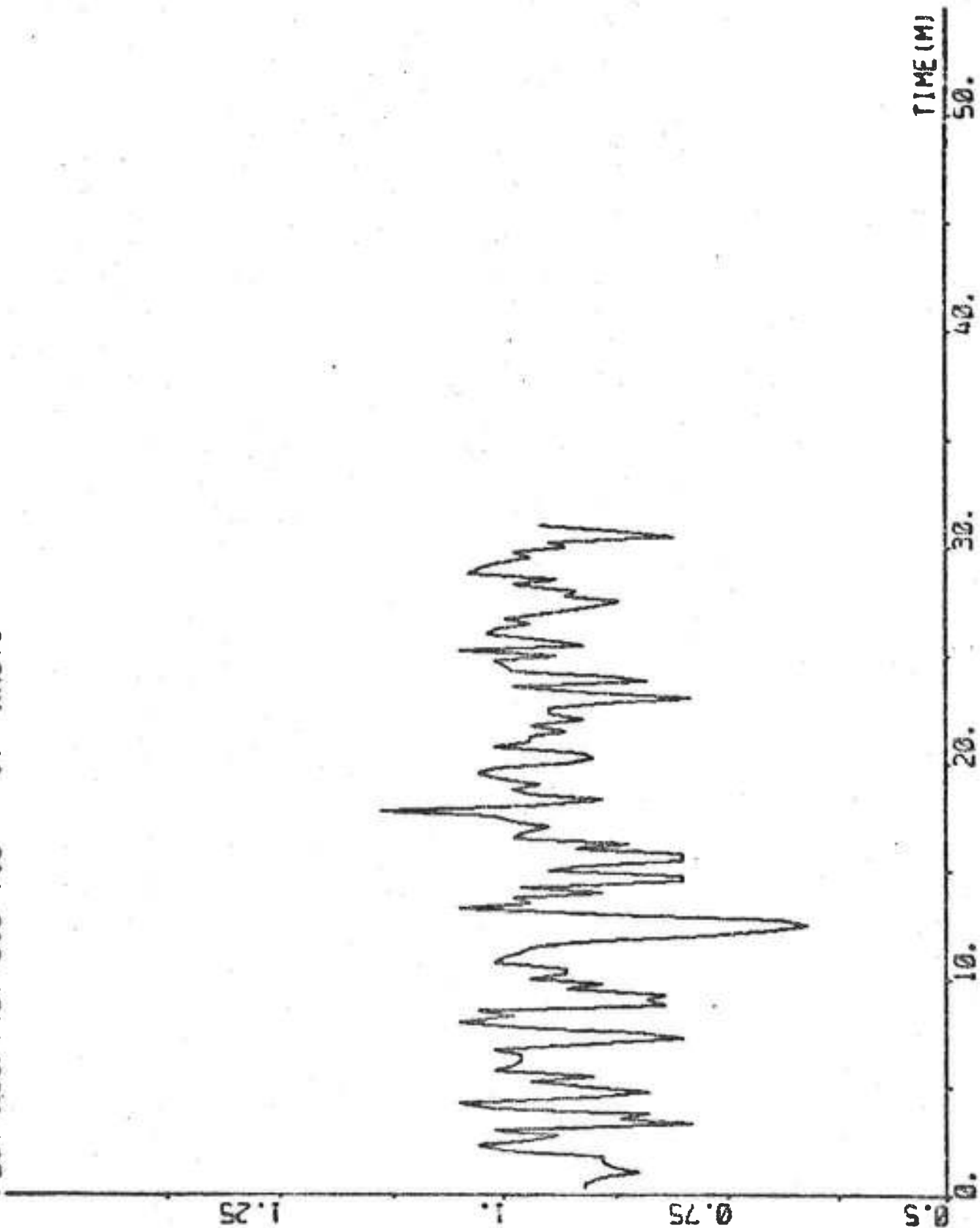




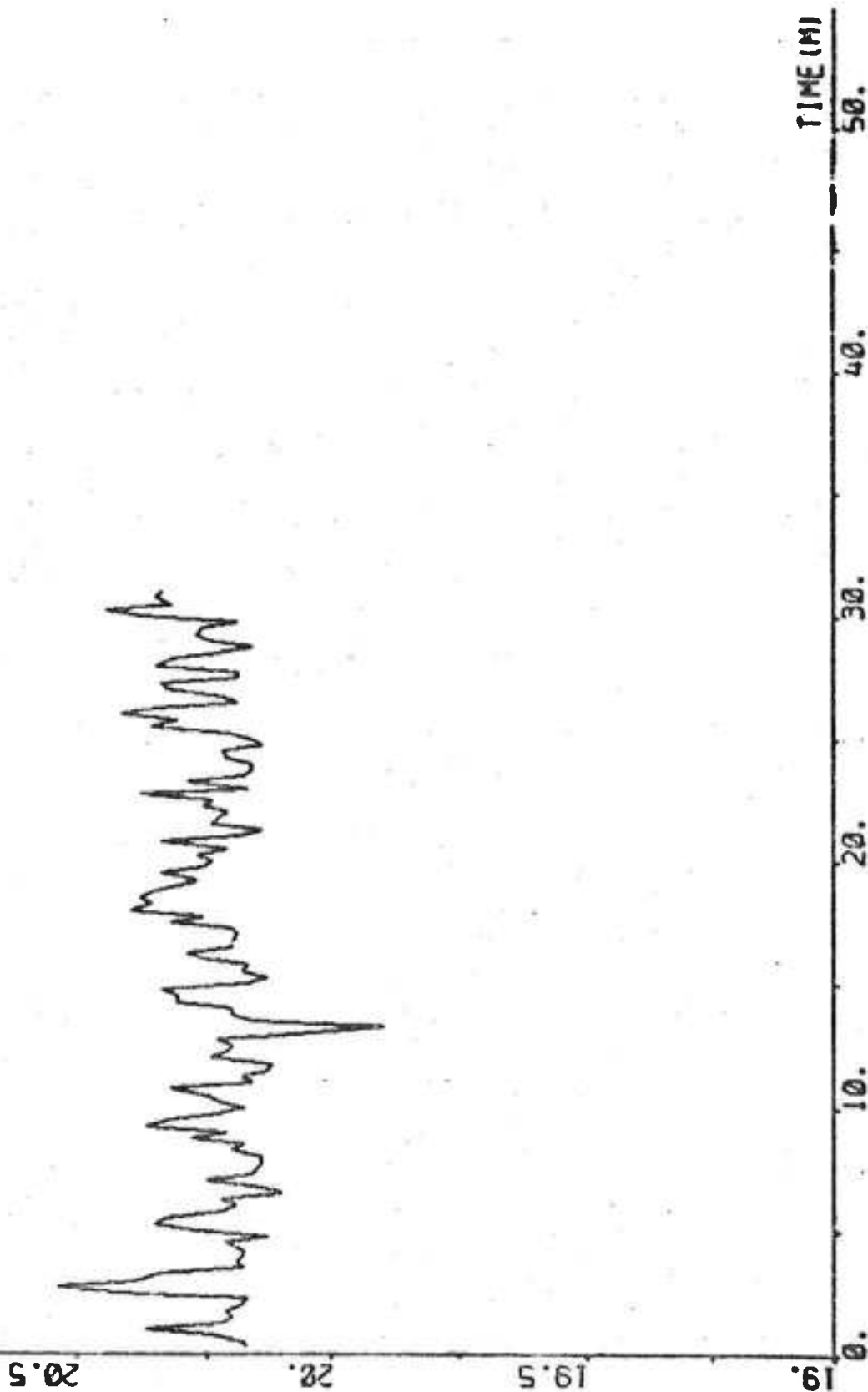
PLOT R3CP1 (6) 84 88 "AH RPH



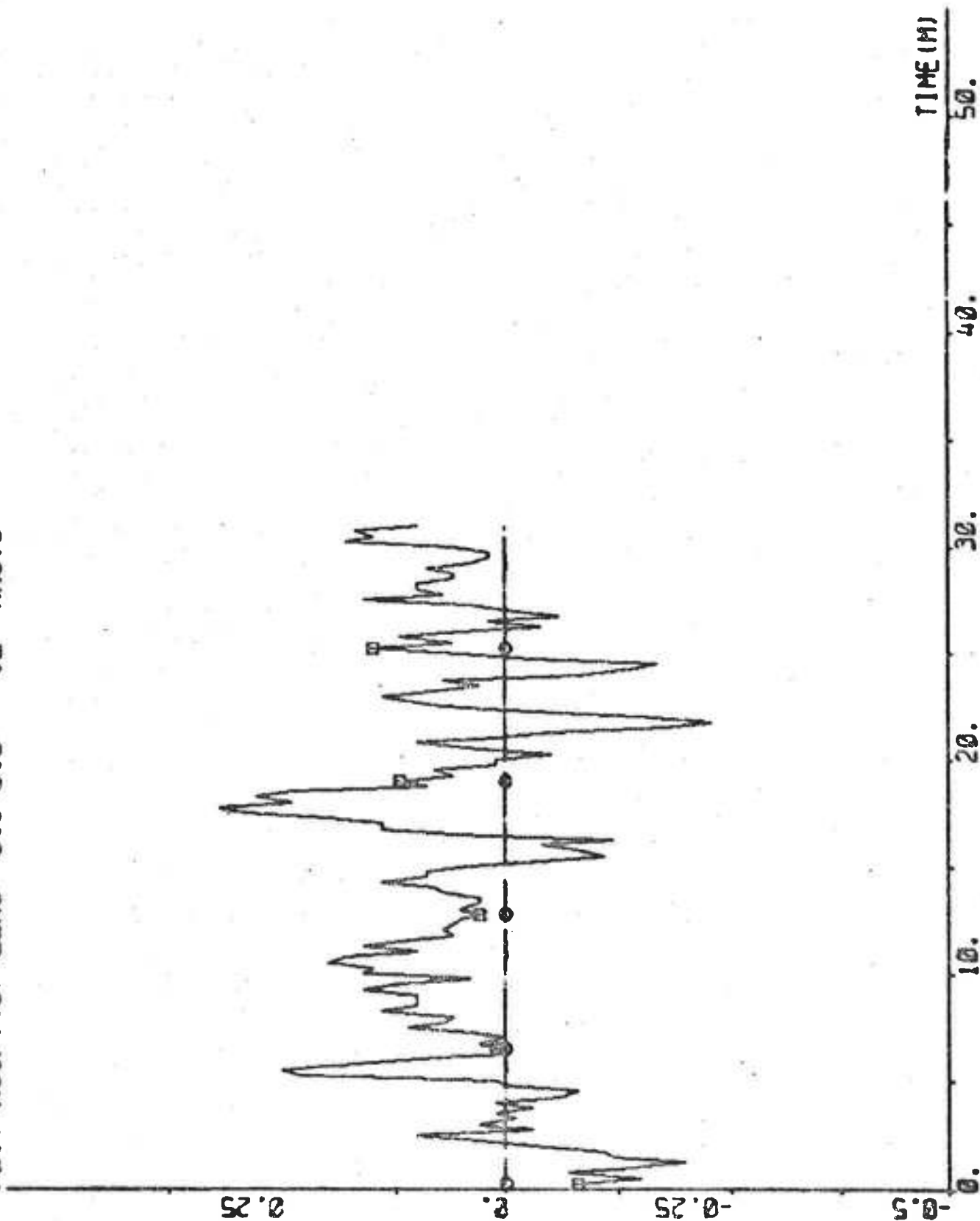
PLOT A30P1(8) 0.5 1.5 "V1 KNOTS



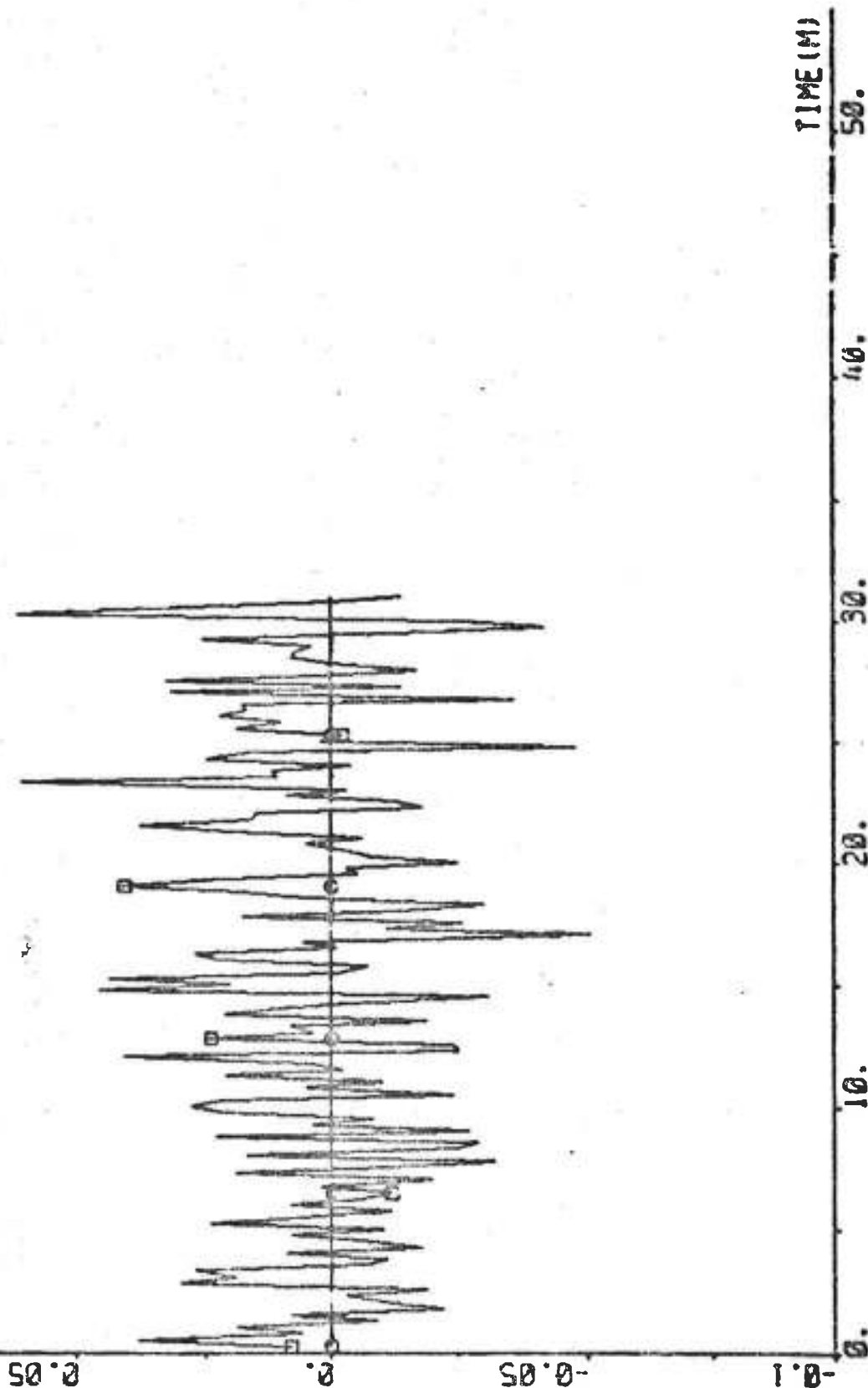
PLOT A30P1(7) 19 21 "U KNOTS



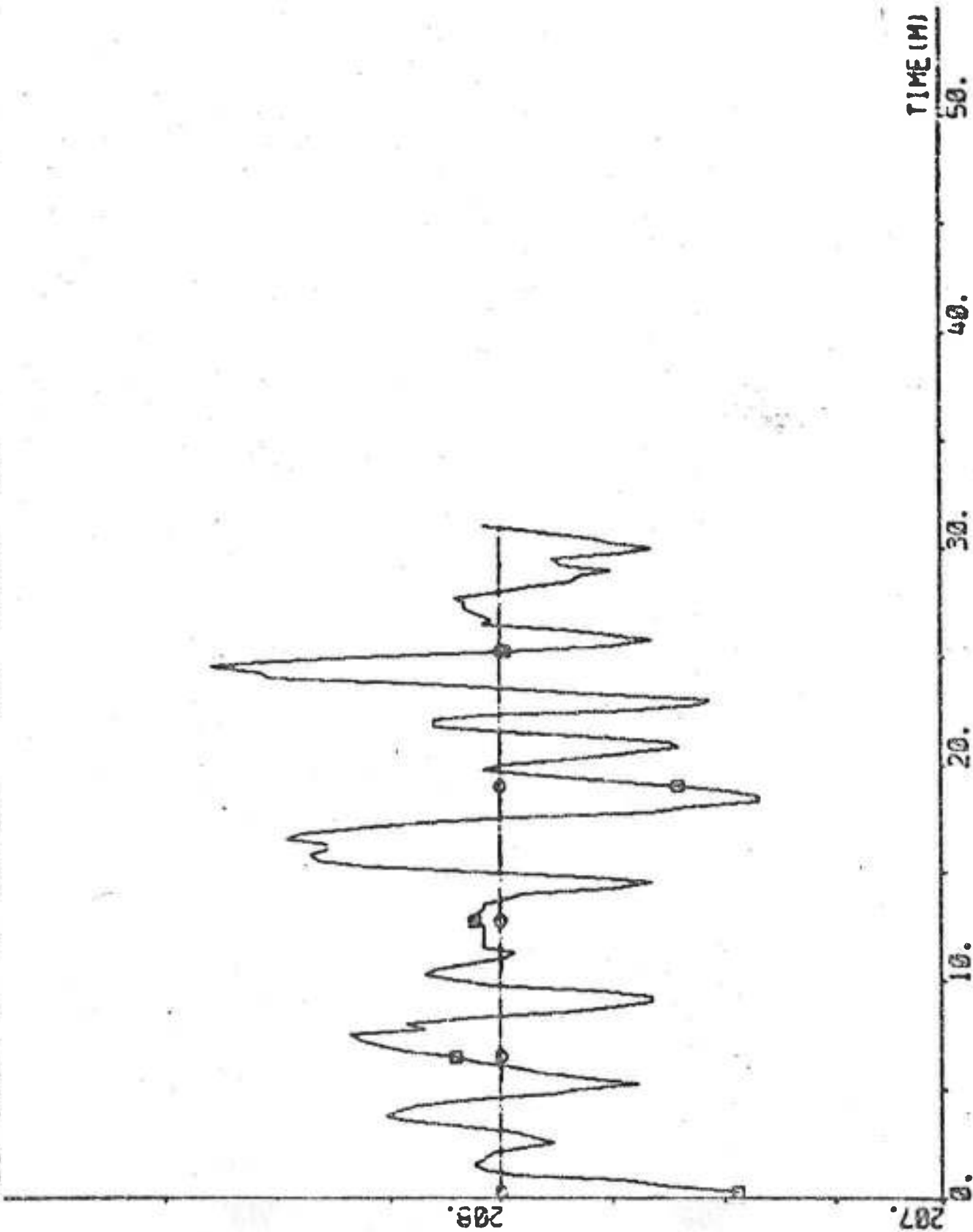
PLOT A36P1(S) ZERO -0.6 0.5 -V2 KNOTS



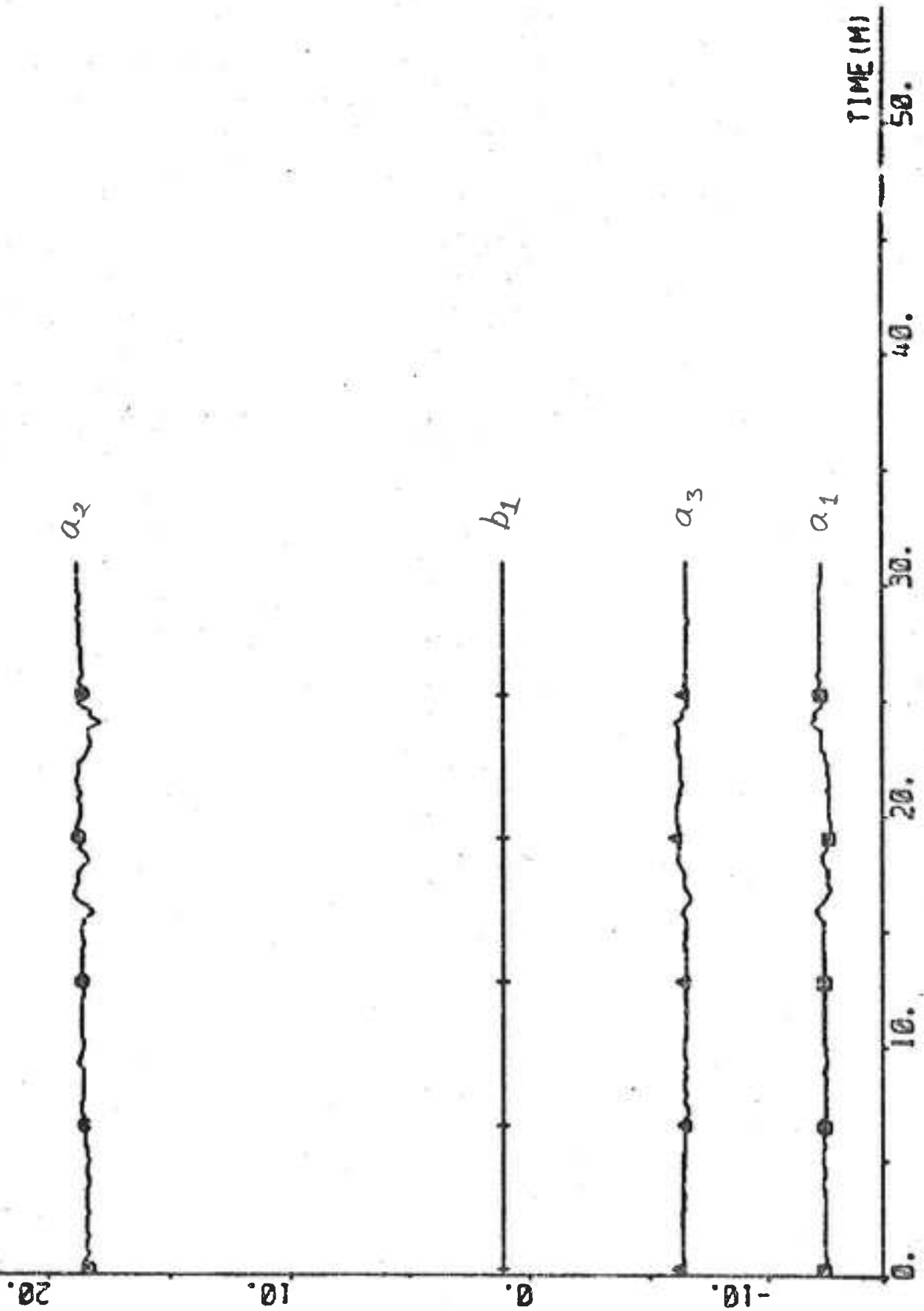
PLOT A30P1(10) ZERO -0.1 0.1 "R DEG/S



PLOT A36PI (13 14) 207 209 °PSI PSIREF DEG



PLOT A30P2 -14 20 REGULATOR PARAMETERS



## EXPERIMENT A31

Date 1974-10-16  
 Time 15.15  
 Duration 31 min  
 Position S 01° 37' E 48° 15'  
 Water depth deep  
 Forward draught 20.2 m  
 Aft draught 20.2 m  
 Wind direction S (8; see Appendix A)  
 Wind velocity 3-4 Beaufort (4-8 m/s, gentle to moderate breeze)  
 Wave height 3 - 4 m  
 PSIREF 208°  
 Rudder limit Not active

Regulator structure

NA = 4      NB = 2      NC = 0      K = 5  
 IREG = 15      RL = 0.98

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ a_4 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} -11.335 \\ 14.571 \\ -3.058 \\ -0.575 \\ 0.961 \\ 0.549 \end{bmatrix} \quad P = \begin{bmatrix} 5.357 & & & & & & & & & \\ -9.784 & 43.765 & & & & & & & & \\ 7.583 & -57.614 & 86.994 & & & & & & & \\ -2.736 & 23.409 & -38.119 & 18.345 & & & & & & \\ 0.166 & -2.452 & 3.911 & -1.657 & 0.219 & & & & & \\ -0.020 & -0.988 & 1.538 & -0.573 & 0.097 & 0.076 & & & & \end{bmatrix}$$

$$a_1 + a_2 + a_3 + a_4 = -0.397$$



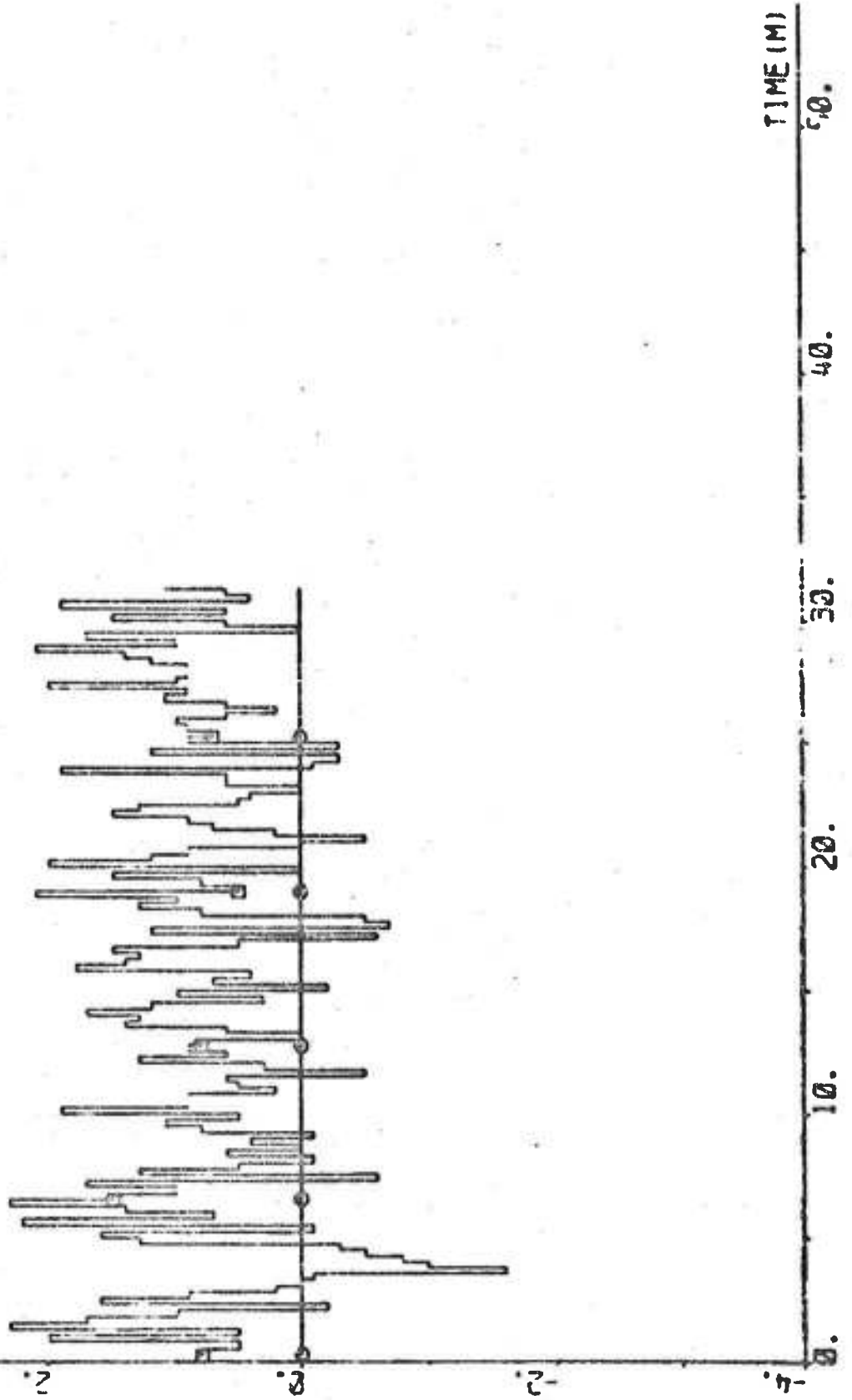
Statistics (mean value and standard deviation)

DELTA	1.57 ± 0.91 deg
PSI-PSIREF	-0.063 ± 0.171 deg
AN	85.65 ± 0.25 rpm
U	18.64 ± 0.09 knots

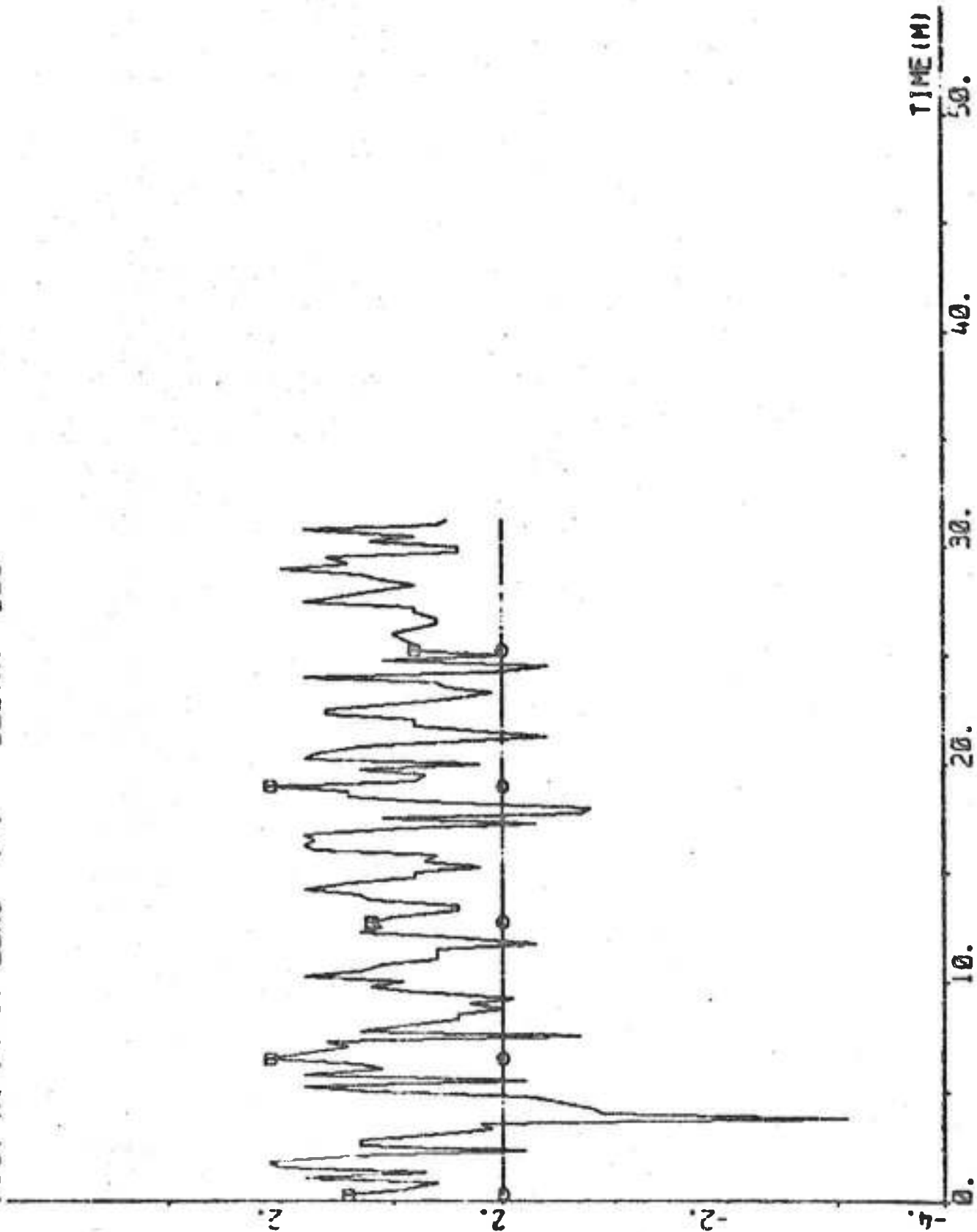
$$V_1 = 0.363$$

$$V_2 = 0.116$$

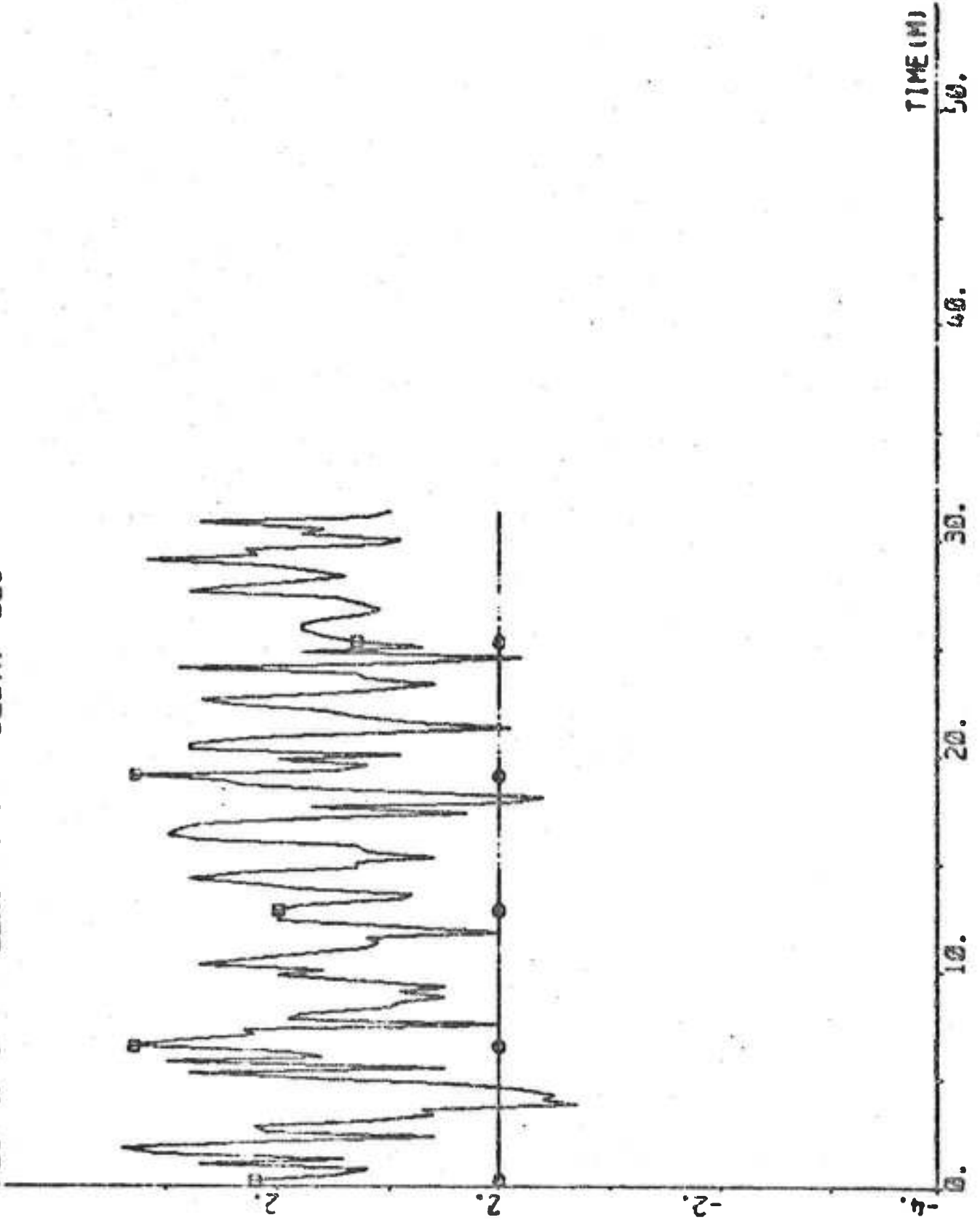
PLOT HP A31P1(1) ZERO -4 4 "DELCOC DEG



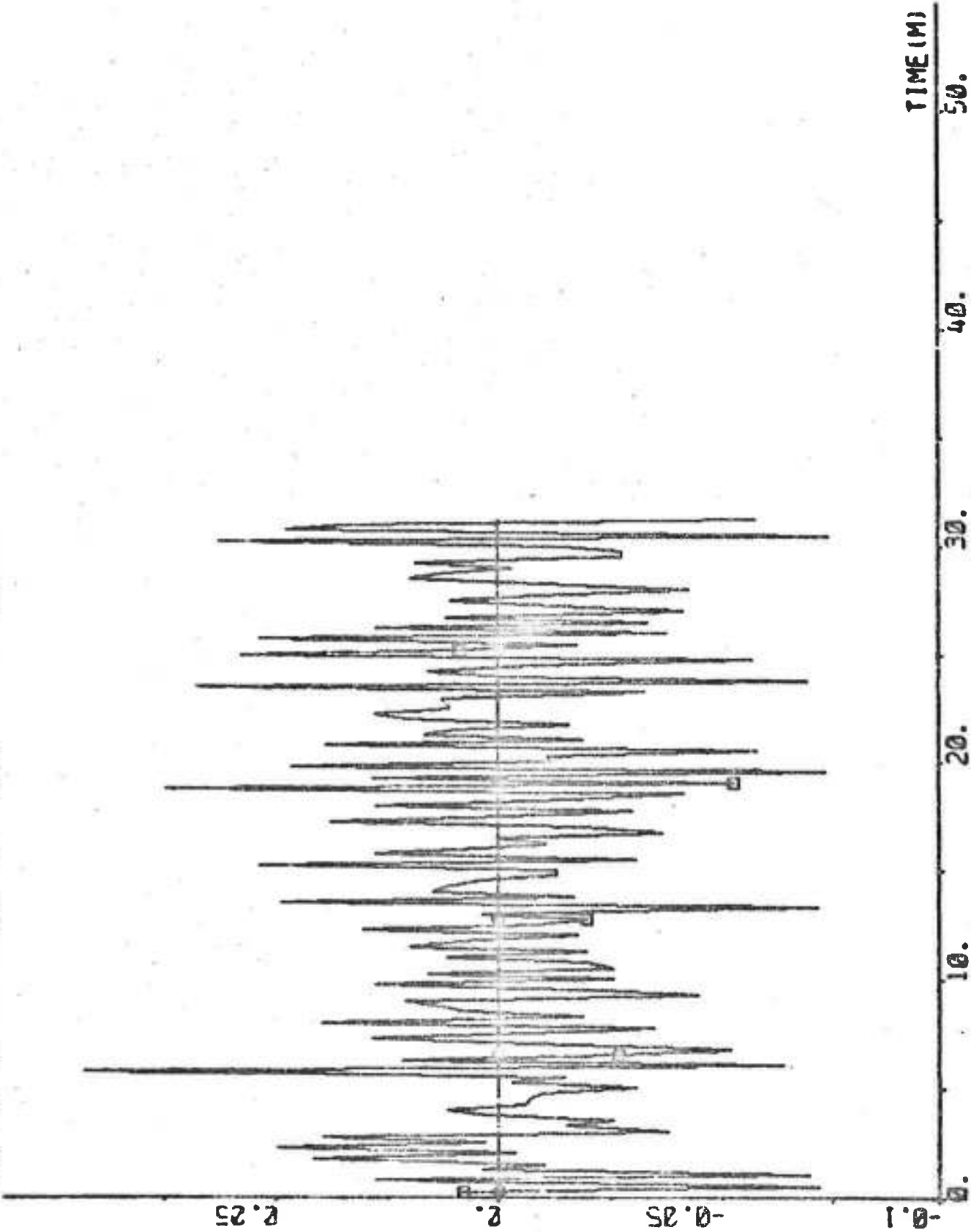
PLOT A31P1(3) ZERO -4 4 "DELTAS DEG



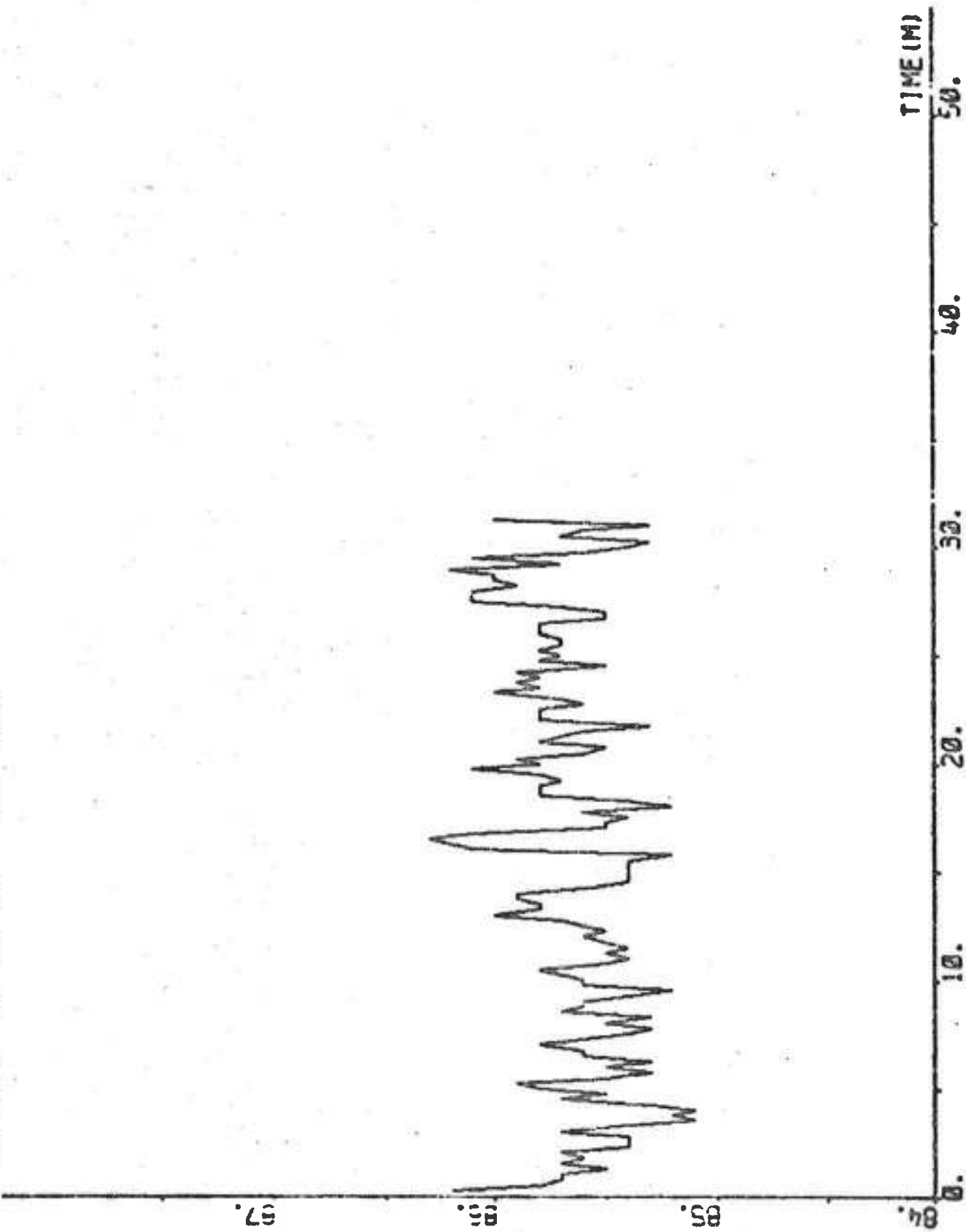
PLOT A31P1(4) ZERO -4 4 "DELTA DEC



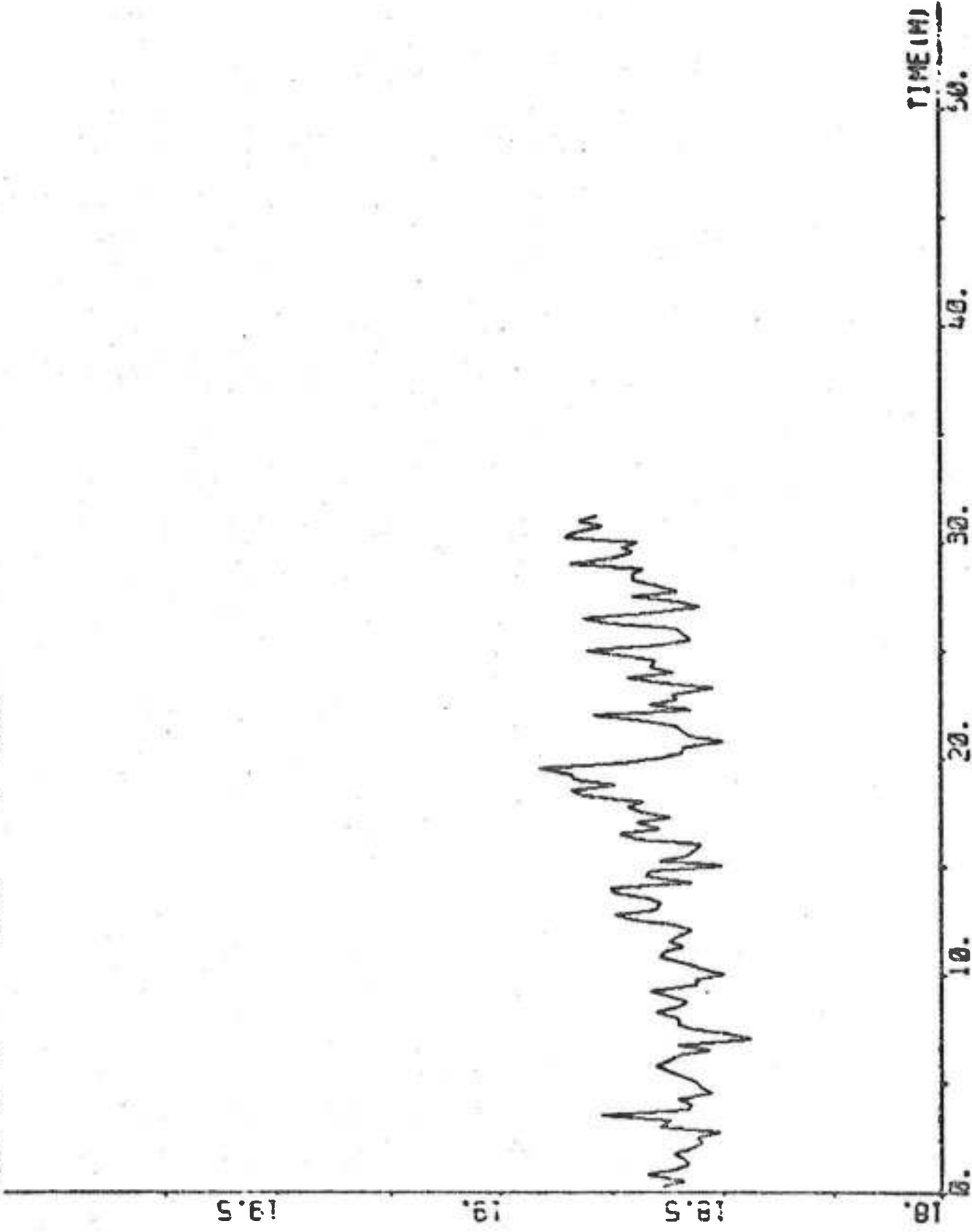
PLOT R31P1(5) ZERO -0.1 0.1 \*PP DEG/S



PLOT R31P1(6) 24 88 -RM RPM



PLOT R31P1(7) 18 20 "U KNOTS



PLOT R31P1(8) 0.5 1.5 "V1 KNOTS

1.25

0.75

0.5



TIME (M)

50.

40.

30.

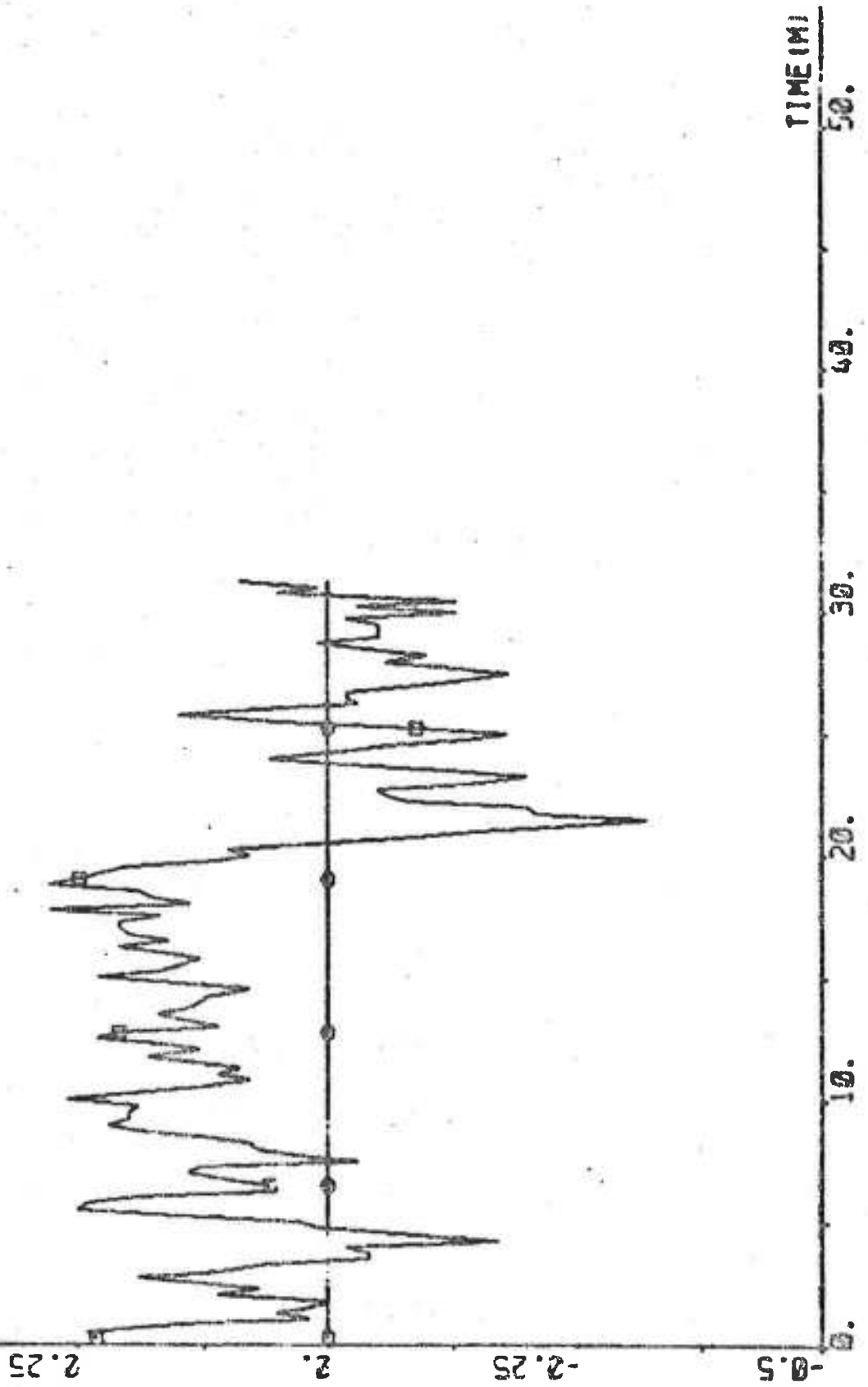
20.

10.

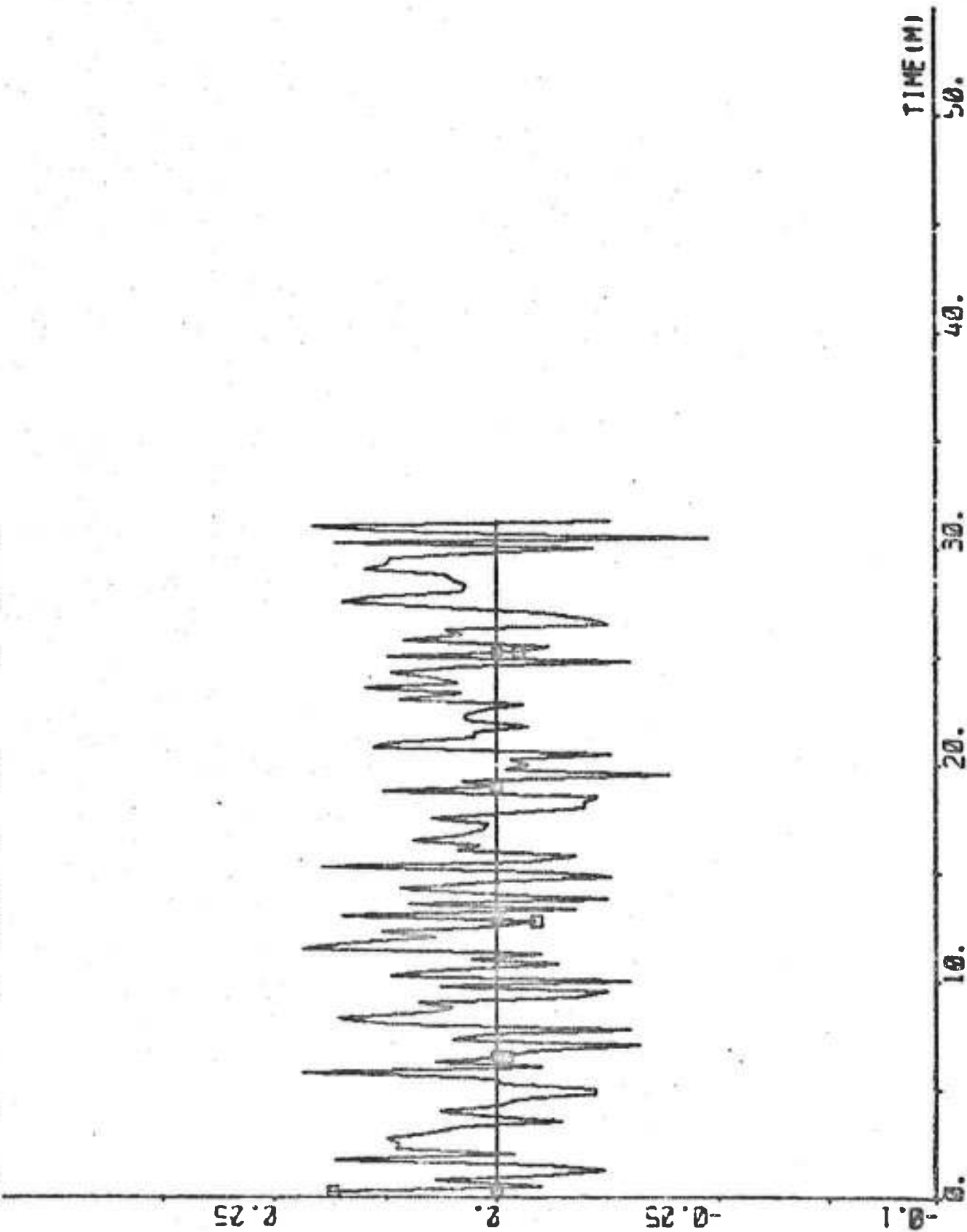
0.



PLOT R31P1(9) ZERO -0.5 0.5 "V2 KNOTS



PLOT R31P1(10) ZERO -0.1 0.1 "R DEG/S



TIME (M)

50.

40.

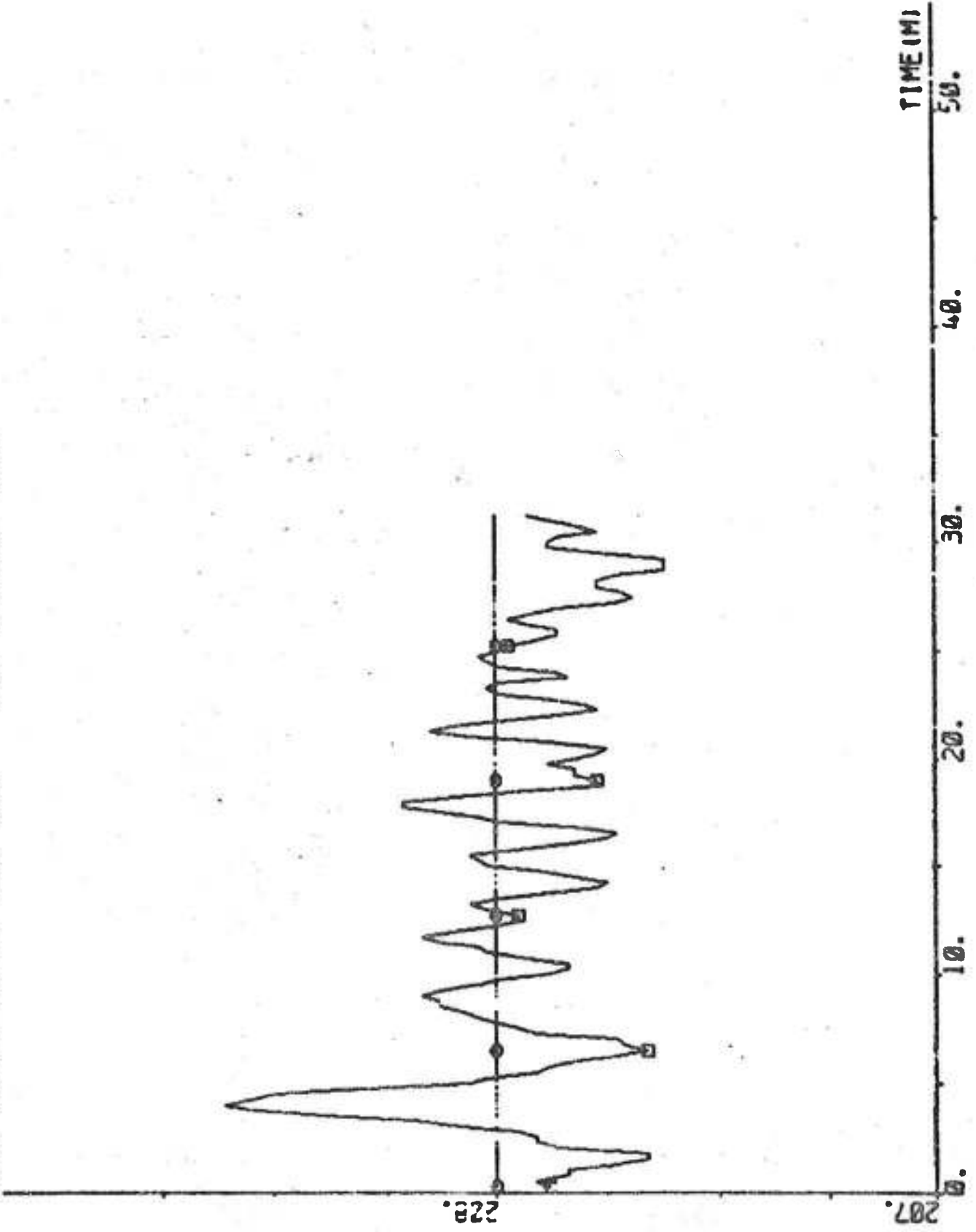
30.

20.

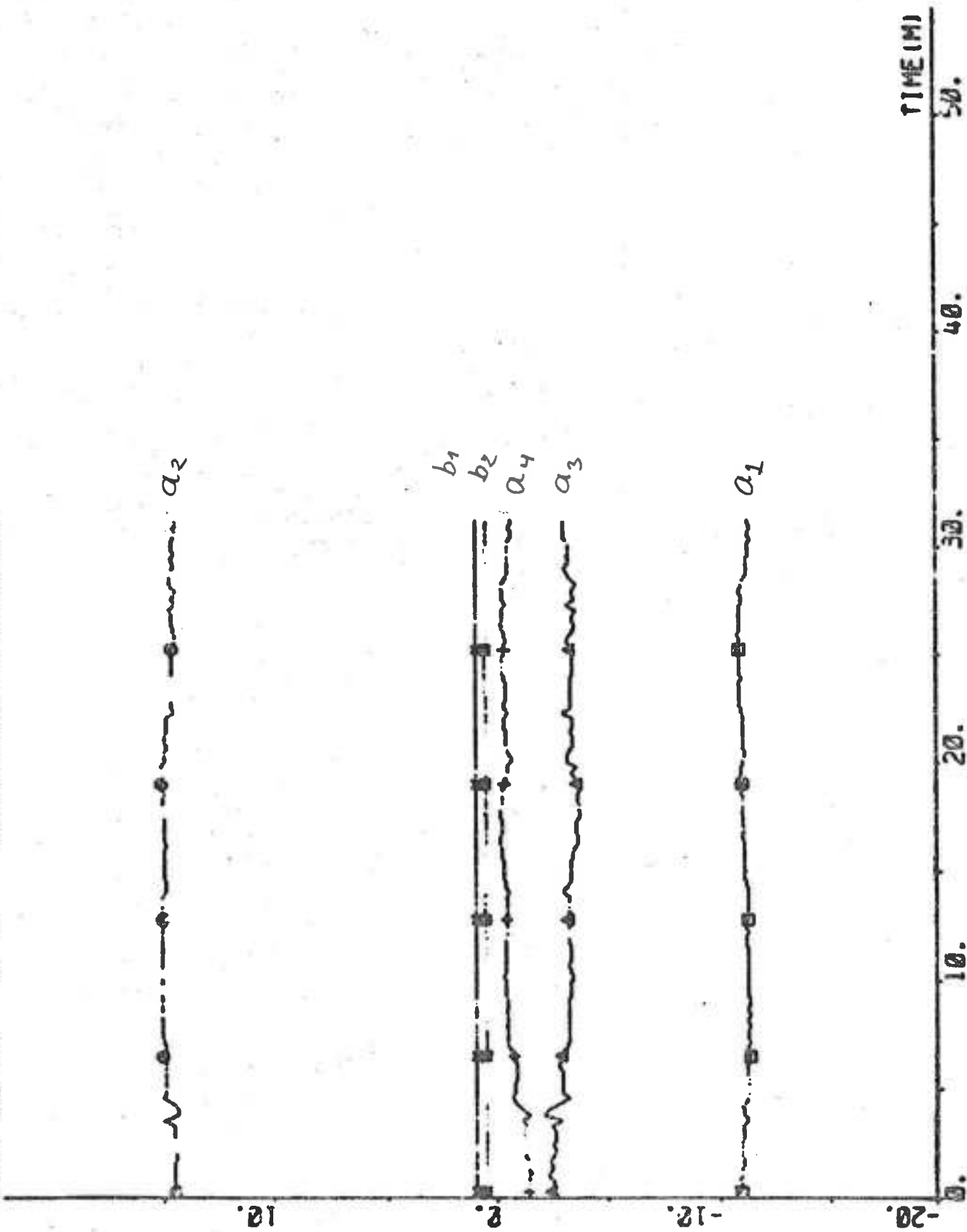
10.

0.

PLOT R31P1(13 14) 207 209 °PSI PSIREF DEG



PLOT A31P2 -15 15 "REGULATOR PARAMETERS



## EXPERIMENT A32

Date 1974-10-17  
 Time 09.13  
 Duration 20 min  
 Position S 05° 48' E 46° 04'  
 Water depth deep  
 Forward draught 20.2 m  
 Aft draught 20.2 m  
 Wind direction SE (7; see Appendix A)  
 Wind velocity 4 Beaufort (6-8 m/s, moderate breeze)  
 Wave height 5 m  
 PSIREF 208°  
 Rudder limit Not active

Regulator structure

NA = 3      NB = 2      NC = 0      K = 5  
 IREG = 15      RL = 0.99

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} -13.014 \\ 20.353 \\ -7.757 \\ 0.645 \\ 0.327 \end{bmatrix} \quad P = \begin{bmatrix} 0.549 & & & & \\ -0.840 & 1.846 & & & \\ 0.371 & -1.132 & 0.869 & & \\ -0.003 & -0.030 & 0.036 & 0.005 & \\ 0.002 & -0.036 & 0.037 & 0.003 & 0.005 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.418$$

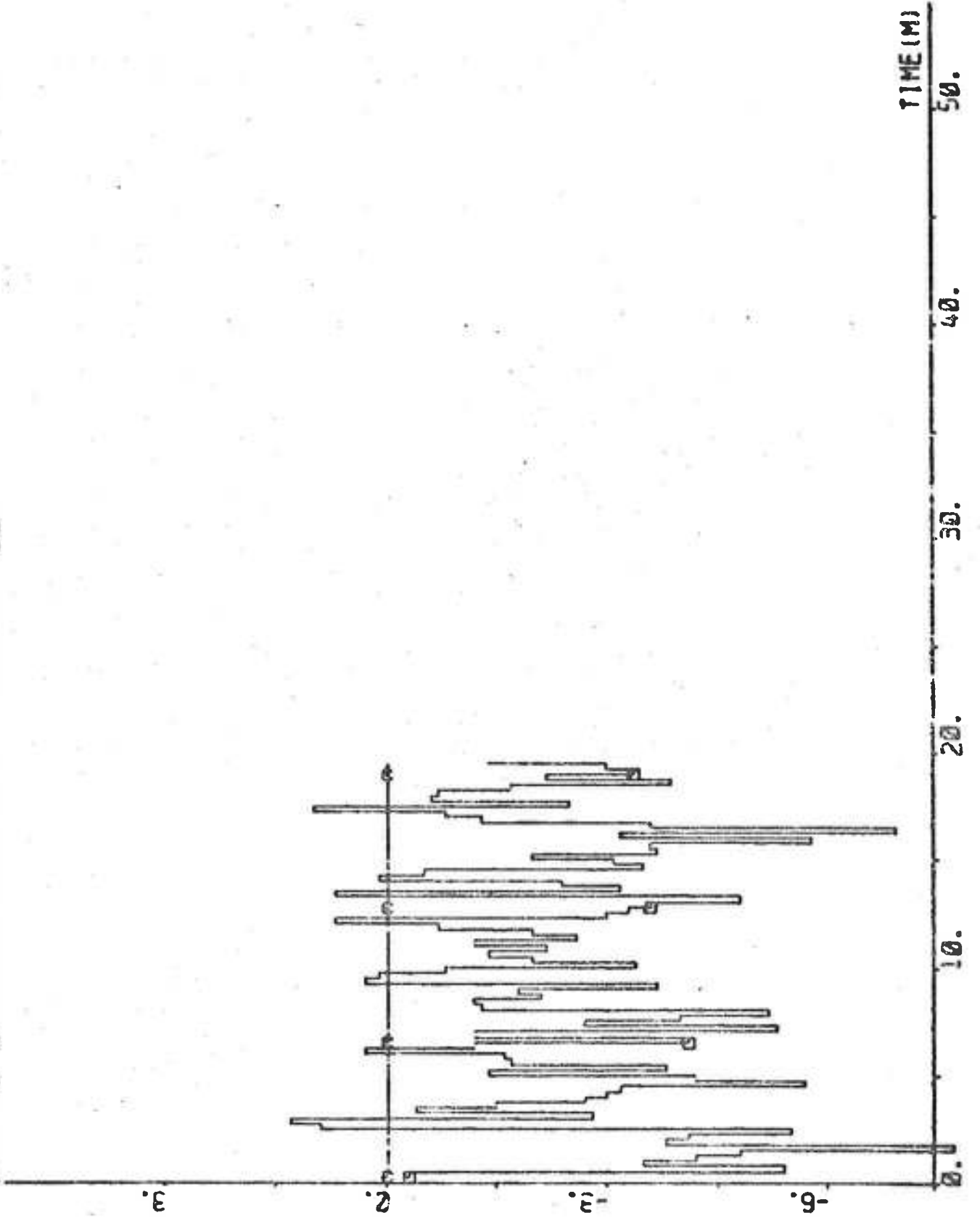
Statistics (mean value and standard deviation)

DELTA	1.65 ± 2.01 deg
PSI-PSIREF	-0.003 ± 0.405 deg
AN	85.99 ± 0.33 rpm
U	7.89 ± 1.83 knots

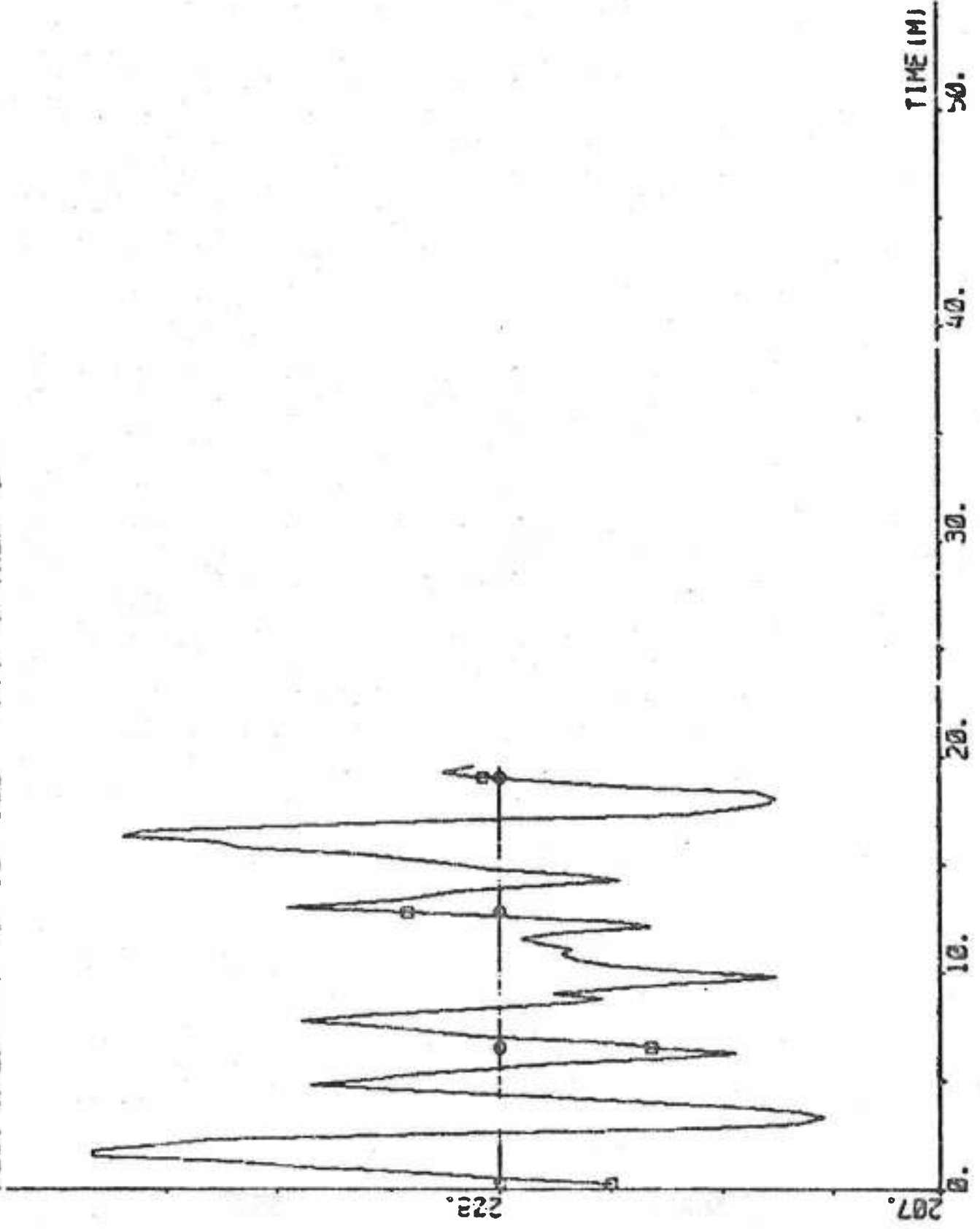
$$V_1 = 0.840$$

$$V_2 = 0.568$$

PLOT HP R32P1(1) ZERO -7 5 "DELCOC DEG

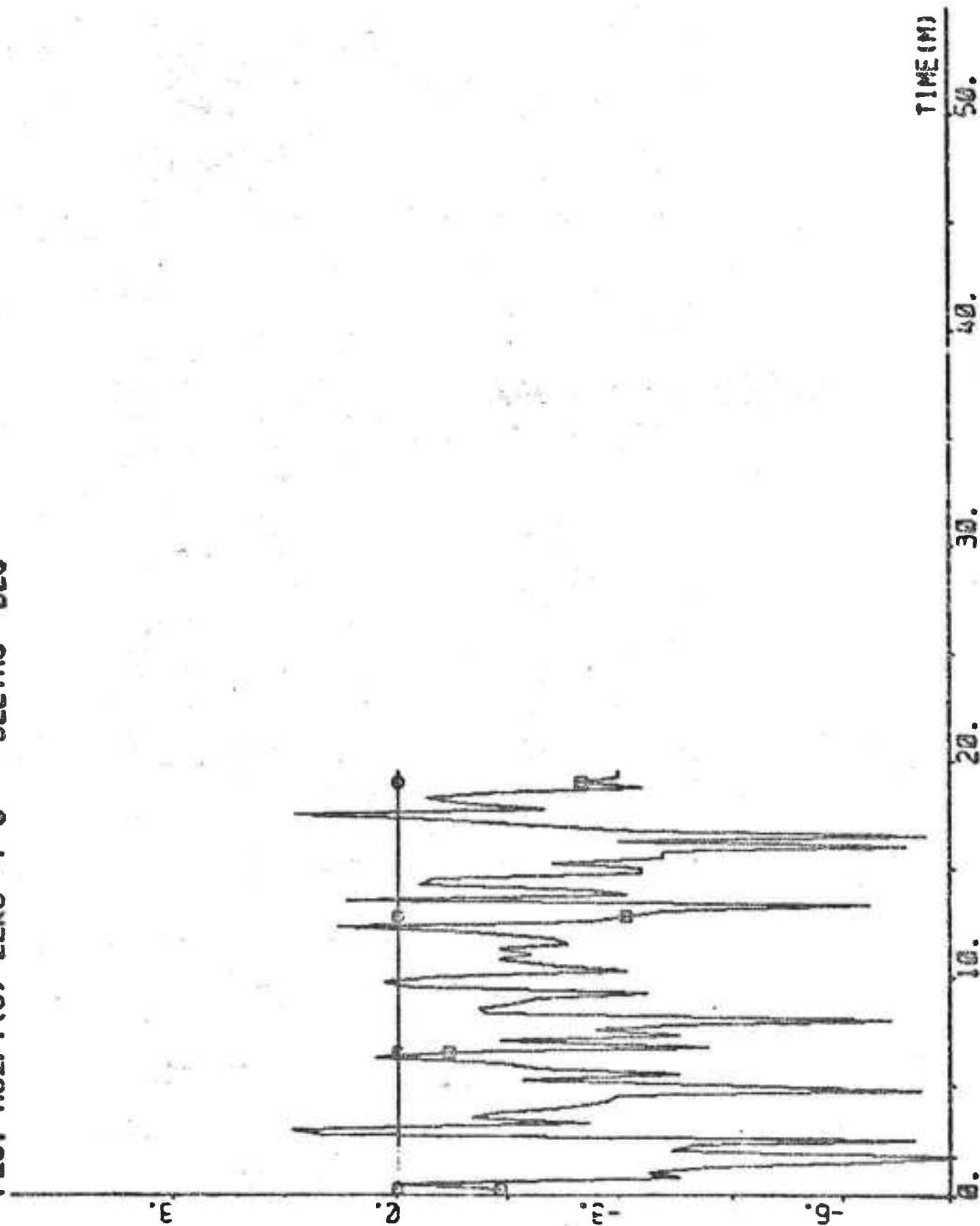


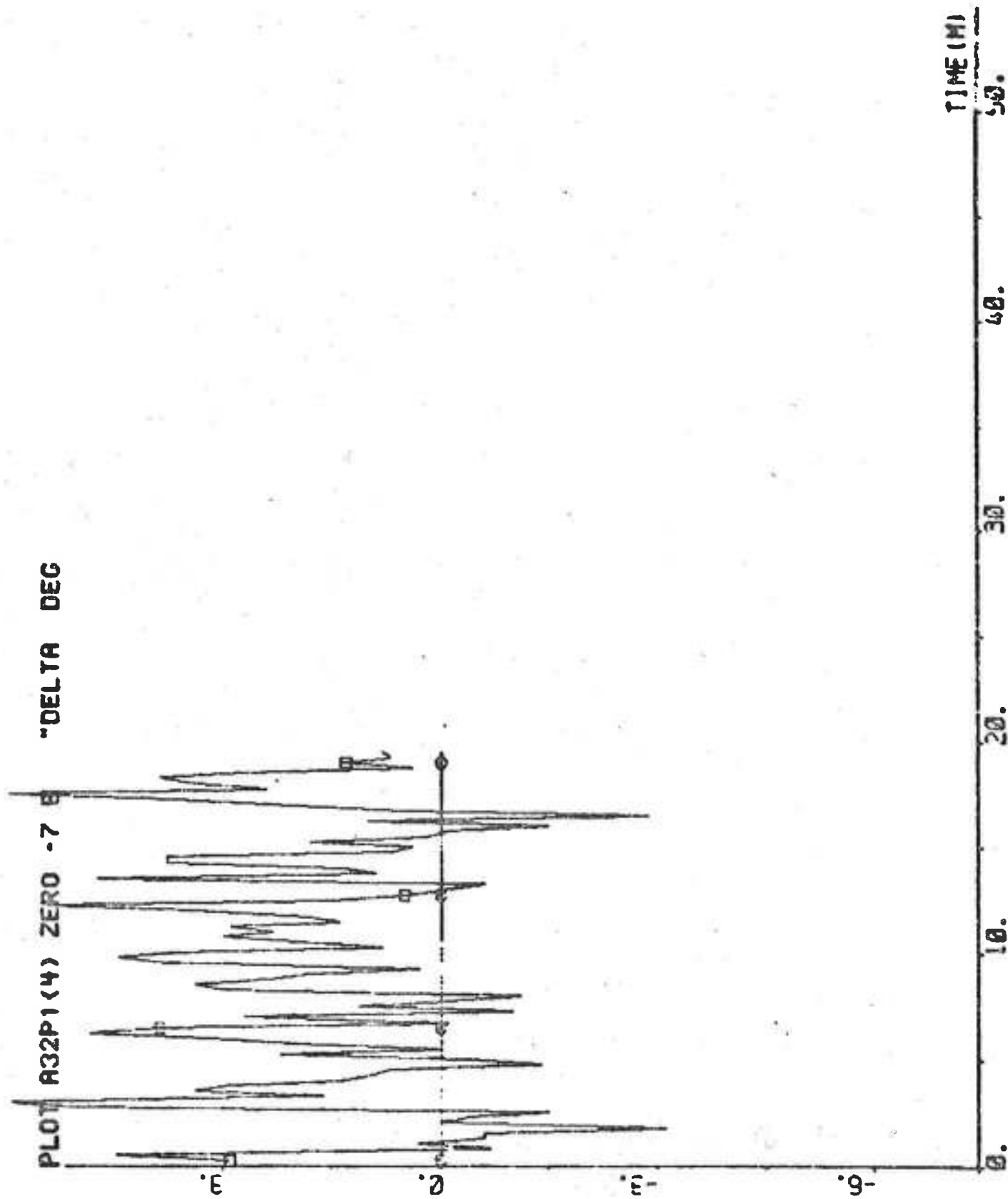
PLOT R32P1(13 14) 207 209 °PSI PSIREF DEG



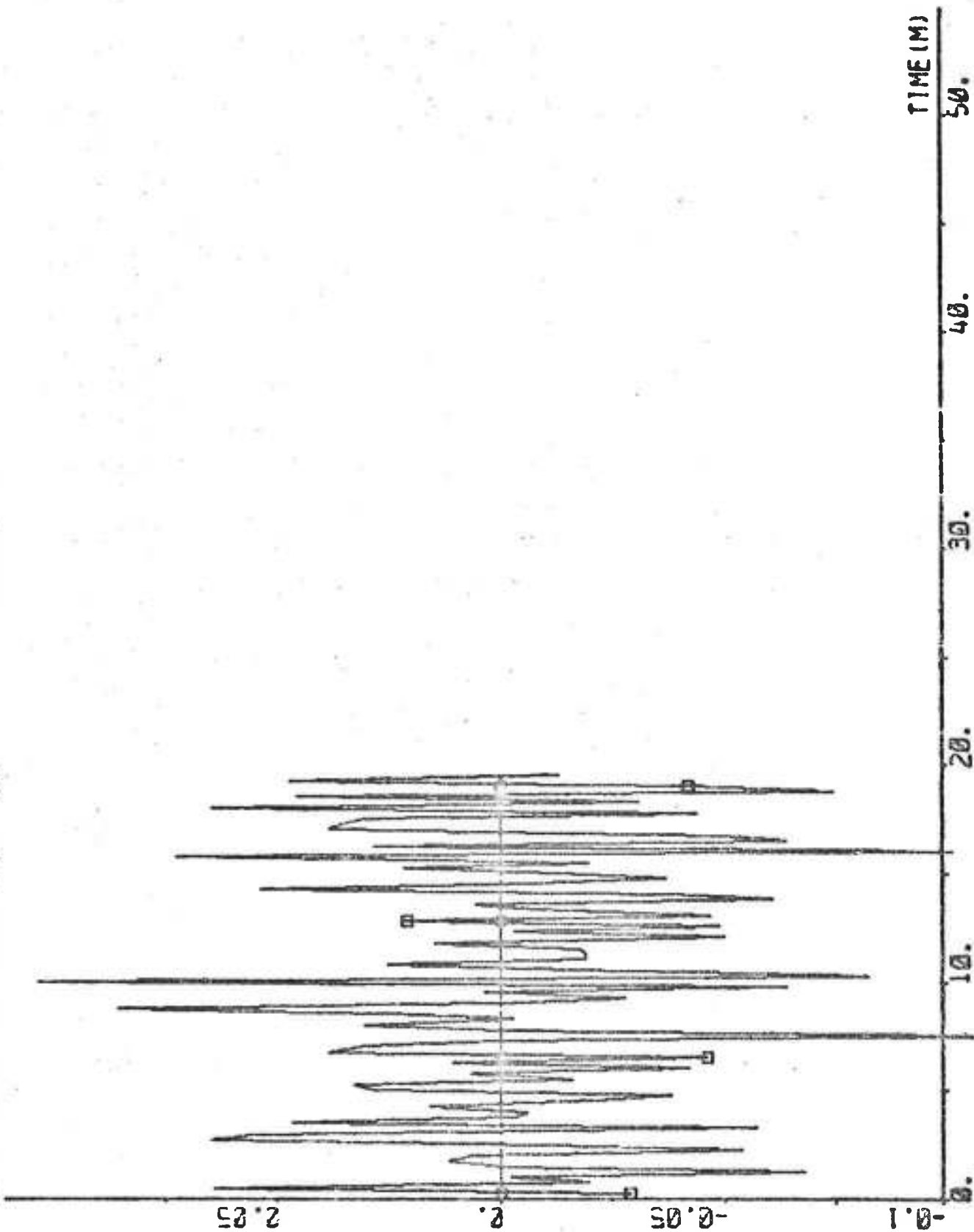


PLOT A32P1(3) ZERO -7 5 -DELTA DEG

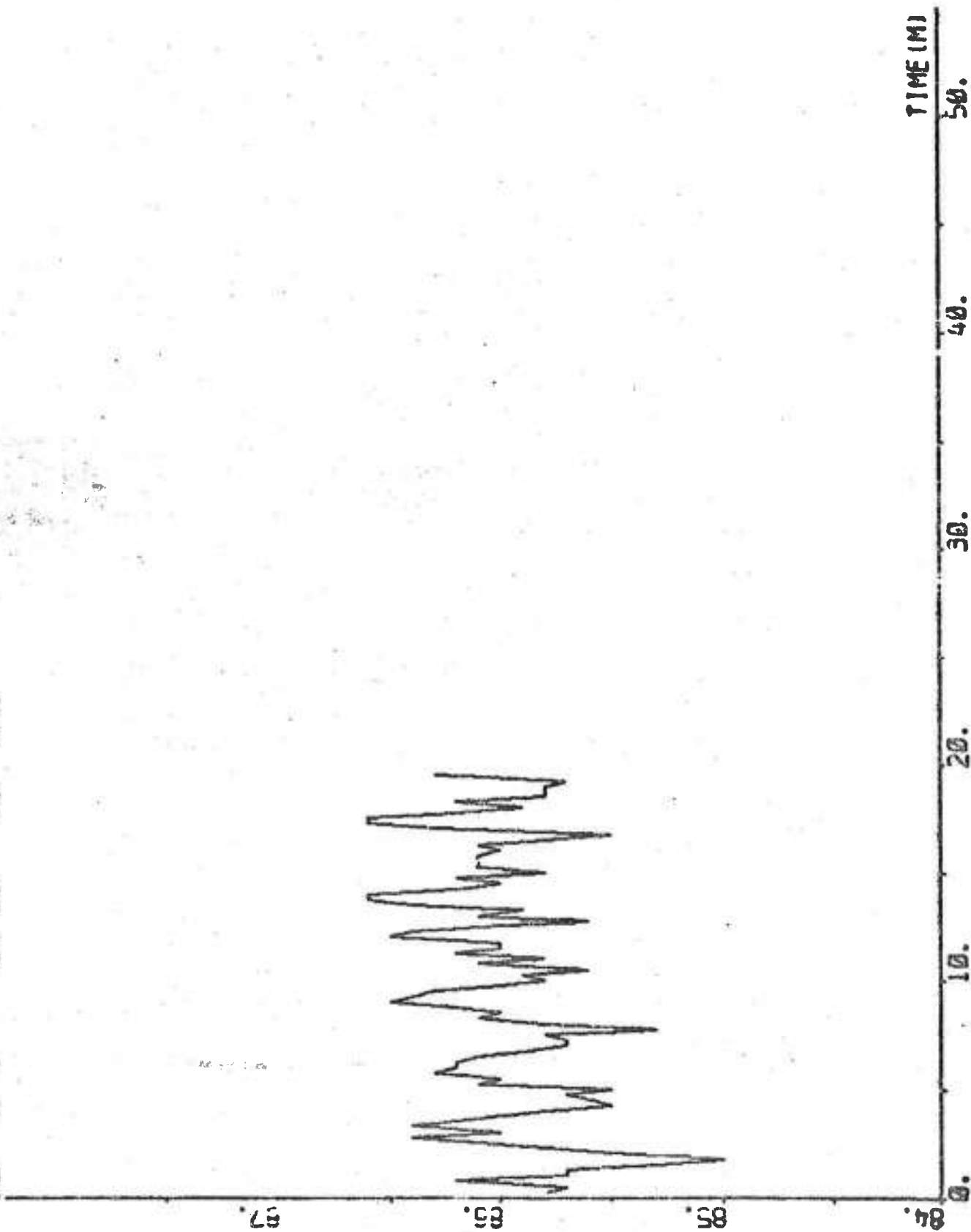




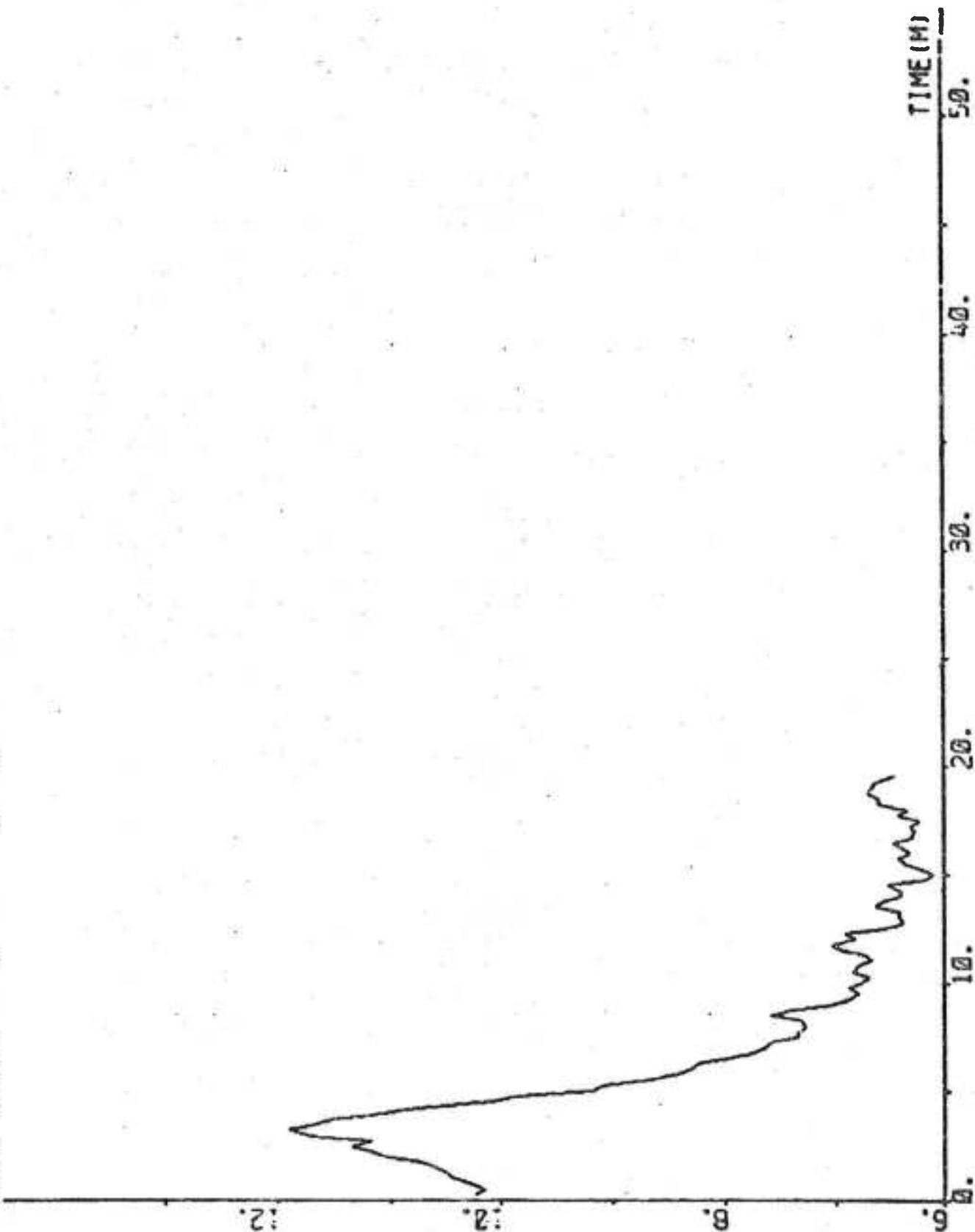
PLOT R32P1(6) ZERO -0.1 0.1 "PP DEG/S



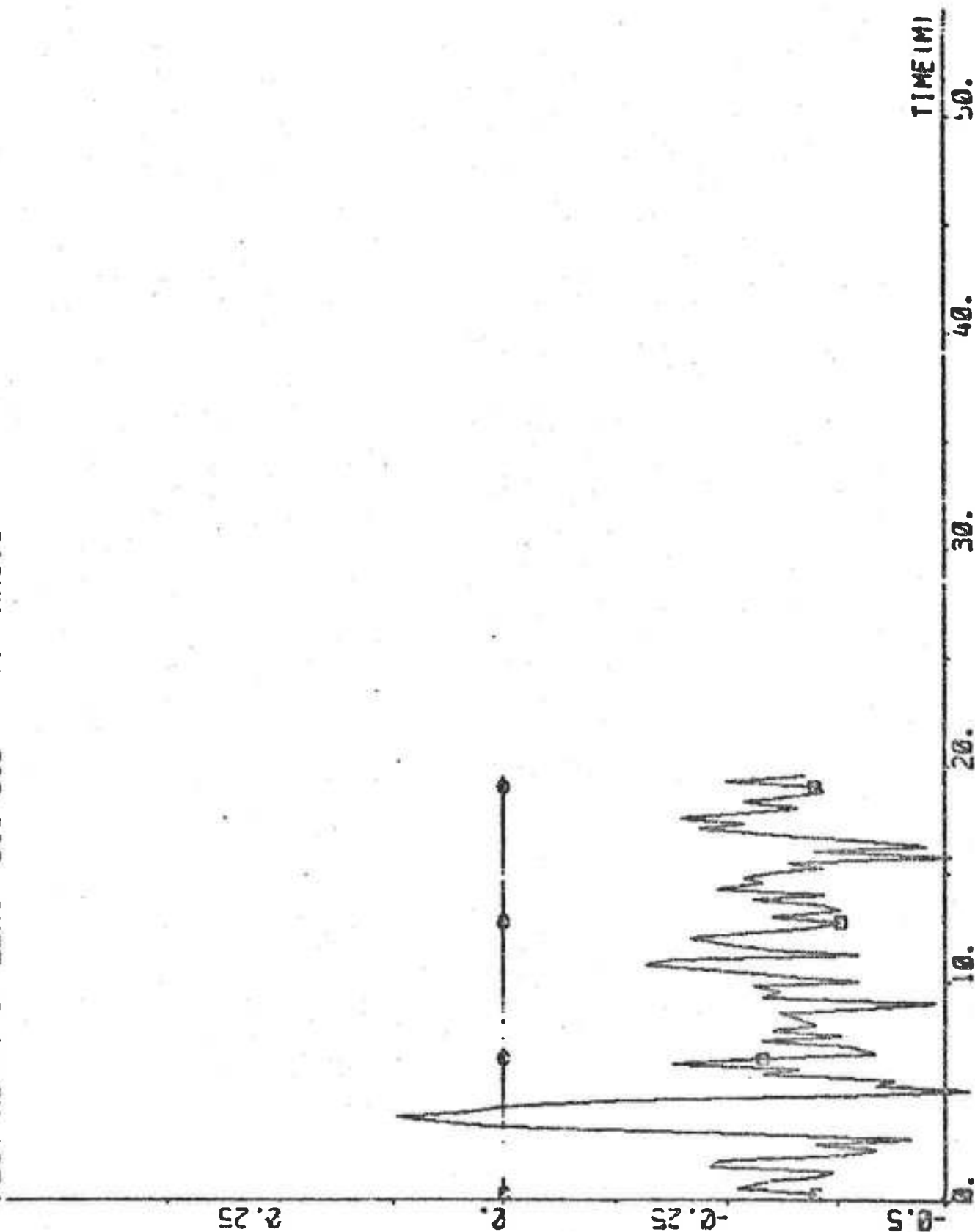
PLOT R32P1(6) 84 88 "RN RPH



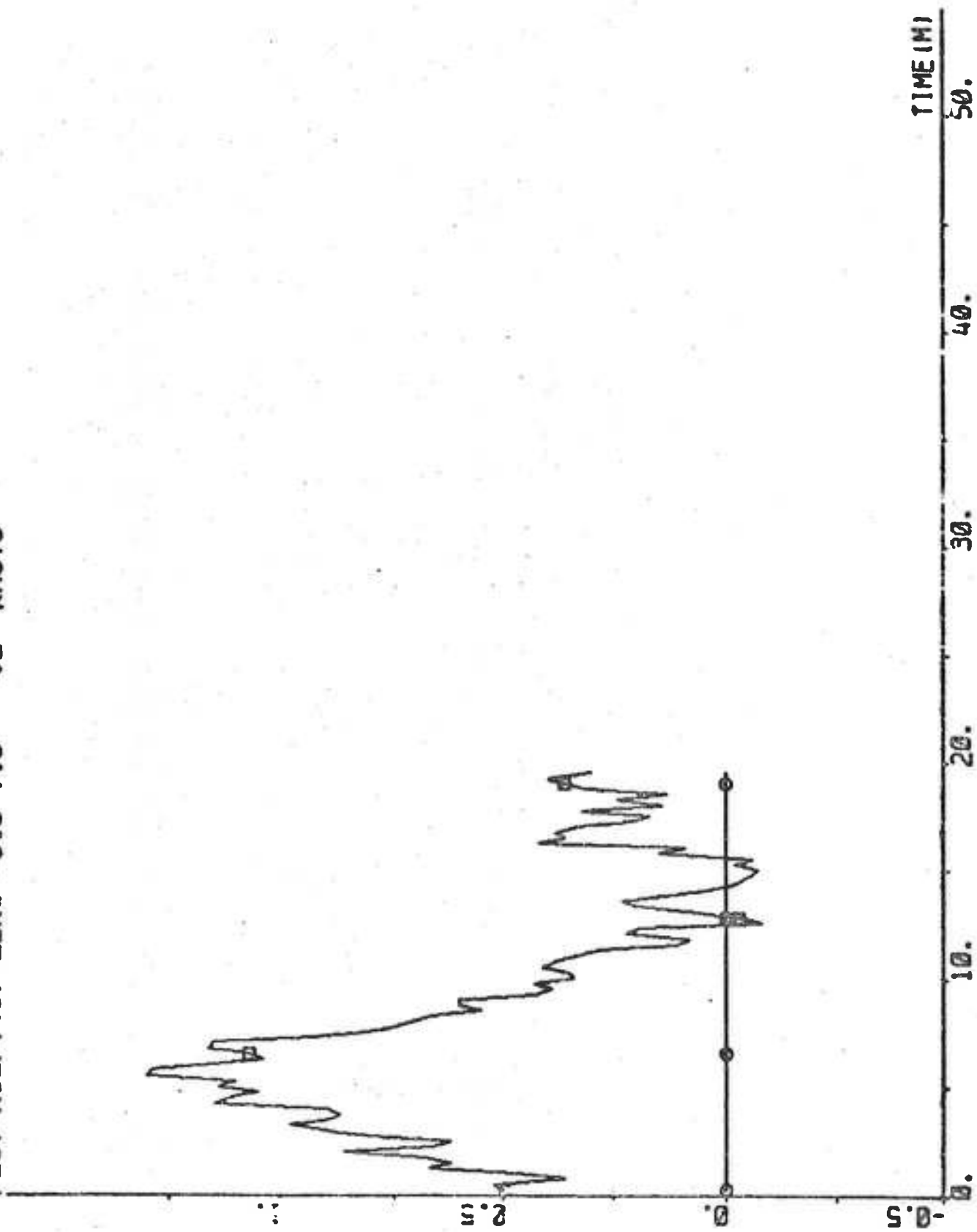
PLOT R32P1(7) 6 12 "U KNOTS



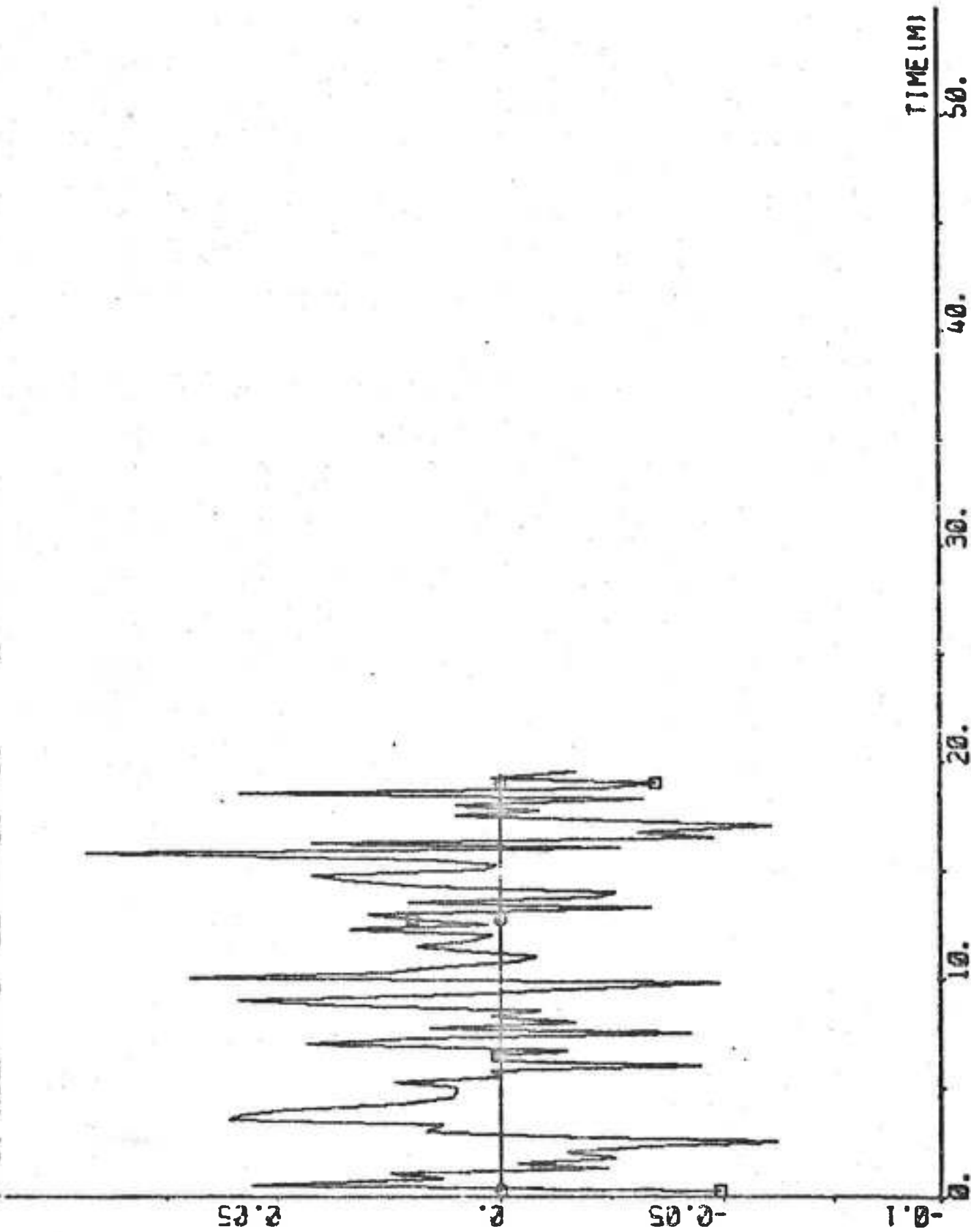
PLOT R32P1(8) ZERO -0.5 0.5 "V1" KNOTS



PLOT A32P1(8) ZERO -0.5 1.5' "V2 KNOTS



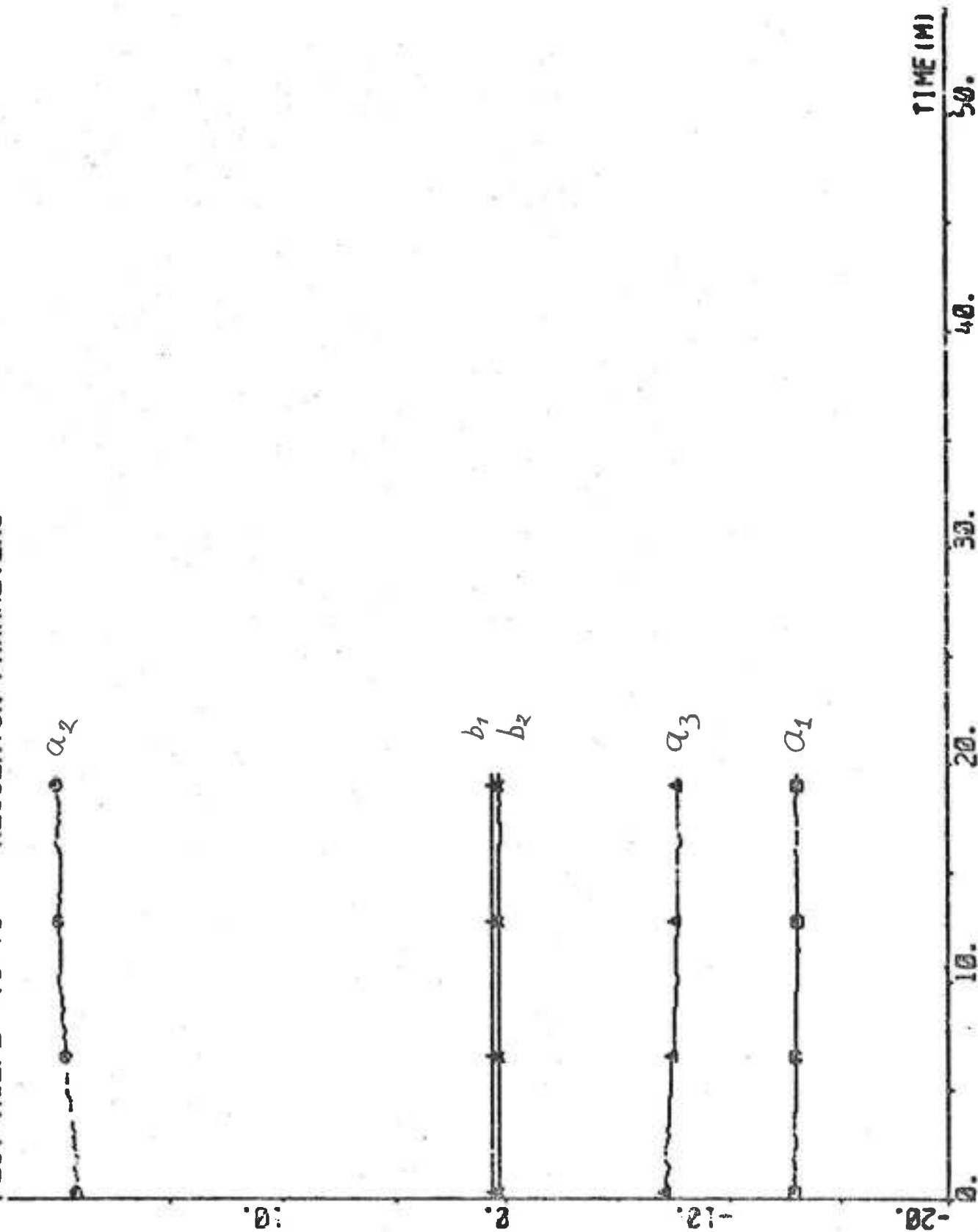
PL0T A32P1(10) ZERO -0.1 0.1 °R DEG/S



TIME (M)



PLOT A32P2 -15 15 "REGULATOR PARAMETERS



## EXPERIMENT A33

Date 1974-10-17  
 Time 10.56  
 Duration 30 min  
 Position S 06° 06' E 45° 59'  
 Water depth deep  
 Forward draught 20.2 m  
 Aft draught 20.2 m  
 Wind direction SE (7; see Appendix A)  
 Wind velocity 4 Beaufort (6-8 m/s, moderate breeze)  
 Wave height 4 - 5 m  
 PSIREF 208°  
 Rudder limit Not active

Regulator structure

NA = 3      NB = 1      NC = 1      K = 5  
 IREG = 15    IRDIF = 0    RL = 0.98    IRR = 3    IDPSI = 5

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ c_1 \end{bmatrix} = \begin{bmatrix} -10.302 \\ 16.913 \\ -6.688 \\ 0.367 \\ 3.424 \end{bmatrix} \quad P = \begin{bmatrix} 3.999 & & & & \\ -5.027 & 7.921 & & & \\ 1.810 & -3.620 & 2.487 & & \\ 0.017 & -0.092 & 0.101 & 0.013 & \\ 21.433 & -26.568 & 7.357 & 0.053 & 172.894 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.077$$

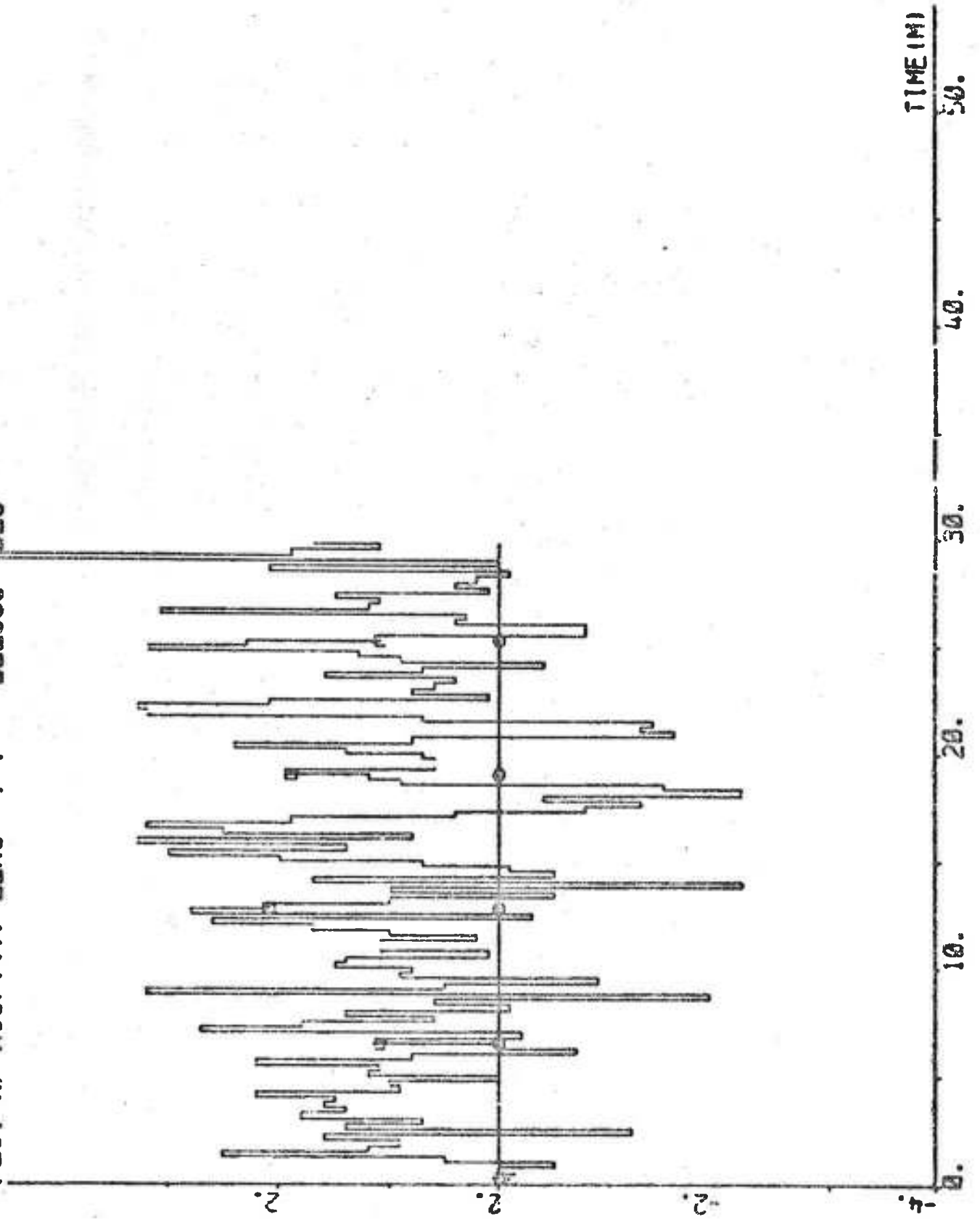
Statistics (mean value and standard deviation)

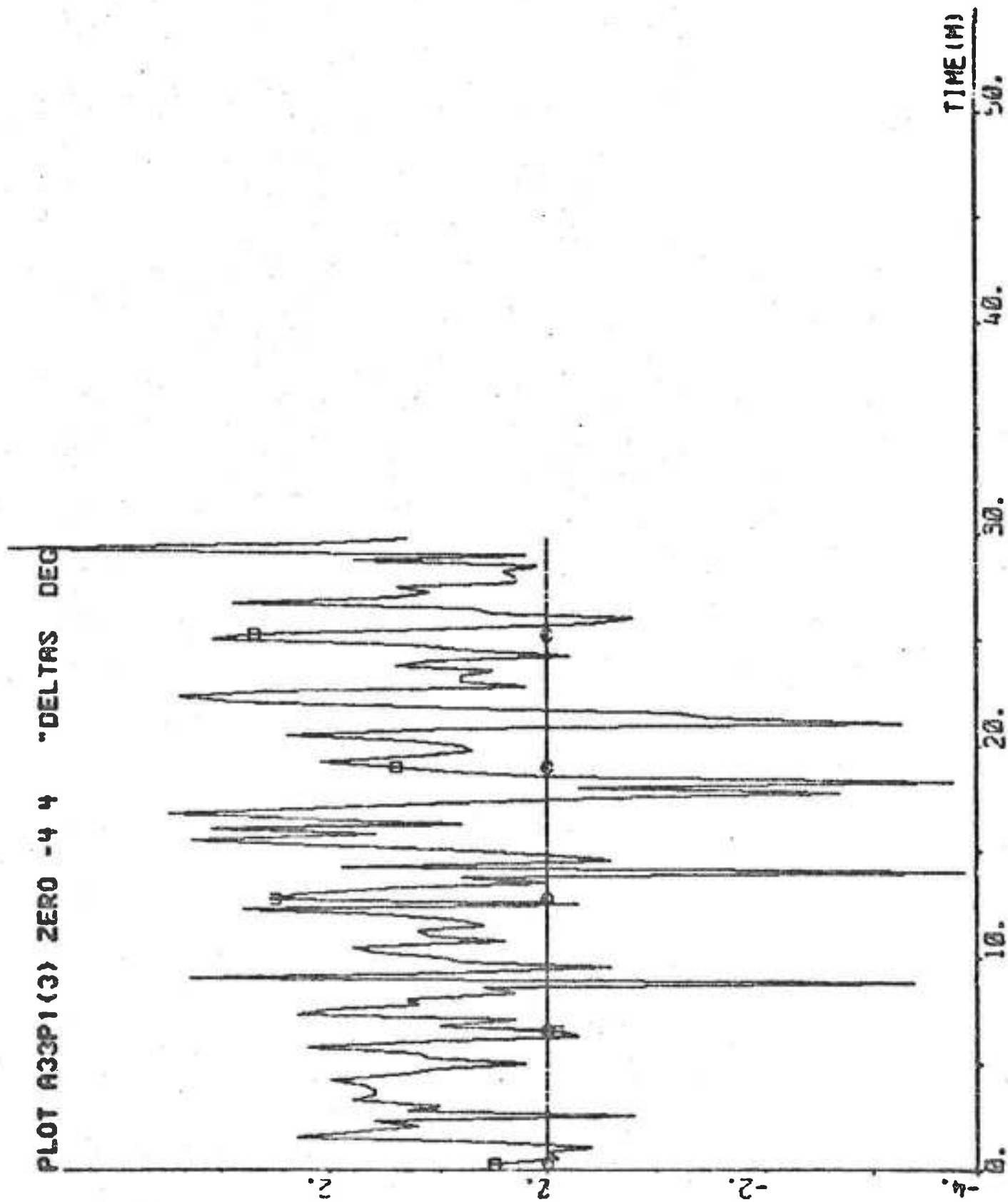
DELTA	1.71 ± 1.36 deg
PSI-PSIREF	0.028 ± 0.239 deg
AN	86.11 ± 0.22 rpm
U	10.77 ± 0.93 knots

$$V_1 = 0.535$$

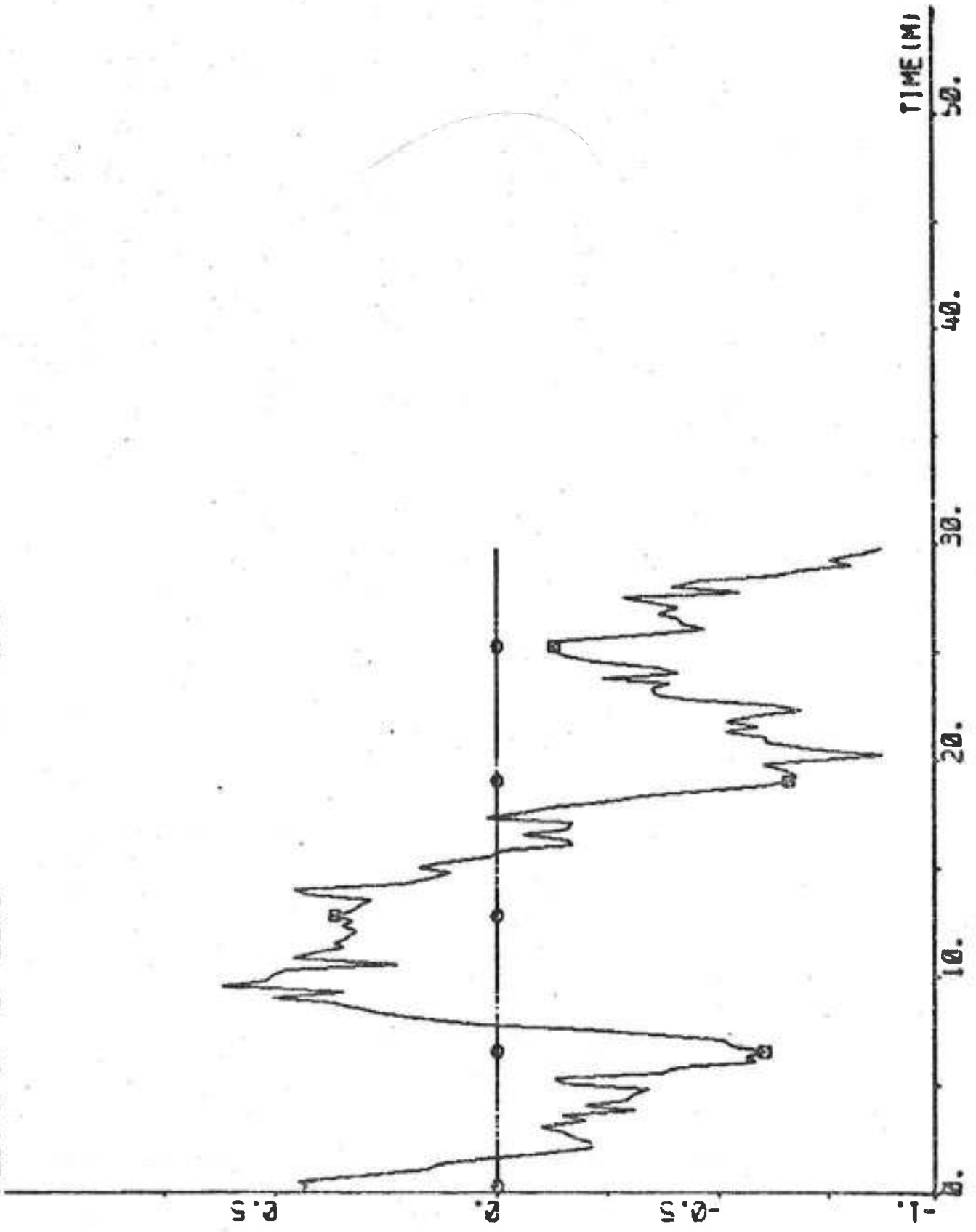
$$V_2 = 0.243$$

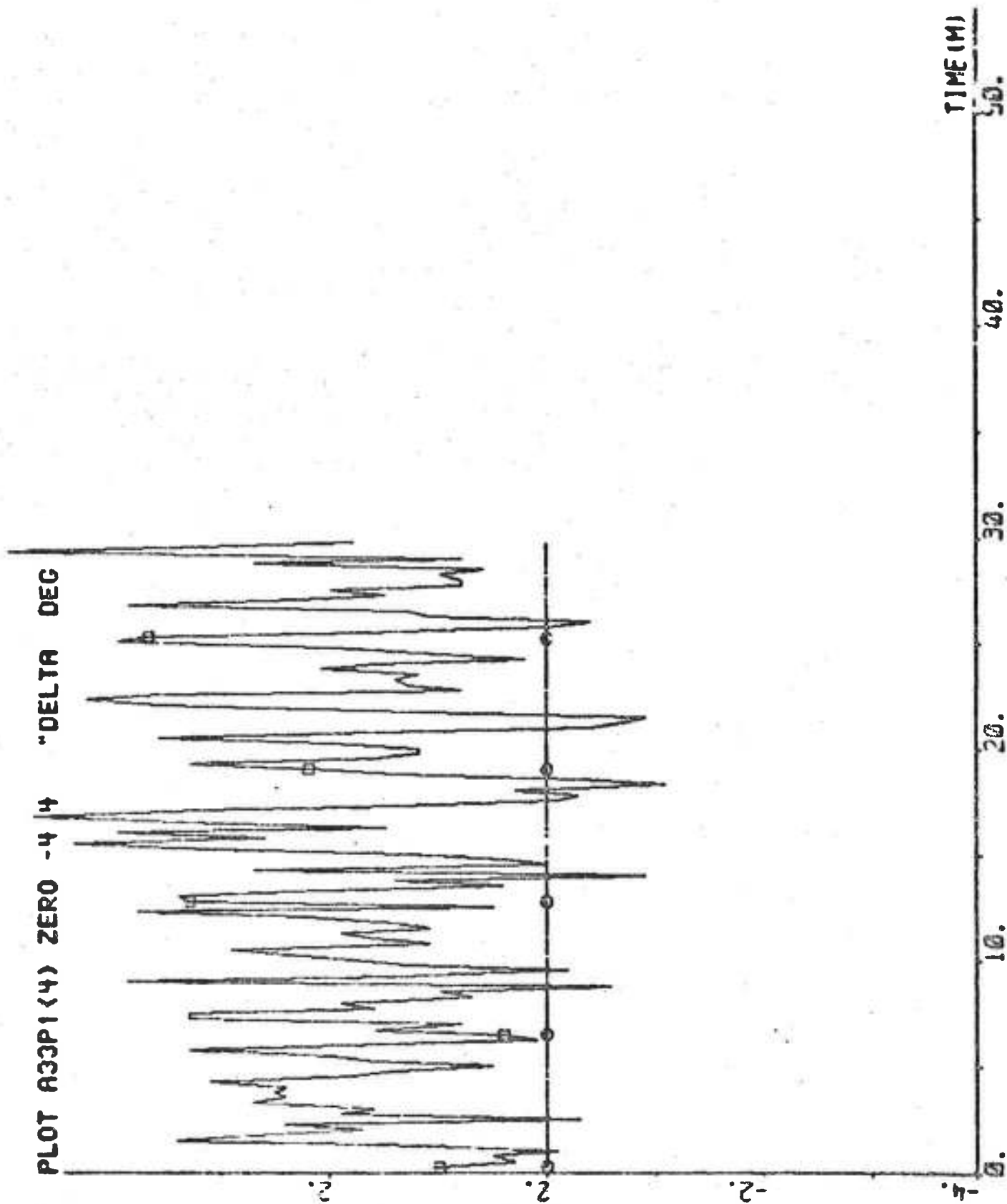
PLOT HP A33P1(1) ZERO -4 4 "DELCOC DEG



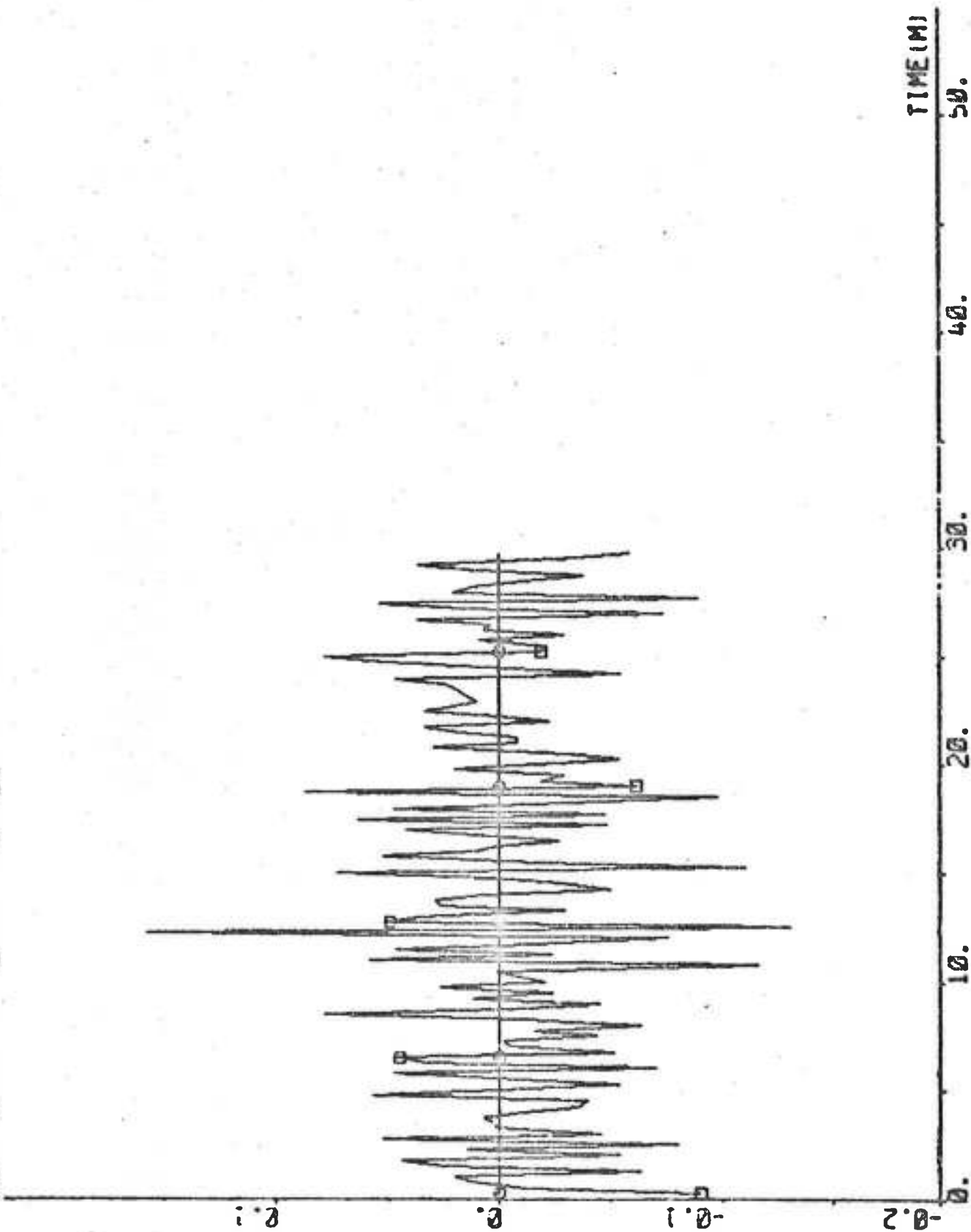


PLOT R33P1(9) ZERO -1 1 -V2 KNOTS



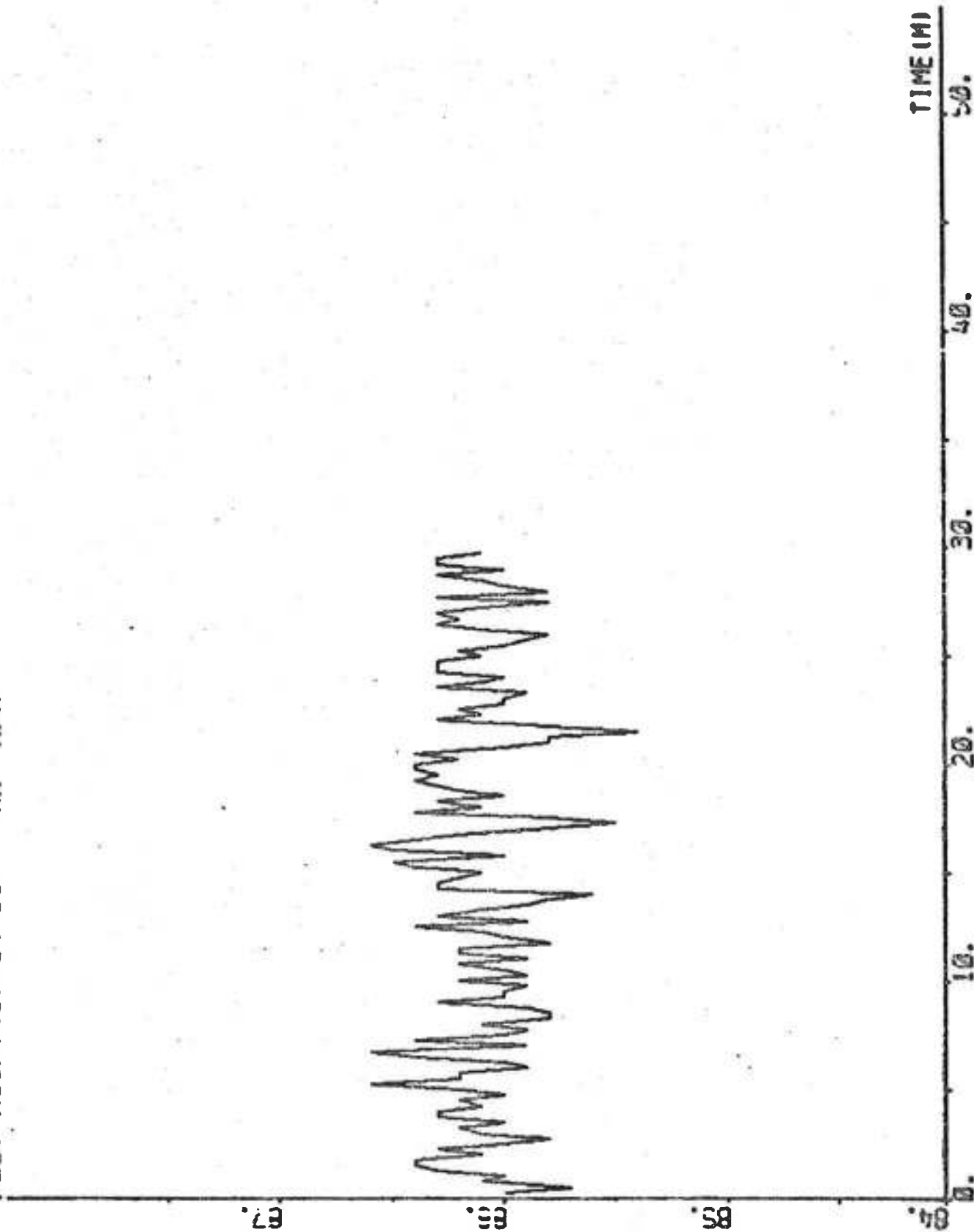


PLOT A33P1(5) ZERO -0.2 0.2 "PP DEG/S

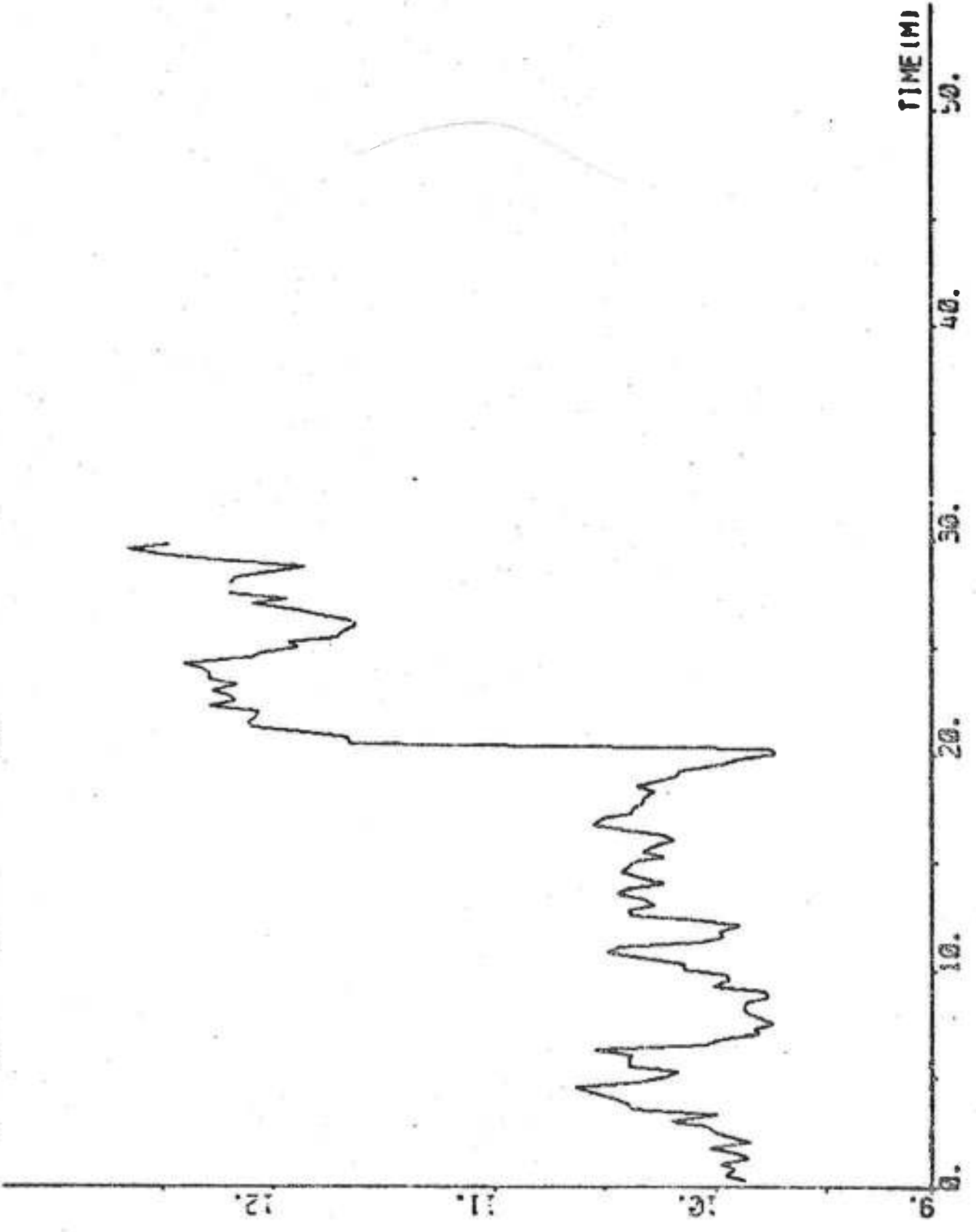




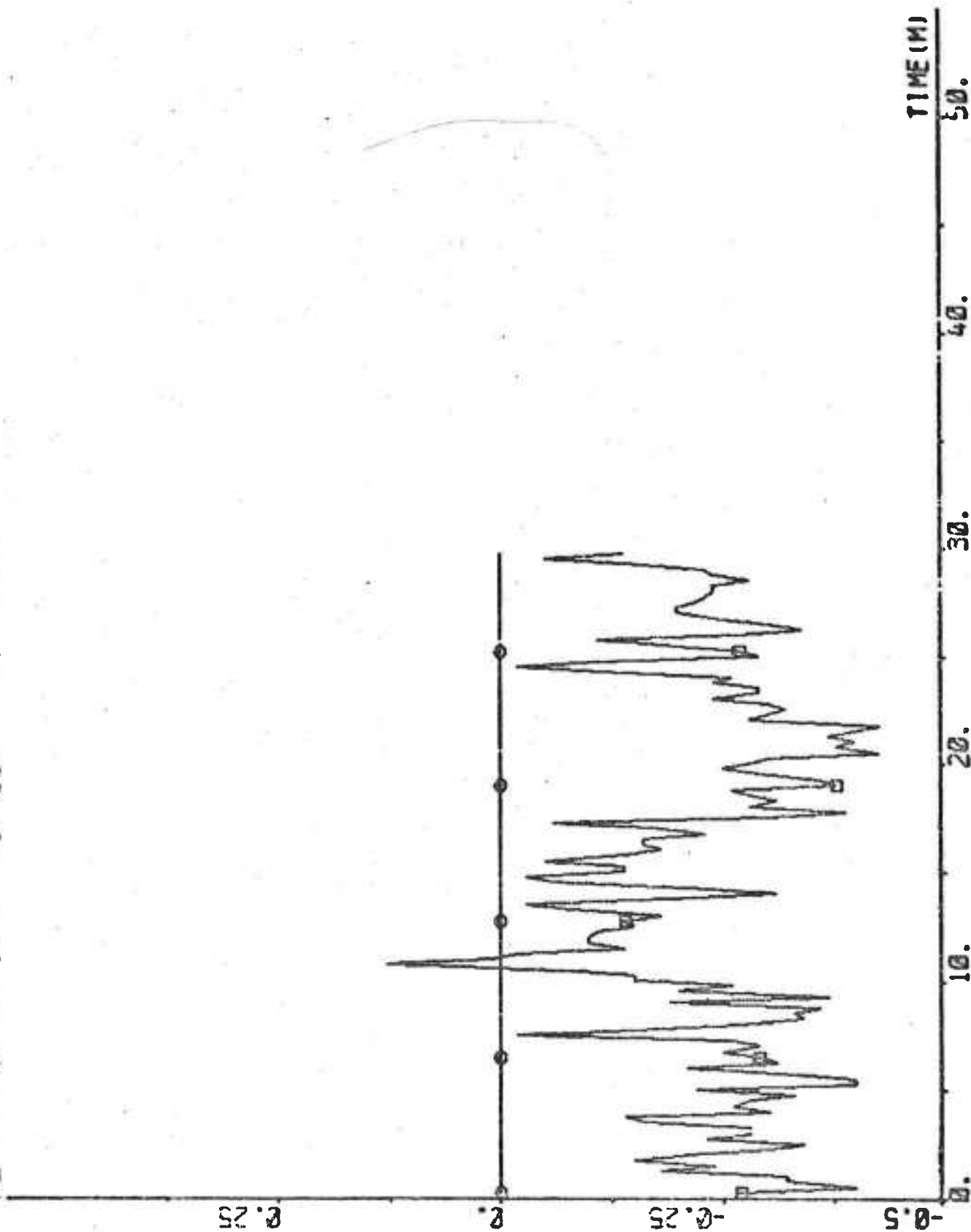
PLOT A33P1(6) 84 88 "AN RPM



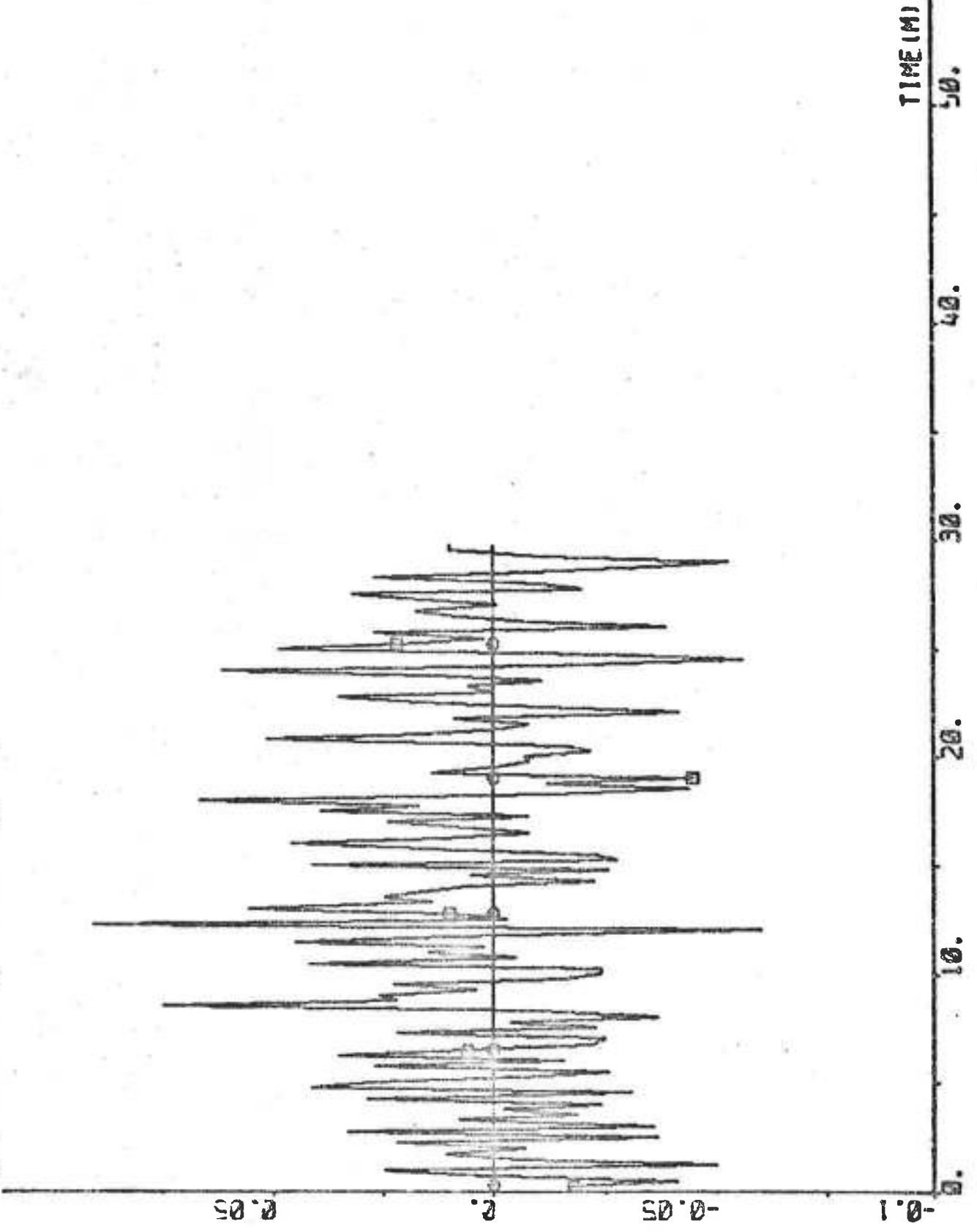
PLOT R33P1(7) 9 13 "U KNOTS



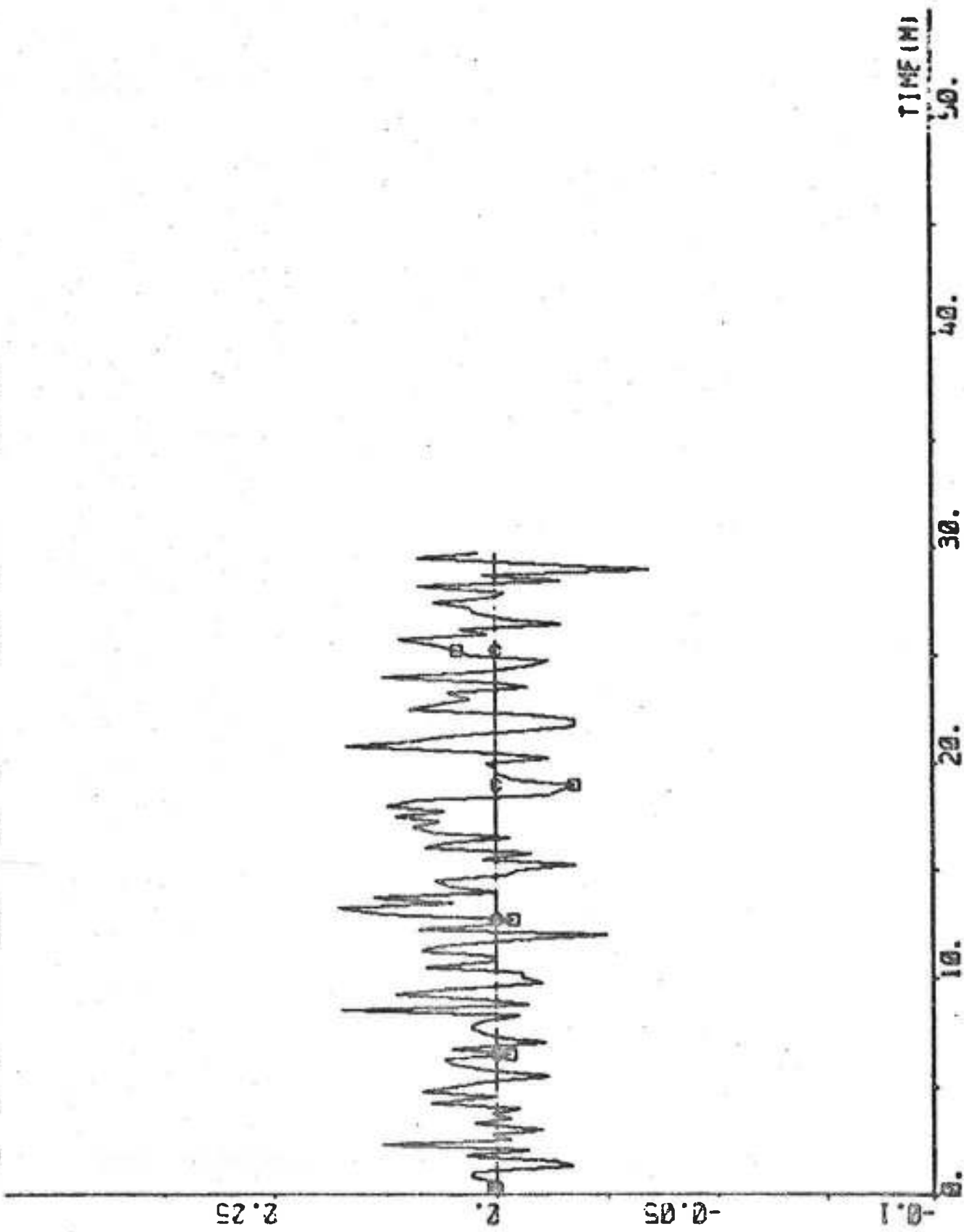
PLOT R33P1(8) ZERO -0.5 0.5 "V1 KNOTS



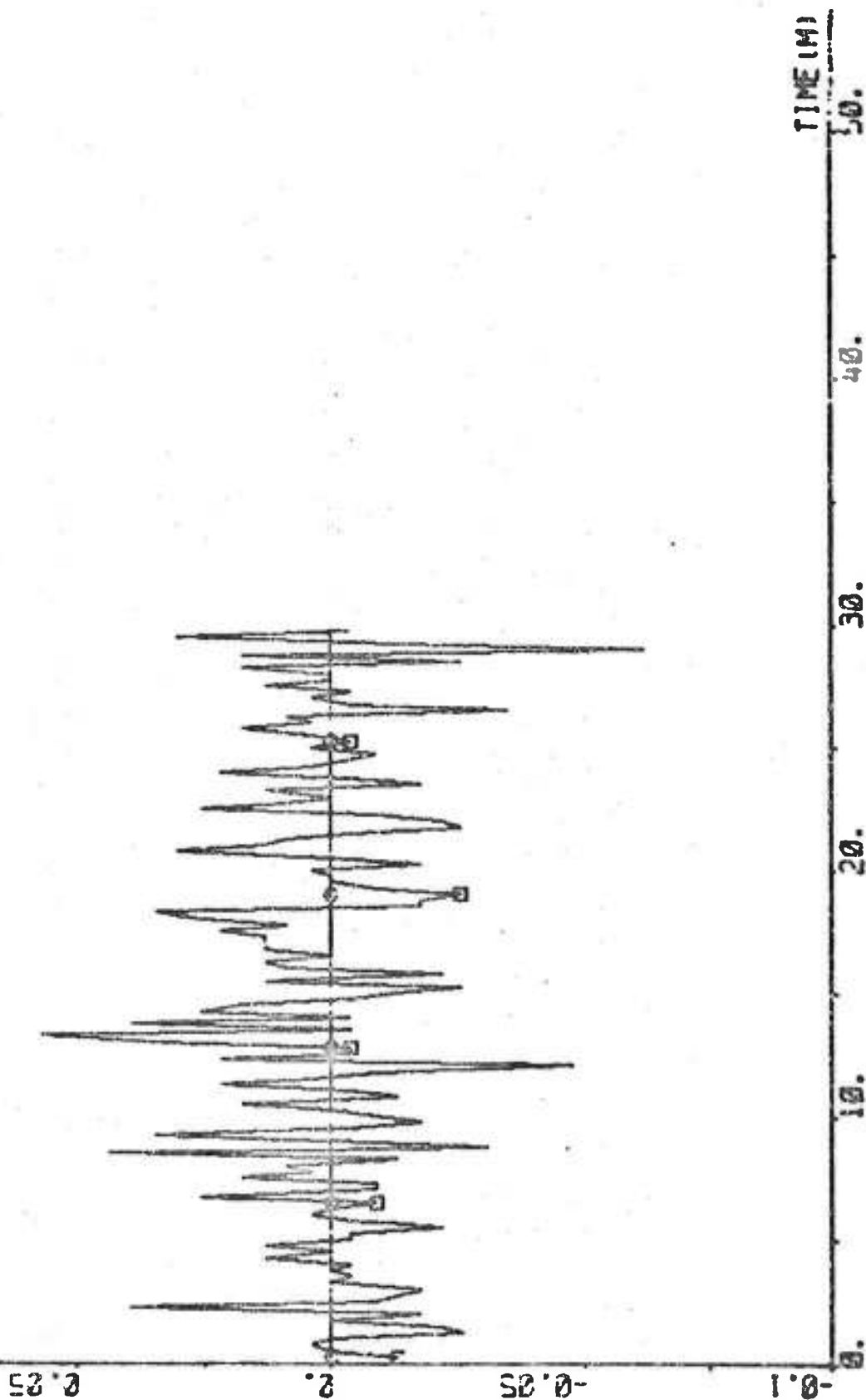
PLOT A33P1(10) ZERO -0.1 0.1 °R DEG/S



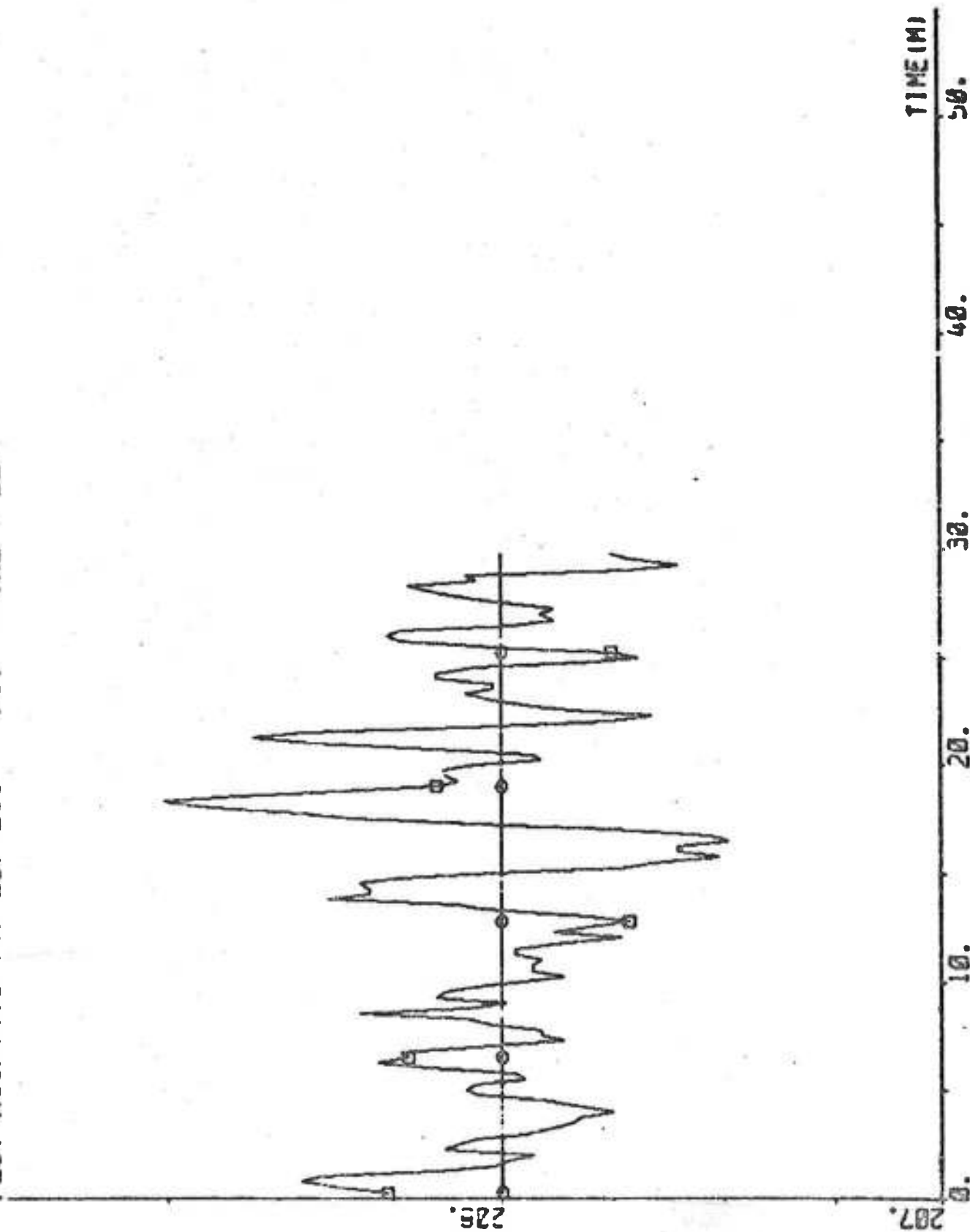
PLOT R33PI(11) ZERO -0.1 0.1 "AVR DEG/S (BR=0.2)



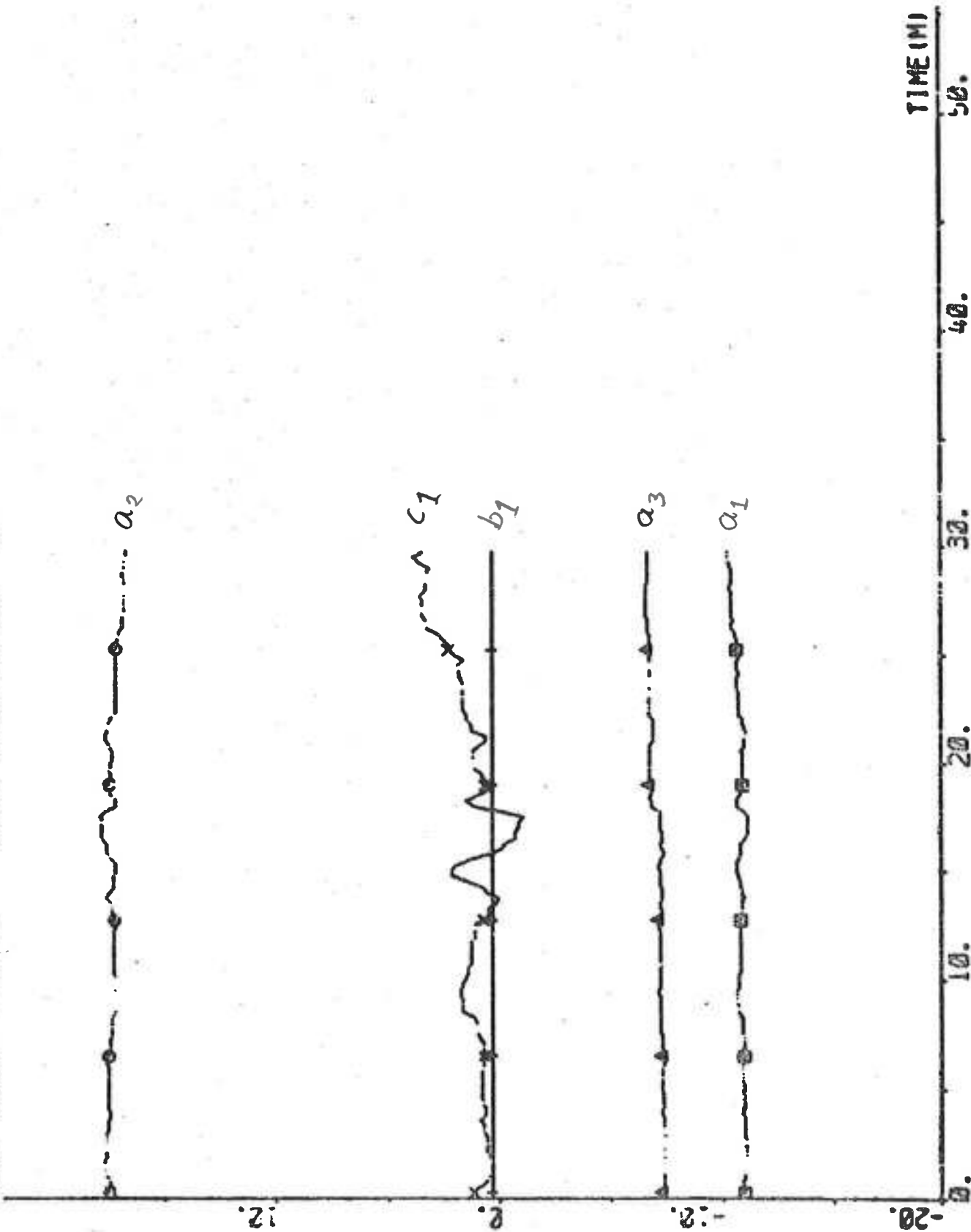
PLOT R33P1(12) ZERO -0.1 0.1 "DPSIDT DEG/S (IDPSI=5)



PLOT R33P1(13 14) 207 208 "PSI PSIREF DEG



PLOT A33P2 - 15 15 "REGULATOR PARAMETERS





## EXPERIMENT A34

Date	1974-10-17
Time	14.20
Duration	33 min
Position	S 07° 04' E 45° 26'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SE (7; see Appendix A)
Wind velocity	4 Beaufort (6-8 m/s, moderate breeze)
Wave height	4 - 5 m
PSIREF	208°
Rudder limit	Not active

Regulator structure

NA = 3      NB = 2      NC = 0      K = 4  
 IREG = 20    RL = 0.98

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} -9.729 \\ 13.809 \\ -4.053 \\ 0.828 \\ 0.667 \end{bmatrix} \quad P = \begin{bmatrix} 1.234 & & & & \\ -1.427 & 2.924 & & & \\ 0.455 & -1.724 & 1.620 & & \\ -0.038 & 0.007 & 0.035 & 0.007 & \\ 0.008 & -0.073 & 0.074 & 0.003 & 0.008 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = 0.027$$

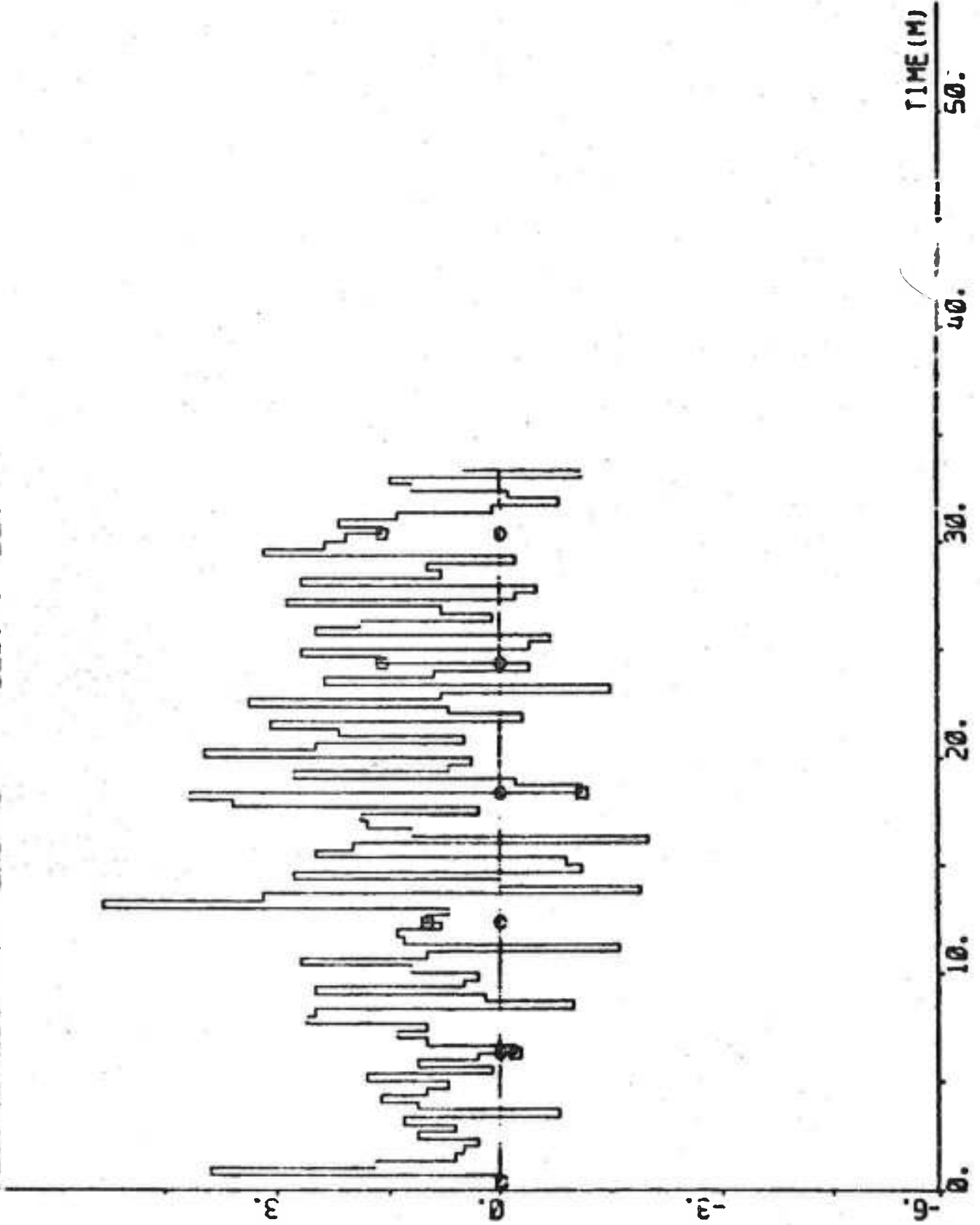
Statistics (mean value and standard deviation)

DELTA	1.89 ± 1.54 deg
PSI-PSIREF	-0.072 ± 0.250 deg
AN	86.05 ± 0.24 rpm
U	16.91 ± 0.23 knots

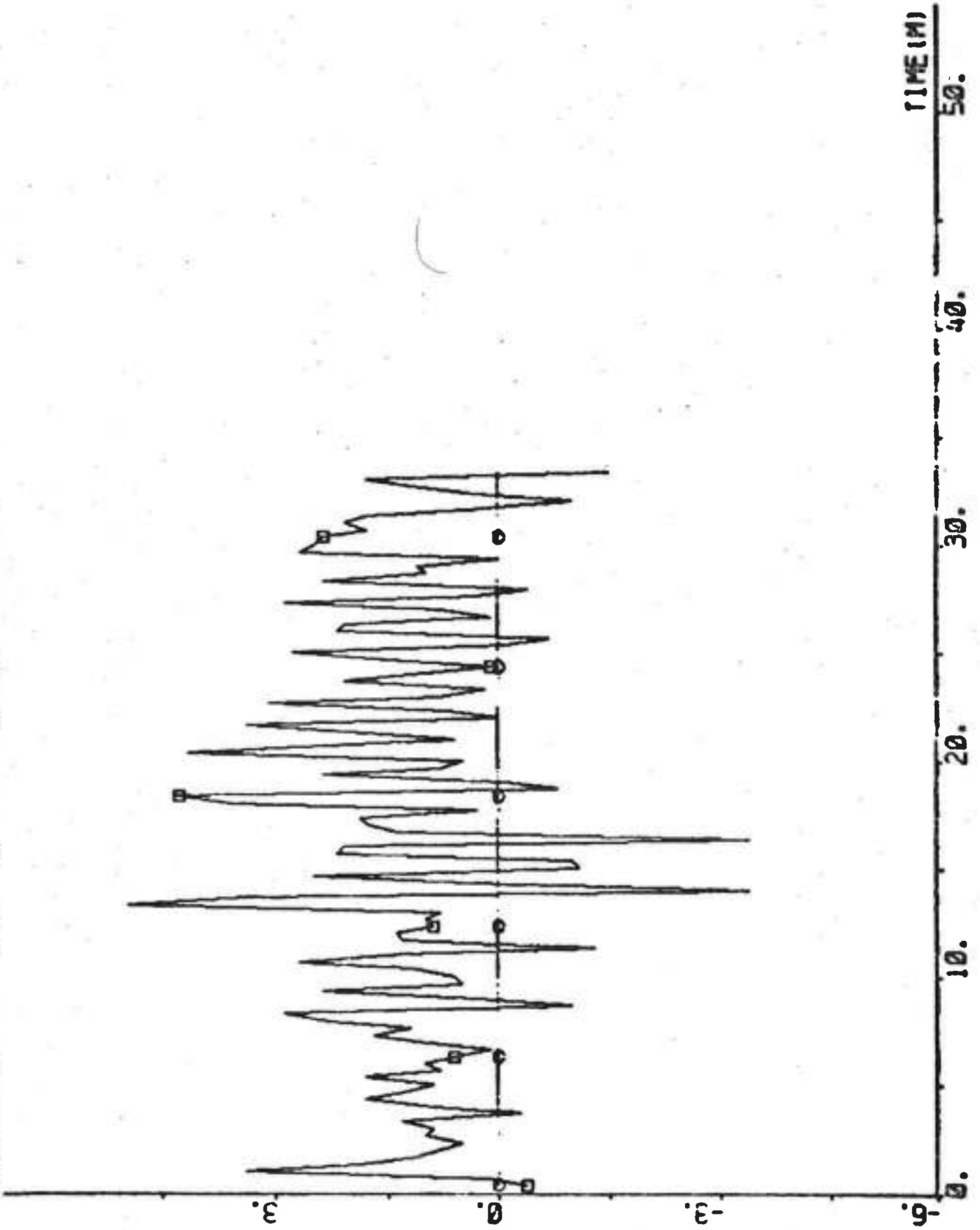
$$V_1 = 0.662$$

$$V_2 = 0.305$$

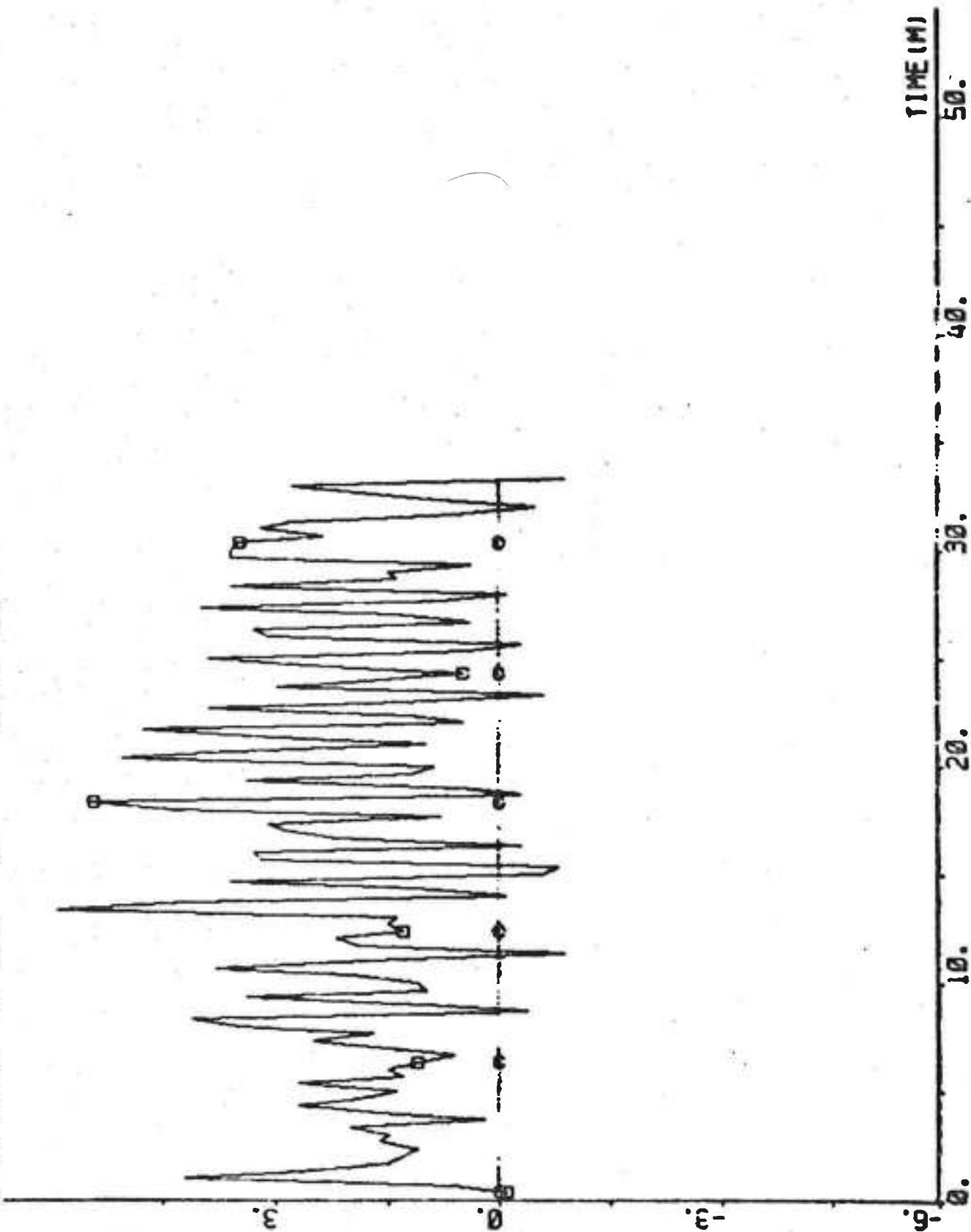
PLOT HP A34P1<1> ZERO -5 7 "DELCOC DEC



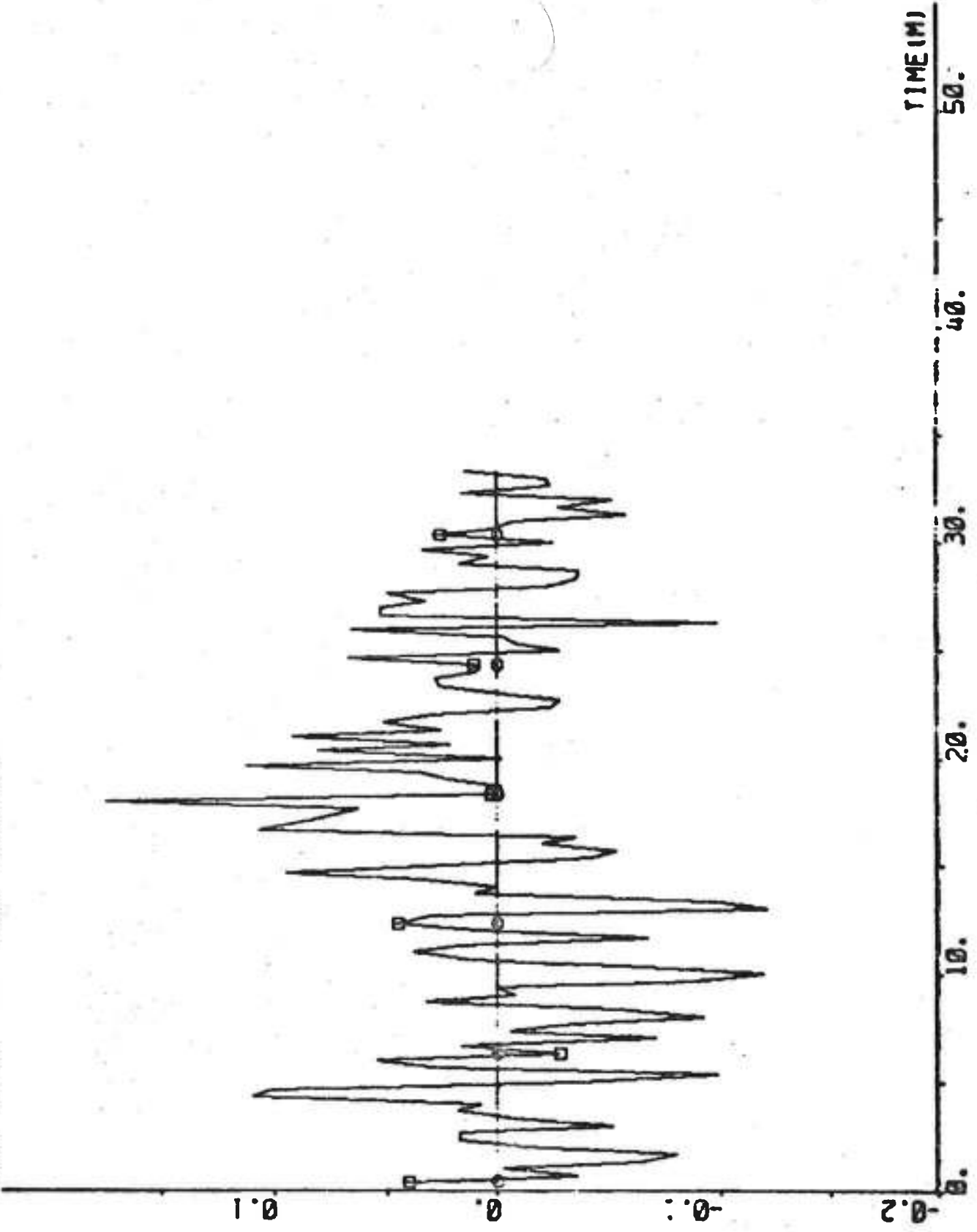
PLOT R34P1(3) ZERO -5 7 "DELTA" DEG



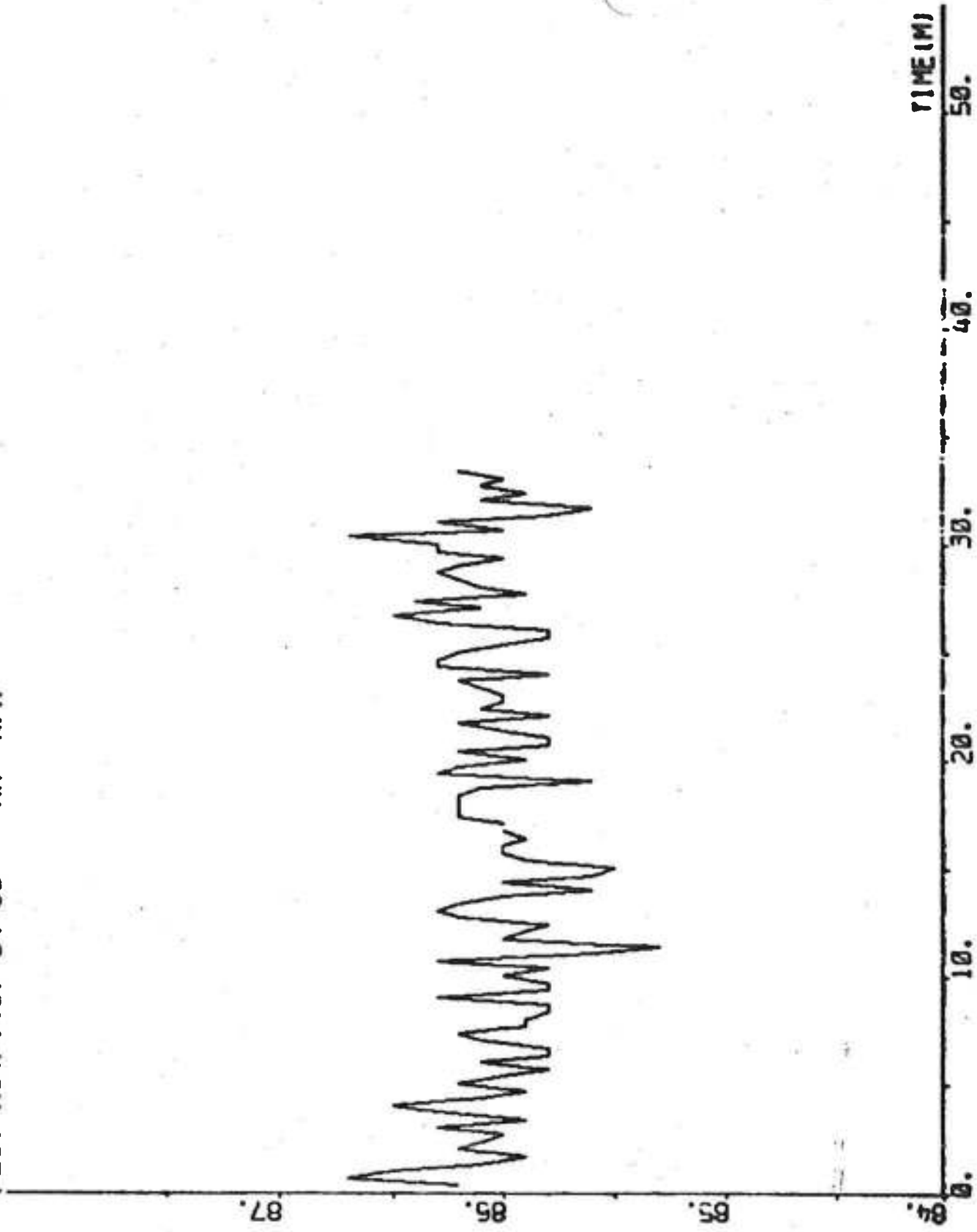
PLOT A34P1(4) ZERO -5 ? "DELTA DEC



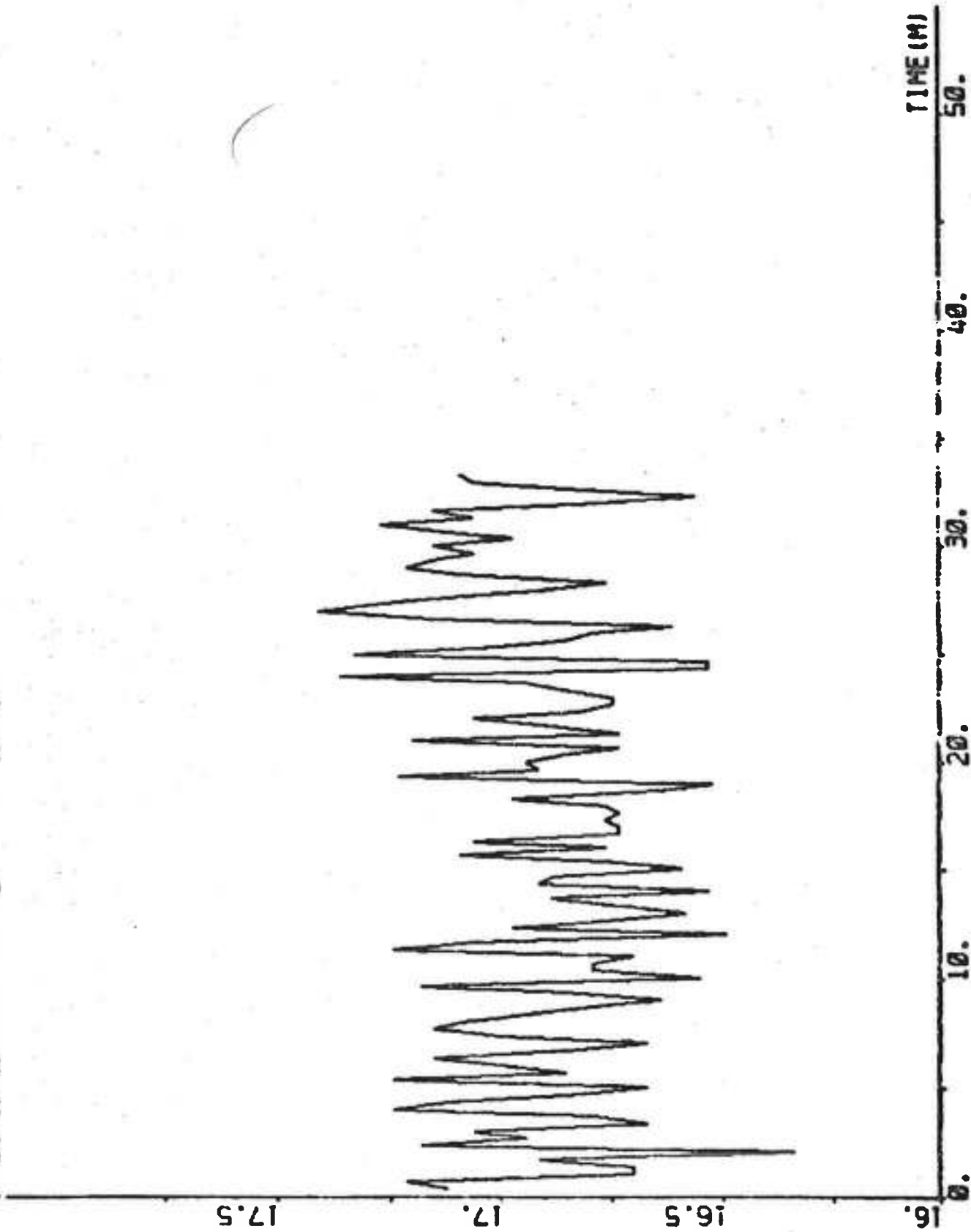
PLOT R34P1(5) ZERO -0.2 0.2 "PP DEG/S



PLOT A34P1(6) 64 88 "AN RPH

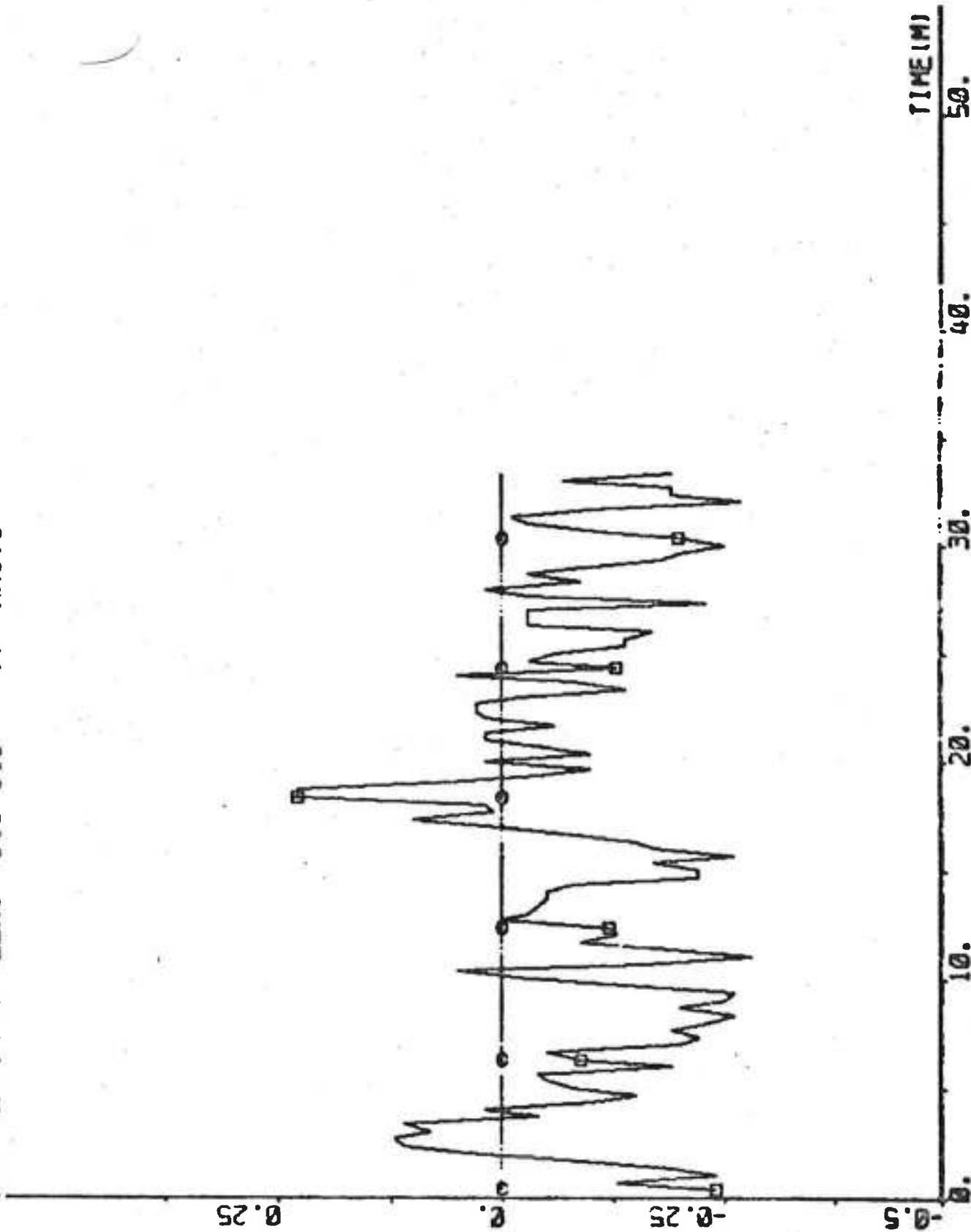


PLOT R34P1(7) 16 18 "U KNOTS

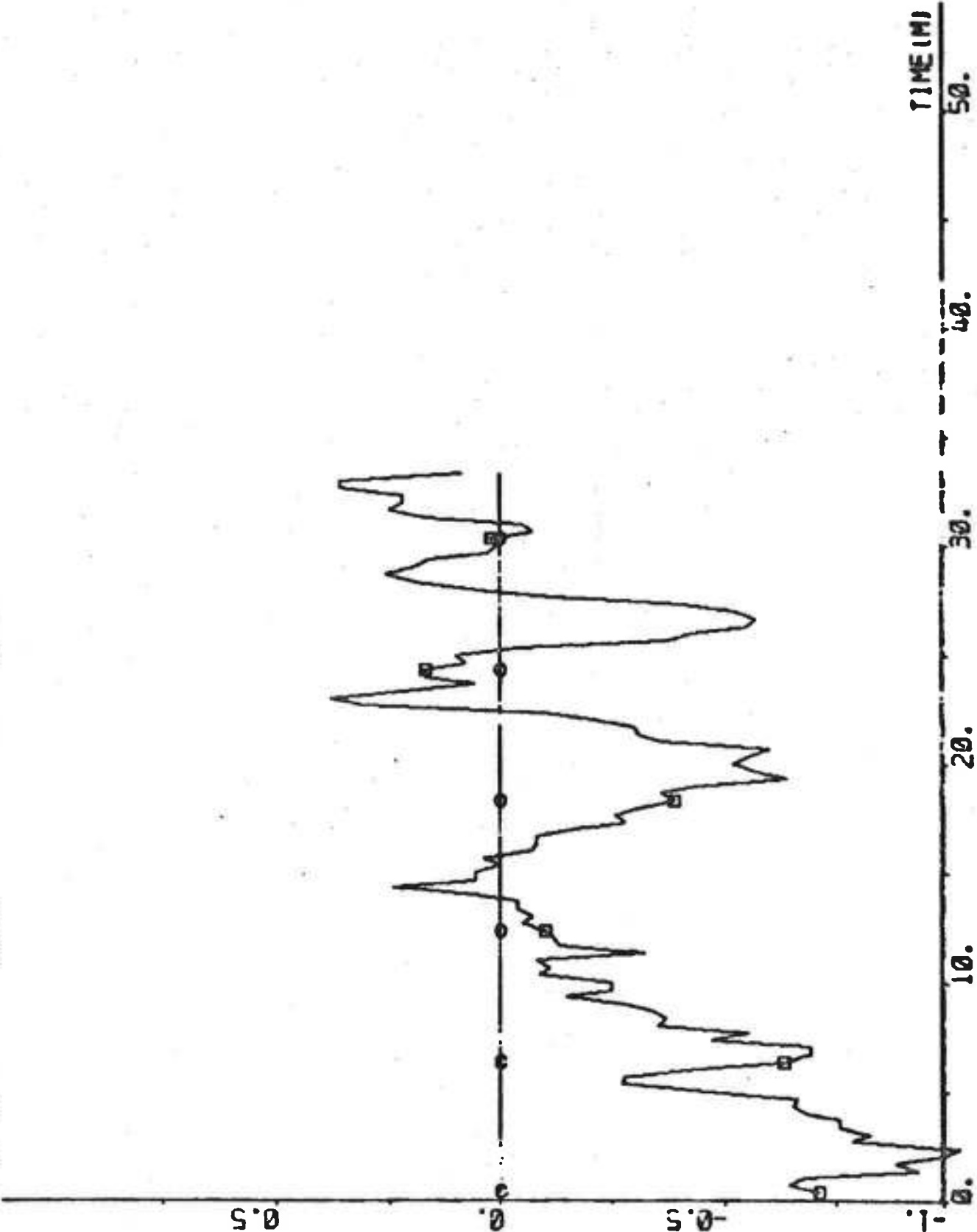




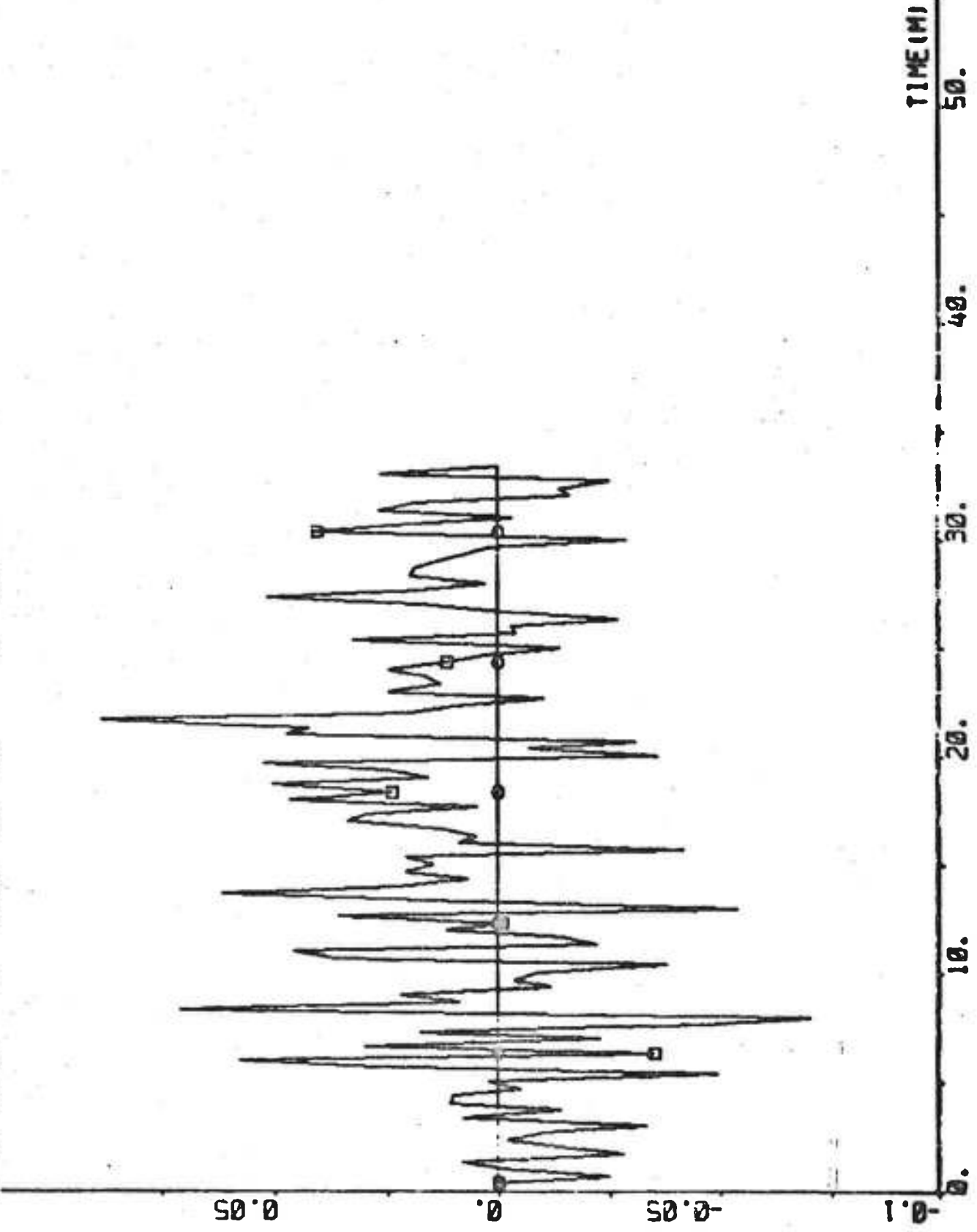
PLOT A34P1(8) ZERO -0.5 0.5 "V1 KNOTS



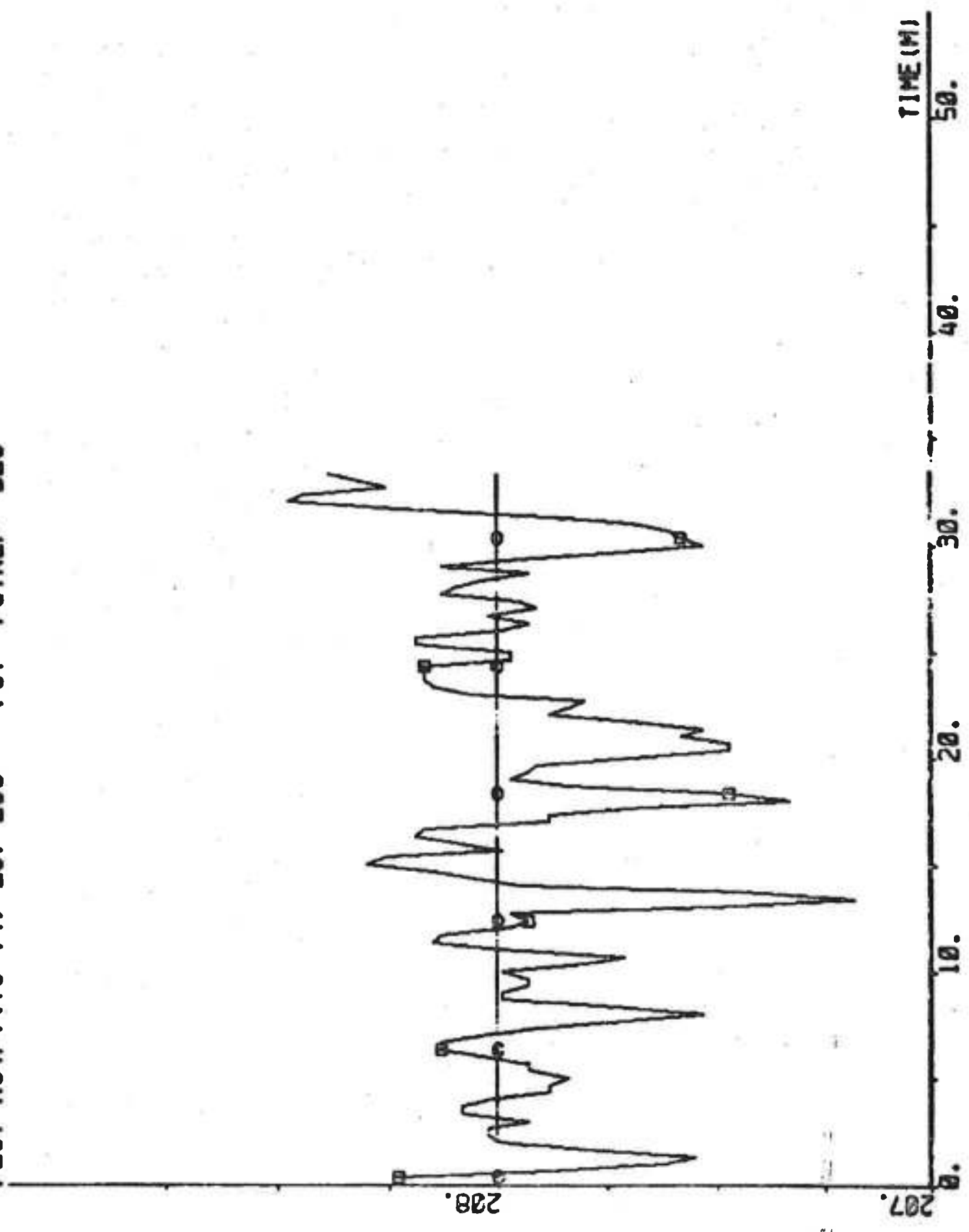
PLOT A34P1(9) ZERO -1 1 "V2 KNOTS



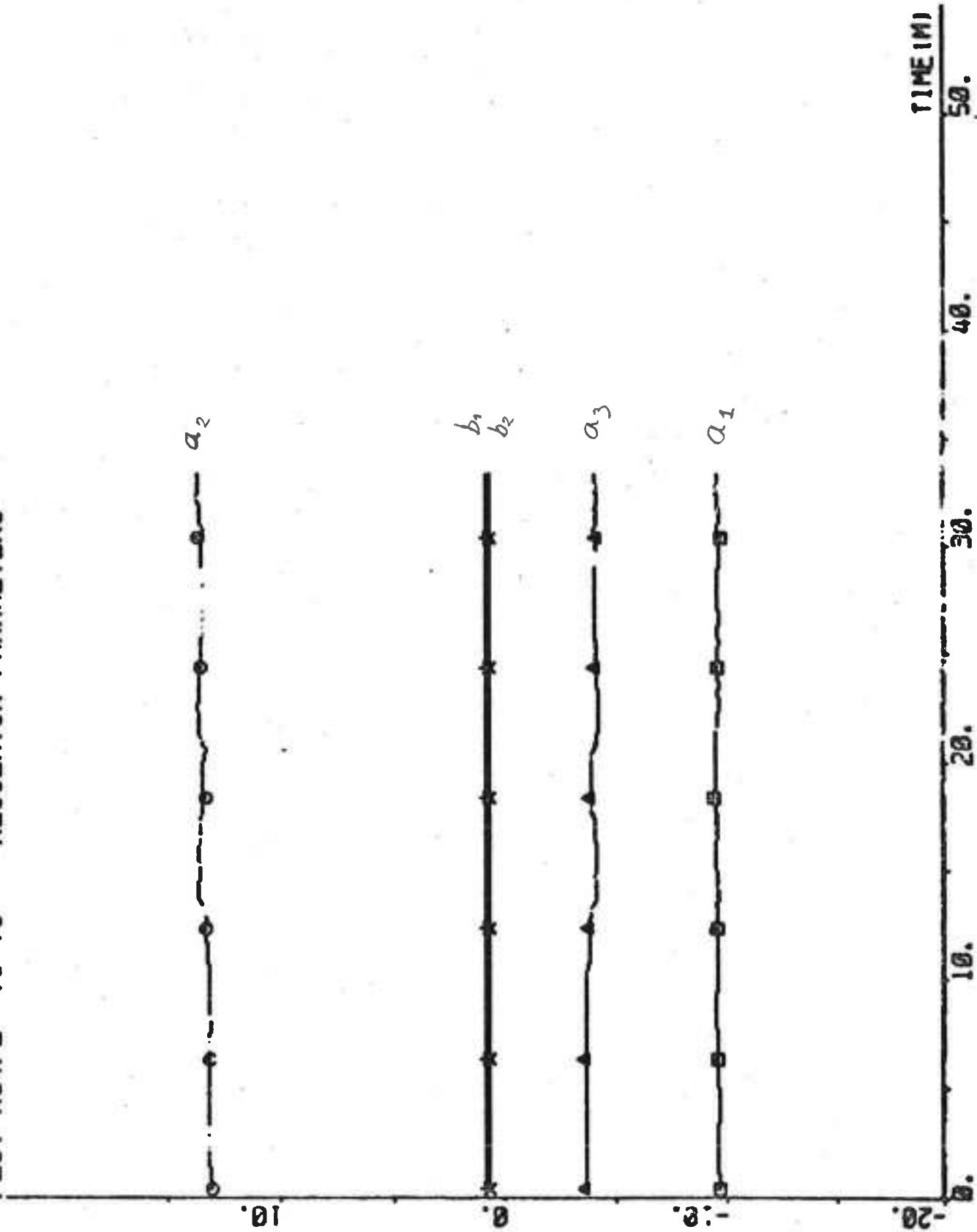
PLOT A34P1(10) ZERO -0.1 0.1 "R DEG/S



PLOT A34P1(13 14) 207 209 °PSI PSIREF DEG



PLOT A34P2 -15 15 REGULATOR PARAMETERS



Statistics (mean value and standard deviation)

DELTA	1.75 ± 1.66 deg
PSI-PSIREF	0.001 ± 0.283 deg
AN	86.14 ± 0.28 rpm
U	17.01 ± 0.20 knots

$$V_1 = 0.662$$

$$V_2 = 0.356$$

## EXPERIMENT A35

Date	1974-10-17
Time	15.46
Duration	28 min
Position	S 07° 25' E 45° 15'
Water depth	deep
Forward draught	20.2 m
Aft draught	20.2 m
Wind direction	SE (7; see Appendix A)
Wind velocity	4 Beaufort (6-8 m/s, moderate breeze)
Wave height	4 - 5 m
PSIREF	208°
Rudder limit	Not active

Regulator structure

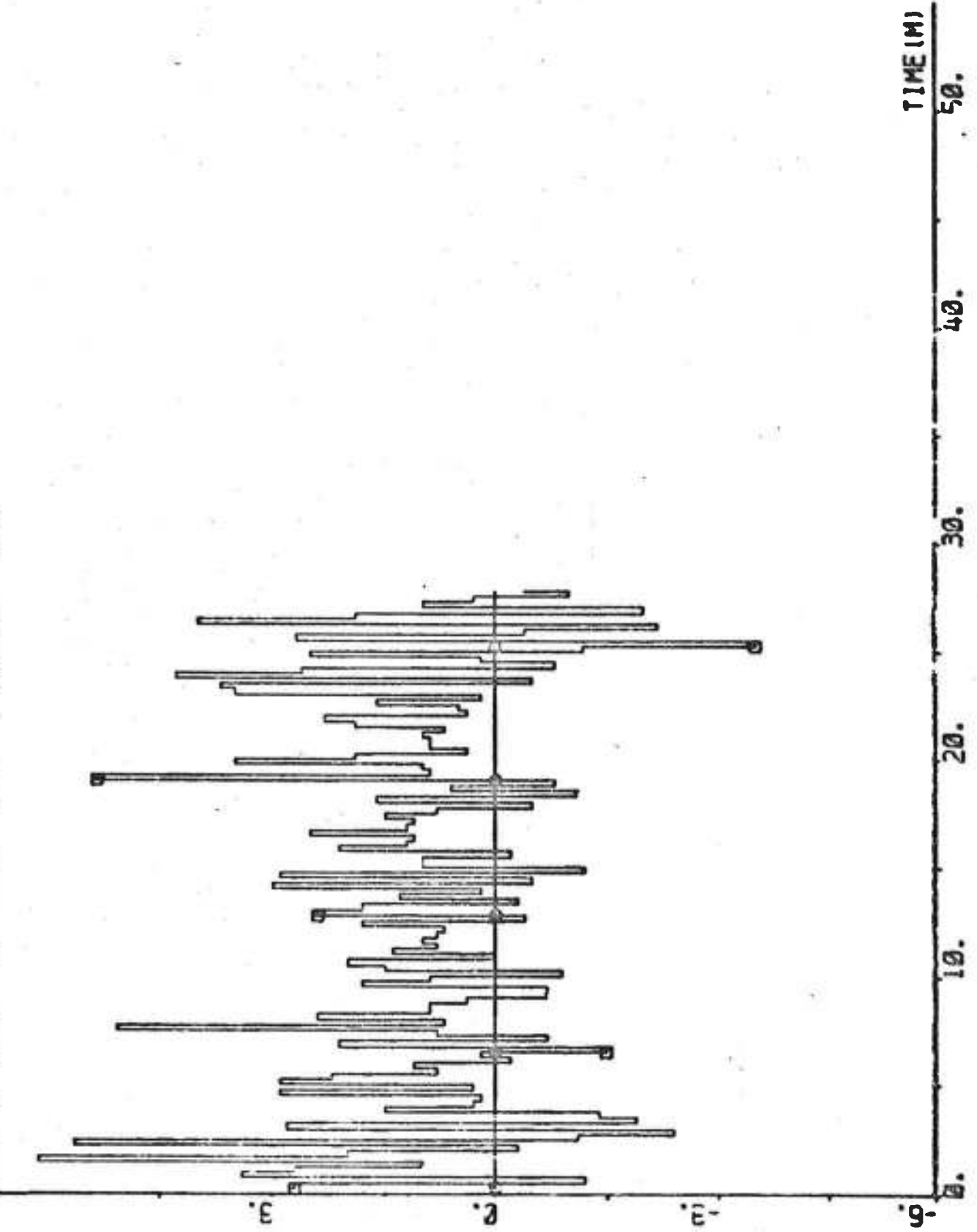
NA = 3      NB = 2      NC = 0      K = 5  
 IREG = 15    RL = 0.99

Final values

$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} -11.569 \\ 15.763 \\ -4.783 \\ 0.894 \\ 0.568 \end{bmatrix} \quad P = \begin{bmatrix} 0.544 & & & & \\ -0.745 & 1.740 & & & \\ 0.257 & -1.055 & 0.871 & & \\ -0.001 & -0.032 & 0.035 & 0.004 & \\ 0.004 & -0.035 & 0.033 & 0.003 & 0.004 \end{bmatrix}$$

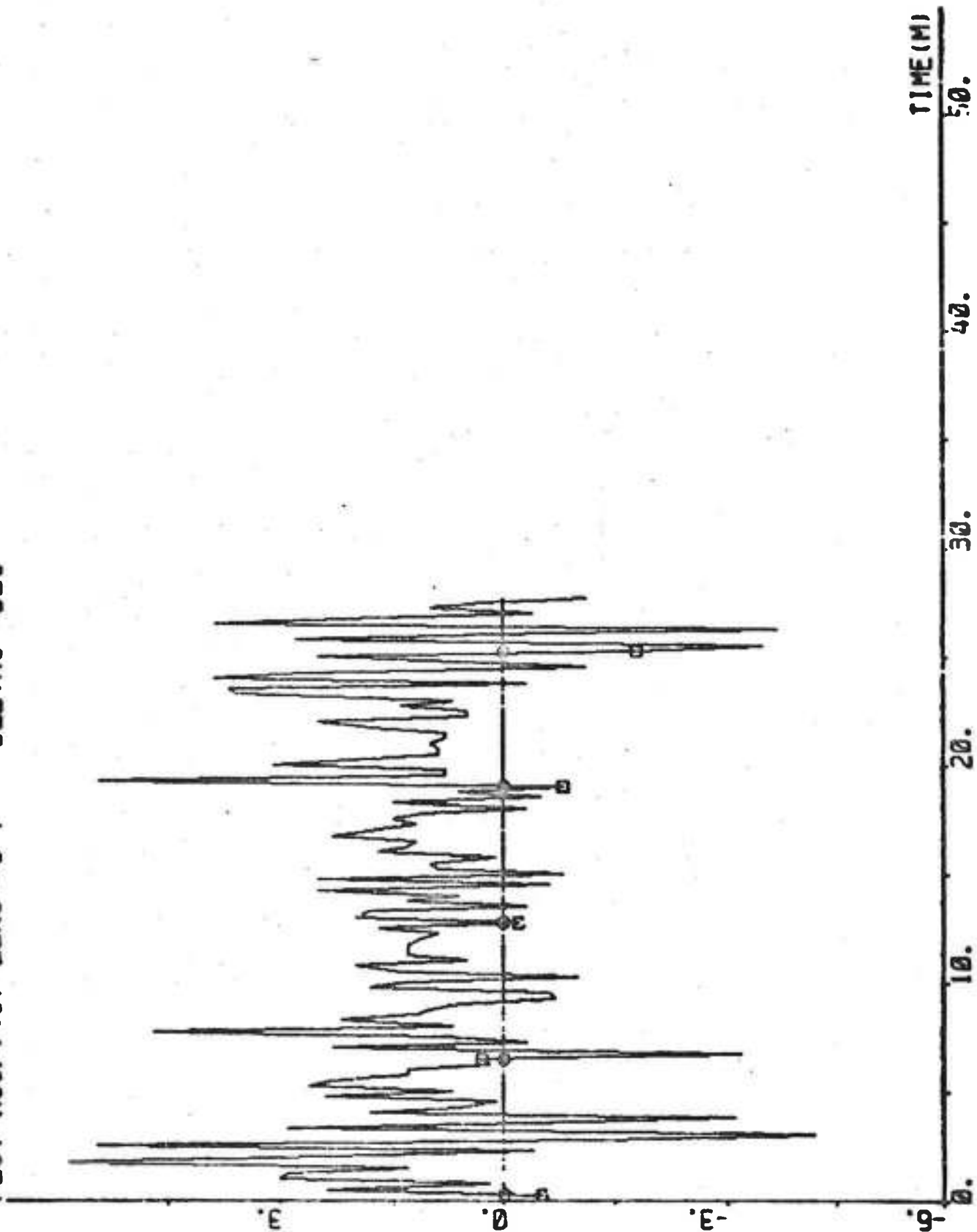
$$a_1 + a_2 + a_3 = -0.589$$

PLOT HP R35PI(1) ZERO -5 7 "DELCOC DEG

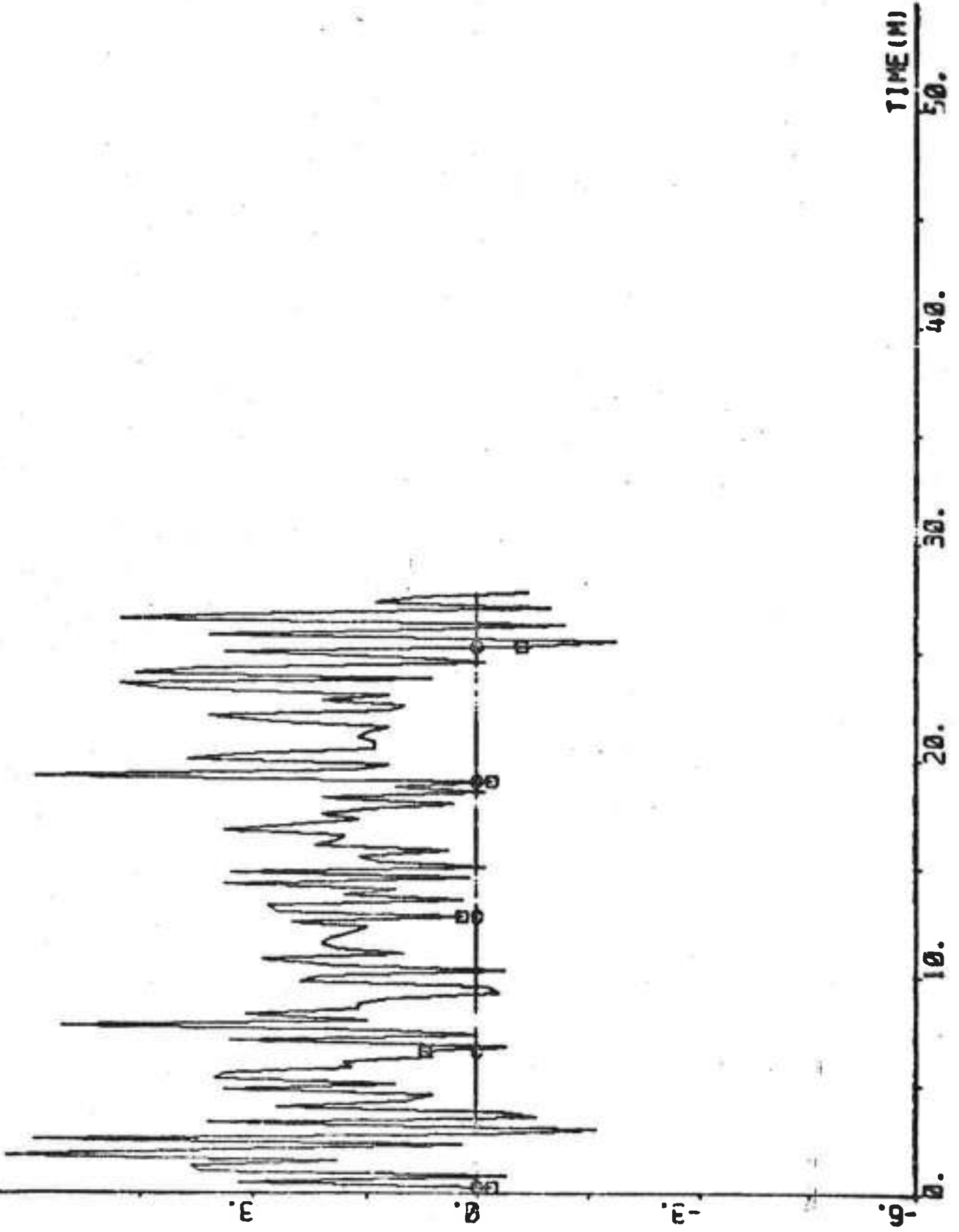




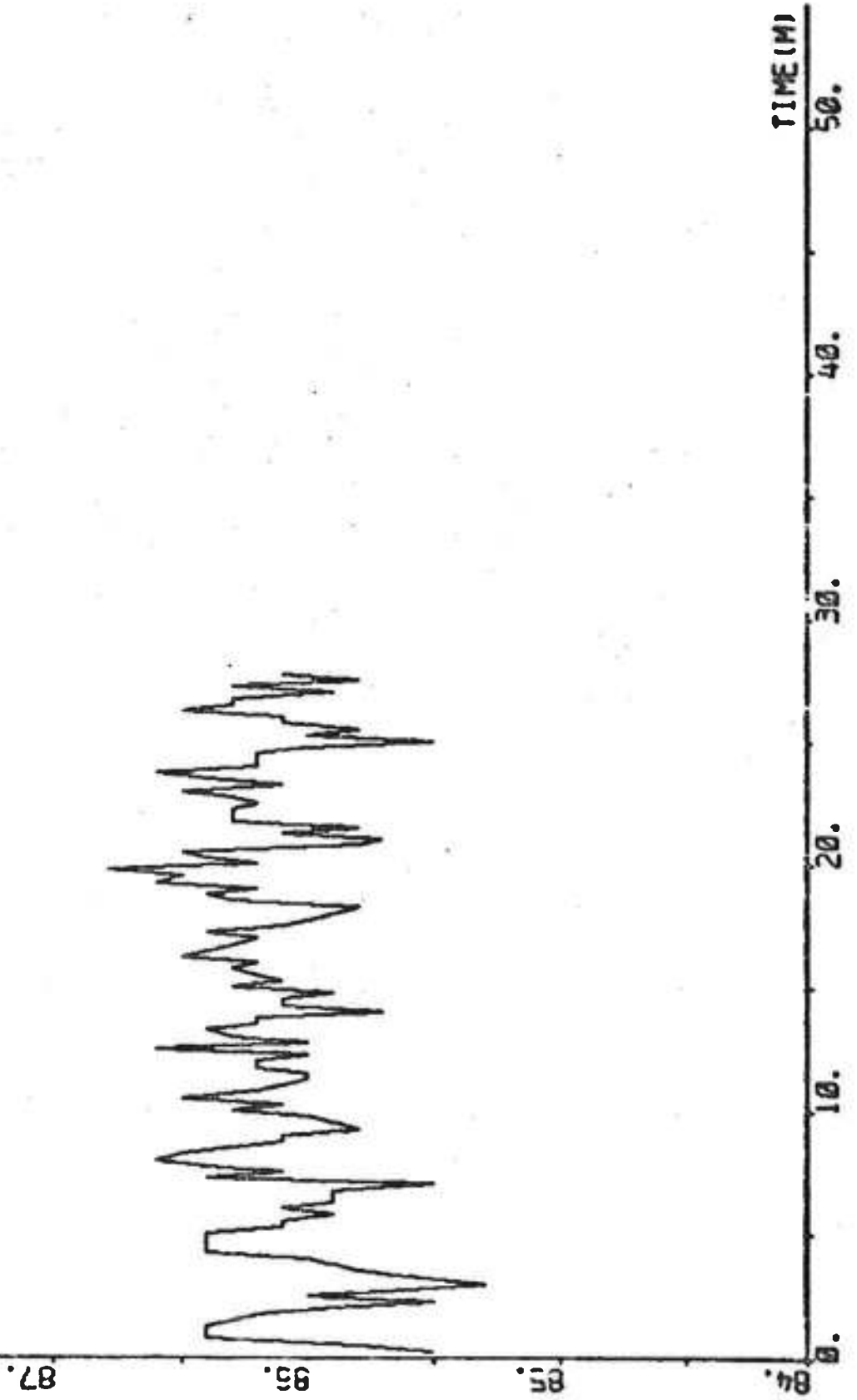
PLOT A36P1(3) ZERO -5 7 "DELTA" DEG



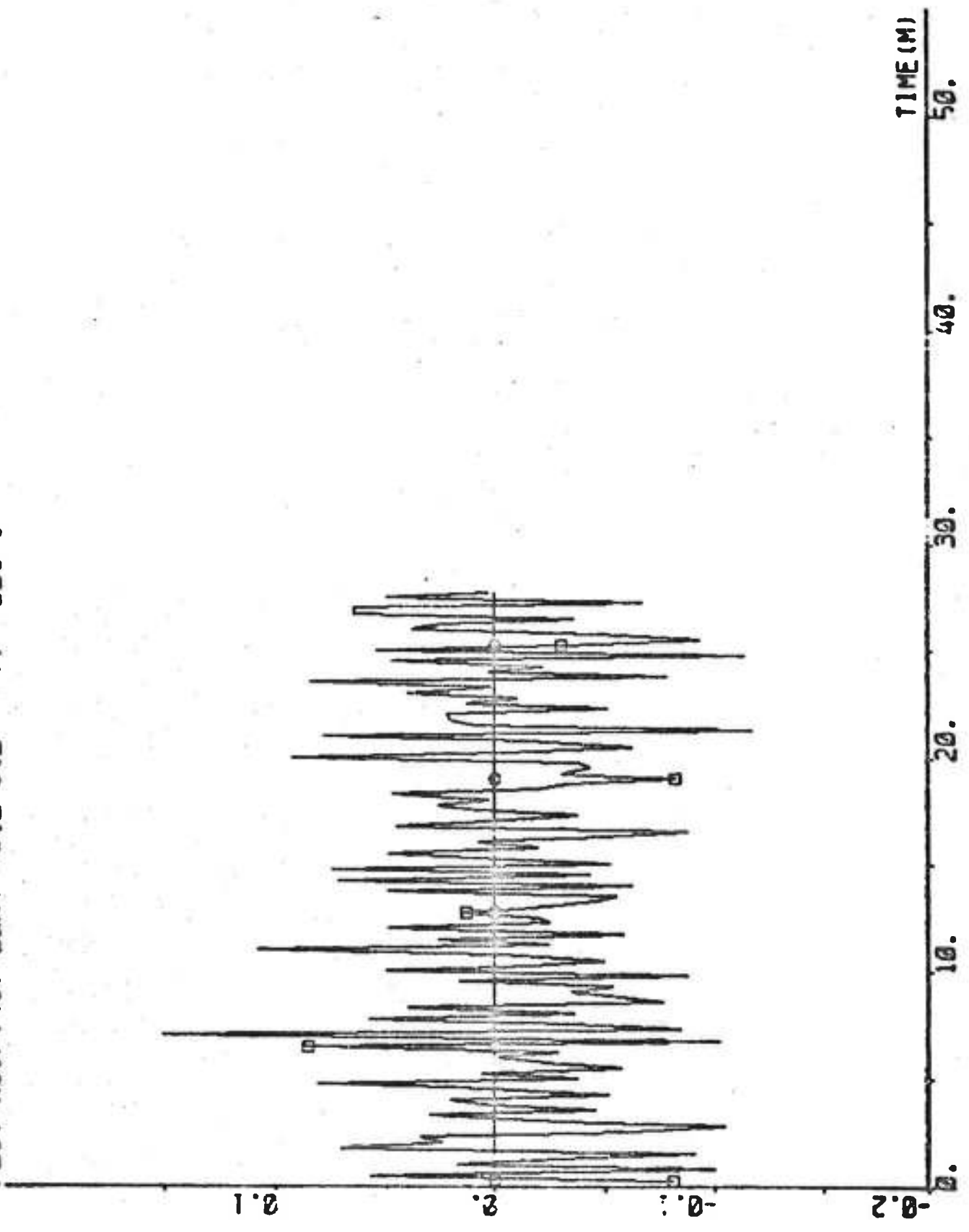
PLOT R35P1(4) ZERO -5 7 "DELTA DEG



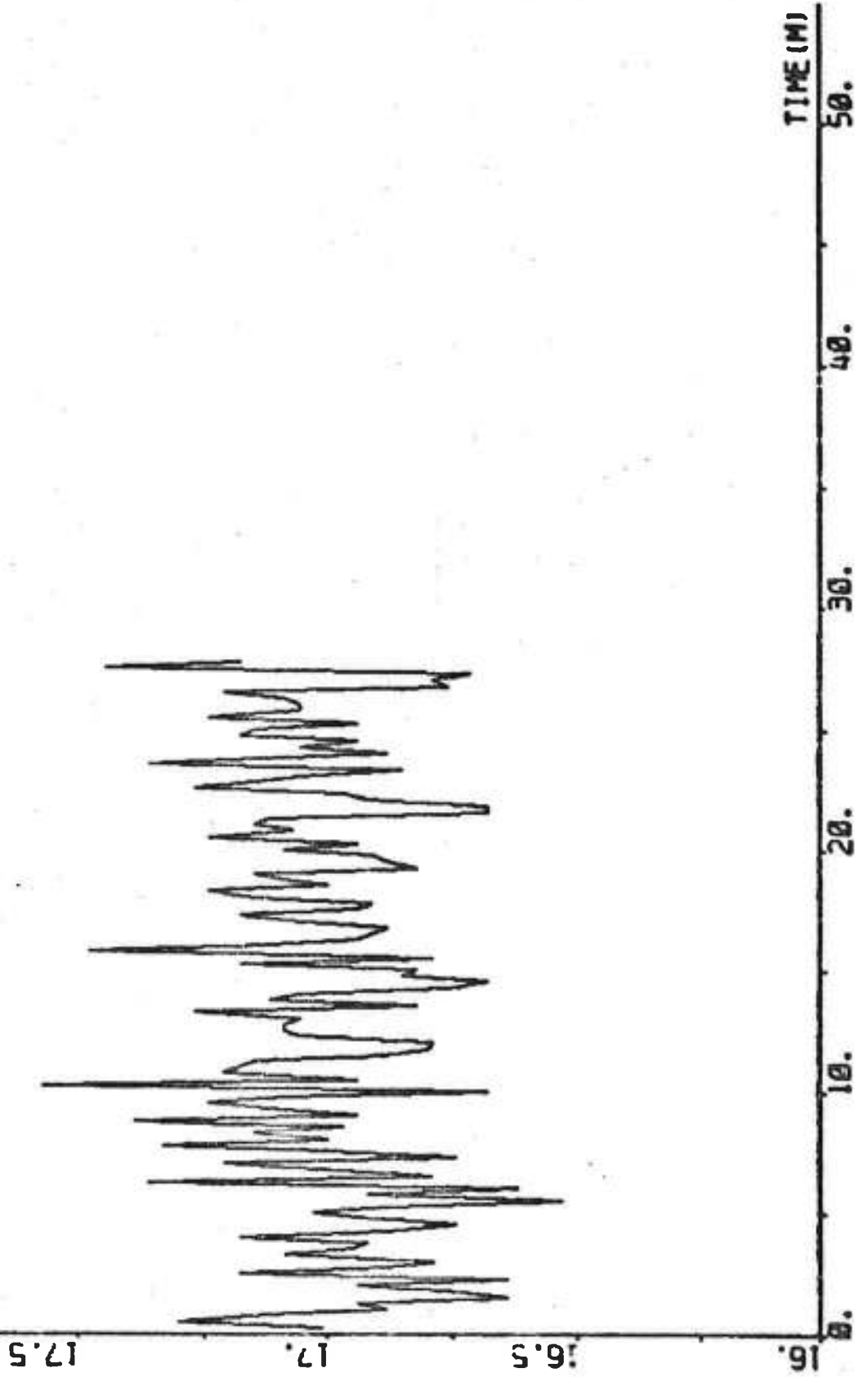
PLOT A35P1(6) 64 00 -AN RPH



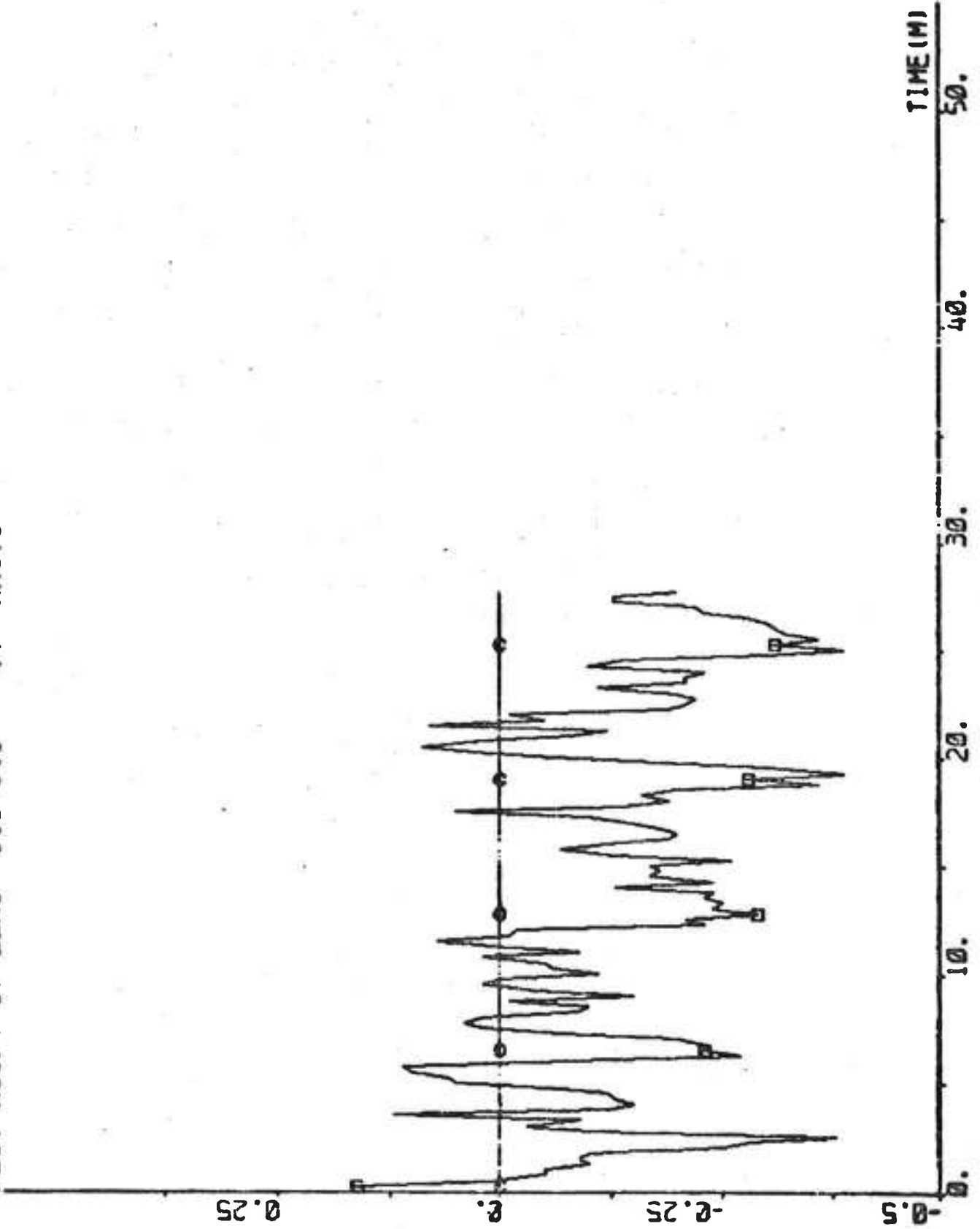
PLOT R35P1(5) ZERO -0.2 0.2 "PP DEG/S



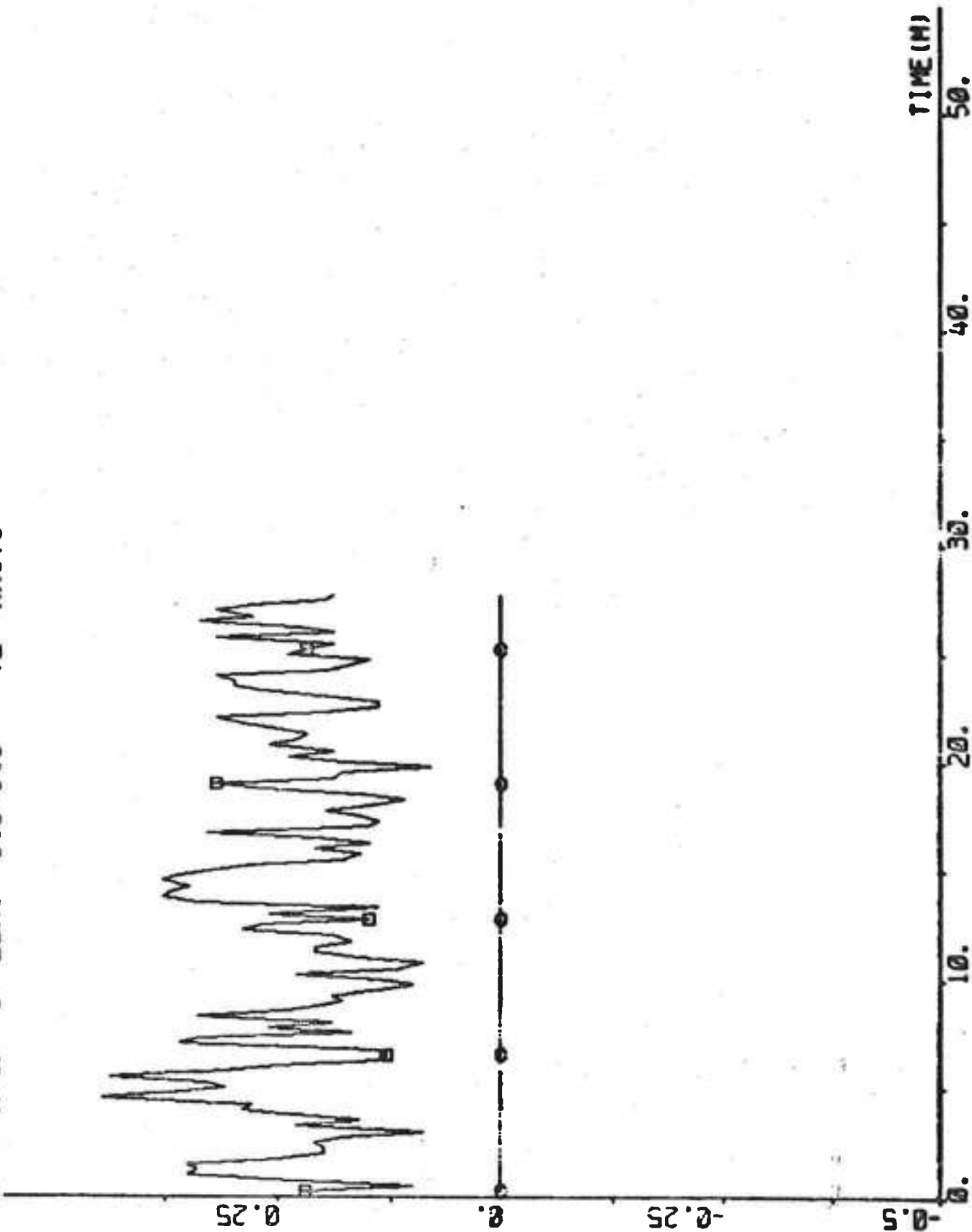
PLOT R3EP1(7) 16 18 "U KNOTS



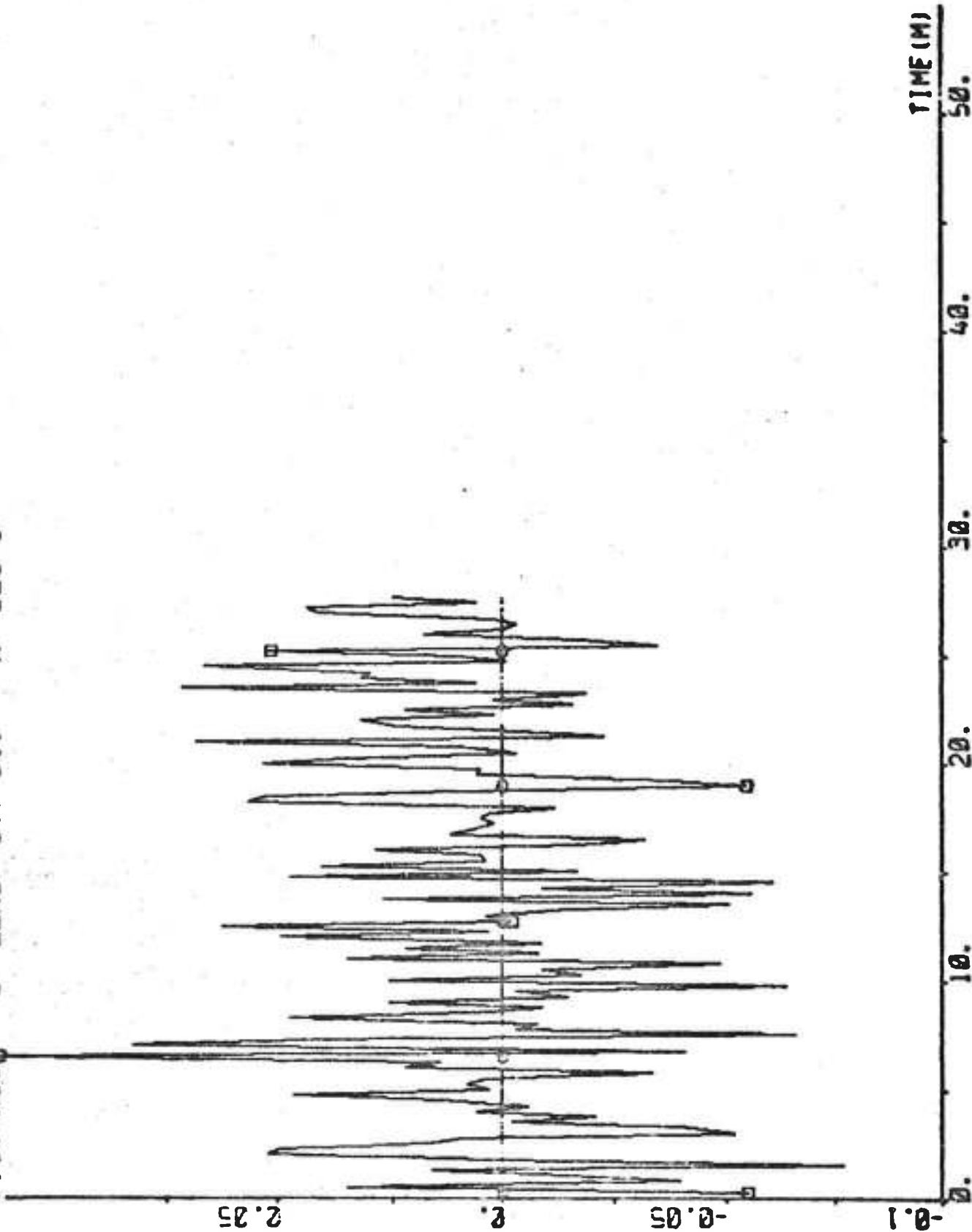
PLOT A35P1(8) ZERO -0.5 0.5 "V1 KNOTS



PLOT A35P1(8) ZERO -0.5 0.5 "V2 KNOTS

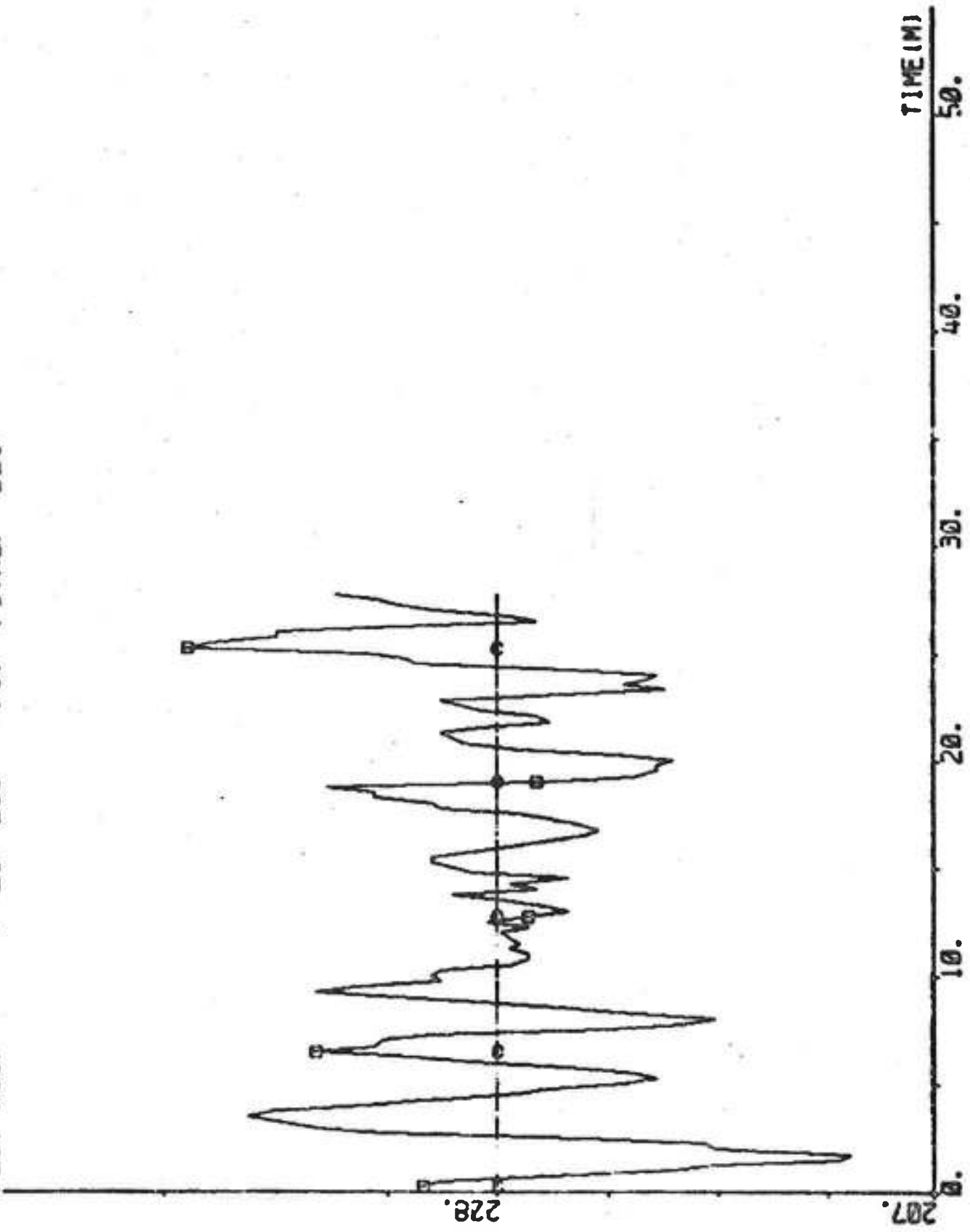


PLOT A3581(10) ZERO -0.1 0.1 "R DEC/S

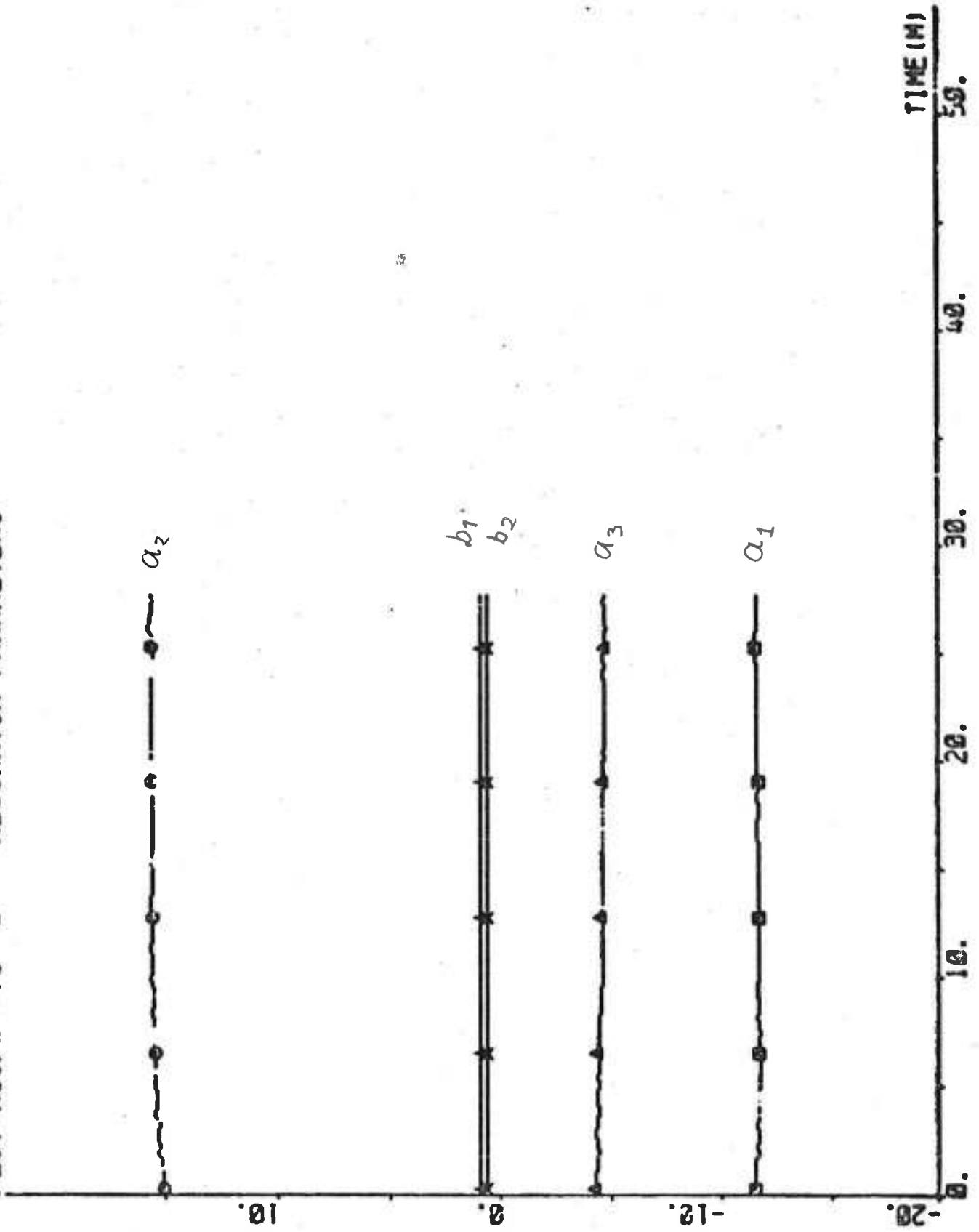




PLOT A35P1(13 14) 207 209 PSI PSIREF DEG



PLOT A36P2 -15 15 "REGULATOR PARAMETERS



Statistics (mean value and standard deviation)

	<u>0-45 min</u>	<u>5-45 min</u>
DELTA	1.68 ± 1.77 deg	1.66 ± 1.45 deg
PSI-PSIREF	-0.001 ± 0.321 deg	0.005 ± 0.219 deg
AN	86.03 ± 0.30 rpm	86.05 ± 0.25 rpm
U	16.55 ± 0.24 knots	16.55 ± 0.24 knots
V <sub>1</sub>	0.699	0.534
V <sub>2</sub>	0.416	0.258

## EXPERIMENT A36

Date 1974-10-17  
 Time 17.29  
 Duration 45 min  
 Position S 07° 54' E 44° 58'  
 Water depth deep  
 Forward draught 20.2 m  
 Aft draught 20.2 m  
 Wind direction SE (7; see Appendix A)  
 Wind velocity 3 Beaufort (4-5.5 m/s, gentle breeze)  
 Wave height 3 - 4 m  
 PSIREF 208°  
 Rudder limit Not active

Regulator structure

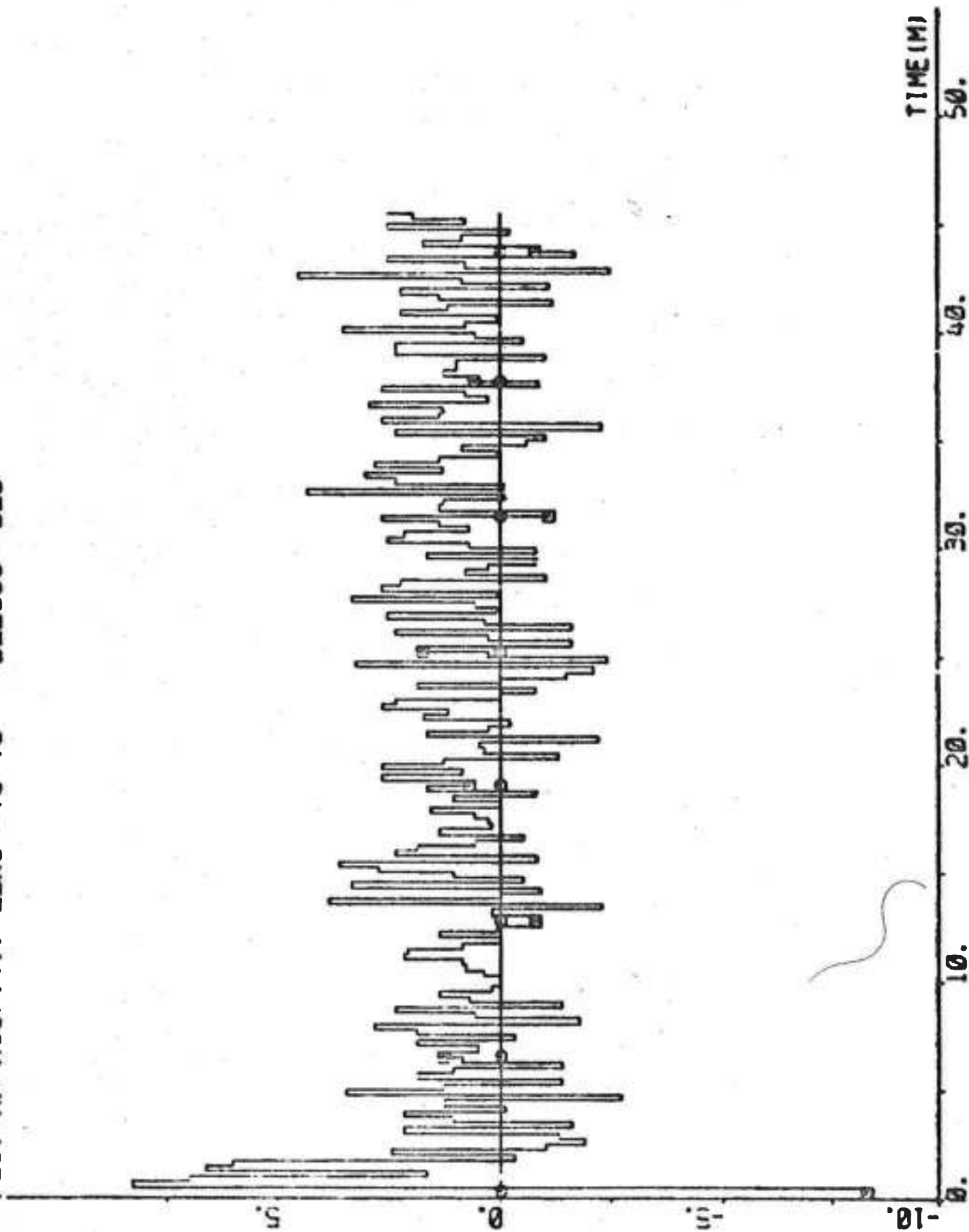
NA = 3      NB = 2      NC = 0      K = 5  
 IREG = 15    RL = 0.99

Final values

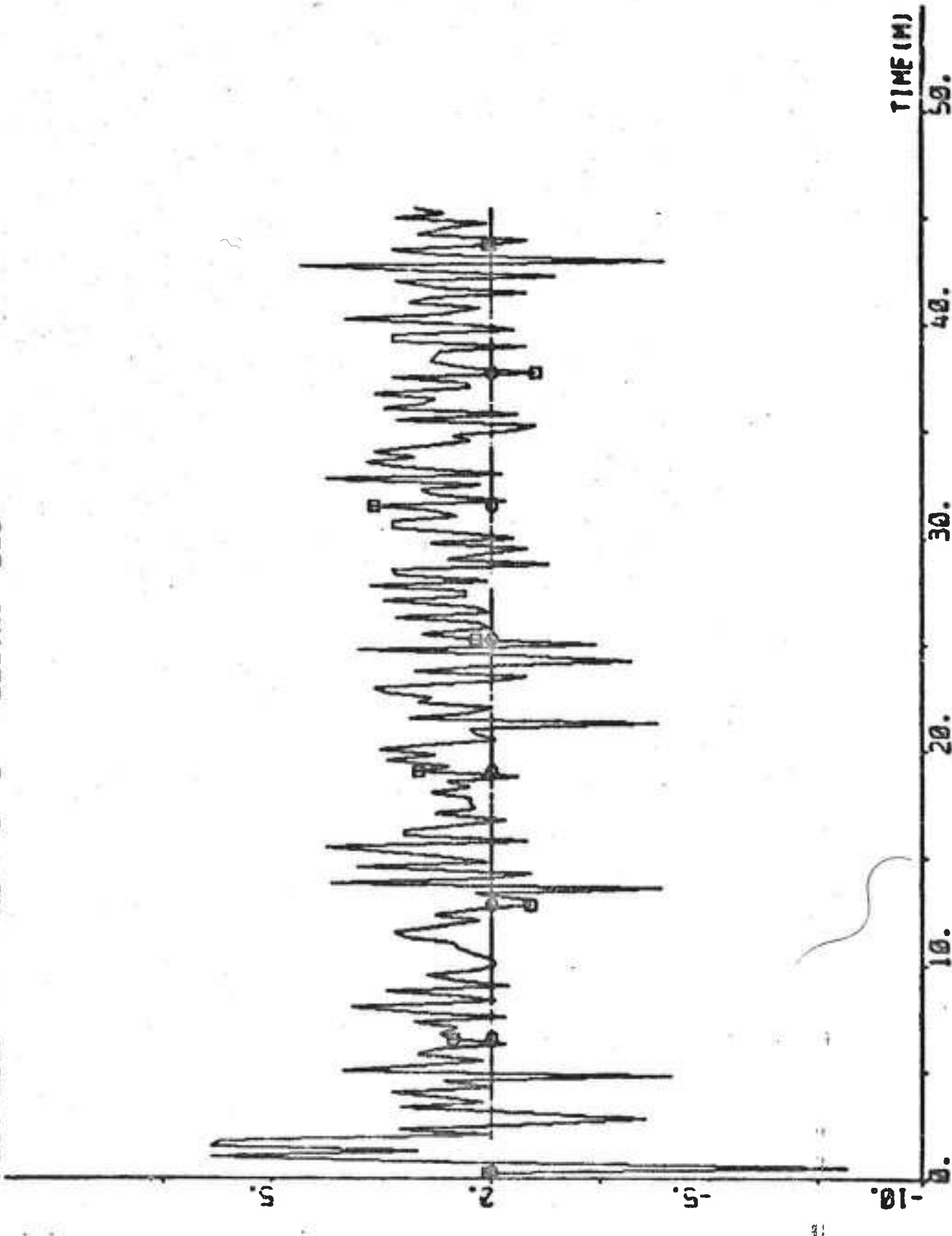
$$\begin{bmatrix} a_1 \\ a_2 \\ a_3 \\ b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} -11.357 \\ 16.107 \\ -4.851 \\ 0.902 \\ 0.576 \end{bmatrix} \quad P = \begin{bmatrix} 0.567 & & & & \\ -0.702 & 1.611 & & & \\ 0.251 & -1.031 & 0.938 & & \\ 0.000 & -0.030 & 0.035 & 0.004 & \\ 0.004 & -0.032 & 0.032 & 0.002 & 0.003 \end{bmatrix}$$

$$a_1 + a_2 + a_3 = -0.101$$

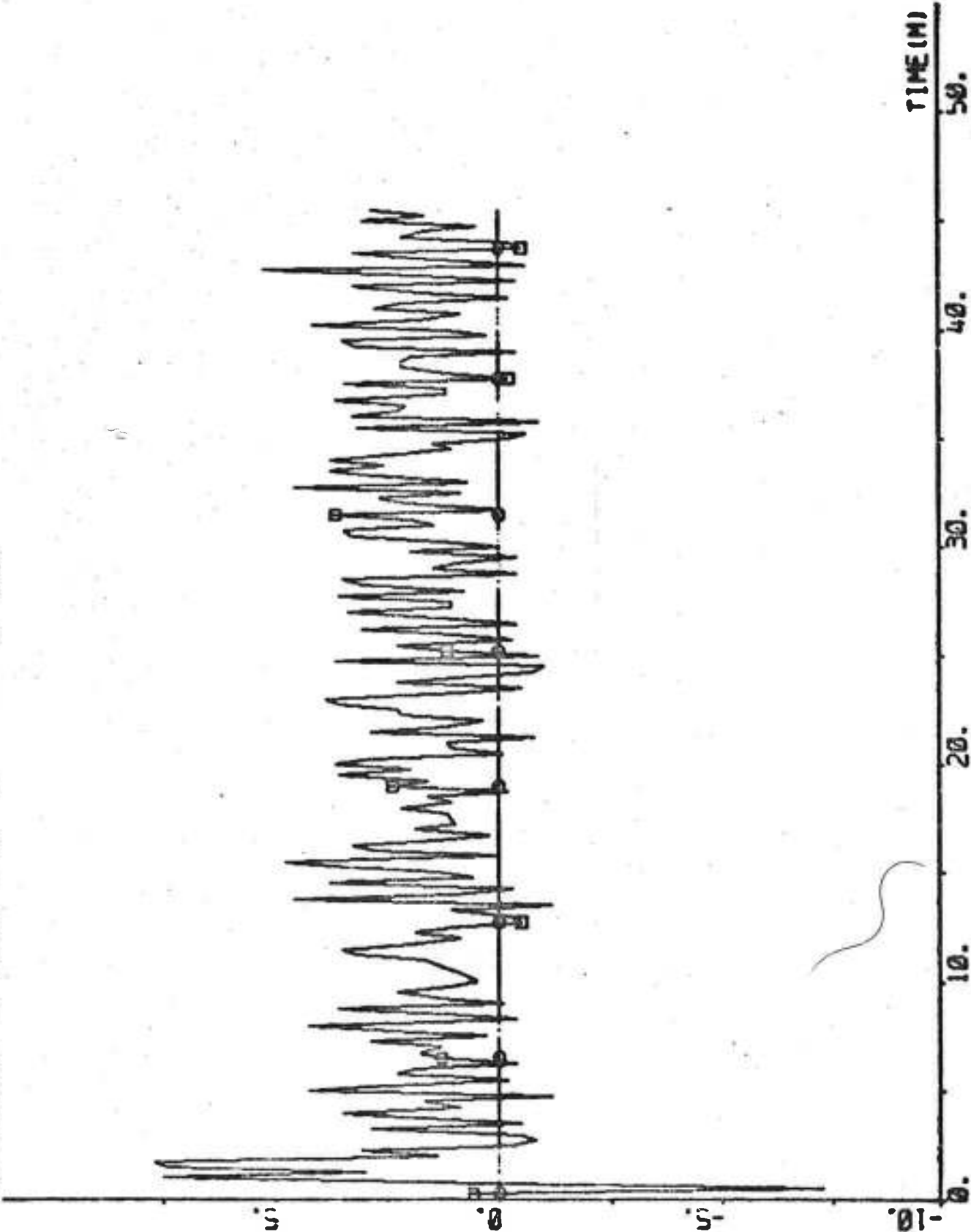
PLOT HP A3SP1(1) ZERO -10 10 "DELCOC DEG



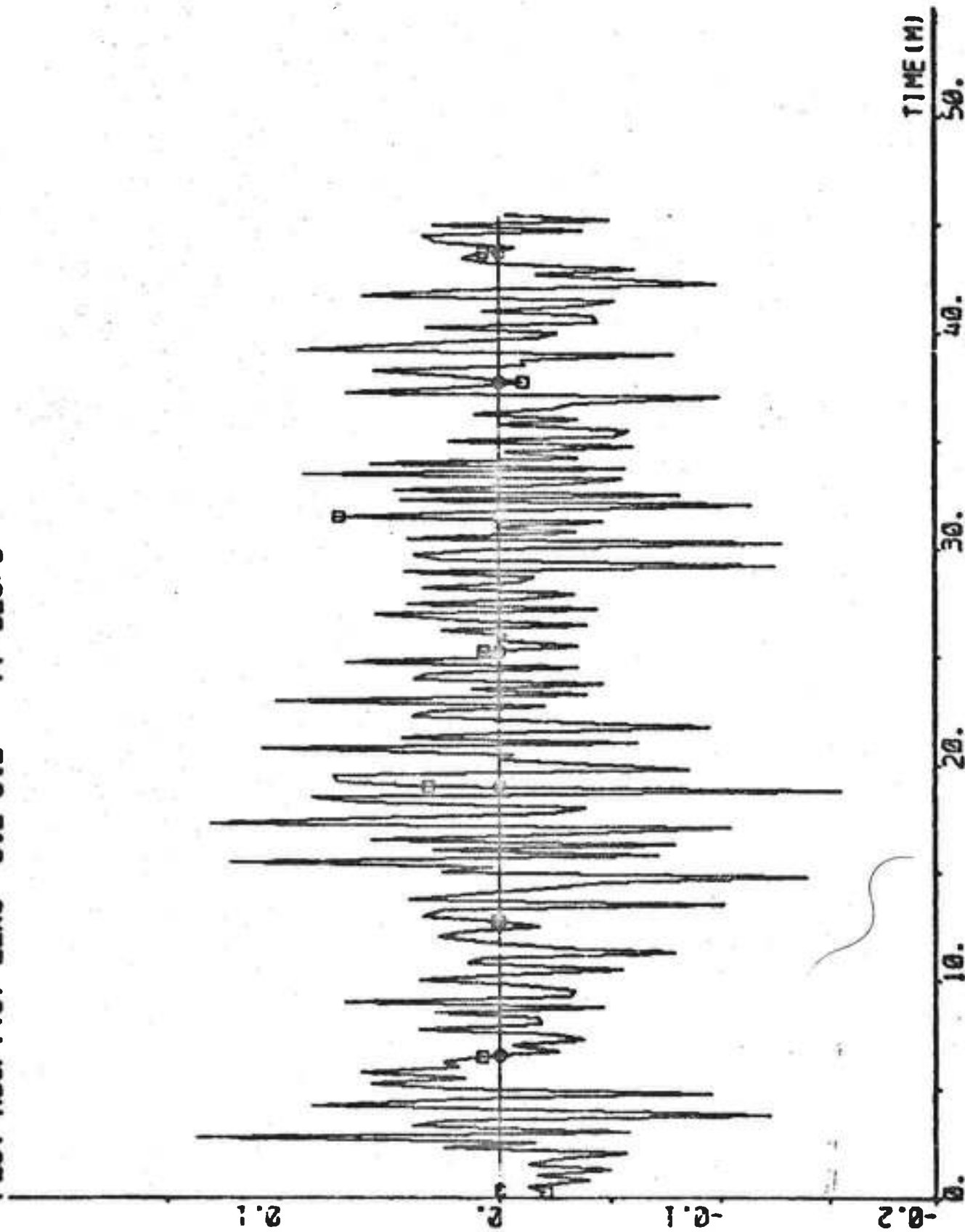
PLOT R36P1(3) ZERO -10 10 "DELTA" DEC



PLOT R3CP1(4) ZERO -10 10 °DELTA DEG

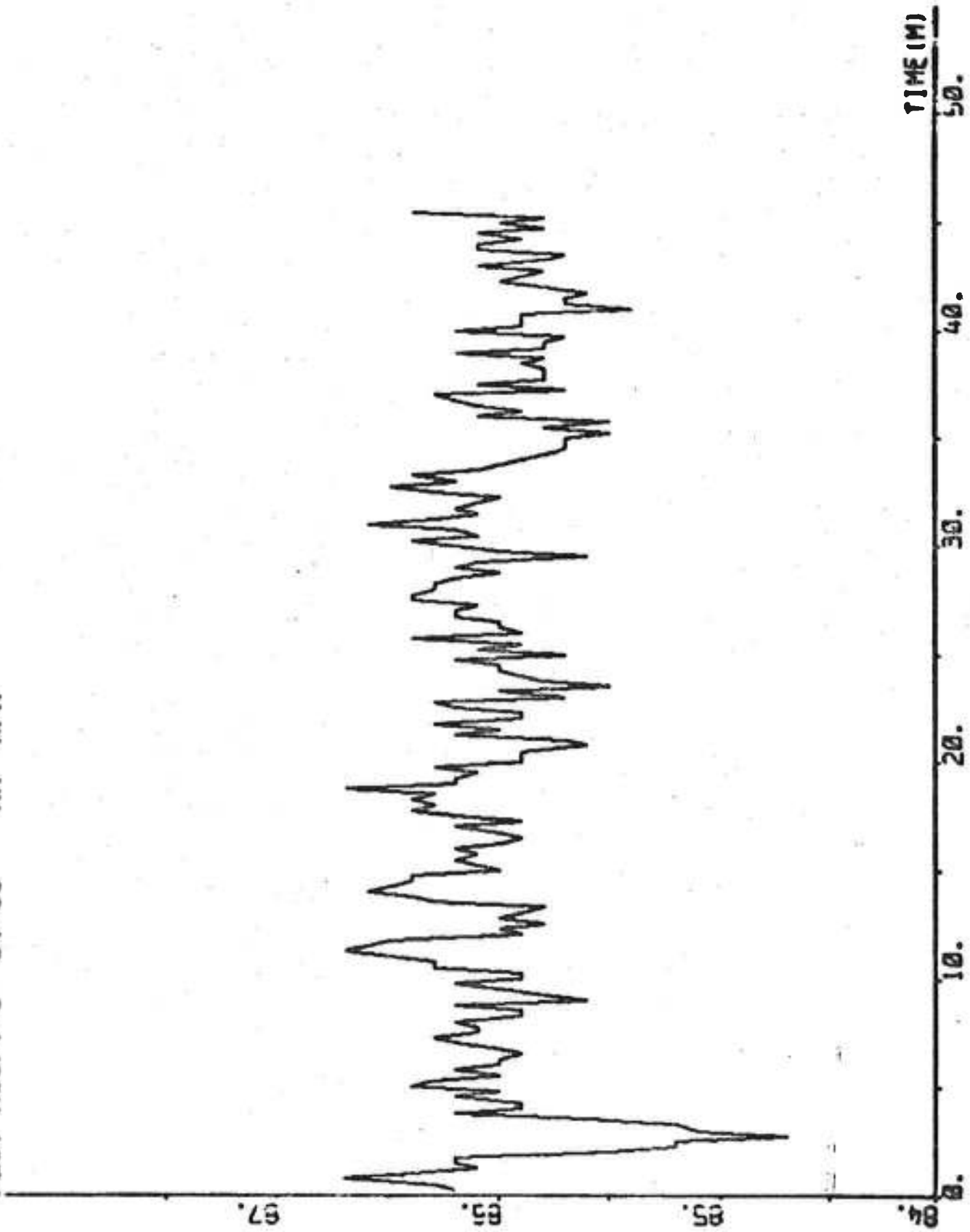


PLOT A36P1(6) ZERO -0.2 0.2 -PP DEG/S



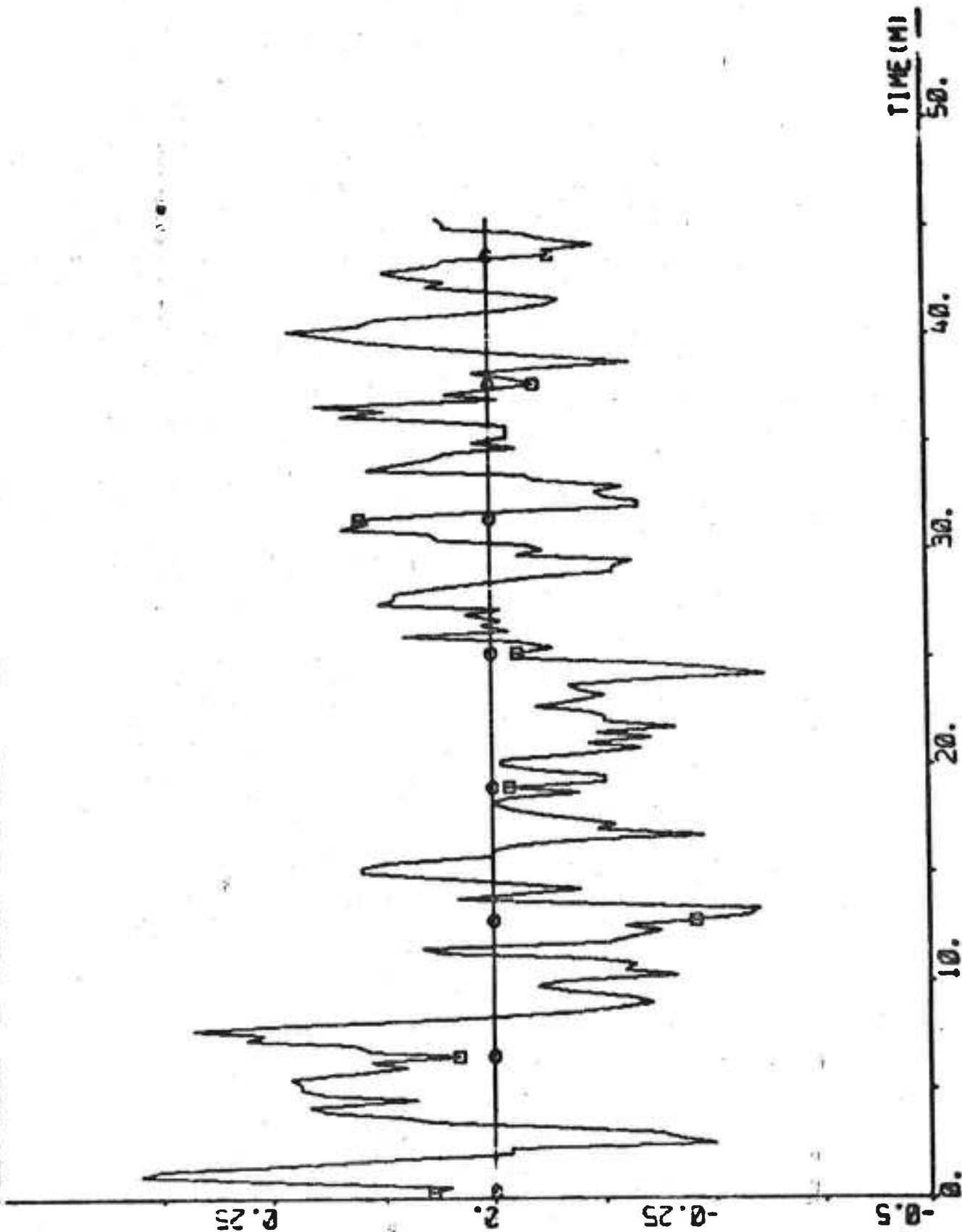


PLOT R36P1(6) 84 88 "AN RPH



2

PLOT A36P1(9) ZERO -0.5 0.5 "V2 KNOTS



PLOT A36PI (13 14) 206 210 °PSI PSIREF DEG

