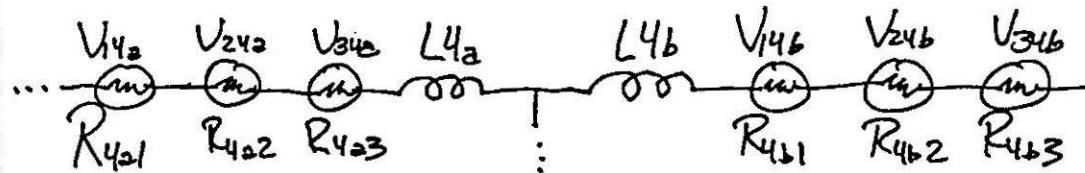
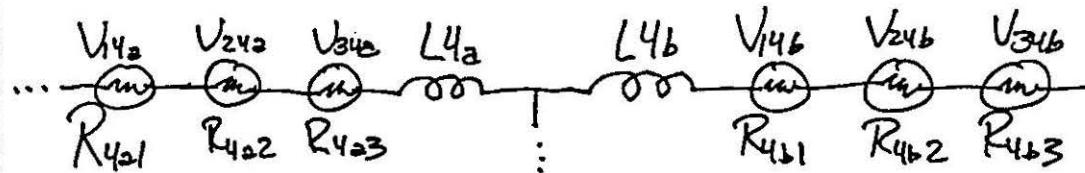
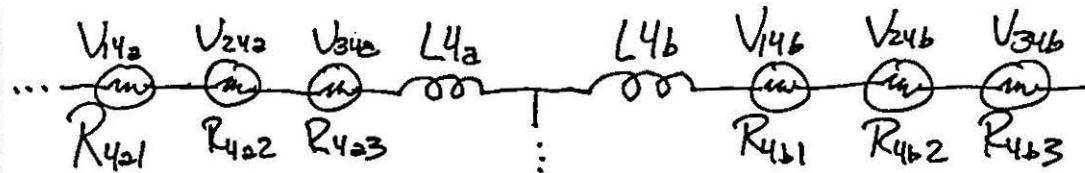
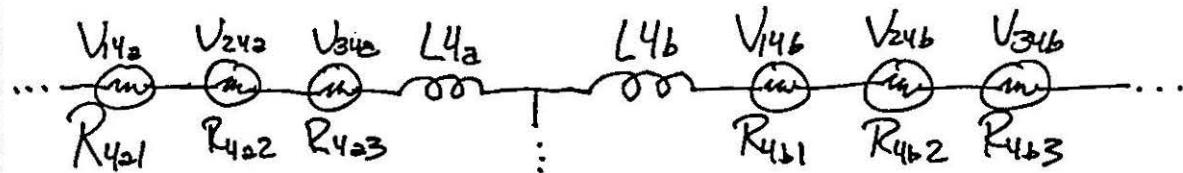
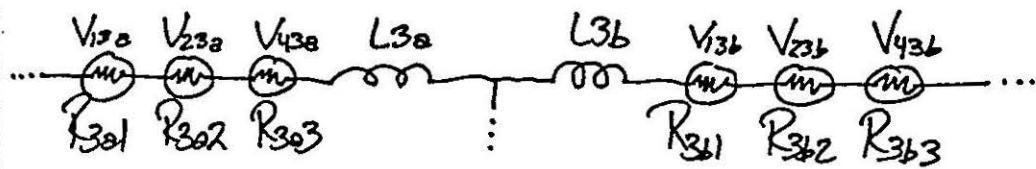
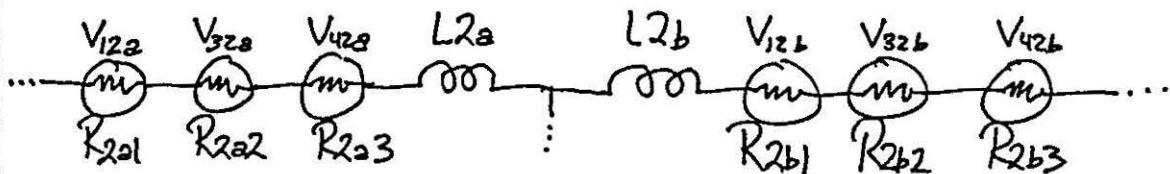
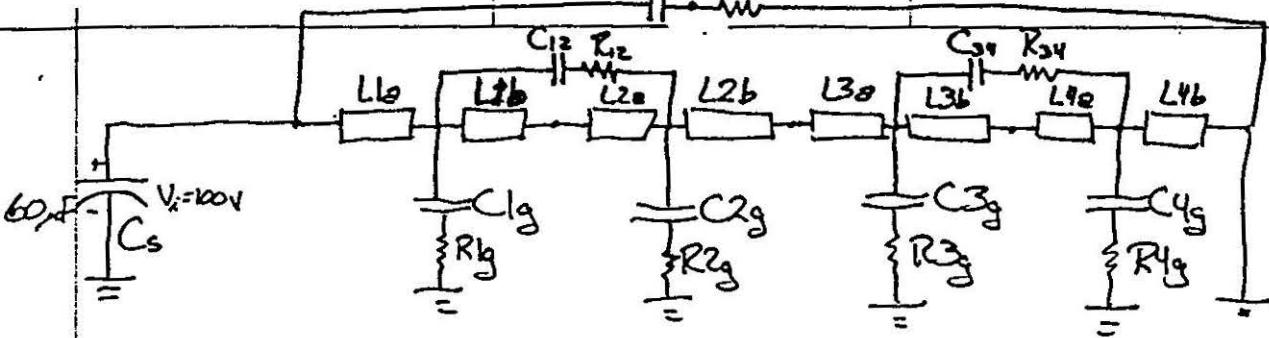


TECHNICAL NOTE

Date: 11/27/91
By: Eric Schmitz
Subject: Electrical Modelling of Magnets - Upper Inner Section
To: Wayne Koska

A 15m 50mm magnet (DC0310) was measured for values of inductance and mutual inductance between coils and then rung at 100V. Printouts of the ringing waveform were obtained. Using a circuit analysis program on the IBM PC, the magnet was electrically modelled, based on values obtained by direct measurement of the magnet. Several models were developed. A ring of each magnet model was then simulated, using the circuit analysis program, and compared to the actual result of ringing the magnet.

cc: R. Sims
L. Curry



Configuration: 1

Filenames: c50m1*.ckt

CVM1A_K.xls

COMPONENT	COIL MODEL [ECA filename: *.ckt]											
	c50m1a	c50m1b	c50m1c	c50m1d	c50m1e	c50m1f	c50m1g	c50m1h	c50m1i	c50m1j	c50m1k	
V21a,b {=.5*V:21}	0.24	0	0.24	0.24	0.024	0.048	0.072	0.096	0.096	0.096	0.096	-
V31a,b {non-dim}	0.24	0	0	0.18	0.018	0.036	0.054	0.072	0.072	0.072	0.072	-
	0.67	0	0	0.67	0.067	0.134	0.201	0.268	0.268	0.268	0.268	-
	0.86	0	0.86	0.86	0.086	0.172	0.258	0.344	0.344	0.344	0.344	-
	0.61	0	0	0.61	0.061	0.122	0.183	0.244	0.244	0.244	0.244	-
	1.75	0	0	0.64	0.064	0.128	0.192	0.256	0.256	0.256	0.256	-
	1	0	0	0.64	0.064	0.128	0.192	0.256	0.256	0.256	0.256	-
	0.68	0	0	0.68	0.068	0.136	0.204	0.272	0.272	0.272	0.272	-
	0.86	0	0.86	0.86	0.086	0.172	0.258	0.344	0.344	0.344	0.344	-
	0.67	0	0	0.67	0.067	0.134	0.201	0.268	0.268	0.268	0.268	-
	0.47	0	0	0.16	0.016	0.032	0.048	0.064	0.064	0.064	0.064	-
V34a,b	0.21	0	0.21	0.21	0.021	0.042	0.063	0.084	0.084	0.084	0.084	-
R1a,b;1,2,3 {ohms}	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0
R2a,b;1,2,3	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0
R3a,b;1,2,3	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0
R4a,b;1,2,3	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0
C1g, C4g {nF}	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	4.5	4.5	5.25	nF
C2g, C3g	25	25	25	25	25	25	25	25	9	9	10.5	nF
R1g, R2g {ohms}	100	100	100	100	100	100	100	100	85	85	75	0
R2g, R3g	100	100	100	100	100	100	100	100	85	85	75	0
C14 {nF}	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	13.5	13.5	15.25	nF
C12	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	13.5	13.5	15.25	nF
C34	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	13.5	13.5	15.25	nF
R14 {ohms}	100	100	100	100	100	100	100	100	85	85	75	0
R12	100	100	100	100	100	100	100	100	85	85	75	0
R34	100	100	100	100	100	100	100	100	85	85	75	0
L1a,b {=.5*L1} {uH}	499	499	499	499	499	499	499	499	499	499	499	uH
L2a,b	1801	1801	1801	1801	1801	1801	1801	1801	1801	1801	1801	uH
L3a,b	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	2005	uH
L4a,b	499	499	499	499	499	499	499	499	499	499	499	uH
L1 {uH}	998	998	998	998	998	998	998	998	998	998	998	uH
L2	3601	3601	3601	3601	3601	3601	3601	3601	3601	3601	3601	uH
L3	4010	4010	4010	4010	4010	4010	4010	4010	4010	4010	4010	uH
L4	998	998	998	998	998	998	998	998	998	998	998	uH

PROGRESSIVE DERIVATION of VALUES for COIL MODEL: C50M1*.CKT
Eric Schmitz
11/21/91

C50M1A:

Mutual Inductance- Used values obtained by direct measurement of magnet.

Inductance- likewise.

Capacitance- Used values given for 40mm coil modeling, multiplied by 1.25.

Series Resistance of Inductors- Used values measured during sizing of coils.

Series Resistance of Capacitors- Assumed a value of 100 ohms.

C50M1B:

Set all mutual inductance to zero. All other values remained the same.

C50M1C:

Included only mutual inductance between two upper coils and between two lower coils. (No M between any upper coil and any lower coil.) All other values remained the same.

C50M1D:

Included M between two upper coils, between two lower coils, between two outer coils, and between two inner coils as measured. Other values seemed unreasonably high. Estimated values of M between upper inner and lower outer, and between upper outer and lower inner. Voltage gains were estimated as follows:

V42 should be less than V12 ($V_{42} < V_{12}$), so try setting $V_{42} = .75 * V_{12}$. (V refers to voltage gain.)

likewise, $V_{13} < V_{43}$, so set $V_{13} = .75 * V_{43}$,

$V_{31} < V_{21}$, so set $V_{31} = .75 * V_{21}$,

$V_{24} < V_{34}$, so set $V_{24} = .75 * V_{34}$.

All other values remained the same.

C50M1E:

Mutual inductance (voltage gain) values set to 1/10 those of C50M1D. All other values remained unchanged.

C50M1F:

Mutual inductance (voltage gain) values set to 2/10 those of C50M1D. All other values remained unchanged.

C50M1G:

Mutual inductance (voltage gain) values set to 3/10 those of C50M1D. All other values remained unchanged.

C50M1H:

Mutual inductance (voltage gain) values set to 4/10 those of C50M1D. All other values remained unchanged.

C50M1I:

Left mutual inductance alone this time. Used capacitance values of .3 times original.

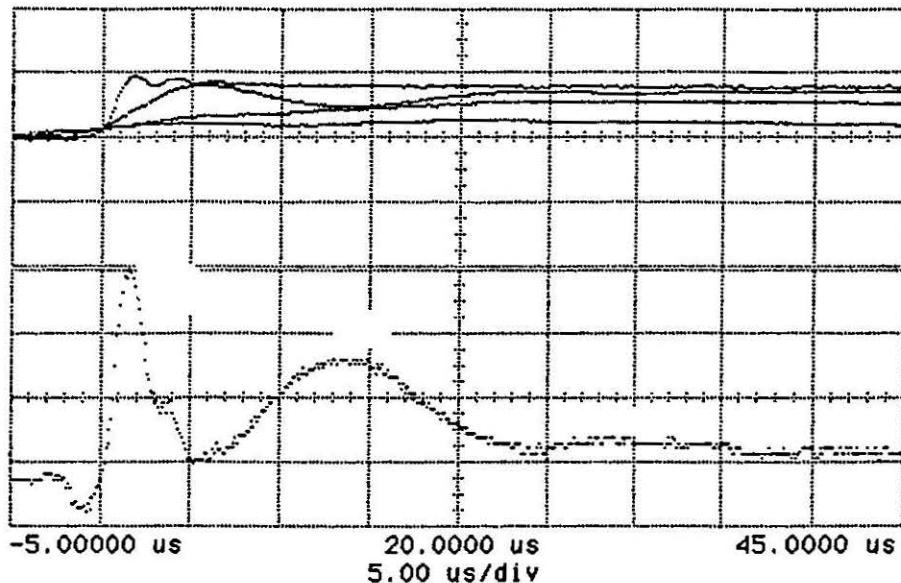
C50M1J:

Changed series resistance of capacitors to 85 ohms.

C50M1K:

Changed capacitance values to .35 times original, and dropped series resistance of capacitors to 75 ohms.

hp stopped



WAVEFORM MATH

f1 12
o *

display off on

chan 1 2 3 4
mem 1 2 3 4

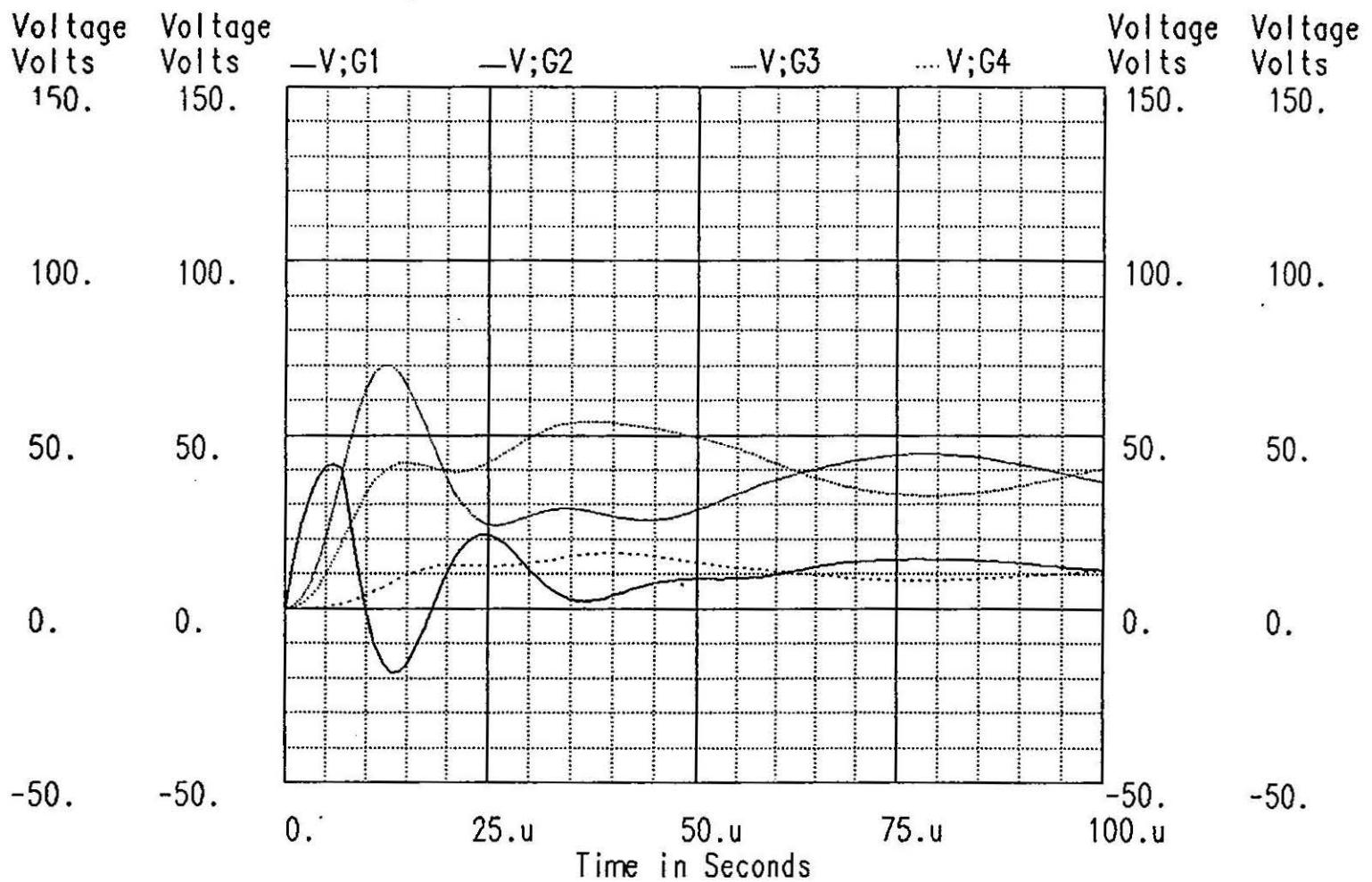
+ - x vs
only invert

chan 1 2 3 4
mem 1 2 3 4

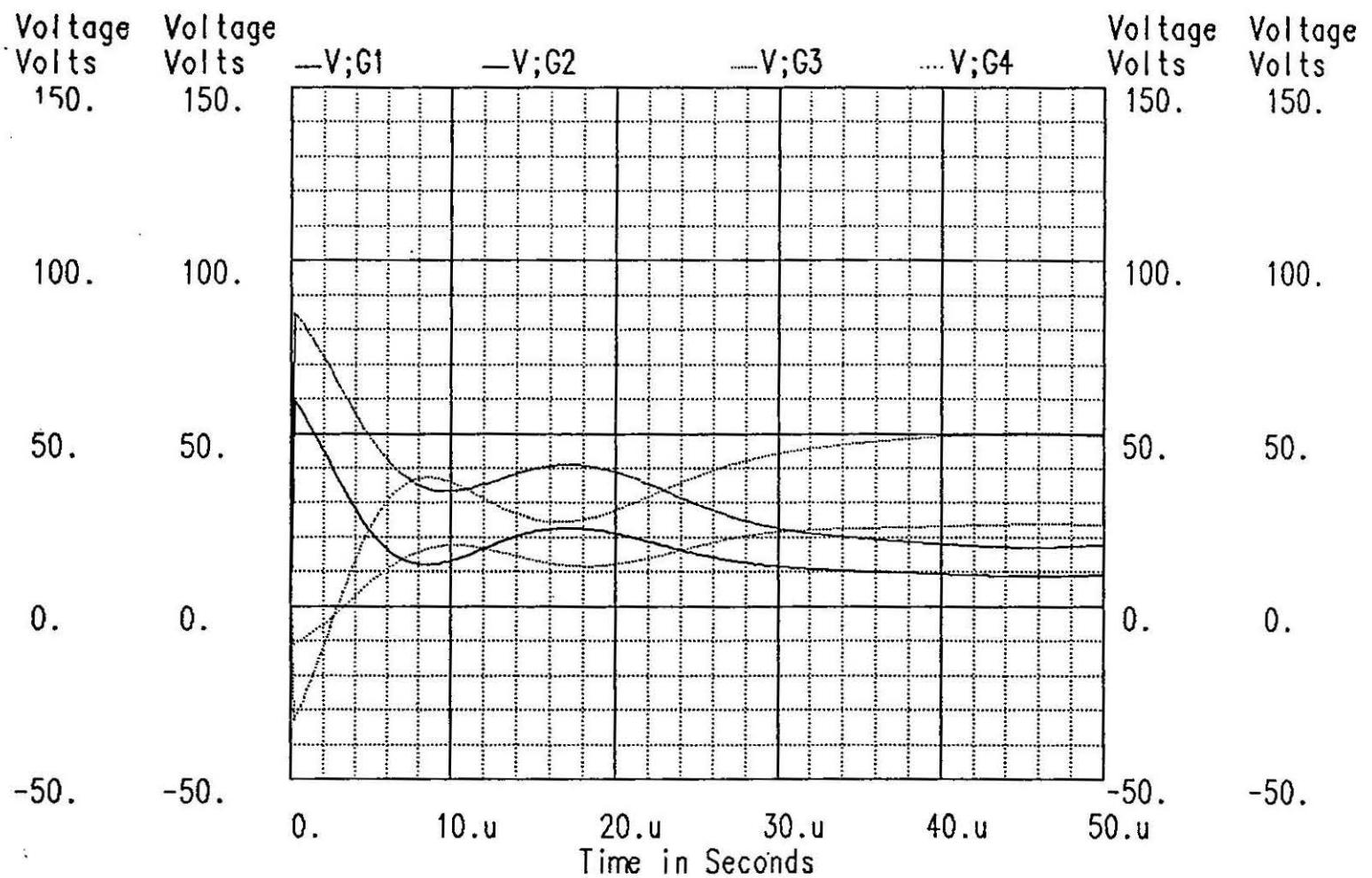
sensitivity 20.0 V/div

offset 25.0000 V

UI



c50m1bmØ (M=Ø)



c50mlc

Voltage

Volts

-V;G1

150.

100.

50.

40.

0.

-50.

0.

10.u

20.u

30.u

40.u

50.u

Time in Seconds

c50mld

UJ

$t_r = 1.5 \mu s$

Voltage
Volts

-V;G1

150.

100.

50.

0.

-50.

0.

10.u

20.u

30.u

40.u

50.u

Time in Seconds

c 50 m/s

UI

Voltage
Volts

-V;G1

150.

100.

82

50.

25

12

0.

-50.

0.

10.u

20.u

30.u

40.u

50.u

Time in Seconds

c 50 mF

UI

$t_r = 1.5 \mu s$

Voltage

Volts

-V;G1

150.

100.

85

50.

25

0.

10

-50.

0.

10.u

20.u

30.u

40.u

50.u

Time in Seconds

c50M¹e
Upper Inner
 $t_r = 1.5\mu s$

Voltage

Volts

150.

-V;G1

100.

50.

0.

-50.

0.

10.u

20.u

30.u

40.u

50.u

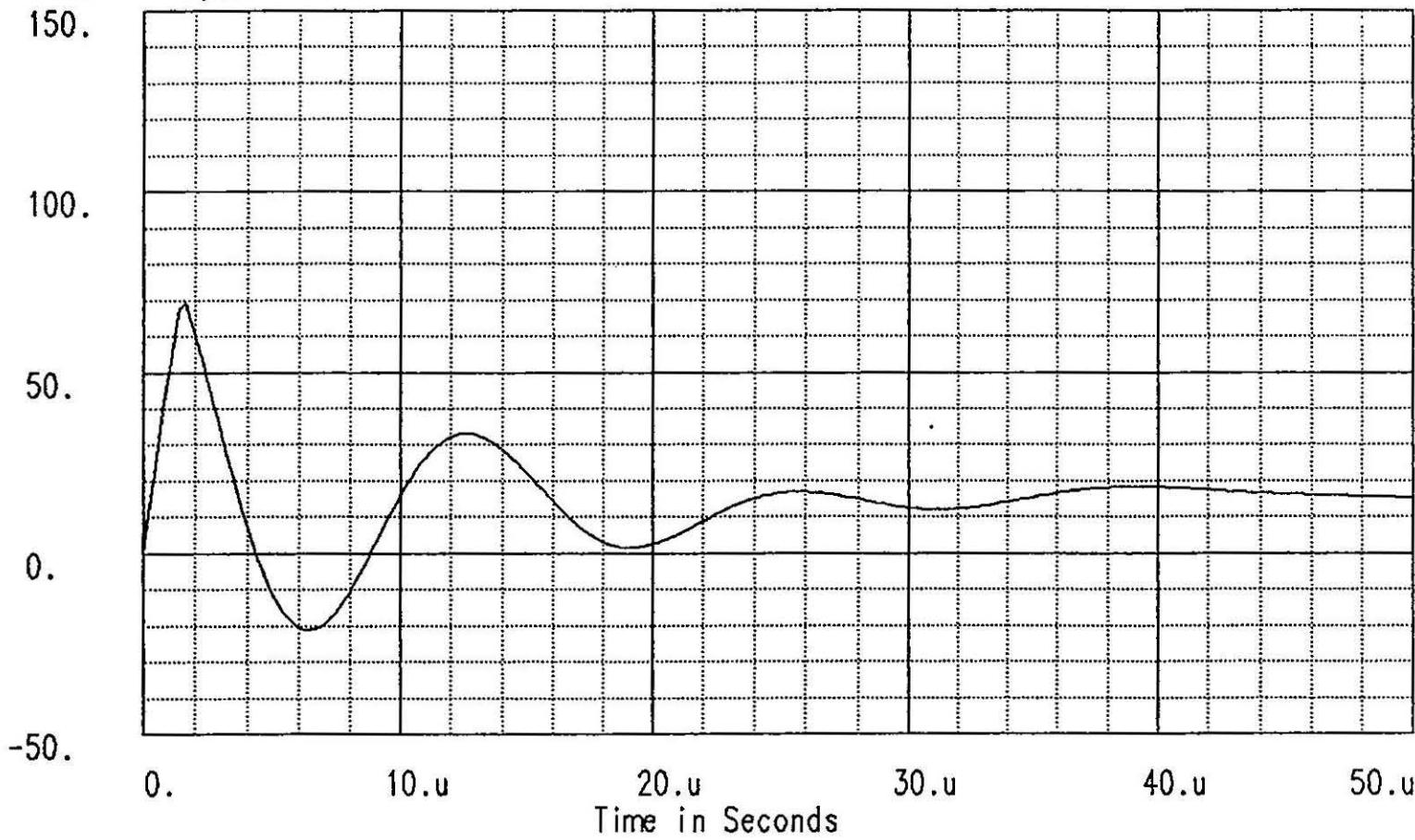
Time in Seconds

c 50m/h

uI

Voltage
Volts
150.

-V;G1



c 50ml

$$C = 3C_{c50ml}$$

Voltage
Volts

-V;G1

150.

100.

50.

0.

-50.

0.

10.u

20.u

30.u

40.u

50.u

Time in Seconds

c50mlj

$$R_c = 85\Omega$$

Voltage

Volts

-V;G1

150.

100.

50.

0.

-50.

0.

10.u

20.u

30.u

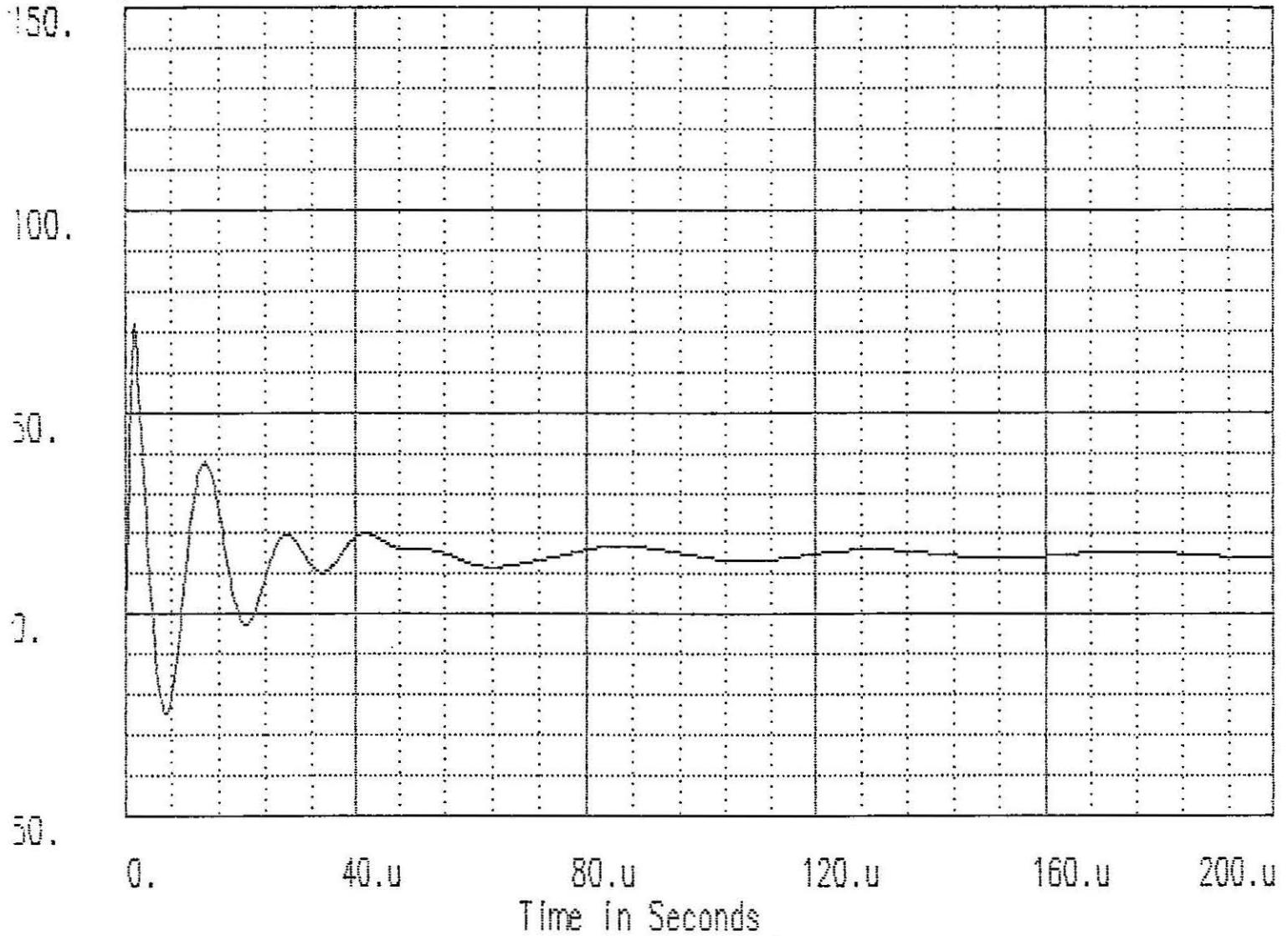
40.u

50.u

Time in Seconds

C50m^k
C = 35C_m
R = 75Ω

Scope
plots -V;G1



c 50mlk

100.

UPPER INNER - HP:C50M1D

50

0

-50

0.

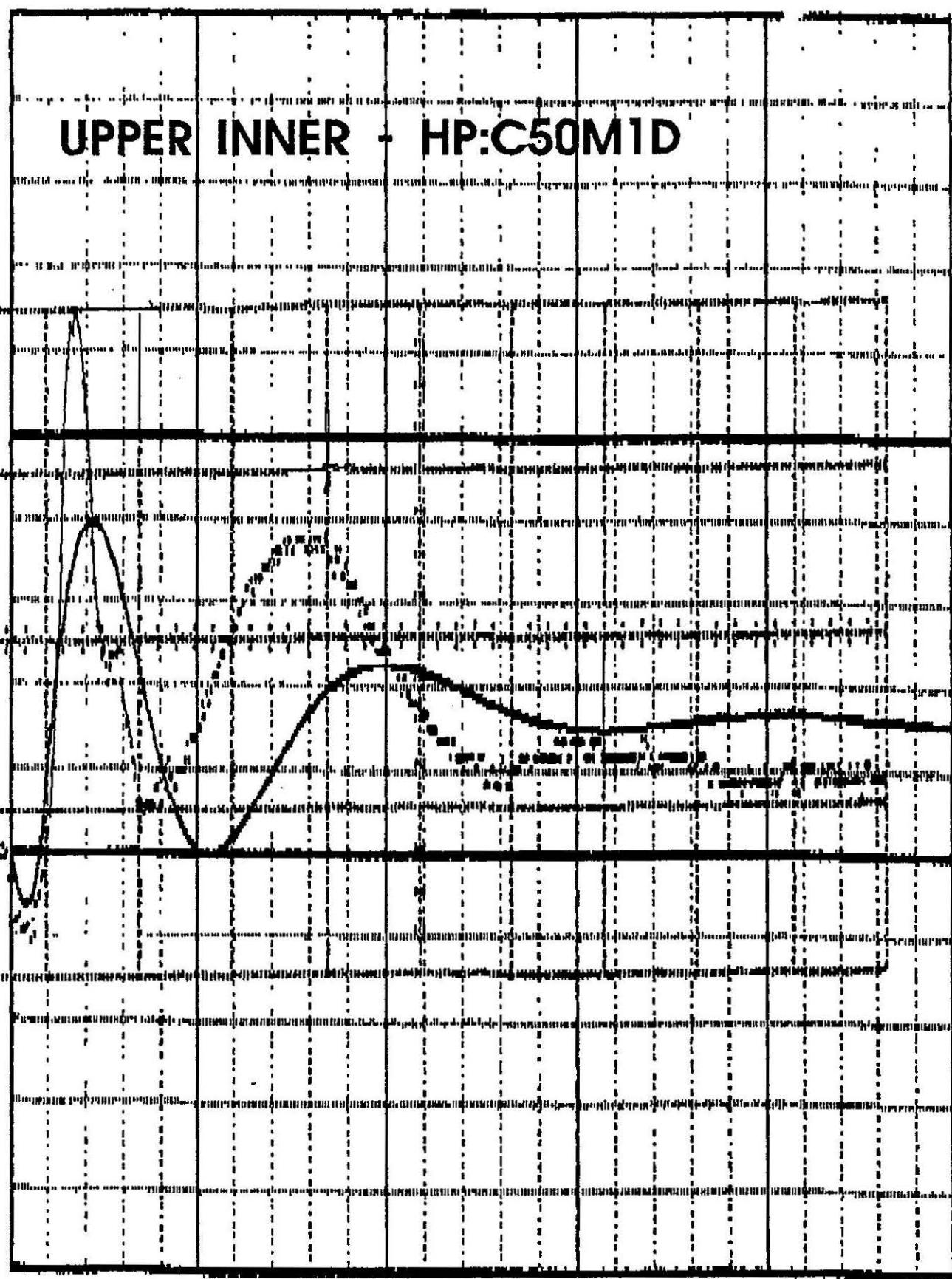
10.u

20.u

30.u

40.u

50.u



100.

UPPER INNER - HP-C50M1E

50.

25.

12.5

6.25

3.125

1.5625

0.78125

0. 10.0 20.0 30.0 40.0 50.0

100.

UPPER INNER - HP-C50M1F

50.

-50.

0.

10.0

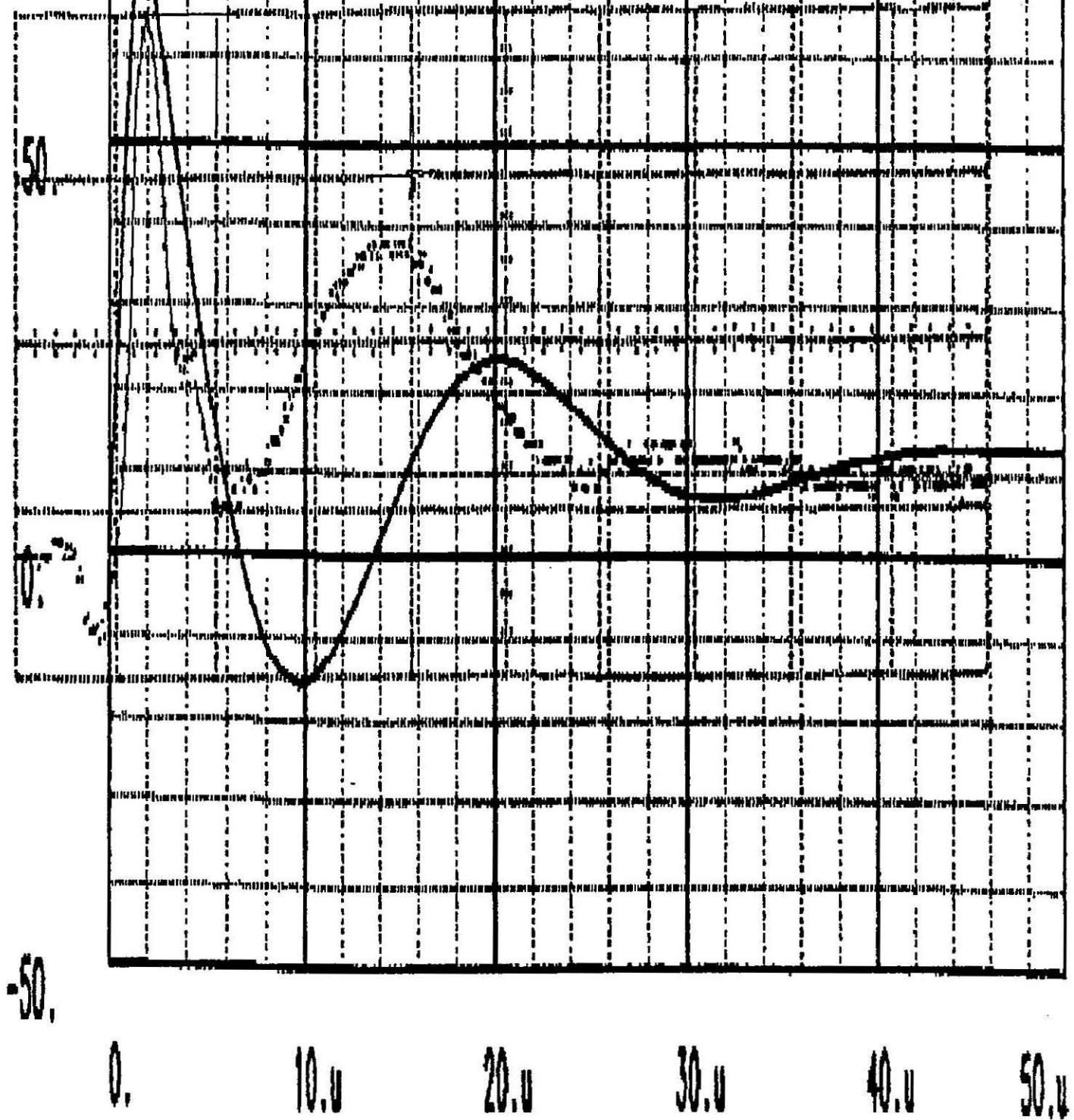
20.0

30.0

40.0

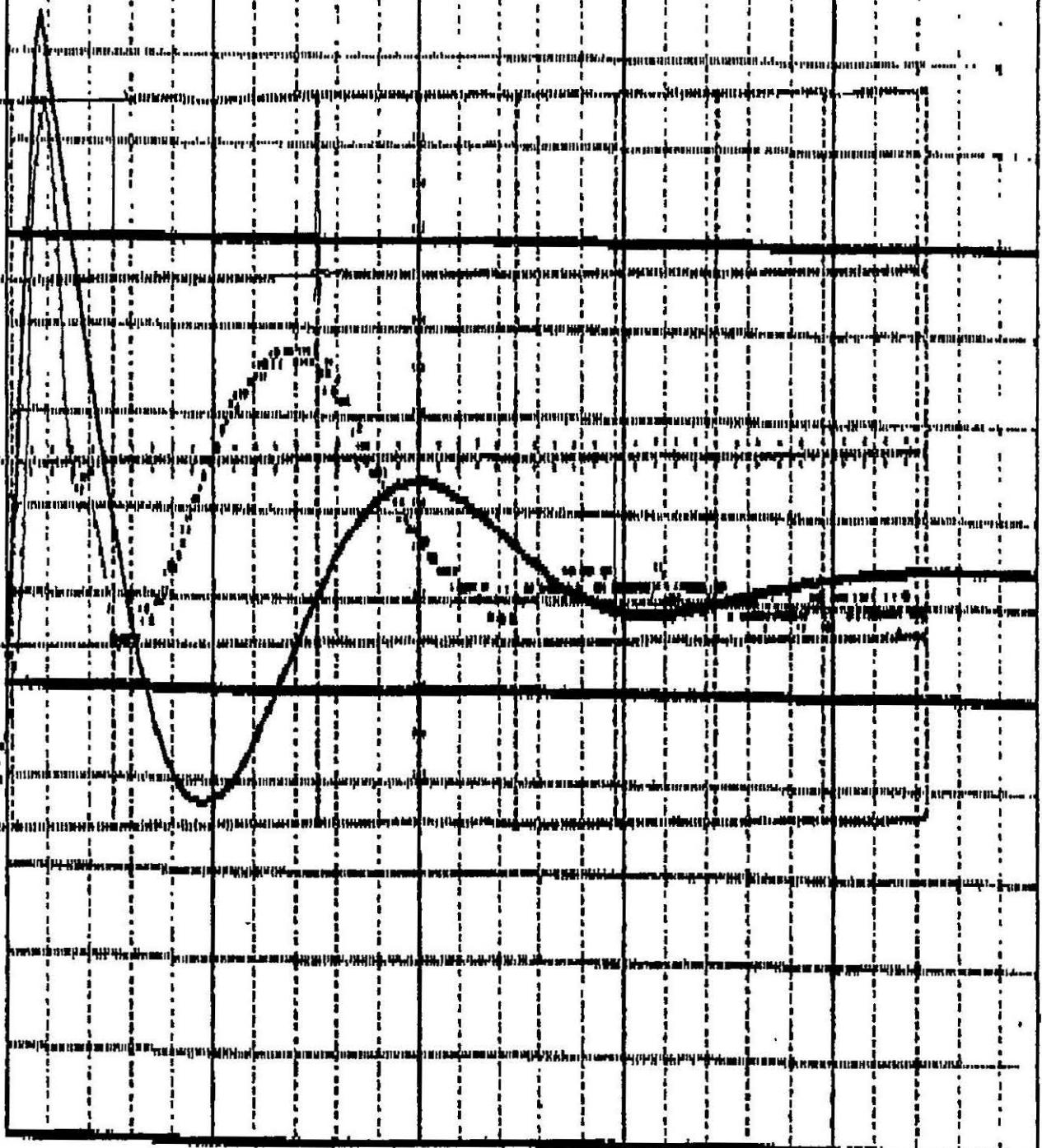
50.0

UPPER INNER - HP:CM50M1G

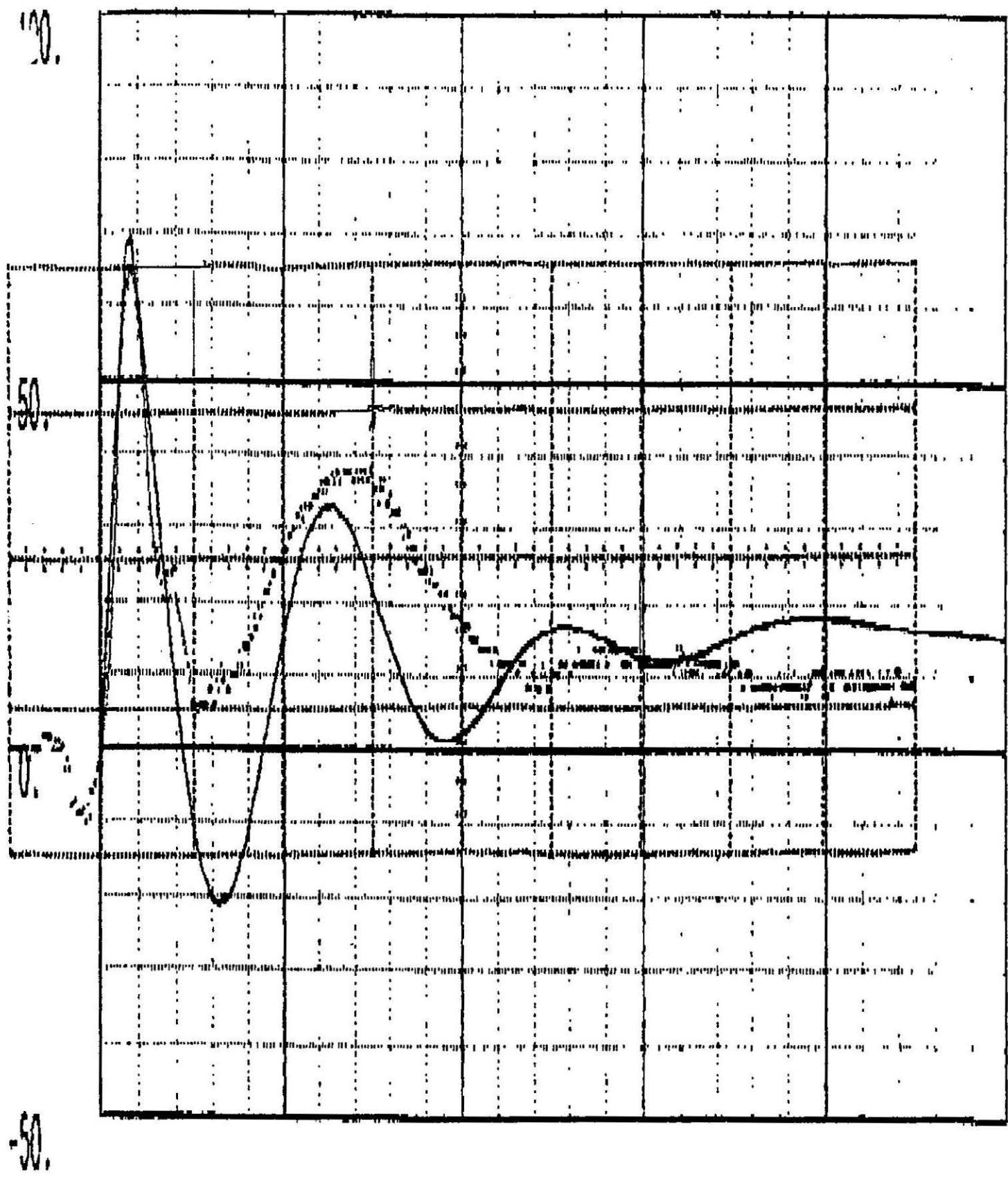


100.
50.
-50.

UPPER INNER - HPC50M1H

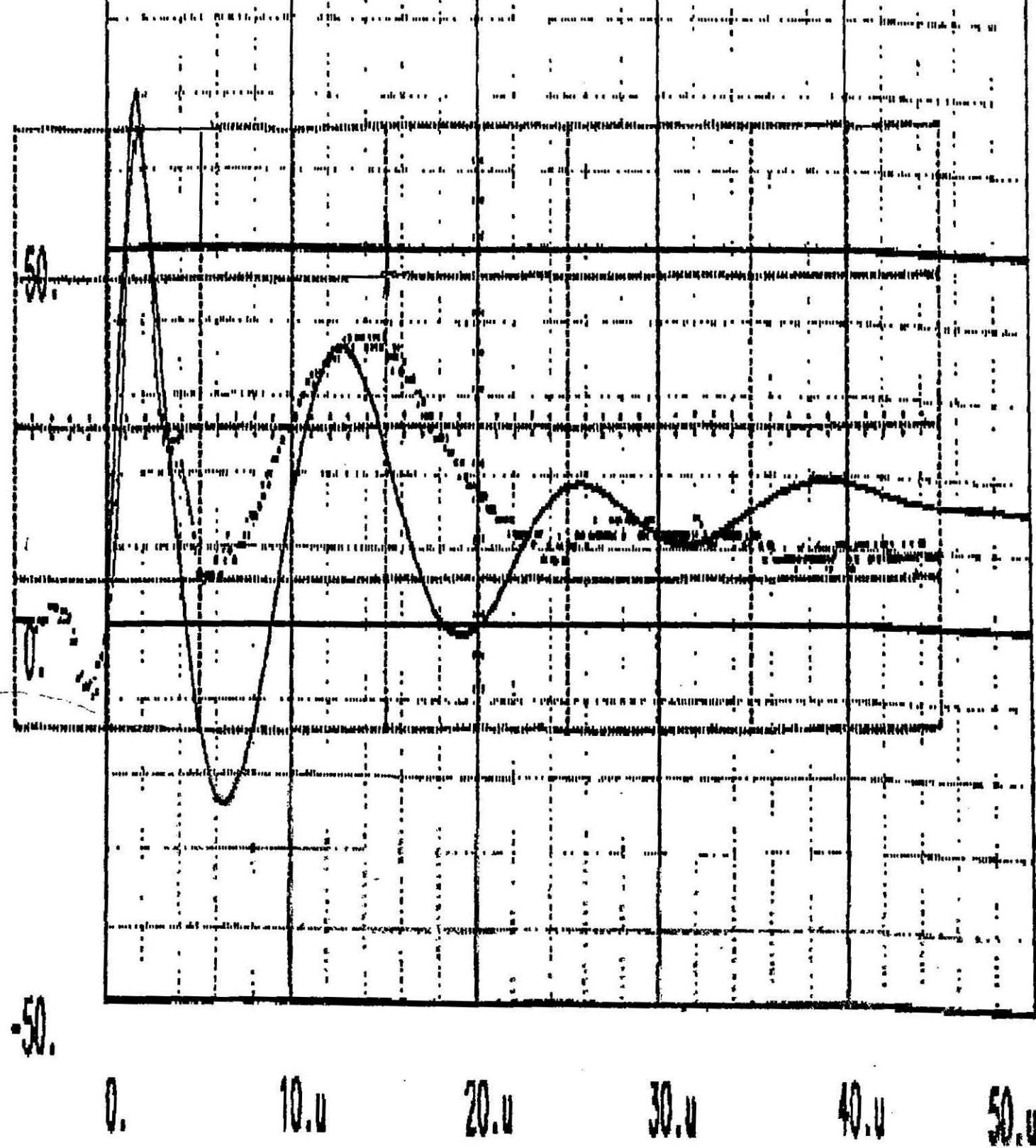


0. 10. 20. 30. 40. 50.



0. 10. 20. 30. 40. 50.
uI c50mI

100. UPPER INNER - HP:C50M1J



UPPER INNER - HP:C50M1K

