Sun Microsystems, Inc.
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Mountain View, CA 94045
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T10 97-281 r0

November 18, 1997

John Lohmeyer
Chairman, T10
4420 ArrowsWest Drive
Colorado Springs, CO 80907-3444

Subject: Passive Lumped Capacitance Compensation on SCSI Signal Lines

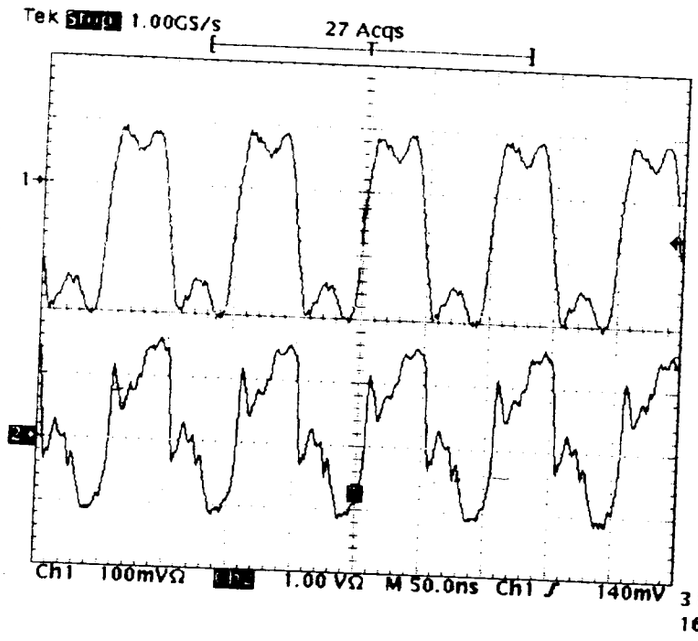
Dear Mr. Lohmeyer:

Here are the slides I use to explain how the passive electrical compensation on the SCSI bus signal lines works.The simulations were run for the Fast-20 SCSI environment but the results and methodology could be generally used on high speed buses for both the single ended and differential applications.

Sincerely,

Vit F. Novak
Sun Microsystems

3/3/97

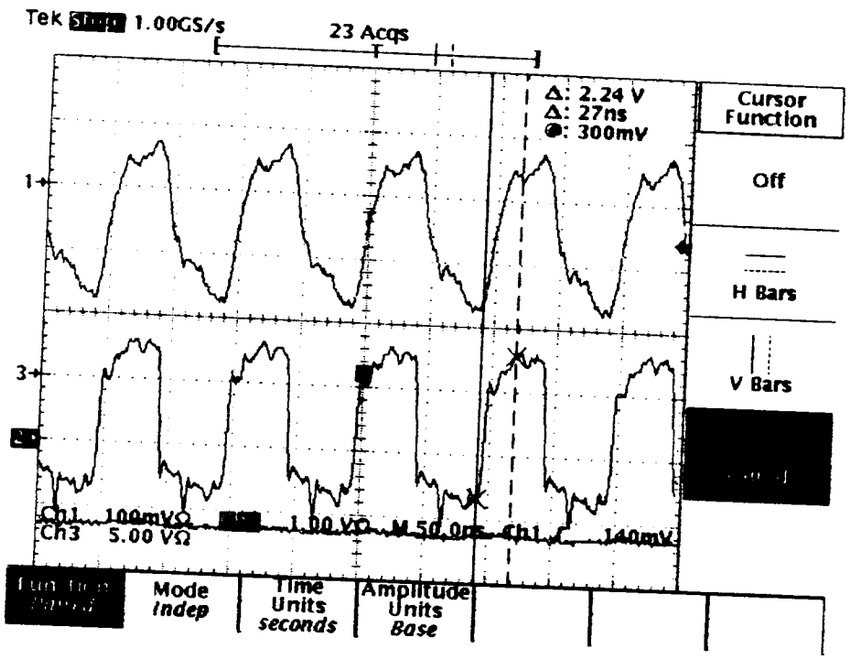


REQ

ACK

no term.

3/4/97



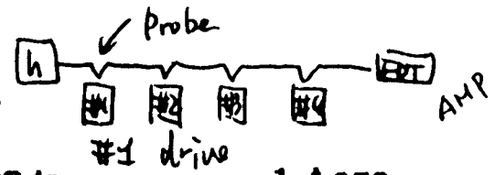
REQ

ACK

comp CR

no term

② 5/23 Write.



4x BP1 B-9 w/FPT (90Ω Cable).

Parity Err · Host detected

Tek Stop 1.00GS/s 1 Acqs

Δ: 12.5ns
@: 26.0ns

ACK.

DB12

DB0

DBP1

DPP0

Ch1 1.00 VΩ Ch2 1.00 VΩ M 25.0ns Glitch Ch3
Ch3 1.00 VΩ

23 May 1997
13:37:34

High → Low
1.2 ± 300mV

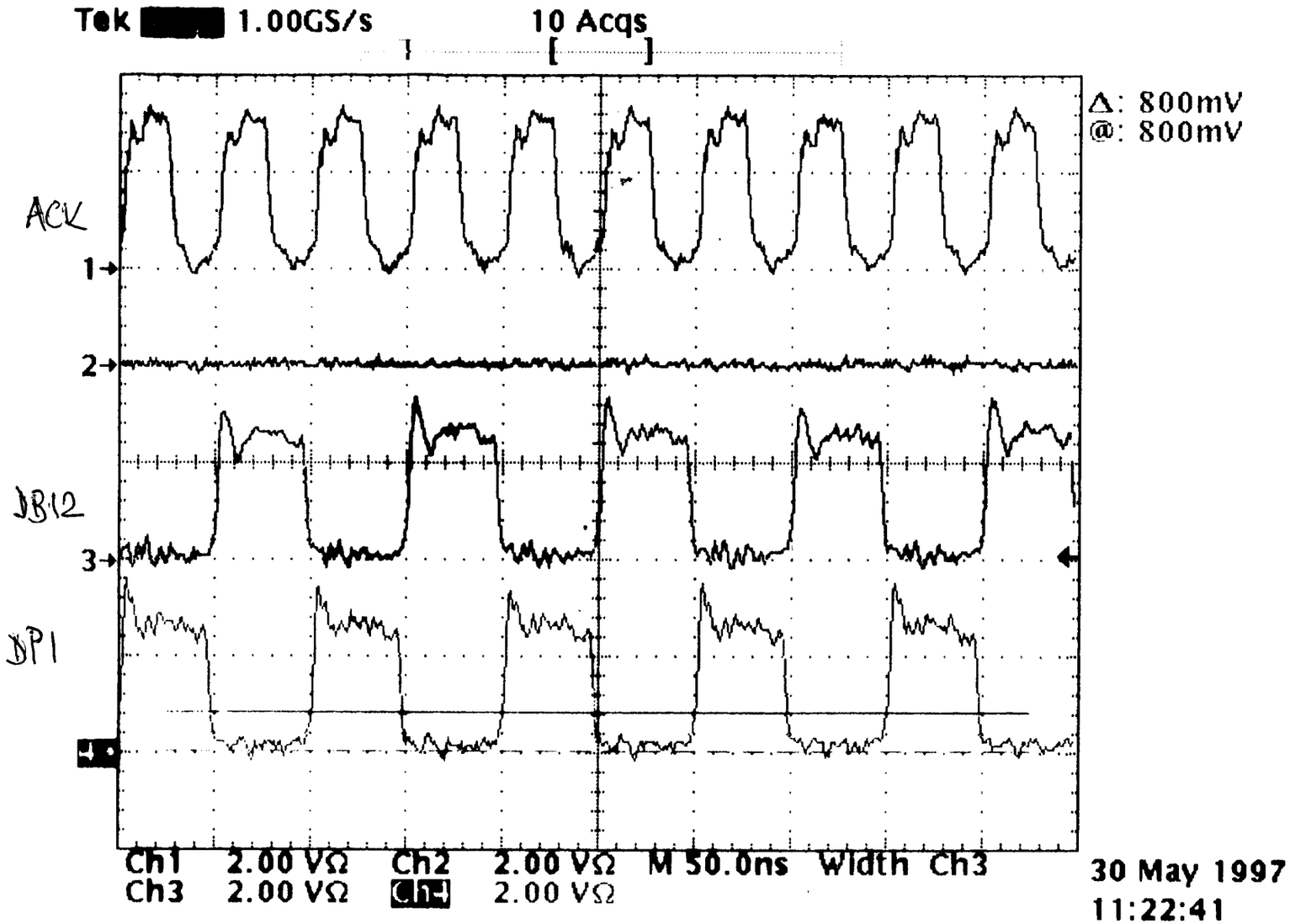
Low → High
1.6 ± 300mV.

B-9 (9G) : 08-47-A1 (1回)
reduce speed (99年式) → 5MB/s, Narrow 33

(4G) : reduce speed . (1回) → 10MB/s

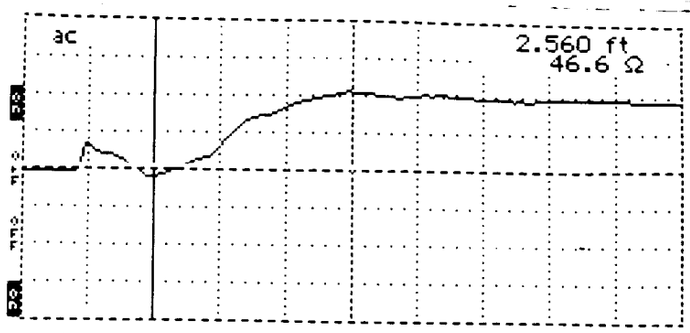
. Transfer Err
P-Err
(B-4G)

4x BP1



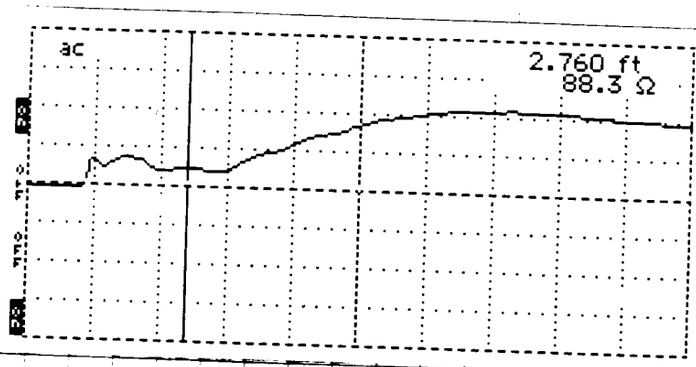
4 compensated BP1

Cursor ..... 2.560 ft
Distance/Div..... 0.5 ft/div
Vertical Scale.... 500 mρ/div
Vp 0.44
Noise Filter..... 1 ave
Power..... ac



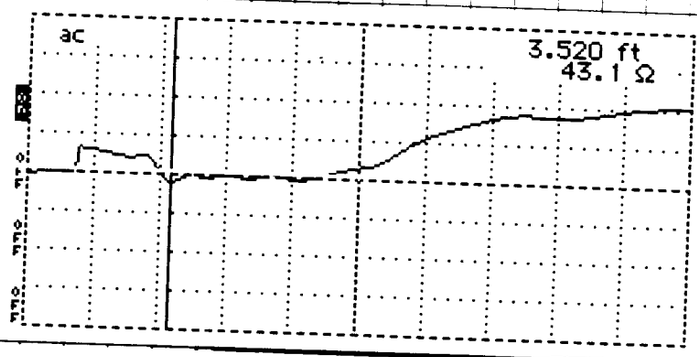
Tektronix 1502B TDR
Date 6/19/96
Cable
Notes not compen.
BP1 w. disk
Input Trace LD
Stored Trace
Difference Trace

Cursor ..... 2.760 ft
Distance/Div..... 0.5 ft/div
Vertical Scale.... 500 mρ/div
Vp 0.44
Noise Filter..... 1 ave
Power..... ac



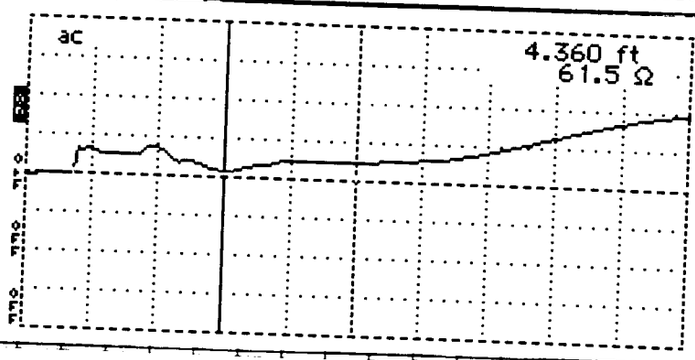
Tektronix 1502B TDR
Date 6/19/96
Cable
Notes compensated
BP1 w. disk
Input Trace REQ
Stored Trace
Difference Trace

Cursor ..... 3.520 ft
Distance/Div..... 1 ft/div
Vertical Scale.... 500 mρ/div
Vp 0.46
Noise Filter..... 1 ave
Power..... ac



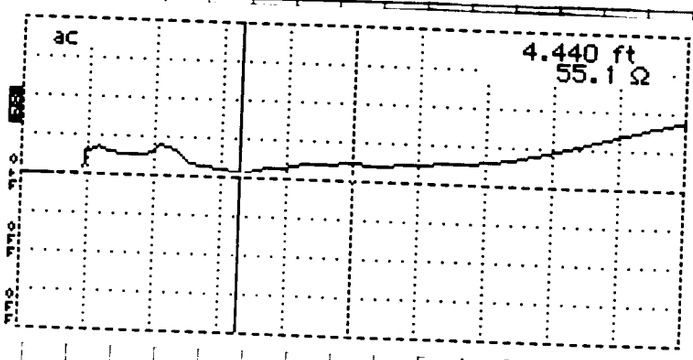
Tektronix 1502B TDR
Date
Cable
Notes non-comp.
BP 6 low C
Input Trace DB3
Stored Trace
Difference Trace

Cursor ..... 4.360 ft
Distance/Div..... 1 ft/div
Vertical Scale.... 500 mρ/div
Vp 0.46
Noise Filter..... 1 ave
Power..... ac



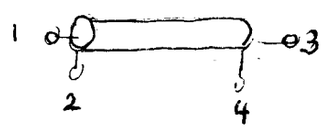
Tektronix 1502B TDR
Date 9/18/
Cable BP6
Notes comp.
low C
Input Trace DB9
Stored Trace
Difference Trace

Cursor ..... 4.440 ft
Distance/Div..... 1 ft/div
Vertical Scale.... 500 mρ/div
Vp 0.46
Noise Filter..... 1 ave
Power..... ac

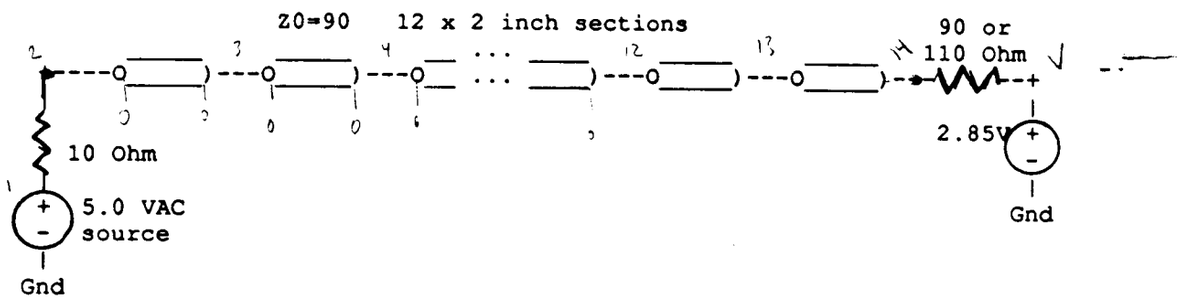


Tektronix 1502B TDR
Date
Cable BP6
Notes comp.
hi C
Input Trace DB9
Stored Trace
Difference Trace

```
term90.  SCSI 12 section, active terminated with 110 Ohms.
.options list node post
.tran 050pS 100nS

  Vin       1 0       pulse (0 5.0 7.5nS 5nS 5nS 45nS 100nS)
  Rin       1 2       10
  Tline01  02 0 03 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline02  03 0 04 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline03  04 0 05 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline04  05 0 06 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline05  06 0 07 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline06  07 0 08 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline07  08 0 09 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline08  09 0 10 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline09  10 0 11 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline10  11 0 12 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline11  12 0 13 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Tline12  13 0 14 0  Z0=90 td='.17nS*02'      $  2 inches of 90 Ohm line.
  Rout     14 V       90
  Vterm     V 0       DC=2.85

.print tran (1)
.end
```



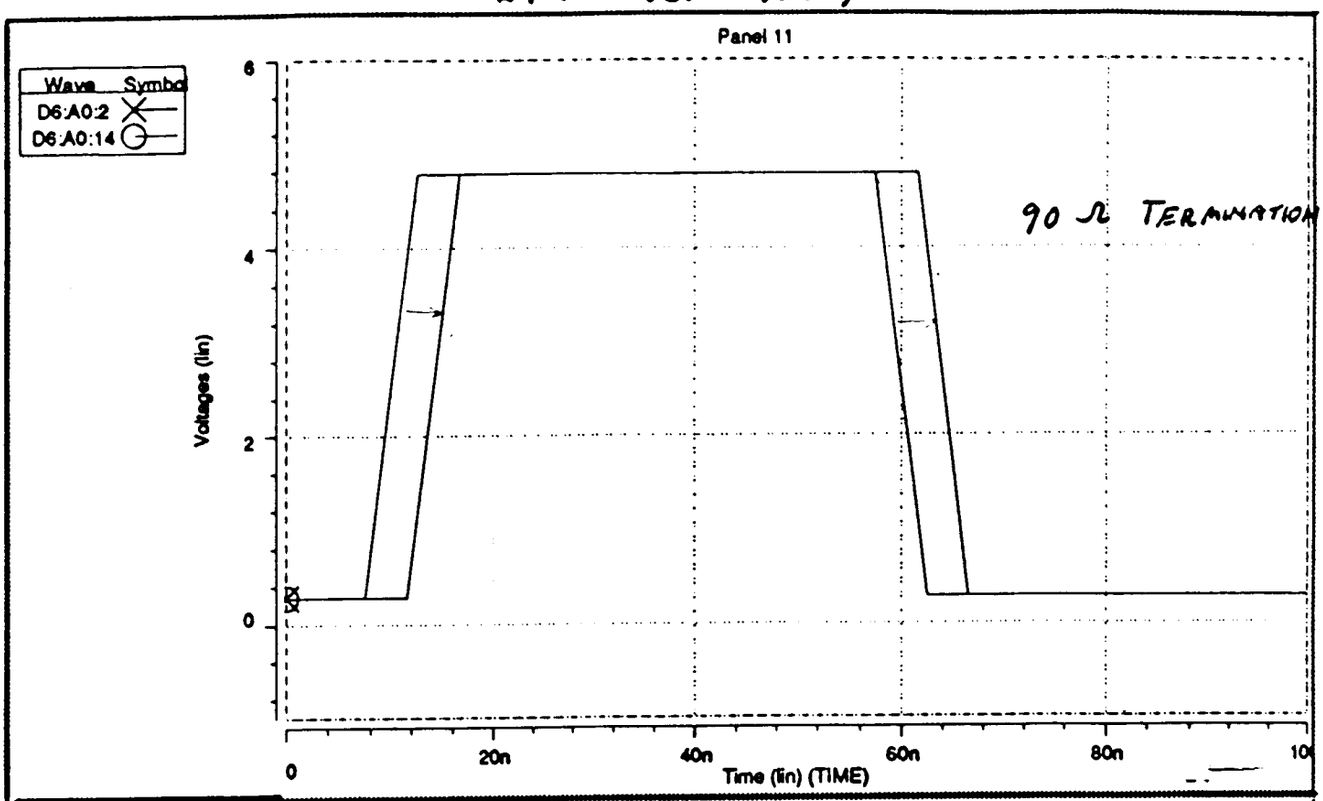
Active Termination

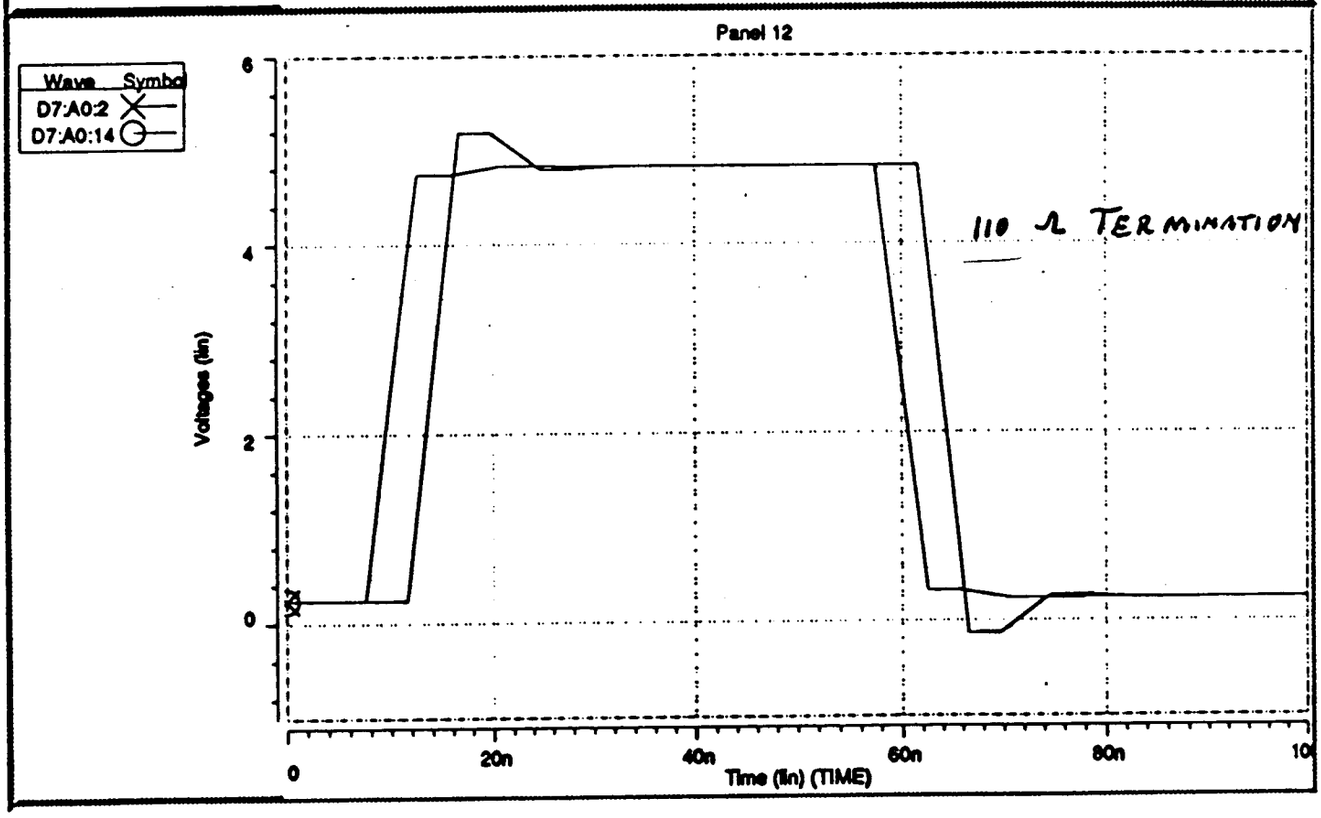


SCSI Bus With 12 Loads.

L. D. Smith
6/4/96

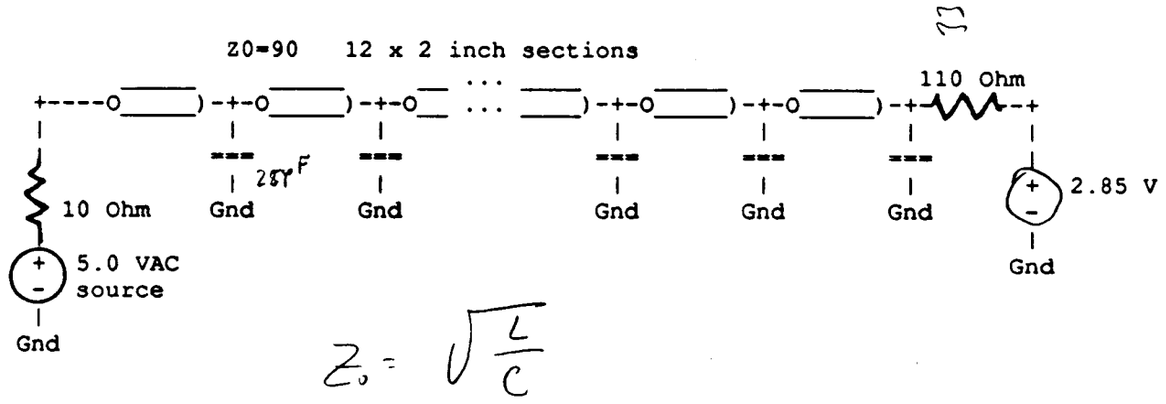
24 INCH SCSI BUS, NO LOADS





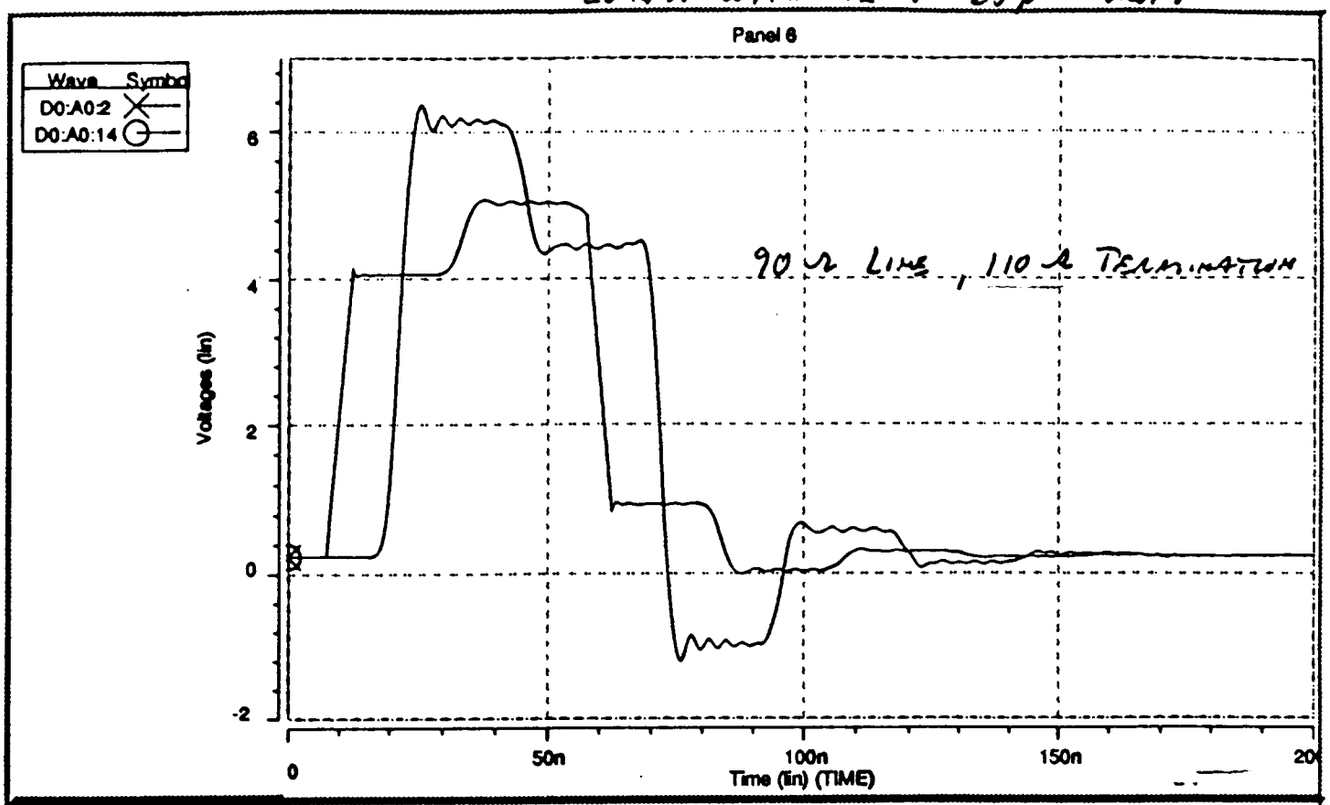
```
loaded110.sp.  Loaded with 25pF drops every 2 inches.
.options list node post
.tran 050pS 200nS

  Vin       1 0       pulse (0 5.0 7.5nS 5nS 5nS 45nS 200nS)
  Rin       1 2       10
  Tline01 02 0 03 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline02 03 0 04 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline03 04 0 05 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline04 05 0 06 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline05 06 0 07 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline06 07 0 08 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline07 08 0 09 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline08 09 0 10 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline09 10 0 11 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline10 11 0 12 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline11 12 0 13 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  Tline12 13 0 14 0 Z0=90 td='.17nS*02'       $  2 inches of 90 Ohm line.
  C03       03 0      25pF
  C04       04 0      25pF
  C05       05 0      25pF
  C06       06 0      25pF
  C07       07 0      25pF
  C08       08 0      25pF
  C09       09 0      25pF
  C10       10 0      25pF
  C11       11 0      25pF
  C12       12 0      25pF
  C13       13 0      25pF
  C14       14 0      25pF
  Rout      14 V      110
  Vterm      V 0      DC=2.85

.print tran (1)
.end
```

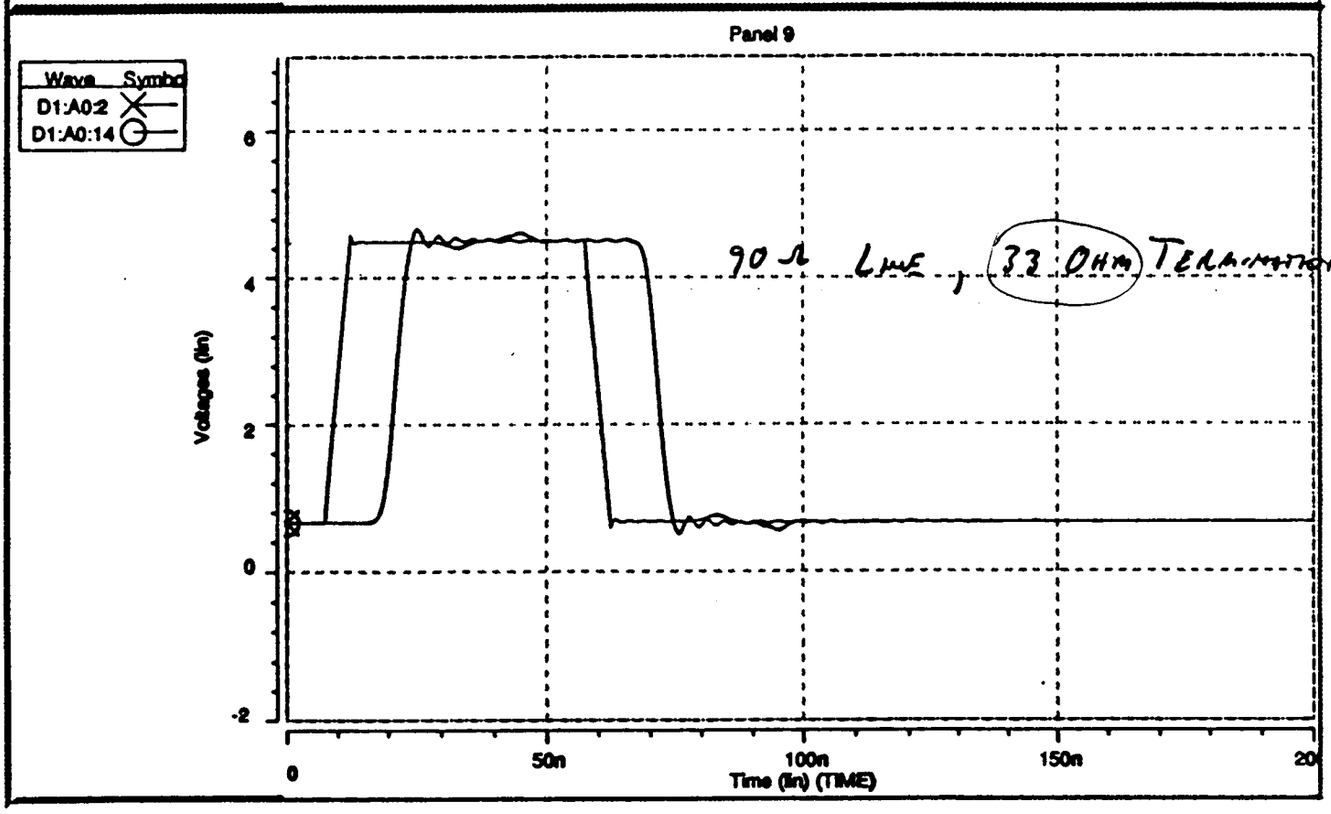
Active Termination, 25 pF loads



$Z_0 = \sqrt{\frac{L}{C}}$

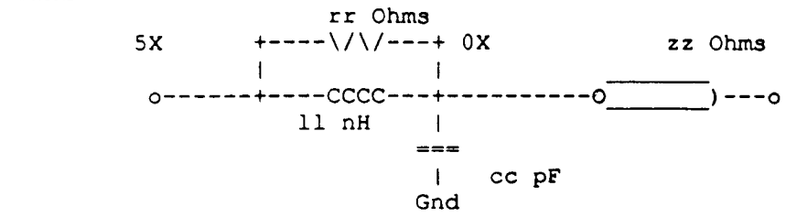
Loads With 12 x 25pF Chips

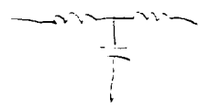


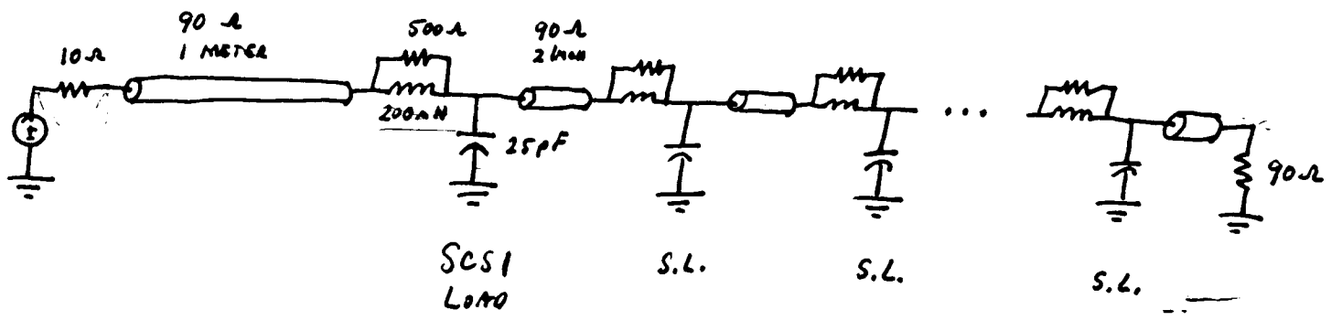


```
res.sp.  Damping resistor in parallel with inductor.
.options list node post
.tran 050pS 300nS
.param zz=90 ll=lnH cc= 25pF term=110 rr=0.001

  Vin       1 0       pulse (0 5.0 7.5nS 5nS 5nS 45nS 500nS)
  Rin       1 /in     10
  Rout   /out V       term
  Vterm     V 0       DC=2.85

  Tline0 /in 0 52 0 Z0=90 td='.17nS*39'      $ 39 inches of 90 Ohm line.
  Tline01 02 0 53 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline02 03 0 54 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline03 04 0 55 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline04 05 0 56 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline05 06 0 57 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline06 07 0 58 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline07 08 0 59 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline08 09 0 60 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline09 10 0 61 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline10 11 0 62 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline11 12 0 63 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
  Tline12 13 0 64 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.

  L02       52 02     'll/2'
  L03       53 03     ll
  L04       54 04     ll
  L05       55 05     ll
  L06       56 06     ll
  L07       57 07     ll
  L08       58 08     ll
  L09       59 09     ll
  L10       60 10     ll
  L11       61 11     ll
  L12       62 12     ll
  L13       63 13     ll
  L14       64 /out    'll/2'

  R02       02 52     rr
  R03       03 53     rr
  R04       04 54     rr
  R05       05 55     rr
  R06       06 56     rr
  R07       07 57     rr
  R08       08 58     rr
  R09       09 59     rr
  R00       10 60     rr
  R11       11 61     rr
  R12       12 62     rr
  R13       13 63     rr

  C02       02 0      cc
  C03       03 0      cc
  C04       04 0      cc
  C05       05 0      cc
  C06       06 0      cc
  C07       07 0      cc
  C08       08 0      cc
  C09       09 0      cc
  C10       10 0      cc
  C11       11 0      cc
  C12       12 0      cc
  C13       13 0      cc

.print tran (1)
```

```
.alter
.param zz=90 ll=200nH cc= 25pF term=110 rr=100k

.alter
.param zz=90 ll=200nH cc= 25pF term=90 rr=500

.end
```







$$Z_0 = \sqrt{\frac{L}{C}}$$

$$L = Z_0^2 C = (90\Omega)^2 (25pF) \doteq 200nH$$

$$\text{RESONANCE} \doteq \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{200nH \cdot 25pF}} \doteq 71\ MHz$$

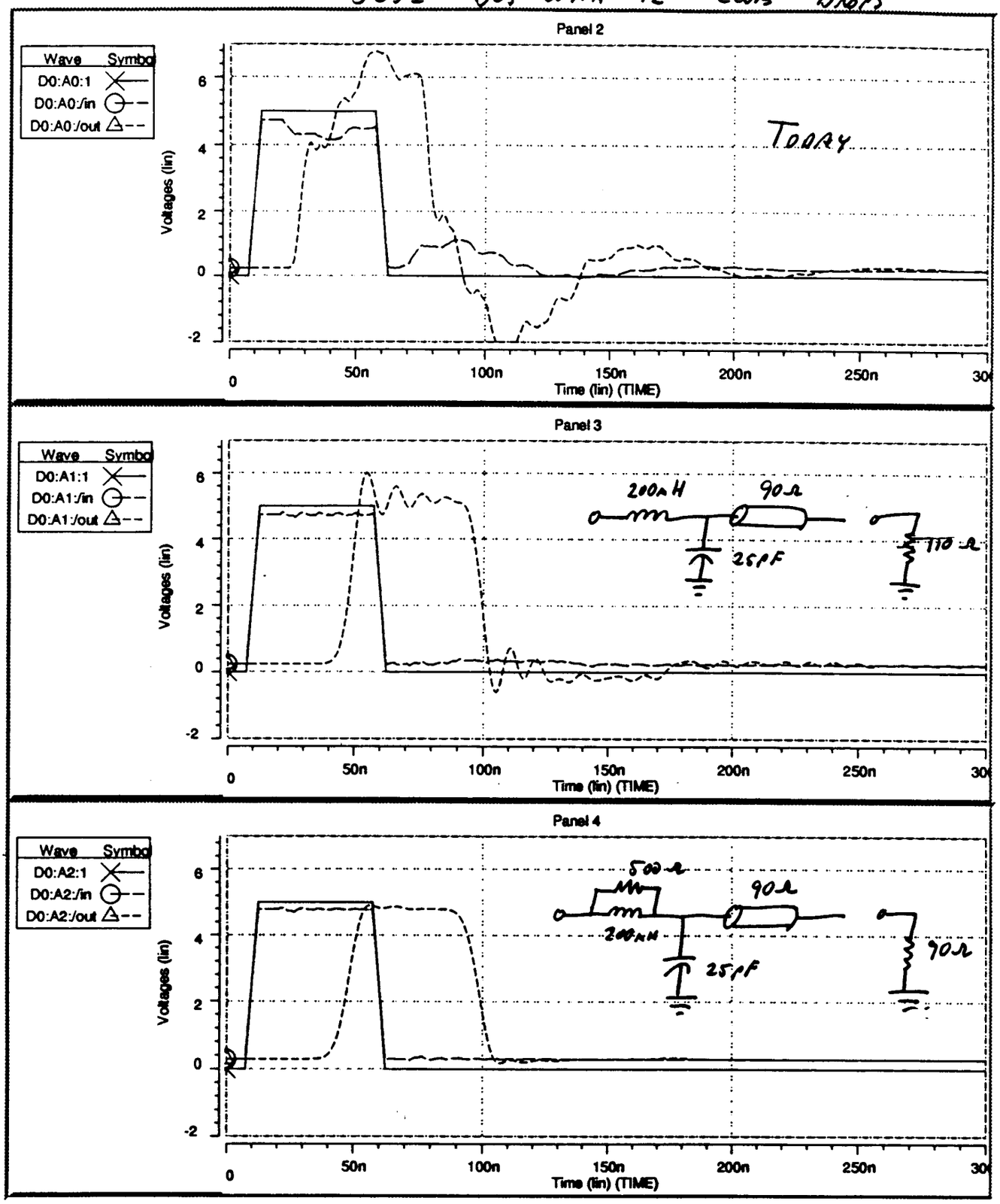
$$j\omega L\,/_{71\,MHz} = 2\pi(71\times10^6)(200nH) \doteq 90\Omega$$

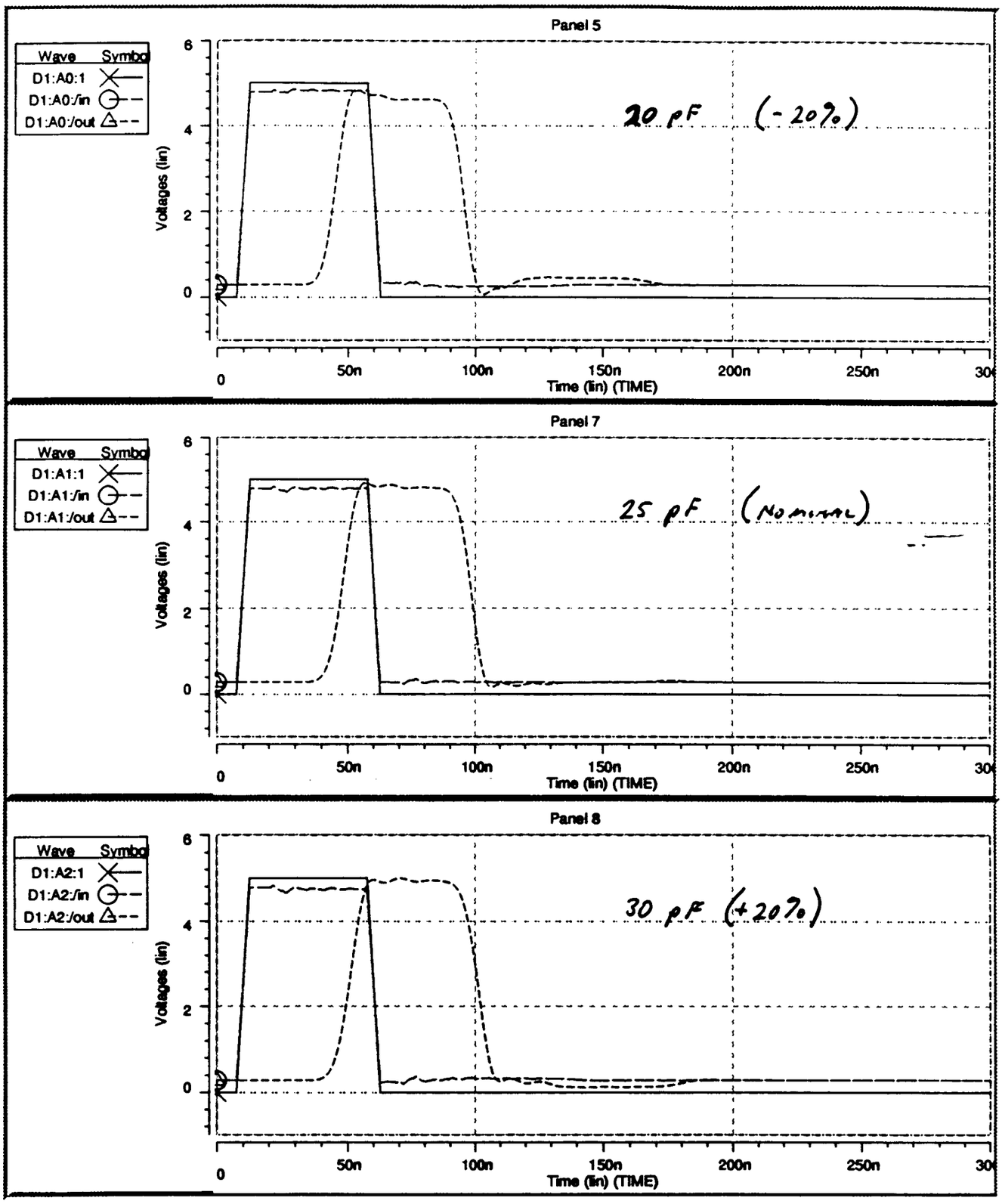
MAKE DAMPING RESISTOR APPROXIMATELY 5X INDUCTIVE REACTANCE.

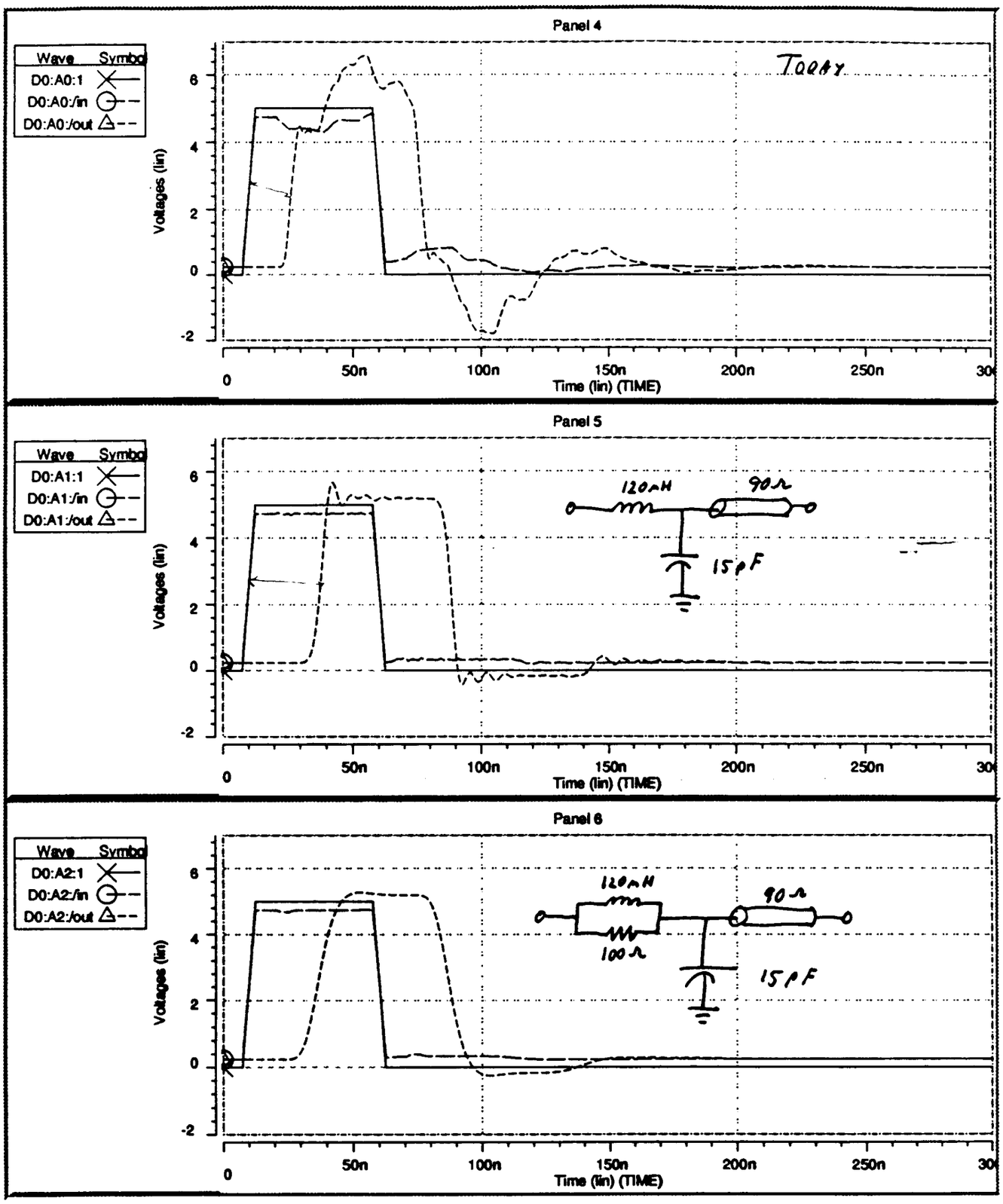
5X 90 ≐ 500 OHMS.

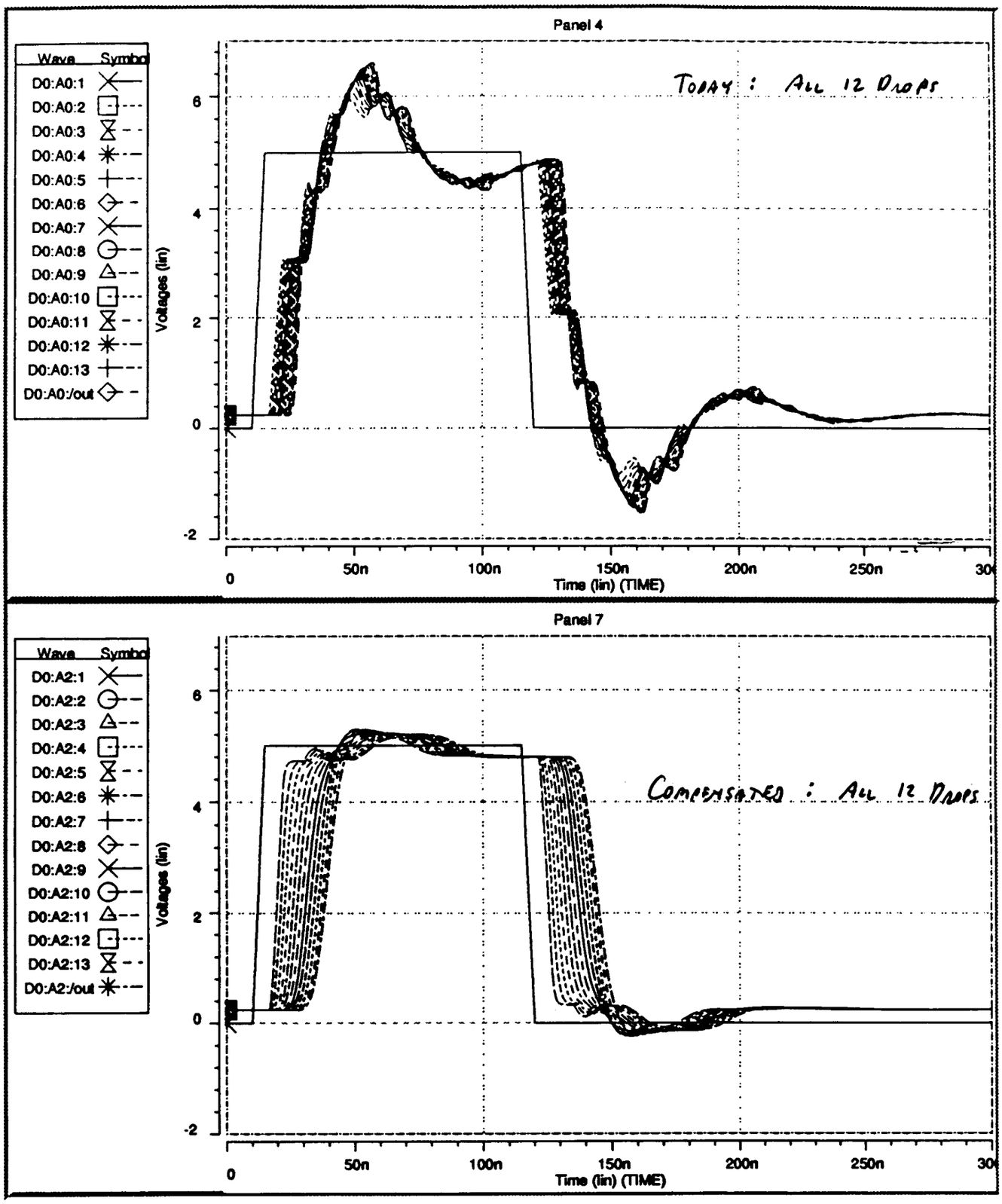
L. O. Smith 6/4/96

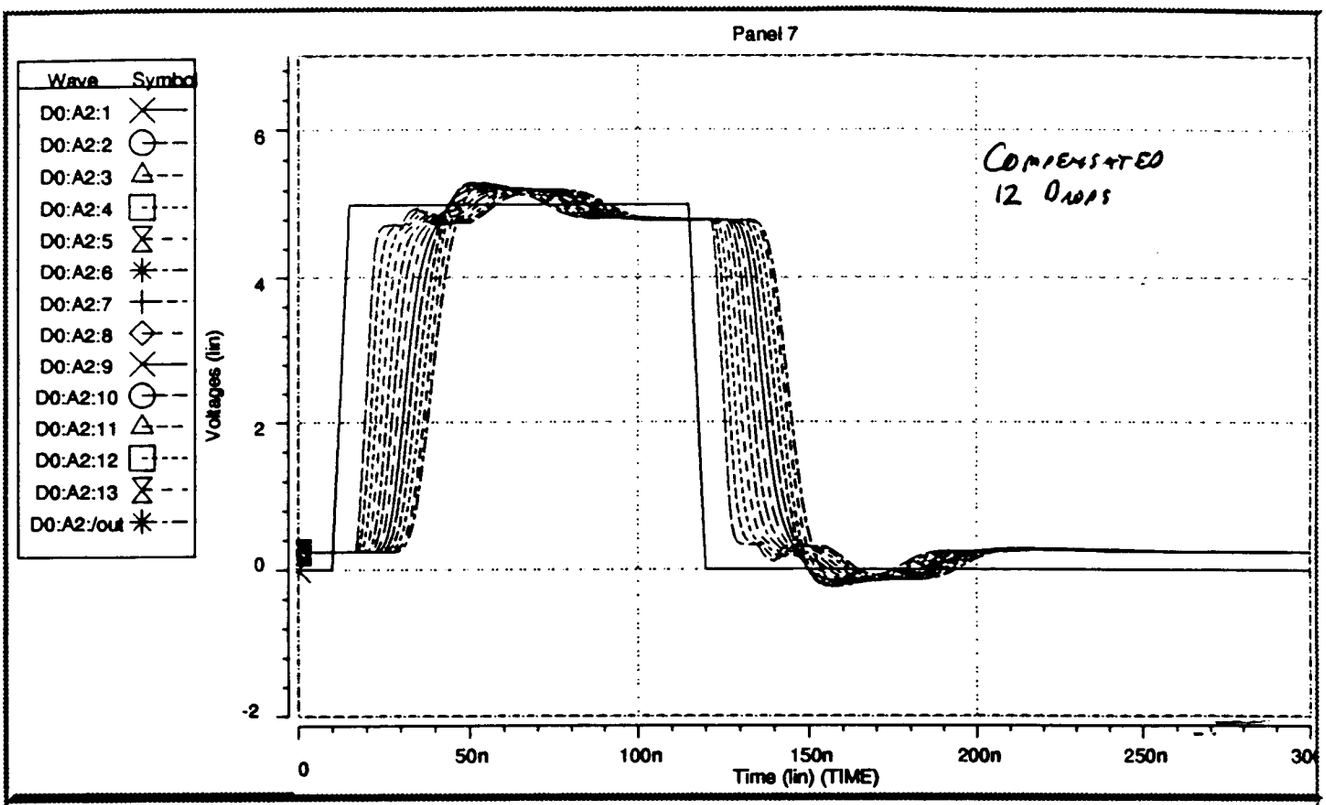
SCSI Bus With 12 "Close" Drops

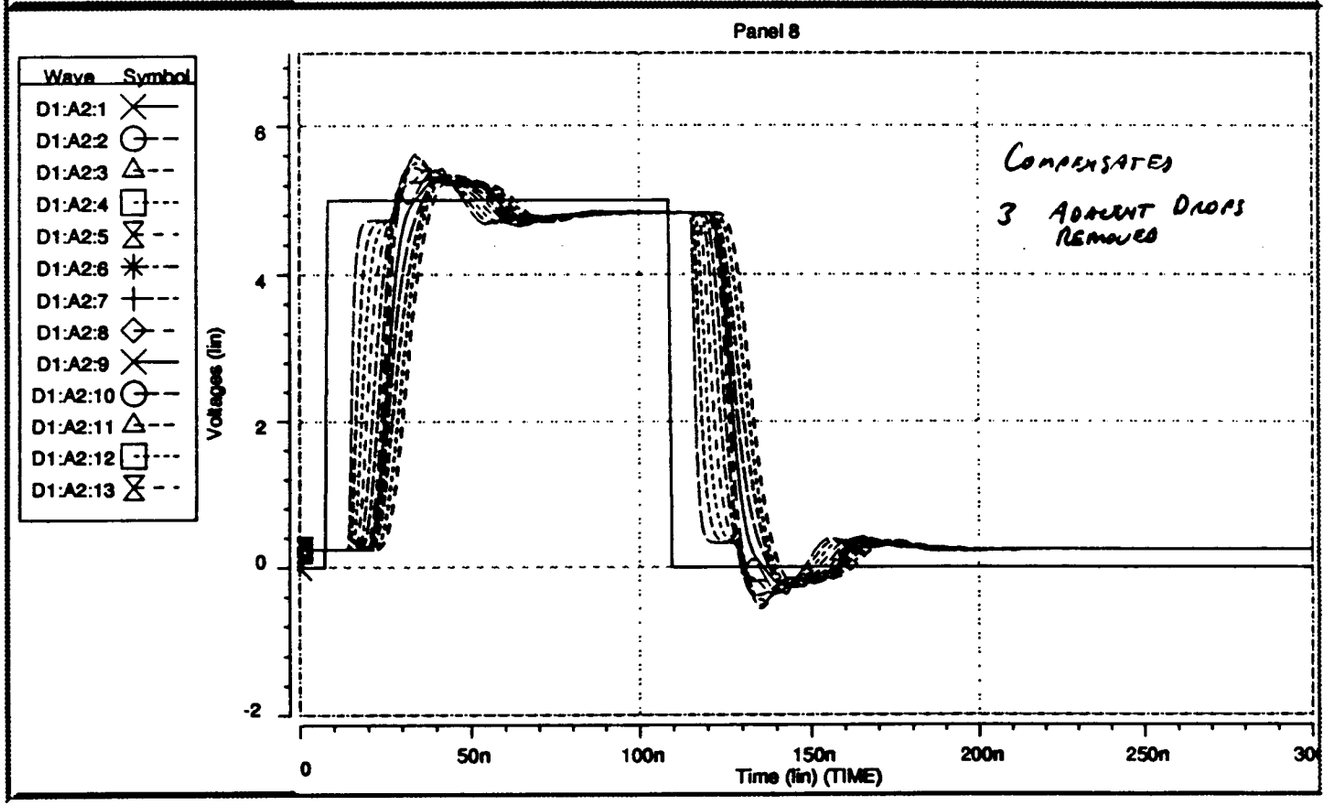



Panel 5
Wave Symbol
D1:A0:1
D1:A0:/in
D1:A0:/out
Voltages (lin)
6
4
2
0
20 pF (-20%)
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
Panel 7
Wave Symbol
D1:A1:1
D1:A1:/in
D1:A1:/out
Voltages (lin)
6
4
2
0
25 pF (Nominal)
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
Panel 8
Wave Symbol
D1:A2:1
D1:A2:/in
D1:A2:/out
Voltages (lin)
6
4
2
0
30 pF (+20%)
0
50n
100n
150n
200n
250n
Time (lin) (TIME)

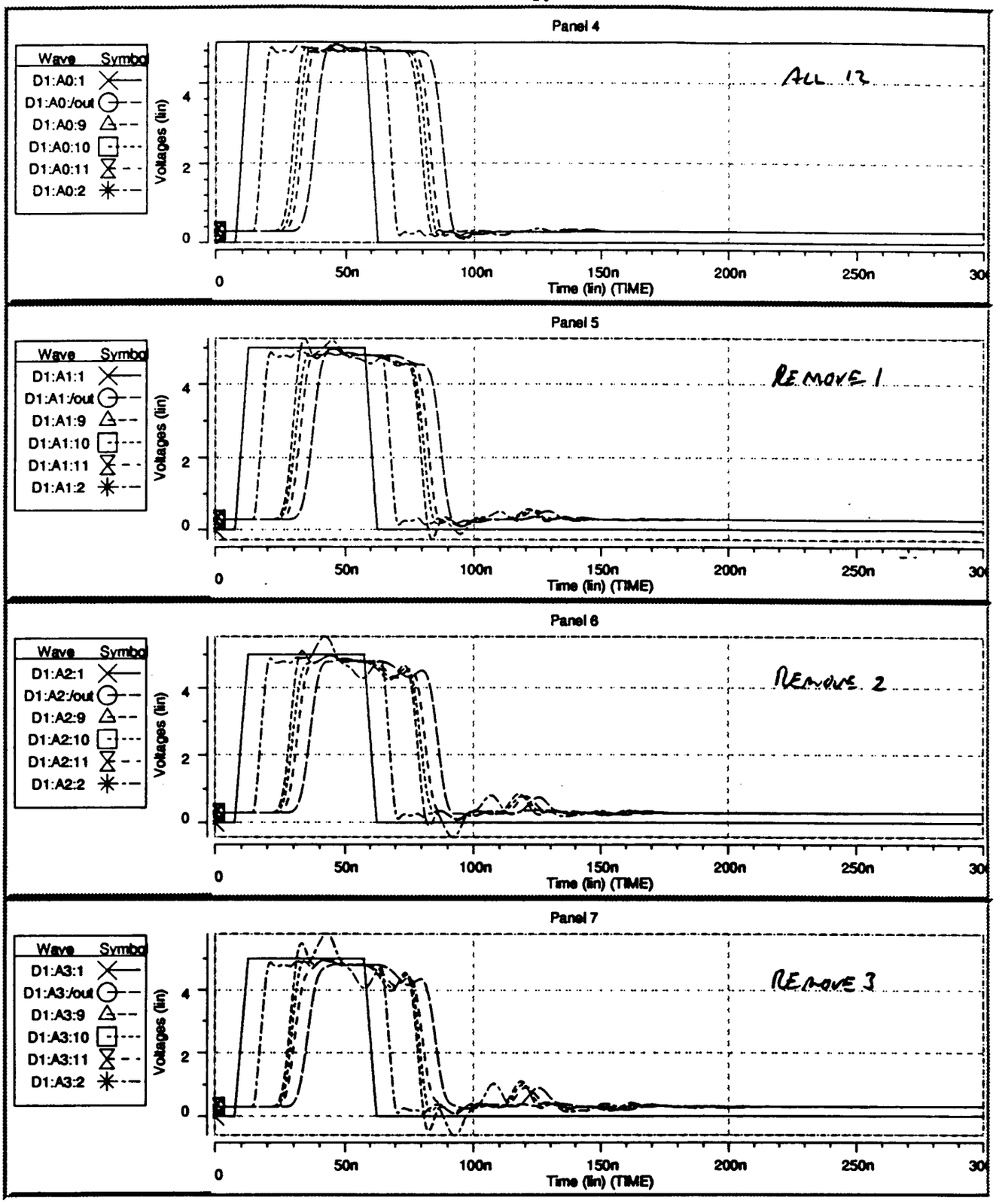

Panel 4
Wave Symbol
D0:A0:1
D0:A0:/in
D0:A0:/out
Voltages (lin)
6
4
2
0
-2
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
TODAY
Panel 5
Wave Symbol
D0:A1:1
D0:A1:/in
D0:A1:/out
Voltages (lin)
Time (lin) (TIME)
120nH
90Ω
15pF
Panel 6
Wave Symbol
D0:A2:1
D0:A2:/in
D0:A2:/out
Voltages (lin)
Time (lin) (TIME)
120nH
90Ω
100Ω
15pF

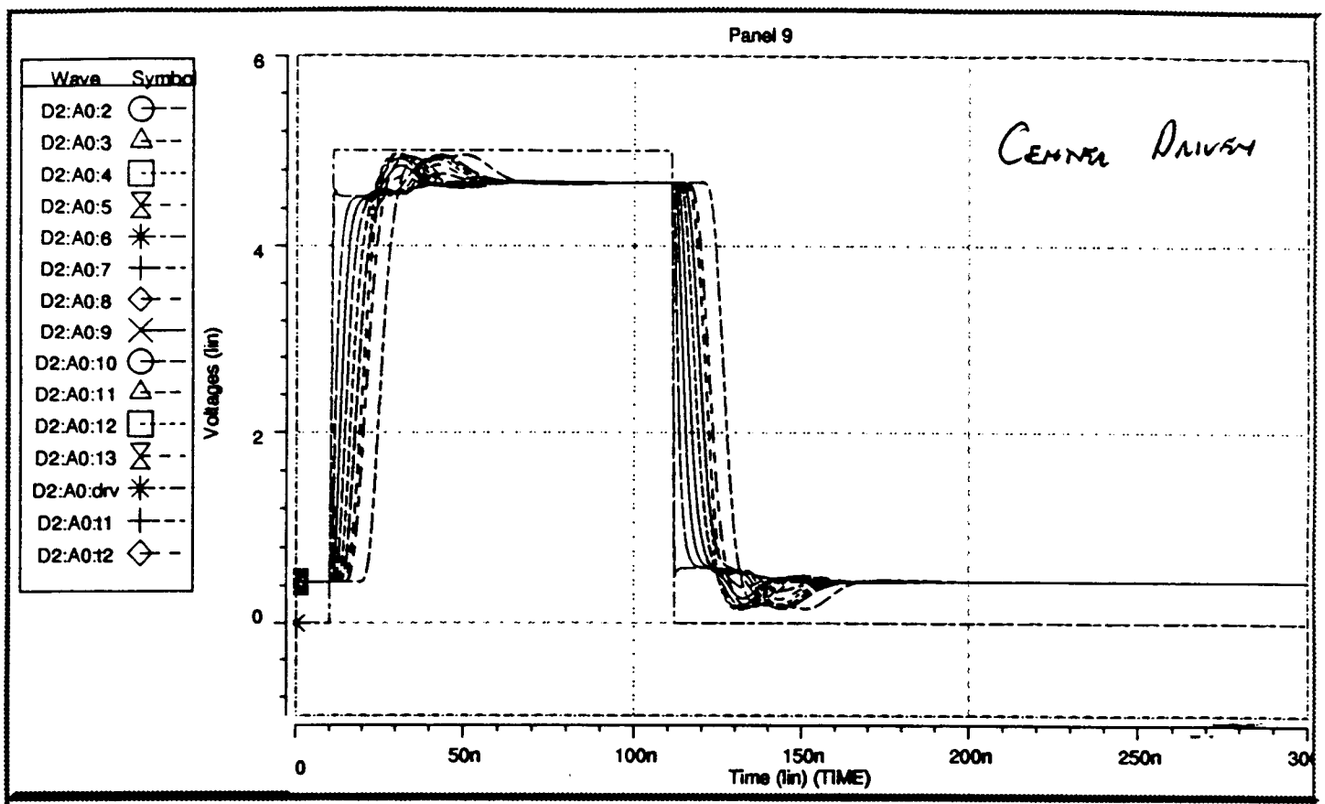

Panel 4
Wave Symbol
D0:A0:1
D0:A0:2
D0:A0:3
D0:A0:4
D0:A0:5
D0:A0:6
D0:A0:7
D0:A0:8
D0:A0:9
D0:A0:10
D0:A0:11
D0:A0:12
D0:A0:13
D0:A0:/out
Voltages (lin)
6
4
2
0
-2
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
TODAY : ALL 12 DROPS
Panel 7
Wave Symbol
D0:A2:1
D0:A2:2
D0:A2:3
D0:A2:4
D0:A2:5
D0:A2:6
D0:A2:7
D0:A2:8
D0:A2:9
D0:A2:10
D0:A2:11
D0:A2:12
D0:A2:13
D0:A2:/out
Voltages (lin)
6
4
2
0
-2
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
COMPENSATED : ALL 12 DROPS

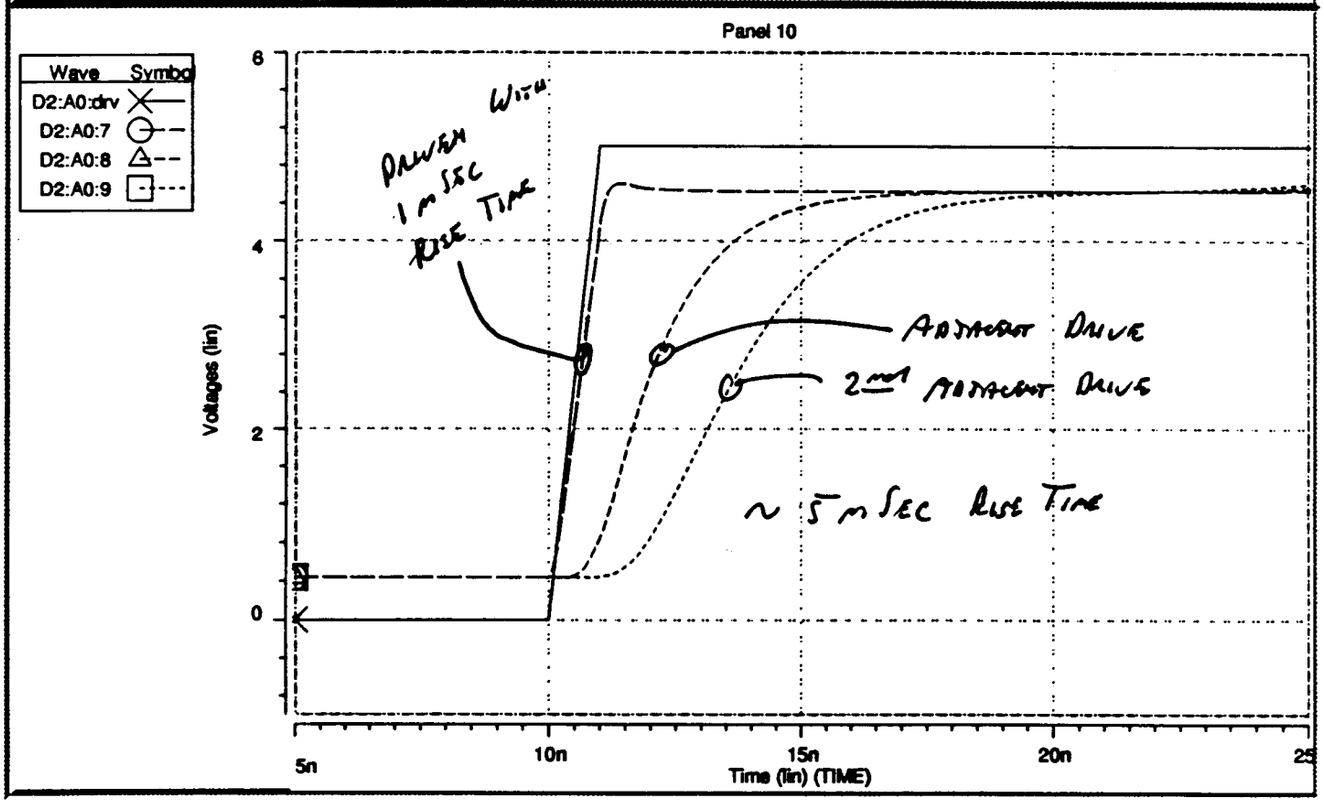

Panel 7
Wave Symbol
D0:A2:1
D0:A2:2
D0:A2:3
D0:A2:4
D0:A2:5
D0:A2:6
D0:A2:7
D0:A2:8
D0:A2:9
D0:A2:10
D0:A2:11
D0:A2:12
D0:A2:13
D0:A2:/out
Voltages (lin)
6
4
2
0
-2
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
COMPENSATED
12 DROPS


Panel 8
Wave Symbol
D1:A2:1
D1:A2:2
D1:A2:3
D1:A2:4
D1:A2:5
D1:A2:6
D1:A2:7
D1:A2:8
D1:A2:9
D1:A2:10
D1:A2:11
D1:A2:12
D1:A2:13
Voltages (lin)
6
4
2
0
-2
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
COMPENSATED
3 ADJACENT DROPS
REMOVED

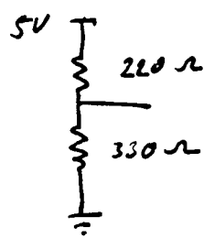
REMOVE DRIVES




Panel 9
Wave Symbol
D2:A0:2
D2:A0:3
D2:A0:4
D2:A0:5
D2:A0:6
D2:A0:7
D2:A0:8
D2:A0:9
D2:A0:10
D2:A0:11
D2:A0:12
D2:A0:13
D2:A0:drv
D2:A0:11
D2:A0:12
Voltages (lin)
6
4
2
0
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
CENTER DRIVEN

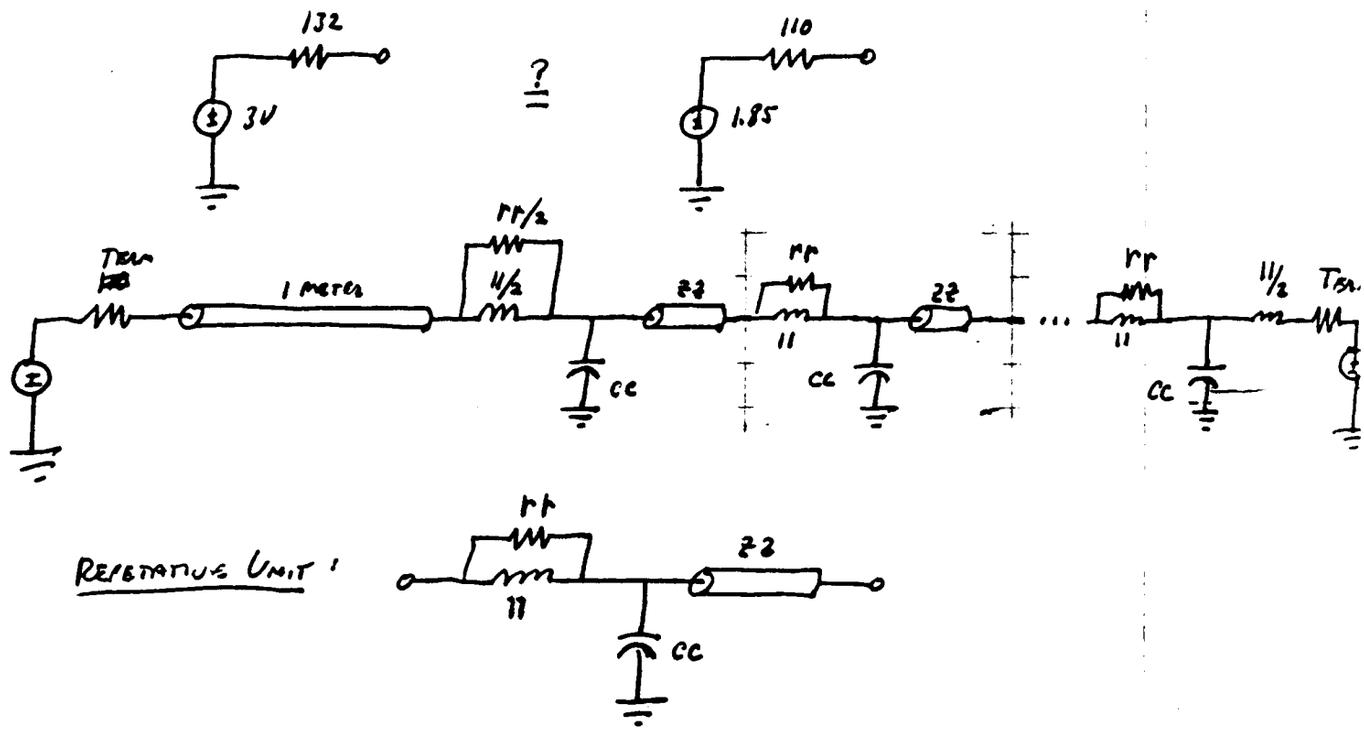

Panel 10
Wave Symbol
D2:A0:drv
D2:A0:7
D2:A0:8
D2:A0:9
Voltages (lin)
6
4
2
0
5n
10n
15n
20n
Time (lin) (TIME)
WITH
DRIVEN
1 n SEC
RISE TIME
ADJACENT DRIVE
2nd ADJACENT DRIVE
~ 5 n SEC RISE TIME

TERMINATOR THEVENIN CKT:



$V_{out} = \frac{330}{220+330}(5) = 3.00$

$R = 220 \| 330 = 132\ \Omega$



REPETATIVE UNIT:

LET $CC = 15\ pF$

For Z_0, $Z = \sqrt{\frac{L}{C}} \Rightarrow L = Z^2 C = (90^2\ \Omega)(15\times10^{-12}\ F) = 122\ nH$

For Damping, $f_0 = \frac{1}{2\pi\sqrt{LC}} = 1/2\pi\sqrt{122\times10^{-9}\cdot 15\times10^{-12}} = 117\ MHz$

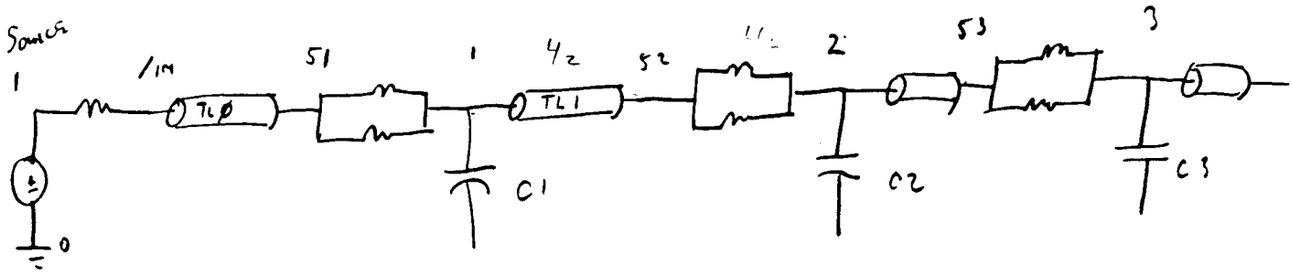
$X_L = j\omega L\ @\ 117\ MHz = 2\pi(117\times10^6)(122\times10^{-9}) = 90.37\ \Omega$

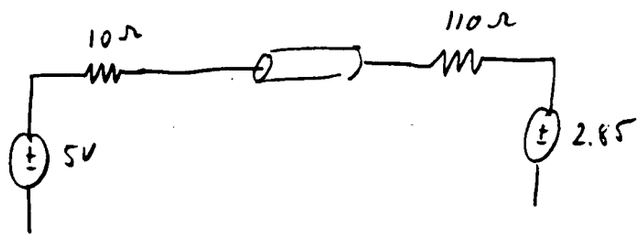
$rr = 5 \times |X_L| = 5 \times 90 = 450\ \Omega$ max For Damping
$= 5 \times Z_0$

For t_p Limiting $\frac{L}{rr} = \gamma = 5\ nSEC$

$rr = \frac{L}{\gamma} = \frac{122\ nH}{5\ nSEC} = 24\ \Omega$ To Limit Rise Time To 5nSEC

```
.end
                        rr Ohms
                  +----\/\/---+ 0X              zz Ohms
                  |           |                 _______
5x o--------------+----CCCC---+-----------o_____)---o 5x+1
                     11 nH    |
                              ===
                              |   cc pF
                             Gnd
```



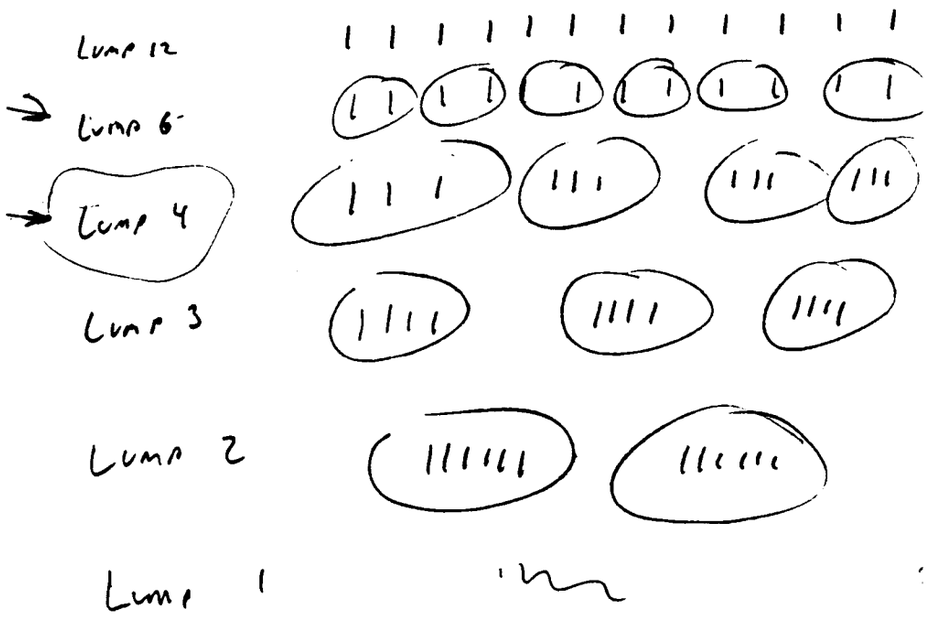


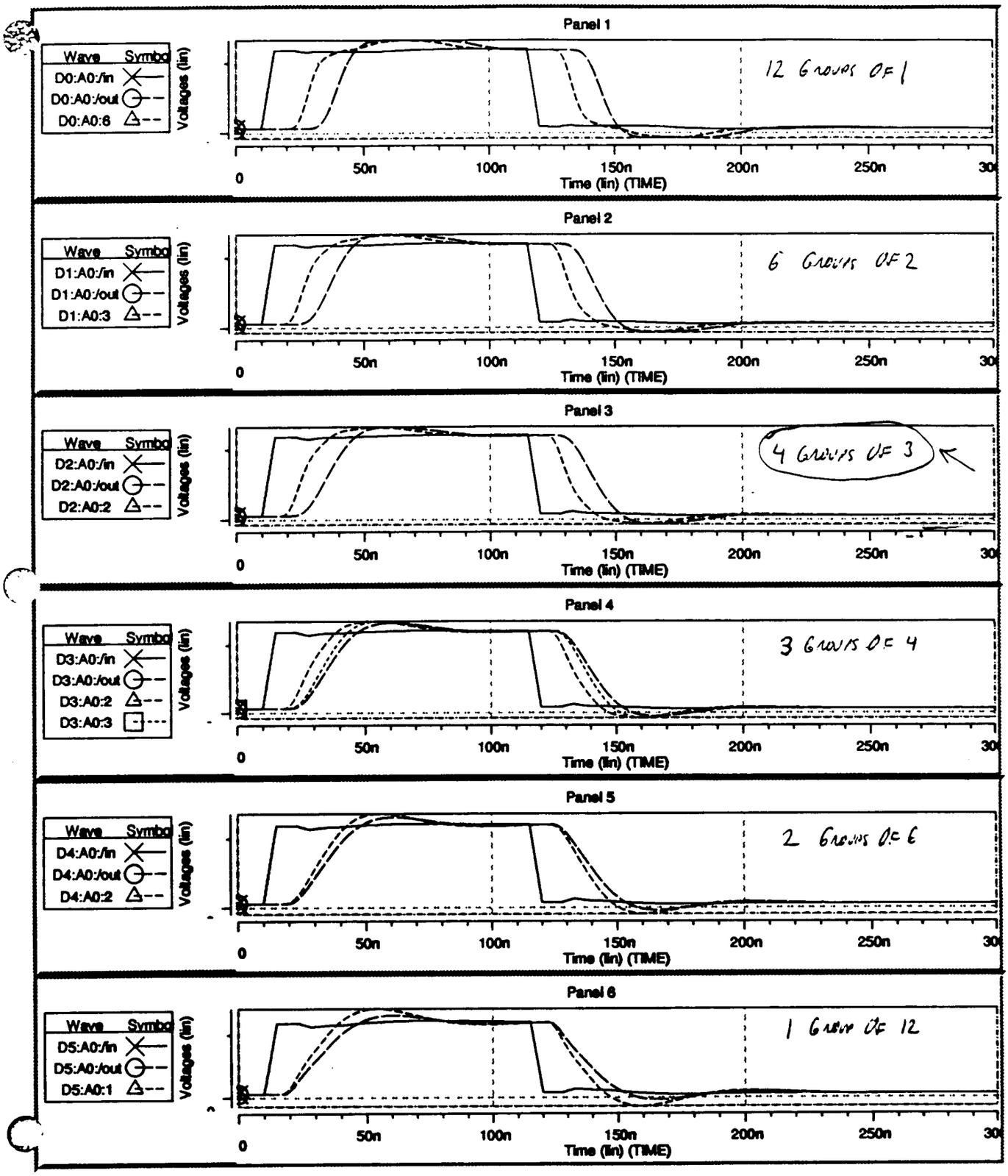
$$\frac{5 - 2.85}{120\,\Omega} = 17.92\ mA \quad DC$$

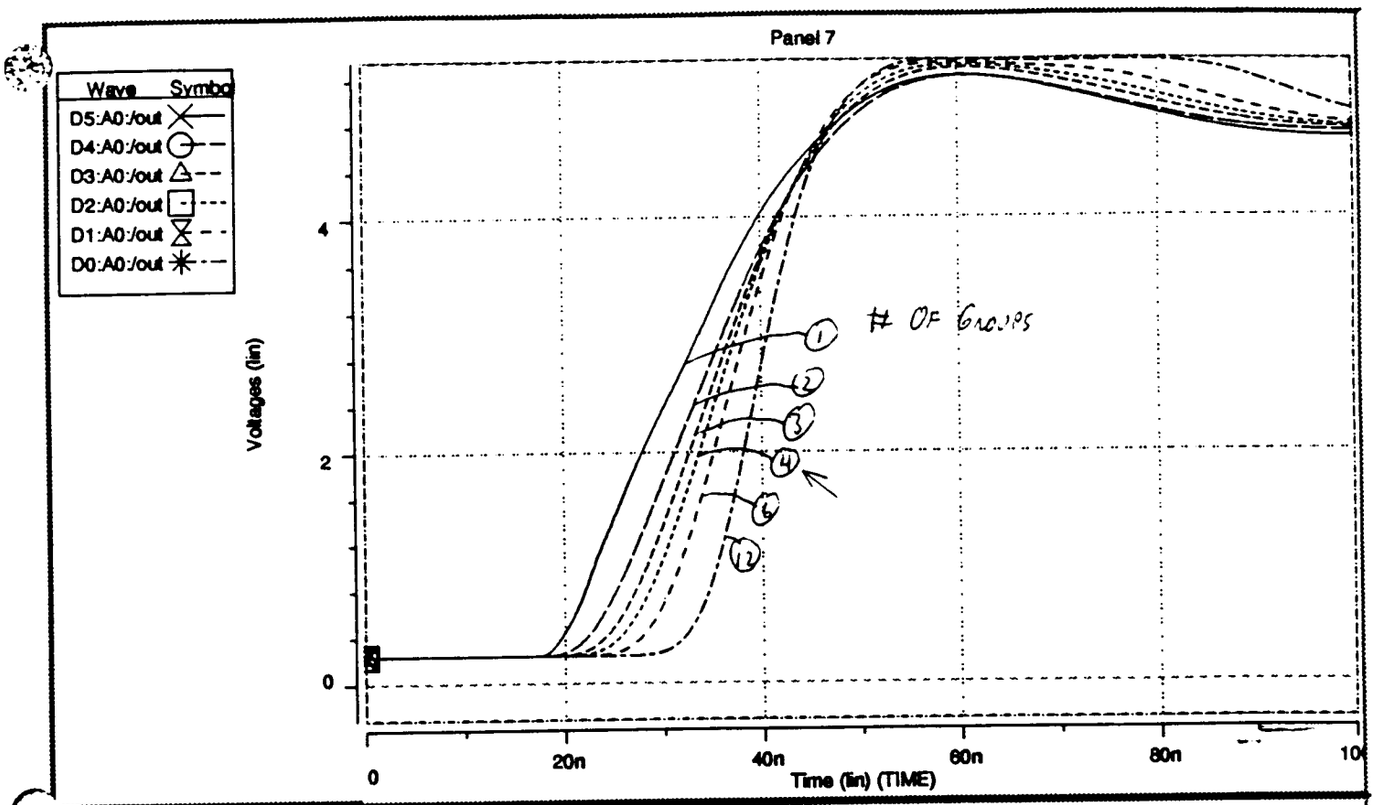
$$\frac{2.85}{120} = 23.75\ mA$$

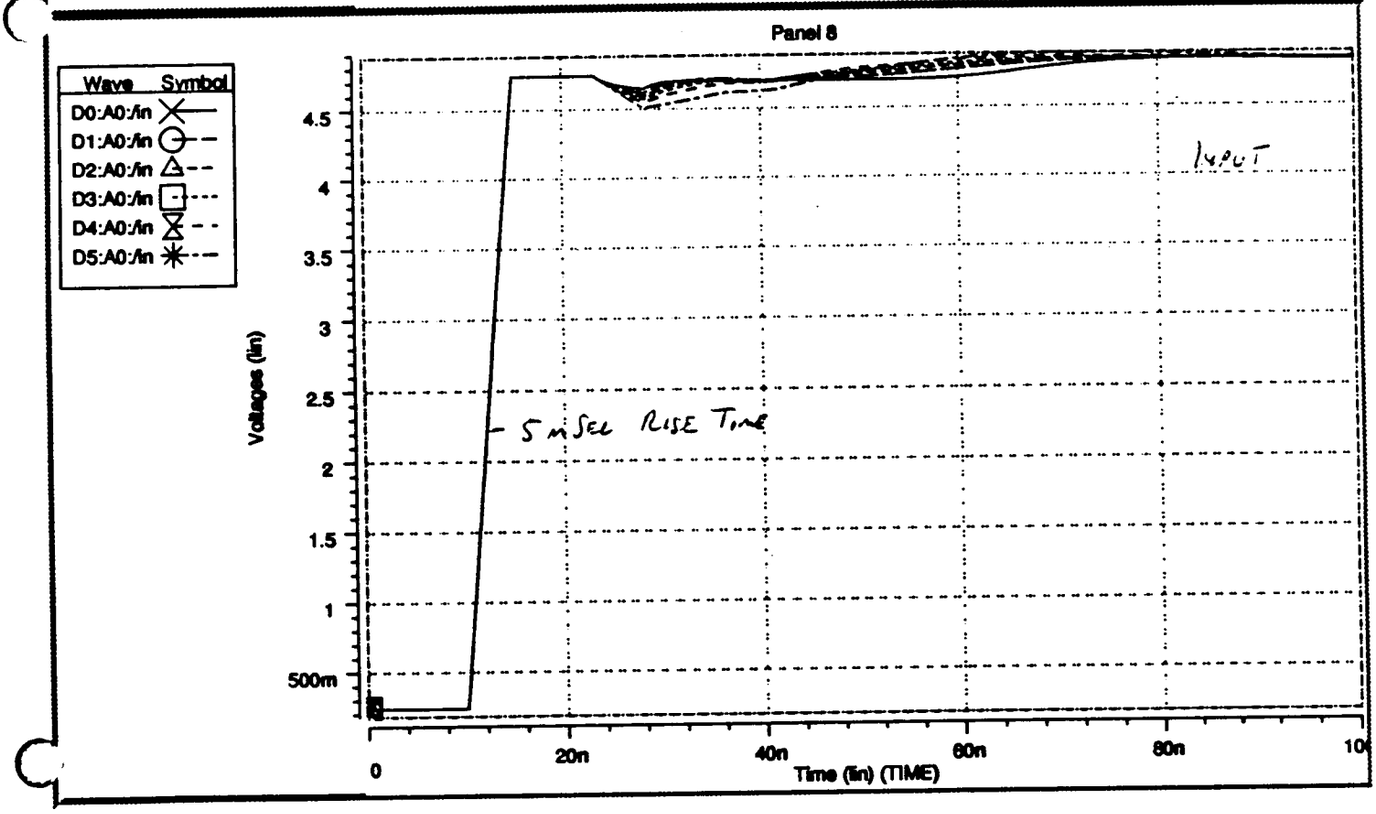
$$5 - (17.92)(.01) = 4.82$$

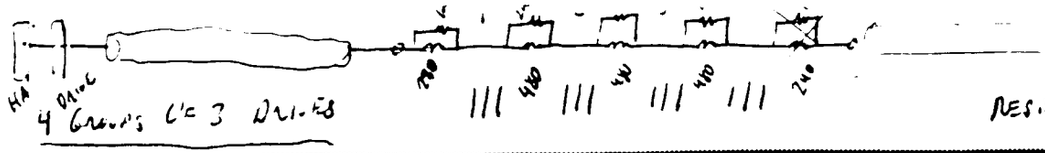
```
summary.sp  1)no change. 2)inductor. 3)inductor and resistor.
.options list node post
.tran 050pS 300nS
.param zz=60 ll=120nH cc= 15pF term=110 rr=100

 Vin       1 0       pulse (0 5.0 10nS 5nS 5nS 100nS 500nS)
 Rin       1 /in     10
 Rout   /out V       term
 Vterm     V 0       DC=2.85

 Tline0 /in 0 51 0 Z0=90 td='.17nS*39'      $ 39 inches of 90 Ohm line.
 Tline01 01 0 52 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline02 02 0 53 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline03 03 0 54 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline04 04 0 55 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline05 05 0 56 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline06 06 0 57 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline07 07 0 58 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline08 08 0 59 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline09 09 0 60 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline10 10 0 61 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline11 11 0 62 0 Z0=zz td='.17nS*02'      $  2 inches of zz Ohm line.
 Tline12 12 0 63 0 Z0=zz td='.17nS*05'      $  5 inches of zz Ohm line.

 L01       51 01     'll/2'
 L02       52 02     ll
 L03       53 03     ll
 L04       54 04     ll
 L05       55 05     ll
 L06       56 06     ll
 L07       57 07     ll
 L08       58 08     ll
 L09       59 09     ll
 L10       60 10     ll
 L11       61 11     ll
 L12       62 12     ll
 L13       63 /out    'll/2'

 R01       51 01     'rr/2'
 R02       52 02     rr
 R03       53 03     rr
 R04       54 04     rr
 R05       55 05     rr
 R06       56 06     rr
 R07       57 07     rr
 R08       58 08     rr
 R09       59 09     rr
 R00       60 10     rr
 R11       61 11     rr
 R12       62 12     rr
 R13       63 /out   'rr/2'

 C01       01 0      cc
 C02       02 0      cc
 C03       03 0      cc
 C04       04 0      cc
 C05       05 0      cc
 C06       06 0      cc
 C07       07 0      cc
 C08       08 0      cc
 C09       09 0      cc
 C10       10 0      cc
 C11       11 0      cc
 C12       12 0      cc

.print tran (1)
```

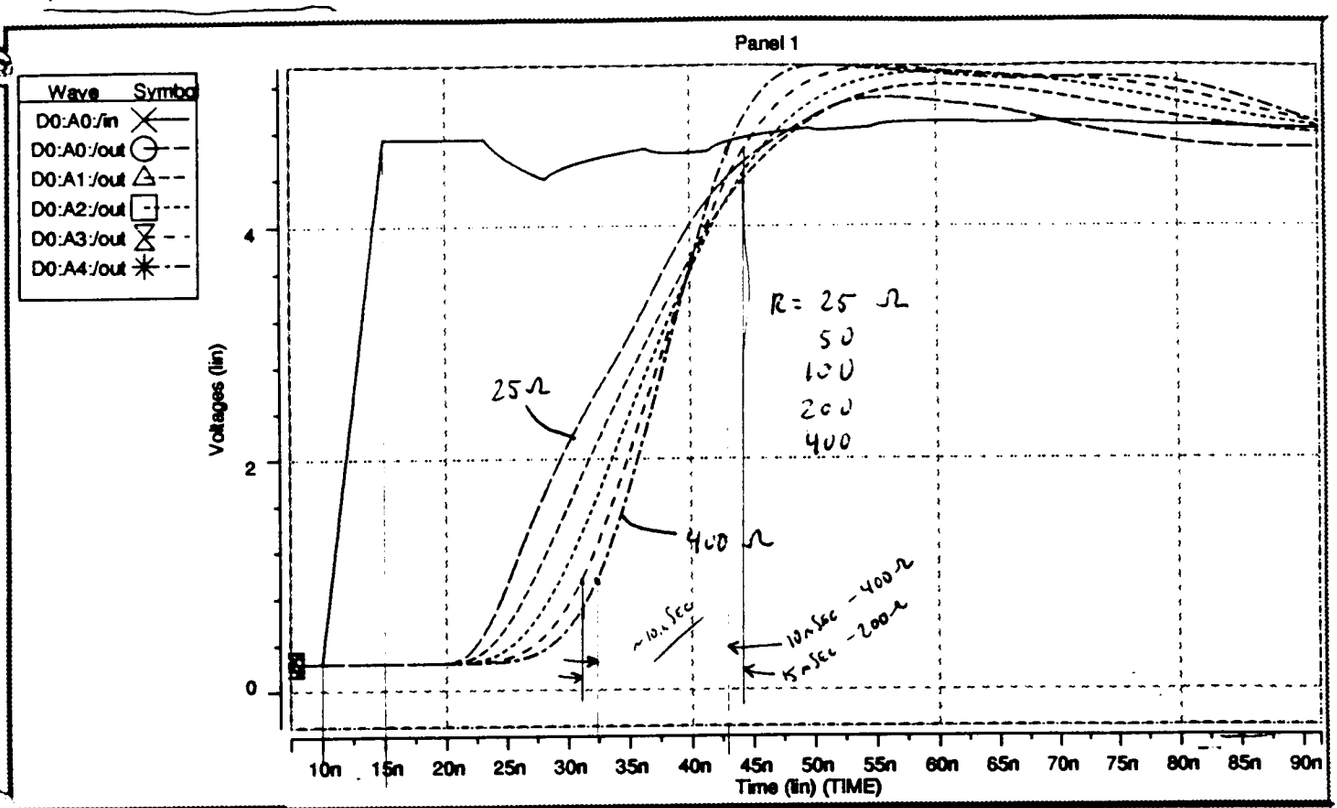


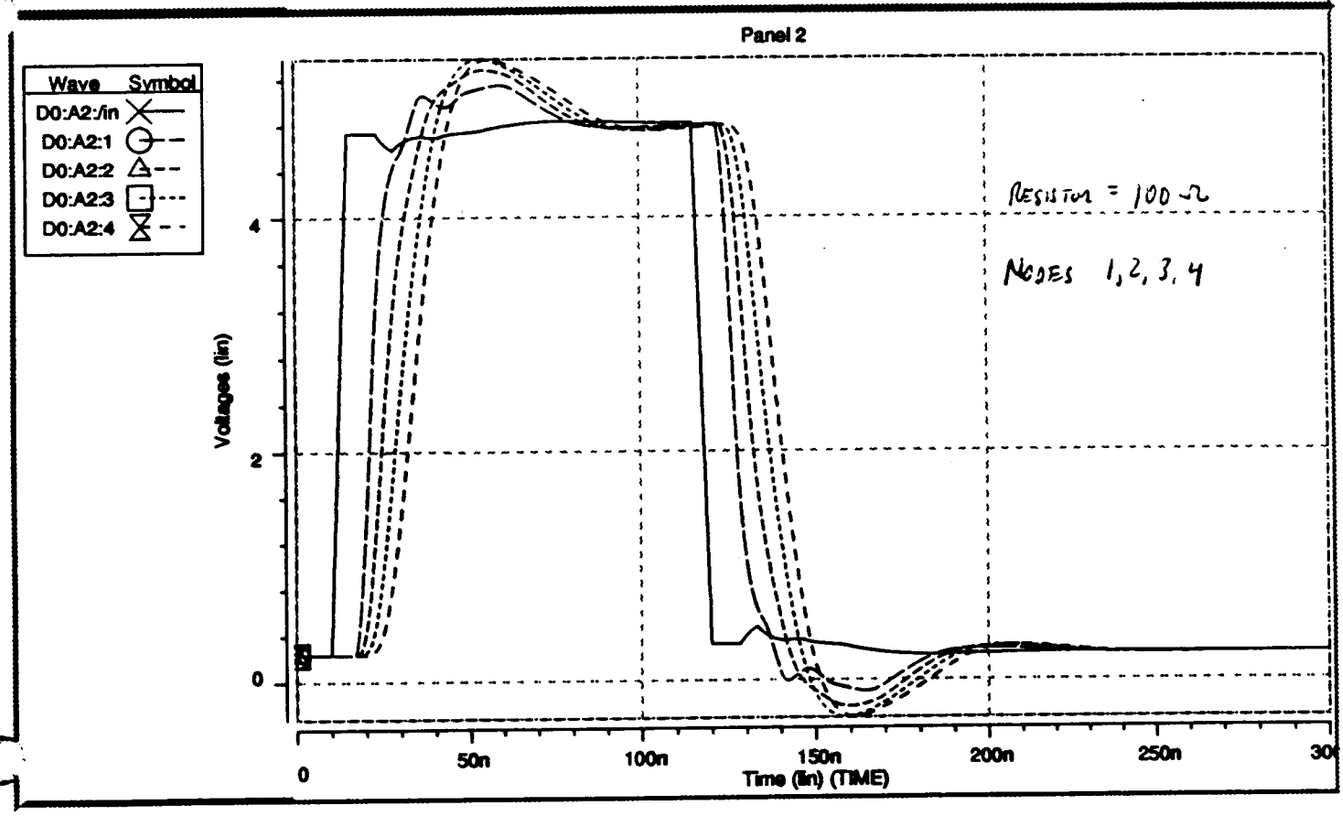

Panel 1
Wave Symbol
D0:A0:/in
D0:A0:/out
D0:A0:6
Voltages (lin)
12 GROUPS OF 1
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
Panel 2
Wave Symbol
D1:A0:/in
D1:A0:/out
D1:A0:3
Voltages (lin)
6 GROUPS OF 2
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
Panel 3
Wave Symbol
D2:A0:/in
D2:A0:/out
D2:A0:2
Voltages (lin)
4 GROUPS OF 3
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
Panel 4
Wave Symbol
D3:A0:/in
D3:A0:/out
D3:A0:2
D3:A0:3
Voltages (lin)
3 GROUPS OF 4
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
Panel 5
Wave Symbol
D4:A0:/in
D4:A0:/out
D4:A0:2
Voltages (lin)
2 GROUPS OF 6
0
50n
100n
150n
200n
250n
Time (lin) (TIME)
Panel 6
Wave Symbol
D5:A0:/in
D5:A0:/out
D5:A0:1
Voltages (lin)
1 GROUP OF 12
0
50n
100n
150n
200n
250n
Time (lin) (TIME)


Panel 7
Wave Symbol
D5:A0:/out
D4:A0:/out
D3:A0:/out
D2:A0:/out
D1:A0:/out
D0:A0:/out
Voltages (lin)
0
2
4
OF GROUPS
1
2
3
4
6
12
0
20n
40n
60n
80n
Time (lin) (TIME)


Panel 8
Wave Symbol
D0:A0:/in
D1:A0:/in
D2:A0:/in
D3:A0:/in
D4:A0:/in
D5:A0:/in
Voltages (lin)
500m
1
1.5
2
2.5
3
3.5
4
4.5
INPUT
5 n SEC RISE TIME
0
20n
40n
60n
80n
Time (lin) (TIME)


4 Drivers C's 3 Drivers
RESISTOR VALUES

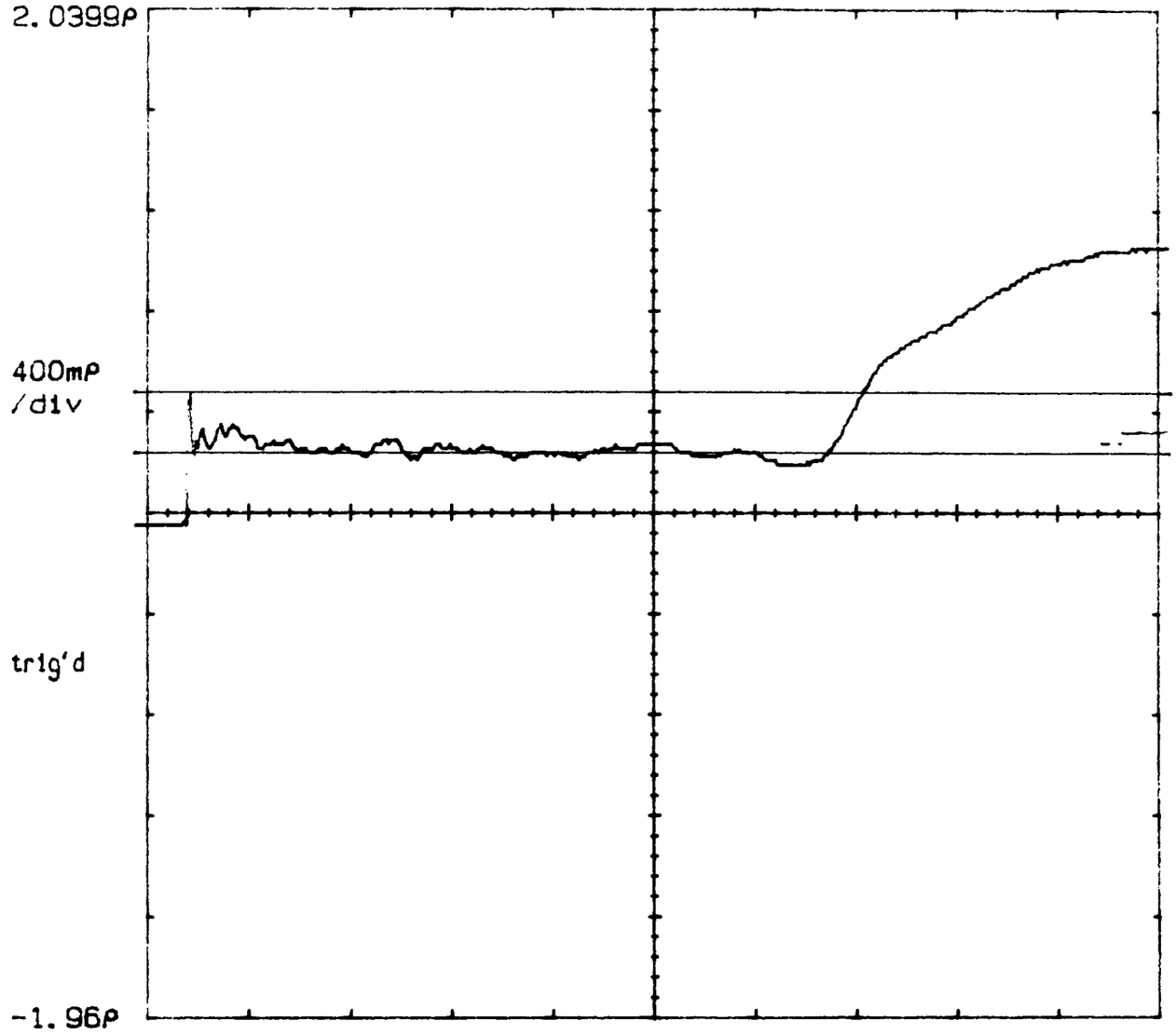

Panel 1
Wave Symbol
D0:A0:/in
D0:A0:/out
D0:A1:/out
D0:A2:/out
D0:A3:/out
D0:A4:/out
Voltages (lin)
Time (lin) (TIME)
R = 25 Ω
50
100
200
400
25Ω
400Ω
~10nSec
10nSec - 400Ω
5nSec - 200Ω


Panel 2
Wave Symbol
D0:A2:/in
D0:A2:1
D0:A2:2
D0:A2:3
D0:A2:4
Voltages (lin)
Time (lin) (TIME)
RESISTOR = 100 Ω
NODES 1, 2, 3, 4

BP6 no comp. no drives

11801B DIGITAL SAMPLING OSCILLOSCOPE
date: 30-OCT-96 time: 17:55:15

Hardcopy complete



Cursor Type		ρ	Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	279.92mρ	88.87Ω	177.7Ω	279.9241mρ
	ρ2	519.92mρ	158.3Ω	316.6Ω	Cursor 2
	Δρ	240.00mρ	69.43Ω	138.9Ω	519.9241mρ
Exit	Set Zero				Remove/Clr Trace 1 M1 Main

BP.6 no comp.
W. drives

11801B DIGITAL SAMPLING OSCILLOSCOPE
date: 30-OCT-96 time: 17:59:02

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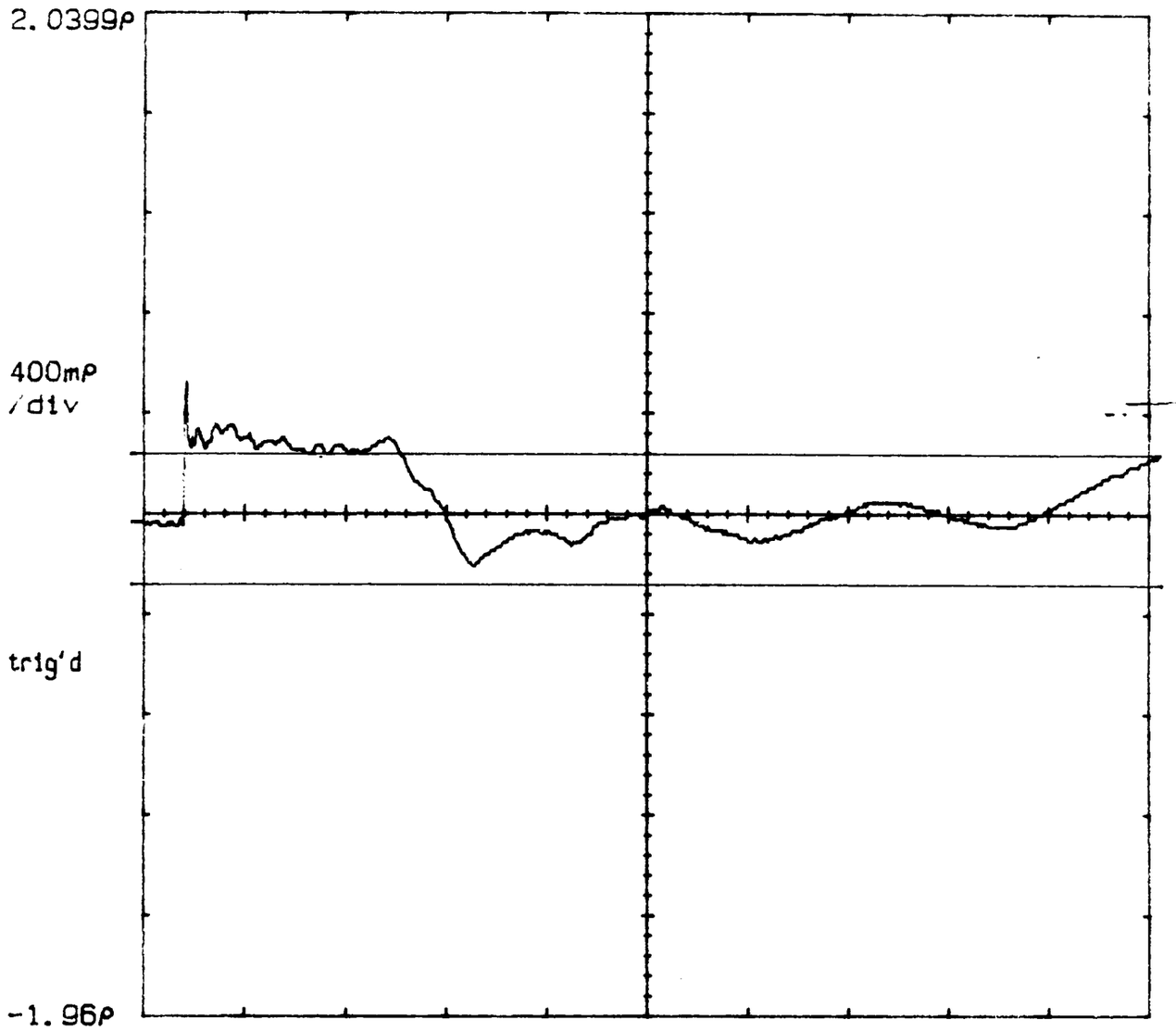

Cursor Type			Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	279.92mρ	88.87Ω	177.7Ω	279.9225mρ
	ρ2	-240.08mρ	30.64Ω	61.28Ω	Cursor 2
	Δρ	-520.00mρ	-58.23Ω	-116.5Ω	-240.0775mρ
Exit / Set Zero					Remove/Clr Trace 1 M1 Main

BP6 w. comp.
no drives

11801B DIGITAL SAMPLING OSCILLOSCOPE
date: 30-OCT-96 time: 17:50:41

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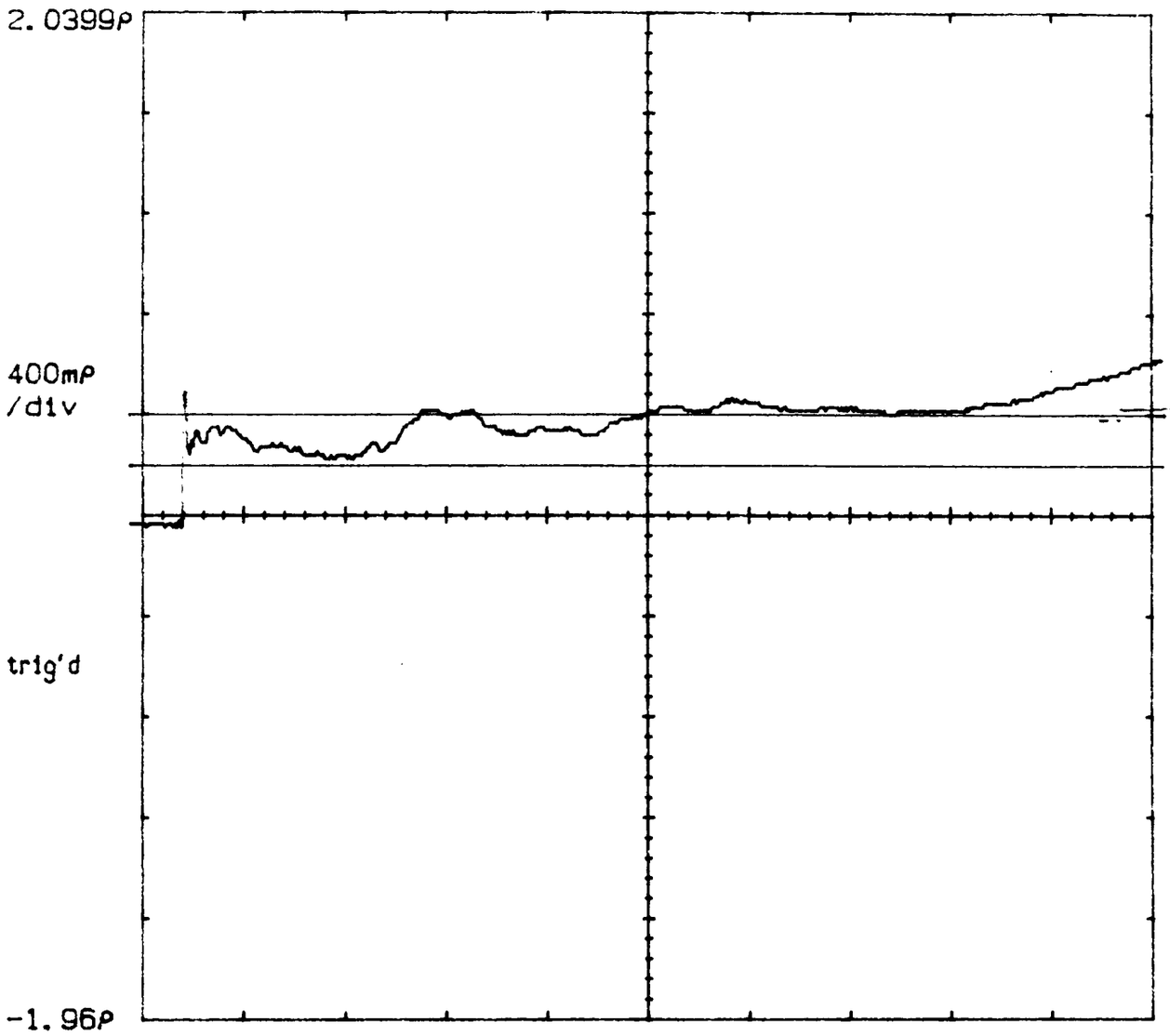

Cursor Type			Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	239.92mρ	81.57Ω	163.1Ω	239.9241mρ
	ρ2	439.92mρ	128.5Ω	257.1Ω	Cursor 2
	Δρ	200.00mρ	46.98Ω	93.96Ω	439.9241mρ
Exit / Set Zero					Remove/Clr Trace 1 M1 Main

BP 6 w. comp.
W. drives

11801B DIGITAL SAMPLING OSCILLOSCOPE
date: 30-OCT-96 time: 17:47:17

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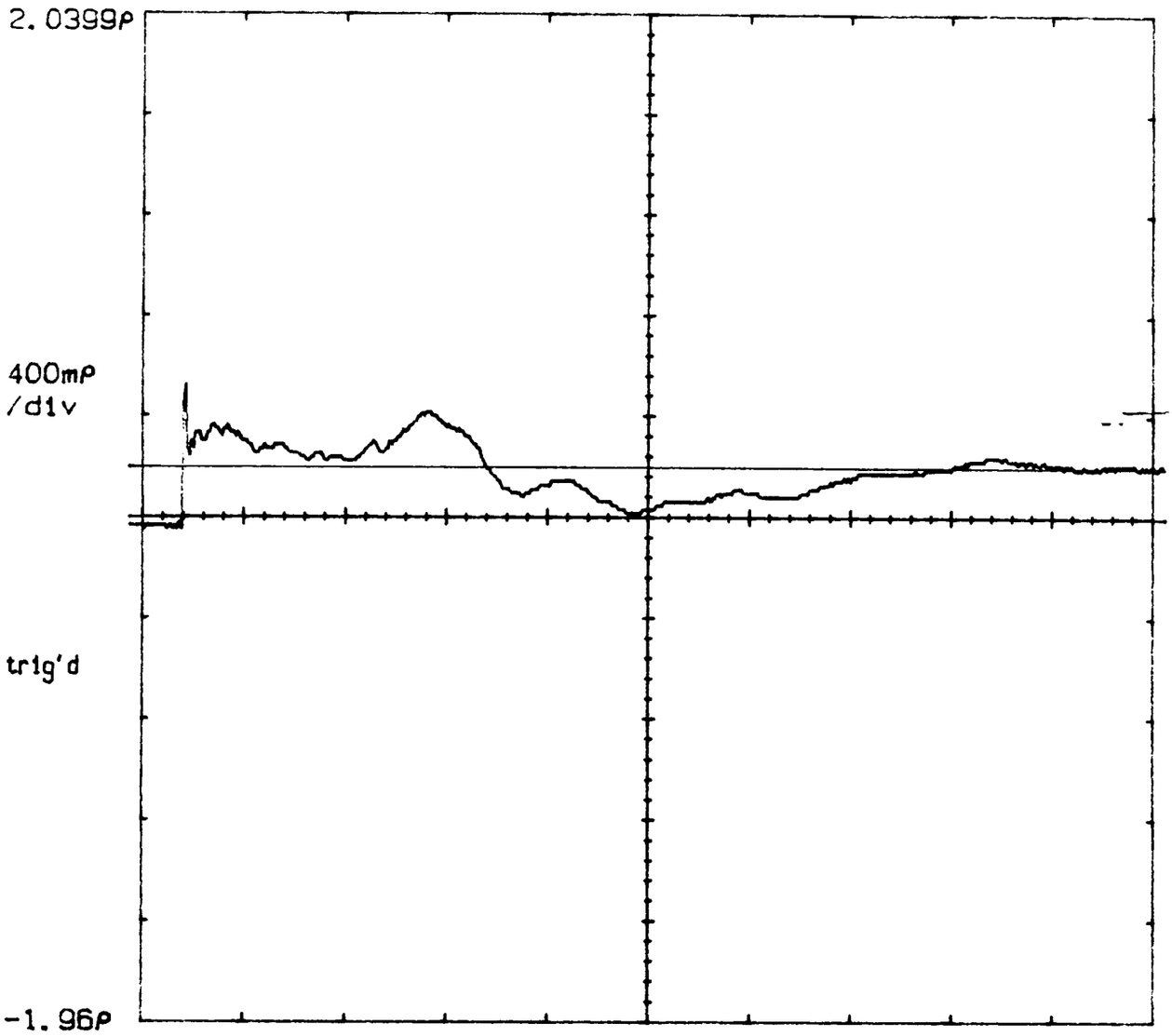
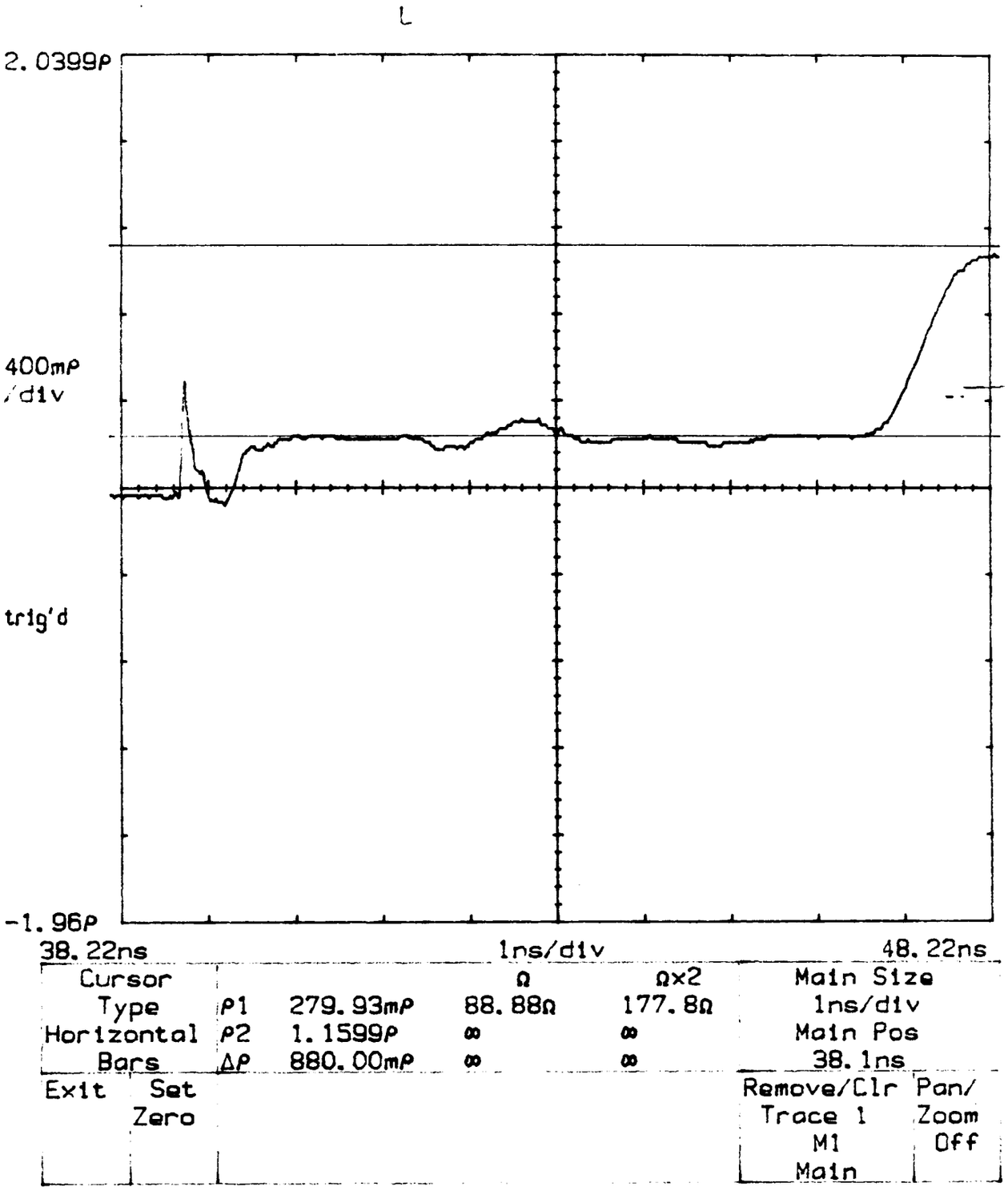


Cursor Type			Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	239.93mρ	81.57Ω	163.1Ω	239.9255mρ
	ρ2	39.926mρ	54.16Ω	108.3Ω	Cursor 2
	Δρ	-200.00mρ	-27.41Ω	-54.81Ω	39.92552mρ

Exit	Set Zero		Remove/Clr Trace 1 M1 Main

BP2 backplane no comp.
no drives

11801B DIGITAL SAMPLING OSCILLOSCOPE
date: 30-OCT-96 time: 17:20:14

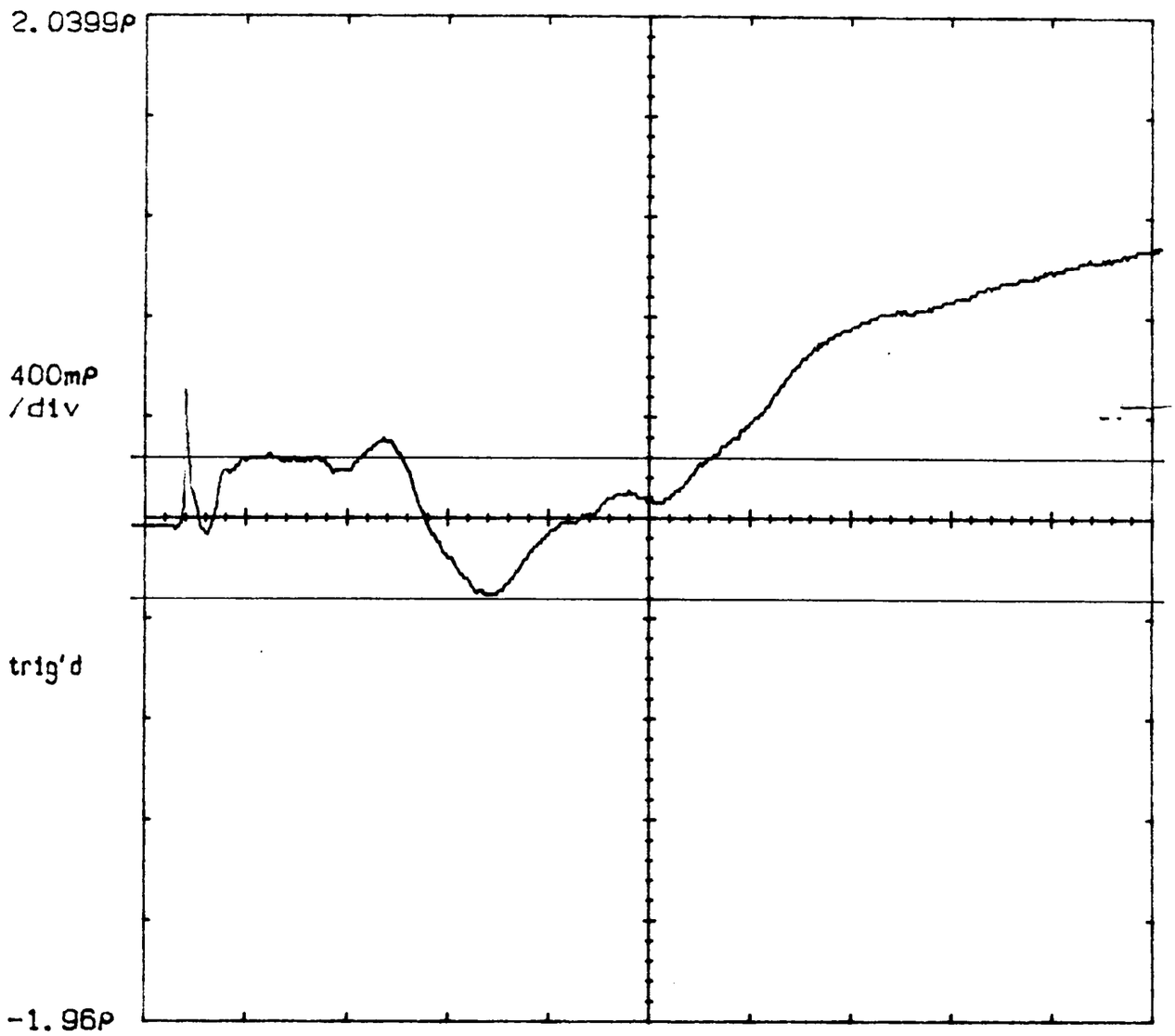


Cursor Type			Ω	Ωx2	Main Size
Horizontal Bars	ρ1	279.93mρ	88.88Ω	177.8Ω	1ns/div
	ρ2	1.1599ρ	∞	∞	Main Pos
	Δρ	880.00mρ	∞	∞	38.1ns

Exit | Set Zero | Remove/Clr Trace 1 M1 Main | Pan/ Zoom Off

BP2 backplane 2 drives no comp.

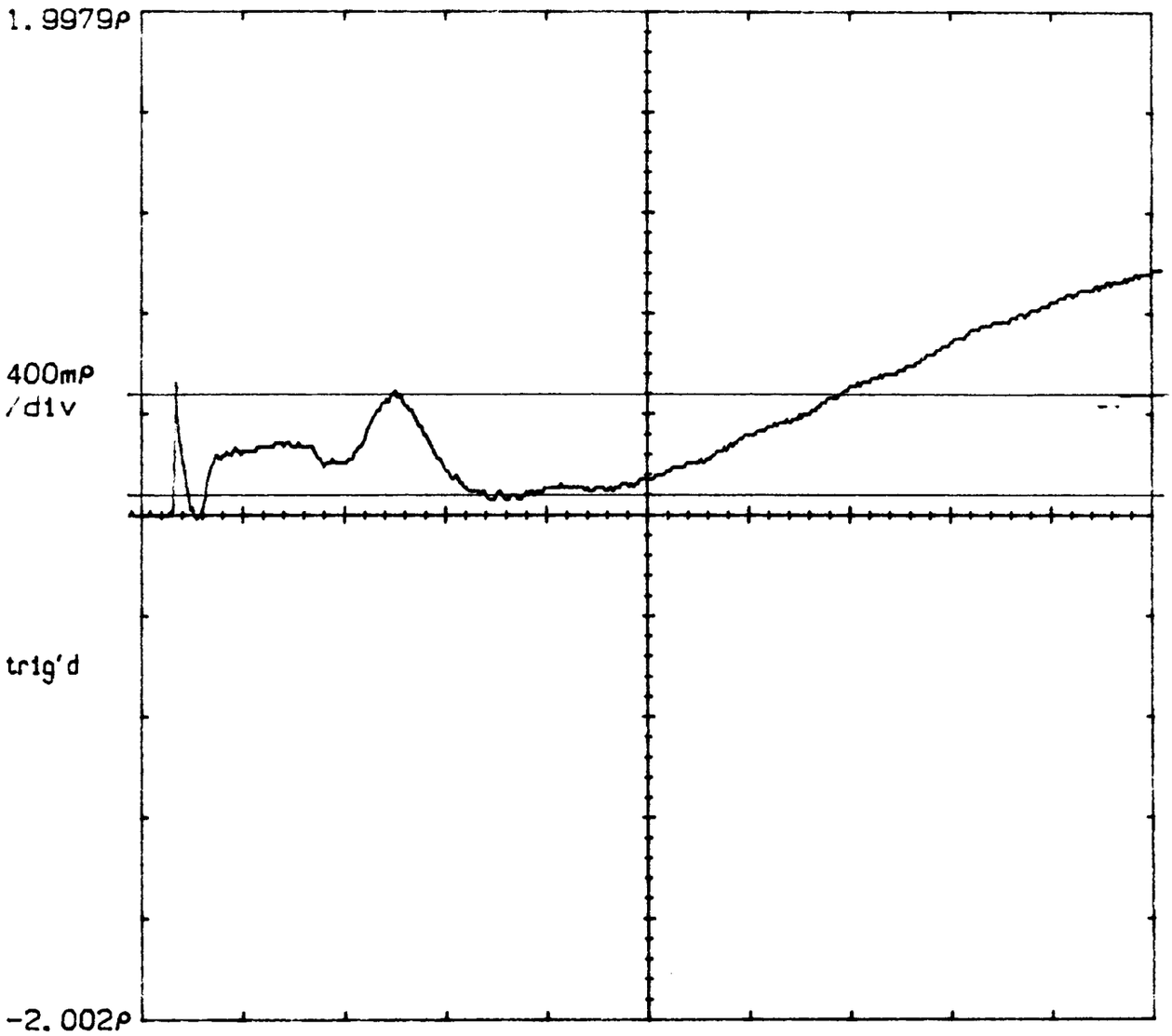
118018 DIGITAL SAMPLING OSCILLOSCOPE
date: 30-OCT-96 time: 17:23:03



Cursor Type			Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	-280.07mρ	28.12Ω	56.24Ω	-280.0684mρ
	ρ2	279.93mρ	88.88Ω	177.8Ω	Cursor 2
	Δρ	560.00mρ	60.75Ω	121.5Ω	279.9316mρ
Exit / Set Zero					Remove/Clr Trace 1 M1 Main

BP2 backplane w. comp. 2drives

11801B DIGITAL SAMPLING OSCILLOSCOPE
date: 31-OCT-96 time: 17:28:09



Cursor Type		ρ	Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	477.92mρ	141.5Ω	283.1Ω	477.9221mρ
	ρ2	77.922mρ	58.45Ω	116.9Ω	Cursor 2
	Δρ	-400.00mρ	-83.09Ω	-166.2Ω	77.92211mρ
Exit / Set Zero					Remove/Clr Trace 1 M1 Main

BP2 backplane W. comp.

no drives

118018 DIGITAL SAMPLING OSCILLOSCOPE
date: 31-OCT-96 time: 17:33:22

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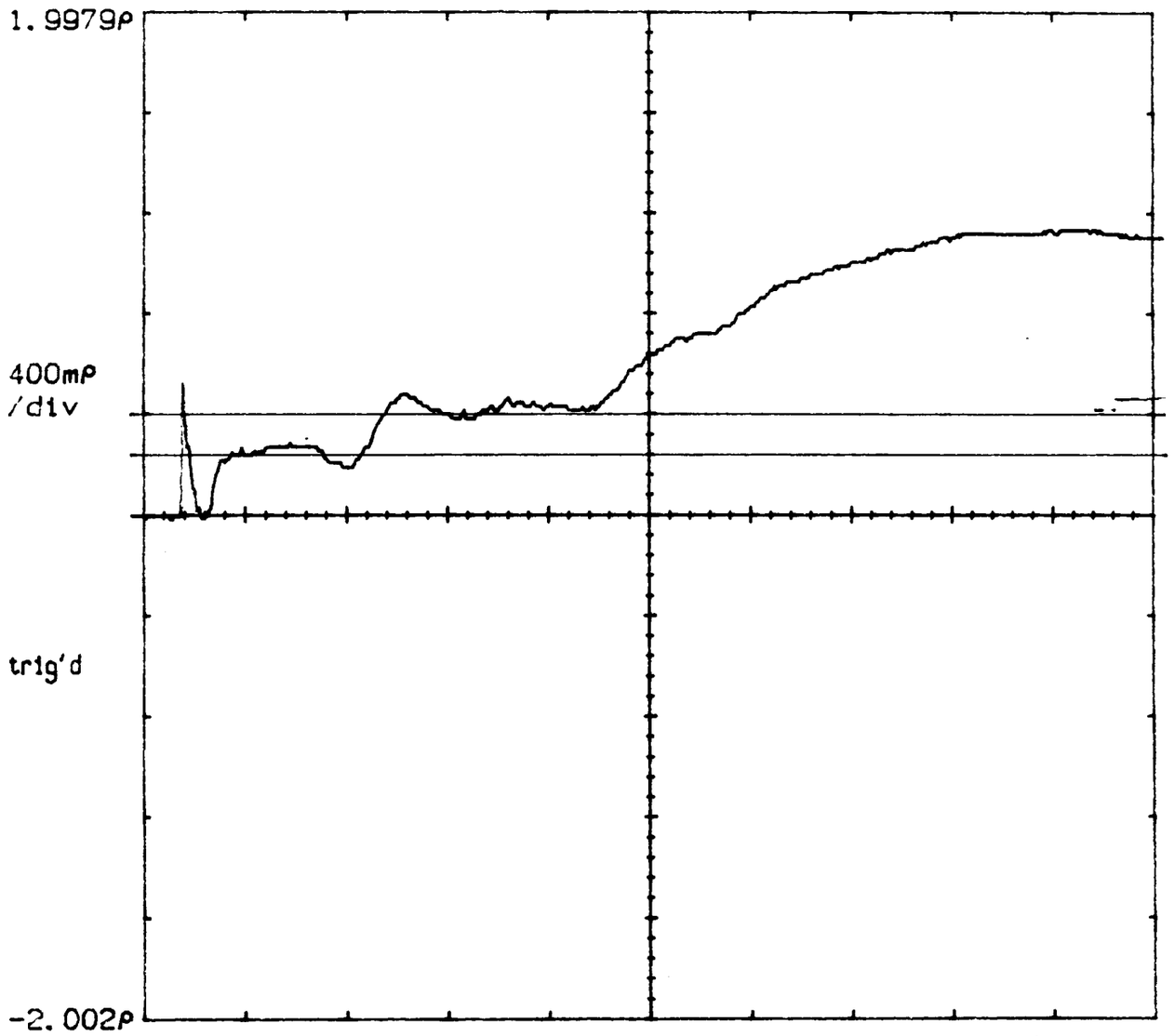


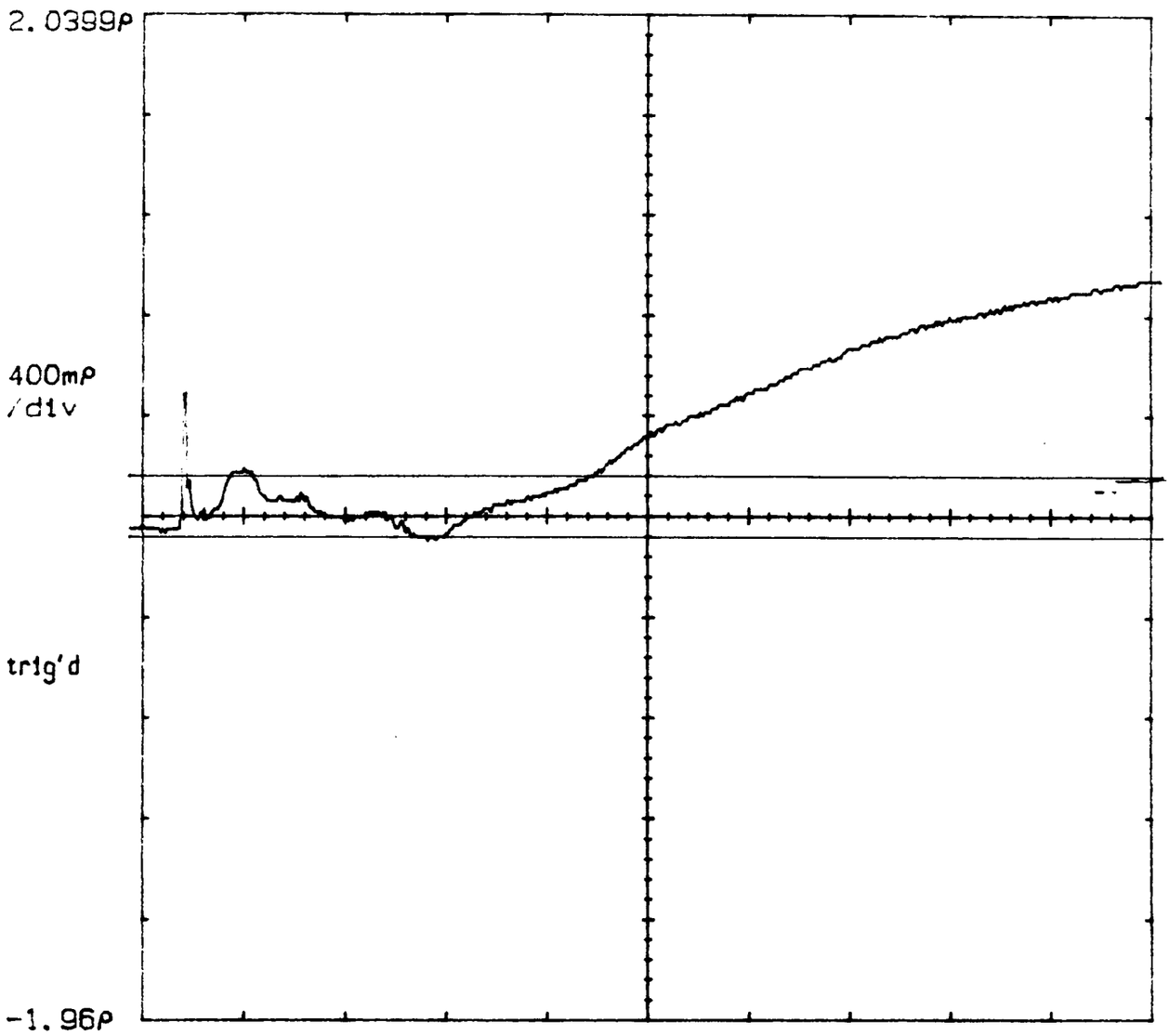
Cursor Type		ρ	Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	397.92mρ	116.1Ω	232.2Ω	397.9219mρ
	ρ2	237.92mρ	81.22Ω	162.4Ω	Cursor 2
	Δρ	-160.00mρ	-34.87Ω	-69.74Ω	237.9218mρ

Exit	Set Zero		Remove/Clr Trace 1 M1 Main	

BP2 backplane w/ comp. +2 drives

SAMPLING OSCILLOSCOPE

date: 30-OCT-96 time: 17:27:27



Cursor Type			Ω	Ωx2	Cursor 1
Horizontal Bars	ρ1	-40.068mρ	46.15Ω	92.30Ω	-40.06839mρ
	ρ2	199.93mρ	74.99Ω	150.0Ω	Cursor 2
	Δρ	240.00mρ	28.84Ω	57.68Ω	199.9316mρ

Exit | Set Zero | Remove/Clr Trace 1 M1 Main