Sun Microsystems, Inc.
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T10 98-238 r0

November 16, 1998

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

Subject: Passive Lumped Capacitance Compensation on SCSI Signal Lines

Dear Mr. Lohmeyer:

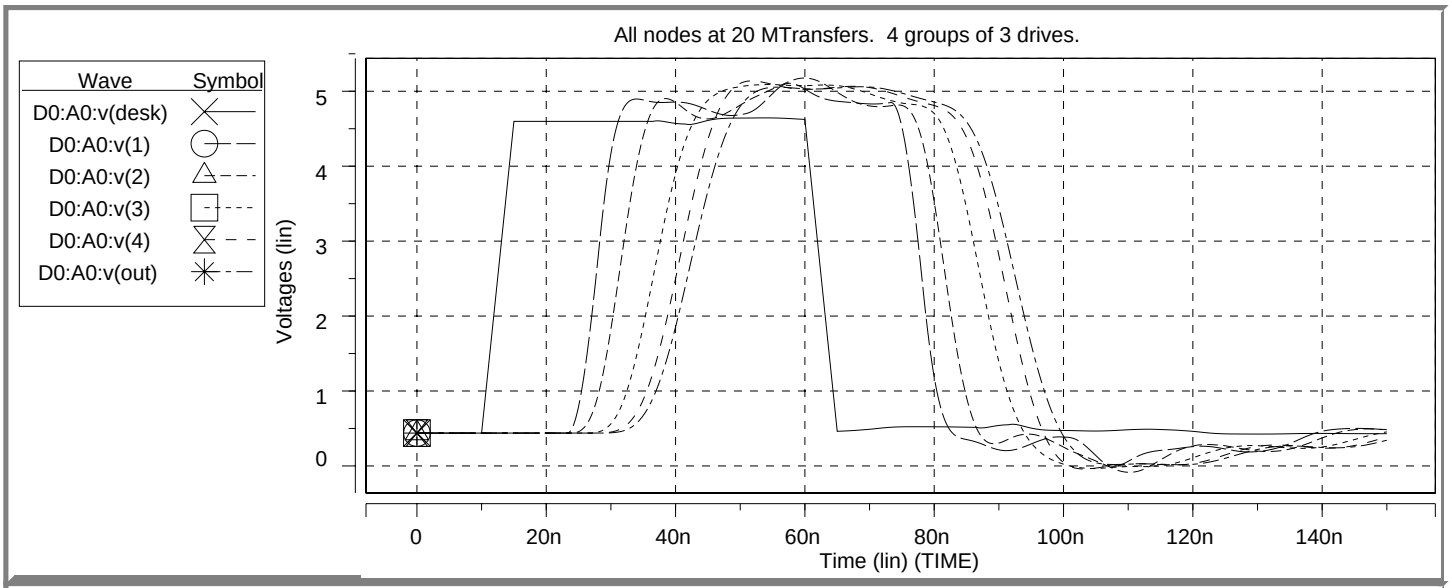
Here are more slides in continuation of what I prepared last year to explain how the passive electrical compensation on the SCSI bus signal lines works for the Fast-20 SCSI bus. I stated there that the simulations were run for Fast-20 SCSI environment but the results and methodology could be generally used on high speed buses for both the single ended and differential applications.

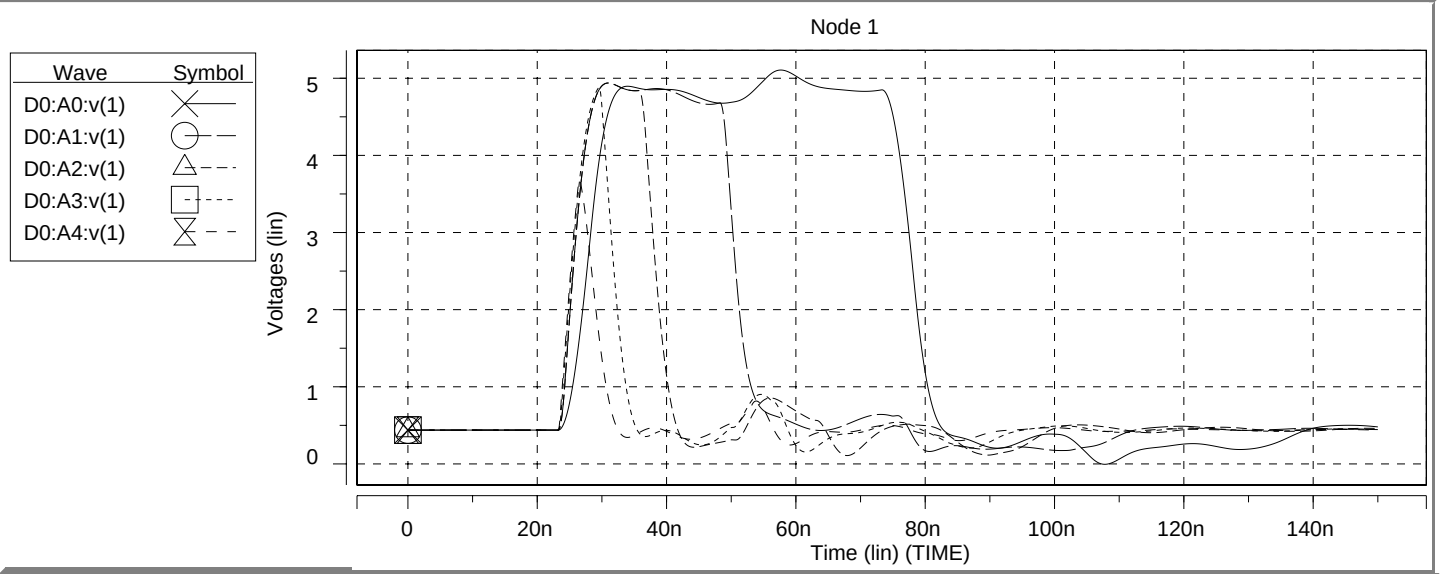
This is exactly what we did here. We increased the speed on the single ended bus and watched how far we could go with the speed (simulation done by Larry Smith). We then switched to the differential bus, the LVD (Low Voltage Differential) bus and simulated behavior at higher speeds, above the 40 M-Transfers baseline, i.e at 80, 160, and 320 M-Transfers (simulations done by Istvan Novak).

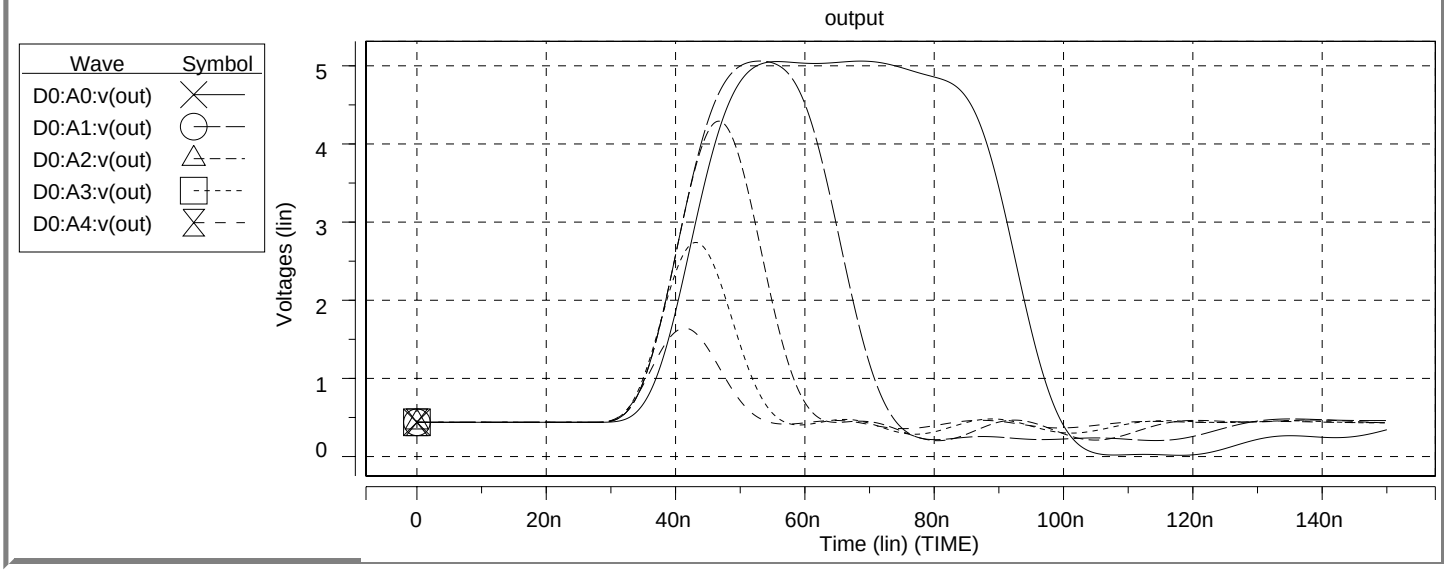
These slides should show the feasibility and improved signal quality of signals on the SCSI bus with the passsive compensation.

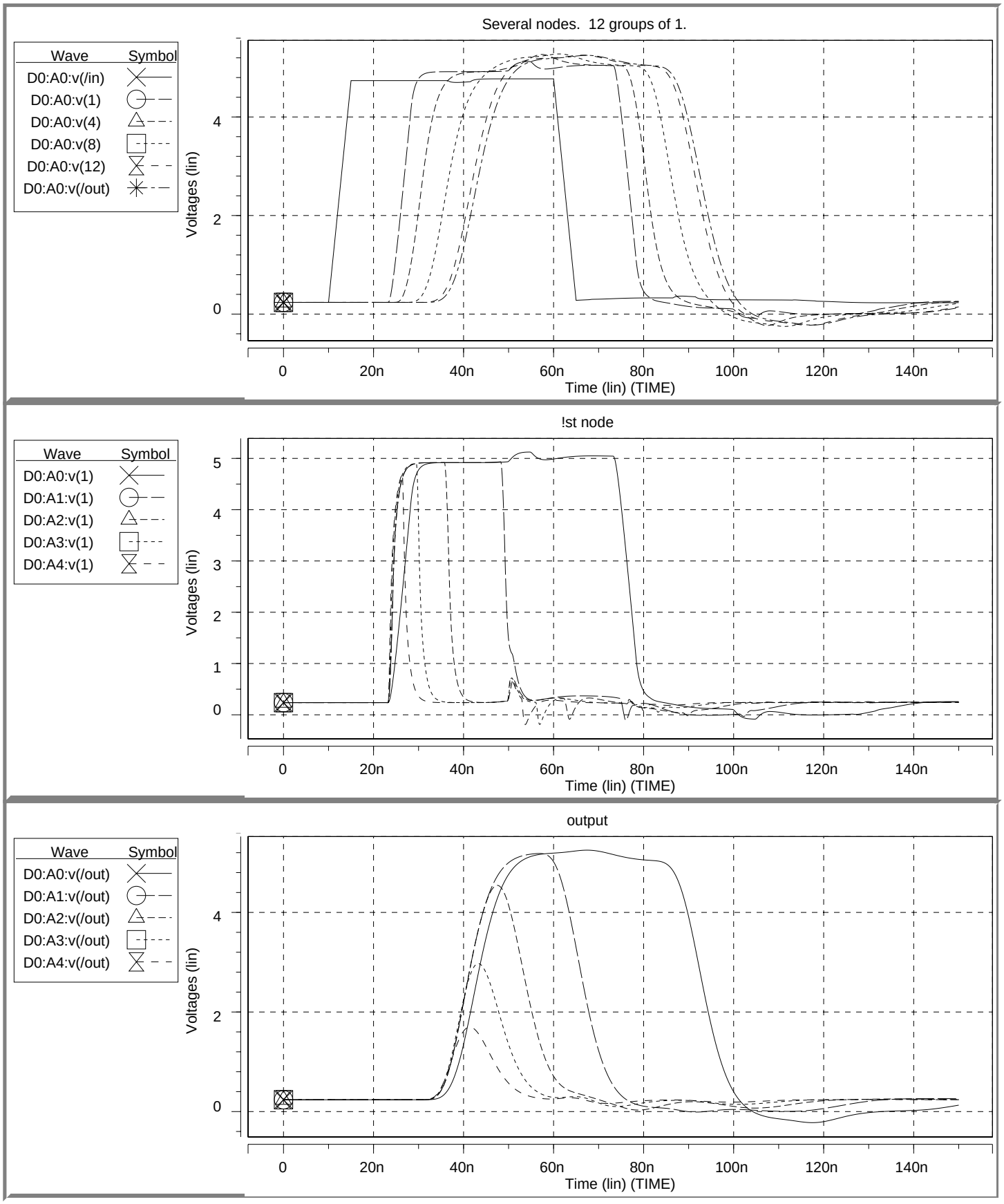
Sincerely,

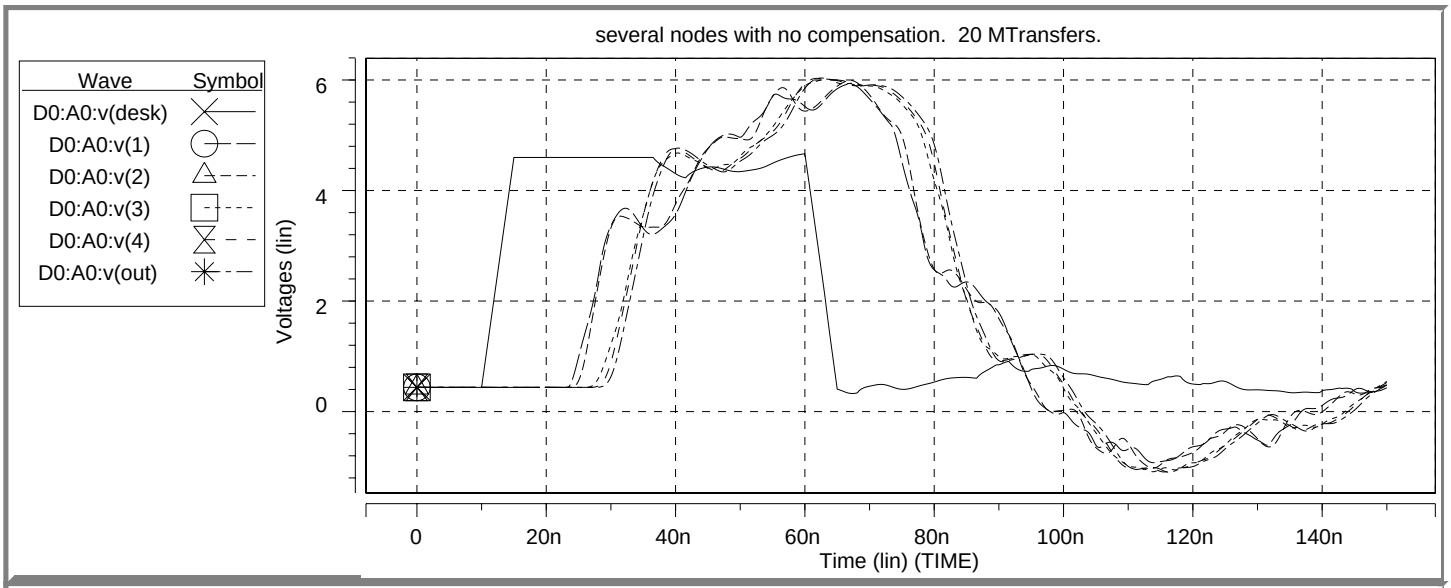
Vit F. Novak
Sun Microsystems

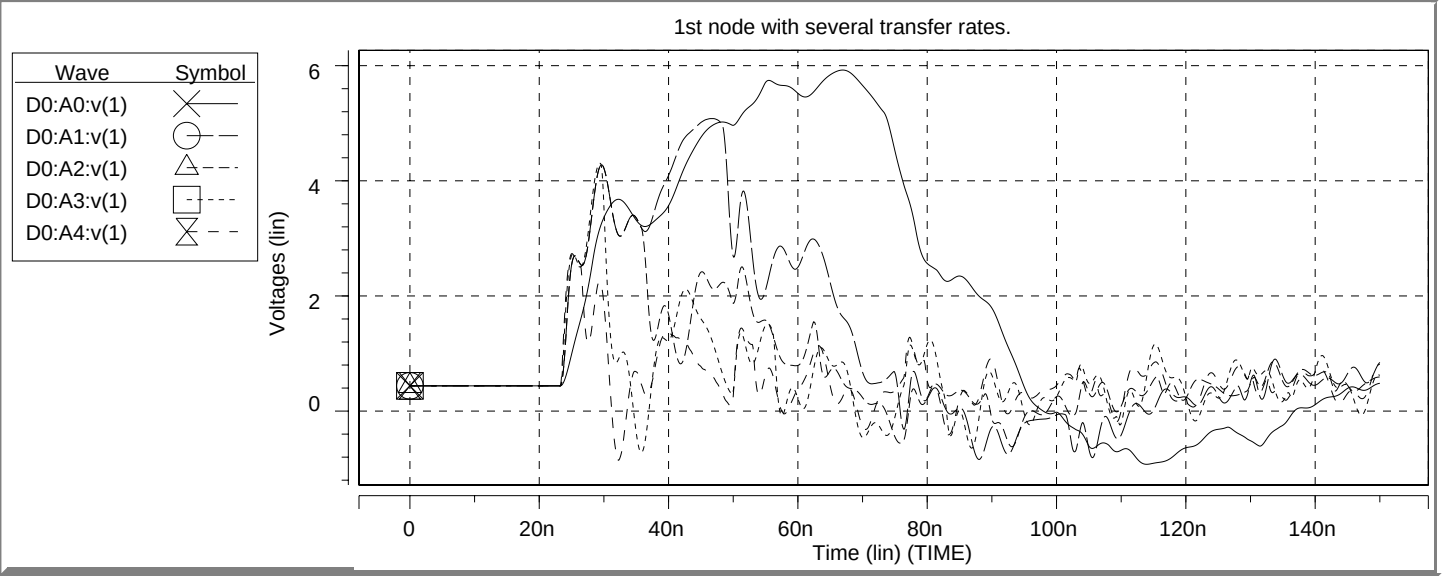

All nodes at 20 MTransfers. 4 groups of 3 drives.
Wave
Symbol
D0:A0:v(desk)
D0:A0:v(1)
D0:A0:v(2)
D0:A0:v(3)
D0:A0:v(4)
D0:A0:v(out)
Voltages (lin)
0
1
2
3
4
5
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)

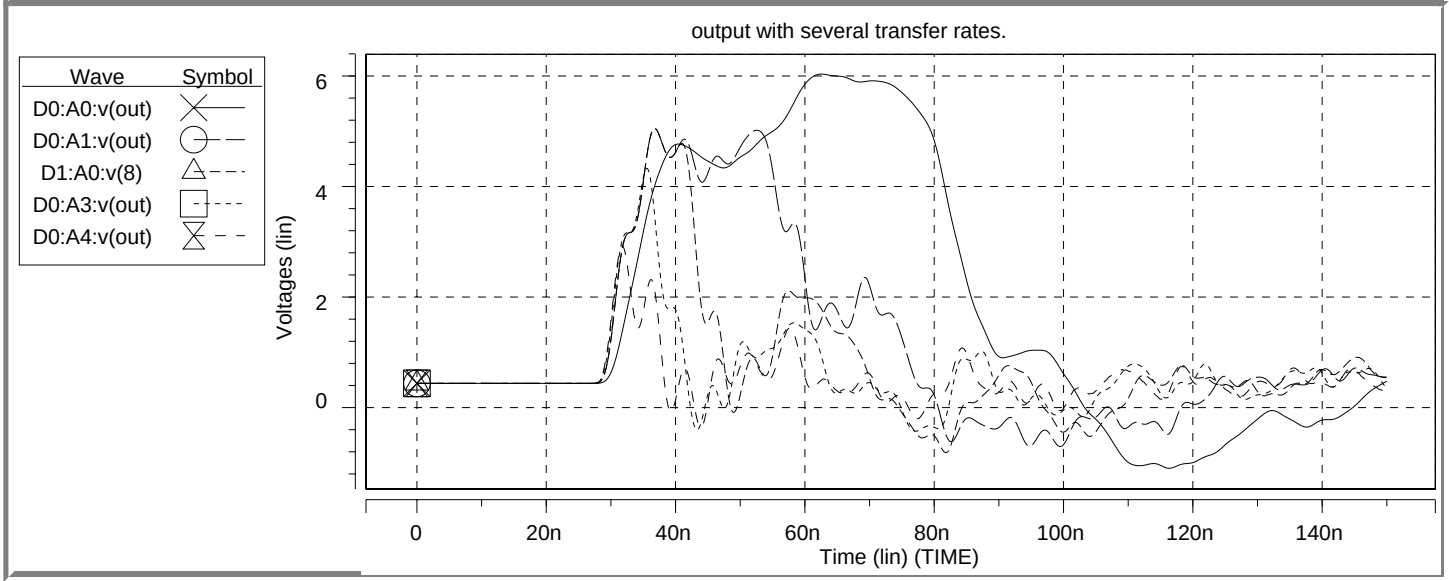

Node 1
Wave
Symbol
D0:A0:v(1)
D0:A1:v(1)
D0:A2:v(1)
D0:A3:v(1)
D0:A4:v(1)
Voltages (lin)
0
1
2
3
4
5
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)


output
Wave
Symbol
D0:A0:v(out)
D0:A1:v(out)
D0:A2:v(out)
D0:A3:v(out)
D0:A4:v(out)
Voltages (lin)
0
1
2
3
4
5
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)

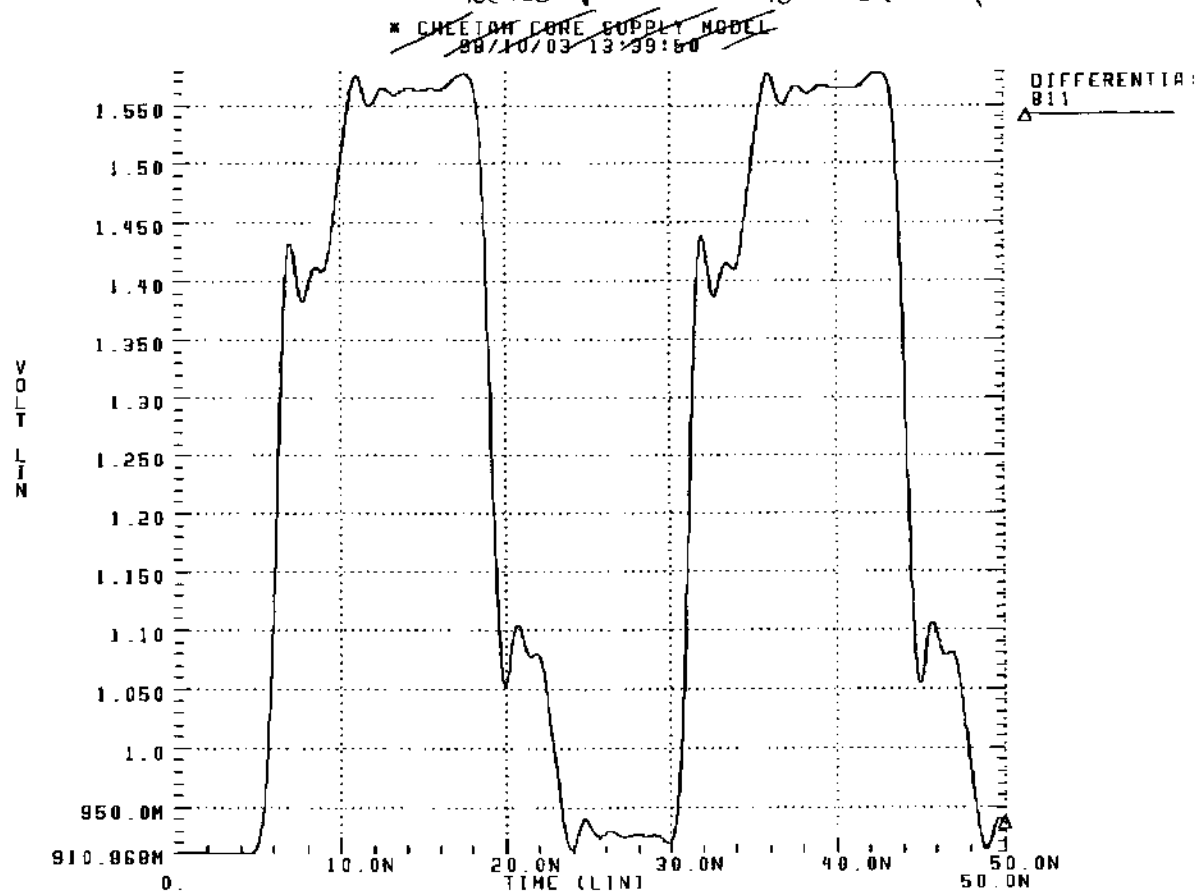

Several nodes. 12 groups of 1.
Wave
Symbol
D0:A0:v(/in)
D0:A0:v(1)
D0:A0:v(4)
D0:A0:v(8)
D0:A0:v(12)
D0:A0:v(/out)
Voltages (lin)
0
2
4
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)
!st node
Wave
Symbol
D0:A0:v(1)
D0:A1:v(1)
D0:A2:v(1)
D0:A3:v(1)
D0:A4:v(1)
Voltages (lin)
0
1
2
3
4
5
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)
output
Wave
Symbol
D0:A0:v(/out)
D0:A1:v(/out)
D0:A2:v(/out)
D0:A3:v(/out)
D0:A4:v(/out)
Voltages (lin)
0
2
4
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)


several nodes with no compensation. 20 MTransfers.
Wave
Symbol
D0:A0:v(desk)
D0:A0:v(1)
D0:A0:v(2)
D0:A0:v(3)
D0:A0:v(4)
D0:A0:v(out)
Voltages (lin)
0
2
4
6
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)

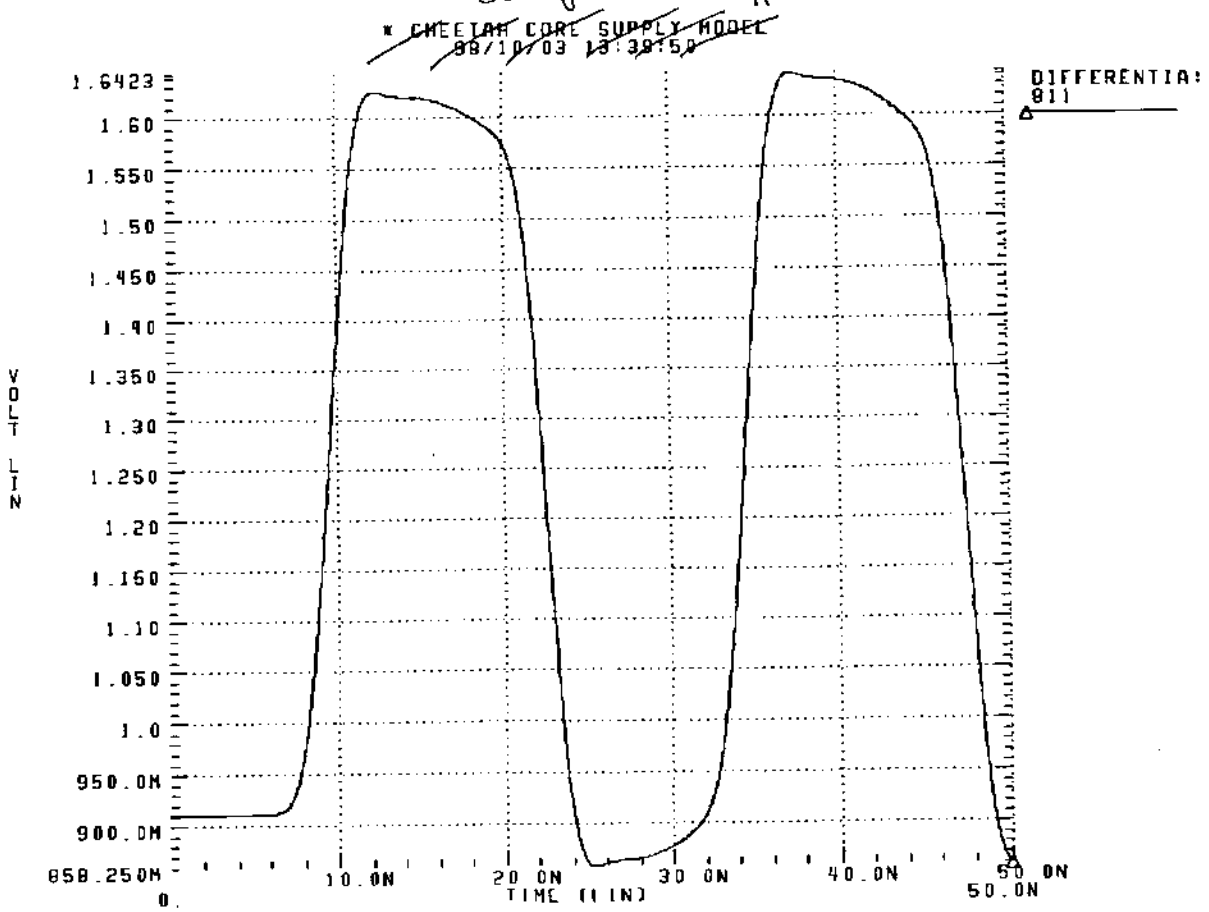

1st node with several transfer rates.
Wave
Symbol
D0:A0:v(1)
D0:A1:v(1)
D0:A2:v(1)
D0:A3:v(1)
D0:A4:v(1)
Voltages (lin)
0
2
4
6
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)

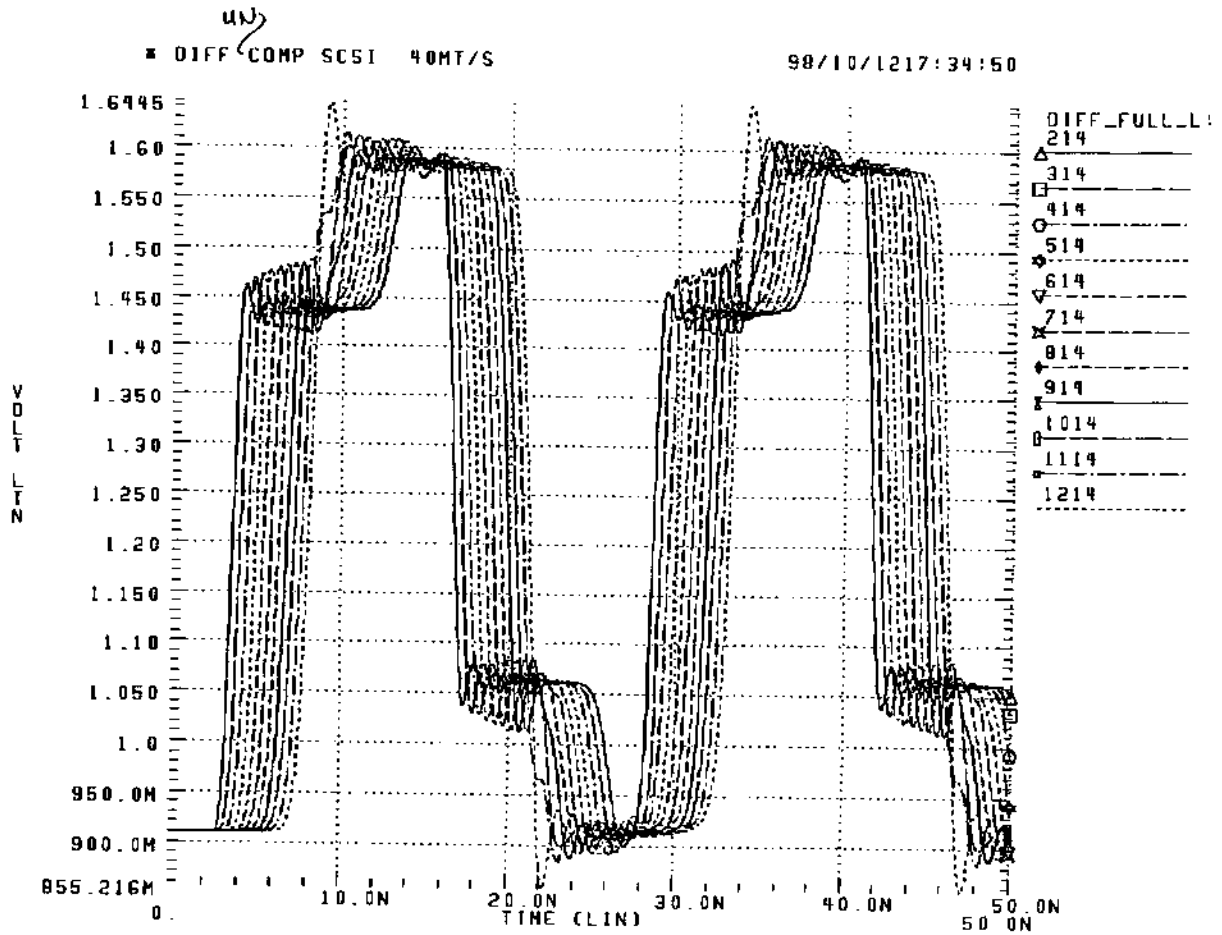

output with several transfer rates.
Wave
Symbol
D0:A0:v(out)
D0:A1:v(out)
D1:A0:v(8)
D0:A3:v(out)
D0:A4:v(out)
Voltages (lin)
0
2
4
6
0
20n
40n
60n
80n
100n
120n
140n
Time (lin) (TIME)

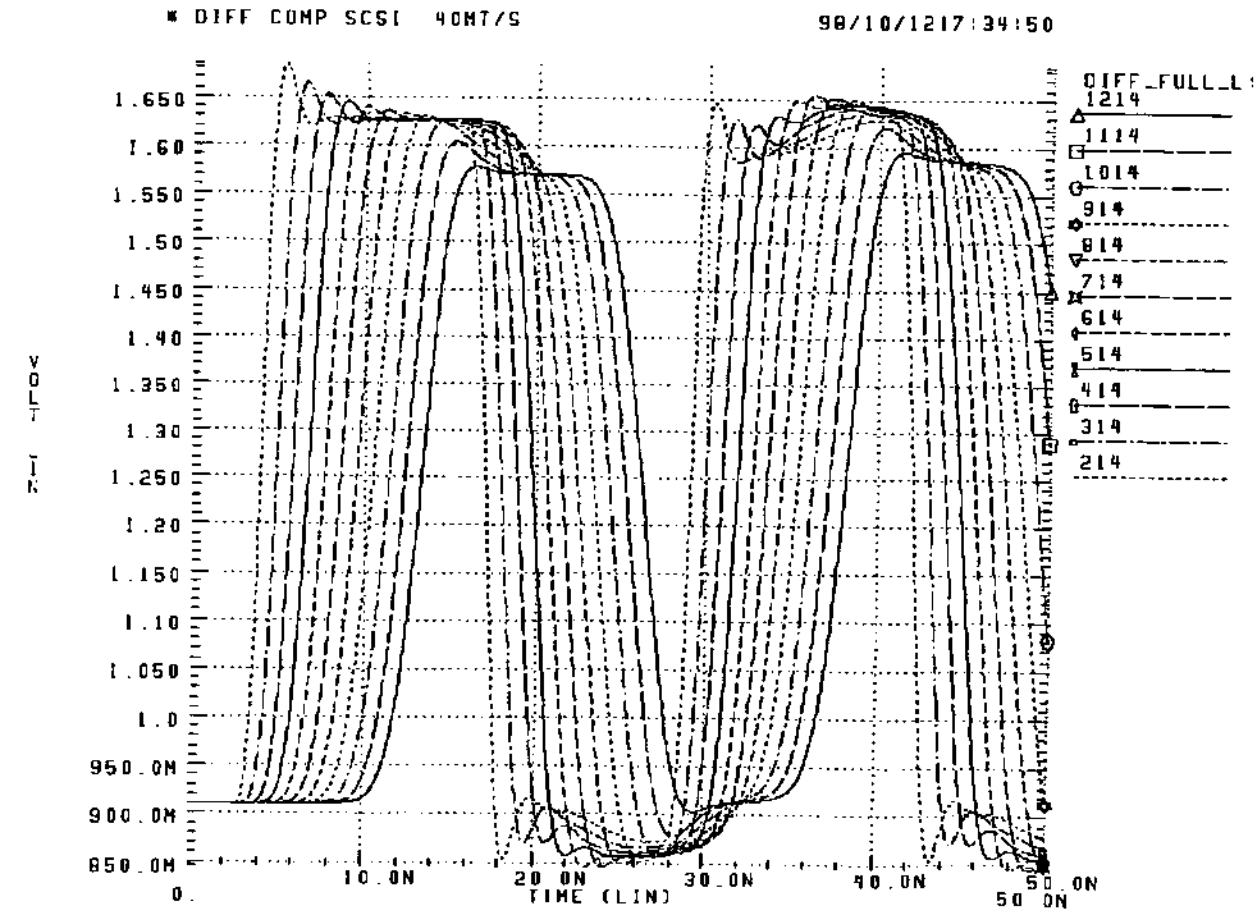
Uncompensated differential SCSI

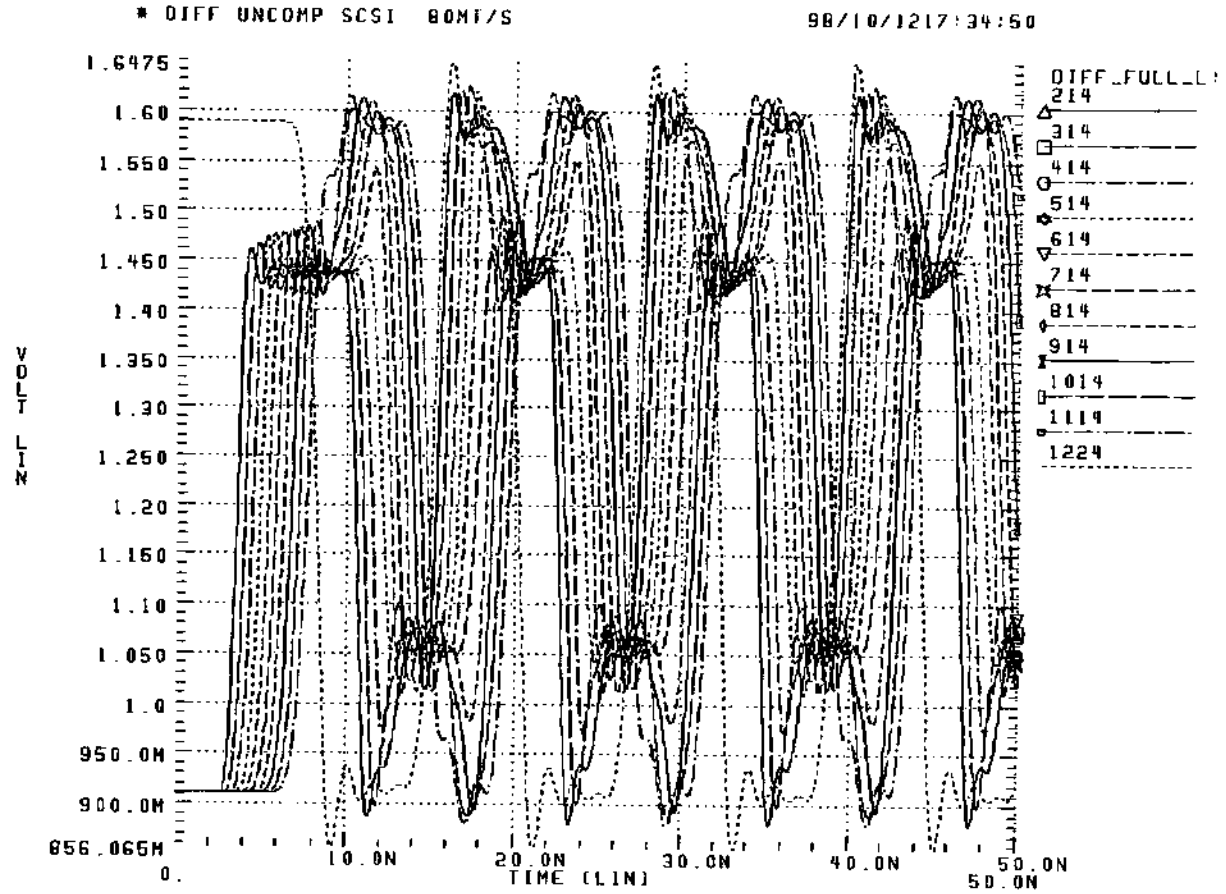


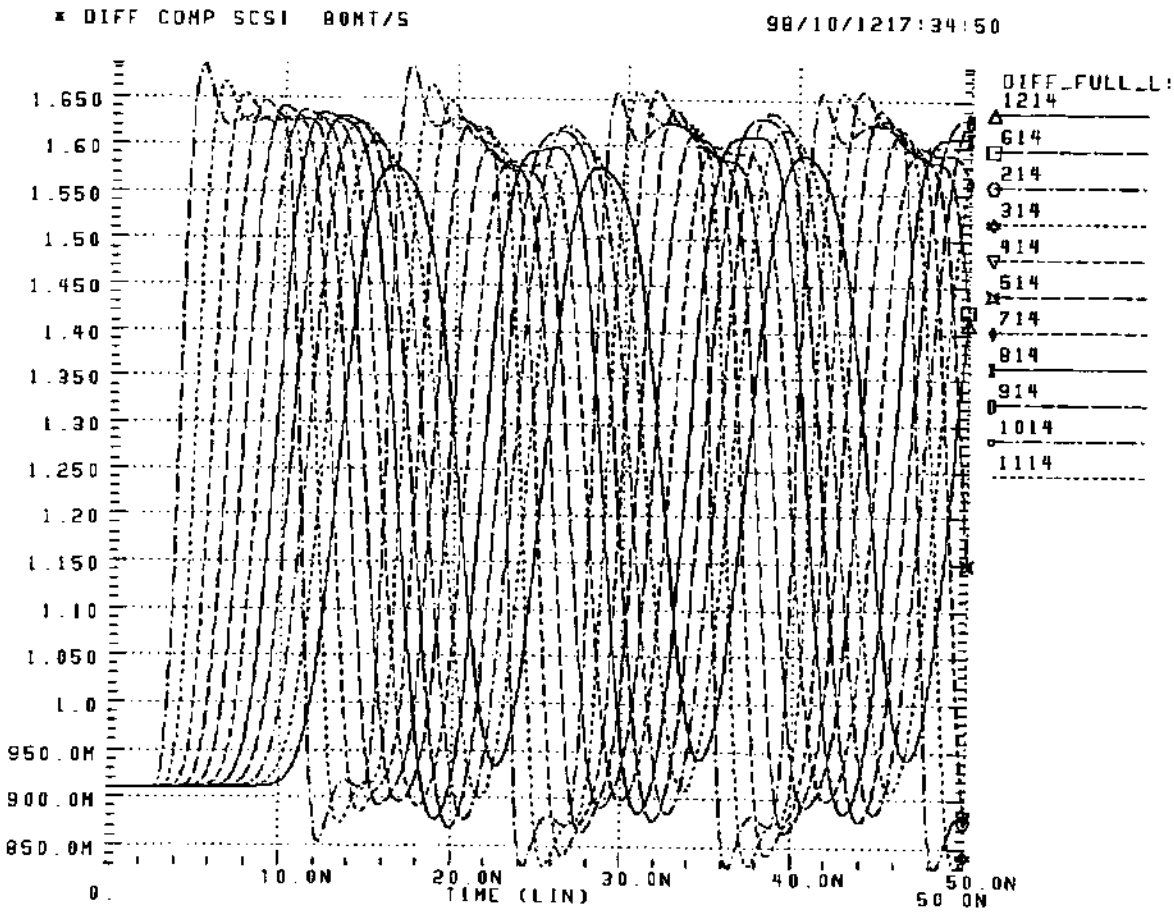
Compensated differential SCSI

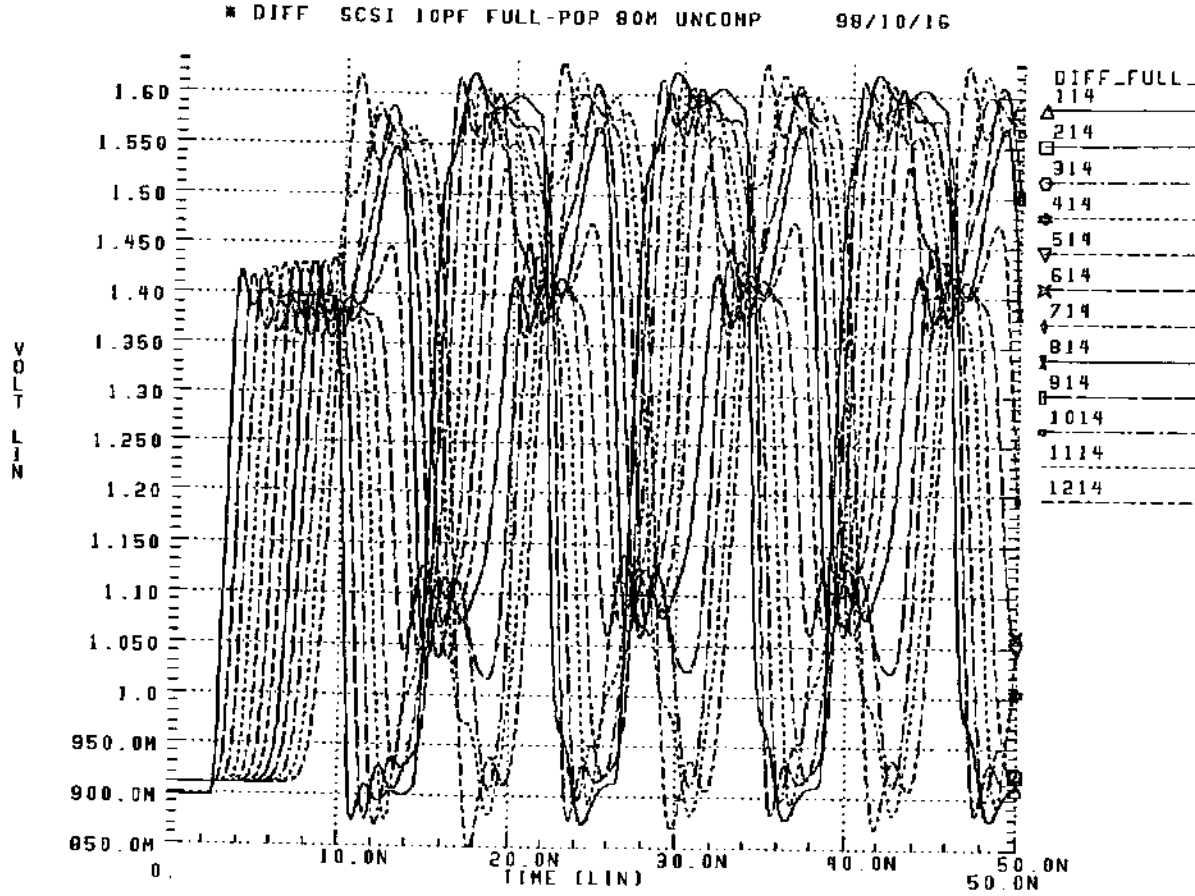


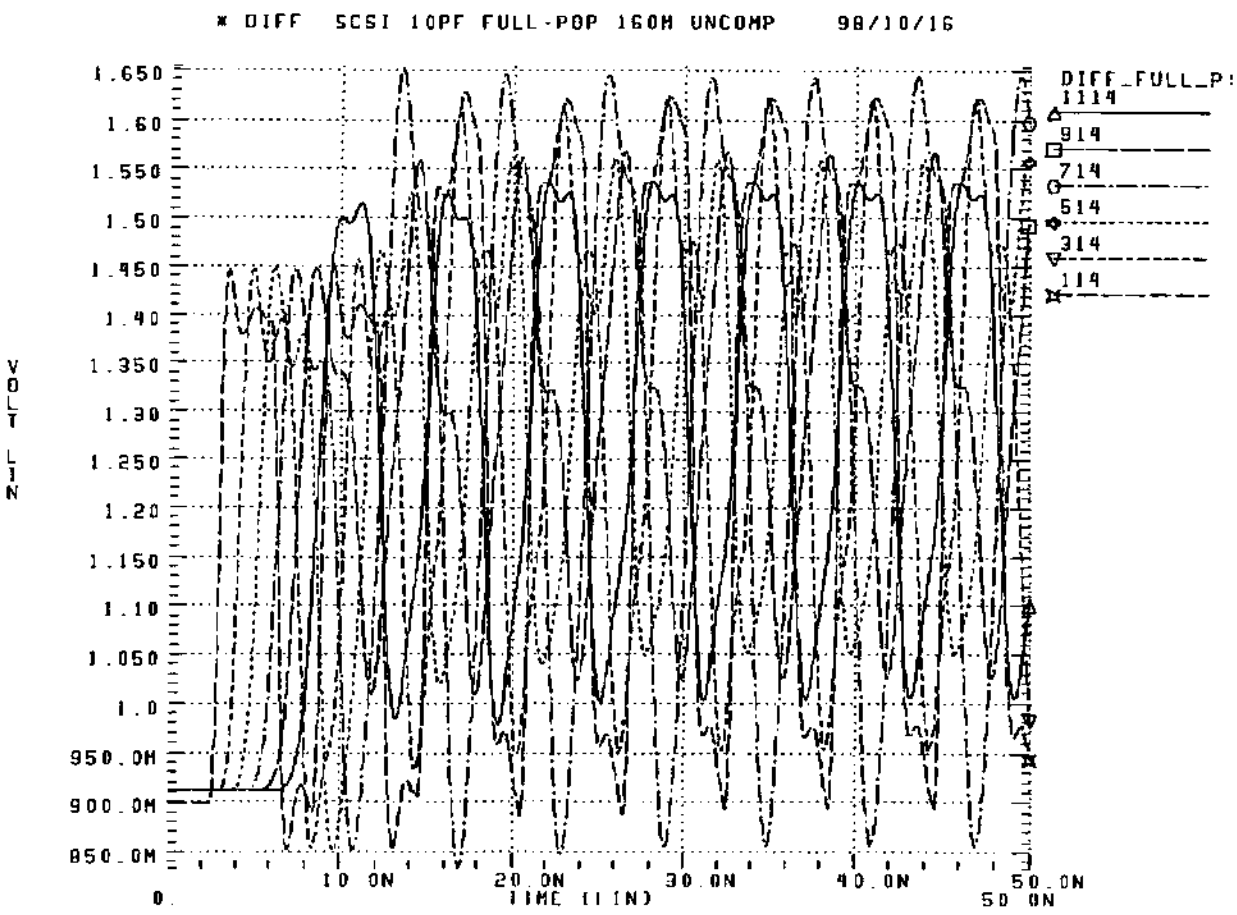

* DIFF COMP SCSI 40MT/S
98/10/1217:34:50
DIFF_FULL_L
214
314
414
514
614
714
814
914
1014
1114
1214
VOLT LIN
1.6945
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
855.216M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
TIME (LIN)

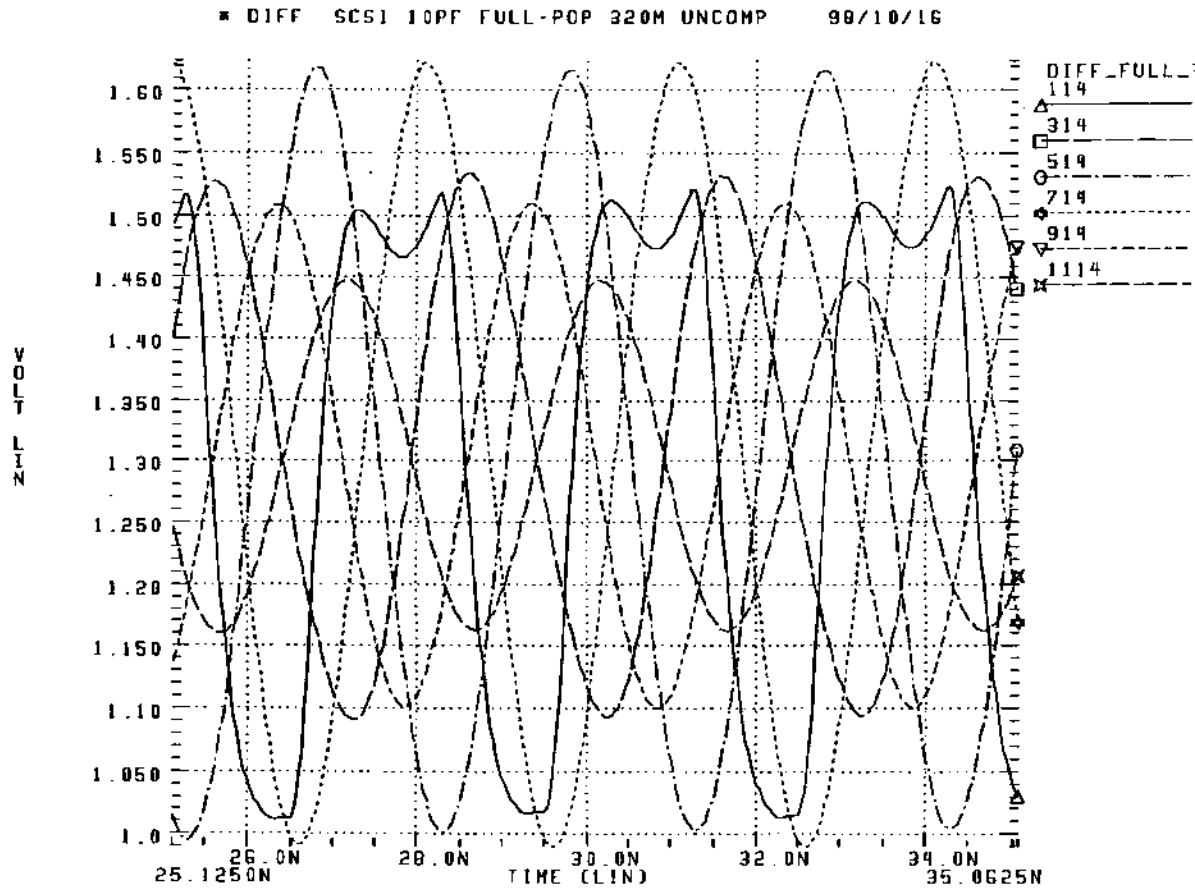

* DIFF COMP SCSI 40MT/S
98/10/1217:34:50
DIFF_FULL_L
1214
1114
1014
914
814
714
614
514
414
314
214
VOLT LIN
1.650
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
850.0M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
TIME (LIN)

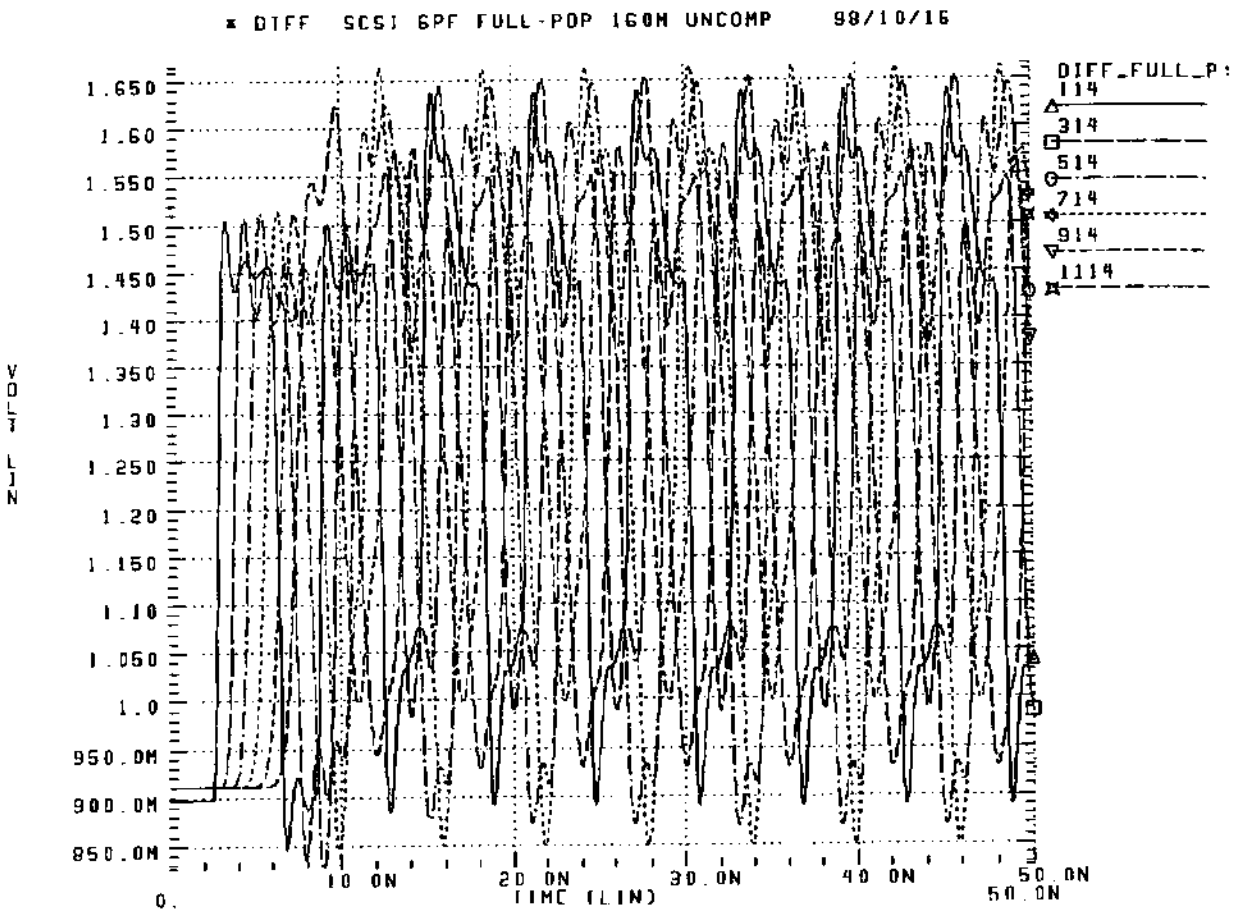

* DIFF UNCOMP SCSI 80MT/S
98/10/1217:34:50
DIFF_FULL_L
214
314
414
514
614
714
814
914
1014
1114
1224
VOLT LIN
1.6475
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
856.066M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
50.0N
TIME (LIN)

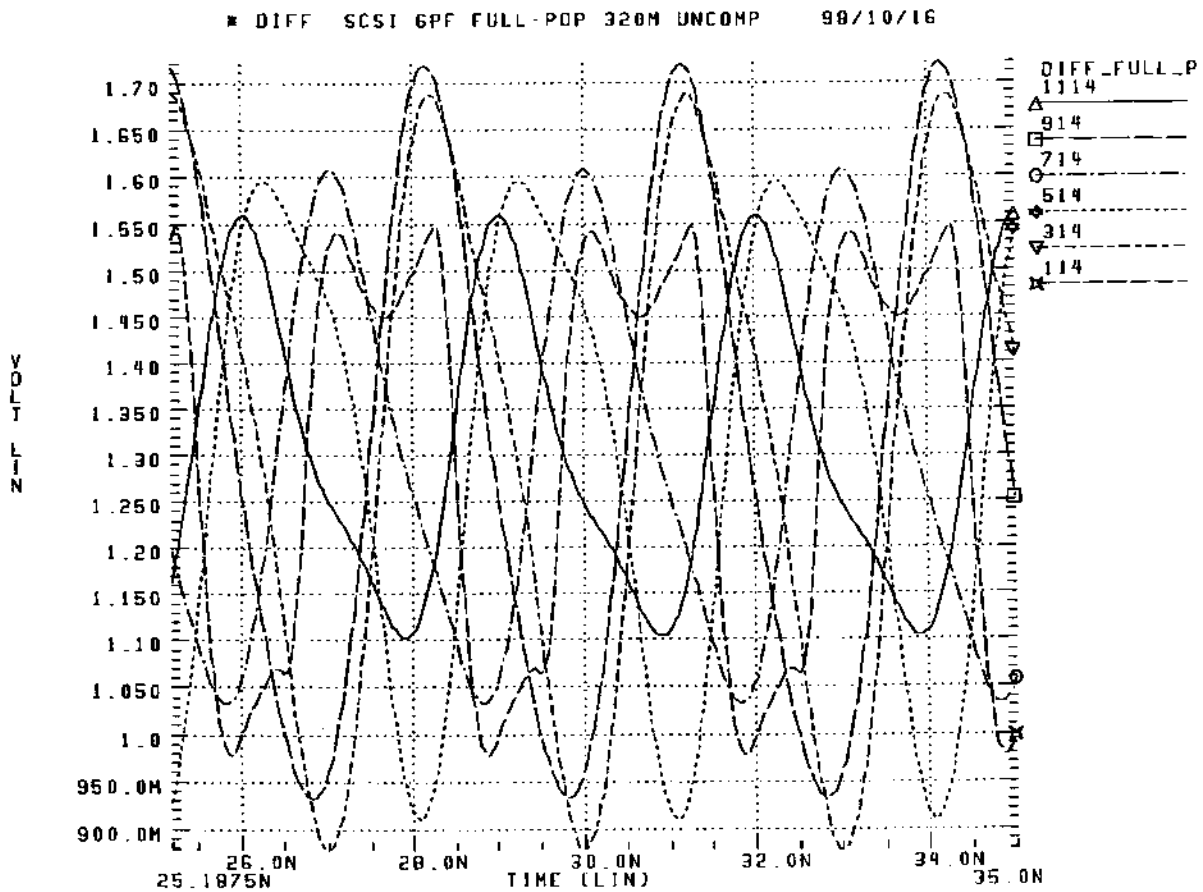

* DIFF COMP SCSI 80MT/S
98/10/1217:34:50
DIFF_FULL_L
1214
614
214
314
414
514
714
814
914
1014
1114
1.650
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
850.0M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
50.0N
TIME (LIN)

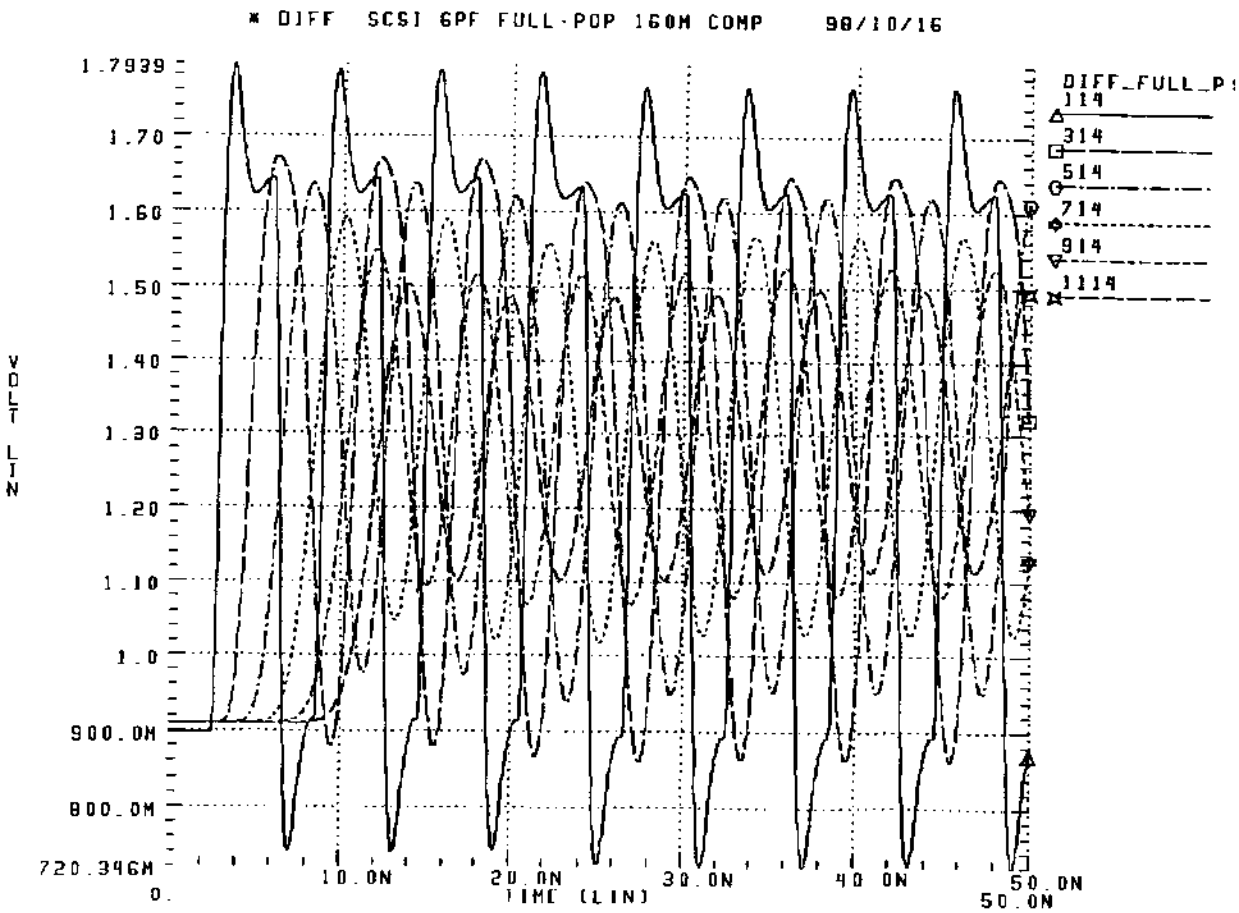

* DIFF SCSI 10PF FULL-POP 80M UNCOMP 98/10/16
VOLT LIN
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
850.0M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
TIME (LIN)
DIFF_FULL_
114
214
314
414
514
614
714
814
914
1014
1114
1214

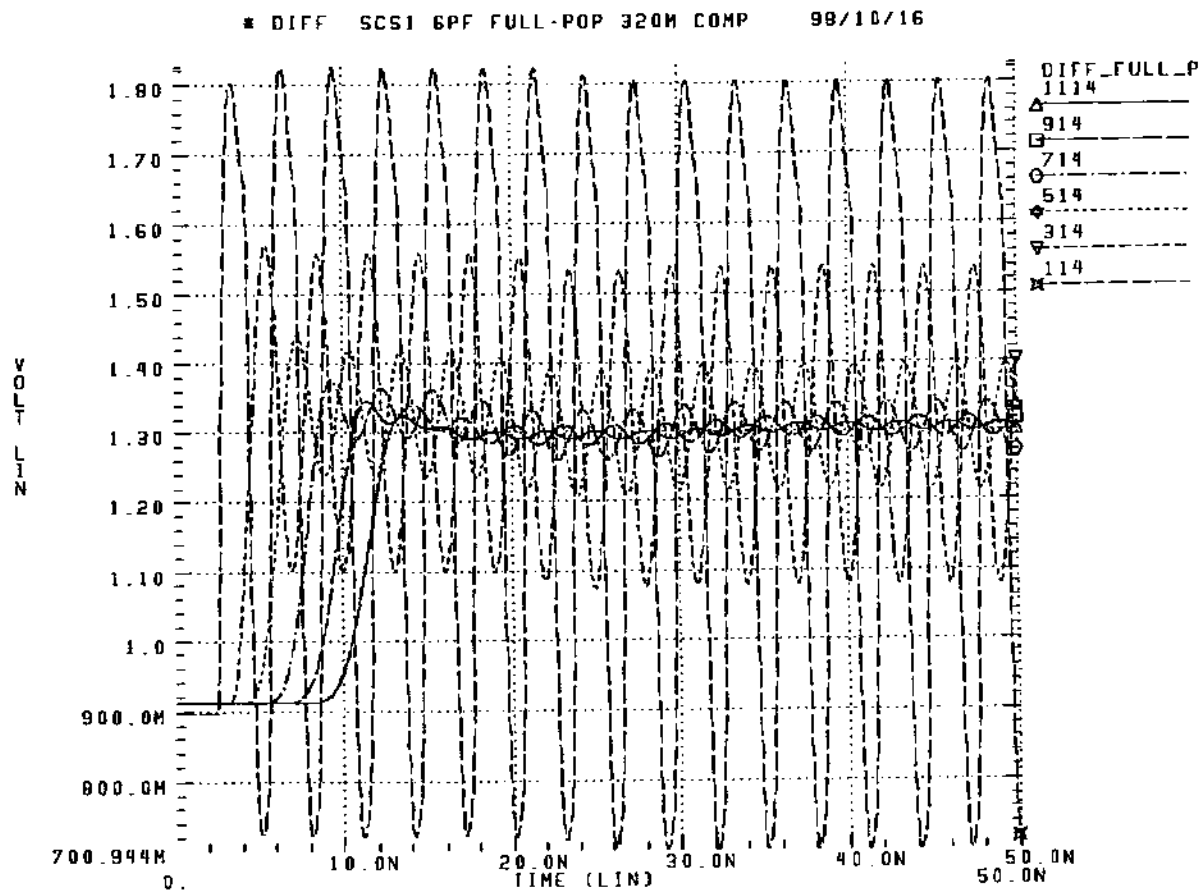

* DIFF SCSI 10PF FULL-POP 160M UNCOMP 98/10/16
VOLT LIN
1.650
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
850.0M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
TIME (LIN)
DIFF_FULL_P
1114
914
714
514
314
114


* DIFF SCSI 10PF FULL-POP 320M UNCOMP 98/10/16
VOLT LIN
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
26.0N
28.0N
30.0N
32.0N
34.0N
25.1250N
TIME (LIN)
35.0625N
DIFF_FULL_
114
314
514
714
914
1114

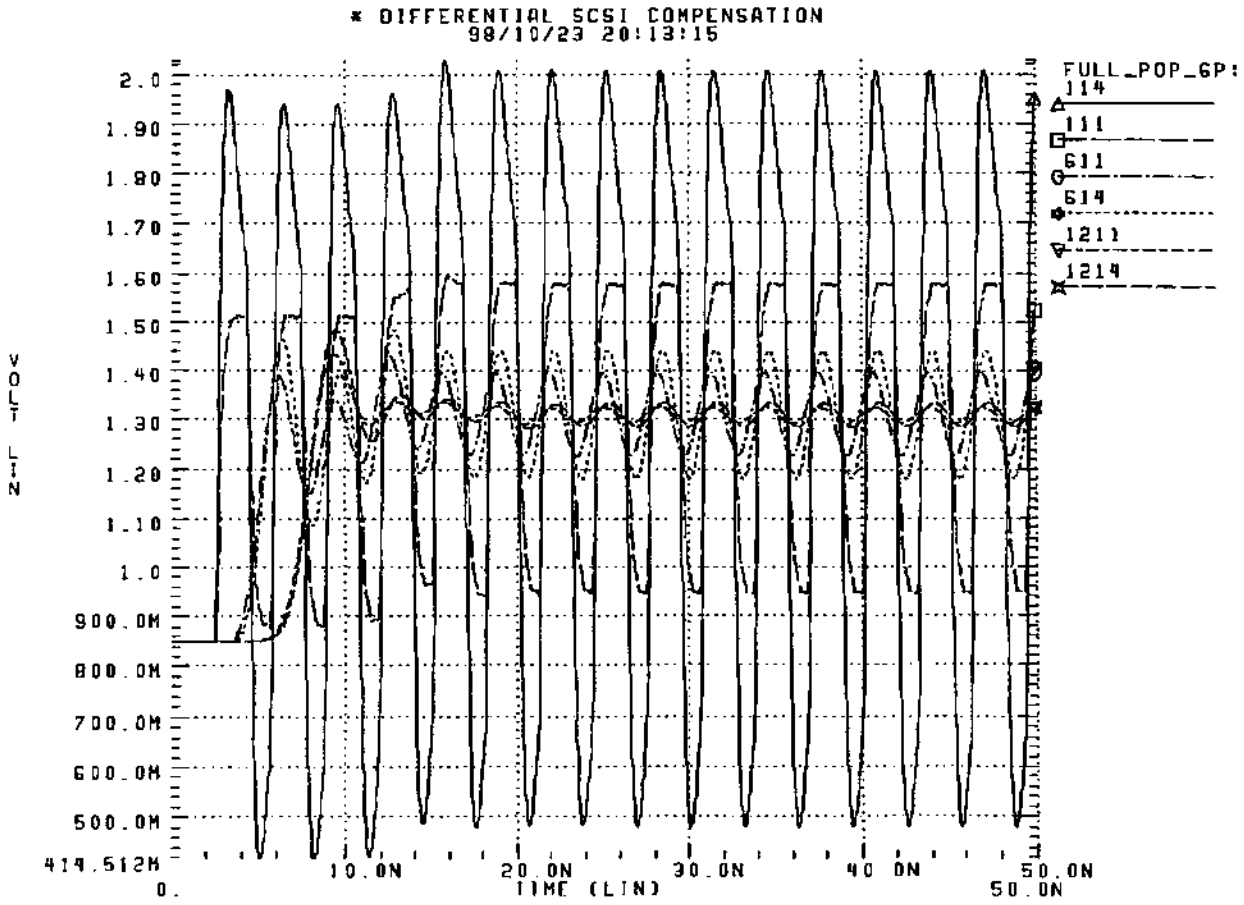

* DIFF SCSI 6PF FULL-POP 160M UNCOMP 98/10/16
VOLT LIN
1.650
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
850.0M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
50.0N
TIME (LIN)
DIFF_FULL_P
114
314
514
714
914
1114


* DIFF SCSI 6PF FULL-POP 320M UNCOMP 98/10/16
DIFF_FULL_P
1114
914
714
514
314
114
VOLT LIN
1.70
1.650
1.60
1.550
1.50
1.450
1.40
1.350
1.30
1.250
1.20
1.150
1.10
1.050
1.0
950.0M
900.0M
25.0N
25.1875N
28.0N
30.0N
32.0N
34.0N
35.0N
TIME (LIN)

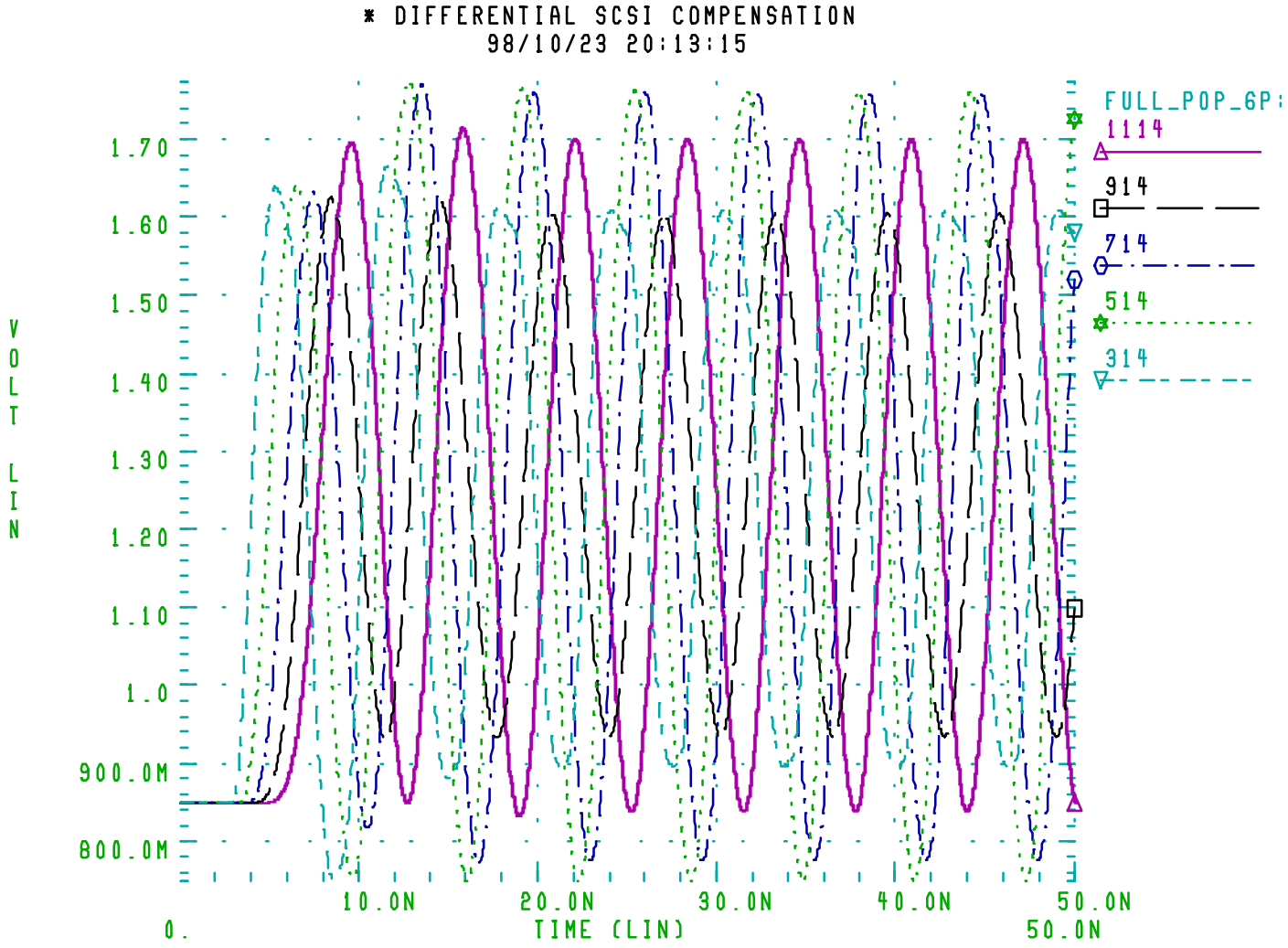

* DIFF SCSI 6PF FULL-POP 160M COMP 98/10/16
DIFF_FULL_P
114
314
514
714
914
1114
VOLT LIN
1.7939
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.0
900.0M
800.0M
720.346M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
50.0N
TIME (LIN)



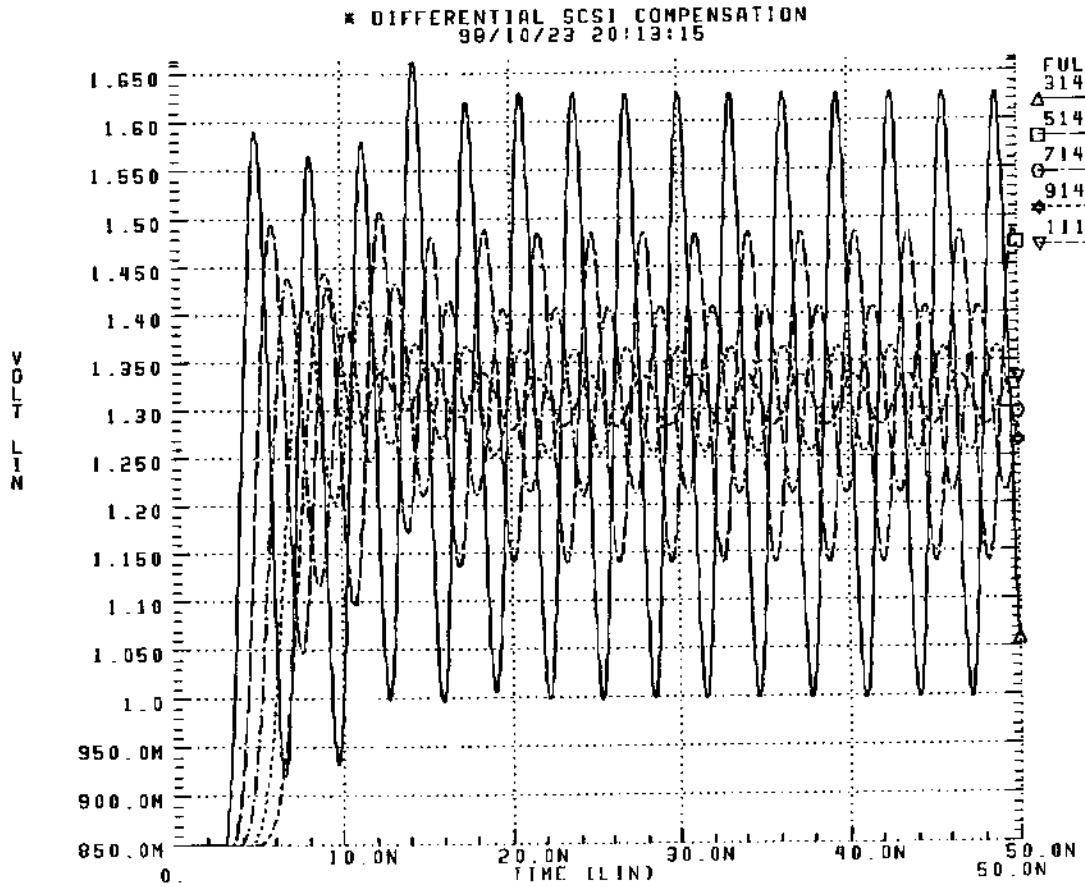
820 Kondaleer 6pF



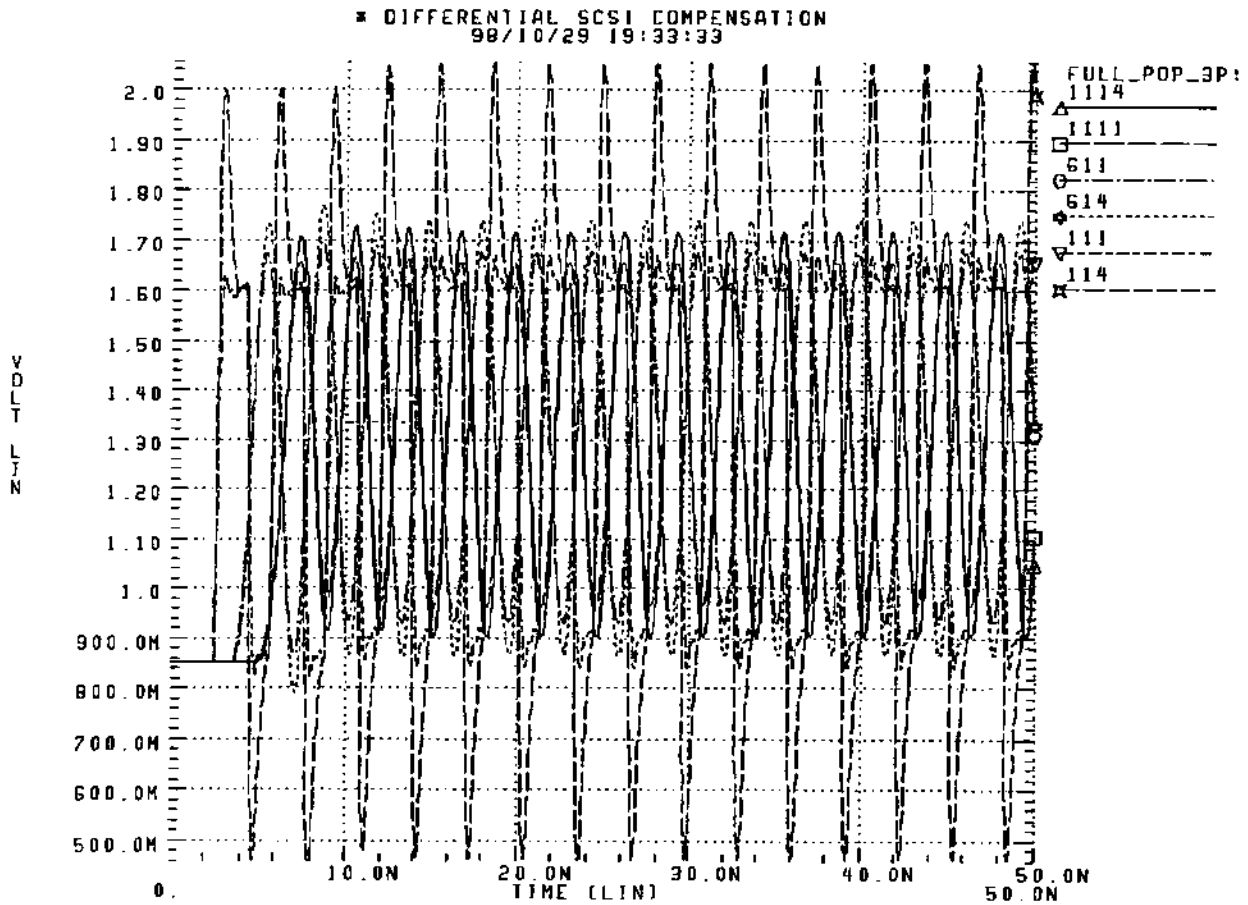
```
* Differential SCSI compensation
* Istvan Novak
* October 29, 1998
* 12pf_320M_sercomp.sp
*

* Node naming convention:
* first two digits: slot number
* third digit:  1: upper trace
*   2: lower trace
* fourth digit: 1: center node in T compensation network
*   2: left side of T compensation network
*   3: right side of T compensation network
*   4: SCSI device behind connector


.options list node post
.tran 50ps 50ns

.param term_b=100
.param term_a=43
.param slot_spacing=1.5
.param term_spacing=0.75

.param source_a=43
.param source_b=43

* In the series compensation circuits, the compensation components in the mai
* leave Rcl=Rcr=0.01
.param Lcl=22nH  Lcr=22nH
.param Rcl=0.01    Rcr=0.01

* Series compensation between the drive and SCSI bus node
.param Rs=40
.param Ls=5nH

.param Rd=1e9
.param Ci=12pF

* The LVDS differential trace impedance should be 122+-8 ohms.
* With the scsi_trace2.rlc file the differential impedance is: 121.7 ohms
**************************************************************************
* This section is just for testing the trace parameters
Xdrtest   1 3 Drv
W_diff  N=2 1 3 0 2 4 0 RLGCfile=scsi_trace2.rlc  l='15*2.54/100'
Xtermtest 2 4 Term
.print tran v(1) v(2) v(3) v(4)
**************************************************************************

* Driver
Xdriver   0114  0124  Drv

* Bus traces
Xtermleft   0010  0020  Term
Xlineleft   0010  0112  0020  0122  diff_trace length=term_spacing

Xline0102   0113  0212  0123  0222  diff_trace length=slot_spacing
Xline0203   0213  0312  0223  0322  diff_trace length=slot_spacing
Xline0304   0313  0412  0323  0422  diff_trace length=slot_spacing
Xline0405   0413  0512  0423  0522  diff_trace length=slot_spacing
```


* DIFFERENTIAL SCSI COMPENSATION
98/10/23 20:13:15
FULL_POP_6P:
1114
914
714
514
314
VOLT LIN
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.0
900.0M
800.0M
0.
10.0N
20.0N
30.0N
40.0N
50.0N
TIME (LIN)
50.0N

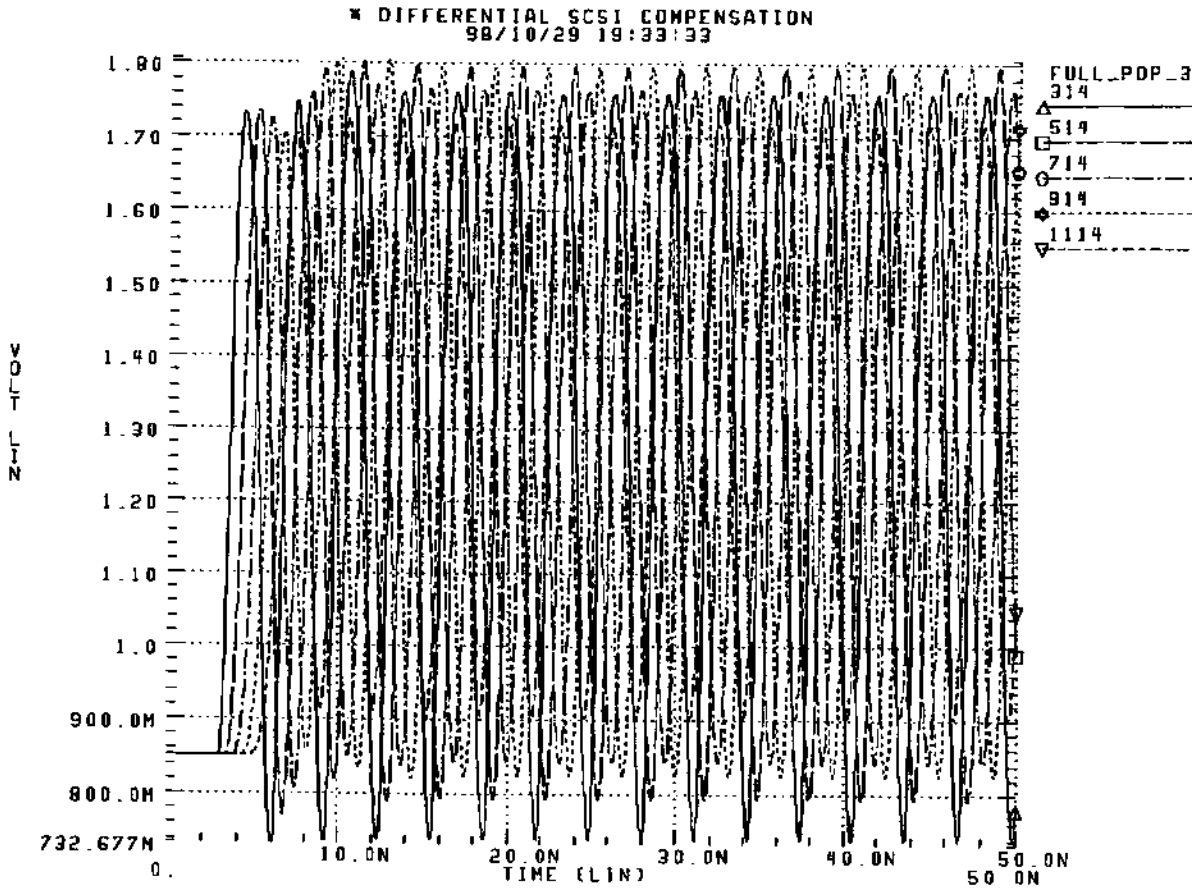
820 Mbaud/sec 6

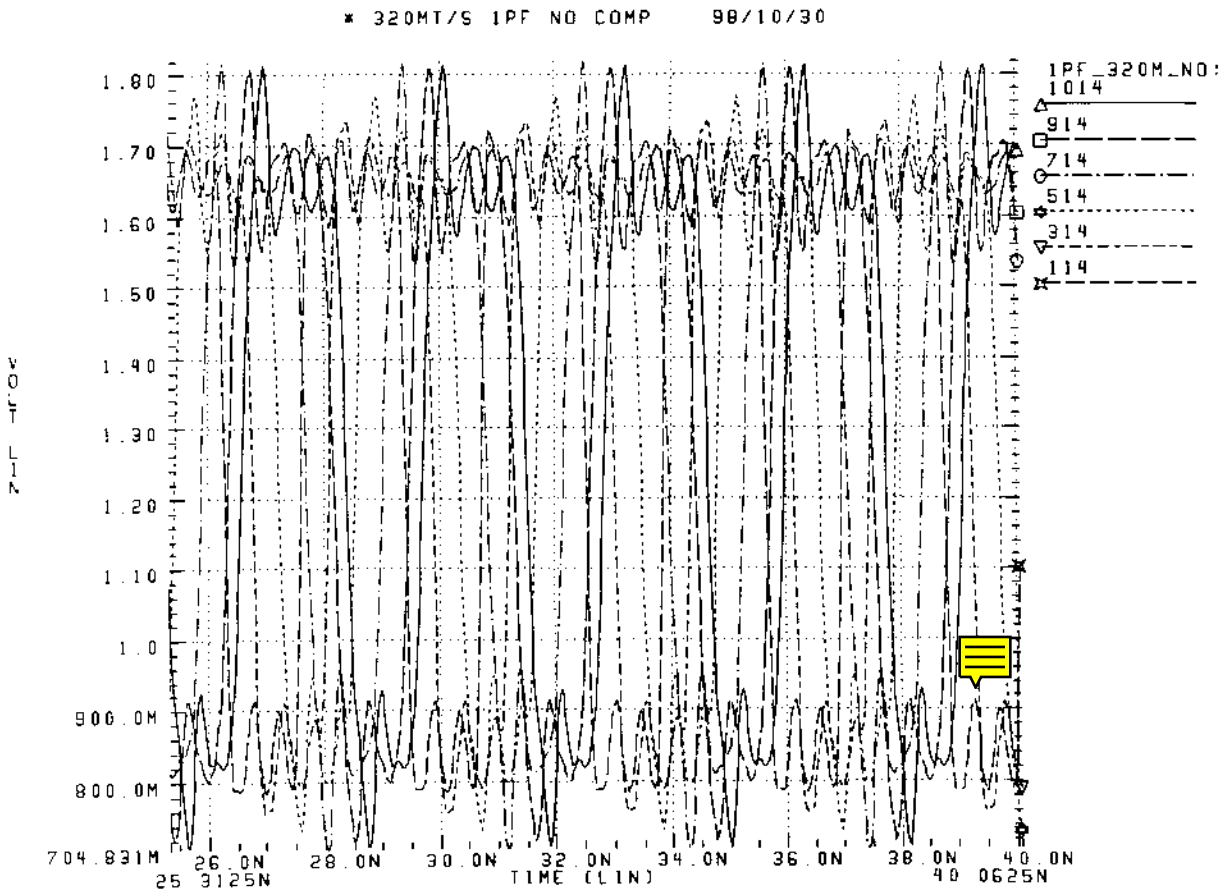


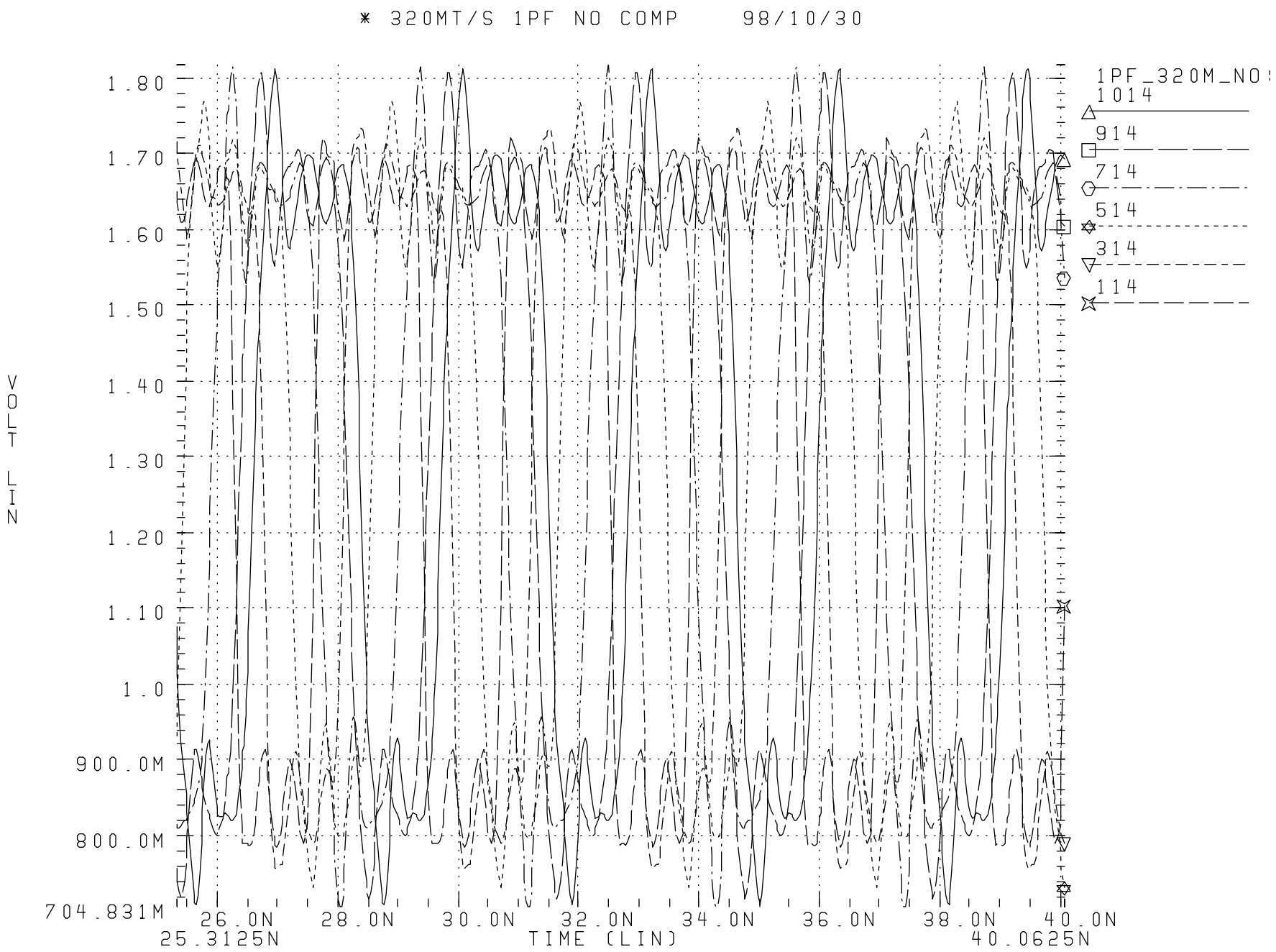
820 Mbaud/sec Spot

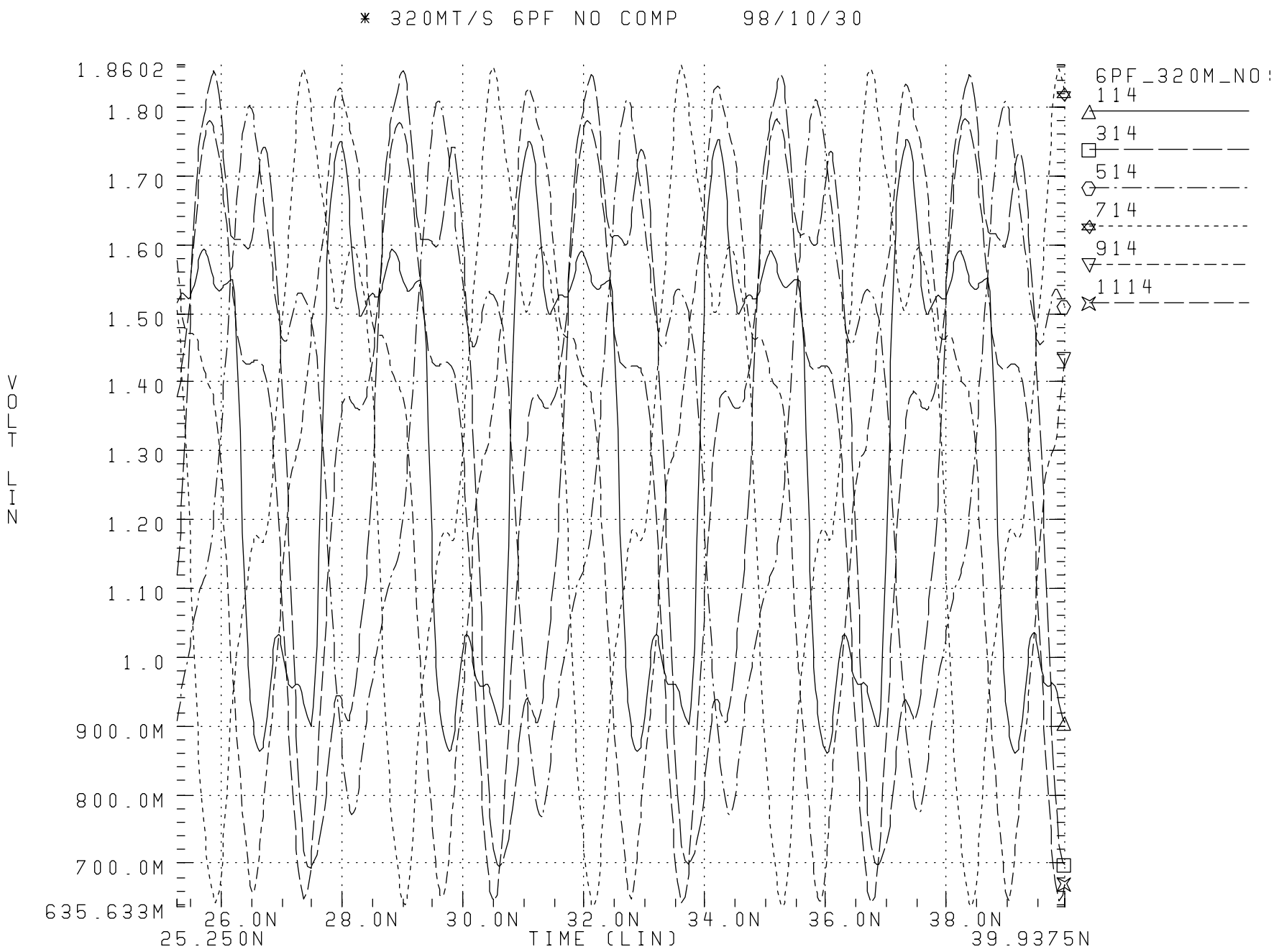


320 Hbrowfa/rec 3






* 320MT/S 1PF NO COMP 98/10/30
1PF_320M_NO
1014
914
714
514
314
114
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.0
900.0M
800.0M
704.831M
VOLT LIN
26.0N
28.0N
30.0N
32.0N
34.0N
36.0N
38.0N
40.0N
25.3125N
TIME (LIN)
40.0625N


* 320MT/S 6PF NO COMP 98/10/30
1.8602
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.0
900.0M
800.0M
700.0M
635.633M
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TIME (LIN)
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314
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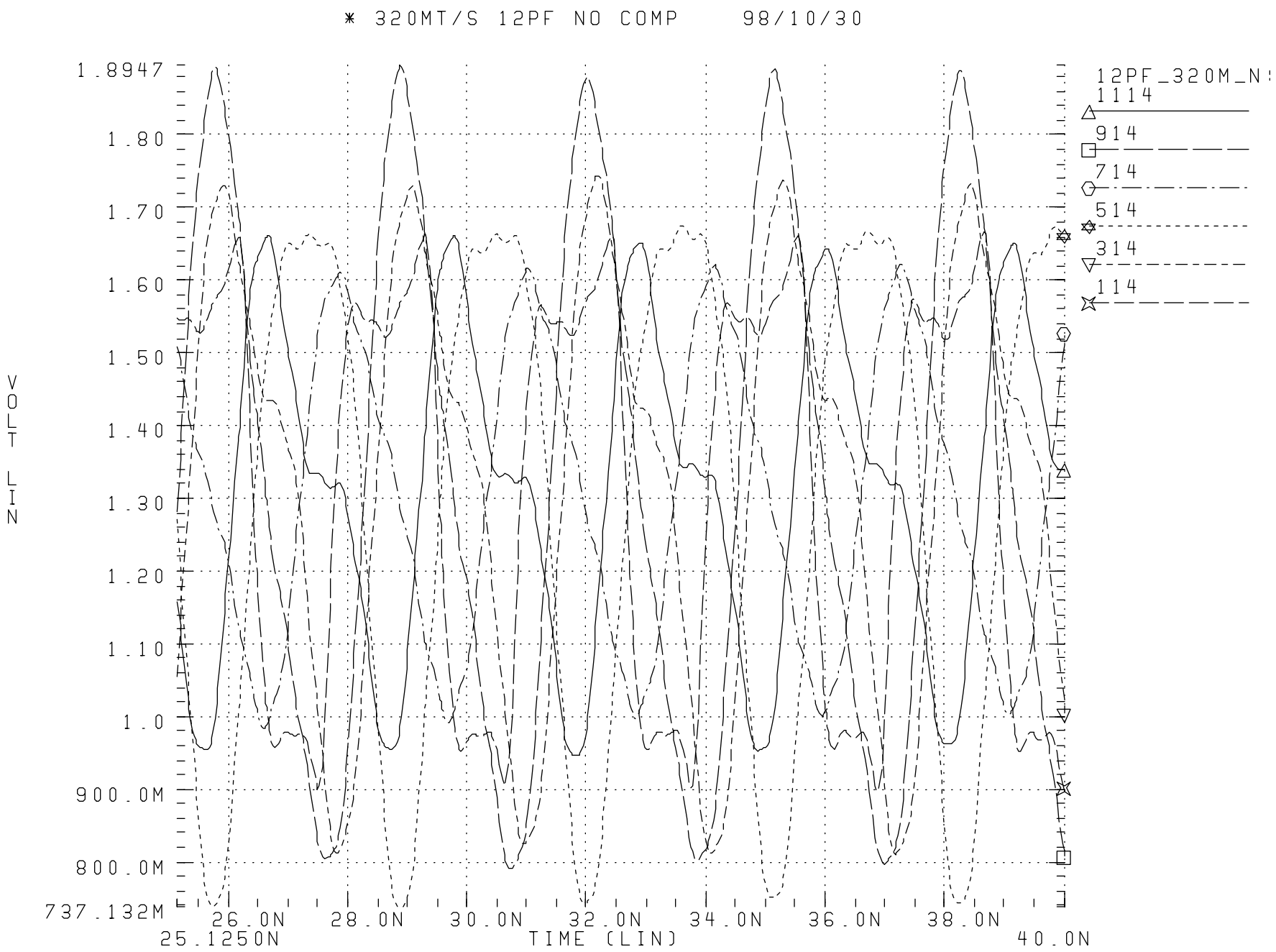
714
914
1114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1.0
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VOLT LIN
26.0N
28.0N
30.0N
32.0N
34.0N
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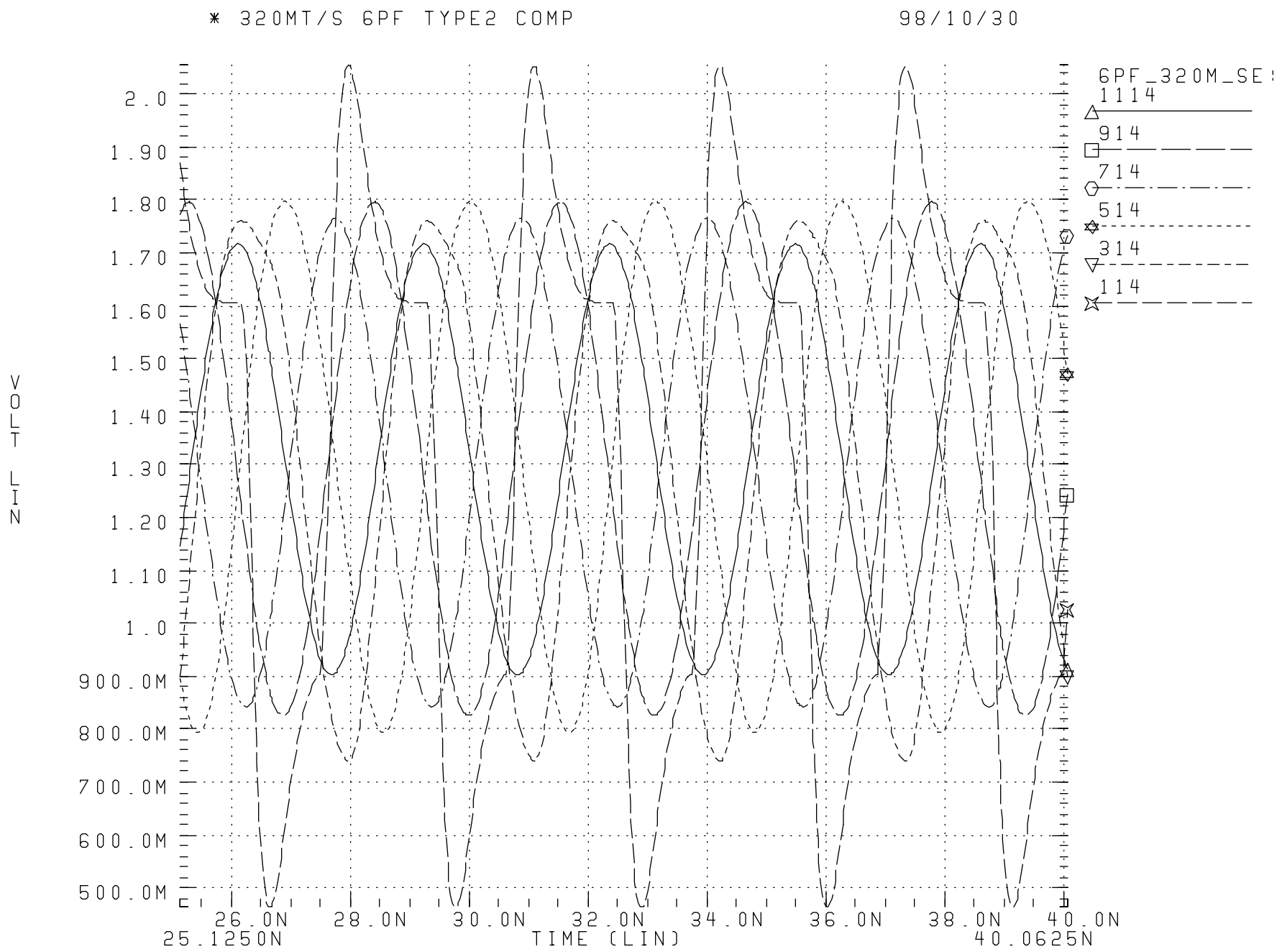
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914
714
514
314
114
VOLT LIN
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1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.0
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800.0M
700.0M
600.0M
500.0M
26.0N
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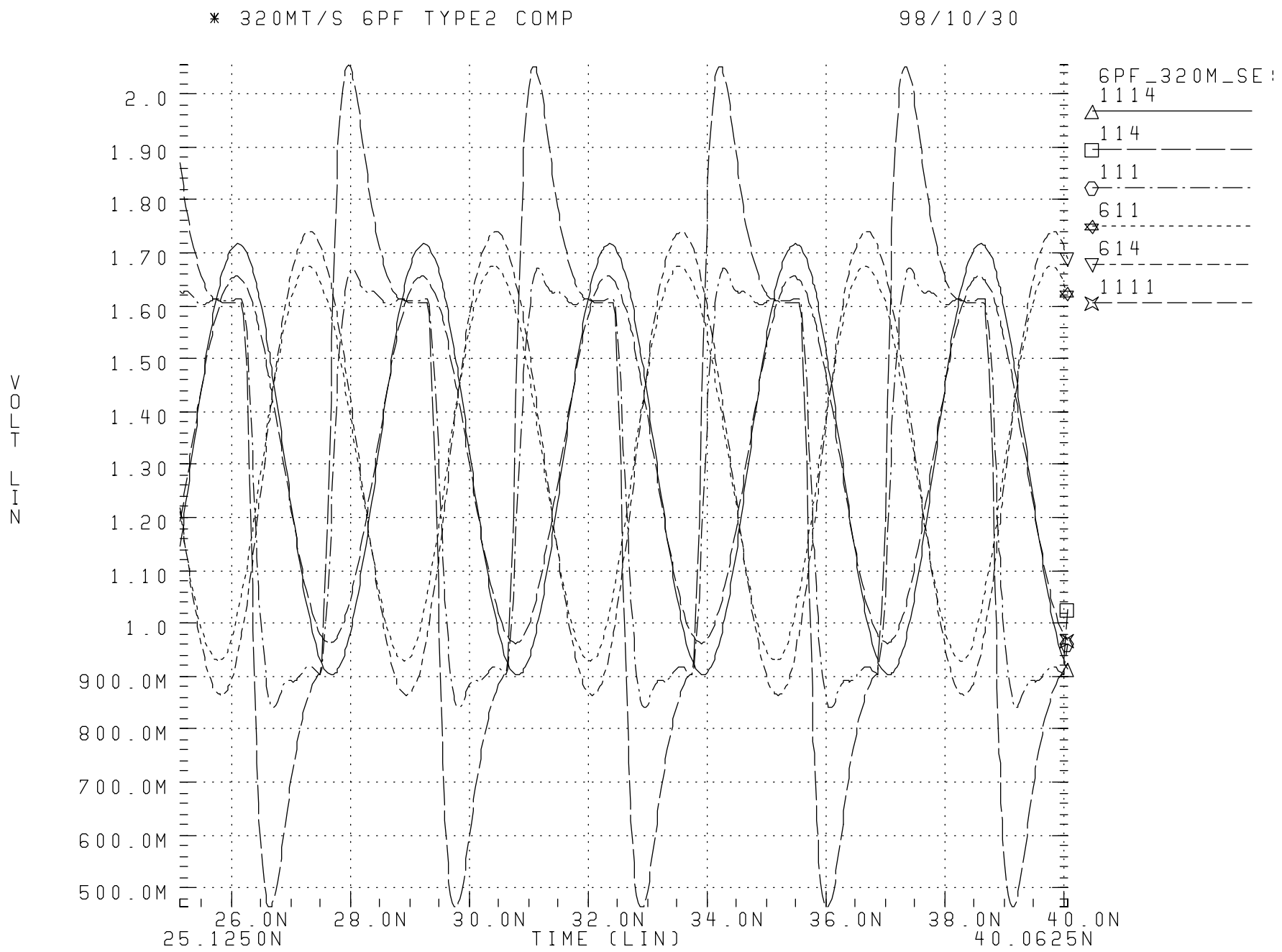
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6PF_320M_SE
1114
114
111
611
614
1111
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1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.0
900.0M
800.0M
700.0M
600.0M
500.0M
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TIME (LIN)
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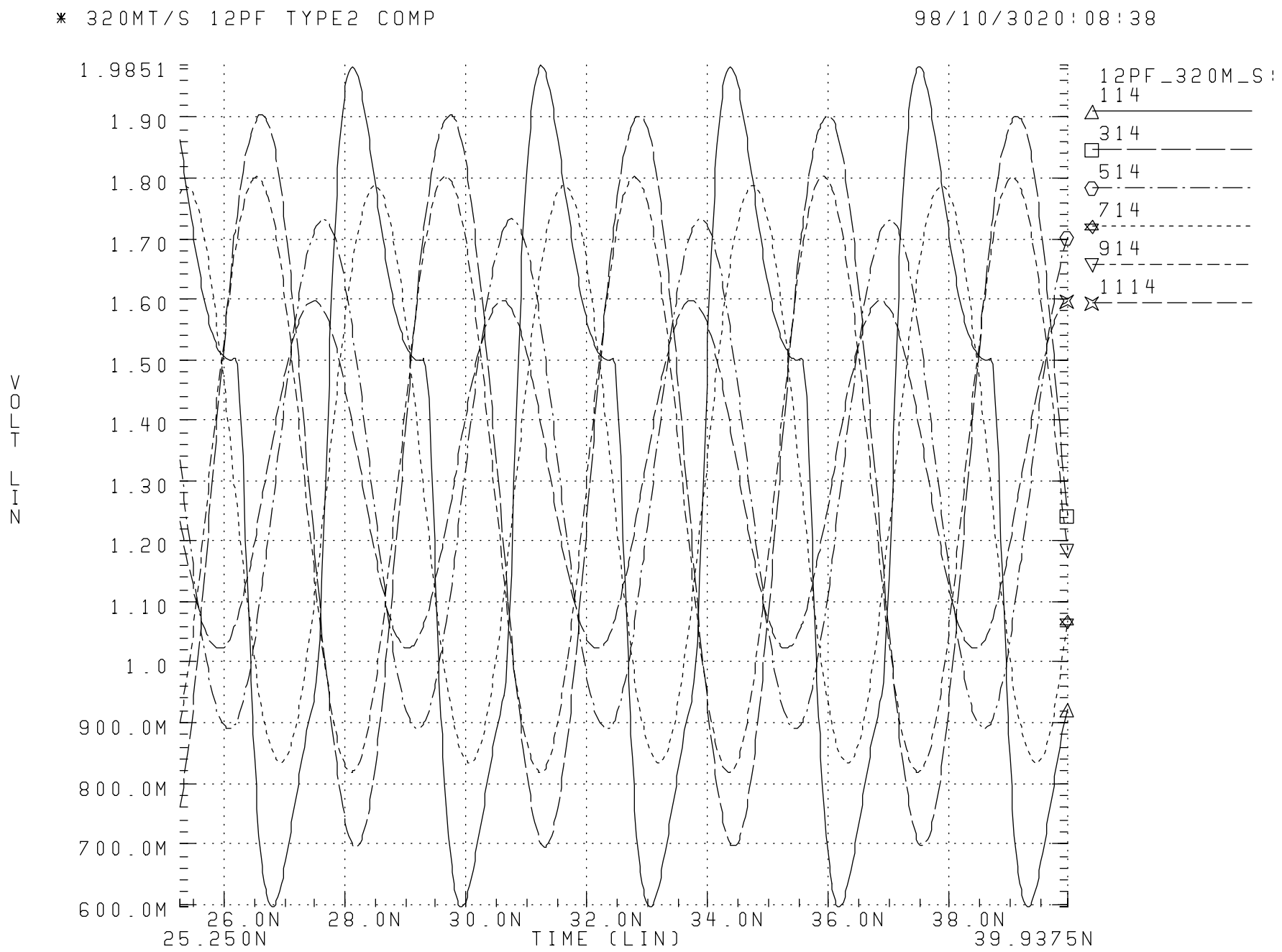
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VOLT LIN
26.0N
28.0N
30.0N
32.0N
34.0N
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12PF_320M_S
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314
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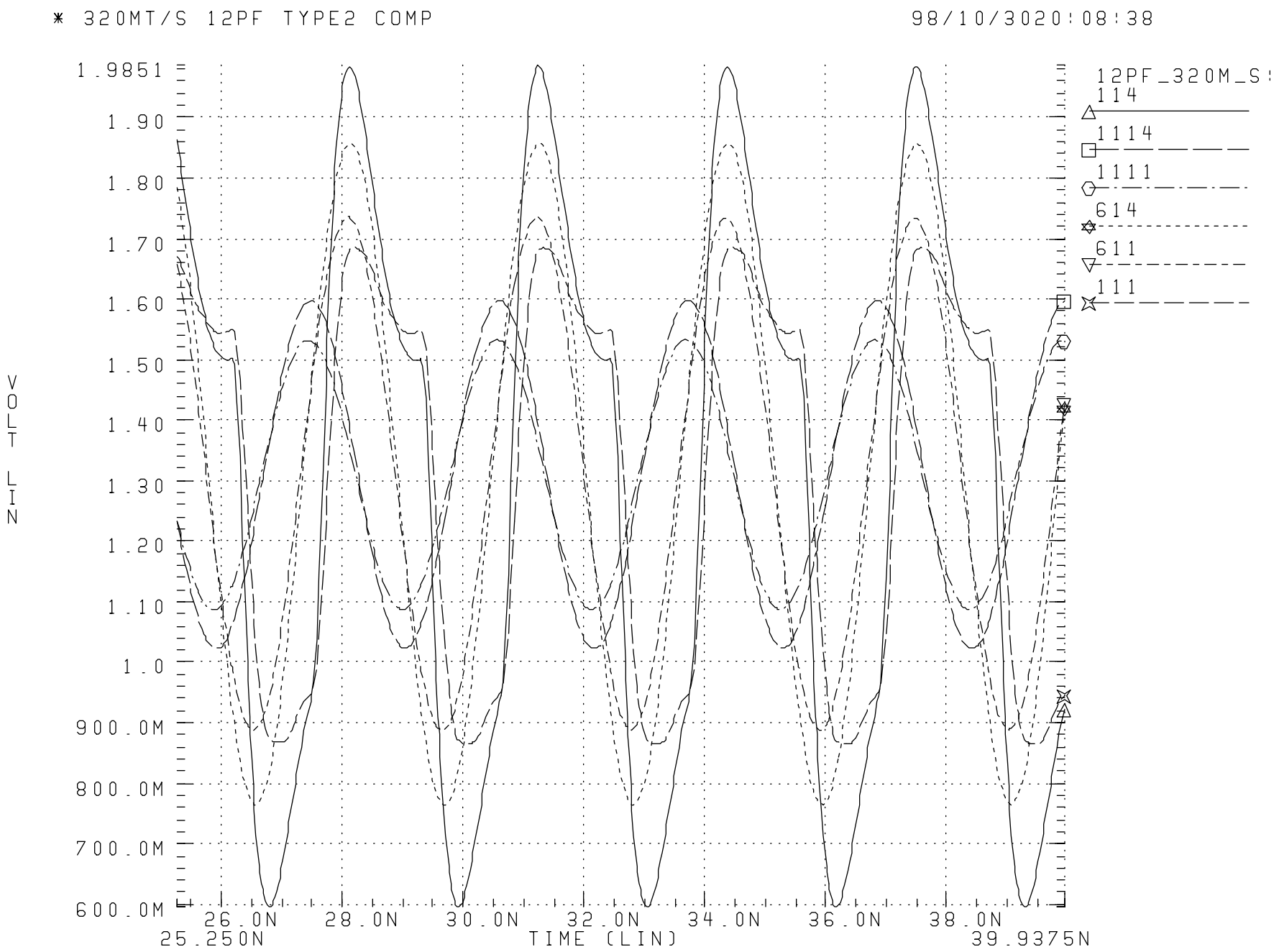
714
914
1114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900.0M
800.0M
700.0M
600.0M
VOLT LIN
26.0N
28.0N
30.0N
32.0N
34.0N
36.0N
38.0N
25.250N
TIME (LIN)
39.9375N
12PF_320M_S
114
1114
1111
614
611
111