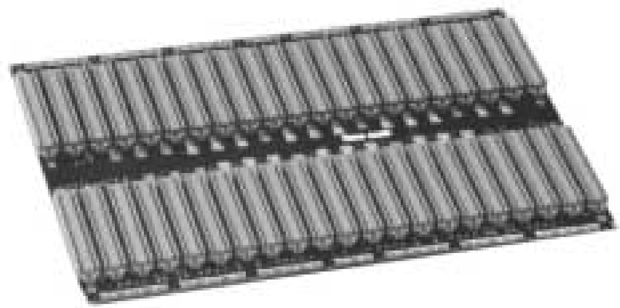
Hybricon VME Enhanced Six-Layer Backplane



Performance Data

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Hybricon VME Enhanced Six-Layer Backplane
Performance Comparison With Industry Four-Layer Backplane

Summary
It is the purpose of this report to illustrate performance differences between the Hybricon enhanced six-layer VME backplane and a very low cost, relatively low performance VME backplane constructed with four-layer printed circuit boards and DIN connectors with single-sided contacts. Connector reliability considerations include the opinions of experts in the field. Performance characteristics of the Hybricon very high performance ten-layer VME backplane are also presented.

Comparison of Four-Layer Construction, Enhanced Six-layer Construction, and High Performance ten-layer Construction
The contacts of the 96-pin DIN connectors are spaced 0.1 inches between centers. Thus the signal lines can be spaced 0.1 inches between centers if the quantity of signal layers equals the quantity of rows of contacts of the connector. This is the case for backplanes with six or more layers, since three layers are required for signal, two for ground, and at least one for power.

In a six-layer construction, two of the signal layers form a microstrip transmission line with the adjacent ground plane while the other signal layer has two adjacent planes with which it forms a stripline transmission line. One of the planes has to be a power plane which is inferior to a ground plane for transmission line purposes (for reasons explained later).

Transmission line signal currents flow forward through the signal line and return through the adjacent plane(s) as a “mirror current” with maximum current density under the forward signal path. The current density profile is a function of the line spacing and line distance from the plane, and thus, geometry design optimization is fundamentally important for crosstalk control and overall signal integrity. In effect, electromagnetic field distribution and the current density profile are uniquely related within the metal-dielectric system for each specific geometry.

Power planes are less effective than ground planes because they force the return currents to find their way through power contacts on the connector and through bypass capacitors in order to arrive back at the ground return of the drivers. The magnitude of the deficiency is a function of the relative inductances of the coupled and non-coupled portions of the return paths.

The signal integrity performance of microstrip lines is not as good as that of striplines because the E/EM field distributions are different. Intelligent geometry design, making use of the difference in effective dielectric constants can improve the performance of microstrip configurations.

The Hybricon six-layer construction was designed with these considerations in mind. Thus the power and ground plane configurations take into account the power plane and geometry issues previously discussed as well as provisions to minimize direct coupling of power supply noise into signal lines. The new enhanced six-layer construction, developed using Hybricon’s proprietary computer generated models and simulation technology, provides a new generation of higher performance without increasing cost.

Four-layer construction forces three signal rows in the connector to be condensed onto two layers of printed circuit board. The resultant microstrip construction has inferior geometry because line separation is reduced and distance from the ground plane is increased. These types of backplanes are disappearing from the market as new processor boards and other boards, requiring better signal integrity designs, become available. The real issue is that backplanes which provide little noise margin, whether four-layer or six-layer, will be a source of system failures due to small increases of crosstalk resulting from increased edge rates or other causes.

The Hybricon ten-layer VME backplane is the highest performance VME backplane available. It is also available with the new enhanced DIN connector which has two extra rows of ground contacts. It is designed to address the issue of crosstalk due to transient ground shift, a phenomenon not understood by most manufacturers. This backplane is especially recommended for parallel computing applications as well as for the new higher performance VME applications.

Connector Reliability Considerations

The Hybricon dual beam DIN contact fully meets the DIN specification and is normally supplied with plating that meets the Quality Level 2 specification, which is the preferred type for quality industrial applications. This quality level corresponds to 400 insertions (500 insertions is the quality level for military applications and 50 insertions for the light duty Quality Level 3). Hybricon's dual beam construction is unique because of the unequal beam length which reduces fabrication cost but actually increases reliability because the two beams have different resonant frequencies under vibration conditions.

Single-sided contacts do not meet the DIN specifications. AMP Inc., Dupont, and Burndy had connectors with these types of contacts and, to the best of our knowledge, they have been withdrawn from the market. It is not commonly accepted practice to make two-piece connectors with single-sided contacts. There are many reasons for this and, for the case of the DIN connector, some of these are:

- Typical contact deflection is .006 inches. Off-center tolerance on two-sided contacts causes contact pressure on one side to increase while the other side diminishes. On single-sided contacts, small deviations off center will cause contact failure.
- To improve the tolerance problem on single-sided contacts, manufacturers used the plastic housing to support the contact on one side. This causes some post bending to compensate for tolerance. Also, the plastic moves with temperature to make the tolerance issue worse. Warpage is also a problem.
- On very inexpensive connectors, contact material may be made of brass like many automotive connectors. Brass is not acceptable for precision applications and is not normally used for electronic equipment. Cost reductions on these connectors could also be achieved by reducing gold plating thickness below the specified minimum.

Hybricon has shipped over 100,000,000 contacts to date with a perfect reliability record. Total usage of these contacts by all manufacturers including Hybricon exceeds 1,000,000,000 contacts.

Hybricon connectors are approved by a large number of companies, among the most demanding are: Bell Labs, AT&T, Kodak, Siemens, Motorola.

Performance Comparisons Predicted by Computer Methods
The attached Figures 1 through 5 show representative cross sections (longitudinal and transverse) and simulations of 4-layer and 6-layer backplanes.

Figure 1 shows cross sections of the 4-layer industry type backplane. We have had to guess at the geometry but the assumptions are reasonable.
Figure 2 shows the computer simulated performance of the 4-layer backplane.
Figure 3 shows cross sections of Hybricon's 6-layer backplane (enhanced version).
Figure 4 shows the simulated performance of the outside signal traces of the 6-layer backplane.
Figure 5 shows the simulated performance of the inside signal traces (stripline) of the 6-layer backplane.
The simulations are for the unassembled backplane without connectors because this shows up the board design influence on crosstalk. The connectors would add additional crosstalk.

The top waveforms are for the driven lines, driven at the center to show the worst case. The waveform for the drive signal shows the normal reflection effect inherent in VME. The bottom waveforms are crosstalk at the drive point and at each end. The crosstalk for the 4-layer backplane is clearly unacceptable (approximately 0.7 volt). It can be seen from Figures 4 and 5 that the Hybricon unit has very low crosstalk, particularly in the stripline section where it is hardly measurable. This is graphic evidence of the superiority of the Hybricon backplane as well as the power of the Hybricon modeling and simulation methods.

The Hybricon 10-layer backplane has all stripline construction since it is not limited by the constraint of six layers. The stripline geometry is similar to the stripline section of the enhanced six-layer construction and therefore, Figure 5 also describes the performance of the ten-layer configuration. The signal integrity of the fully assembled backplane is affected by the DIN connectors, particularly due to ground bounce. For this reason, the ten-layer High Performance backplane is also available with shielded DIN connectors with two additional rows of ground pins to reduce crosstalk and ground bounce.

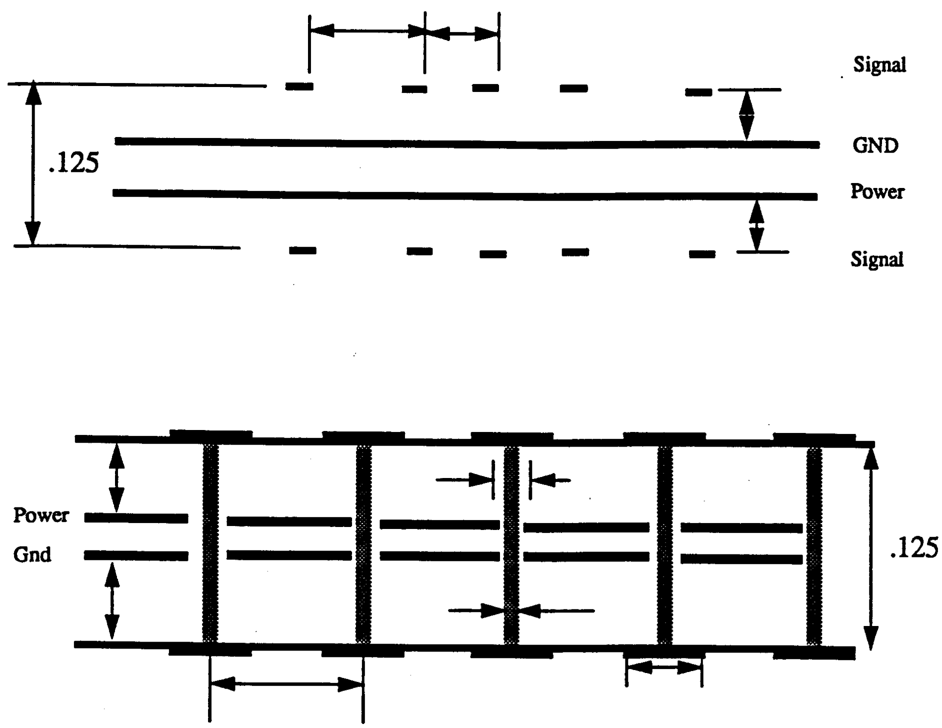

Figure 1
4-Layer Board Cross Section

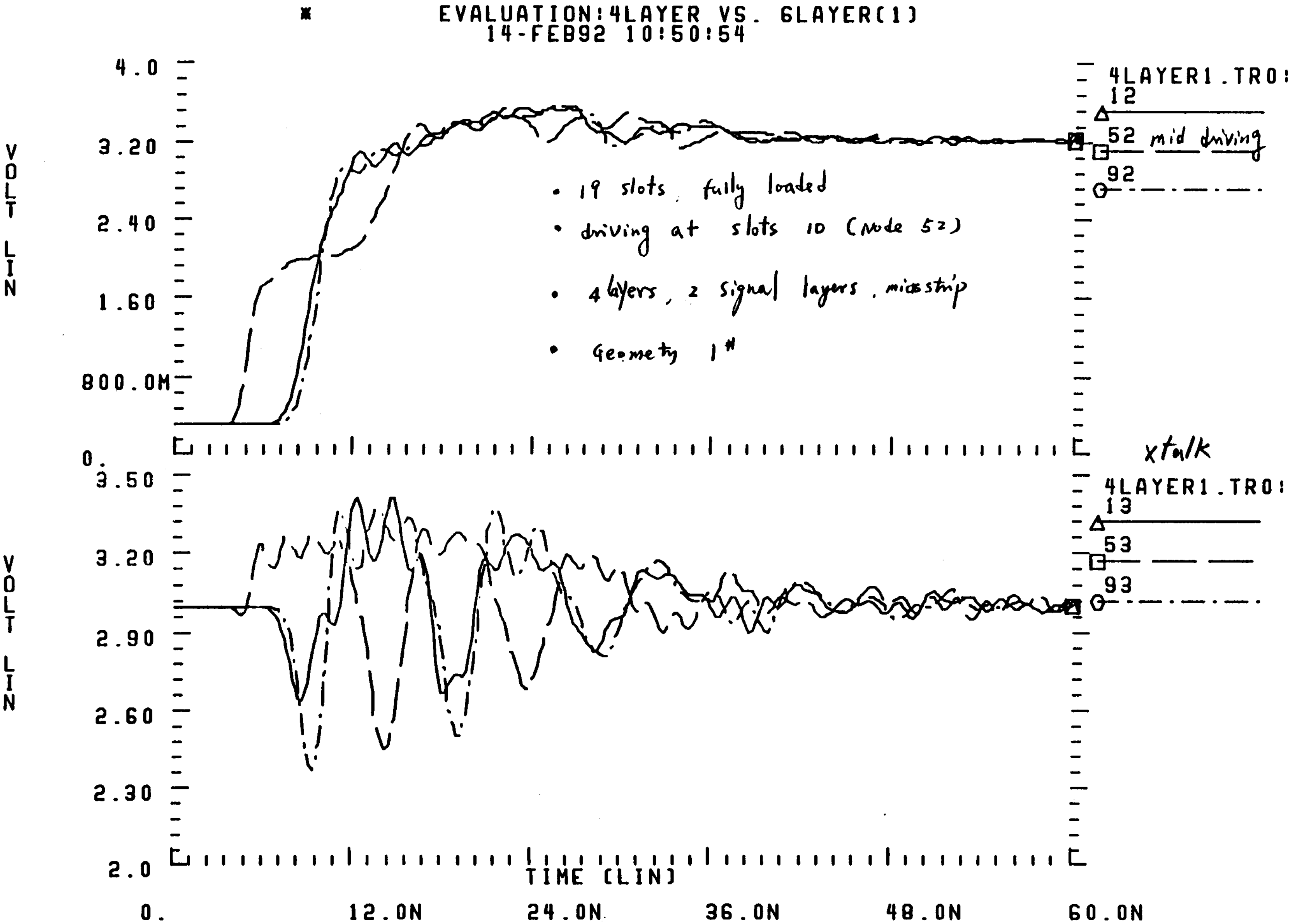

Figure 2
4-Layer Board Simulated Performance

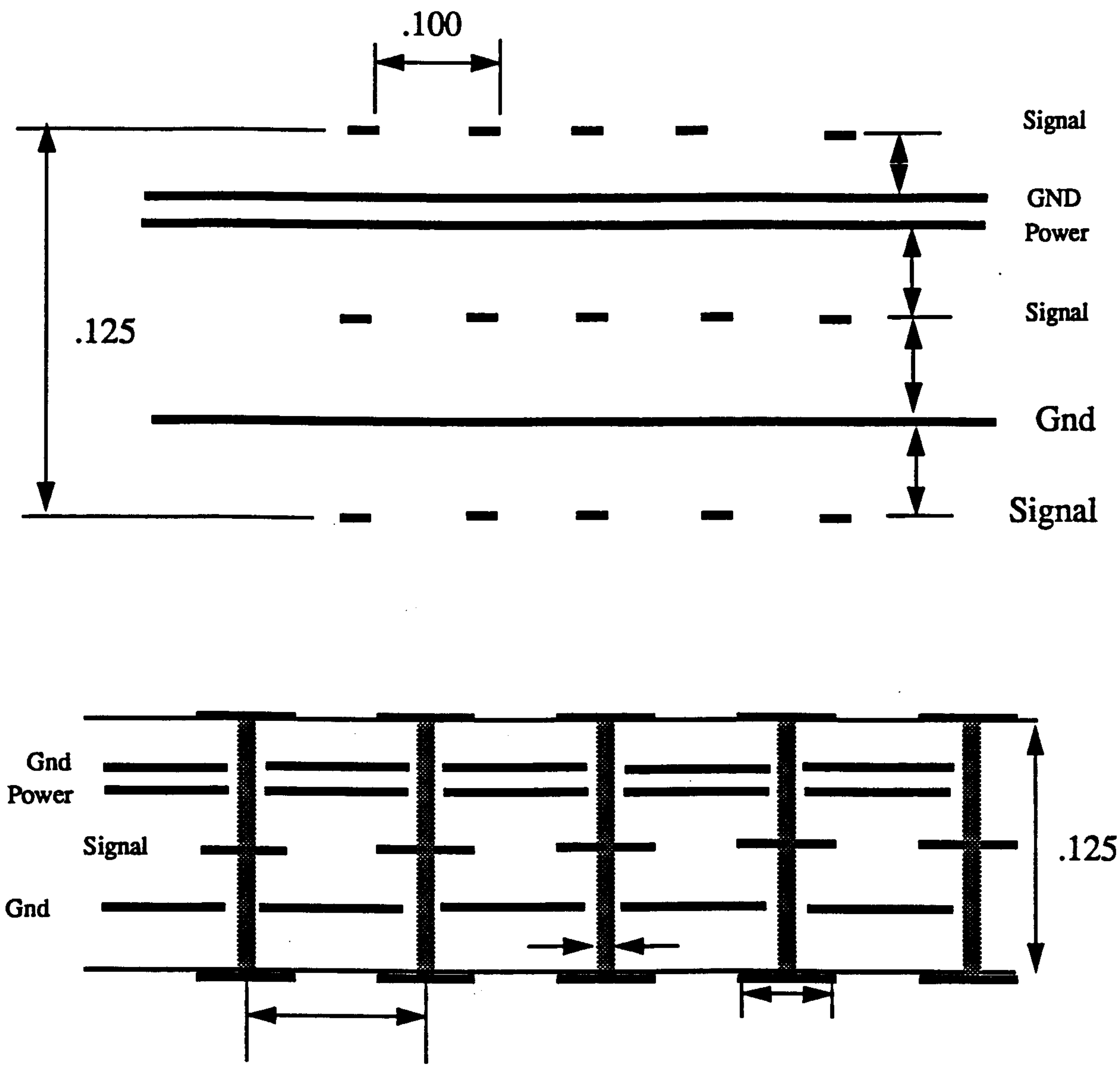

Figure 3
6-Layer Board Cross Section

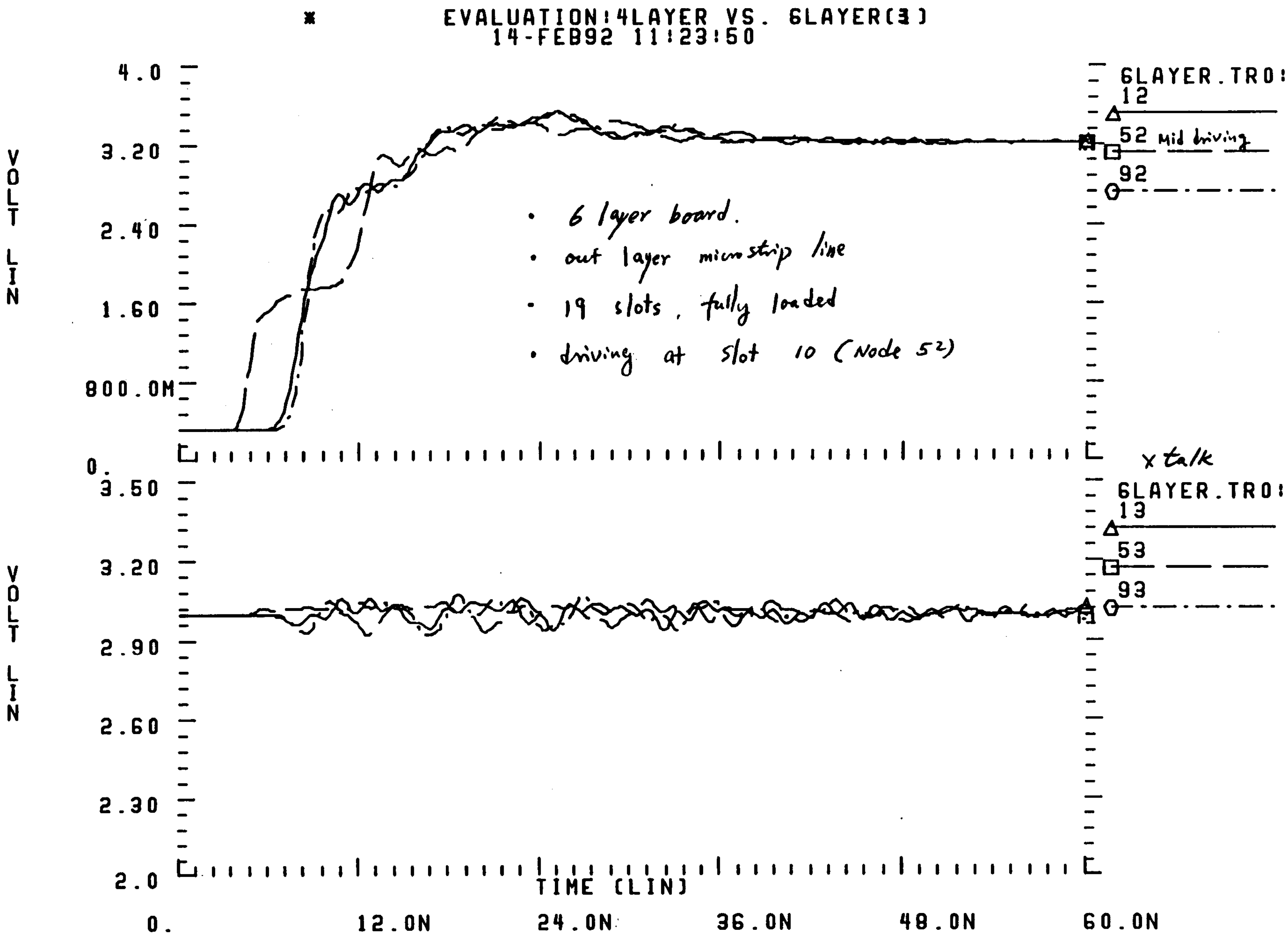

Figure 4
6-Layer Board (Outside Signal Traces) Simulated Performance

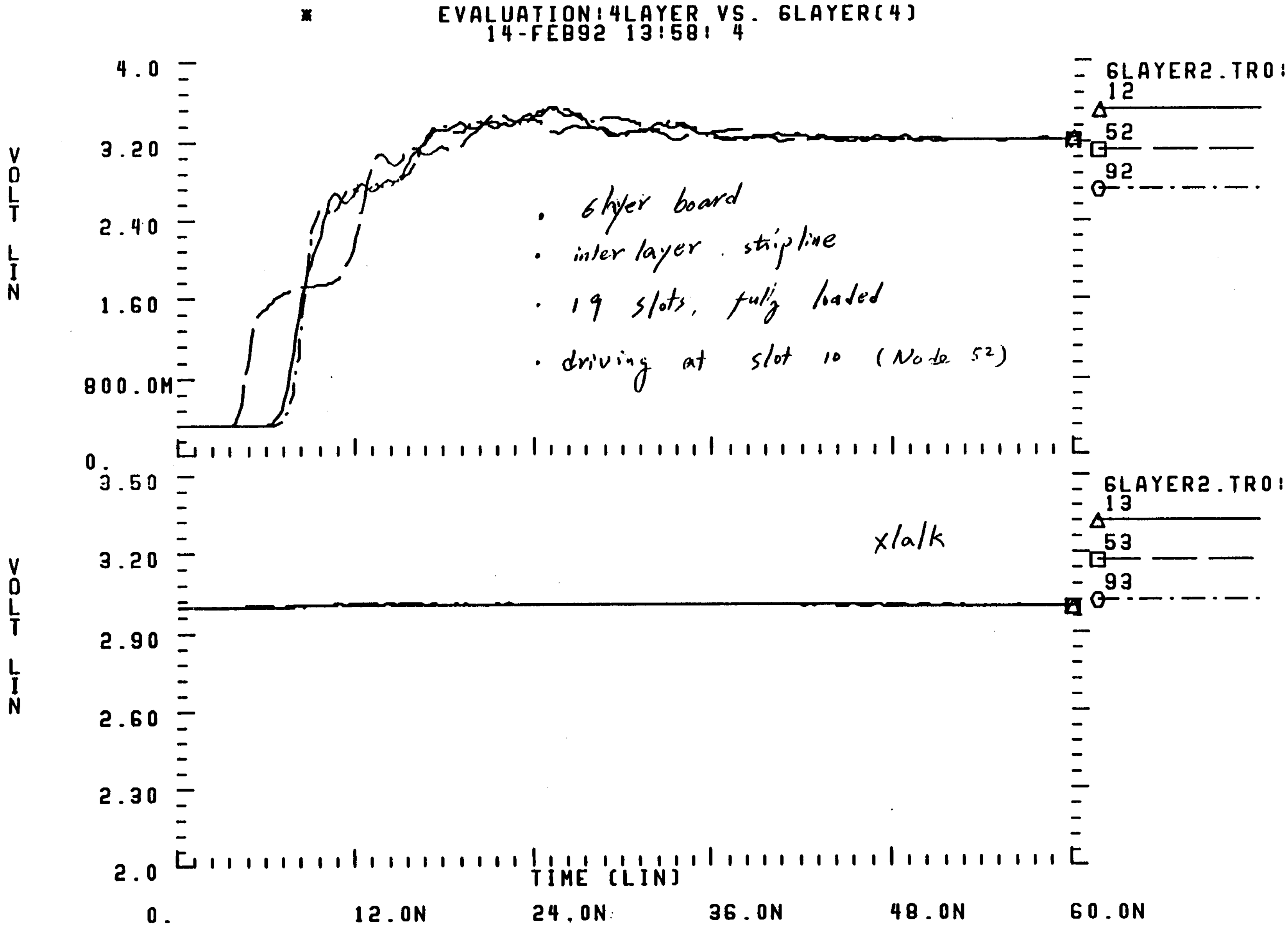

Figure 5
6-Layer Board (Inside Signal Traces) Simulated Performance