

High-Speed Amplifier PCB Layout Tips

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ABSTRACT

High-speed op amp circuit design requires special attention. This application brief presents some tips for PCB layout.

The layout of a Texas Instruments EVM, designed for use with high-speed signals, can be used as an example when designing PCBs incorporating high-speed op amps. Careful attention has been given to component selection, grounding, power supply bypassing, and signal path layout. Disregarding these basic design considerations could result in less than optimum performance of a high-speed operational amplifier. Surface-mount components, selected because of the extremely low lead inductance associated with this technology, help minimize both stray inductance and capacitance. Also, because surface-mount components are physically small, the layout can be very compact.

Tantalum power supply bypass capacitors at the power input pads help filter switching transients from the laboratory power supply. Place power supply bypass capacitors as close as possible to the IC power input pins in order to minimize the return path impedance. This improves high frequency bypassing and reduces harmonic distortion. The GND sides of these capacitors should be located close to each other, minimizing the differential current loops associated with differential output currents. A proper ground plane on both sides of the PCB should be used with high-speed circuit design. This provides low-inductive ground connections for return current paths.

In the area of the amplifier input pins, however, remove the ground plane to minimize stray capacitance and reduce ground plane noise coupling into these pins. This is especially important for the inverting input pin. Capacitance as low as 1 pF at the inverting input can significantly affect the amplifier's response, or even induce oscillations.

In general, it is best to keep signal lines as short and as straight as possible. Incorporation of microstrip or stripline techniques is also recommended when signal lines are greater than 1 inch in length. These traces must be designed with a characteristic impedance of either 50 Ω or 75 Ω , as required by the application. Such a signal line must also be properly terminated with an appropriate resistor.

For fully differential op amps, circuit pathways should be made as symmetrical as possible for both feedback pathways to minimize second and other even-harmonic content.

The printed-circuit board that is used with PowerPAD™ packages must have features included in the design to remove the heat from the package efficiently. As a minimum, there must be an

area of solder-tinned-copper underneath the PowerPAD package. This area is called the thermal land. The thermal land varies in size depending on the PowerPAD package being used, the PCB construction, and the amount of heat that needs to be removed. In addition, this thermal land may or may not contain thermal vias, depending on PCB construction. The requirements for thermal lands and thermal vias are detailed in SLMA002 and SLMA004.

Finally, all inputs and outputs must be properly terminated, either in the layout or in the load instrumentation. Unterminated lines, such as coaxial cable, can appear to be a reactive load to the amplifier. By terminating a transmission line with its characteristic impedance, the amplifier's load then appears to be purely resistive, and reflections are absorbed at each end of the line. Another advantage of using an output termination resistor is that capacitive loads are isolated from the amplifier output. This isolation helps minimize the reduction in the amplifier's phase-margin and improves the amplifier stability resulting in reduced peaking and settling times.

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