The PowerPAK SO-8L: A Package with Thermo-Mechanical Resilience

By Kandarp Pandya

Vishay is adding to its package portfolio with the PowerPAK SO-8L, an AEC Q101 qualified package. Its power cycling capabilities at rated temperature ensure the product life cycle in high-power automotive applications where the standard leadless packages can fail for various reasons. The new design shares certain characteristics of two previous packages the high-efficiency, leadless PowerPAK SO-8 and the industry work-horse DPAK (TO-252) with its heat dissipating tab. Figures 1, 2, and 3 highlight the commonalities of these three package types.

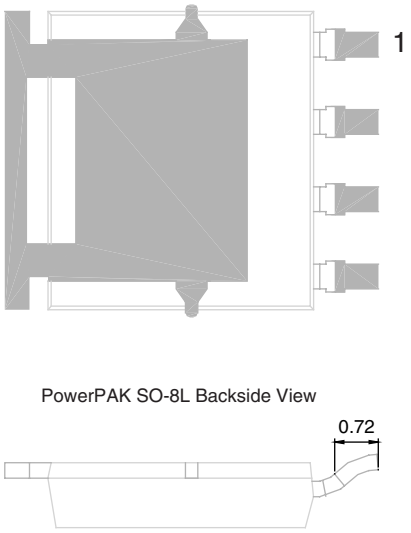
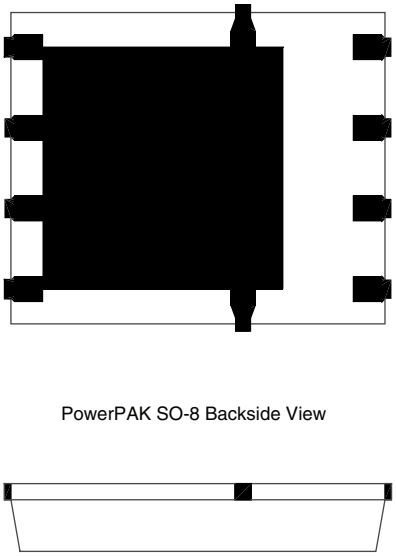


Fig. 1 - PowerPAK SO-8L Concept



PowerPAK SO-8 Backside View

Fig. 2 - PowerPAK SO-8

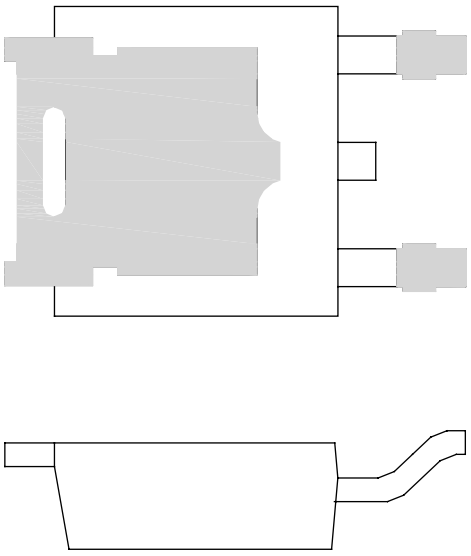


Fig. 3 - DPAK Bottom and side view

APPLICATION NOTE

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Vishay performed a design level solder fatigue analysis and characterization using Ansys 9.0 on the SO-8, PowerPAK SO-8 and PowerPAK SO-8L packages using identical material properties and electrical power/load assumptions. The 2D modeling used 82 structural elements and Visco108 for solder material. The load power cycle ramped from room temperature to 125 °C in a minute, stayed at 125 °C for 40 minutes, and then returned back to room temperature. The PCB was held in the UX and UY directions in the lower left corner and held in the UY in direction the lower right corner, allowing the PCB to freely expand in the UX direction during thermal expansion. A comparison of thermal fatigue displacement is shown in figure 4.

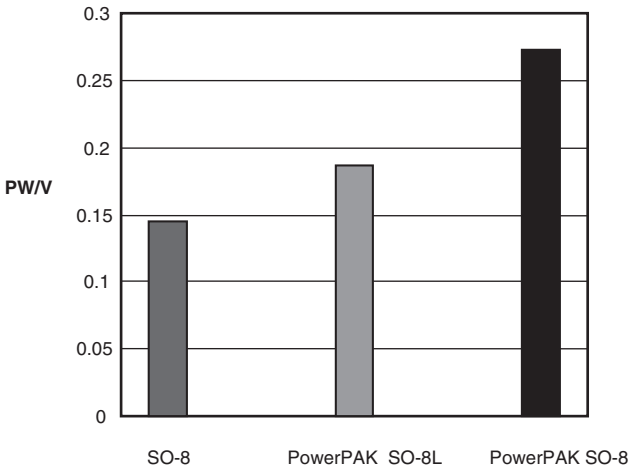


Fig. 4 - Thermal Fatigue Displacement Comparisons

The thermal fatigue displacement of the PowerPAK SO-8 was 72 % higher than the SO-8, while PowerPAK SO-8L displacement was only 24 % higher. In other words, the new package design provides for a significant improvement in thermo-mechanical resilience.

The gate and source pins in the new package are terminated like those on the DPAK, while the package's dimensional profile remains the same as the regular PowerPAK SO-8. The contoured shape of the pins allows them to expand in order to relieve the thermo-mechanical stress generated by the mismatch of coefficient of thermal expansion (CET) among the different material elements constituting the device, including the silicon die, die attach epoxy, copper lead frame, and plastic mold compound. The pin experiences a spring action in the central portion of its contour as the two ends are rigidly held in its place, one by the molding compound and the other by the solder joint on the PC board assembly. Thus the thermo-mechanical resilience is built into the package design to eliminate damaging stresses experienced mainly by the solo gate pin, which could otherwise lead to failure of the solder joint either during the product life cycle test, the solder joint reliability test, or the power cycling test.

The recommended minimum PAD pattern for PowerPAK SO-8 single is shown in figure 5.

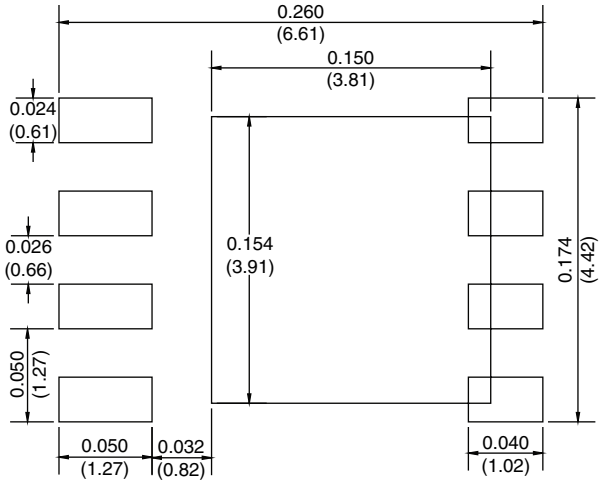
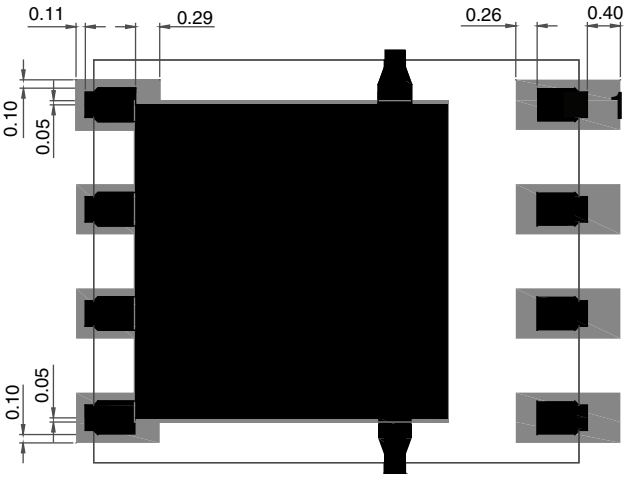


Fig. 5 - Recommended Minimum PADs for PowerPAK SO-8 Single Dimensions in Inches/(mm)

The part overlay over the recommended PAD for single channel PowerPAK SO-8 is shown in figure 6 and the part overlay over the same recommended single channel PAD for PowerPAK SO-8L is shown in figure 7.



Overlap Flipped "PowerPAK SO-8 PCB Foot Print" onto "PowerPAK SO-8 Backside View"

Fig. 6 - Single Channel PowerPAK SO-8 on its PAD Layout

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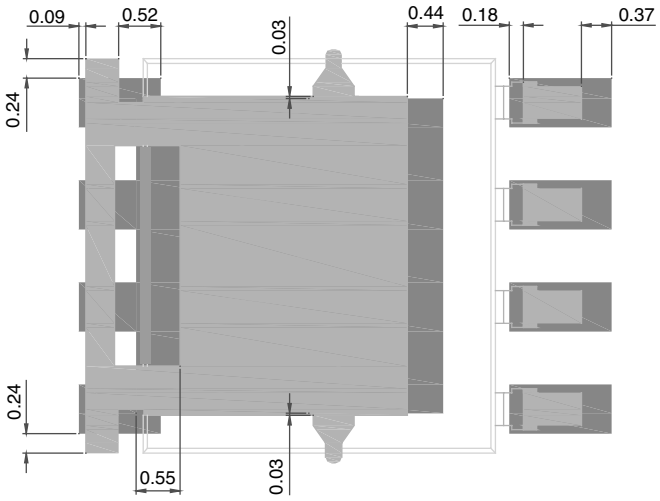

Fig. 7 - Single Channel PowerPAK SO-8L on Single Channel PowerPAK SO-8 PAD Layout

As figures 6 and 7 indicate, the single-channel PowerPAK SO-8L serves as a drop-in replacement for the single-channel PowerPAK SO-8, even though the packages differ in their physical appearance.

Figures 8 shows the recommended minimum PAD pattern for new designs using the single-channel PowerPAK SO-8L. The four side leaps are part of different drain tab design.

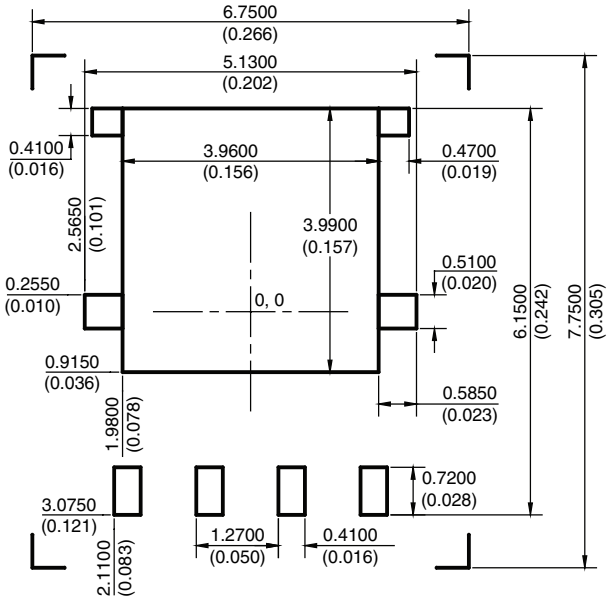

Fig. 8 - Recommended PAD for Single Channel Power PAK SO-8L
Dimensions in mm (inches)
Keep-out 6.75 (0.266) x 7.75 (0.305)

SUMMARY

The single channel PowerPAK SO-8L is an AEC Q101 qualified package for high-power, high-temperature automotive applications. Its key feature is the package's thermo-mechanical resilience, which allows the PowerPAK SO-8L to survive the designed life cycle of the application. The single-channel PowerPAK SO-8L serves as a drop-in replacement for the single-channel PowerPAK SO-8. Solder joint reliability test using IPC 9701 guidelines will be tested in the future.