



TO-LL: the latest evolution in SMD power packages STPOWER MOSFET SJ MDmesh series



TO-LL the new space-saving and thermally efficient package

The compact and thermally efficient TO-LL leadless package allows power converter designs with higher power density.

This package is now available for the latest STPOWER superjunction MDmesh M9/DM9 series MOSFETs, as well as the established M6/DM6 series.



KEY FEATURES

- Reduced space on board
- Distributed heat sinks
- Additional Kelvin source
- Reduced thickness (2.3 mm)
- High creepage (distance 2.7 mm)

MAIN BENEFITS

- Increased power density
- Competitive thermal dissipation
- Improvement in turn-on / turn-off efficiency

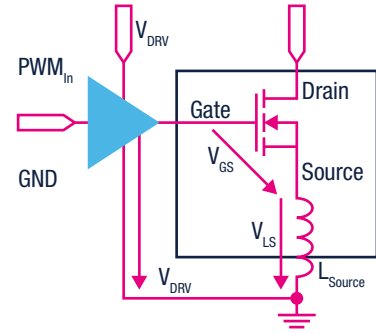
KEY APPLICATIONS

- Data centers and AI servers
- Telecom Power
- Solar microinverters



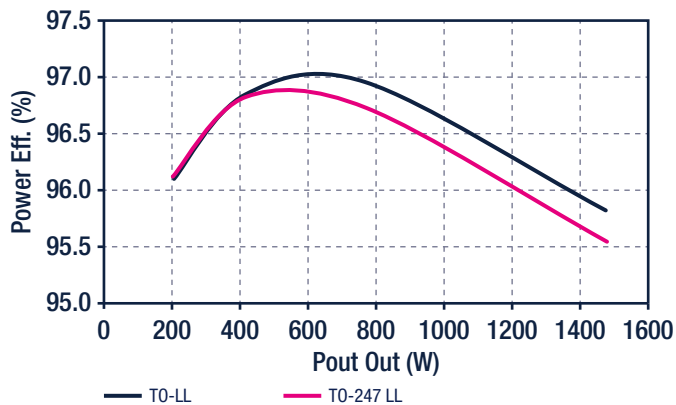
TO-LL PACKAGE COMPARISON TESTS WITH MDmesh MOSFETs

The TO-Leadless (TO-LL) package solution was tested against the TO-247 in the PFC and LLC sections of a 1.5 kW SMPS to compare their respective thermal performance and efficiency. The additional Kelvin-source lead generates significant efficiency gains in the PFC section at full load with high current levels, thanks to the reduction of the inductive effect on turn-on commutation. The efficiency in the LLC section remains identical for both packages.



Power efficiency in PFC section

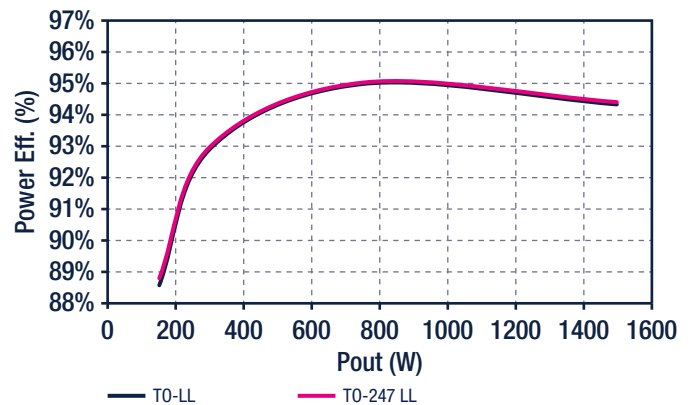
System power efficiency



The Kelvin pin on the TO-LL package delivers better efficiency than the conventional TO-247 package, especially at full load.

Power efficiency in LLC section

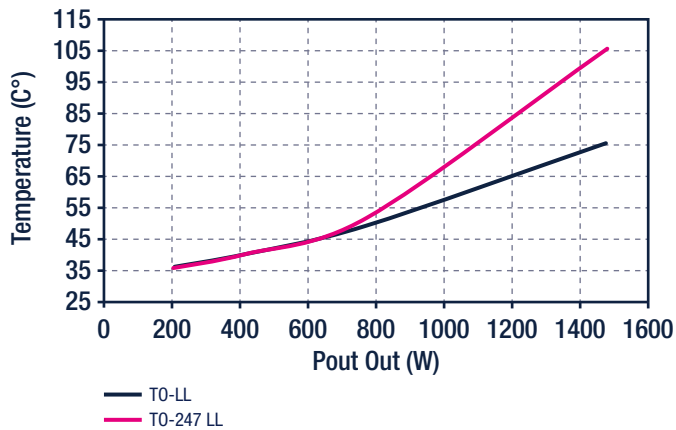
System power efficiency



The power efficiency in the LLC is the same for both packages. The Kelvin pin does not impact efficiency because current at turn-off is very low and turn-on losses are zero due to ZVS.

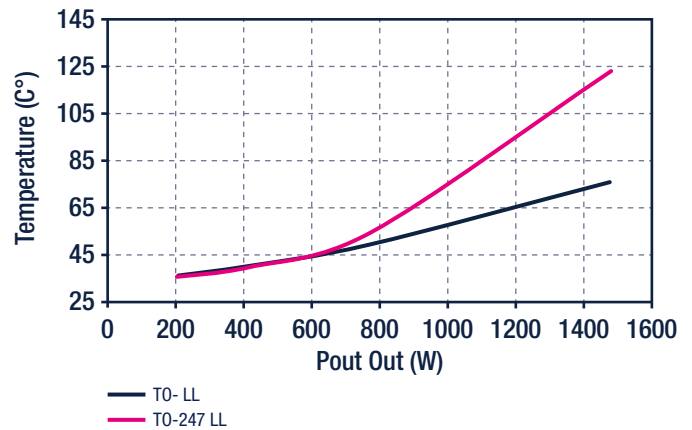


Thermal comparison with same $R_{thj-amb}$



Thermal comparison between TO-LL and TO-247 at the same $R_{thj-amb}$ in 1.5 kW PFC.

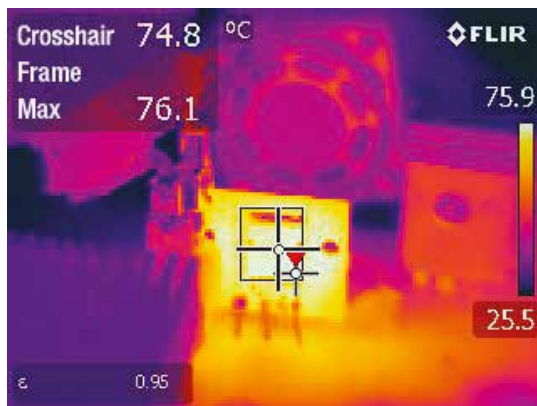
Thermal comparison with same fan



Thermal comparison between TO-LL and TO-247 with the same fan in 1.5 kW PFC

Thermal comparison with same $R_{thj-amb}$ in 1.5 kW PFC

TO-LL T_{case} at 1.5 kW



TO-247 T_{case} at 1.5 kW



The TO-LL package generates less heat than the TO-247 option for an equivalent $R_{thj-amb}$ (in this case about 3.75 °C/W). To maintain a constant thermal resistance, we used a cooling fan for the TO-LL package and a heatsink for the TO-247.

Thermal comparison with same fan

TO-LL T_{case} at 1.5 kW

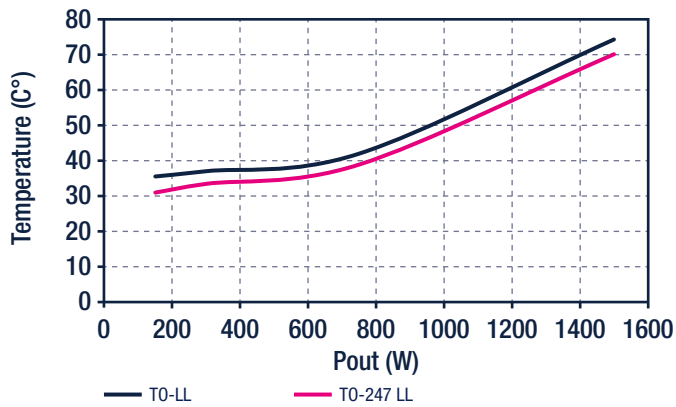


TO-247 T_{case} at 1.5 kW



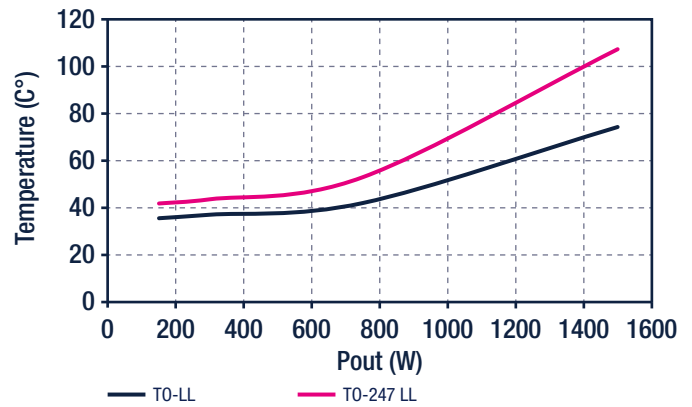
When we remove the heatsink from the TO-247 and use the same fan cooling system for both packages, the thermal performance of the TO-LL does not degrade like the TO-247.

Thermal comparison with same $R_{thj-amb}$



Thermal comparison between TO-LL and TO-247 at the same $R_{thj-amb}$ in 1.5 kW LLC.

Thermal comparison with same fan



Thermal comparison between TO-LL and TO-247 with the same fan in 1.5 kW LLC.

Thermal comparison with same $R_{thj-amb}$ in 1.5 kW LLC

TO-LL T_{case} at 1.5 kW



TO-247 T_{case} at 1.5 kW



The TO-LL solution achieves almost the same temperature as the TO-247 when we use the same $R_{thj-amb}$, approximately 12.5 °C/W.

To maintain a constant thermal resistance, we used a cooling fan for the TO-LL package, and a heatsink for the TO-247.

Thermal comparison with same fan

TO-LL T_{case} at 1.5 kW



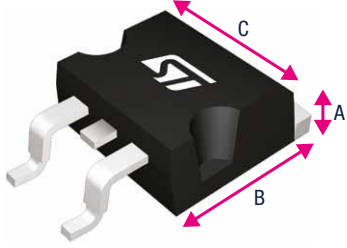
TO-247 T_{case} at 1.5 kW



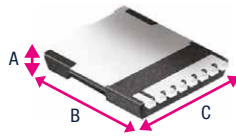
When we remove the heatsink from the TO-247 and use the same fan cooling system for both packages, the thermal performance of the TO-LL does not degrade like the TO-247.

TO-LL vs D²PAK

Size and thermal performance comparisons



D²PAK
Area on board: 164.3 mm²



TO-LL
Area on board: 115.6 mm²

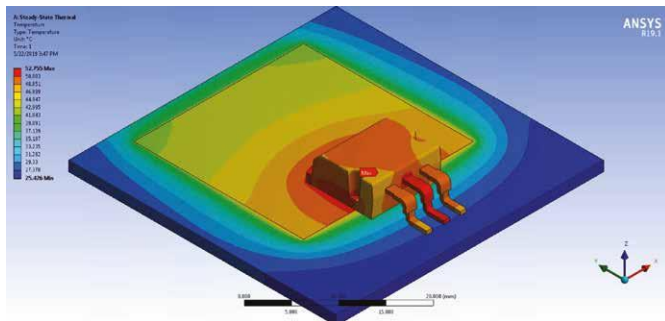
Dimensions (mm)

	A	B	C
D ² PAK	4.6	15.8	10.4
TO-LL	2.3	11.7	9.9

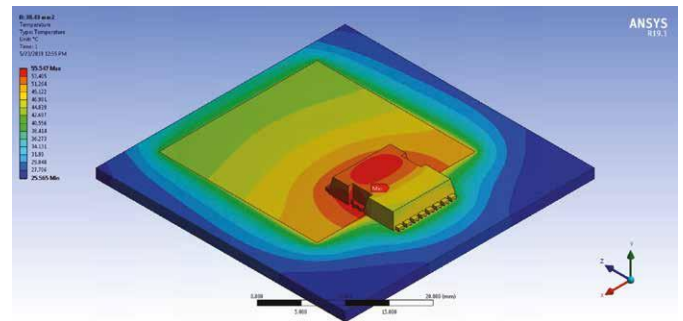
TO-LL: 30% saved area on board vs D²PAK

TO-LL

Thermal performance comparisons



D²PAK using 1 inch² 70 µm thick Cu layer
 $R_{thj-pcb} = 27.76 \text{ }^{\circ}\text{C/W}$



TO-LL using 1 inch² 70 µm thick Cu layer
 $R_{thj-pcb} = 30.55 \text{ }^{\circ}\text{C/W}$





MDmesh M9

<https://www.st.com/en/power-transistors/mdmesh-m9-series/products.html>



MDmesh DM9

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MDmesh M6

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