Thermal Advantages of Overmolding Power System in Package (PSiP) Modules

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ABSTRACT

- This poster shows the advantages of using a transfer-based mold compound to assist an integrated power system in package (PSiP) with the dissipation of heat and lower the junction temperature during operation.
- FEM simulation software was used to create a realistic model of the PSiP and analyze the thermal performance impact of material choice in the various aspects of the packaging process.
- The simulation results were confirmed by measurement with thermal imaging technology. The simulation results show a decrease in the junction temperature of the silicon device.
- The confirmation of the simulation results by the measurement results indicates that the mold compound draws heat away from the IC allowing it to operate at a lower junction temperature than if the IC only had air around it.

MOTIVATION

- Thermal management of switch mode power supplies is essential for efficient operation and becomes increasingly critical as integration creates systems that have small footprints with high power densities.
- Packaging techniques offer an elegant solution to integration and heat management issues by encapsulating the device in a material that can conduct heat away from critical components while protecting the system from mechanical disturbances and providing a uniform surface for handling machines to use.
- Providing a cost-effective solution that is high in efficiency and minimizes required space and external components.

DESIGN SPECIFICATIONS

- The system consists of a power and control IC with an inductor assembled on an epoxy substrate overmolded with a silicon dioxide-based epoxy resin material that flows easily under small components.

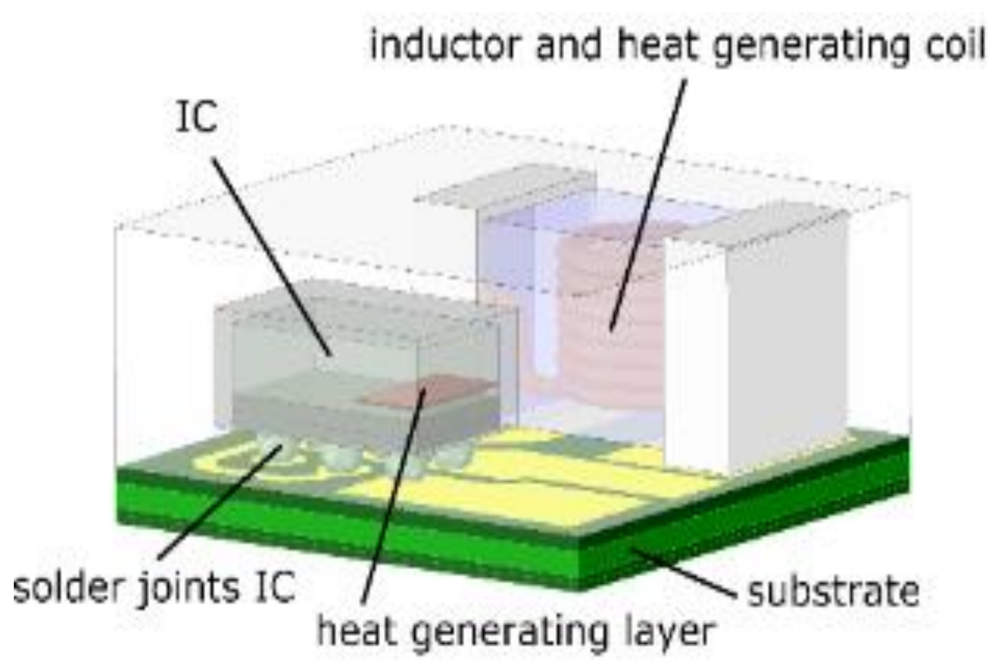

Figure 1: Module Internal Structure

- The module has an input voltage range of 2.5V to 5.5V and is capable of an output voltage as low as 0.8V while supplying up to 1.2A.
- The module switches at a nominal switching frequency of 4MHz allowing for an inductor under 1µH in inductance, further facilitating integration and size reduction.
- The device has no current derating necessary for its operation between -40°C and +85°C.

HYPOTHESIS

- An FMEA simulation was performed to evaluate the effects of the overmolding materials on the thermal performance of a DC-DC buck converter IC.
- These results were compared with the IC without overmolding to evaluate the improvement in junction temperature.
- The IC contributed the most to the heat generation due to the power switches located inside the device. Figure 2 shows the power loss of the IC and the inductor over the current range of the device. Total loss was measured using a Yokogawa power analyzer and inductor losses were calculated using the redExpert web tool. IC losses were calculated from the results

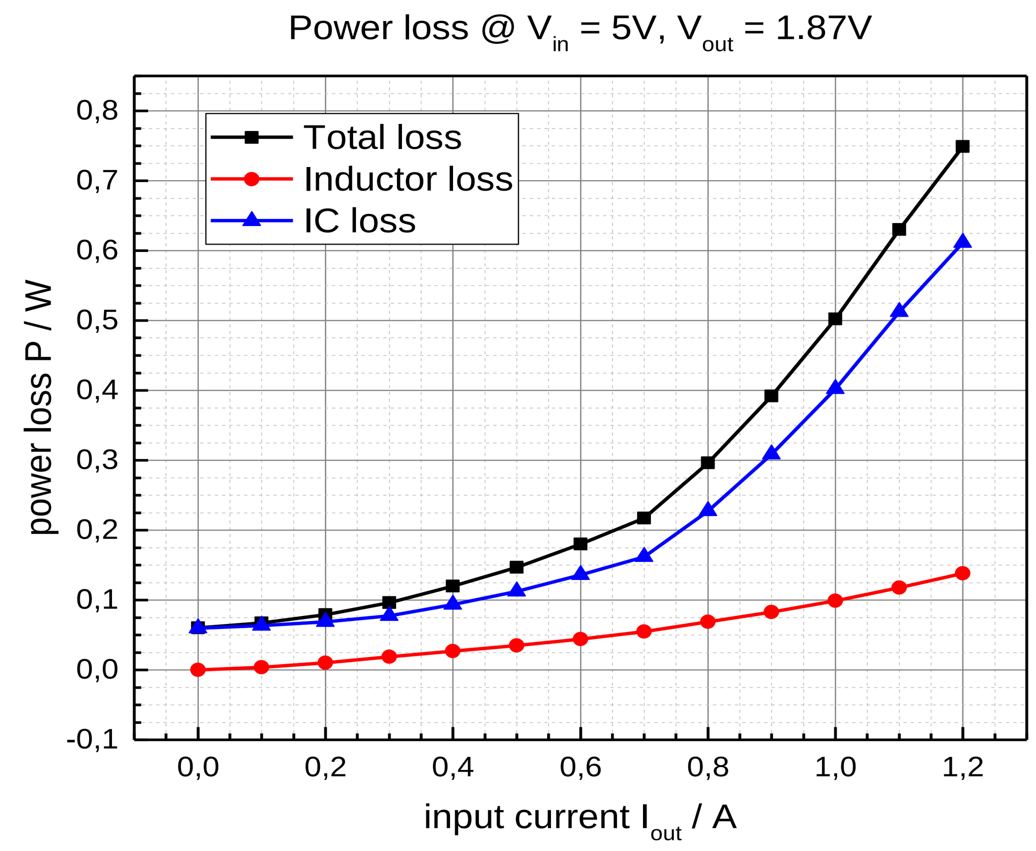

Figure 2: Power Losses of IC and Inductor

RESULTS

- Simulation results showed the solder interface between the IC and the substrate to be very important when considering thermal management.
- Figure 3 shows the simulated results of how material selection for the mold compound, substrate and solder affects the junction temperature

Surrounding Area of IC	Junction Temp in °C	Solder Alloy	Junction Temp in °C
Air	61.6	Sn-3.5Ag	63.3
SiO_2	57.9	Sn-0.7Cu	56.8
MgO 49%	56.8	In-3Ag	55.8
MgO 56%	56.2		

Figure 3: Material Selection and Junction Temperature Impact

- The module uses a silicon dioxide-based mold compound, which shows a 6% reduction in junction temperature
- Solder material used is 96.5Sn/3.0Ag/0.5Cu, providing approximately a 5% reduction in junction temperature

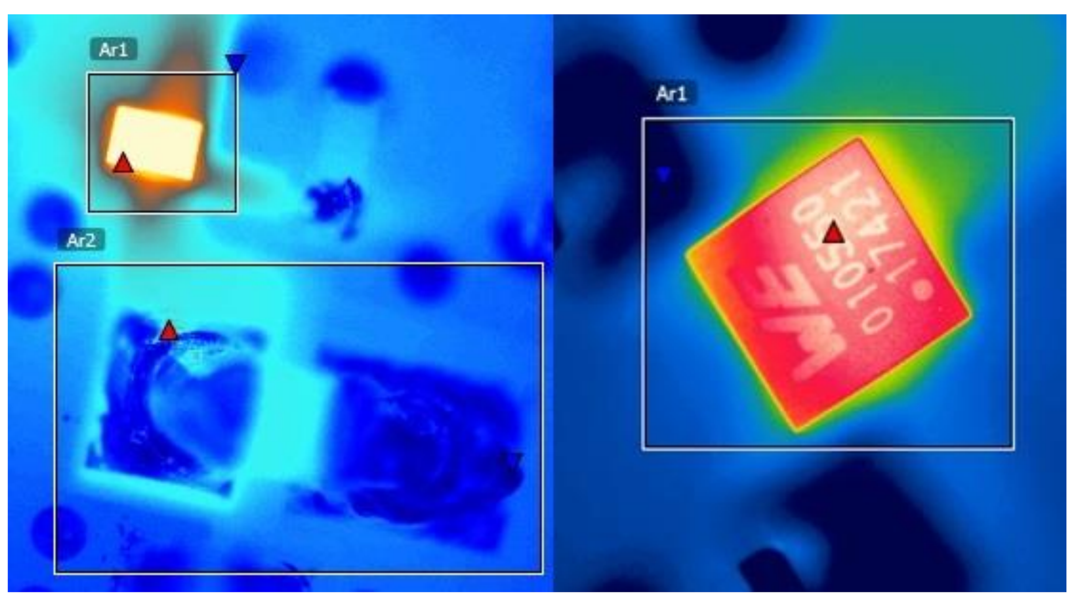

Figure 4: IC Thermal Image and Module Thermal Image

CONTACT

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