

# Proposal for heat loss calculation by high-precision actuator modeling

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In this research, we explain how to calculate the heat loss value of a semiconductor with high accuracy so that the junction temperature of a semiconductor device, which is one of the criteria, can be grasped in the heat transfer design of an ECU. The analysis problems "increased computational load due to transients" and "difficulty in obtaining input information" were solved.

If the concealed element model method becomes the industry standard, it will be easier to obtain models for circuit analysis from semiconductor manufacturers. Furthermore, Tj temperature judgment, which is one of the product evaluation criteria, can be judged with high accuracy, which is useful for circuit design of product design.

Regarding the co-simulate of circuit analysis and heat transfer analysis, an injector drive circuit that injects fuel into an automobile engine will be explained. OEM and Tier 1 require time to verify electronic control. Actuator makers, semiconductor makers, and Tier 1 designers of ECU products are involved in the determination of control requirements requested by OEM. If an electronic designer verifies it by circuit analysis, it seems that it can be done in a short time, but in addition to the semiconductor circuit model, an actuator model of the injector to be driven is required, but it is difficult to obtain. In the first place, it is difficult to replace mechanical parts with electrical equivalent circuits, and actuator modeling has not progressed. Therefore, we have designed the circuit by experimental verification. The main reasons why it is difficult to replace with a circuit model are that it is difficult to measure electrical resistance and capacitance, it is difficult to verify the upper and lower limits due to variations in members, and there is no standard for actuator models, so it takes a lot of time to verify modeling. As mentioned, if there is an actuator model, the following studies can be made.

- ① Control study at the development stage without an actual ECU
- ② The amount of heat generated by the semiconductor synchronized with the control
- ③ Verification and validation for actuator performance fluctuations and worst-case

By combining system simulation, circuit analysis, and heat transfer analysis, electronic designers can easily verify the temperature at the stage of component selection from multiple manufacturers and circuit constant design, improving product development speed. This process is considered necessary for future control design not only for in-vehicle electronic devices but also for various problems required for heat transfer design of products with control.

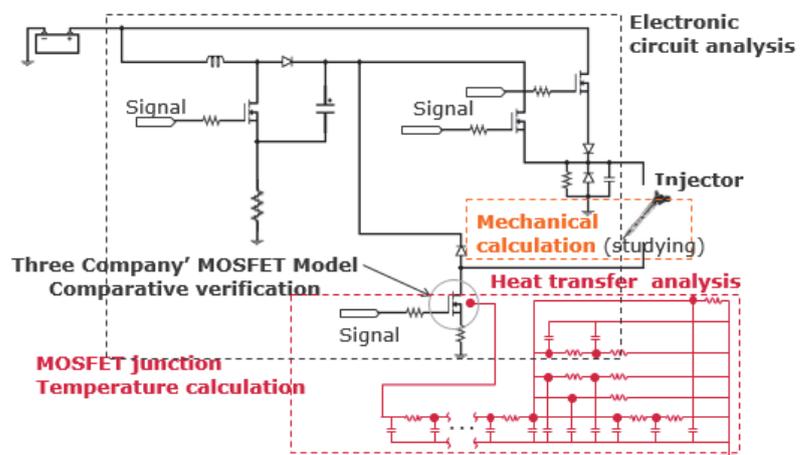


Fig.1 Circuit diagram of the thermal network in the semiconductor