

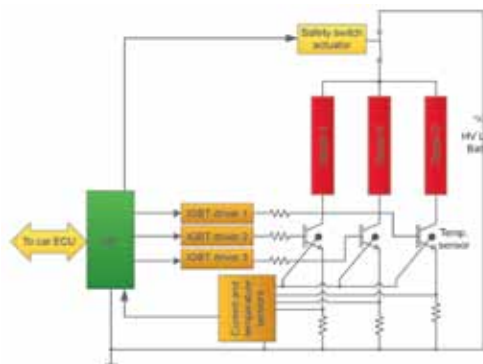
Simplified heating circuits

Offering functionality and protection, a new Smart-IGBT offers a simpler, cheaper solution to the architecture of electric heaters in hybrid and electric cars

►► Electric heaters are a non-negligible part of the electric energy needed to operate a car. Their control is, therefore, quite complicated and is supervised by the ECU of the vehicle. Usually, a uP, grounded to the same HV battery negative pole, is used locally to control the full functionality and protection of the heating system. Because the only purpose of this system is to generate heat to warm the driver's cabin, there is no need for the heaters to operate at high speed, and therefore the switching frequency is usually in the range of 100-400Hz. The power involved in each section is quite high, ranging from 1-6kW. Because of this, EMI is a sensitive issue and, to reduce the noise, a very high gate resistor and consequently slow turn-on/off of the IGBTs is implemented.

Protection is the other critical element of this system. The heater is supplied directly by the main battery of the hybrid or electric car, and stores a huge amount of energy (up to 80kW in some cars). Therefore adequate protection for current limitation and over-voltage has to be implemented. For this reason, all OEM manufacturers are adding a lot of sparse electronics around the power devices to read the current in each element and report any failure to the uP for consequent action. Temperature feedback of the power switches is also very important, as this information is used to limit the power dissipated in the event of overheating, and therefore controls their operating life.

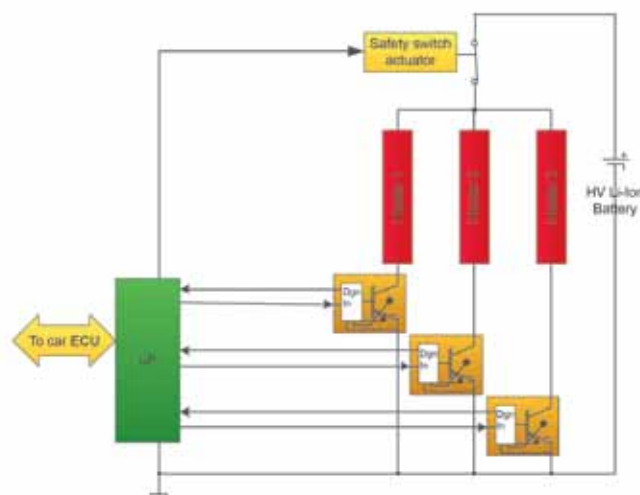
The development of the Smart-IGBT from International Rectifier offers a novel, simplified and cheaper solution, simplifying the block schematic and complexity of the design. In the new system block schematic, many electronic blocks



A general example of a high-voltage heater block schematic



The Smart-IGBT package simplifies heating circuit design



High-voltage heater block schematic employing International Rectifier's Smart-IGBT

have now disappeared, and all protections are inside the Smart-IGBT. The final block schematic is much simpler and cleaner.

In particular, the device reads the main emitter current through a sense emitter cell whose output is checked during on-state for consistency. If a too-high or too-low current is measured, the consequent short circuit or overload is detected, stopping the device operation and reporting the fault through the serial line.

The internal temperature protection continuously checks the IGBT die temperature and reports a warning signal to the DGN serial line if this goes above a specified threshold, enabling the uP to take necessary action. If the die temperature rises again and passes the turn-off limit, the device is stopped and an OVT error is reported to the uP.

Over-voltage protection limits the maximum voltage applied on the IGBT gate; the gate monitoring

protection verifies that the gate voltage is at the correct level at the right time and that the gate frequency of operation is not exceeding the maximum allowed by the power device. This means the device can report loss of gate oxide isolation or stop operation if the input PWM frequency is too high.

The different turn-on/turn-off time is optimized for reduced EMI in the 100-400Hz switching frequency. The fast gate turn-off ensures full protection during short-circuit conditions, and the wide supply range and TTL input logic compatibility allows for driving of the device directly from any uP or DSP on the market.

All these protection and diagnostic functions ensure that the device easily meets new ISO26262 standards for automotive safety applications. The collector pin of the IGBT has been separated from the other low-voltage pins to allow for easier routing on the PCB of this high-voltage power line and to avoid PCB coating, further reducing the overall system cost. ☺

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