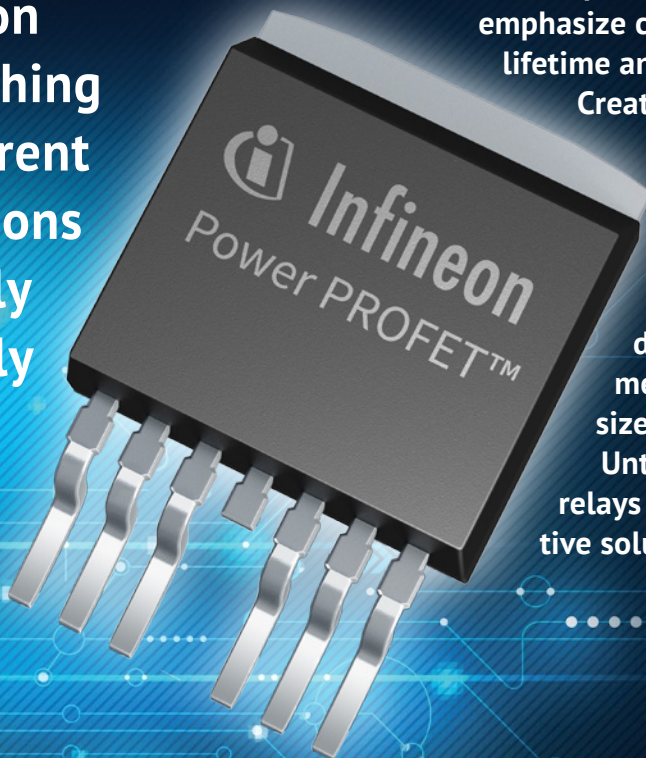


POWER PROFET™

A simpler solution with integrated protection for switching high-current applications efficiently & reliably



FOR HIGH-CURRENT APPLICATIONS, engineers have traditionally relied on large relays backed by a fuse to protect the load from shorts or other faults. Although this approach has served as an adequate solution in the past, their large package size, slow switching speed, and limited mechanical lifetime make them a poor match for application trends that emphasize compact designs with extended lifetime and switching cycle requirements.

Created to provide a more effective alternative to relays and fuses, the Infineon Power PROFET series offers benchmark power and energy performance for high-current load protection and diagnosis while simplifying implementation and optimizing design size and cost.

Until recently, electromechanical relays have served as the most effective solution for protecting circuits in

high-current applications. Yet, their reliance on the physical movement of a switching element leaves them vulnerable to early life failures caused by contamination or simply the constant wear of their internal switching contacts – particularly in the face of high in-rush currents, sustained currents, and voltage spikes. As a result, these devices offer limited endurance, typically reflected with specified lifetimes on the order of 200K switching cycles.

Because wires, traces, and contacts need protection from overload conditions and short-circuiting, designers typically back relay output with a fuse for additional protection. Along with increasing the sheer size of the protection solution, the combination of relay and fuse contributes significant power loss. Furthermore, this approach leads to functional limitations when the need to replace a blown fuse results in extended downtime of the protected application itself.

EFFICIENT ALTERNATIVE

SEMICONDUCTOR SWITCHES have earned an important role in power protection. Until recently, however, these devices could not offer reliable protection for high-current loads for reasonable costs. With the availability of Infineon's Power PROFET devices, designers now find an effective alternative for replacing relay and fuse assemblies traditionally required in high-current applications.

Designed specifically to drive high-current loads, the Power PROFET series extends the Infineon PROFET family with protection at high-current loads (Fig. 1). In fact, the Power PROFET sets a new benchmark in the market for driving high-current applications up to 40 A DC. Indeed, Power PROFET devices can replace mechanical protection components in a wide range of 12-V automotive and industrial designs for power distribution, heating, lighting, motor control, or in any high-current application with resistive, capacitive, or inductive loads.

In fact, these devices offer a number of distinct advantages over conventional relay and fuse protection methods. Power PROFET devices reduce power losses up to a factor of seven compared to those traditional methods. Functionally, they offer improved load mon-

itoring and protection, while supporting significantly faster switching speeds and switching lifetimes way beyond 1 million cycles. Compared with relays and fuses, these switches are immune to dust, shock, and vibration. Besides improving electrical endurance, they eliminate maintenance required with a fuse and enhance application availability because when faults cause power shutdown, they require only a simple software reset rather

than physical fuse replacement.

At the system level, these semiconductor switches minimize module size and optimize cost. A single Power PROFET device can replace not only the relay and fuse, but also the associated relay driver, socket, cable, connectors, and heavy relay box. In addition, when using this device, designers can eliminate the freewheeling diode required with traditional methods for many applications.

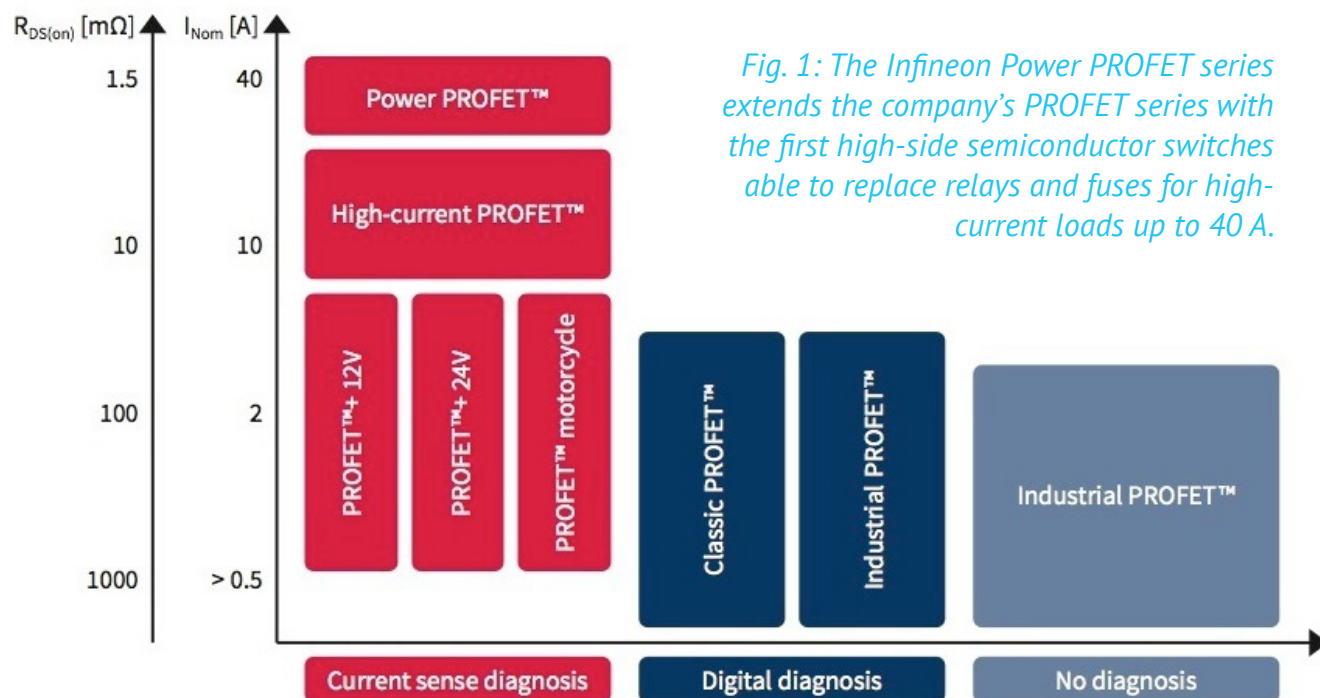


Fig. 1: The Infineon Power PROFET series extends the company's PROFET series with the first high-side semiconductor switches able to replace relays and fuses for high-current loads up to 40 A.

INTEGRATED PROTECTION

THE INFINEON POWER PROFET series is a family of high-side switches built to simplify implementation of sophisticated protection and diagnostic functions for all types of resistive, inductive, and capacitive loads in harsh automotive and 12-V industrial applications. Integrated in these devices, a mixed-signal control chip monitors and controls output of a robust high-current power chip (Fig. 2).

The power chip delivers benchmark energy capabilities, supporting up to 3,000 mJ at 33 A for a single pulse and up to 550 mJ at 33 A for repetitive energy pulses. Members of the family feature R_{DSon} as low as 1 m Ω , providing the lowest ohmic-protected device in the industry. Built with TO263-7 (D²PAK) packaging and 500- μ m bond wires, the device features exceptional thermal capability (R_{THJC} 0.5 K/W; typical system resistance R_{THJA} 20 K/W) to offer best-in-class current capability.

While the base chip and packaging ensure reliable high-current operation, the control chip integrates a comprehensive set of protection and diagnostic features. Among its protection capabilities, the device offers short-circuit, overload, overvoltage, thermal, and >>>

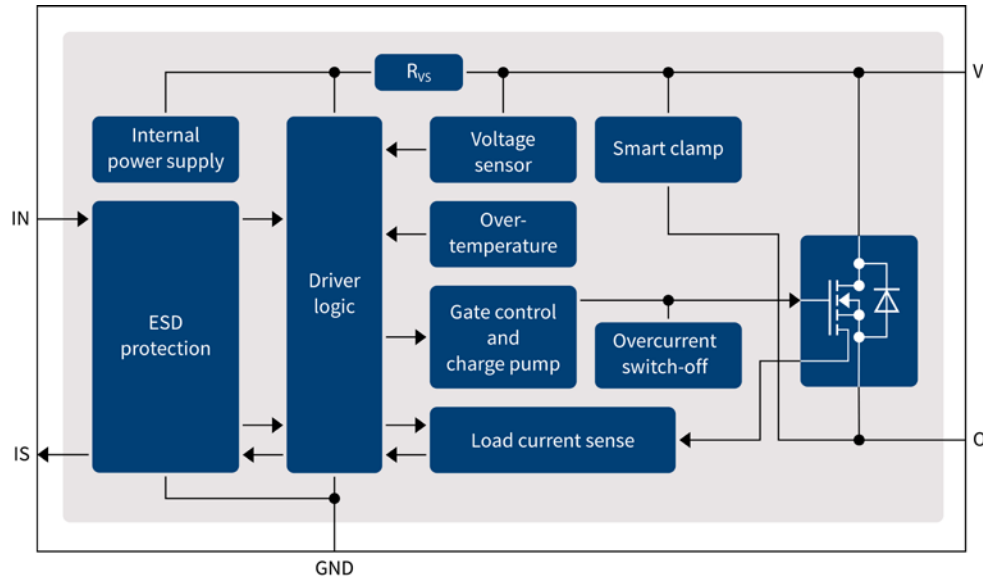
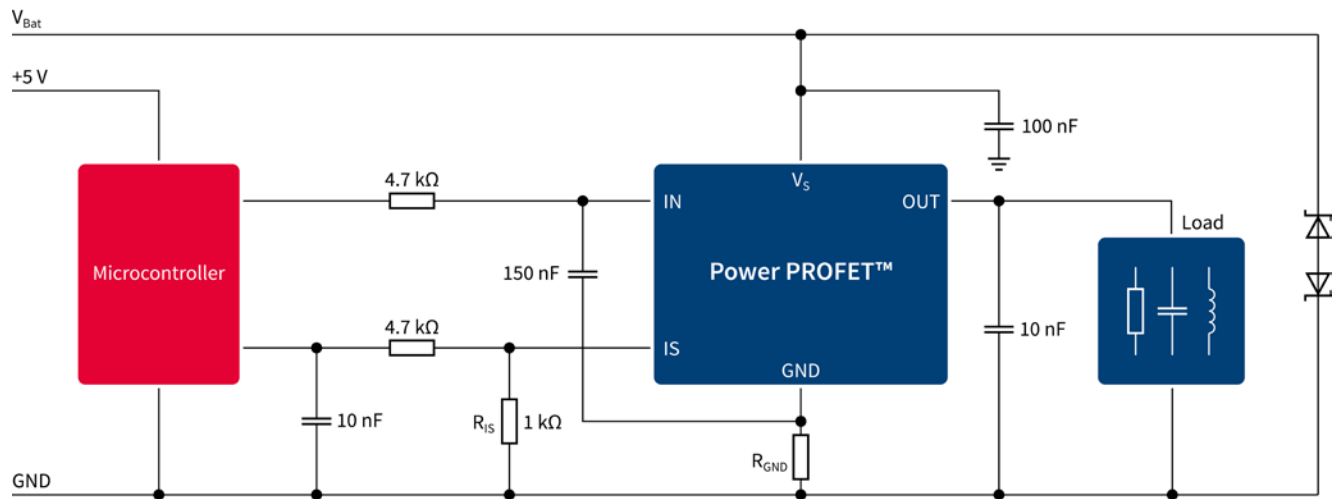


Fig. 2: Offering a simple interface for MCU control and high-current output, Infineon's Power PROFET devices combine a power chip with a control chip that integrates a comprehensive set of protection and diagnostic features.

Fig. 3: Placed on the high side of the load, an Infineon Power PROFET device presents a simple interface for power monitoring and control by a host microcontroller.





electrostatic discharge (ESD) protection as well as protection against loss of ground or loss of battery. Placed on the high side of the load, the device offers its turnkey protection functionality with few additional components (Fig. 3).

With their ability to mitigate short-circuit hazards and reduce system costs, high-side switches such as Power PROFET devices have earned a leading role as a safe solution for automotive and industrial applications. In many automotive applications, high-side switches are preferred because a short circuit within the load is more likely to occur to ground than to the battery supply voltage. In addition, even when low-side switches are in the off state, battery voltage remains present at the load. Under certain circumstances, this might lead to corrosion.

DIAGNOSIS AND PROTECTION

HIGH-SIDE SWITCHES IMPLEMENT current sensing to diagnose the load for ensuring proper operation and to measure output current for controlling output power. Indeed, Power PROFET devices use a sophisticated current-sensing mechanism to provide the host MCU with diagnostic information on load current as well as indication of faults, including short circuits and overtemperature conditions. With Power PROFET devices, this diagnostic information is presented as an enhanced current sense signal, called I_{IS} , at pin I_S (see Figs. 2 and 3). In the absence of any

“hard” failure mode – such as short circuit, overcurrent, or overtemperature – the chip presents I_{IS} as a signal proportional to the load current. In case of failure, it presents a fixed $I_{IS(FAULT)}$ value (Fig. 4). Diagnosis and protection happen rapidly with current sense time ranges from no delay to a maximum of 100 μs and overload shutdown occurs in only 12 μs (typical).

During normal operation, the host MCU can use its (typically) integrated analog-to-digital converter (ADC) to evaluate the current sense signal, I_{IS} by reading the voltage on the I_S pin of the Power PROFET defined by sense resistor and sense current ($R_{IS} * I_{IS}$). In turn, the MCU calculates the load current, I_L , by combining the I_{IS} value with device characteristics and I_{IS} stored in non-volatile memory. Finally, the >>>

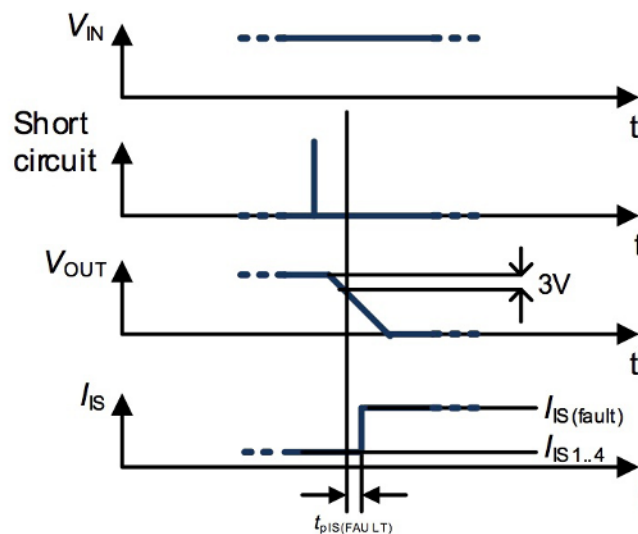


Fig. 4: An Infineon Power PROFET device provides a host MCU with an enhanced current sense signal, I_{IS} , that is proportional to the load current but rapidly latches to a fixed value, $I_{IS(FAULT)}$, in the event of a power fault, such as a short circuit – informing the host MCU of the event while simultaneously shutting down power output through its base chip.



MCU compares this calculated load current to expected normal or faulted threshold limits to determine the condition of the load and to take appropriate action.

The use of current sensing for diagnostics is a well-accepted feature in high-side power switches. At the same approach, any high-side switch typically exhibits an offset current that degrades the current sense accuracy, especially at lower load currents – and that may even disable the current sense functionality below certain load current thresholds. Off the shelf, Power PROFET devices deliver protection accuracy that is well within the requirements of typical applications. For highly sensitive applications, the devices support calibration methods that deliver more accurate device characteristics for storage in non-volatile memory – resulting in more accurate load current calculations by the host MCU. With this approach, Power PROFET devices can achieve current-sense accuracy as low as $\pm 8\%$ (Fig. 5).

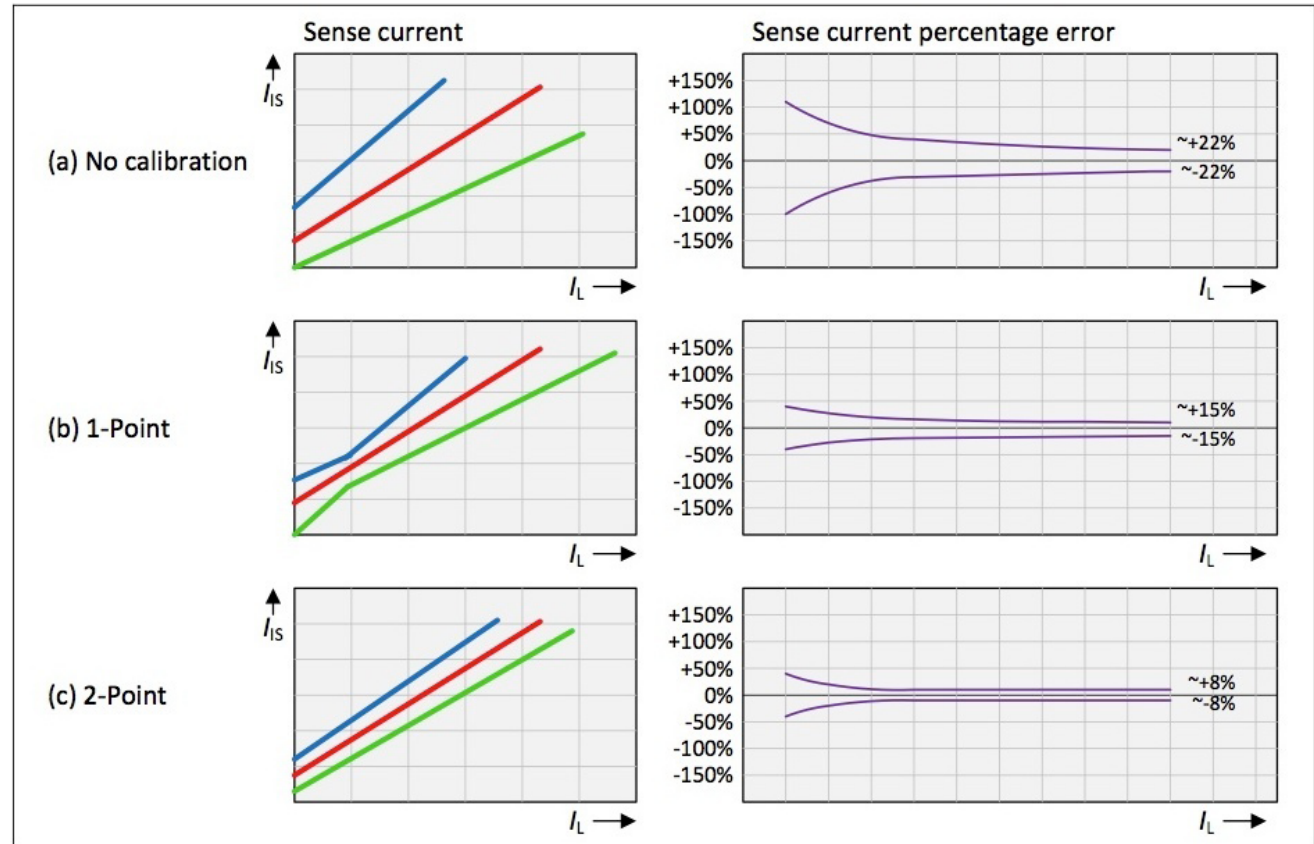


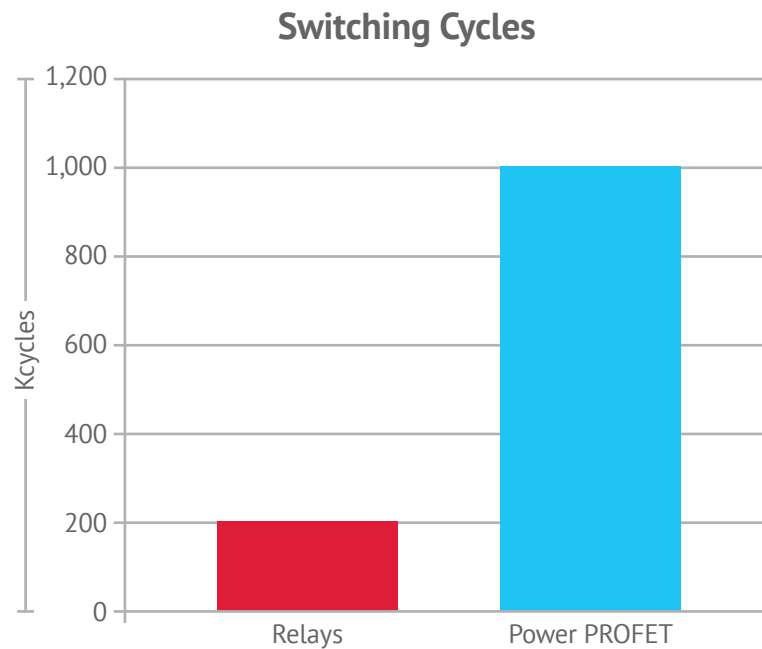
Fig. 5: While the “default” characteristics of a Power PROFET device meet accuracy requirements of most power protection applications, calibration methods can deliver device characteristic parameters that enable even more accurate current load calculations.

SWITCHING CYCLES

Power PROFET-protected high-side switches are very robust and provide for high reliability.

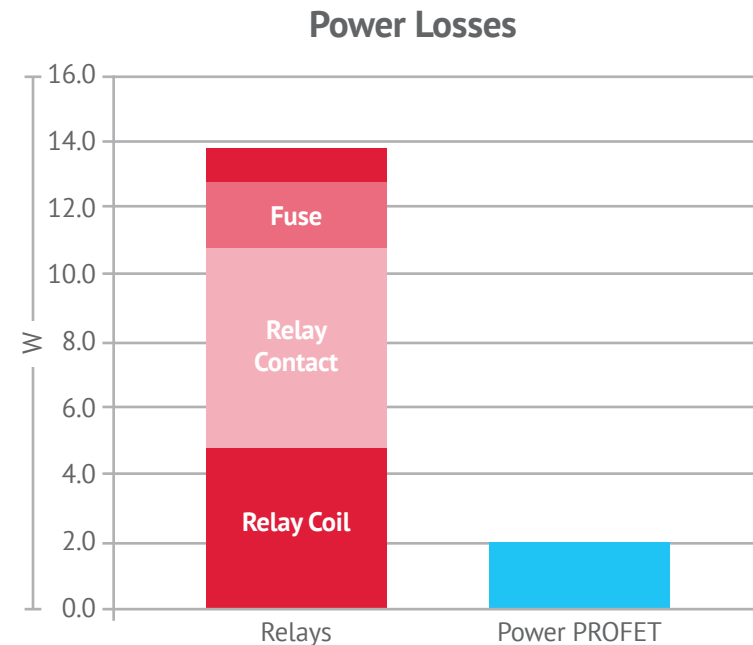
» Semiconductor solutions offer an almost unlimited number of switching cycles, whereas relays can't fulfill the latest requirements (e.g., start-stop).

- » Application examples:
- Starter relay
 - Vacuum pump
 - AC clutch



POWER LOSS REDUCTION

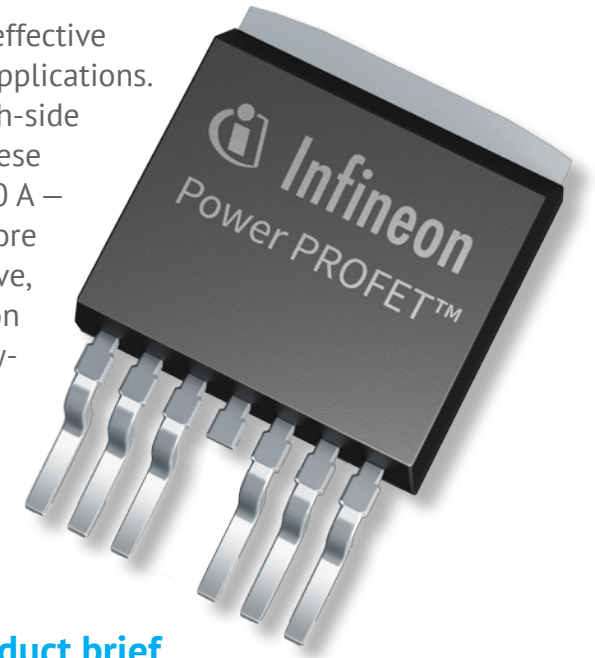
Power PROFET reduces power losses significantly and provides for high efficiency. Compared to relays, power losses can be reduced up to a factor of seven.



IMPROVED POWER PROTECTION



IN THE PAST, relays and fuses offered the most effective solution for protecting the load in high-current applications. The Infineon Power PROFET series is the first high-side semiconductor switch solution able to replace these components in high-current applications up to 40 A – reducing system size and cost while providing more sophisticated diagnosis and protection for resistive, capacitive, or inductive loads. With its combination of integrated features and simple interface, a Power PROFET device offers designers an improved solution for power protection in any high-current application.



FOR MORE INFORMATION, please view our [product page](#), [application note](#), and [product brief](#).

