PROFET™: Smart High-Side Switches

www.infineon.com/profet
General Introduction

Infineon’s PROFET™ products are high-side switches placed between the supply and load in order to control the application. The high-side switches comprise a broad range of smart features, including diverse protection and diagnostic functions. Since the PROFET™ products are capable of addressing all kinds of resistive, capacitive and inductive loads, they can be used in a big variety of automotive, commercial, agricultural & industrial applications.

**Automotive Applications**
- Lighting
  - Exterior and interior lighting (bulb/LED)
- Power Distribution
  - Relay & fuse replacement, solid state, relay, Smart Power Distribution Center (PDC)
- Heating
  - Seat, PTC, auxiliary, glow plug
- Motor Control
  - DC brush motor, pumps, fans
- Infotainment

**Industrial Applications**
- Automation/robotics
- General load management
- Electric drives
- Control systems/energy saving

The block diagram of the BTS500x0-1EGA shows the main functions and components of a PROFET™.

**Block Diagram BTS500x0-1EGA**

For more information about the PROFET™ family, the benefits and functionality of its protection and diagnosis features, please refer to www.infineon.com/profet.

**Family Overview**

**Classic PROFET™**

**Basic Features**
- High-Side Switches for load currents between 0.25A and 12A
- Suitable for resistive, capacitive and inductive loads
- Wide operating voltage range
- On-state resistance between 2.5Ω and 20mΩ
- Improved electromagnetic compatibility (EMC)
- Protection: overtemperature, overvoltage, load dump, reverse polarity
- Diagnosis: open load in OFF detection, current sense (partially)

**Benefits**
- Established and proven technology/products since more than 10 years
- Benchmark energy robustness
- High-voltage capability
- Fast switching capability
- Fast demagnetization of inductive loads

**PROFET™+ 12V & 24V**

**Basic Features**
- High-Side Switches for load currents between 0.5A and 10A
- Especially suitable for capacitive loads
- Operating voltage range:
  - PROFET™+ 12V: 5 – 28V
  - PROFET™+ 24V: 5 – 36V
- 3.3V and 5V compatible logic input
- PWM capability up to 200Hz (PROFET™+ 12V) or 400Hz (PROFET™+ 24V)
- Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit
- Diagnosis: load current sense output
**Benefits**
- Maximum design flexibility thanks to identical footprint
- Pin-compatibility between 12V and 24V and within each of the individual family members
- Very low stand-by current (< 0.5µA max.)
- High short-circuit robustness
- Outstanding current sense accuracy
- Improved heat dissipation of DSO package

**PROFET™ Motorcycle**
**Basic Features**
- Suitable for 2x 10W + 2W motorcycle left/right indicators
- Extended operating voltage range: 8–24V
- Minimum Load Dump protection: 65V
- Protected against overtemperature, overvoltage and short circuit/overload
- RoHS compliant & AEC qualified

**Benefits**
- Autonomous frequency generation
- Reduced current consumption
- Ground-less device
- Rain function capability
- Smaller external capacitors
- Accurate flashing and bulb failure detection
- Small PG-DSO-8 package for reduced space requirements

**Power PROFET™**
**Basic Features**
- High-Side Switches for load currents up to 40A
- Optimized for 12V supply voltage
- Voltage-driven input logic (3.3V and 5V)
- Stable behavior during cranking down to 3.2V supply voltage
- Lowest on-state resistance down to 1.0mΩ
- Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit
- Diagnosis: load current sense output

**Benefits**
- Efficient and robust drivers for High-Current loads
- Monitoring of load current
- Protection of device, wiring harness and load
- High short-circuit robustness (up to 100k cycles in accordance with AEC Q100-012)
- Available in standard power package (D²PAK)

**Industrial PROFET™**
**Basic Features**
- High-Side Switches for load currents between 0.25A and 4.5A
- Suitable for resistive, capacitive and inductive loads
- Maximum current limit typically at 3 times I_{nom}
- Voltage-driven input logic (3.3V and 5V)
- On-state resistance 60mΩ up to 2.5Ω
- Industry qualification compliant
- Protection: overtemperature, short-circuit, reverse V_s, under-/overvoltage
- Diagnosis: short-circuit, overload, overtemperature, open load

**Benefits**
- Efficient and robust load management for small and midsize current loads
- Digital diagnosis via status pin
- Protection of device, wiring harness and load
- High-voltage capability for industrial applications
- Freewheeling diode or active clamping on chip

**High-Current PROFET™**
**Basic Features**
- High-Side Switches for load currents up to 45A
- Suitable for resistive, capacitive and inductive loads
- Optimized for 12V and 24V supply voltages
- Current-driven and voltage-driven input logic
- On-state resistance from typically 20mΩ to 2.5mΩ
- PWM capability
- Very high energy capability up to 3 joules
- Protection: overtemperature, overvoltage, load dump, reverse polarity, short-circuit
- Diagnosis: load current sense output

**Benefits**
- Efficient and robust drivers for High-Current loads
- Monitoring of load current
- Protection of device, wiring harness and load
- Available in standard power packages, such as DPAK and D²PAK
**System Benefits**
- Compact design for basic control functions
- Protected load control and diagnostics capability
- Automotive grade quality and reliability

*www.infineon.com/motorcycle-bcm*

**Power Distribution**

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Power Distribution Module or Distributed Sub-Modules

- TLE49x6
- TLE42xx
- TLE46xx
- TLE72xx

Motorcycle BCM

- Starter Relay
- High scalability and benchmark short-circuit robustness of power semiconductors (PROFET™)
- Reduced board space due to integrated functionality
- Supports a smooth transition to LEDs for interior and exterior lighting
- Automotive grade quality and reliability
- Compact design for basic control functions

*www.infineon.com/powerdistribution*

**System Benefits**
- Smart high-current, high-power switching
- Sophisticated diagnostic features
- Bidirectional blocking power switches
- Active diode functionality
- Semiconductor relay functionality with alternative fuse
- Solid State Relay (power switch inside relay housing)
- Smart relay drivers, optional with constant current control
- Idle mode, operation current in µA range while power switch active
- High scalability of power semiconductors
- Alternative protection modes: smart or fuse protection
- High number of switching activations, negligible aging
- Extreme low-ohmic power switches with low power losses
- Current input control for long control wires

www.infineon.com/bcm

For our 24V solution, please refer to www.infineon.com/bcm-24v

**Application Diagrams**

Small Body Control Module for 2 Wheeler

- Motorcycle BCM
- Regulator
- Microcontroller
- Horn Relay
- Hall Switch
- PROFET™

**Body Control Module (12V)**

- Left Rear-Light Control
- Right Rear-Light Control
- Door & Wiper Control
- Interior Light
- Indicators
- Brake
- Fog
- ECU Power Supply
- Engine Van Cycles, e.g.: Door, Infotainment

*www.infineon.com/bcm*
## Current Sense, Current Input

### Basic Features
- 12V or 24V capable
- Single channel

### Protection Features
- Current limitation
- Overload protection
- Short-circuit protection
- ReversSave™
- Loss of GND

### Diagnosis Features
- Analog signal proportional to load current
- Overload detection
- Short-circuit detection

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## Current Sense, Voltage Input

### Basic Features
- 12V or 24V capable
- Single or multi-channel

### Protection Features
- Short-circuit shutdown with auto-restart or latch
- Overtemperature shutdown with auto-restart or latch
- Reverse polarity protection by ReverSave™ or with external components
- Loss of GND

### Diagnosis Features
- Analog signal proportional to load current
- Overload
- Open load in ON
- Overtemperature
- Short-circuit to GND

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1) Speed PROFET™, capable for PWM up to 25kHz
### Basic Features
- 12V or 24V capable
- Single or multi-channel

### Protection Features
- Overload protection
- Loss of battery / GND
- Short-circuit protection
- Overvoltage protection

### Diagnosis Features
- Open drain status feedback
- Overtemperature
- Open load
- Current limitation

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Product Family</th>
<th>Nominal Load Current</th>
<th>R_{DS(on,typ)} (mΩ)</th>
<th>I_{SBO} (A)</th>
<th>Operating Voltage</th>
<th>Diagnosis Features</th>
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<td>4.0 ... 45.0</td>
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1) Inverted logic for diagnosis  
2) at $T_i = 125^\circ C$  
3) Available in Q3/2014  
4) Having freewheeling diode built in
No Diagnosis

Basic Features
- 12V or 24V capable
- Single channel

Protection Features
- Short-circuit protection
- Current limitation
- Overvoltage protection
- Overtemperature protection

<table>
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<tr>
<th>Product Type</th>
<th>Product Family</th>
<th>R_{D(on)} (typ) [mΩ]</th>
<th>R_{D(on)} (max.) @ Tj = 150°C [mΩ]</th>
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<th>EAS [mJ]</th>
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1) Current-controlled input 2) at Tj = 125°C
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Order Number: B127-H9861-G1-X-7600
05 / 2014