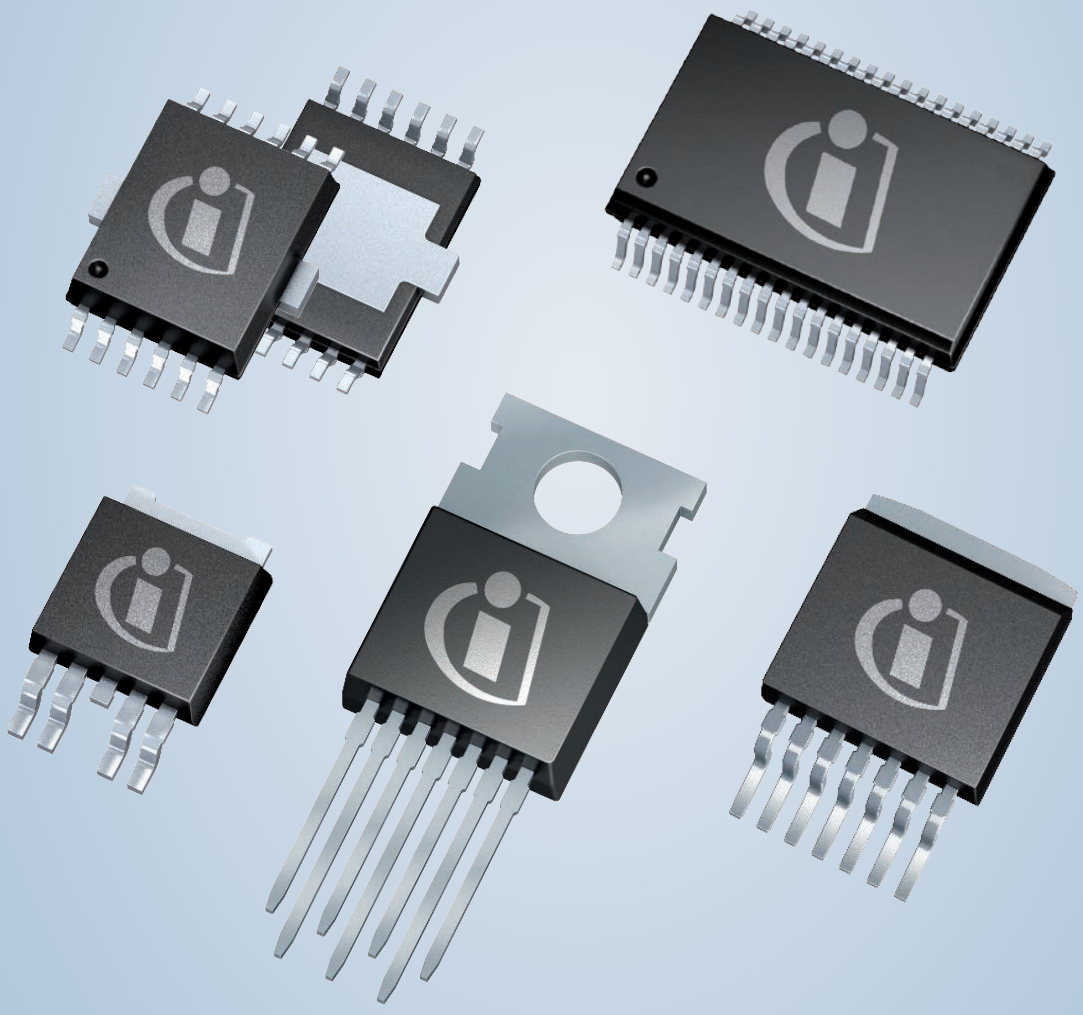


PROFET™ in Automotive Heating Systems

www.infineon.com/profet

Content

Automotive Heating

With its unrivalled broad portfolio in the low-ohmic arena, Infineon is market leader in the Automotive Heating segment.

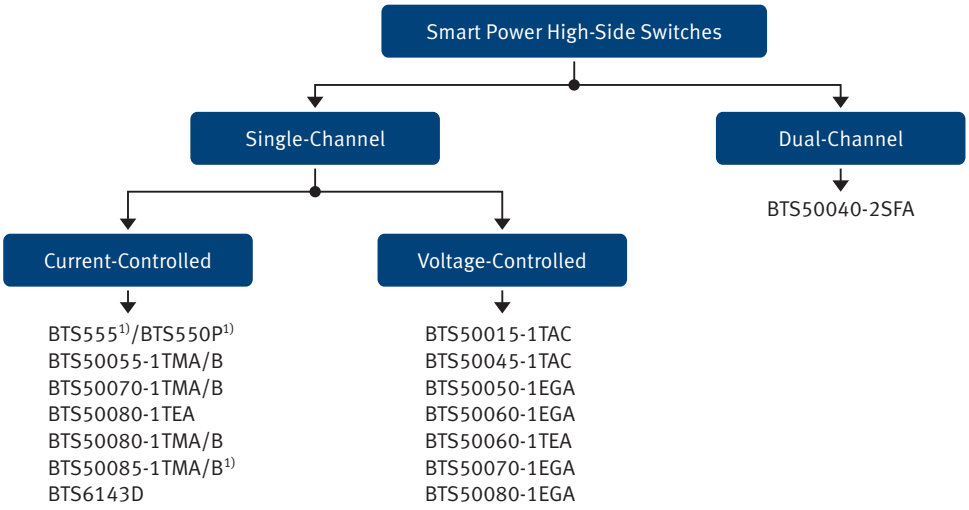
Boosted by an increased demand for comfort and energy efficiency, new heating applications (e.g. SCR – Selective Catalytic Reduction) are emerging, in addition to “classical” systems, such as Seat Heating and Glow Plug Driver.

Infineon’s current product portfolio, enhanced with the new upcoming flexible product families, is perfectly suited to provide the best solutions for all existing and new heating applications.

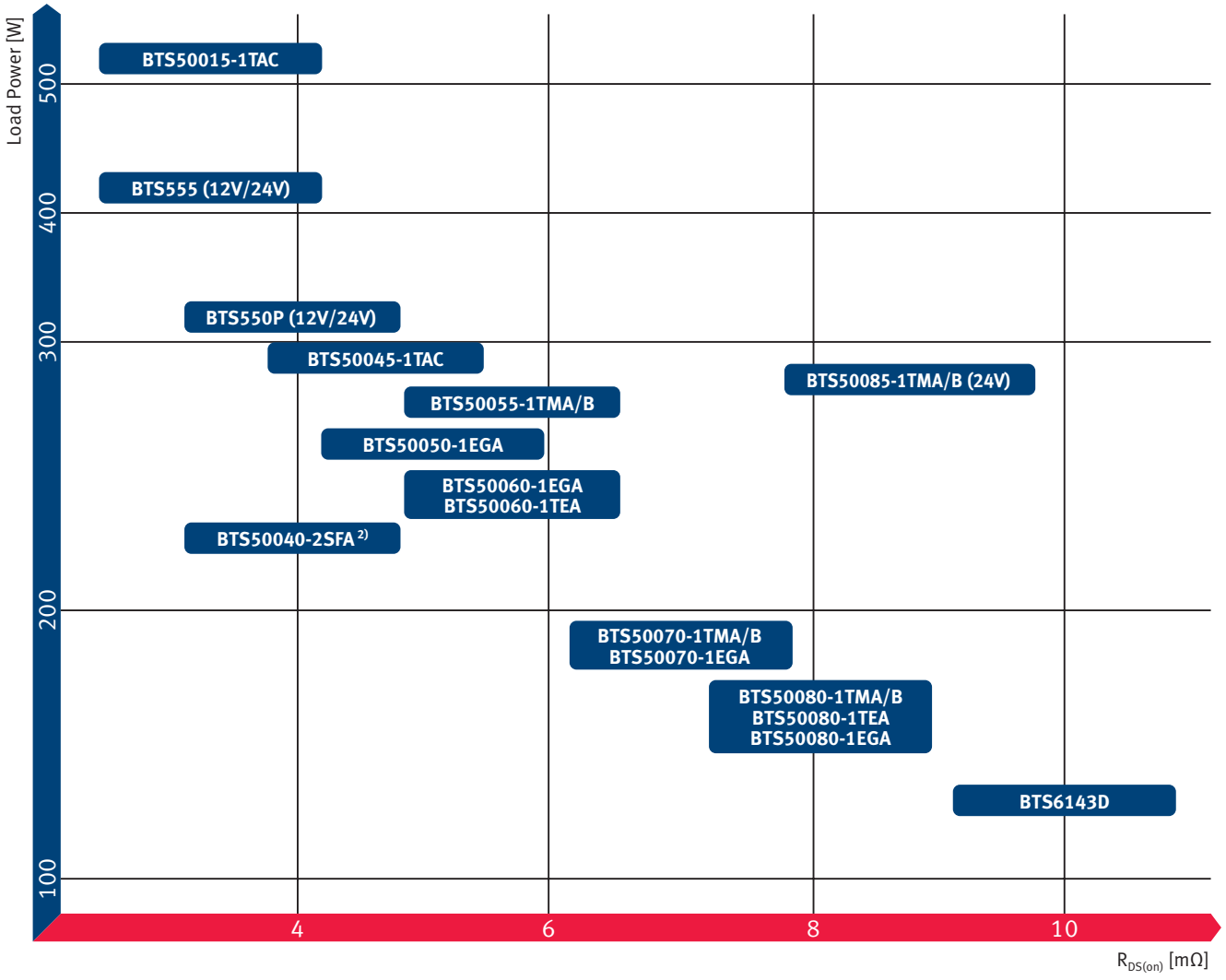
This brochure provides an overview of Infineon Smart Power High-Side Switches – which are suitable for various heating systems – and outlines their key functions and benefits.

For more detailed information, please visit the Infineon websites www.infineon.com/profet or contact your local sales partner.

Product Selection Tree



Product Portfolio



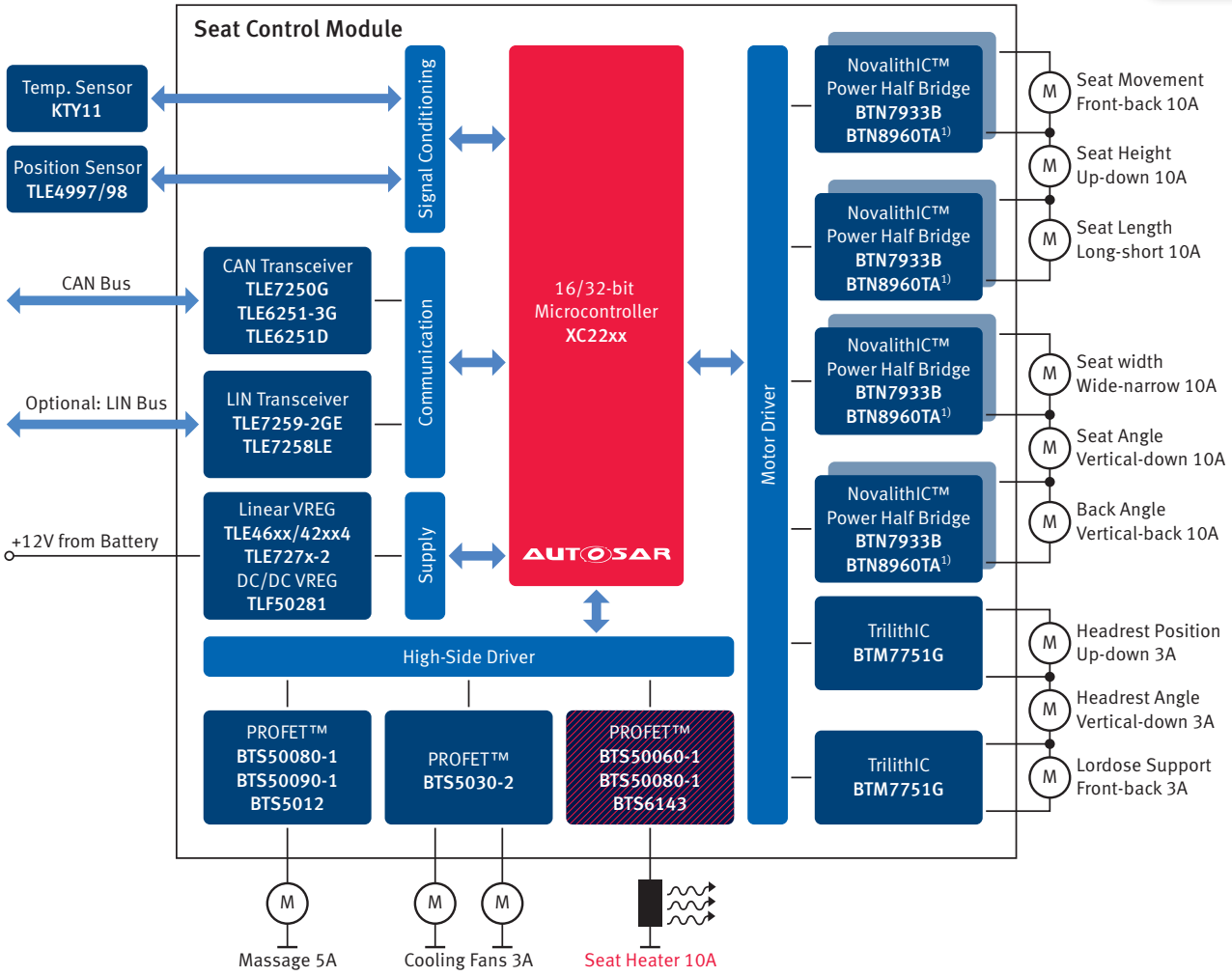
1) For 12V & 24V applications
2) Power per channel

Typical Automotive Applications

CO_2 Reduction

Fuel Efficiency

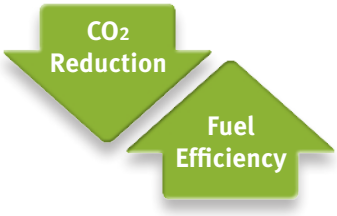
Body – Seat Control Module



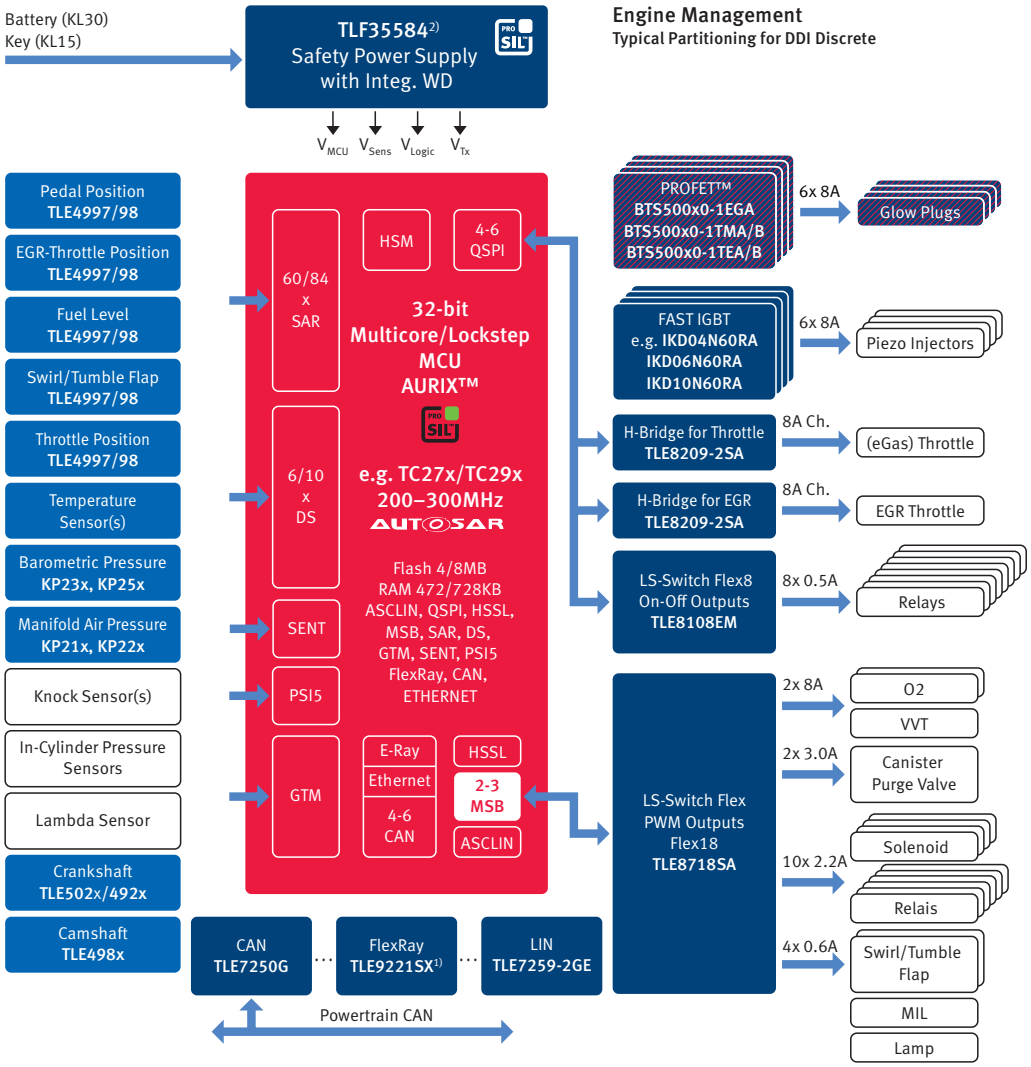
Body System Solutions for Greater Comfort

- Air scarf in convertible cars
  - Requiring: 6–10mΩ switches
- Auxiliary PTC heating systems
  - Requiring: 4–8mΩ switches with high inrush current (PTC heater)
  - Trend: Rapidly growing in conjunction with the introduction of fuel-efficient engines
- Rear window heating
  - Requiring: 2–4mΩ switches
  - Trend: Replacing relays with silicon
- Seat heating
  - Requiring: 6–10mΩ switches
  - Trend: Lower $R_{DS(on)}$ for reduced power losses in more compact modules

1) In development, samples available



Powertrain – Diesel Engine Management



Powertrain System Solutions for Fuel Efficient Engines

- Air-intake pre-heating
  - Requiring: < 4mΩ switches (24V)
  - Trend: Becoming prevalent in trucks and bus

- SCR (Selective Catalytic Reduction)
  - Requiring: 4–8mΩ switches
  - Trend: Initially used in diesel trucks and commercial vehicles only, now becoming more widespread

- Glow plug (diesel engines)
  - Requiring: 6–10mΩ switches
  - Trend: Lower $R_{DS(on)}$ for reduced power losses in more compact modules with plastic cases (lower thermal conductivity)

1) In development, samples available

High-Current PROFET™ – Current-Controlled

First generation of low-ohmic smart power switches

The High-Current (HiC) PROFET™ is a low-ohmic PROFET™ (PROtected FET) suitable for use in heating systems. Housed in different types of packages, these devices are single-channel high-side switches, assembled in chip-on-chip technology.

The current-controlled High-Current PROFET™ needs an external small signal transistor – connected at the input (IN) pin – to switch the current which turns the device on and off.

Classical High-Current PROFET™ Devices are Current-controlled and have

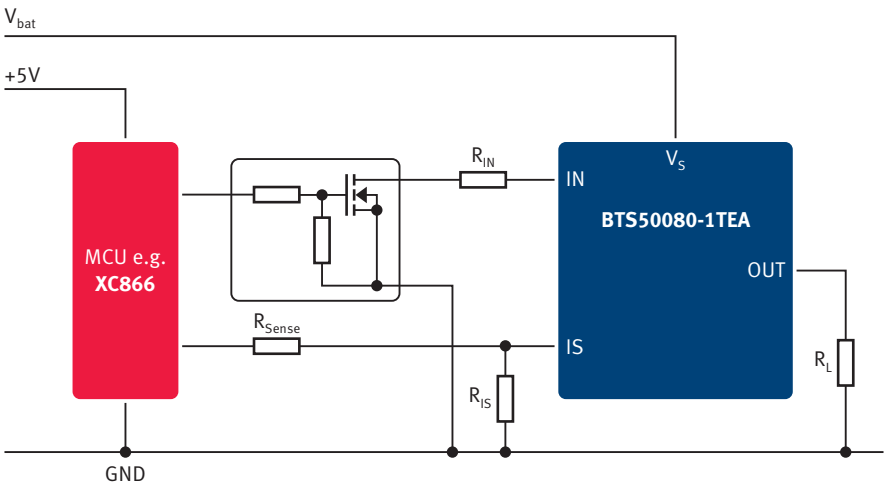
- Multi-step current limitation
- Short-ciruit protection with latch
- Thermal shutdown with restart

Other Important Features are

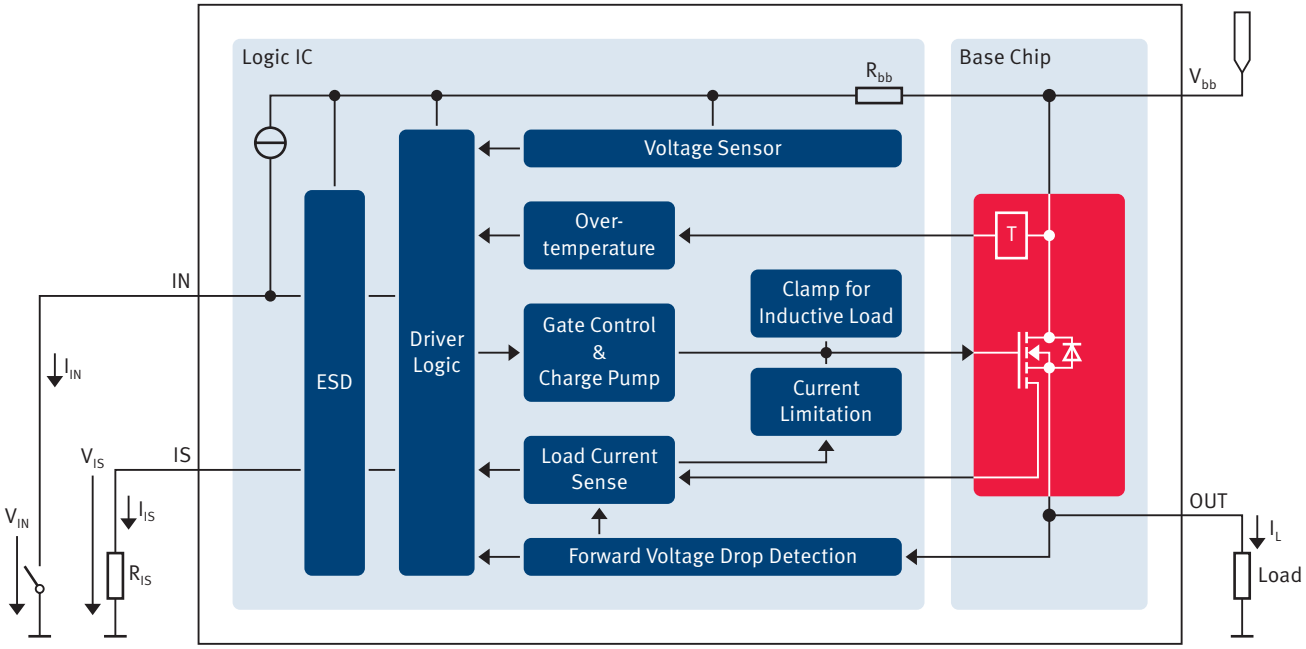
- ReverSave™ (reverse battery protection via the self turn-on on of Power MOSFET)
- Proportional load current sensing, with defined fault signal
- Overvoltage protection (including load dump)
- Open load detection in ON state
- Loss of ground and loss of V_{bb} protection
- ESD protection

Key Features	Benefits
Low-ohmic	Reduced power dissipation high-current capability
Embedded protection features (e.g. overcurrent shutdown, overtemperature shutdown)	Protection of both the load and the device
ReverSave™	Reduced power dissipation in reverse battery condition
Current-controlled logic	Easy replacement of electromechanical relays
Defined fault signal via sense pin	Easy failure type detection via direct connection to the microcontroller
AEC-qualified green packages (RoHS-compliant)	Suitable for lead-free soldering in accordance with IPC/JEDEC J-STD-020

BTS50080-1TEA – Application Diagram



BTS50080-1TEA – Block Diagram



High-Current PROFET™ – Voltage-Controlled

BTS500x0-1EGA – Scalable 5-8mΩ smart high-side switches family

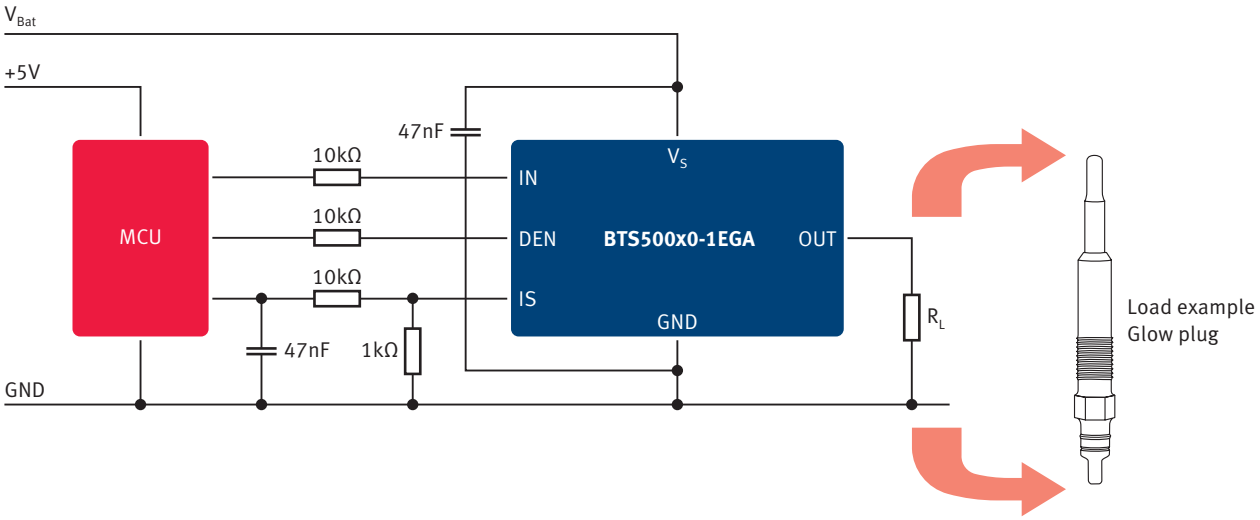
The latest High-Current PROFET™ devices are voltage-controlled. The input (IN) pin, which is CMOS-compatible, can be connected directly to a microcontroller, thereby reducing the external circuitry necessary to drive the device.

- The first group of voltage-controlled devices is the BTS500x0-1EGA family. It consists of four switches, with $R_{DS(on)}$ ranging from 5 to 8mΩ. Assembled in the same package (PG-DSO-12), the switches are pin and functionally compatible with each other and are scalable by $R_{DS(on)}$ and related parameters
- The products' scalability offers great design flexibility – the same board layout can be used for different loads, with minimum software changes
- In addition to the protection and diagnostic feature set embedded in the previous generation of High-Current PROFET™, the BTS500x0-1EGA family comes with Infineon® Enhanced Sense, which improves the diagnostic capability on the current sense (IS) pin and has the potential to support open load and short-to-battery detection in the OFF state
- The DEN (Diagnostic ENable) pin enables the multiplexing of the diagnostic signal, as well as a reduction of the stand-by current

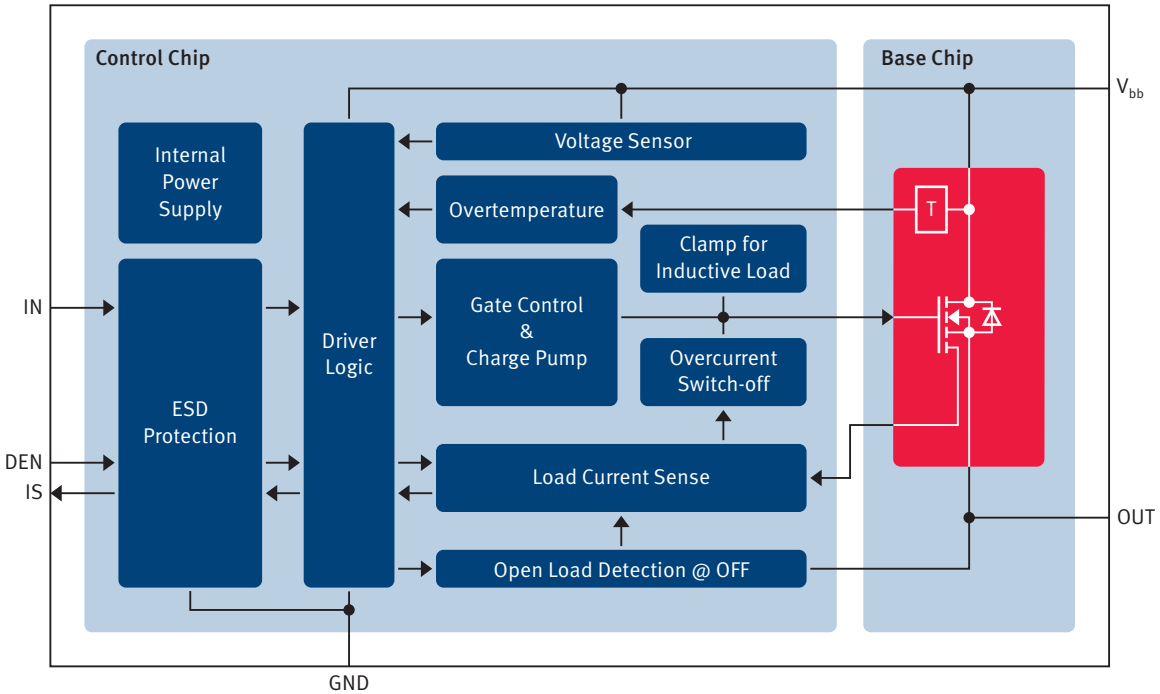
Key Features	Benefits
Scalability by $R_{DS(on)}$ – Pin, package and functionally compatible products	Simplified board design and layout; Reduced qualification and software complexity; Easy implementation of fallback solution
Voltage-controlled with 3.3 and 5V CMOS-compatible inputs	Can be connected directly to a microcontroller
ReverSave™	Reduced power dissipation in reverse battery condition
Supports a multiplexed current sense signal	One A/D converter shared among several devices
Embedded protection features (e.g. latched overcurrent shutdown, latched overtemperature shutdown)	Protection of both the load and the device
Defined fault signal via sense pin (Infineon® Enhanced Sense)	Easy failure type detection via direct connection to the microcontroller
AEC-qualified green packages (RoHS-compliant)	Suitable for lead-free soldering in accordance with IPC/JEDEC J-STD-020

AEC Qualified RoHS

BTS500x0-1EGA – Application Diagram



BTS500x0-1EGA – Application Diagram



High-Current PROFET™ – Voltage-Controlled

BTS50060-1TEA – Optimized EMC Performance;
Easy Current Sense Calibration for Precise Load Current Measurement

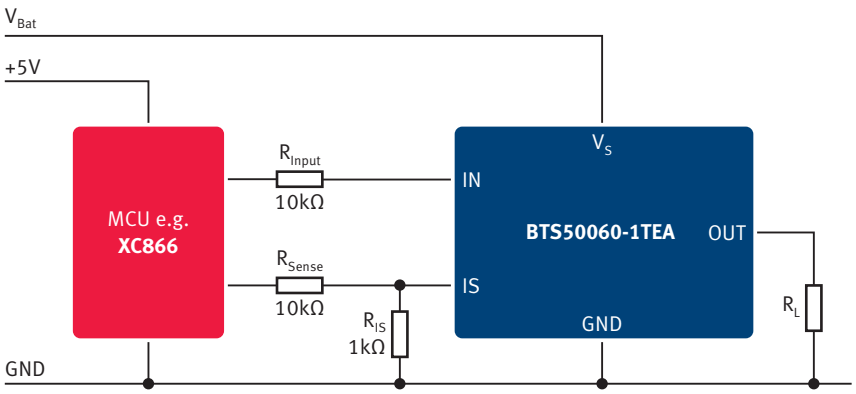
- BTS50060-1TEA – a 6mΩ high-side switch – is the latest voltage-controlled High-Current PROFET™
- Housed in a PG-TO252-5 package (RoHS 5-pin DPAK), it features a P-Channel MOS as its power stage
- The usage of a P-Channel MOS results in
  - Low switching losses
  - Improved EMC performance – low emissions, high immunity, required for seat heating modules
- BTS50060-1TEA includes – like the other High-Current PROFET™ – embedded protection and diagnostic features, such as short-circuit protection, overload protection, latched thermal shutdown, open load detection in both the ON and OFF state and, short-to-battery detection.
- Furthermore, an advanced load current sense signal supports easy calibration for very high accuracy

Key Features	Benefits
6mΩ $R_{DS(on)}$ (max 12mΩ @ 150°C) with inrush current up to 60A	Supports a high-current drive in a small package
EMC-optimized performance	Easy noise filtering
Low switching losses	Optimized $R_{DS(on)}$
Voltage-controlled with 3.3 and 5V CMOS-compatible inputs	Can be connected to a microcontroller directly
Embedded protection features (e.g. latched overcurrent shutdown, latched overtemperature shutdown)	Protection of both the load and the device
Defined fault signal via sense pin	Easy failure type detection by differentiating between different failure modes via direct connection to the microcontroller
Advanced analog load current sense signal	Easy current sense calibration; Precise load current measurement to save extra sensor circuitry
AEC-qualified green packages(RoHS-compliant)	Suitable for lead-free soldering in accordance with IPC/JEDEC J-STD-020

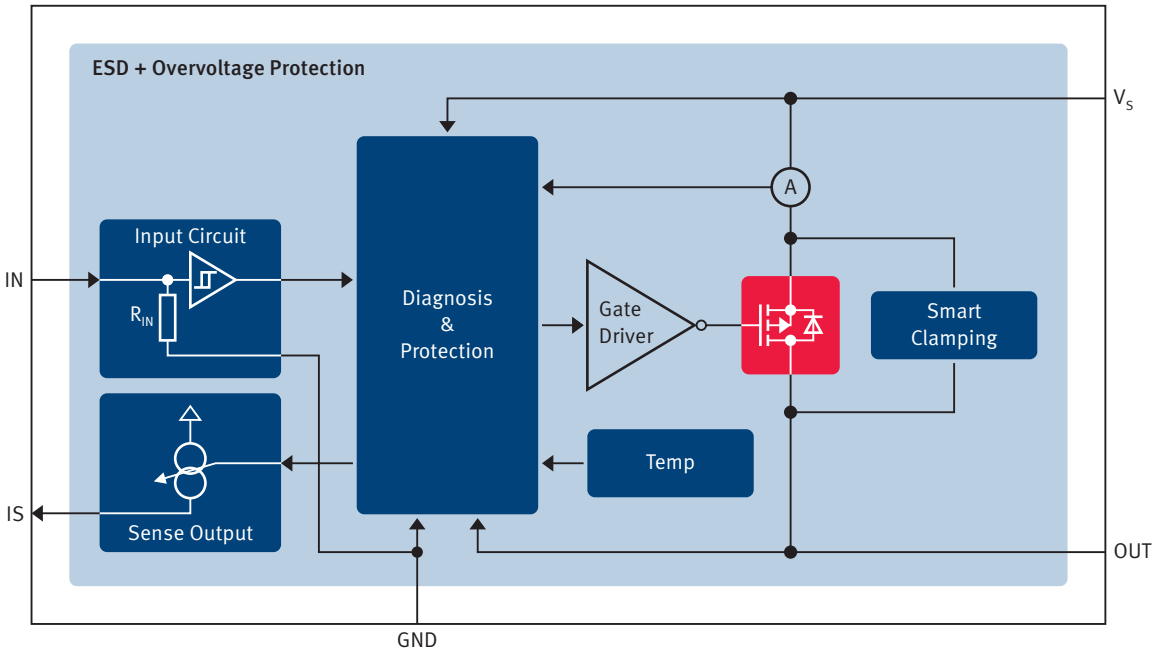
AEC Qualified

RoHS

BTS50060-1TEA – Application Diagram



BTS50060-1TEA – Block Diagram



Power PROFET™ – Voltage-Controlled

BTS50015-1TAC, BTS50045-1TAC

The Power PROFET™ is single-channel protected high-side switch in the PG-TO263-7-8 (SMD) package, with integrated protection functions and diagnostics.

The family is designed to drive high-current loads up to 30A DC, for applications like switched battery couplings, power distribution switches, heaters and glow plugs in the harsh automotive environment. The BTS50015-1TAC for example can pass inrush and momentary currents up to 135A each (minimum, worst case).

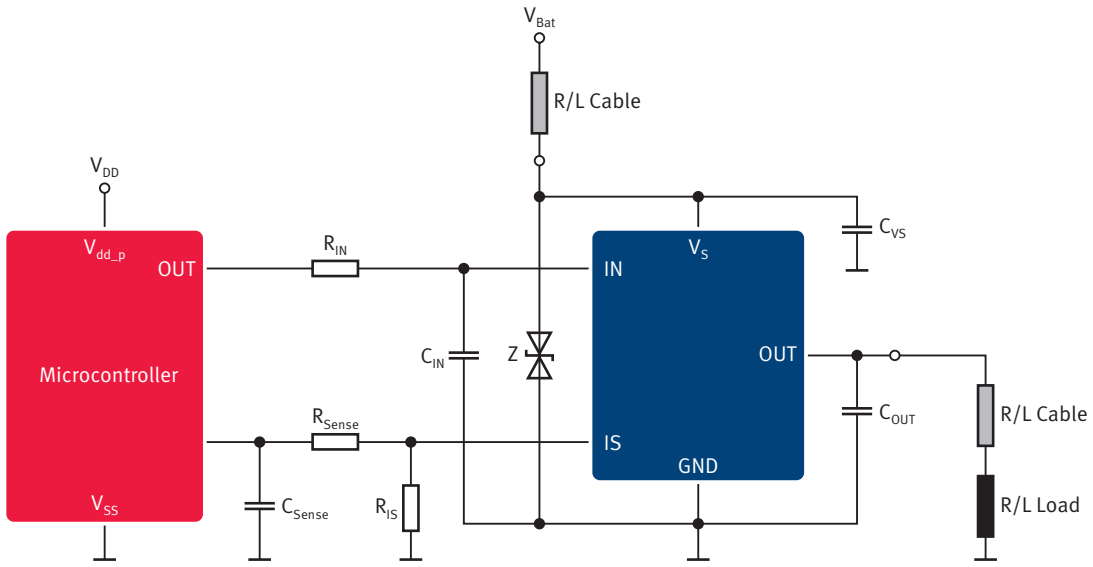
Applications

- 12V grounded high-side loads up to 40A DC (permanent/channel)
- Suitable for automotive and industrial applications
- Replaces electromechanical relays, fuses and discrete circuits
- Designed for high current loads, such as switching for power distribution and heating systems
- All types of resistive, inductive and capacitive loads

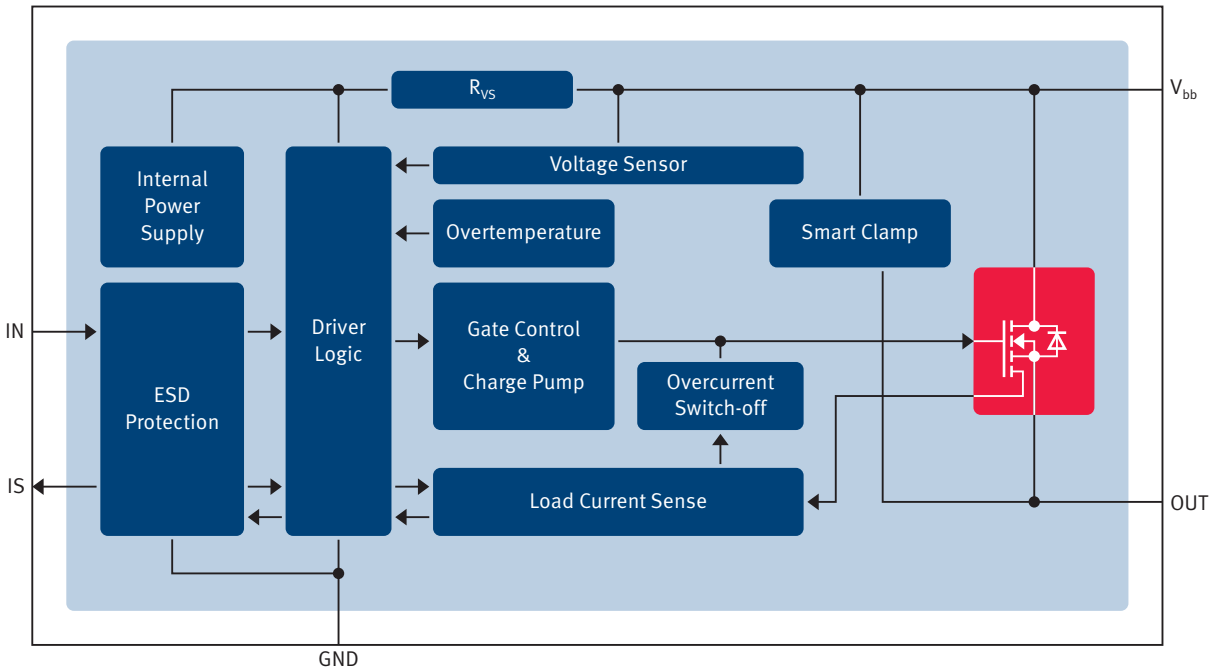
Key Features	Benefits
N-channel MOSFET with charge pump	Infineon ReverSave™ provides low power dissipation in reverse mode
AEC Qualified, RoHS and ELV compliant	Low power consumption in ON and OFF
Analog current sense combined with digital fault feedback	Stable behavior at undervoltage
ESD, overvoltage, overload and overtemperature protected	EMC optimized
Current threshold tripping and thermal tripping	Chip-on-chip construction gives lowest $R_{DS(on)}$ in smallest footprint
Infineon Smart Clamp active load dump suppression	Short circuit robustness specified in the datasheets

AEC Qualified RoHS

BTS50015-1TAC – Application Diagram



BTS50015-1TAC – Block Diagram



High-Current PROFET™ – Dual-Channel

BTS50040-2SFA – Low-ohmic (4mΩ) dual-channel switch with adjustable slew rate

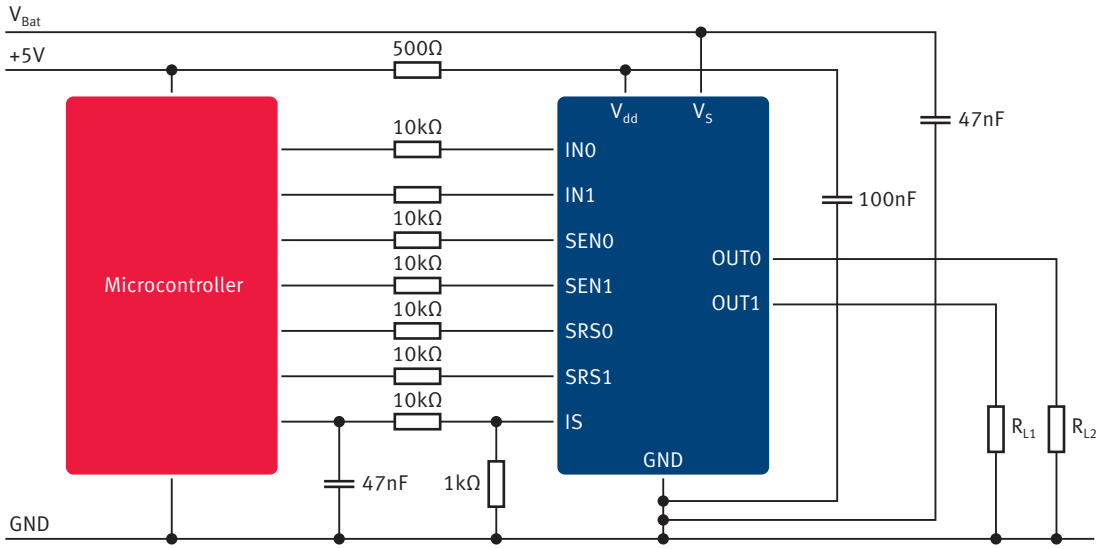
- BTS50040-2SFA is the first dual-channel High-Current PROFET™
- Housed in an RoHS-compliant PG-DSO-36 package, it consists of two 4mΩ channels, and is particularly suitable for applications with multiple loads and board space constraints, e.g. seat heating or glow plugs
- Compared to existing High-Current PROFET™ devices, one of its most innovative features is the option of slew rate adjustment, via the SRSx pin, to optimize the EMC (electromagnetic compatibility) performance
- A separate enable function for the two channels allows load current sense multiplexing, as well as the sharing of one A/D converter between various devices and a reduction of the microcontroller pin count
- Latched overcurrent and overtemperature shutdown, overvoltage protection (including load dump), ReverSave™, and a proportional load current sense signal (used as a diagnostic pin in the event of a fault) complete the embedded set of protection and diagnostic features

Key Features	Benefits
Low-ohmic	Reduced power dissipation high-current capability
Adjustable slew rate	Best trade-off between switching losses and EMC performance
Voltage-controlled with 3.3 and 5V CMOS-compatible inputs	Can be connected directly to a microcontroller
ReverSave™	Reduced power dissipation in reverse battery condition
Very low stand-by current	Reduces current consumption of application in off-state
Multiplexed current sense signal, with a separate enable function for the two channels	One A/D converter shared between several devices
Embedded protection features (e.g. latched overcurrent shutdown, latched overtemperature shutdown)	Protection of both the load and the device
Defined fault signal via sense pin	Easy failure type detection via direct connection to the microcontroller
AEC-qualified green packages (RoHS-compliant)	Suitable for lead-free soldering in accordance with IPC/JEDEC J-STD-020

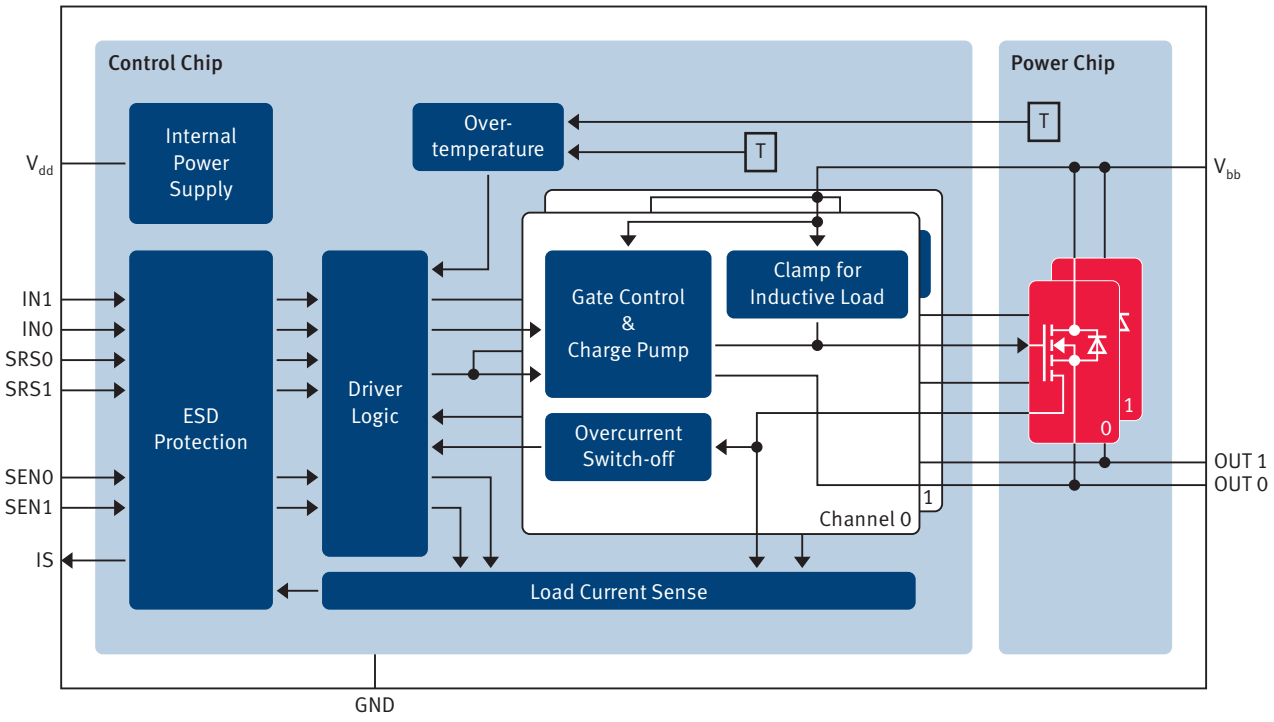
AEC Qualified

RoHS

BTS50040-2SFA – Application Diagram



BTS50040-2SFA – Block Diagram



Product Portfolio

Product Type	$R_{DS(on)}$ (typ.) [mΩ]	$R_{DS(on)}$ (max.) @ T_j = 150°C [mΩ]	Nominal Load Current [A]	EAS [mJ]	Recommended Operating Voltage Range [V]	$I_{L(SC)}$ (typ.) [A]	Package
High-Current PROFET™ – Current-Controlled							
BTS6143D	10.0	18	10	300 @ 20A	5.5 ... 38.0	105	PG-TO252-5-11
BTS50085-1TMA	9.0	17	11	1200 @ 20A	5.5 ... 58.0	90	PG-TO220-7-4
BTS50085-1TMB	9.0	17	11	1200 @ 20A	5.0 ... 58.0	90	PG-TO220-7-11
BTS50080-1TMA	8.0	16	12	400 @ 20A	5.5 ... 38.0	130	PG-TO220-7-4
BTS50080-1TMB	8.0	16	12	400 @ 20A	5.5 ... 38.0	130	PG-TO220-7-12
BTS50080-1TMC	8.0	16	12	400 @ 20A	5.5 ... 38.0	130	PG-TO220-7-4
BTS50080-1TEA	8.0	16	10	300 @ 20A	5.5 ... 30.0	125	PG-TO252-5-11
BTS50080-1TEB	8.0	16	10	300 @ 20A	5.5 ... 30.0	125	PG-TO252-5-11
BTS50070-1TMA	7.0	14	12	400 @ 20A	5.5 ... 30.0	95	PG-TO220-7-4
BTS50070-1TMB	7.0	14	12	400 @ 20A	5.5 ... 30.0	95	PG-TO220-7-12
BTS50055-1TMA	6.0	11	17	1500 @ 20A	5.0 ... 34.0	130	PG-TO220-7-4
BTS50055-1TMB	6.0	11	17	1500 @ 20A	5.0 ... 34.0	130	PG-TO220-7-11
BTS50055-1TMC	6.0	11	17	1500 @ 20A	5.5 ... 34.0	95	PG-TO220-7-4
BTS550P	3.5	7	35	3000 @ 20A	5.0 ... 34.0	220	PG-TO218-5-146
BTS555	2.5	4	45	3000 @ 20A	5.0 ... 34.0	400	PG-TO218-5-146
BTS500x0-1EGA Family – Voltage Controlled							
BTS50080-1EGA	8	16	13	125 @ 50A	6.0 ... 28.0	150	PG-DSO-12-16
BTS50070-1EGA	7	14	14	145 @ 50A	6.0 ... 28.0	150	PG-DSO-12-16
BTS50060-1EGA	6	12	15	170 @ 50A	6.0 ... 28.0	150	PG-DSO-12-16
BTS50050-1EGA	5	10	16	200 @ 50A	6.0 ... 28.0	150	PG-DSO-12-16
BTS50060-1TEA – Voltage Controlled							
BTS50060-1TEA	6	12	13.5	280 @ 20A	4.7 ... 28.0	75	PG-TO252-5-11
Power PROFET™ – Voltage Controlled							
BTS50015-1TAC	1.5	3	39	550 @ 33A	5.3 ... 28	135	PG-TO263-7-8
BTS50045-1TAC	4.5	9	19	570 @ 19A	5.3 ... 28	70	PG-TO263-7-8

BTS50040-2SFA – 2 Channel Device, Voltage Controlled

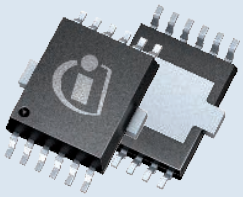
Product Type	$R_{DS(on)}$ (typ.) Per channel [mΩ]	$R_{DS(on)}$ (max.) Per channel @ T_j = 150°C [mΩ]	Nominal Load Current Per channel [A]	EAS [mJ]	Recommended Operating Voltage Range [V]	$I_{L(SC)}$ (typ.) [A]	Package
BTS50040-2SFA	4	8.2	11.0	411 @ 20A	6.0 ... 28.0	160	PG-DSO-36-44

AEC Qualified

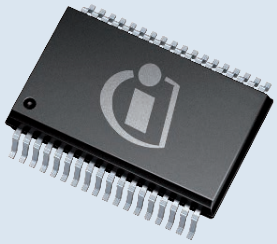
RoHS

Package Overview

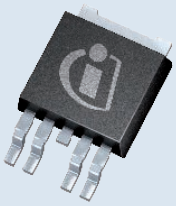
PG-DSO-12-16



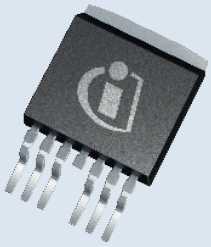
PG-DSO-36-44



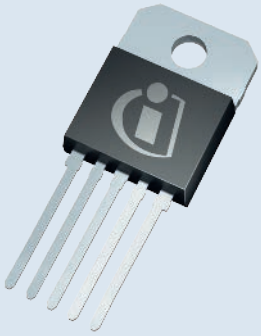
PG-TO252-5-11



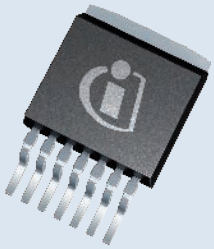
PG-TO263-7-8 (SMD)



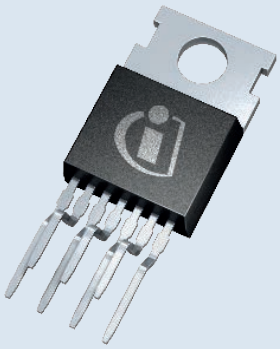
PG-TO218-5-146



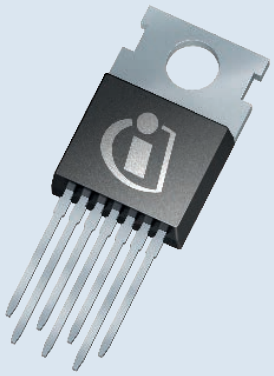
PG-TO220-7-4 (SMD)



PG-TO220-7-11



PG-TO220-7-12



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- India ..... 000 800 4402 951 (English)
- USA ..... 1-866 951 9519 (English/German)
- Other countries ..... 00* 800 951 951 951 (English/German)
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Published by
Infineon Technologies AG
85579 Neubiberg, Germany

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