# Smart Highside High Current Power Switch

## Features

- Overload protection
- Current limitation
- Short circuit protection
- Overtemperature protection
- Overvoltage protection (including load dump)
- Clamp of negative voltage at output
- Fast deenergizing of inductive loads [1)]
- Low ohmic inverse current operation
- Reverse battery protection
- Diagnostic feedback with load current sense
- Open load detection via current sense
- Loss of $V_{bb}$ protection[2)]
- **E**lectro**s**tatic **d**ischarge (**ESD**) protection

## Product Summary

| | | | |
|---|---|---|---|
| Overvoltage protection | $V_{bb(AZ)}$ | 70 | V |
| Output clamp | $V_{ON(CL)}$ | 60 | V |
| Operating voltage | $V_{bb(on)}$ | 5.0 ... 55 | V |
| On-state resistance | $R_{ON}$ | 4 | mΩ |
| Load current (ISO) | $I_{L(ISO)}$ | 96 | A |
| Short circuit current limitation | $I_{L(SCp)}$ | 320 | A |
| Current sense ratio | $I_L : I_{IS}$ | 25 000 | |

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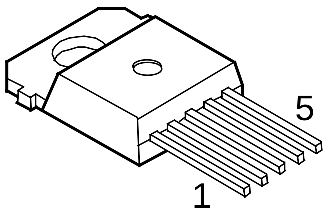


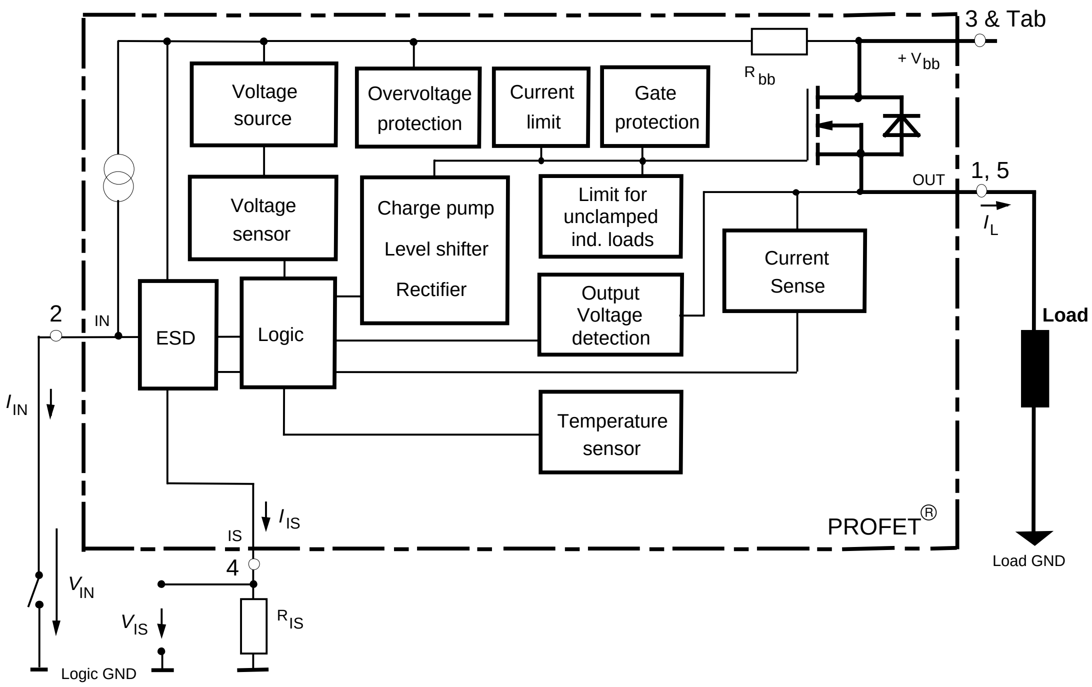

Straight leads

## Application

- Power switch with current sense diagnostic feedback for up to 48 V DC grounded loads
- Most suitable for loads with high inrush current like lamps and motors; all types of resistive and inductive loads
- Replaces electromechanical relays, fuses and discrete circuits

## General Description

N channel vertical power FET with charge pump, current controlled input and diagnostic feedback with load current sense, integrated in Smart SIPMOS® chip on chip technology. Fully protected by embedded protection functions.

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1) With additional external diode.

2) Additional external diode required for energized inductive loads (see page 8).

| Pin | Symbol | | Function |
|---|---|---|---|
| 1 | OUT | O | Output to the load. The pins 1 and 5 must be shorted with each other especially in high current applications![3] |
| 2 | IN | I | Input, activates the power switch in case of short to ground |
| 3 | Vbb | + | Positive power supply voltage, the tab is electrically connected to this pin. In high current applications the tab should be used for the $V_{bb}$ connection instead of this pin[4]. |
| 4 | IS | S | Diagnostic feedback providing a sense current proportional to the load current; zero current on failure (see Truth Table on page 6) |
| 5 | OUT | O | Output to the load. The pins 1 and 5 must be shorted with each other especially in high current applications![3] |

**Maximum Ratings** at $T_j$ = 25 °C unless otherwise specified

| Parameter | Symbol | Values | Unit |
|---|---|---|---|
| Supply voltage (overvoltage protection see page 4) | $V_{bb}$ | 60 | V |
| Supply voltage for full short circuit protection, resistive load or L < tbd µH $T_{j,start}$ =-40 ...+150°C: | $V_{bb}$ | 55 | V |
| Load current (short circuit current, see page 4) | $I_L$ | self-limited | A |
| Load dump protection $V_{LoadDump} = U_A + V_s$, $U_A = 13.5$ V<br>$R_I$[5] = 2 Ω, $R_L$ = 0.1 Ω, $t_d$ = 200 ms,<br>IN, IS = open or grounded | $V_{Load\ dump}$[6] | 80 | V |
| Operating temperature range<br>Storage temperature range | $T_j$<br>$T_{stg}$ | -40 ...+150<br>-55 ...+150 | °C |
| Power dissipation (DC), $T_C \leq 25$ °C | $P_{tot}$ | 310 | W |
| Inductive load switch-off energy dissipation, single pulse<br>$V_{bb}$ = 12V, $T_{j,start}$ = 150°C, $T_C$ = 150°C const.,<br>$I_L$ = tbd (>=20) A, $Z_L$ = tbd mH, 0 Ω, see diagrams on page 9 | $E_{AS}$ | tbd | J |
| Electrostatic discharge capability (ESD)<br>Human Body Model acc. MIL-STD883D, method 3015.7 and ESD assn. std. S5.1-1993, C = 100 pF, R = 1.5 kΩ | $V_{ESD}$ | 2.0 | kV |
| Current through input pin (DC)<br>Current through current sense status pin (DC)<br>see internal circuit diagrams on page 7 | $I_{IN}$<br>$I_{IS}$ | +15 , -250<br>+15 , -250 | mA |

3) Not shorting all outputs will considerably increase the on-state resistance, reduce the peak current capability and decrease the current sense accuracy

4) Otherwise add up to 0.5 mΩ (depending on used length of the pin) to the $R_{ON}$ if the pin is used instead of the tab.

5) $R_I$ = internal resistance of the load dump test pulse generator.

6) $V_{Load\ dump}$ is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839.

## Thermal Characteristics

| Parameter and Conditions | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min | typ | max | |
| Thermal resistance chip - case: | $R_{thJC}$[7] | -- | -- | 0.40 | K/W |
| junction - ambient (free air): | $R_{thJA}$ | -- | 30 | -- | |

## Electrical Characteristics

| Parameter and Conditions<br>at $T_j$ = -40 ... +150 °C, $V_{bb}$ = 12 V unless otherwise specified | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min | typ | max | |

### Load Switching Capabilities and Characteristics

| Parameter and Conditions | Symbol | min | typ | max | Unit |
|---|---|---|---|---|---|
| On-state resistance (Tab to pins 1,5, see measurement circuit page 7) $I_L$ = tbd (>=20) A, $T_j$ = 25 °C: | $R_{ON}$ | -- | 3.3 | 4.0 | mΩ |
| $V_{IN}$ = 0, $I_L$ = tbd (>=20) A, $T_j$ = 150 °C: | | | 6.5 | 7.8 | |
| $I_L$ = 150 A, $T_j$ = 150 °C: | | | | 7.9 | |
| Nominal load current[8] (Tab to pins 1,5)<br>ISO 10483-1/6.7: $V_{ON}$ = 0.5 V, $T_C$ = 85 °C [9] | $I_{L(ISO)}$ | 80 | 96 | -- | A |
| Maximum load current in resistive range<br>(Tab to pins 1,5) $V_{ON}$ = 1.8 V, $T_C$ = 25 °C: | $I_{L(Max)}$ | tbd | -- | -- | |
| see diagram on page 12 $V_{ON}$ = 1.8 V, $T_C$ = 150 °C: | | tbd | -- | -- | A |
| Turn-on time[10] $I_{IN}$ _\|‾ to 90% $V_{OUT}$: | $t_{on}$ | 130 | -- | 550 | µs |
| Turn-off time $I_{IN}$ ‾\|_ to 10% $V_{OUT}$:<br>$R_L$ = 1 Ω , $T_j$ =-40...+150°C | $t_{off}$ | 60 | -- | 240 | |
| Slew rate on[10] (10 to 30% $V_{OUT}$ )<br>$R_L$ = 1 Ω | $dV/dt_{on}$ | -- | 0.8 | -- | V/µs |
| Slew rate off[10] (70 to 40% $V_{OUT}$ )<br>$R_L$ = 1 Ω | $-dV/dt_{off}$ | -- | 0.8 | -- | V/µs |

### Inverse Load Current Operation

| Parameter and Conditions | Symbol | min | typ | max | Unit |
|---|---|---|---|---|---|
| On-state resistance (Pins 1,5 to pin 3)<br>$V_{bIN}$ = 12 V, $I_L$ = - tbd (>=20) A $T_j$ = 25 °C: | $R_{ON(inv)}$ | -- | 3.3 | 4.0 | mΩ |
| see diagram on page 9 $T_j$ = 150 °C: | | | 6.5 | 7.8 | |
| Nominal inverse load current (Pins 1,5 to Tab)<br>$V_{ON}$ = -0.5 V, $T_C$ = 85 °C9 | $I_{L(inv)}$ | 80 | 96 | -- | A |
| Drain-source diode voltage ($V_{out}$ > $V_{bb}$)<br>$I_L$ = - tbd (>=20) A, $I_{IN}$ = 0, $T_j$ = +150°C | $-V_{ON}$ | -- | tbd | -- | mV |

7) Thermal resistance $R_{thCH}$ case to heatsink (about 0.25 K/W with silicone paste) not included!

8) Not tested, specified by design.

9) $T_J$ is about 105°C under these conditions.

10) See timing diagram on page 13.

| Parameter and Conditions<br>at $T_j$ = -40 ... +150 °C, $V_{bb}$ = 12 V unless otherwise specified | Symbol | Values min | typ | max | Unit |
|---|---|---|---|---|---|

### Operating Parameters

| Parameter and Conditions | Symbol | min | typ | max | Unit |
|---|---|---|---|---|---|
| Operating voltage ($V_{IN}$ = 0) [11] | $V_{bb(on)}$ | 5.0 | -- | 55 | V |
| Undervoltage shutdown [12] | $V_{bIN(u)}$ | -- | 3.5 | 4.5 | V |
| Undervoltage start of charge pump see diagram page 14 | $V_{bIN(ucp)}$ | -- | 5 | 6.5 | V |
| Overvoltage protection[13] $T_j$ =-40°C:<br>$I_{bb}$ = 15 mA $T_j$ = 25...+150°C: | $V_{bIN(Z)}$ | 68<br>70 | --<br>74 | --<br>-- | V |
| Standby current $T_j$ =-40...+25°C:<br>$I_{IN}$ = 0 $T_j$ = 150°C: | $I_{bb(off)}$ | --<br>-- | 15<br>25 | 25<br>60 | µA |

### Protection Functions

| Parameter and Conditions | Symbol | min | typ | max | Unit |
|---|---|---|---|---|---|
| Short circuit current limit (Tab to pins 1,5)<br>$V_{ON}$ = 12 V, time until shutdown max. 300 µs $T_c$ =-40°C:<br>$T_c$ =25°C:<br>$T_c$ =+150°C: | $I_{L(SCp)}$ | --<br>tbd<br>tbd | 370<br>320<br>225 | --<br>tbd<br>tbd | A |
| Short circuit shutdown delay after input current positive slope, $V_{ON} > V_{ON(SC)}$<br>min. value valid only if input "off-signal" time exceeds 30 µs | $t_{d(SC)}$ | 80 | -- | 300 | µs |
| Output clamp [14] $I_L$= 40 mA:<br>(inductive load switch off) $I_L$= 20 A:<br>(typ. $I_{IS}$ = -120µA) | $-V_{OUT(CL)}$ | --<br>-- | 15<br>17 | --<br>-- | V |
| Output clamp (inductive load switch off) at $V_{OUT} = V_{bb} - V_{ON(CL)}$ (e.g. overvoltage)<br>$I_L$= 40 mA | $V_{ON(CL)}$ | 60 | 64 | 68 | V |
| Short circuit shutdown detection voltage (pin 3 to pins 1,5) | $V_{ON(SC)}$ | -- | 6 | -- | V |

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11) For all voltages 0 ... 55 V the device is fully protected against overtemperature and short circuit.

12) $V_{bIN} = V_{bb} - V_{IN}$ see diagram on page 7. When $V_{bIN}$ increases from less than $V_{bIN(u)}$ up to $V_{bIN(ucp)}$ = 5 V (typ.) the charge pump is not active and $V_{OUT} \approx V_{bb}$ - 3 V.

13) See also $V_{ON(CL)}$ in circuit diagram on page 8.

14) This output clamp can be "switched off" by using an additional diode at the IS-Pin (see page 7). If the diode is used, $V_{OUT}$ is clamped to $V_{bb}$- $V_{ON(CL)}$ at inductive load switch off.

| Parameter and Conditions at $T_j$ = -40 ... +150 °C, $V_{bb}$ = 12 V unless otherwise specified | Symbol | Values min | typ | max | Unit |
|---|---|---|---|---|---|
| Thermal overload trip temperature | $T_{jt}$ | 150 | -- | -- | °C |
| Thermal hysteresis | $\Delta T_{jt}$ | -- | 10 | -- | K |

**Reverse Battery**

| Parameter and Conditions | Symbol | min | typ | max | Unit |
|---|---|---|---|---|---|
| Reverse battery voltage [15] | $-V_{bb}$ | -- | -- | 42 | V |
| On-state resistance (Pins 1,5 to pin 3) $T_j$ = 25 °C: $V_{bb}$ = -12V, $V_{IN}$ = 0, $I_L$ = -tbd (>=20) A, $R_{IS}$ = 1 kΩ $T_j$ = 150 °C: | $R_{ON(rev)}$ | -- | 3.7 0 | tbd 0 | mΩ |
| Integrated resistor in $V_{bb}$ line | $R_{bb}$ | -- | tbd | -- | Ω |

**Diagnostic Characteristics**

| Parameter and Conditions | Symbol | min | typ | max | Unit |
|---|---|---|---|---|---|
| Current sense ratio, static on-condition, $k_{ILIS} = I_L : I_{IS}$, $V_{ON} < 1.5\,V$[16], $V_{IS} < V_{OUT}$ - 5 V, $V_{bIN} > 4.5\,V$ -40°C: | $k_{ILIS}$ | -- | 26 530 | -- | |
| 25°C: | | -- | 25 430 | -- | |
| 150°C: | | -- | 23 520 | -- | |
| | | -40°C: | +25°C: | 150°C: | |
| $I_L$ = 150 A: | | ±4.5% | ±4.2% | ±4.0% | |
| see diagram on page 11 $I_L$ = 25 A: | | ±8.9% | ±7.5% | ±6.1% | |
| $I_L$ = 12 A: | | ±15% | ±12% | ±9.0% | |
| $I_L$ = 6 A: | | ±46% | ±36% | ±24% | |
| $I_{IN}$ = 0, $I_{IS}$=0 (e.g. during deenergizing of inductive loads): | | -- | -- | -- | |
| Sense current saturation | $I_{IS,lim}$ | 5.5 | -- | -- | mA |
| Current sense leakage current $I_{IN}$ = 0, $V_{IS}$ = 0: | $I_{IS(LL)}$ | -- | -- | 0.5 | µA |
| $V_{IN}$ = 0, $V_{IS}$ = 0, $I_L \le 0$: | $I_{IS(LH)}$ | -- | 2 | -- | |
| Current sense settling time[17] after positive input slope (90% of $I_{IS}$ static) $I_L$ = 0 / tbd (>=20) A: | $t_{son(IS)}$ | -- | tbd | 500 | µs |
| Current sense settling time[17] after negative input slope (10% of $I_{IS}$ static) $I_L$ = tbd (>=20) / 0 A: | $t_{soff(IS)}$ | -- | tbd | 500 | µs |
| Current sense settling time[17] after change of load current (60% to 90%) $I_L$ = 15 / tbd (>=20) A: | $t_{slc(IS)}$ | -- | tbd | 500 | µs |
| Overvoltage protection $T_j$ = -40°C: | $V_{bIS(Z)}$ | 68 | -- | -- | V |
| $I_{bb}$ = 15 mA $T_j$ = 25...+150°C: | | 70 | 74 | -- | |

[15] The reverse load current through the intrinsic drain-source diode has to be limited by the connected load (as it is done with all polarity symmetric loads). Note that under off-conditions ($I_{IN}$ = $I_{IS}$ = 0) the power transistor is not activated. This results in raised power dissipation due to the higher voltage drop across the intrinsic drain-source diode. The temperature protection is not active during reverse current operation! Increasing reverse battery voltage capability is simply possible as described on page 8.

[16] If $V_{ON}$ is higher, the sense current is no longer proportional to the load current due to sense current saturation, see $I_{IS,lim}$ .

[17] Not tested, specified by design.

| Parameter and Conditions<br>at $T_j$ = -40 ... +150 °C, $V_{bb}$ = 12 V unless otherwise specified | Symbol | Values | | | Unit |
|---|---|---|---|---|---|
| | | min | typ | max | |

**Input**

| | | | | | |
|---|---|---|---|---|---|
| Input and operating current (see diagram page 12)<br>IN grounded ($V_{IN}$ = 0) | $I_{IN(on)}$ | -- | 1 | 2 | mA |
| Input current for turn-off[18] | $I_{IN(off)}$ | -- | -- | 40 | µA |

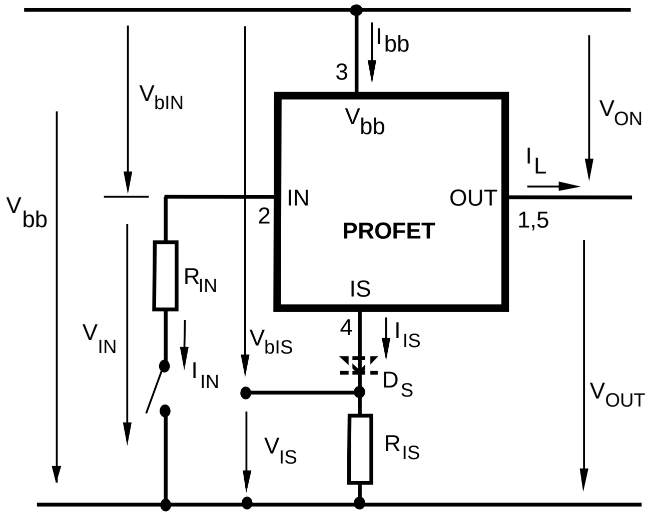
## Truth Table

| | Input current level | Output level | Current Sense $I_{IS}$ | Remark |
|---|---|---|---|---|
| Normal operation | L<br>H | L<br>H | 0<br>nominal | $=I_L / k_{ilis}$, up to $I_{IS}=I_{IS,lim}$ |
| Very high load current | H | H | $I_{IS,\ lim}$ | up to $V_{ON}=V_{ON(Fold\ back)}$<br>$I_{IS}$ no longer proportional to $I_L$ |
| Current-limitation | H | H | 0 | $V_{ON} > V_{ON(Fold\ back)}$<br>if $V_{ON}>V_{ON(SC)}$, shutdown will occure |
| Short circuit to GND | L<br>H | L<br>L | 0<br>0 | |
| Over-temperature | L<br>H | L<br>L | 0<br>0 | |
| Short circuit to $V_{bb}$ | L<br>H | H<br>H | 0<br><nominal [19] | |
| Open load | L<br>H | Z[20]<br>H | 0<br>0 | |
| Negative output voltage clamp | L | L | 0 | |
| Inverse load current | L<br>H | H<br>H | 0<br>0 | |

L = "Low" Level
H = "High" Level
Overtemperature reset via input: $I_{IN}$=low and $T_j < T_{jt}$ (see diagram on page 15)
Short circuit to GND: Shutdown remains latched until next reset via input (see diagram on page 13)

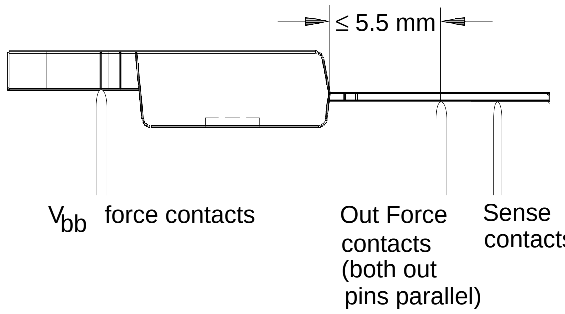
18) We recommend the resistance between IN and GND to be less than 0.5 kΩ for turn-on and more than 500kΩ for turn-off. Consider that when the device is switched off ($I_{IN}$ = 0) the voltage between IN and GND reaches almost $V_{bb}$.
19) Low ohmic short to $V_{bb}$ may reduce the output current $I_L$ and can thus be detected via the sense current $I_{IS}$.
20) Power Transistor "OFF", potential defined by external impedance.

## Terms

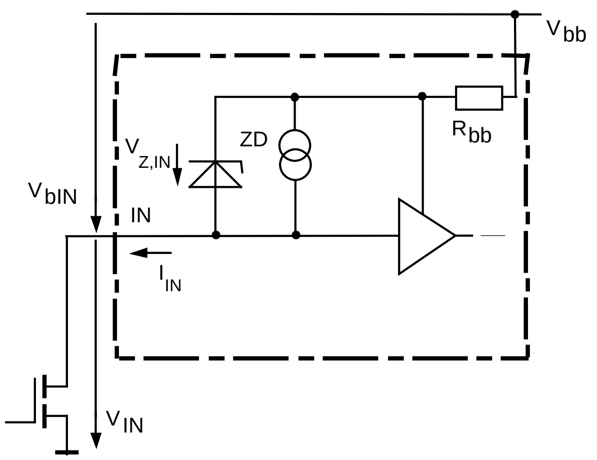



Two or more devices can easily be connected in parallel to increase load current capability.

## $R_{ON}$ measurement layout

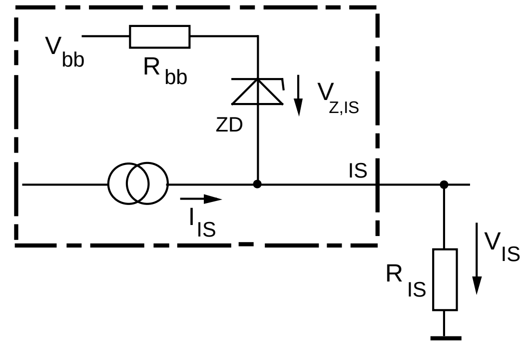



## Input circuit (ESD protection)




When the device is switched off ($I_{IN} = 0$) the voltage between IN and GND reaches almost $V_{bb}$. Use a mechanical switch, a bipolar or MOS transistor with appropriate breakdown voltage as driver.
$V_{Z,IN} = 74\,V$ (typ).

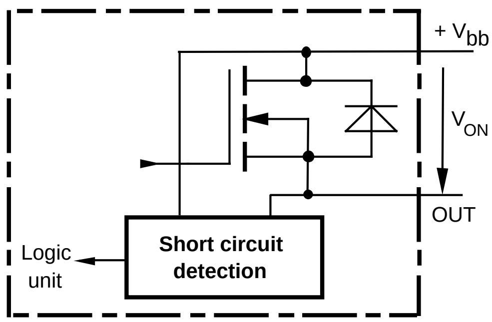
## Current sense status output



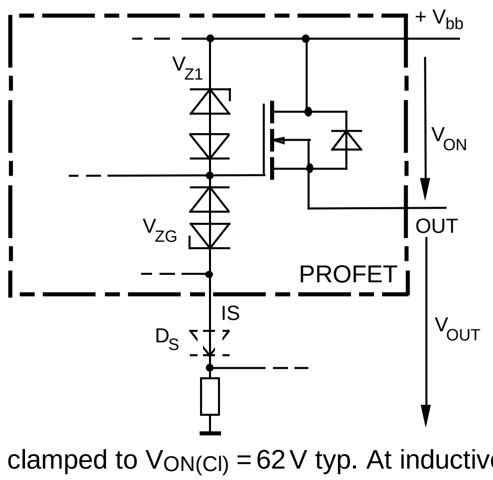

$V_{Z,IS} = 74\,V$ (typ.), $R_{IS} = 1\,k\Omega$ nominal (or $1\,k\Omega$ /n, if n devices are connected in parallel). $I_S = I_L/k_{ilis}$ can be only driven by the internal circuit as long as $V_{out}$ - $V_{IS}$ > 5 ??? V. If you want to measure load currents up to $I_{L(M)}$, $R_{IS}$ should be less than $\frac{V_{bb} - 5\ ???\ V}{I_{L(M)} / K_{ilis}}$.
Note: For large values of $R_{IS}$ the voltage $V_{IS}$ can reach almost $V_{bb}$. See also overvoltage protection.
If you don't use the current sense output in your application, you can leave it open.

## Short circuit detection

Fault Condition: $V_{ON} > V_{ON(SC)}$ (6 V typ.) and t> $t_{d(SC)}$ (80 ...300 µs).

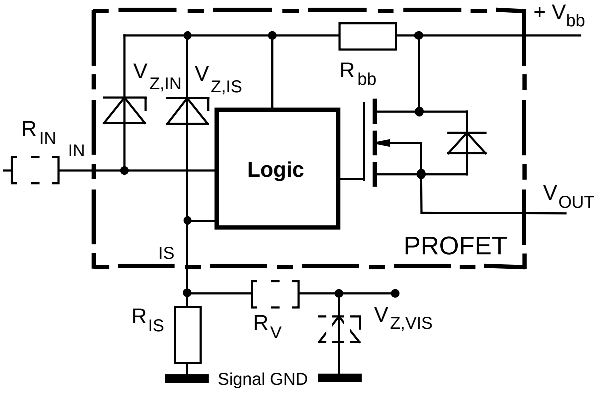



## Inductive and overvoltage output clamp



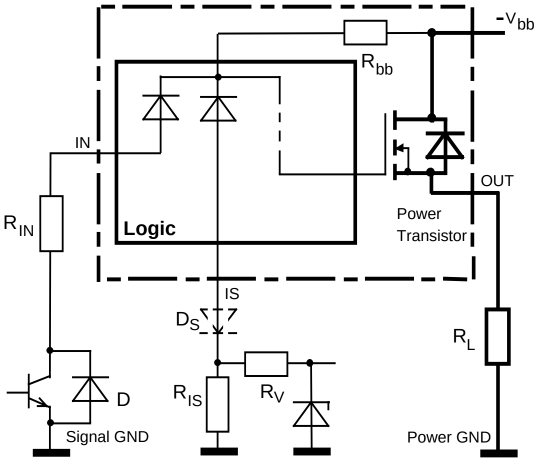

$V_{ON}$ is clamped to $V_{ON(Cl)} = 62\,V$ typ. At inductive load switch-off without $D_S$, $V_{OUT}$ is clamped to $V_{OUT(CL)}$ = -15 V typ. via $V_{ZG}$. With $D_S$, $V_{OUT}$ is clamped to $V_{bb}$ - $V_{ON(CL)}$ via $V_{Z1}$. Using $D_S$ gives faster deenergizing of the inductive load, but higher peak power dissipation in the PROFET.

### Overvoltage protection of logic part




$R_{bb} = 120\,\Omega$ typ., $V_{Z,IN} = V_{Z,IS} = 74\,V$ typ., $R_{IS} = 1\,k\Omega$ nominal. Note that when overvoltage exceeds 79 V typ. a voltage above 5V can occur between IS and GND, if $R_V$, $V_{Z,VIS}$ are not used.

### Reverse battery protection



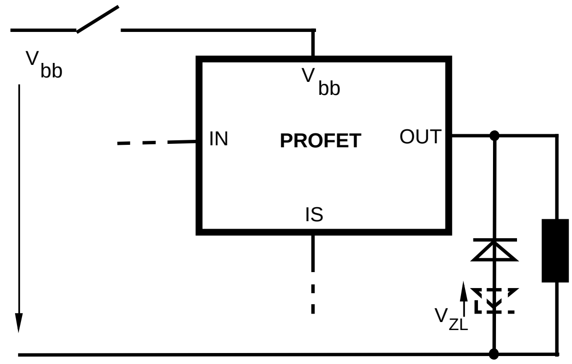

$R_V \geq 1\,k\Omega$, $R_{IS} = 1\,k\Omega$ nominal. Add $R_{IN}$ for reverse battery protection in applications with $V_{bb}$ above 16 V[15]; recommended value: $\frac{1}{R_{IN}} + \frac{1}{R_{IS}} + \frac{1}{R_V} = \frac{0.1A}{|V_{bb}| - 12V}$ if $D_S$ is not used (or $\frac{1}{R_{IN}} = \frac{0.1A}{|V_{bb}| - 12V}$ if $D_S$ is used).

To minimize power dissipation at reverse battery operation, the summarized current into the IN and IS pin should be about 120mA. The current can be provided by using a small signal diode D in parallel to the input switch, by using a MOSFET input switch or by proper adjusting the current through $R_{IS}$ and $R_V$.

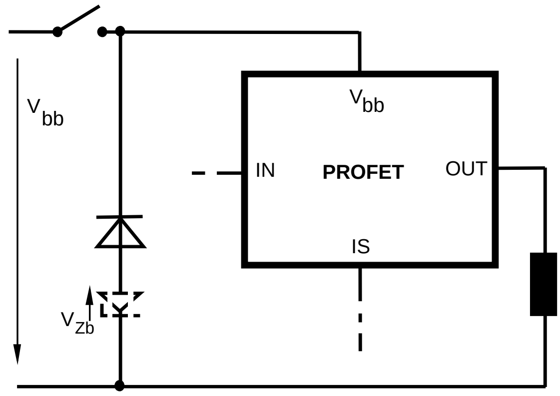
### $V_{bb}$ disconnect with energized inductive load

Provide a current path with load current capability by using a diode, a Z-diode, or a varistor. ($V_{ZL} < 70$ V or $V_{Zb} < 42$ V if $R_{IN}$=0). For higher clamp voltages currents at IN and IS have to be limited to 250 mA.

Version a:

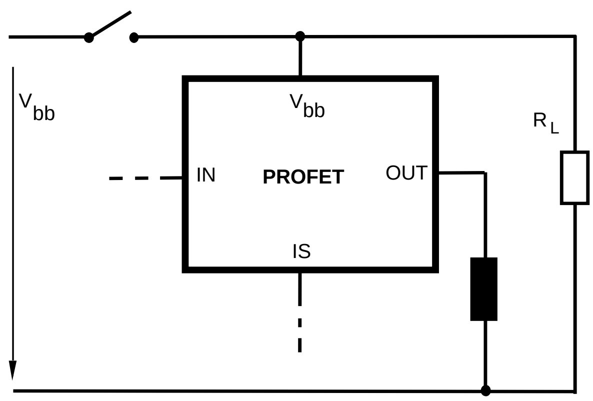



Version b:

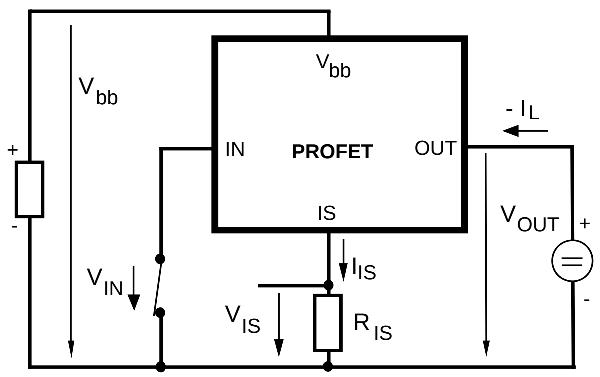



Note that there is no reverse battery protection when using a diode without additional Z-diode $V_{ZL}$, $V_{Zb}$.

Version c: Sometimes a neccessary voltage clamp is given by non inductive loads $R_L$ connected to the same switch and eliminates the need of clamping circuit:



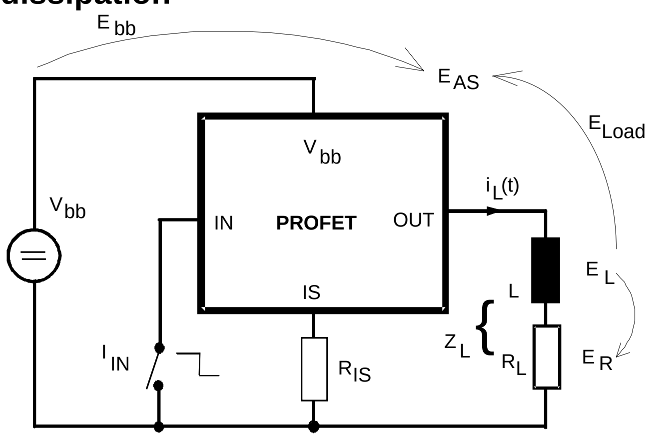
## Inverse load current operation




The device is specified for inverse load current operation ($V_{OUT}$ > $V_{bb}$ **> 0V**). The current sense feature is not available during this kind of operation ($I_{IS}$ = 0). With $I_{IN}$ = 0 (e.g. input open) only the intrinsic drain source diode is conducting resulting in considerably increased power dissipation. If the device is switched on ($V_{IN}$ = 0), this power dissipation is decreased to the much lower value $R_{ON(INV)}$ * $I^2$ (specifications see page 3).

Note: *Temperature protection during inverse load current operation is not possible!*

## Inductive load switch-off energy dissipation




Energy stored in load inductance:

$$E_L = {}^1\!/_2 \cdot L \cdot I_L^2$$

While demagnetizing load inductance, the energy dissipated in PROFET is

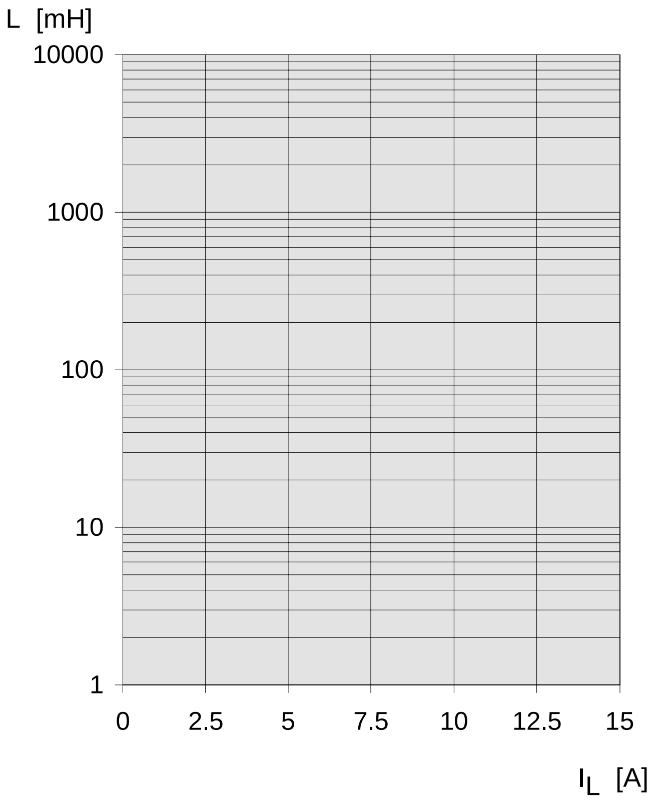
$$E_{AS} = E_{bb} + E_L - E_R = \int V_{ON(CL)} \cdot i_L(t)\, dt,$$

with an approximate solution for $R_L > 0\,\Omega$:

$$E_{AS} = \frac{I_L \cdot L}{2 \cdot R_L} \left( V_{bb} + |V_{OUT(CL)}| \right) \; ln\left(1 + \frac{I_L \cdot R_L}{|V_{OUT(CL)}|}\right)$$

## Maximum allowable load inductance for a single switch off

$L = f(I_L)$; $T_{j,start} = 150°C$, $V_{bb} = 12\,V$, $R_L = 0\,\Omega$



**Options Overview**

| Type BTS | 660P | 560 |
|---|---|---|
| Overtemperature protection with hysteresis | X | X |
| $T_j$ >150 °C, latch function[21] | | X |
| $T_j$ >150 °C, with auto-restart on cooling | X | |
| Short circuit to GND protection<br>switches off when $V_{ON}$>6 V typ.<br>(when first turned on after approx. 180 μs) | X | X |
| Overvoltage shutdown | - | - |
| Output negative voltage transient limit<br>to $V_{bb}$ - $V_{ON(CL)}$<br>to $V_{OUT}$ = -15 V typ | X<br>X[22] | X<br>X[22] |

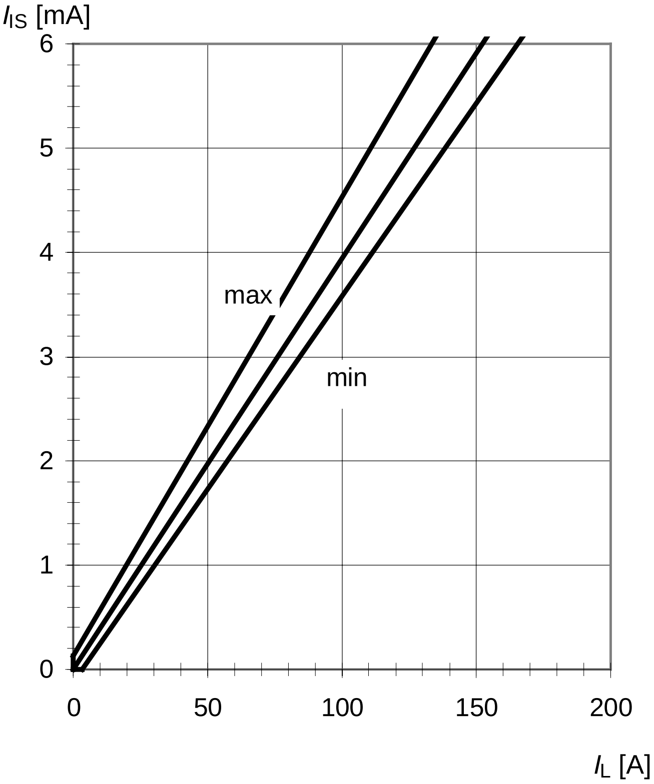
---

21) Latch except when $V_{bb}$ - $V_{OUT}$ < $V_{ON(SC)}$ after shutdown. In most cases $V_{OUT}$ = 0 V after shutdown ($V_{OUT}$ ≠ 0 V only if forced externally). So the device remains latched unless $V_{bb}$ < $V_{ON(SC)}$ (see page 4). No latch between turn on and $t_{d(SC)}$.

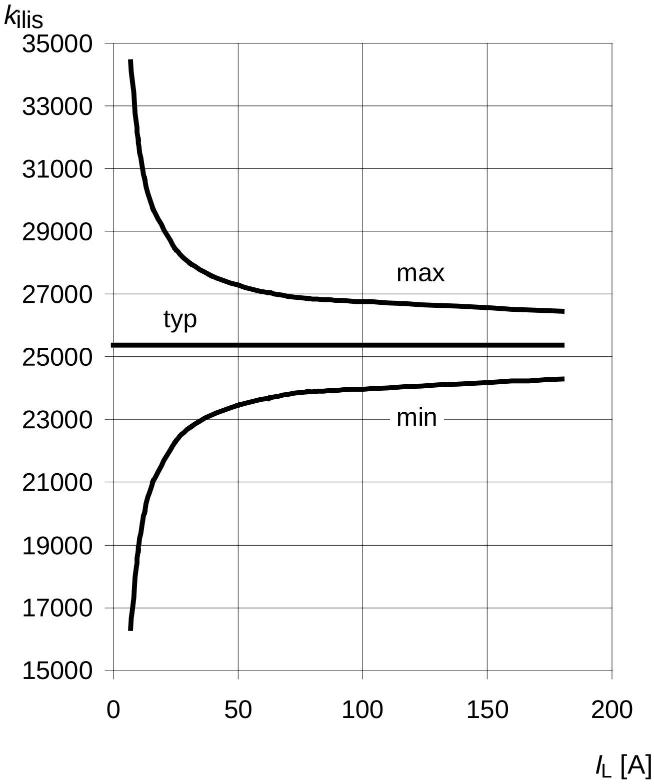
22) Can be "switched off" by using a diode $D_S$ (see page 7) or leaving open the current sense output.

# Characteristics

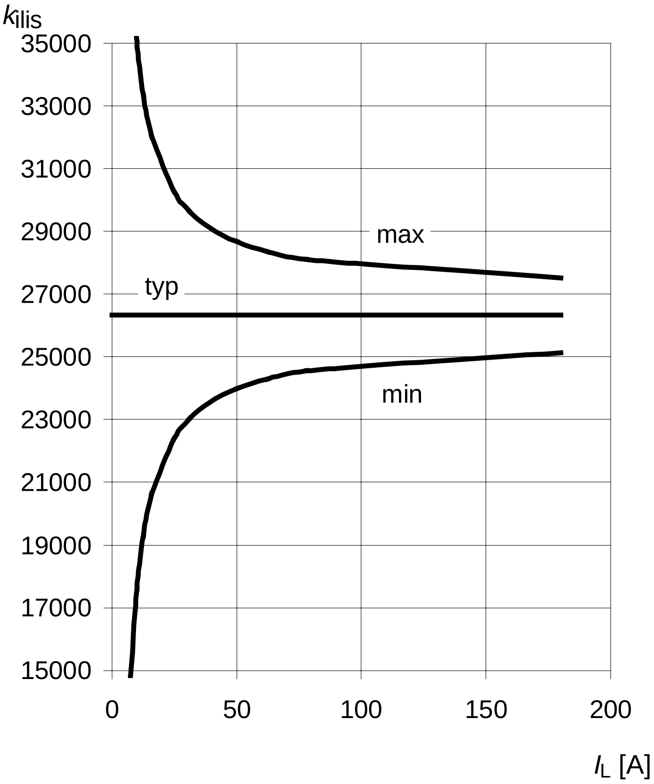
**Current sense versus load current:**
$I_{IS} = f(I_L)$



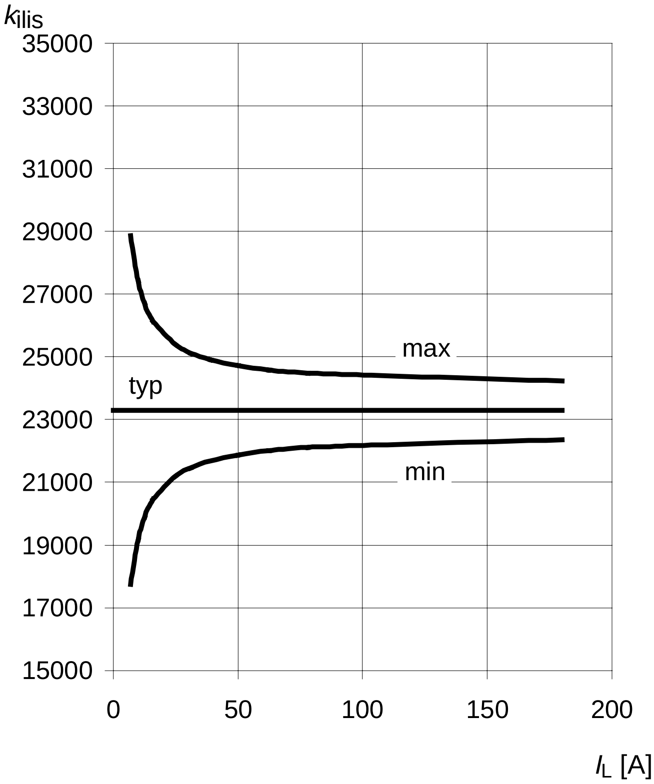

**Current sense ratio:**
$K_{ILIS} = f(I_L)$, $T_J = 25$ °C




**Current sense ratio:**
$K_{ILIS} = f(I_L)$, $T_J = -40$ °C

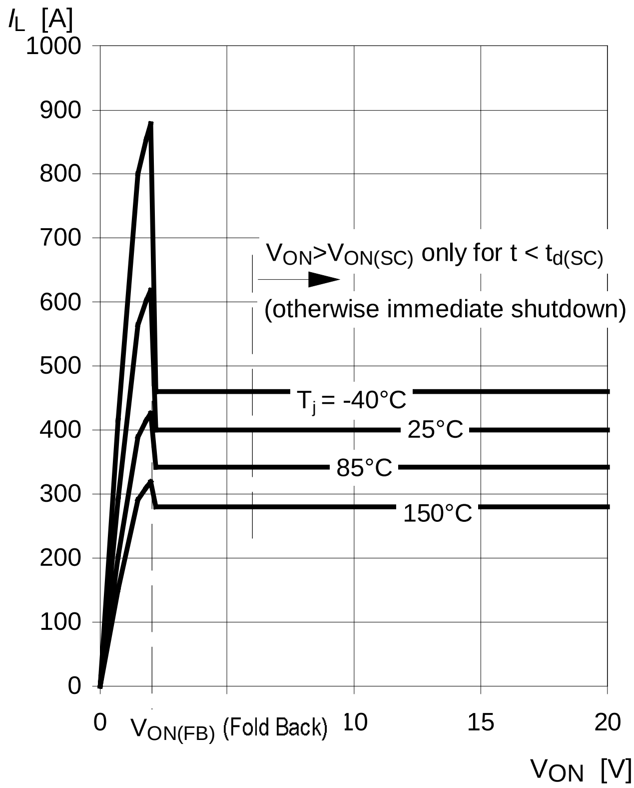



**Current sense ratio:**
$K_{ILIS} = f(I_L)$, $T_J = 150$ °C



**Typ. current limitation characteristic**

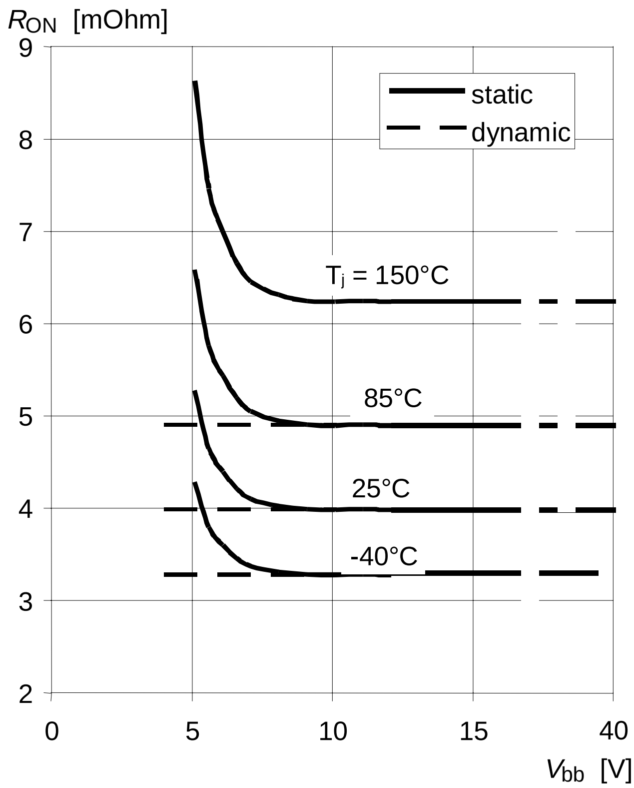
$I_L = f(V_{ON}, T_j)$




In case of $V_{ON} > V_{ON(SC)}$ (typ. 6 V) the device will be switched off by internal short circuit detection.

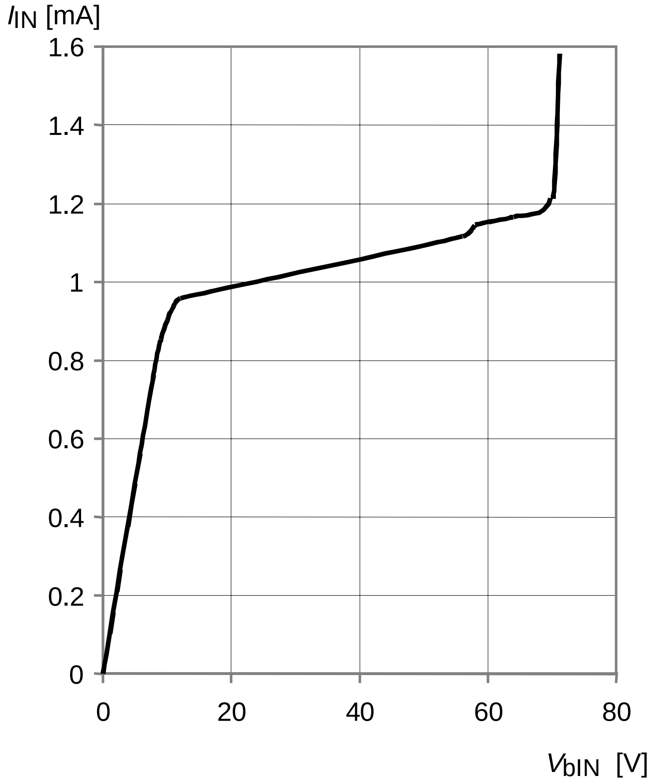
**Typ. on-state resistance**

$R_{ON} = f(V_{bb}, T_j)$; $I_L$ = tbd (>=20) A; $V_{IN}$ = 0



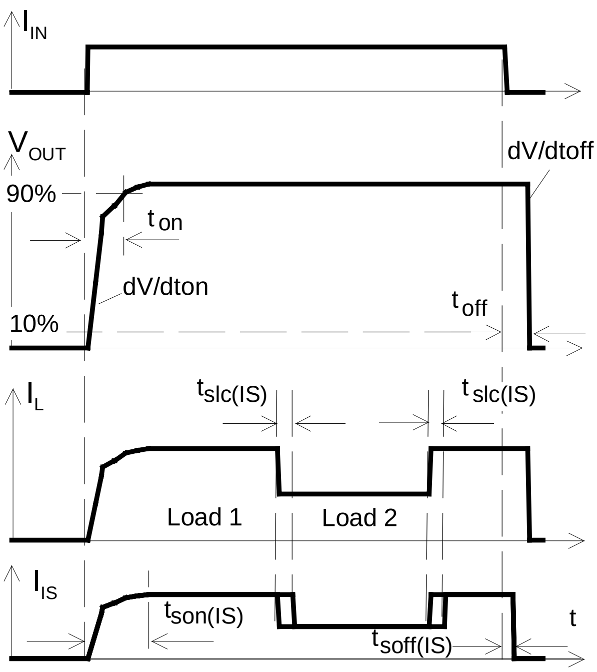

**Typ. input current**

$I_{IN} = f(V_{bIN})$, $V_{bIN} = V_{bb} - V_{IN}$



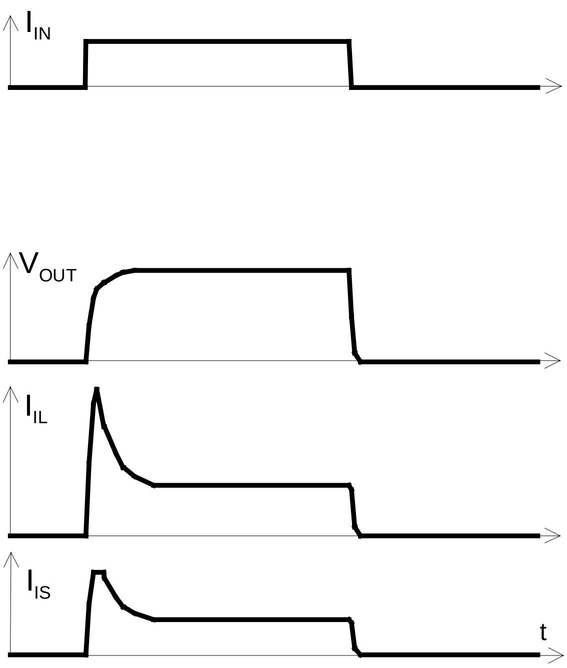
# Timing diagrams

**Figure 1a:** Switching a resistive load, change of load current in on-condition:




The sense signal is not valid during a settling time after turn-on/off and after change of load current.

**Figure 2a:** Switching motors and lamps:




Sense current saturation can occur at very high inrush currents (see $I_{IS,lim}$ on page 5).

**Figure 2b:** Switching an inductive load:

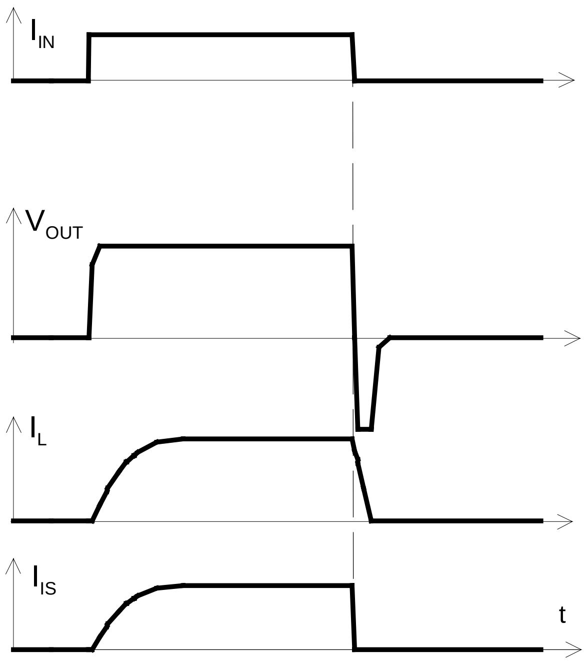
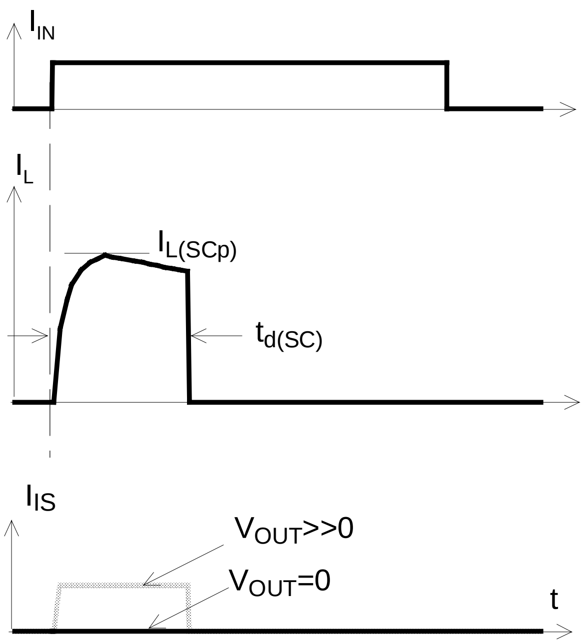



**Figure 3a:** Short circuit:
shut down by short circuit detection, reset by $I_{IN} = 0$.




Shut down remains latched until next reset via input.

**Figure 4a:** Overtemperature,
Reset if ($I_{IN}$=low) and ($T_j$<$T_{jt}$)

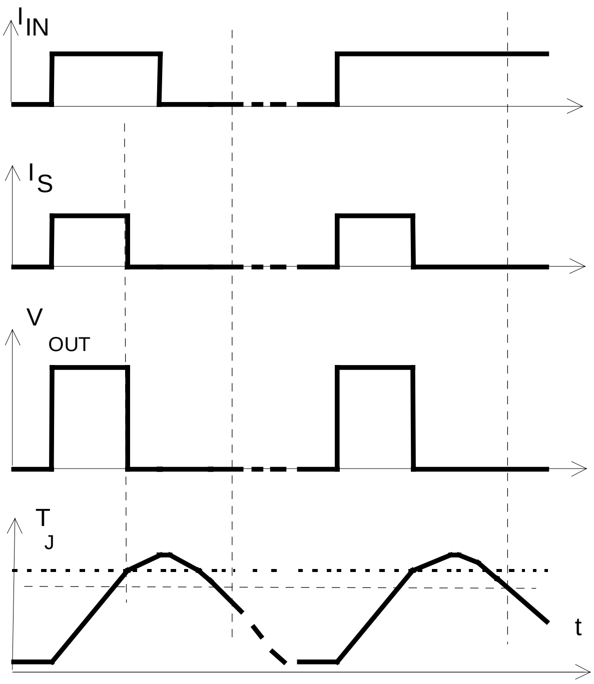
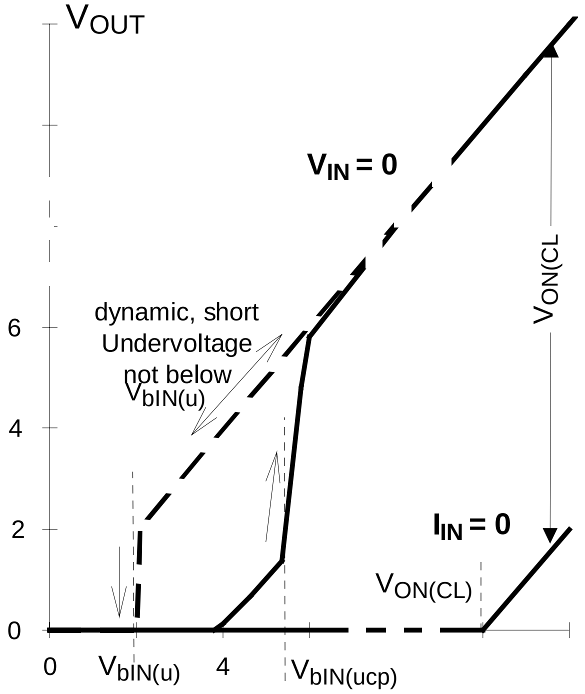



**Figure 6a:** Undervoltage restart of charge pump,
overvoltage clamp

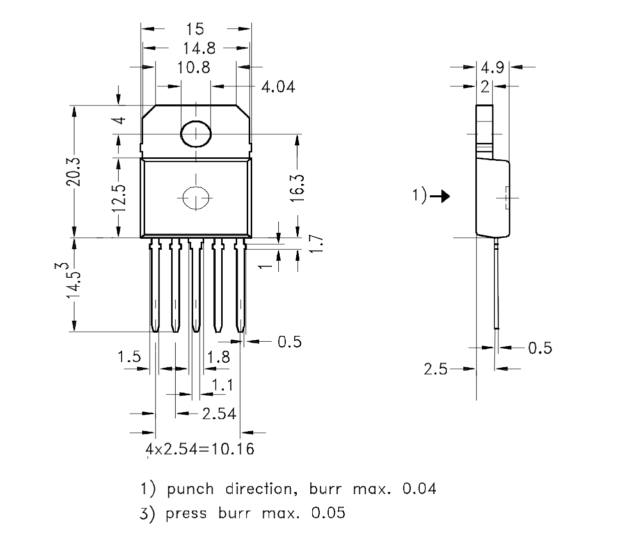


# Package and Ordering Code

All dimensions in mm

### TO-218AB/5 Option E3146 Ordering code

| | |
|---|---|
| BTS560 E3146 | Q67060-S6953A3 |

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