

### 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 <sup>1)</sup>
- 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<sup>2)</sup>
- **Electrostatic discharge (ESD)** protection

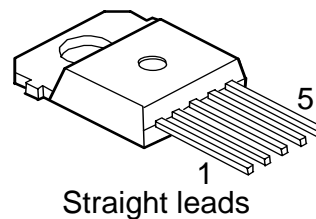
#### Product Summary

Overvoltage protection	$V_{bb(AZ)}$	63	V
Output clamp	$V_{ON(CL)}$	42	V
Operating voltage	$V_{bb(on)}$	5.0 ... 34	V
On-state resistance	$R_{ON}$	2.9	m $\Omega$
Load current (ISO)	$I_L(ISO)$	132	A
Short circuit current limitation	$I_L(SCp)$	400	A
Current sense ratio	$I_L : I_S$	25 000	

#### Application

- Power switch with current sense diagnostic feedback for 12V and 24V 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

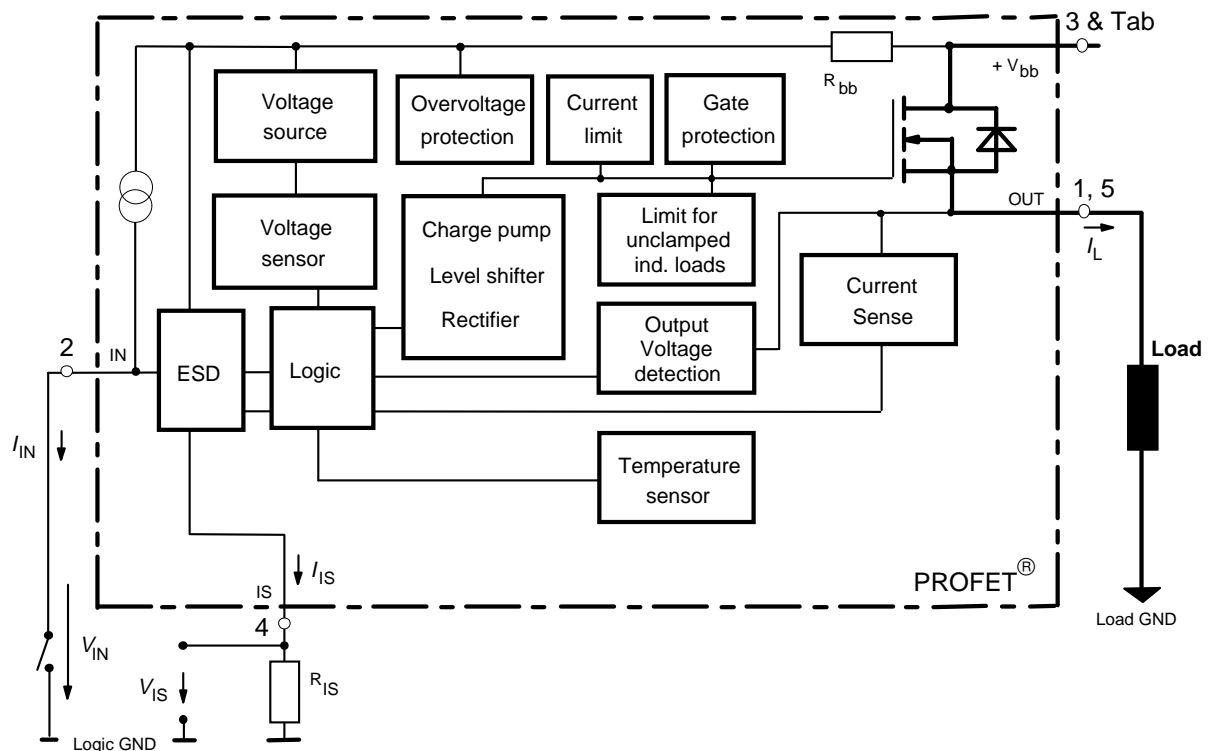
TO-218AB/5



Straight leads

#### General Description

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



1) With additional external diode.

2) Additional external diode required for energized inductive loads (see page9).

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 <sup>3)</sup>
2	IN I	Input, activates the power switch in case of short to ground
3	V <sub>bb</sub> +	Positive power supply voltage, the tab is electrically connected to this pin. In high current applications the tab should be used for the V <sub>bb</sub> connection instead of this pin <sup>4)</sup> .
4	IS S	Diagnostic feedback providing a sense current proportional to the load current; zero current on failure (see Truth Table on page 7)
5	OUT O	Output to the load. The pins 1 and 5 must be shorted with each other especially in high current applications <sup>3)</sup>

### Maximum Ratings at $T_j = 25\text{ °C}$ unless otherwise specified

Parameter	Symbol	Values	Unit
Supply voltage (overvoltage protection see page 4)	$V_{bb}$	42	V
Supply voltage for full short circuit protection, resistive load or $L < t_{bd}\ \mu\text{H}$ $T_{j,start} = -40 \dots +150\text{ °C}$ :	$V_{bb}$	34	V
Load current (short circuit current, see page 5)	$I_L$	self-limited	A
Load dump protection $V_{LoadDump} = U_A + V_S$ , $U_A = 13.5\text{ V}$ $R_1^{5)} = 2\ \Omega$ , $R_L = 0.1\ \Omega$ , $t_d = 200\text{ ms}$ , IN, IS = open or grounded	$V_{Load\ dump}^{6)}$	80	V
Operating temperature range	$T_j$	-40 ... +150	°C
Storage temperature range	$T_{stg}$	-55 ... +150	
Power dissipation (DC), $T_C \leq 25\text{ °C}$	$P_{tot}$	310	W
Inductive load switch-off energy dissipation, single pulse $V_{bb} = 12\text{ V}$ , $T_{j,start} = 150\text{ °C}$ , $T_C = 150\text{ °C const.}$ , $I_L = t_{bd} (>=20)\text{ A}$ , $Z_L = t_{bd}\text{ mH}$ , $0\ \Omega$ , see diagrams on page 10	$E_{AS}$	tbd	J
Electrostatic discharge capability (ESD) Human Body Model acc. MIL-STD883D, method 3015.7 and ESD assn. std. S5.1-1993, $C = 100\text{ pF}$ , $R = 1.5\text{ k}\Omega$	$V_{ESD}$	2.0	kV
Current through input pin (DC)	$I_{IN}$	+15, -250	mA
Current through current sense status pin (DC) see internal circuit diagrams on page 8	$I_{IS}$	+15, -250	

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)  $R_1$  = 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: junction - ambient (free air):	$R_{thJC}^{7)}$	--	--	0.40	K/W
	$R_{thJA}$	--	30	--	

### Electrical Characteristics

Parameter and Conditions	Symbol	Values			Unit
		min	typ	max	
at $T_j = -40 \dots +150^\circ\text{C}$ , $V_{bb} = 12\text{V}$ unless otherwise specified					

### Load Switching Capabilities and Characteristics

On-state resistance (Tab to pins 1,5, see measurement circuit page 8) $I_L = \text{tbd} (>=20)\text{A}$ , $T_j = 25^\circ\text{C}$ : $V_{IN} = 0$ , $I_L = \text{tbd} (>=20)\text{A}$ , $T_j = 150^\circ\text{C}$ : $I_L = \text{tbd A}$ , $T_j = 150^\circ\text{C}$ : $V_{bb} = \text{tbd V}^8)$ , $I_L = \text{tbd A}$ , $T_j = 150^\circ\text{C}$ :	$R_{ON}$    $R_{ON(Static)}$	--	2.4 4.6 tbd tbd	2.9 5.7 tbd tbd	$m\Omega$
Nominal load current <sup>9)</sup> (Tab to pins 1,5) ISO 10483-1/6.7: $V_{ON} = 0.5\text{V}$ , $T_C = 85^\circ\text{C}$ <sup>10)</sup>	$I_{L(ISO)}$	111	132	--	
Maximum load current in resistive range (Tab to pins 1,5) $V_{ON} = 1.8\text{V}$ , $T_C = 25^\circ\text{C}$ : see diagram on page 13 $V_{ON} = 1.8\text{V}$ , $T_C = 150^\circ\text{C}$ :	$I_{L(Max)}$	tbd tbd	-- --	-- --	A
Turn-on time <sup>11)</sup> $I_{IN}$  to 90% $V_{OUT}$ :	$t_{on}$	130	--	550	$\mu\text{s}$
Turn-off time $I_{IN}$  to 10% $V_{OUT}$ : $R_L = 1\Omega$ , $T_j = -40\dots+150^\circ\text{C}$	$t_{off}$	60	--	240	
Slew rate on <sup>11)</sup> (10 to 30% $V_{OUT}$ ) $R_L = 1\Omega$	$dV/dt_{on}$	--	0.8	--	$\text{V}/\mu\text{s}$
Slew rate off <sup>11)</sup> (70 to 40% $V_{OUT}$ ) $R_L = 1\Omega$	$-dV/dt_{off}$	--	0.8	--	$\text{V}/\mu\text{s}$

### Inverse Load Current Operation

On-state resistance (Pins 1,5 to pin 3) $V_{bIN} = 12\text{V}$ , $I_L = -\text{tbd} (>=20)\text{A}$ see diagram on page 10	$T_j = 25^\circ\text{C}$ : $T_j = 150^\circ\text{C}$ : $R_{ON(inv)}$	--	2.4 4.6	2.9 5.7	$m\Omega$
Nominal inverse load current (Pins 1,5 to Tab) $V_{ON} = -0.5\text{V}$ , $T_C = 85^\circ\text{C}$ <sup>10)</sup>	$I_{L(inv)}$	111	132	--	
Drain-source diode voltage ( $V_{out} > V_{bb}$ ) $I_L = -\text{tbd} (>=20)\text{A}$ , $I_{IN} = 0$ , $T_j = +150^\circ\text{C}$	$-V_{ON}$	--	tbd	--	mV

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

8) Decrease of  $V_{bb}$  below 10 V causes slowly a dynamic increase of  $R_{ON}$  to a higher value of  $R_{ON(Static)}$ . As long as  $V_{bIN} > V_{bIN(u) \text{max}}$ ,  $R_{ON}$  increase is less than 10 % per second for  $T_j < 85^\circ\text{C}$ .

9) Not tested, specified by design.

10)  $T_j$  is about  $105^\circ\text{C}$  under these conditions.

11) See timing diagram on page 14.

Parameter and Conditions at $T_j = -40 \dots +150^\circ\text{C}$ , $V_{bb} = 12\text{V}$ unless otherwise specified	Symbol	Values			Unit
		min	typ	max	

### Operating Parameters

Operating voltage ( $V_{IN} = 0$ ) Fehler! Textmarke nicht definiert, 12)	$V_{bb(on)}$	5.0	--	34	V	
Undervoltage shutdown 13)	$V_{bIN(u)}$	--	3.5	4.5	V	
Undervoltage start of charge pump see diagram page 15	$V_{bIN(ucp)}$	--	5	6.5	V	
Overvoltage protection <sup>14)</sup> $I_{bb} = 15\text{ mA}$	$V_{bIN(z)}$	$T_j = -40^\circ\text{C}$ : $T_j = 25\dots+150^\circ\text{C}$ :	60 62	-- 66	-- --	V
Standby current $I_{IN} = 0$	$I_{bb(off)}$	$T_j = -40\dots+25^\circ\text{C}$ : $T_j = 150^\circ\text{C}$ :	-- --	15 25	25 60	$\mu\text{A}$

### Protection Functions

Short circuit current limit (Tab to pins 1,5) $V_{ON} = 12\text{V}$ , time until shutdown max. $300\mu\text{s}$	$I_{L(SCp)}$	$T_c = -40^\circ\text{C}$ : $T_c = 25^\circ\text{C}$ : $T_c = +150^\circ\text{C}$ :	-- tbd tbd	460 400 280	-- tbd tbd	A
Short circuit shutdown delay after input current positive slope, $V_{ON} > V_{ON(SC)}$ min. value valid only if input "off-signal" time exceeds $30\mu\text{s}$	$t_d(SC)$		80	--	300	$\mu\text{s}$
Output clamp <sup>15)</sup> (inductive load switch off)	$-V_{OUT(CL)}$	$I_L = 40\text{ mA}$ : $I_L = 20\text{ A}$ :	-- --	15 17	-- --	V
Output clamp (inductive load switch off) at $V_{OUT} = V_{bb} - V_{ON(CL)}$ (e.g. overvoltage) $I_L = 40\text{ mA}$	$V_{ON(CL)}$		39	42	46	V
Short circuit shutdown detection voltage (pin 3 to pins 1,5)	$V_{ON(SC)}$		--	6	--	V

12) For all voltages  $0 \dots 34\text{V}$  the device is fully protected against overtemperature and short circuit.

13)  $V_{bIN} = V_{bb} - V_{IN}$  see diagram on page 8. When  $V_{bIN}$  increases from less than  $V_{bIN(u)}$  up to  $V_{bIN(ucp)} = 5\text{V}$  (typ.) the charge pump is not active and  $V_{OUT} \approx V_{bb} - 3\text{V}$ .

14) See also  $V_{ON(CL)}$  in circuit diagram on page 9.

15) This output clamp can be "switched off" by using an additional diode at the IS-Pin (see page 8). If the diode is used,  $V_{OUT}$  is clamped to  $V_{bb} - V_{ON(CL)}$  at inductive load switch off.

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

### Reverse Battery

Reverse battery voltage <sup>16)</sup>	$-V_{bb}$	--	--	16	V
On-state resistance (Pins 1,5 to pin 3) $T_j = 25 \text{ }^\circ\text{C}$ : $V_{bb} = -12 \text{ V}$ , $V_{IN} = 0$ , $I_L = -\text{tbd}$ ( $\geq 20$ ) A, $R_{IS} = 1 \text{ k}\Omega$ $T_j = 150 \text{ }^\circ\text{C}$ :	$R_{ON(\text{rev})}$	--	2.8 0	tbd 0	$\text{m}\Omega$
Integrated resistor in $V_{bb}$ line	$R_{bb}$	--	120	--	$\Omega$

### Diagnostic Characteristics

Current sense ratio, static on-condition, $k_{ILIS} = I_L : I_{IS}$ , $V_{ON} < 1.5 \text{ V}^{17)}$ , $V_{IS} < V_{OUT} - 5 \text{ V}$ , $V_{bIN} > 4.5 \text{ V}$	$k_{ILIS}$	-40 $^\circ\text{C}$ : 25 $^\circ\text{C}$ : 150 $^\circ\text{C}$ :	-- -- --	26 530 25 430 23 520	-- -- --	
see diagram on page 12 $I_L = 180 \text{ A}$ : $I_L = 50 \text{ A}$ : $I_L = 25 \text{ A}$ : $I_L = 10 \text{ A}$ : $I_{IN} = 0$ (e.g. during deenergizing of inductive loads):				-40 $^\circ\text{C}$ : $\pm 4.5\%$ $\pm 8.9\%$ $\pm 15\%$ $\pm 46\%$	+25 $^\circ\text{C}$ : $\pm 4.2\%$ $\pm 7.5\%$ $\pm 12\%$ $\pm 36\%$	150 $^\circ\text{C}$ : $\pm 4.0\%$ $\pm 6.1\%$ $\pm 9.0\%$ $\pm 24\%$
Sense current saturation	$I_{IS,lim}$		6.5	--	--	mA
Current sense leakage current $I_{IN} = 0$ , $V_{IS} = 0$ : $V_{IN} = 0$ , $V_{IS} = 0$ , $I_L \leq 0$ :	$I_{IS(LL)}$ $I_{IS(LH)}$		--	--	0.5 --	$\mu\text{A}$
Current sense settling time <sup>18)</sup> after positive input slope (90% of $I_{IS}$ static) $I_L = 0 / \text{tbd}$ ( $\geq 20$ ) A:	$t_{son(IS)}$		--	tbd	500	$\mu\text{s}$
Current sense settling time <sup>18)</sup> after negative input slope (10% of $I_{IS}$ static) $I_L = \text{tbd}$ ( $\geq 20$ ) / 0 A:	$t_{soff(IS)}$		--	tbd	500	$\mu\text{s}$
Current sense settling time <sup>18)</sup> after change of load current (60% to 90%) $I_L = 15 / \text{tbd}$ ( $\geq 20$ ) A:	$t_{slc(IS)}$		--	tbd	500	$\mu\text{s}$
Overvoltage protection $I_{bb} = 15 \text{ mA}$	$V_{bIS(Z)}$	$T_j = -40 \text{ }^\circ\text{C}$ : $T_j = 25 \dots +150 \text{ }^\circ\text{C}$ :	60 62	-- 66	-- --	V

<sup>16)</sup> 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 9.

<sup>17)</sup> If  $V_{ON}$  is higher, the sense current is no longer proportional to the load current due to sense current saturation, see  $I_{IS,lim}$ .

<sup>18)</sup> Not tested, specified by design.

Parameter and Conditions at $T_j = -40 \dots +150 \text{ }^\circ\text{C}$ , $V_{bb} = 12 \text{ V}$ unless otherwise specified	Symbol	Values			Unit
		min	typ	max	

### Input

Input and operating current (see diagram page 13) IN grounded ( $V_{IN} = 0$ )	$I_{IN(on)}$	--	1	2	mA
Input current for turn-off <sup>19)</sup>	$I_{IN(off)}$	--	--	80	$\mu\text{A}$

### Truth Table

	Input current level	Output level	Current Sense $I_{IS}$	Remark
Normal operation	L H	L H	0 nominal	$=I_L / k_{IIS}$ , up to $I_{IS}=I_{IS,lim}$
Very high load current	H	H	$I_{IS,lim}$	up to $V_{ON}=V_{ON(Fold\ back)}$ $I_{IS}$ no longer proportional to $I_L$
Current-limitation	H	H	0	$V_{ON} > V_{ON(Fold\ back)}$ if $V_{ON} > V_{ON(SC)}$ , shutdown will occur
Short circuit to GND	L	L	0	
	H	L	0	
Over-temperature	L	L	0	
	H	L	0	
Short circuit to $V_{bb}$	L	H	0	
	H	H	<nominal <sup>20)</sup>	
Open load	L	Z <sup>21)</sup>	0	
	H	H	0	
Negative output voltage clamp	L	L	0	
Inverse load current	L	H	0	
	H	H	0	

L = "Low" Level

H = "High" Level

Overtemperature reset via input:  $I_{IN}=\text{low}$  and  $T_j < T_{jt}$  (see diagram on page Fehler! Textmarke nicht definiert.)

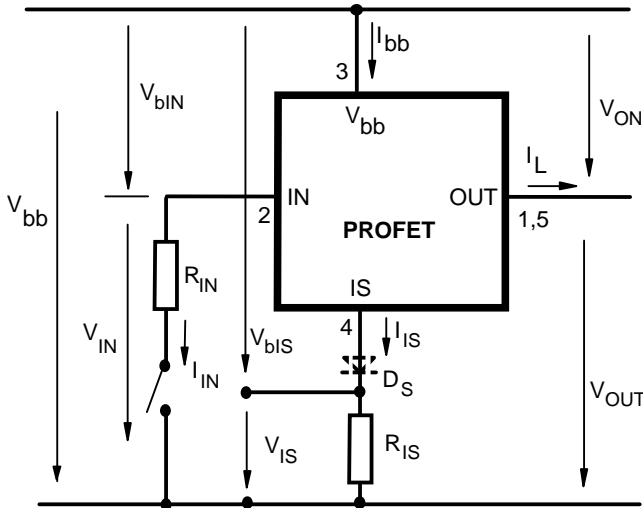
Short circuit to GND: Shutdown remains latched until next reset via input (see diagram on page 14)

<sup>19)</sup> We recommend the resistance between IN and GND to be less than  $0.5 \text{ k}\Omega$  for turn-on and more than  $500 \text{ k}\Omega$  for turn-off. Consider that when the device is switched off ( $I_{IN} = 0$ ) the voltage between IN and GND reaches almost  $V_{bb}$ .

<sup>20)</sup> Low ohmic short to  $V_{bb}$  may reduce the output current  $I_L$  and can thus be detected via the sense current  $I_{IS}$ .

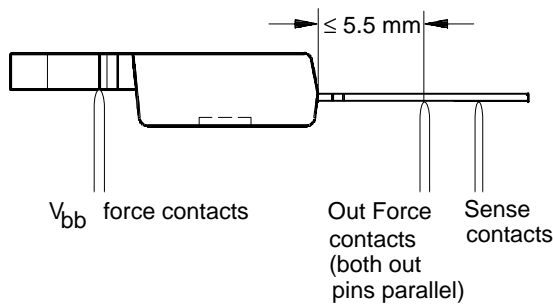
<sup>21)</sup> Power Transistor "OFF", potential defined by external impedance.

### Terms

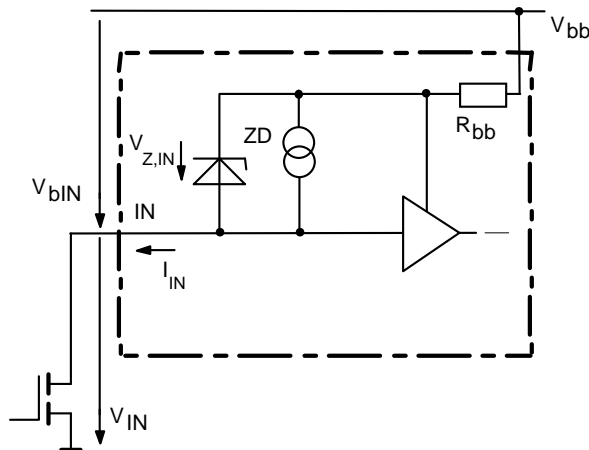


Two or more devices can easily be connected in parallel to increase load current capability.

### R<sub>ON</sub> measurement layout

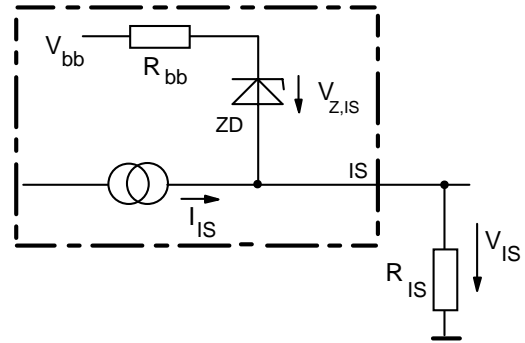


### Input circuit (ESD protection)



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.  
 $V_{Z,IN} = 66 \text{ V (typ.)}$ .

### Current sense status output

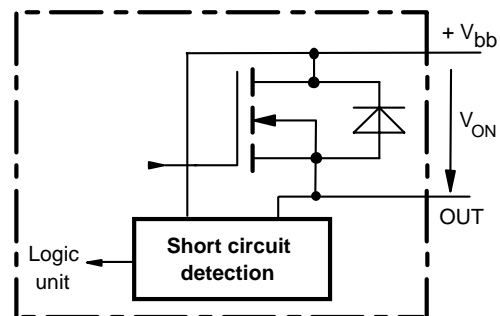


$V_{Z,IS} = 66 \text{ V (typ.)}$ ,  $R_{IS} = 1 \text{ k}\Omega$  nominal (or  $1 \text{ k}\Omega / n$ , if  $n$  devices are connected in parallel).  $I_S = I_L / K_{IIS}$  can be only driven by the internal circuit as long as  $V_{out} - V_{IS} > 5 \text{ V}$ . If you want to measure load currents up to  $I_{L(M)}$ ,  $R_{IS}$  should be less than  $\frac{V_{bb} - 5 \text{ V}}{I_{L(M)} / K_{IIS}}$ .

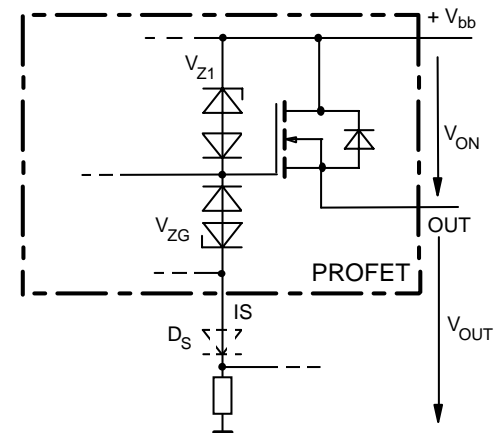
Note: For large values of  $R_{IS}$  the voltage  $V_{IS}$  can reach almost  $V_{bb}$ . See also overvoltage protection. If you don't use the current sense output in your application, you can leave it open.

### Short circuit detection

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



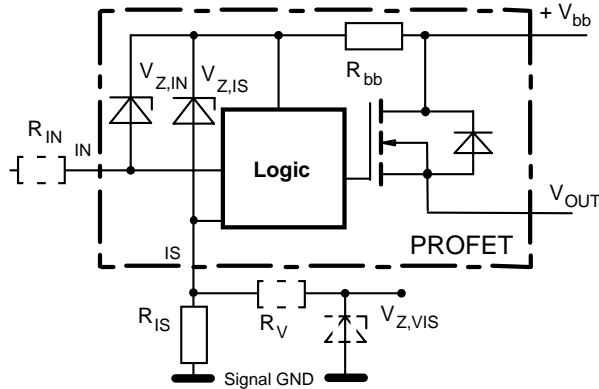
### Inductive and overvoltage output clamp



$V_{ON}$  is clamped to  $V_{ON(CL)} = 42 \text{ V typ.}$  At inductive load switch-off without  $D_S$ ,  $V_{OUT}$  is clamped to  $V_{OUT(CL)} = -15 \text{ V typ.}$  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

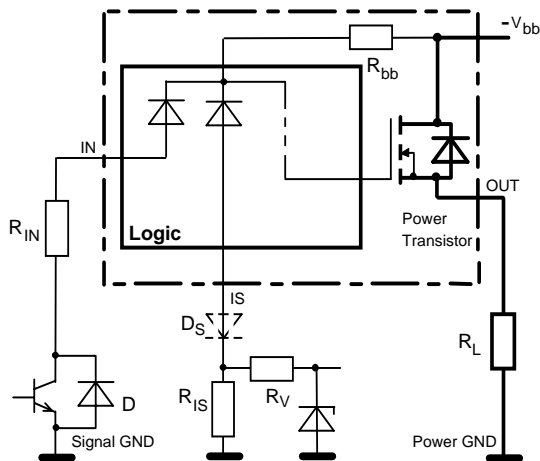
the inductive load, but higher peak power dissipation in the PROFET.

### Overvoltage protection of logic part



$R_{bb} = 120\Omega$  typ.,  $V_{Z,IN} = V_{Z,IS} = 66V$  typ.,  $R_{IS} = 1k\Omega$  nominal. Note that when overvoltage exceeds  $71V$  typ. a voltage above  $5V$  can occur between  $IS$  and  $GND$ , if  $R_V, V_{Z,VIS}$  are not used.

### Reverse battery protection



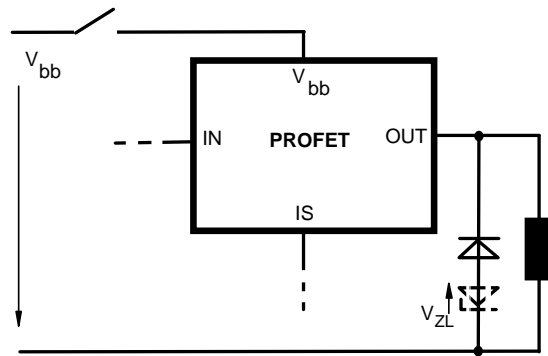
$R_V \geq 1k\Omega$ ,  $R_{IS} = 1k\Omega$  nominal. Add  $R_{IN}$  for reverse battery protection in applications with  $V_{bb}$  above  $16V^{(16)}$ ; recommended value:  $\frac{1}{R_{IN}} + \frac{1}{R_{IS}} + \frac{1}{R_V} = \frac{0.1A}{|V_{bb}| - 12V}$  if  $D_S$  is not used (or  $\frac{1}{R_{IN}}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

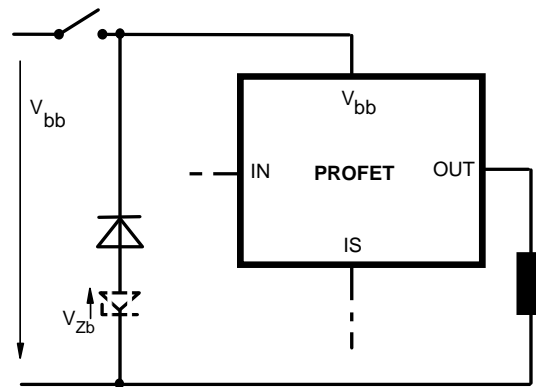
### $V_{bb}$ disconnect with energized inductive load

Provide a current path with load current capability by using a diode, a Z-diode, or a varistor. ( $V_{ZL} < 72V$  or  $V_{Zb} < 30V$  if  $R_{IN}=0$ ). For higher clamp voltages currents at  $IN$  and  $IS$  have to be limited to  $250mA$ .

Version a:

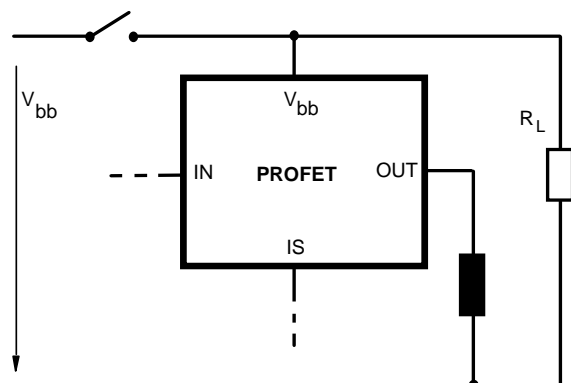


Version b:



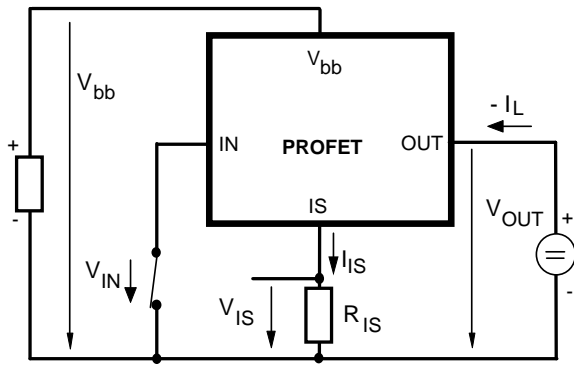
Note that there is no reverse battery protection when using a diode without additional Z-diode  $V_{ZL}, V_{Zb}$ .

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





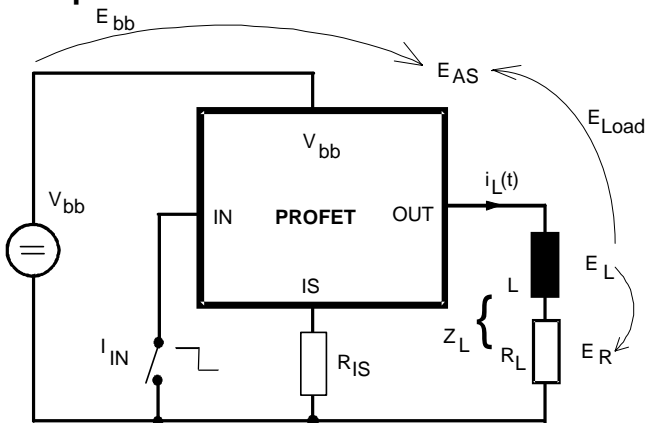
### Inverse load current operation



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  $R_{ON(INV)} \cdot I^2$  (specifications see page 4).

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

### Inductive load switch-off energy dissipation



Energy stored in load inductance:

$$E_L = \frac{1}{2} \cdot L \cdot I_L^2$$

While demagnetizing load inductance, the energy dissipated in PROFET is

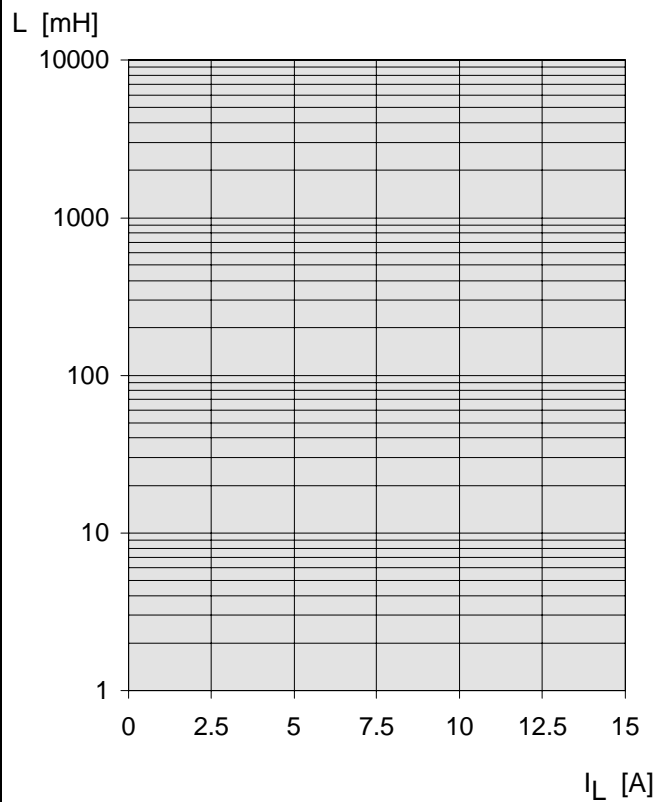
$$E_{AS} = E_{bb} + E_L - E_R = \int V_{ON(CL)} \cdot i_L(t) dt,$$

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

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

### Maximum allowable load inductance for a single switch off

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



### Options Overview

Type	BTS	550P 650P	555
Overtemperature protection with hysteresis $T_j > 150\text{ °C}$ , latch function <sup>22)</sup>		X	X X
$T_j > 150\text{ °C}$ , with auto-restart on cooling		X	
Short circuit to GND protection switches off when $V_{ON} > 6\text{ V}$ typ. (when first turned on after approx. $180\text{ }\mu\text{s}$ )		X	X
Overvoltage shutdown		-	-
Output negative voltage transient limit to $V_{bb} - V_{ON(CL)}$ to $V_{OUT} = -15\text{ V}$ typ		X X <sup>23)</sup>	X X <sup>23)</sup>

<sup>22)</sup> Latch except when  $V_{bb} - V_{OUT} < V_{ON(SC)}$  after shutdown. In most cases  $V_{OUT} = 0\text{ V}$  after shutdown ( $V_{OUT} \neq 0\text{ V}$  only if forced externally). So the device remains latched unless  $V_{bb} < V_{ON(SC)}$  (see page 5). No latch between turn on and  $t_{d(SC)}$ .

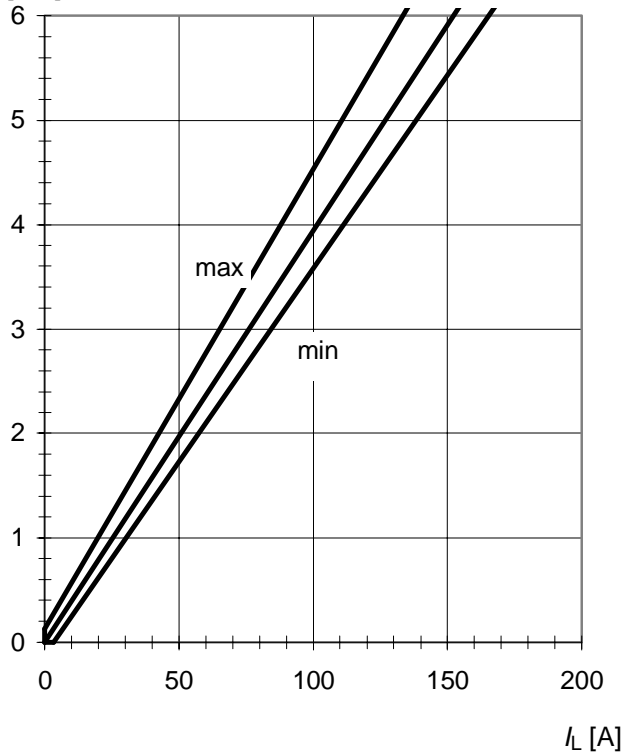
<sup>23)</sup> Can be "switched off" by using a diode  $D_S$  (see page 8) or leaving open the current sense output.

### Characteristics

**Current sense versus load current:**

$$I_{IS} = f(I_L)$$

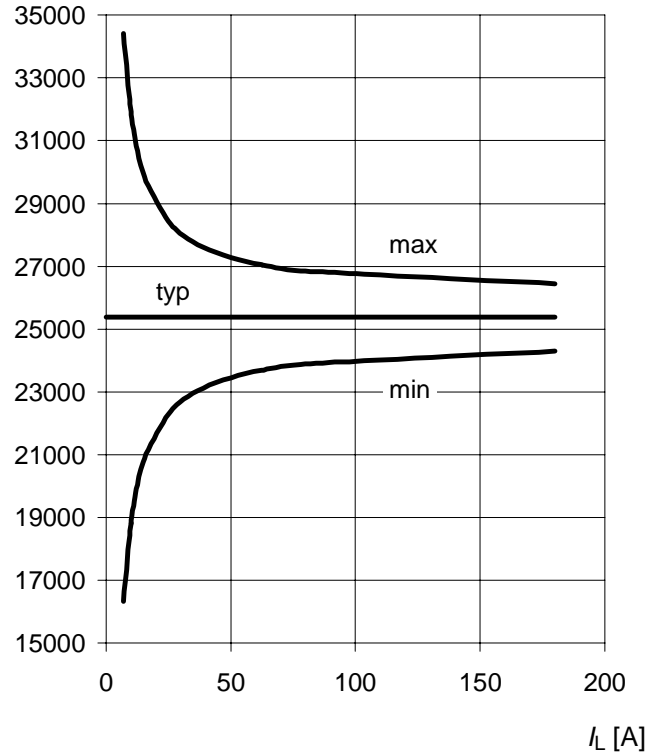
$I_{IS}$  [mA]



**Current sense ratio:**

$$K_{ILIS} = f(I_L), T_J = 25\text{ °C}$$

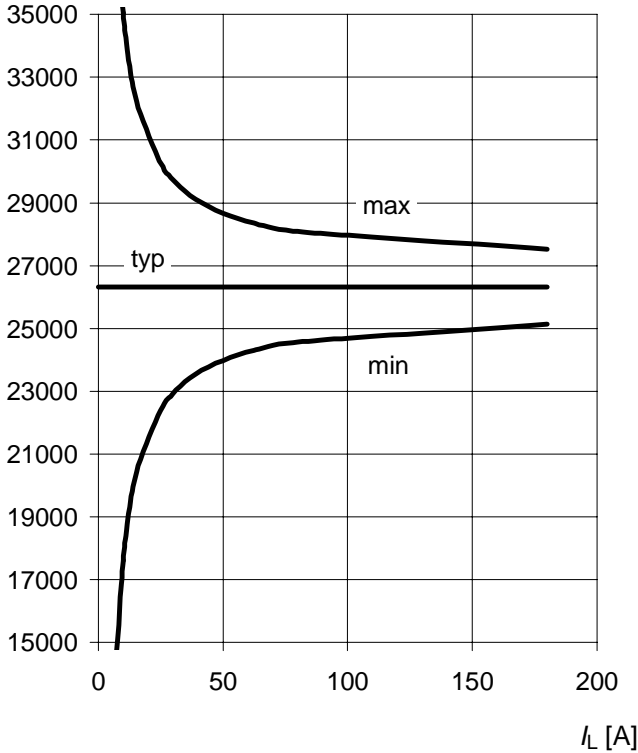
$K_{ILIS}$



**Current sense ratio:**

$$K_{ILIS} = f(I_L), T_J = -40\text{ °C}$$

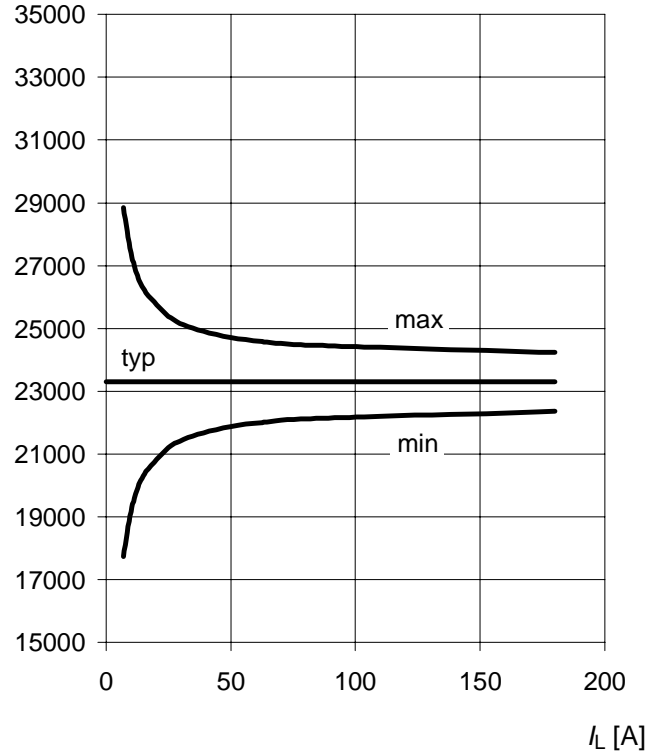
$K_{ILIS}$



**Current sense ratio:**

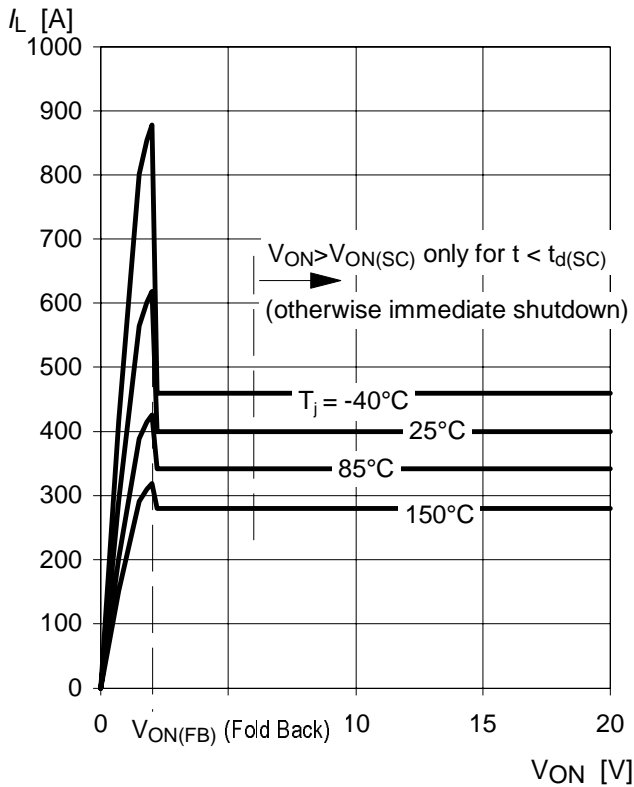
$$K_{ILIS} = f(I_L), T_J = 150\text{ °C}$$

$K_{ILIS}$



### Typ. current limitation characteristic

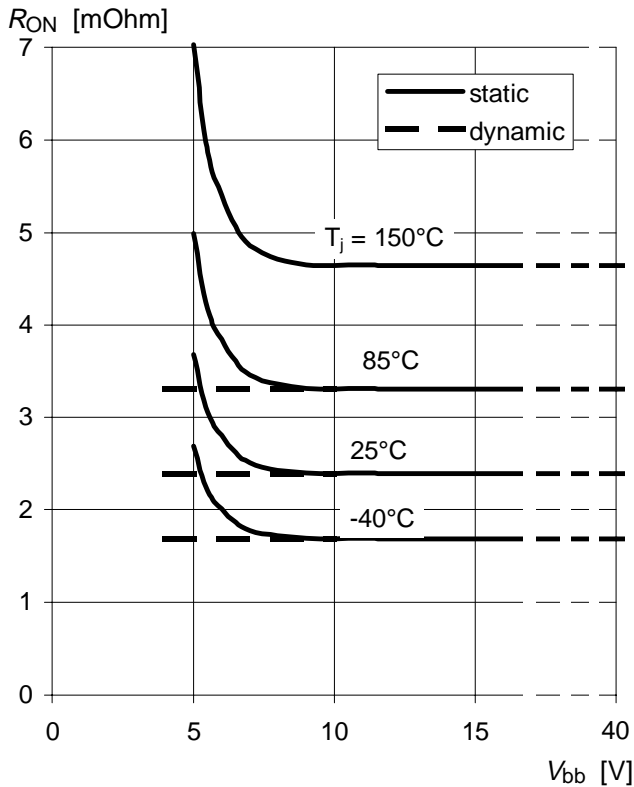
$$I_L = f(V_{ON}, T_j)$$



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

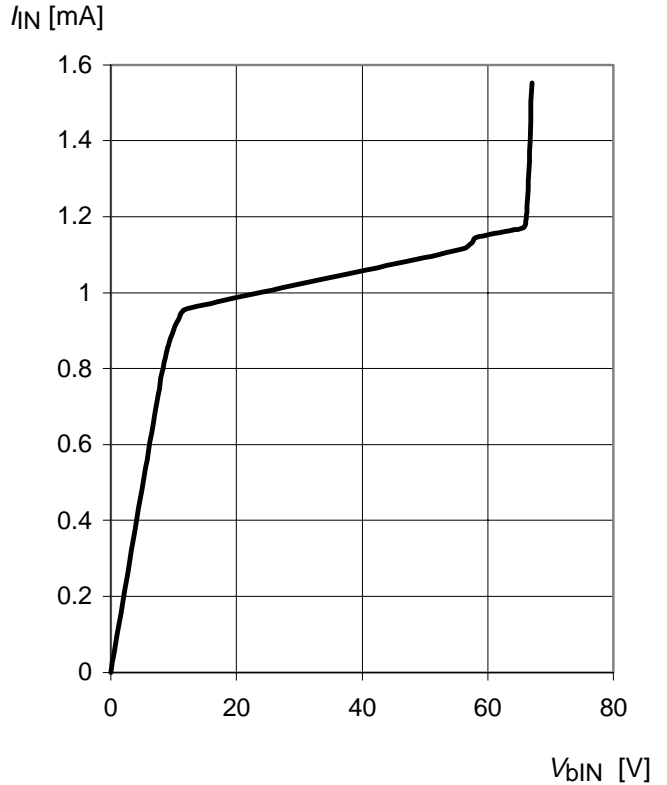
### Typ. on-state resistance

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



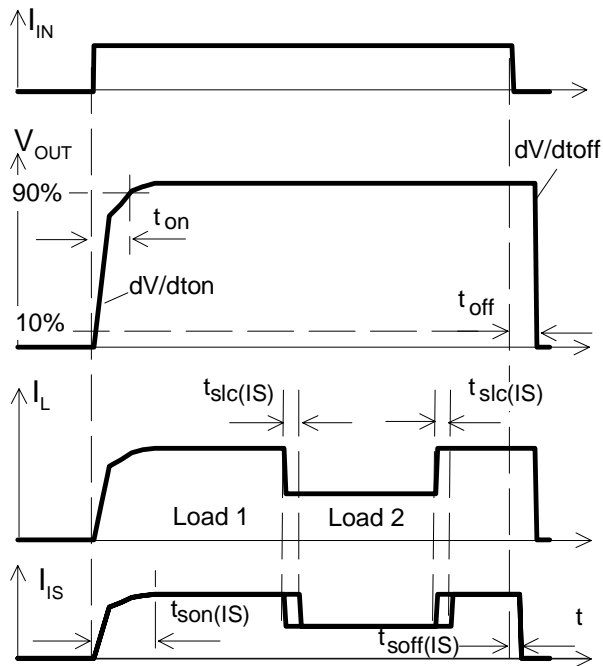
### Typ. input current

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



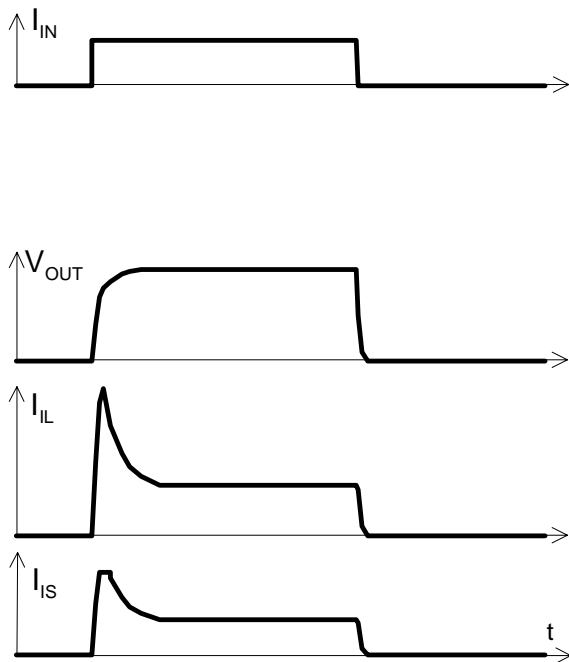
### Timing diagrams

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



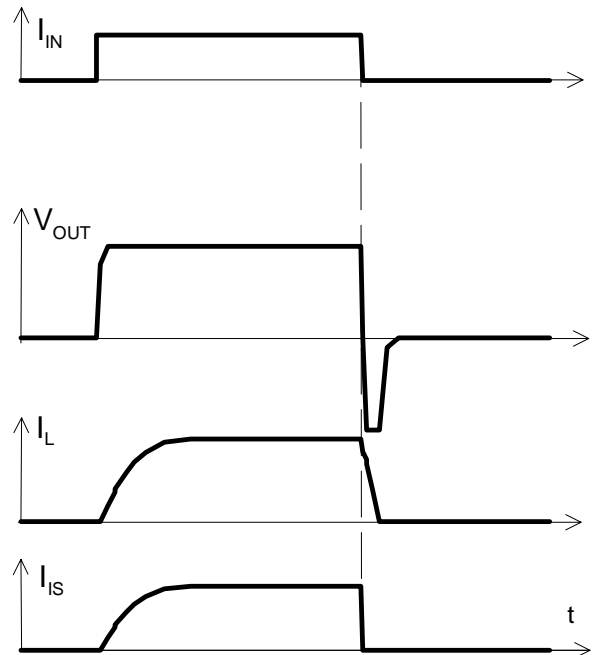
The sense signal is not valid during a settling time after turn-on/off and after change of load current.

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



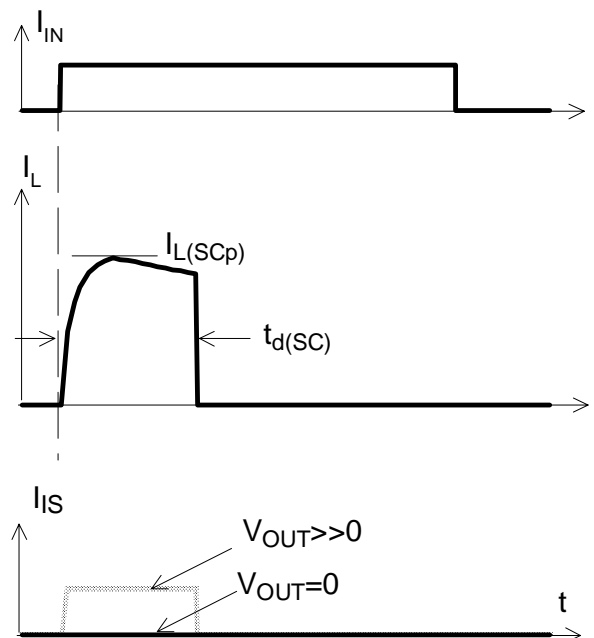
Sense current saturation can occur at very high inrush currents (see  $I_{IS,lim}$  on page 6).

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



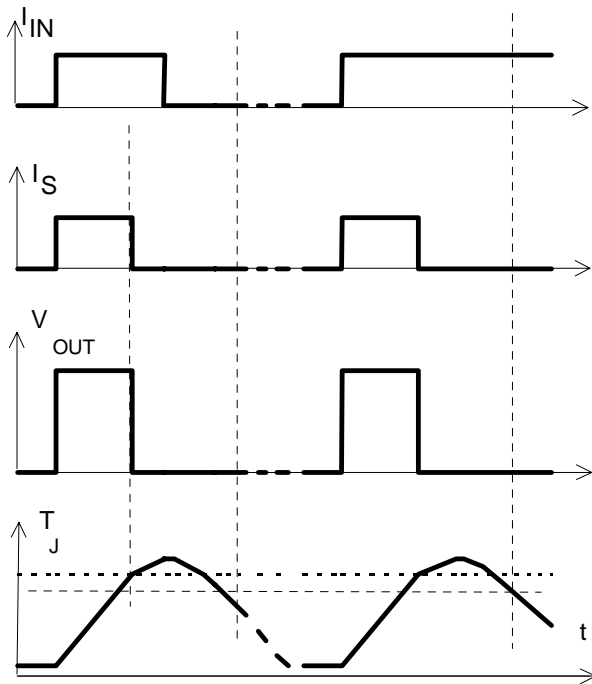
**Figure 3a:** Short circuit:

shut down by short circuit detection, reset by  $I_{IN} = 0$ .

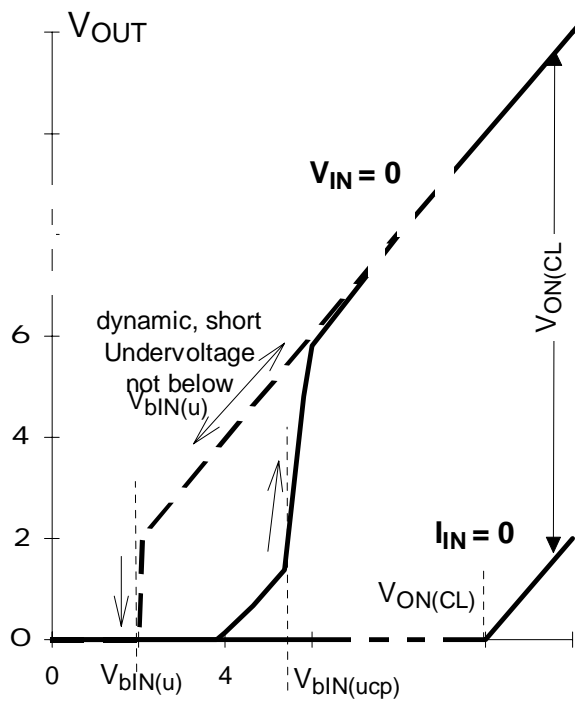


Shut down remains latched until next reset via input.

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



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



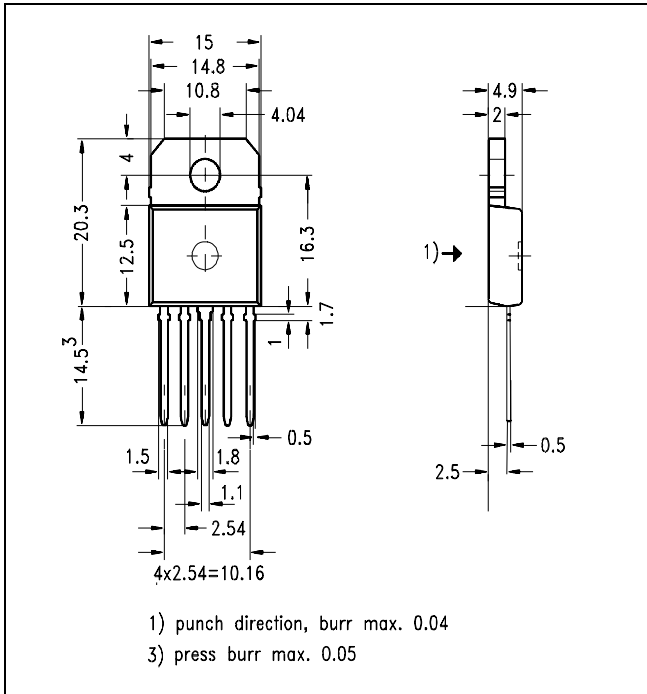
### Package and Ordering Code

All dimensions in mm

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

BTS555 E3146

Q67060-S6953A3



Published by Siemens AG, Bereich Halbleiter Vertrieb, Werbung,  
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