

### 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

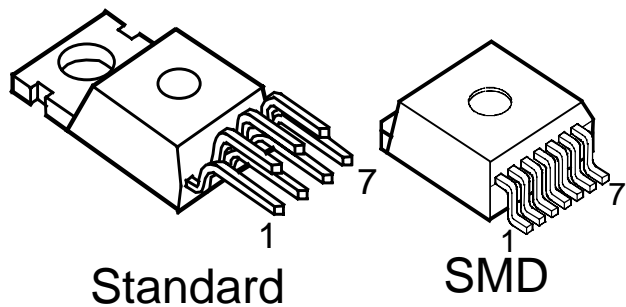
#### Product Summary

Overvoltage protection	$V_{bb(AZ)}$	70	V
Output clamp	$V_{ON(CL)}$	60	V
Operating voltage	$V_{bb(on)}$	5.0 ... 55	V
On-state resistance	$R_{ON}$	9	m $\Omega$
Load current (ISO)	$I_L(ISO)$	44	A
Short circuit current limitation	$I_L(SCp)$	145	A
Current sense ratio	$I_L : I_{IS}$	13 000	

#### Application

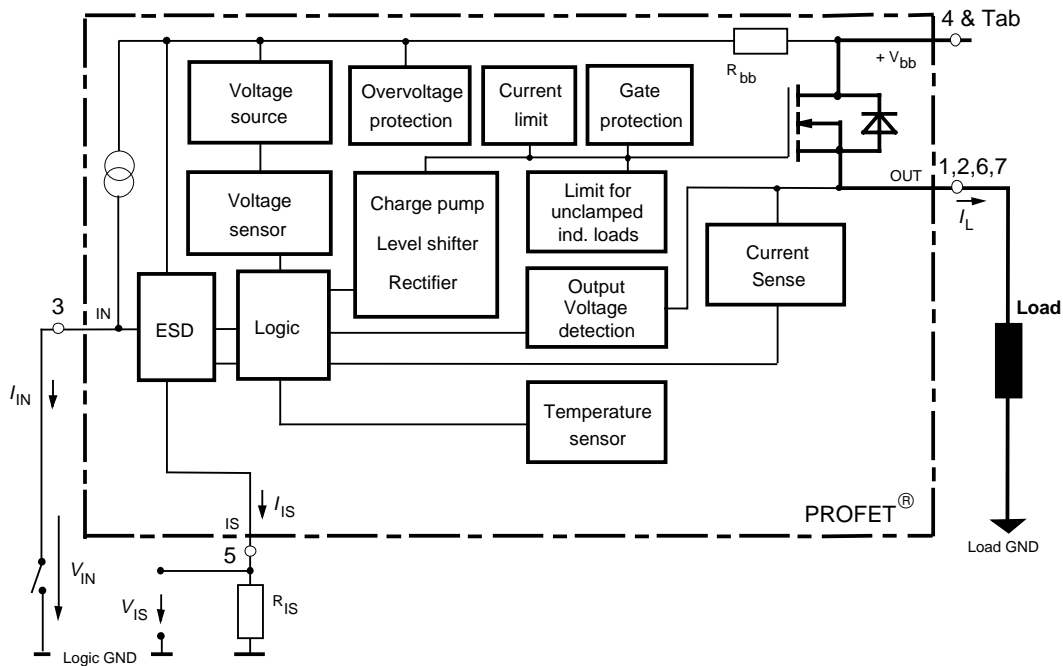
- Power switch with current sense diagnostic feedback for up to 48V DC grounded loads
- Most suitable for loads with high inrush current like lamps and motors; all types of resistive and inductive loads
- Replaces electromechanical relays, fuses and discrete circuits

TO-220AB/7



#### 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.



<sup>1)</sup> With additional external diode.

<sup>2)</sup> Additional external diode required for energized inductive loads (see page 9).

Pin	Symbol		Function
1	OUT	O	Output to the load. The pins 1,2,6 and 7 must be shorted with each other especially in high current applications! <sup>3)</sup>
2	OUT	O	Output to the load. The pins 1,2,6 and 7 must be shorted with each other especially in high current applications! <sup>3)</sup>
3	IN	I	Input, activates the power switch in case of short to ground
4	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> .
5	IS	S	Diagnostic feedback providing a sense current proportional to the load current; zero current on failure (see Truth Table on page 7)
6	OUT	O	Output to the load. The pins 1,2,6 and 7 must be shorted with each other especially in high current applications! <sup>3)</sup>
7	OUT	O	Output to the load. The pins 1,2,6 and 7 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 <sub>bb</sub>	60	V
Supply voltage for full short circuit protection, resistive load or $L < \text{tbd } \mu\text{H}$ $T_{j,\text{start}} = -40 \dots +150\text{ °C}$ :	V <sub>bb</sub>	55	V
Load current (short circuit current, see page 5)	I <sub>L</sub>	self-limited	A
Load dump protection $V_{\text{LoadDump}} = U_A + V_S$ , $U_A = 13.5\text{ V}$ $R_l^5) = 2\ \Omega$ , $R_L = 0.23\ \Omega$ , $t_d = 200\ \text{ms}$ , IN, IS = open or grounded	V <sub>Load dump</sub> <sup>6)</sup>	80	V
Operating temperature range	T <sub>j</sub>	-40 ... +150	°C
Storage temperature range	T <sub>stg</sub>	-55 ... +150	
Power dissipation (DC), $T_C \leq 25\text{ °C}$	P <sub>tot</sub>	170	W
Inductive load switch-off energy dissipation, single pulse $V_{bb} = 12\text{ V}$ , $T_{j,\text{start}} = 150\text{ °C}$ , $T_C = 150\text{ °C}$ const., $I_L = 20\ \text{A}$ , $Z_L = \text{tbd}$ mH, $0\ \Omega$ , see diagrams on page 10	E <sub>AS</sub>	tbd (>1.2)	J
Electrostatic discharge capability (ESD) Human Body Model acc. MIL-STD883D, method 3015.7 and ESD assn. std. S5.1-1993, C = 100 pF, R = 1.5 kΩ	V <sub>ESD</sub>	2.0	kV
Current through input pin (DC)	I <sub>IN</sub>	+15, -250	mA
Current through current sense status pin (DC) see internal circuit diagrams on page 7 and 8	I <sub>IS</sub>	+15, -250	

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

<sup>4)</sup> Otherwise add up to 0.7 mΩ (depending on used length of the pin) to the R<sub>ON</sub> if the pin is used instead of the tab.

<sup>5)</sup> R<sub>l</sub> = internal resistance of the load dump test pulse generator.

<sup>6)</sup> V<sub>Load dump</sub> 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): SMD version, device on PCB <sup>8)</sup> :	$R_{thJC}^{7)}$	--	--	0.75	K/W
	$R_{thJA}$	--	60	--	
				33	

### Electrical Characteristics

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	

### Load Switching Capabilities and Characteristics

On-state resistance (Tab to pins 1,2,6,7, see measurement circuit page 7) $I_L = 20\text{A}$ , $T_j = 25^\circ\text{C}$ : $V_{IN} = 0$ , $I_L = 20\text{A}$ , $T_j = 150^\circ\text{C}$ : $I_L = 80\text{A}$ , $T_j = 150^\circ\text{C}$ :	$R_{ON}$	--	7.2 14.6 --	9 17 17	mΩ
Nominal load current <sup>9)</sup> (Tab to pins 1,2,6,7) ISO 10483-1/6.7: $V_{ON} = 0.5\text{V}$ , $T_C = 85^\circ\text{C}$ <sup>10)</sup>	$I_{L(ISO)}$	38	44	--	A
Nominal load current <sup>9)</sup> , device on PCB <sup>8)</sup> $T_A = 85^\circ\text{C}$ , $T_j \leq 150^\circ\text{C}$ $V_{ON} \leq 0.5\text{V}$ ,	$I_{L(NOM)}$	9.9	11.1	--	A
Maximum load current in resistive range (Tab to pins 1,2,6,7) $V_{ON} = 1.8\text{V}$ , $T_C = 25^\circ\text{C}$ : see diagram on page 12 $V_{ON} = 1.8\text{V}$ , $T_C = 150^\circ\text{C}$ :	$I_{L(Max)}$	185 105	-- --	-- --	A
Turn-on time <sup>11)</sup> $I_{IN}$  to 90% $V_{OUT}$ :	$t_{on}$	80	--	320	μs
Turn-off time $I_{IN}$  to 10% $V_{OUT}$ : $R_L = 1\Omega$ , $T_j = -40\dots+150^\circ\text{C}$	$t_{off}$	30	--	110	
Slew rate on <sup>11)</sup> (10 to 30% $V_{OUT}$ ) $R_L = 1\Omega$	$dV/dt_{on}$	--	0.8	--	V/μs
Slew rate off <sup>11)</sup> (70 to 40% $V_{OUT}$ ) $R_L = 1\Omega$	$-dV/dt_{off}$	--	0.7	--	V/μs

<sup>7)</sup> Thermal resistance  $R_{thCH}$  case to heatsink (about 0.5 ... 0.9 K/W with silicone paste) not included!

<sup>8)</sup> Device on 50mm\*50mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70μm thick) copper area for  $V_{bb}$  connection. PCB is vertical without blown air.

<sup>9)</sup> Not tested, specified by design.

<sup>10)</sup>  $T_j$  is about 105°C under these conditions.

<sup>11)</sup> See timing diagram on page 14.

### Inverse Load Current Operation

On-state resistance (Pins 1,2,6,7 to pin 4) $V_{bIN} = 12\text{ V}$ , $I_L = -20\text{ A}$ see diagram on page 10	$T_j = 25\text{ °C}$ : $T_j = 150\text{ °C}$ :	$R_{ON(inv)}$	--	7.2 14.6	9 17	mΩ
Nominal inverse load current (Pins 1,2,6,7 to Tab) $V_{ON} = -0.5\text{ V}$ , $T_C = 85\text{ °C}^{10}$		$I_{L(inv)}$	50	60	--	A
Drain-source diode voltage ( $V_{out} > V_{bb}$ ) $I_L = -20\text{ A}$ , $I_{IN} = 0$ , $T_j = +150\text{ °C}$		$-V_{ON}$	--	tbd	--	mV

### Operating Parameters

Operating voltage ( $V_{IN} = 0$ ) <sup>12)</sup>		$V_{bb(on)}$	5.0	--	55	V
Undervoltage shutdown <sup>13)</sup>		$V_{bIN(u)}$	--	3.5	--	V
Undervoltage start of charge pump see diagram page 15		$V_{bIN(ucp)}$	--	5	6.5	V
Overvoltage protection <sup>14)</sup> $I_{bb} = 15\text{ mA}$	$T_j = -40\text{ °C}$ : $T_j = 25\text{...}+150\text{ °C}$ :	$V_{bIN(z)}$	68 70	-- 74	-- --	V
Standby current $I_{IN} = 0$	$T_j = -40\text{...}+25\text{ °C}$ : $T_j = 150\text{ °C}$ :	$I_{bb(off)}$	-- --	-- --	25 50	μA

<sup>12)</sup> For all voltages 0 ... 55 V the device is fully protected against overtemperature and short circuit.

<sup>13)</sup>  $V_{bIN} = V_{bb} - V_{IN}$  see diagram on page 7. When  $V_{bIN}$  increases from less than  $V_{bIN(u)}$  up to  $V_{bIN(ucp)} = 5\text{ V}$  (typ.) the charge pump is not active and  $V_{OUT} \approx V_{bb} - 3\text{ V}$ .

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

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	

### Protection Functions

Short circuit current limit (Tab to pins 1,2,6,7) $V_{ON} = 12\text{V}$ , time until shutdown max. $300\ \mu\text{s}$ $T_C = -40^\circ\text{C}$ : see diagram page 8 $T_C = 25^\circ\text{C}$ : $T_C = +150^\circ\text{C}$ :	$I_{L(SCpeak)}$ $I_{L(SC)}$ $I_{L(SC)}$	-- tbd tbd	170 145 120	-- 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) see diagram Ind. and overvolt. output clamp page 8 (typ. $I_{IS} = -120\ \mu\text{A}$ )	$-V_{OUT(CL)}$	-- --	15 17	-- --	V
Output clamp (inductive load switch off) at $V_{OUT} = V_{bb} - V_{ON(CL)}$ (e.g. overvoltage) $I_L = 40\ \text{mA}$	$V_{ON(CL)}$	60	64	68	V
Short circuit shutdown detection voltage (pin 4 to pins 1,2,6,7)	$V_{ON(SC)}$	--	6	--	V
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>	$-V_{bb}$	--	--	42	V
On-state resistance (Pins 1,2,6,7 to pin 4) $V_{bb} = -12\text{V}$ , $V_{IN} = 0$ , $I_L = -20\text{A}$ , $R_{IS} = 1\ \text{k}\Omega$	$R_{ON(rev)}$	--	8.8 --	10.5 20	$\text{m}\Omega$
Integrated resistor in $V_{bb}$ line	$R_{bb}$	--	tbd	--	$\Omega$

<sup>15)</sup> 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.

<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.

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	

### Diagnostic Characteristics

Current sense ratio, static on-condition, $k_{ILIS} = I_L : I_{IS}$ , $V_{ON} < 1.5\text{V}^{17)}$ , $V_{IS} < V_{OUT} - 5\text{V}$ , $V_{bIN} > 4.0\text{V}$ see diagram on page 12	$I_L = 80\text{A}$ , $T_j = -40^\circ\text{C}$ :	$k_{ILIS}$	11400	13 000	15400	
	$T_j = 25^\circ\text{C}$ :		11400	13 000	14600	
	$T_j = 150^\circ\text{C}$ :		11800	13 000	14200	
	$I_L = 20\text{A}$ , $T_j = -40^\circ\text{C}$ :		11000	13 000	16000	
	$T_j = 25^\circ\text{C}$ :		11000	13 000	15000	
	$T_j = 150^\circ\text{C}$ :		11500	13 000	14500	
	$I_L = 10\text{A}$ , $T_j = -40^\circ\text{C}$ :		10500	13 000	17000	
	$T_j = 25^\circ\text{C}$ :		10500	13 000	15500	
	$T_j = 150^\circ\text{C}$ :		11000	13 000	15000	
	$I_L = 4\text{A}$ , $T_j = -40^\circ\text{C}$ :		10500	13 000	19000	
$T_j = 25^\circ\text{C}$ :	10500	13 000	17000			
$T_j = 150^\circ\text{C}$ :	11000	13 000	16000			
$I_{IN} = 0$ , $I_{IS} = 0$ (e.g. during deenergizing of inductive loads):		--	--	--		
Sense current saturation	$I_{IS,lim}$	6.5	--	--	mA	
Current sense leakage current $I_{IN} = 0$ , $V_{IS} = 0$ :	$I_{S(LL)}$	--	--	0.5	$\mu\text{A}$	
	$V_{IN} = 0$ , $V_{IS} = 0$ , $I_L \leq 0$ :	$I_{S(LH)}$	--	2	--	
Current sense overvoltage protection $T_j = -40^\circ\text{C}$ : $I_{bb} = 15\text{mA}$ $T_j = 25 \dots +150^\circ\text{C}$ :	$V_{bIS(Z)}$	68	--	--	V	
		70	74	--		
Current sense settling time <sup>18)</sup> after positive input slope (90% of $I_{IS}$ static) $I_L = 0/20\text{A}$ :	$t_{son(IS)}$	--	tbd	500	$\mu\text{s}$	
Current sense settling time <sup>18)</sup> after negative input slope (10% of $I_{IS}$ static) $I_L = 20/0\text{A}$ :	$t_{soff(IS)}$	--	tbd	500	$\mu\text{s}$	
Current sense settling time <sup>18)</sup> after change of load current (60% to 90%) $I_L = 15/20\text{A}$ :	$t_{slc(IS)}$	--	tbd	500	$\mu\text{s}$	

### Input

Input and operating current (see diagram page 13) $I_{IN}$ grounded ( $V_{IN} = 0$ )	$I_{IN(on)}$	--	1	2	mA
Input current for turn-off <sup>19)</sup>	$I_{IN(off)}$	--	--	40	$\mu\text{A}$

<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.

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

### 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 H	L L	0 0	
Over-temperature	L H	L L	0 0	
Short circuit to $V_{bb}$	L H	H H	0 <nominal <sup>20)</sup>	
Open load	L H	Z <sup>21)</sup> H	0 0	
Negative output voltage clamp	L	L	0	
Inverse load current	L H	H H	0 0	

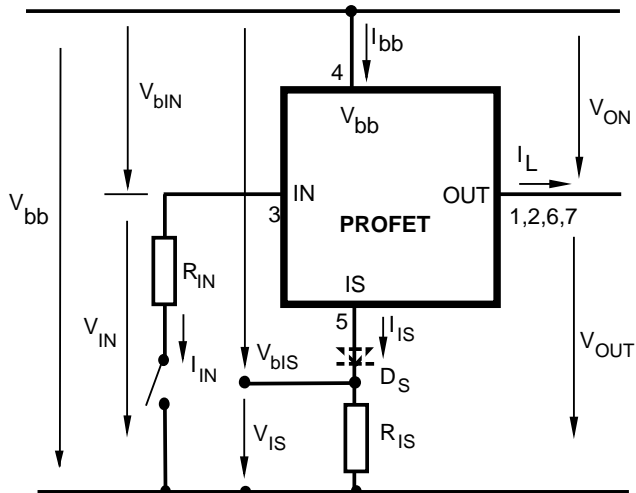
L = "Low" Level

H = "High" Level

Overtemperature reset by cooling:  $T_j < T_{jt}$  (see diagram on page 15)

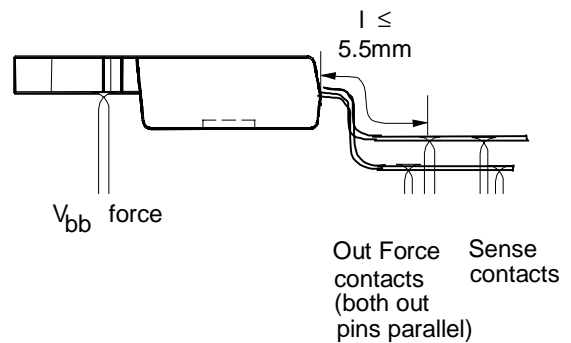
Short circuit to GND: Shutdown remains latched until next reset via input (see diagram on page 14)

### Terms



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

### RON measurement layout

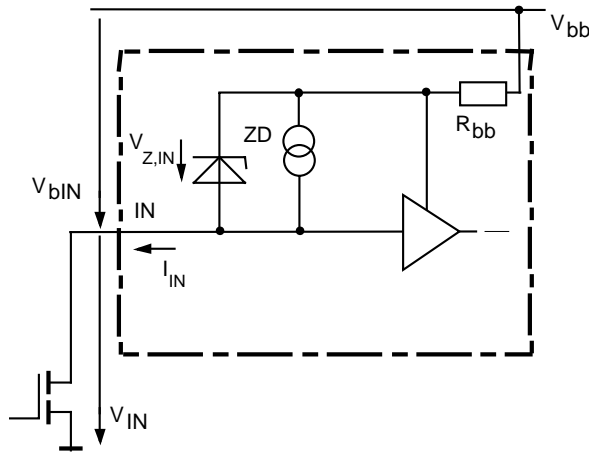


Typical RON for SMD version is about 0.2 mΩ less than straight leads due to  $l \approx 2\text{ mm}$

<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.

### Input circuit (ESD protection)

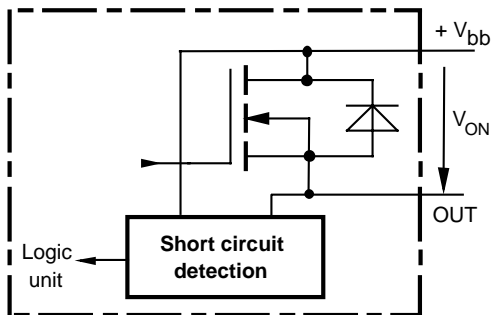


When the device is switched off ( $I_{IN} = 0$ ) the voltage between IN and GND reaches almost  $V_{bb}$ . Use a mechanical switch, a bipolar or MOS transistor with appropriate breakdown voltage as driver.

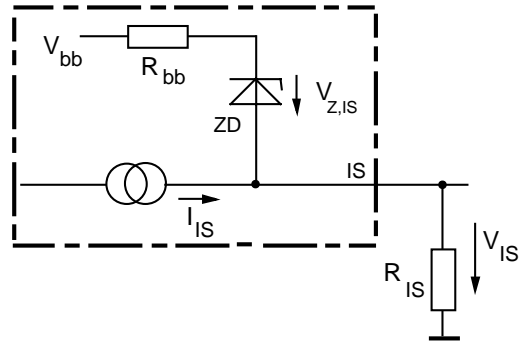
$V_{Z,IN} = 74\text{ V (typ.)}$ .

### Short circuit detection

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



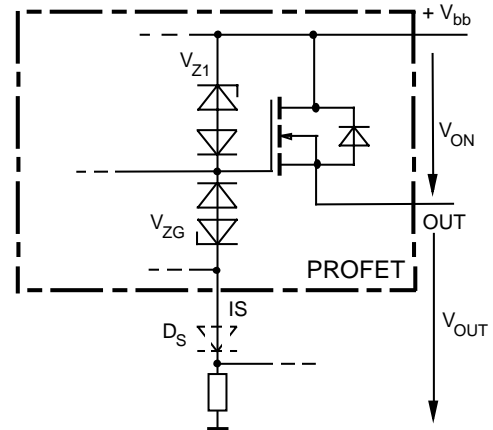
### Current sense status output



$V_{Z,IS} = 74\text{ V (typ.)}$ ,  $R_{IS} = 1\text{ k}\Omega$  nominal (or  $1\text{ k}\Omega / n$ , if  $n$  devices are connected in parallel).  $I_S = I_L / K_{iis}$  can be driven only by the internal circuit as long as  $V_{out} - V_{IS} > 5\text{ V}$ . If you want 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.

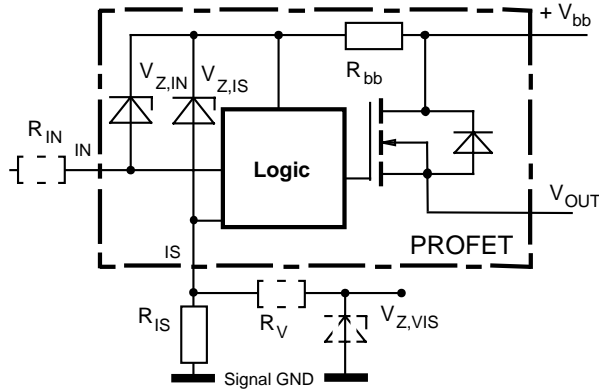
### Inductive and overvoltage output clamp



$V_{ON}$  is clamped to  $V_{ON(CL)} = 62\text{ V typ.}$  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.

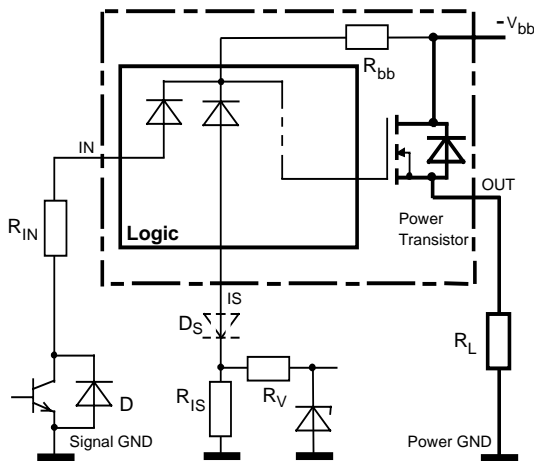


### Overvoltage protection of logic part



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

### Reverse battery protection



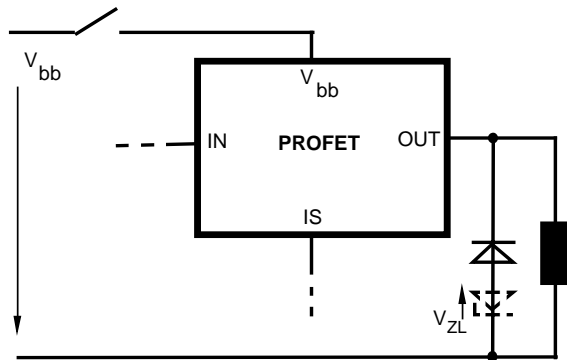
$R_V \geq 1k\Omega$ ,  $R_{IS} = 1k\Omega$  nominal. Add  $R_{IN}$  for reverse battery protection in applications with  $V_{bb}$  above  $16V^{(6)}$ ; recommended value:  $\frac{1}{R_{IN}} + \frac{1}{R_{IS}} + \frac{1}{R_V} = \frac{0.1A}{|V_{bb}| - 12V}$  if  $D_S$  is not used (or  $\frac{1}{R_{IN}} = \frac{0.1A}{|V_{bb}| - 12V}$  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  $R_V$ .

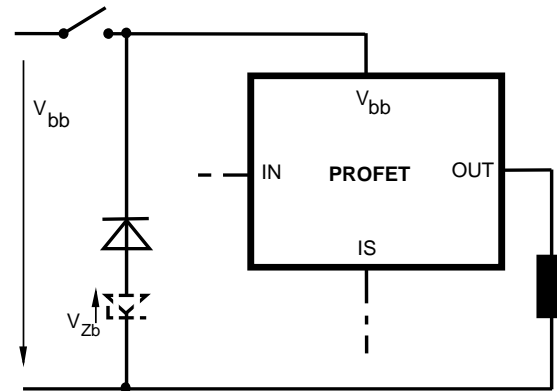
### $V_{bb}$ disconnect with energized inductive load

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

Version a:

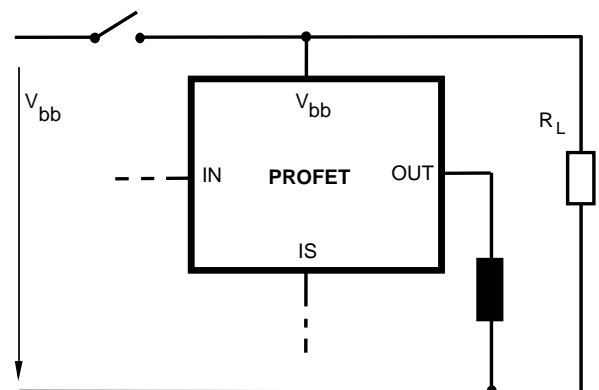


Version b:

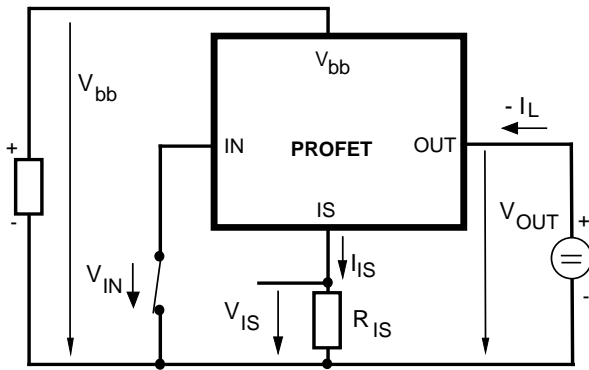


Note that there is no reverse battery protection when using a diode without additional Z-diode  $V_{ZL}$ ,  $V_{Zb}$ .

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:



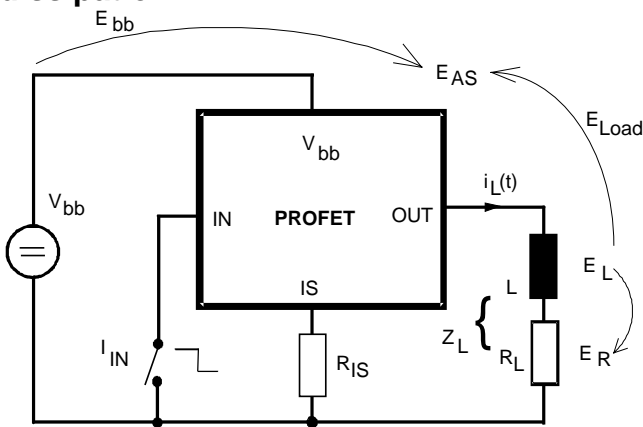
### Inverse load current operation



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

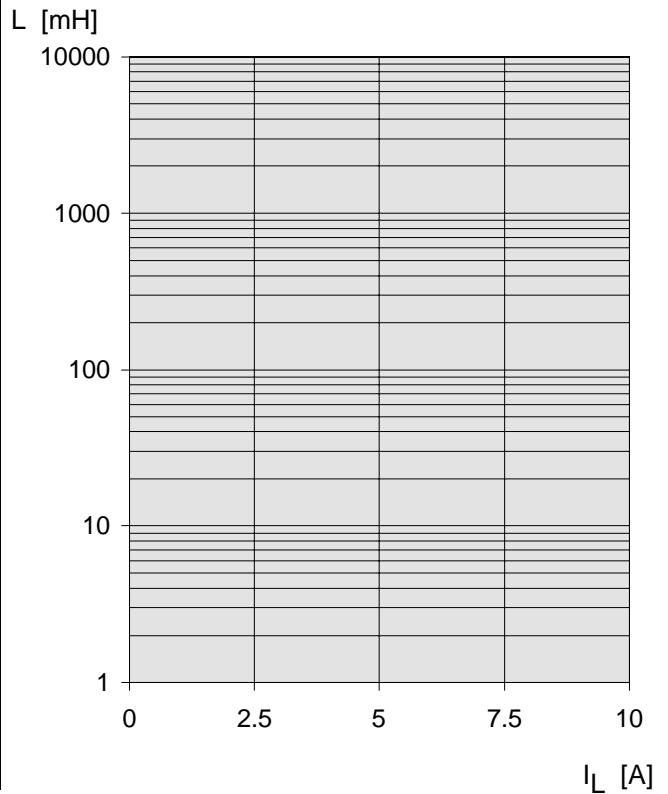
$$E_{AS} = E_{bb} + E_L - E_R = \int V_{ON(CL)} \cdot i_L(t) dt,$$

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	660P	560
Overtemperature protection with hysteresis $T_j > 150\text{ °C}$ , latch function <sup>22)</sup>		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>

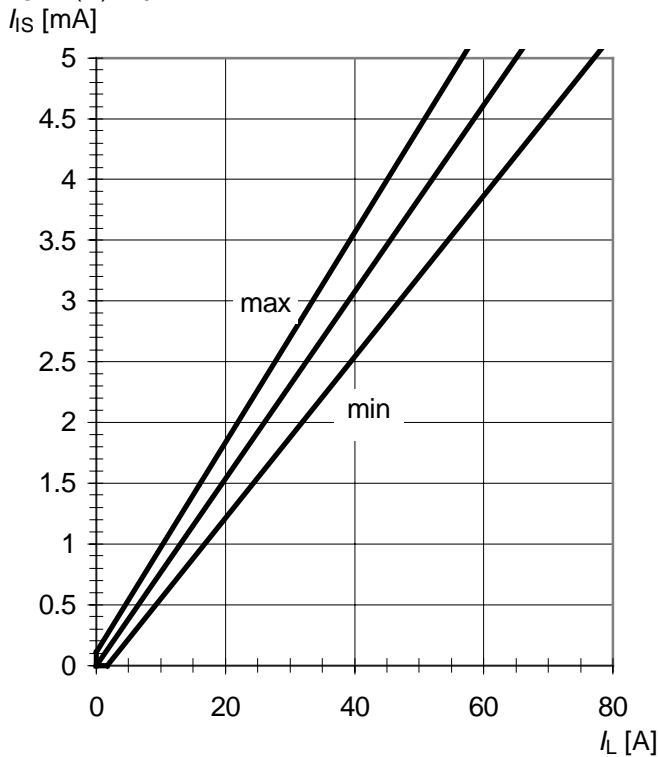
<sup>22)</sup> Latch except when  $V_{bb} - V_{OUT} < V_{ON(SC)}$  after shutdown. In most cases  $V_{OUT} = 0\text{ V}$  after shutdown ( $V_{OUT} \neq 0\text{ V}$  only if forced externally). So the device remains latched unless  $V_{bb} < V_{ON(SC)}$  (see page 5). No latch between turn on and  $t_{d(SC)}$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

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

### Characteristics

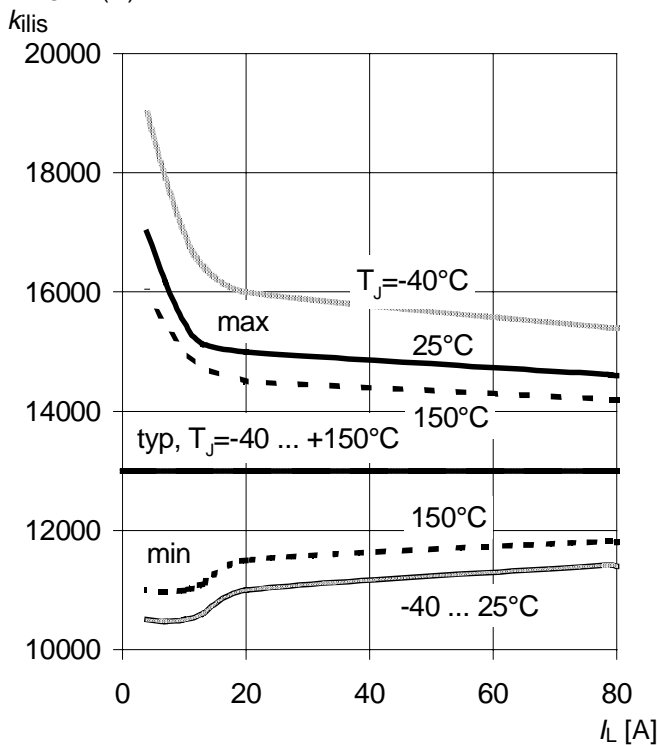
#### Current sense versus load current:

$$I_{IS} = f(I_L), T_J = -40 \dots +150 \text{ } ^\circ\text{C}$$



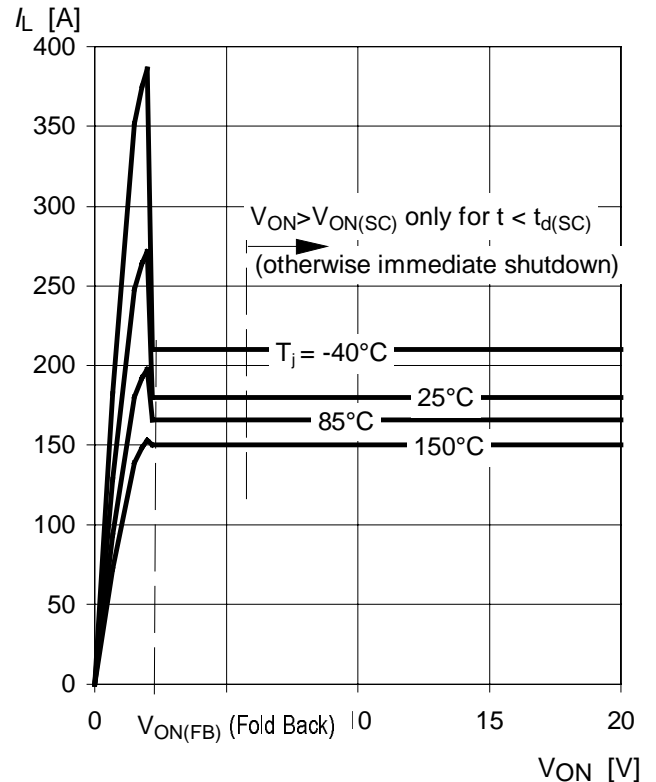
#### Current sense ratio:

$$K_{ILIS} = f(I_L)$$



#### Typ. current limitation characteristic

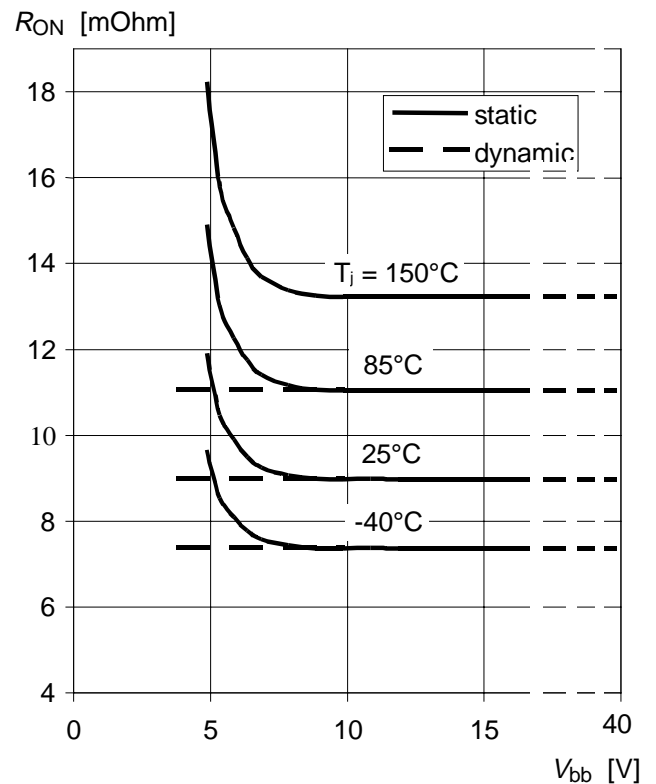
$$I_L = f(V_{ON}, T_J)$$



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

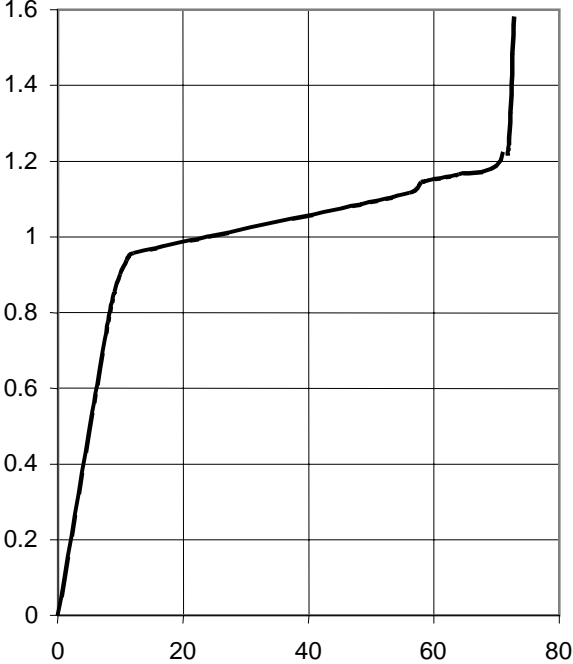
$$R_{ON} = f(V_{bb}, T_J); I_L = 20 \text{ A}; V_{IN} = 0$$



Typ. input current

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

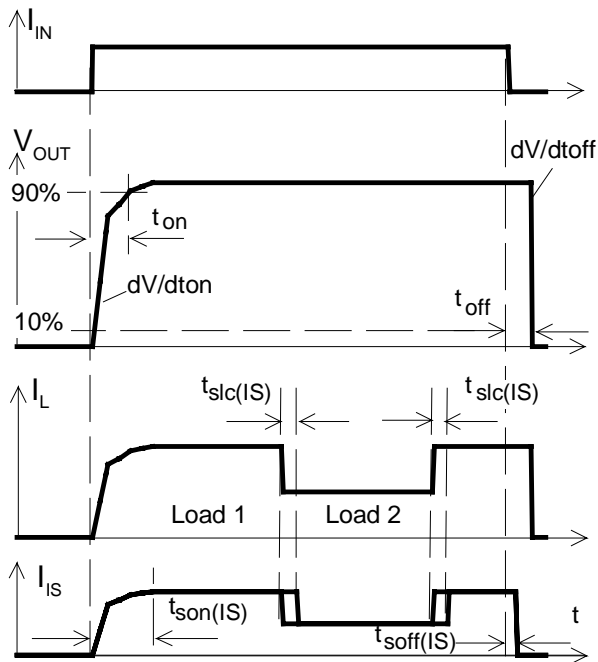
$I_{IN}$  [mA]



$V_{bIN}$  [V]

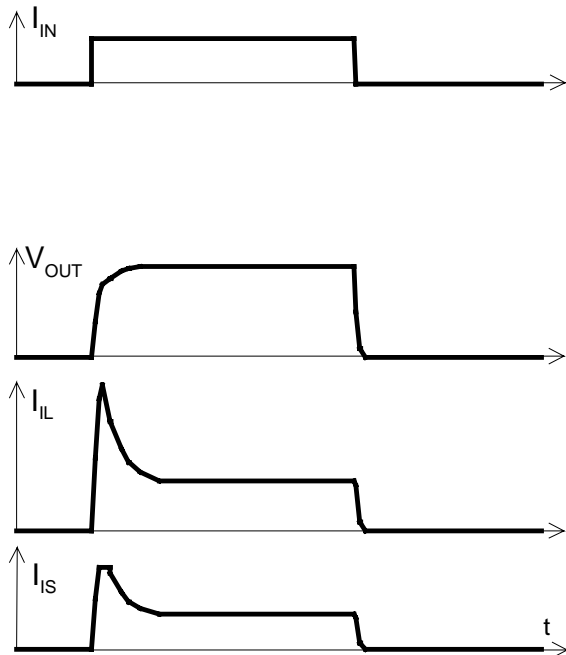
### Timing diagrams

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



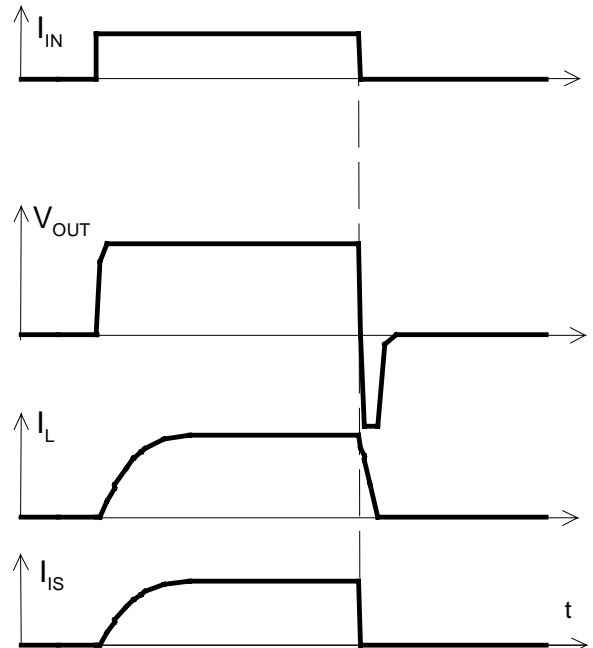
The sense signal is not valid during a settling time after turn-on/off and after change of load current.

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



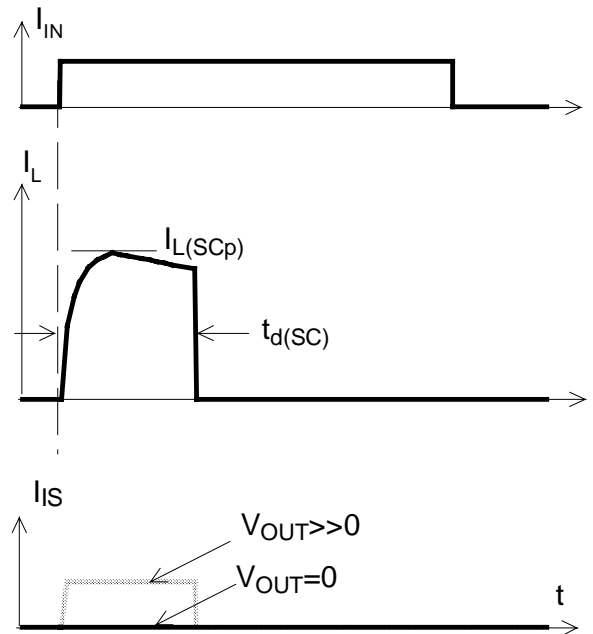
Sense current saturation can occur at very high inrush currents (see  $I_{IS,lim}$  on page 6).

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



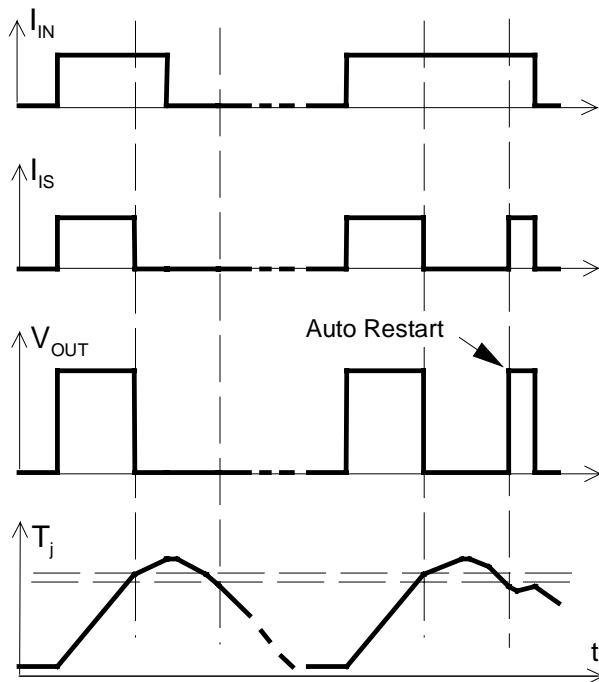
**Figure 3a:** Short circuit:

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

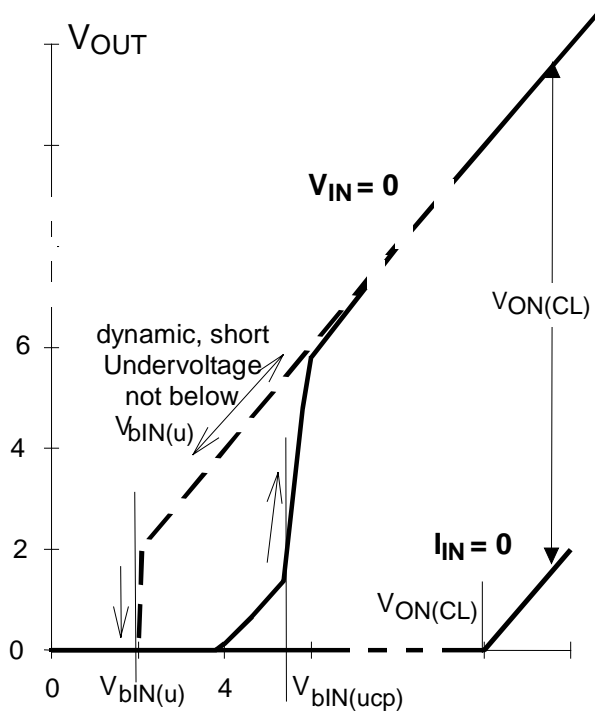


Shut down remains latched until next reset via input.

**Figure 4a:** Overtemperature  
Reset if  $T_j < T_{jt}$



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

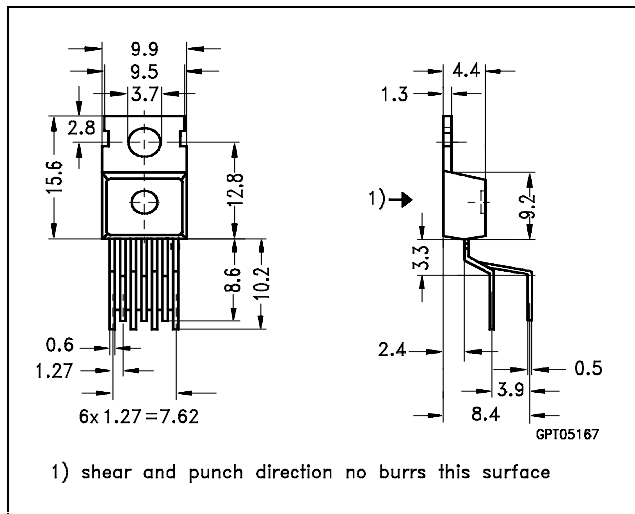


### Package and Ordering Code

All dimensions in mm

**Standard TO-220AB/7**      Ordering code

BTS660P	Q67060-S6308-A2
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**Attention please!**

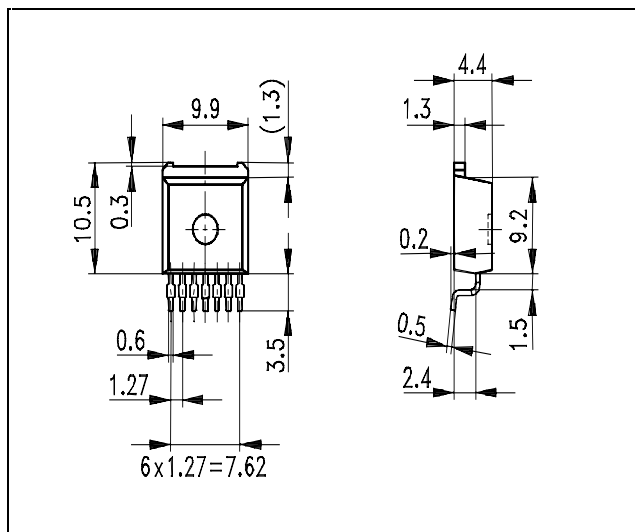
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**SMD TO 220AB/7, Opt. E3180** Ordering code

BTS660P E3180A	T&R: Q67060-S6308-A4
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Footprint:

<b>on request</b>
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