Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Smart High-Side Power Switch for Industrial Applications

One Channel: 38mΩ

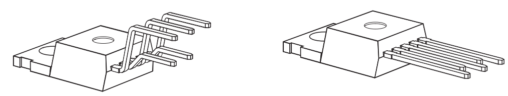
Status Feedback

Product Summary

On-state Resistance	R_{ON}	38mΩ
Operating Voltage	$V_{bb(on)}$	4.75...41V
Nominal load current	$I_{L(NOM)}$	9.8A
Current limitation	$I_{L(SCr)}$	40A
Operating Temperature	T_a	-30 …+85°C

Package

PG-TO220-5-11 PG-TO220-5-12



Standard Straight

General Description

- N channel vertical power MOSFET with charge pump, ground referenced CMOS compatible input and diagnostic feedback, monolithically integrated in Smart SIPMOS® technology.
- Providing embedded protective functions

Applications

- µC compatible high-side power switch with diagnostic feedback for 5V, 12V and 24V grounded loads in industrial applications
- All types of resistive, inductive and capacitve loads
- Most suitable for loads with high inrush currents, so as lamps
- Replaces electromechanical relays, fuses and discrete circuits

Basic Functions

- Very low standby current
- CMOS compatible input
- Fast demagnetization of inductive loads
- Stable behaviour at undervoltage
- Wide operating voltage range
- Logic ground independent from load ground

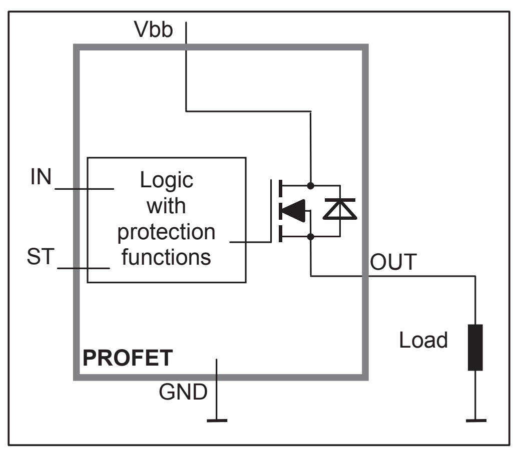
Protection Functions

- Short circuit protection
- Overload protection
- Current limitation
- Thermal shutdown
- Overvoltage protection (including load dump) with external resistor
- Reverse battery protection with external resistor
- Loss of ground and loss of V_{bb} protection
- Electrostatic discharge protection (ESD)

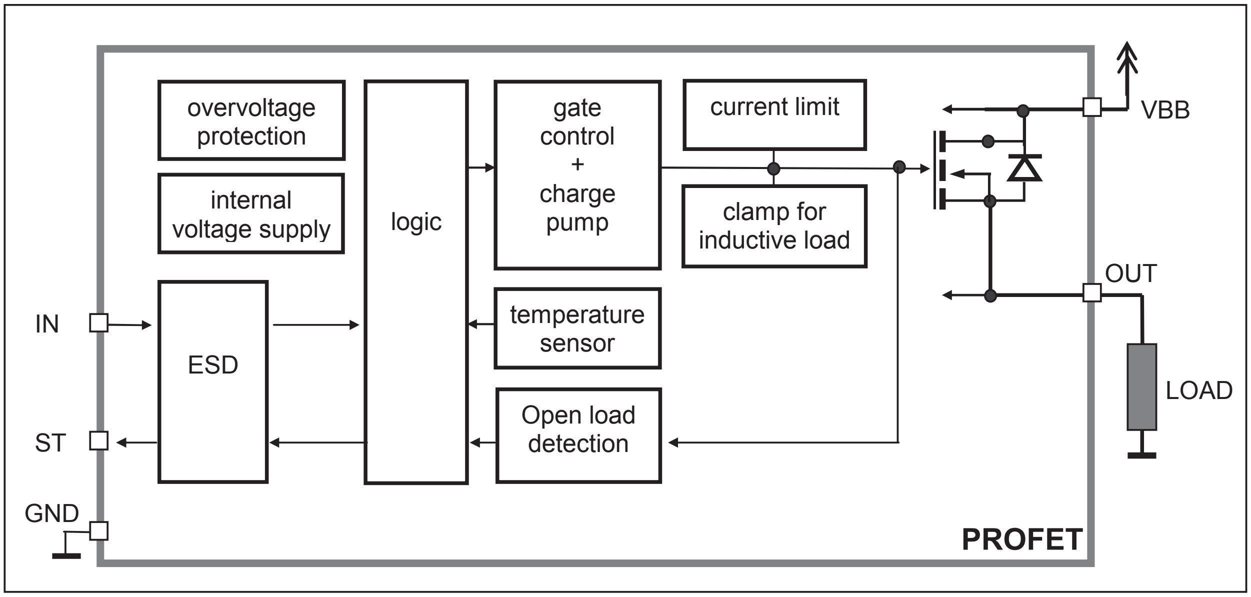
Diagnostic Function

- Diagnostic feedback with open drain output
- Open load detection in ON-state
- Feedback of thermal shutdown in ON-state

Block Diagram



Functional diagram

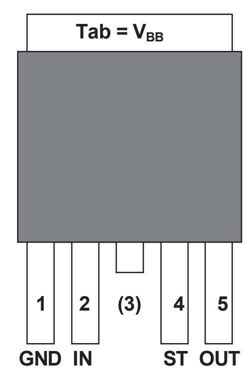


Pin Definitions and Functions

Pin	Symbol	Function
1	GND	**Logic ground**
2	IN	**Input**, activates the power switch in case of logical high signal
3	V_{bb}	**Positive power supply voltage** The tab is shorted to pin 3
4	ST	**Diagnostic feedback**, low on failure
5	OUT	**Output** to the load
Tab	V_{bb}	**Positive power supply voltage** The tab is shorted to pin 3

Pin configuration

(top view)



Maximum Ratings at T_j = 25 °C unless otherwise specified

Parameter	Symbol	Values	Unit
Supply voltage (overvoltage protection see page 4)	V_{bb}	43	V
Supply voltage for full short circuit protection $T_{j\ Start}$=-40 ...+150°C	V_{bb}	24	V
Load dump protection[1] $V_{LoadDump} = V_A + V_s$, V_A = 13.5 V R_I[2]= 2 Ω, R_L= 4.0 Ω, t_d= 200 ms, IN= low or high	$V_{Load\ dump}$[3]	60	V
Load current (Current limit, see page 5)	I_L	self-limited	A
Junction temperature Operating temperature range Storage temperature range	T_j T_a T_{stg}	+150 -30 … +85 -40 ...+105	°C
Power dissipation (DC), $T_C \leq$ 25 °C	P_{tot}	75	W
Maximal switchable inductance, single pulse V_{bb} = 12V, $T_{j,start}$ = 150°C, T_C = 150°C const. (See diagram on page 8) $I_{L(ISO)}$ = 9.8 A, R_L = 0 Ω, E_{AS}[4]=0.33J:	Z_L	5.0	mH
Electrostatic discharge capability (ESD) IN: (Human Body Model) ST: out to all other pins shorted: acc. MIL-STD883D, method 3015.7 and ESD assn. std. S5.1-1993; R=1.5kΩ; C=100pF	V_{ESD}	1.0 4.0 8.0	kV
Input voltage (DC) Current through input pin (DC) Current through status pin (DC) see internal circuit diagrams page 7	V_{IN} I_{IN} I_{ST}	-10 ... +16 ±2.0 ±5.0	V mA

Thermal Characteristics

Parameter and Conditions	Symbol	Values			Unit
		min	typ	max	
Thermal resistance chip - case:	R_{thJC}	--	--	1.75	K/W
junction - ambient (free air):	R_{thJA}	--	--	75	
device on pcb[5]:		--	33	--	

[1] Supply voltages higher than $V_{bb(AZ)}$ require an external current limit for the GND and status pins (a 150Ω resistor for the GND connection is recommended).

[2] R_I = internal resistance of the load dump test pulse generator

[3] $V_{Load\ dump}$ is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839

[4] E_{AS} is the maximum inductive switch-off energy

[5] Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm^2 (one layer, 70µm thick) copper area for V_{bb} connection. PCB is vertical without blown air.

Electrical Characteristics

Parameter and Conditions at T_j =-40...+150°C, V_{bb} = 12 V unless otherwise specified	Symbol	Values min	Values typ	Values max	Unit
Load Switching Capabilities and Characteristics					
On-state resistance (pin 3 to 5) I_L = 2 A; $V_{BB} \geq 7V$ T_j=25 °C: T_j=150 °C: see diagram, page 9	R_{ON}	-- 	35 64	38 72	mΩ
Nominal load current, (pin 3 to 5) ISO 10483-1, 6.7:V_{ON}=0.5V, T_C=85°C	$I_{L(ISO)}$	8.8	9.8	--	A
Output current (pin 5) while GND disconnected or GND pulled up[6], V_{bb}=30 V, V_{IN}= 0, see diagram page 7	$I_{L(GNDhigh)}$	--	--	2	mA
Turn-on time IN ↑ to 90% V_{OUT}: Turn-off time IN ↓ to 10% V_{OUT}: R_L = 12 Ω,	t_{on} t_{off}	50 50	100 120	200 250	µs
Slew rate on 10 to 30% V_{OUT}, R_L = 12 Ω,	dV/dt_{on}	0.1	--	1	V/µs
Slew rate off 70 to 40% V_{OUT}, R_L = 12 Ω,	$-dV/dt_{off}$	0.1	--	1	V/µs
Operating Parameters					
Operating voltage T_j =-40 T_j =+25...+150°C:	$V_{bb(on)}$	4.75	-- --	41 43	V
Overvoltage protection[7] T_j =-40°C: I_{bb}=40 mA T_j =25...+150°C:	$V_{bb(AZ)}$	41 43	-- 47	-- 52	V
Standby current (pin 3)[8] T_j=-40...+25°C: V_{IN}=0; see diagram on page 9 T_j= 150°C:	$I_{bb(off)}$	-- --	5 --	8 25	µA
Off-State output current (included in $I_{bb(off)}$) V_{IN}=0	$I_{L(off)}$	--	1	10	µA
Operating current[9], V_{IN}=5 V	I_{GND}	--	0.8	1.4	mA

6) not subject to production test, specified by design
7) Supply voltages higher than $V_{bb(AZ)}$ require an external current limit for the GND and status pins (a 150Ω resistor for the GND connection is recommended. See also $V_{ON(CL)}$ in table of protection functions and circuit diagram page 7.
8) Measured with load
9) Add I_{ST}, if I_{ST} > 0, add I_{IN}, if V_{IN}>5.5 V

Parameter and Conditions at T_j =-40...+150°C, V_{bb} = 12 V unless otherwise specified	Symbol	Values min	typ	max	Unit
Protection Functions[10]					
Current limit (pin 3 to 5) (see timing diagrams on page 11) T_j =-40°C: T_j =25°C: T_j =+150°C:	$I_{L(lim)}$	46 39 30	58 51 38	68 58 46	A
Repetitive short circuit shutdown current limit T_j = T_{jt} (see timing diagrams, page 11)	$I_{L(SCr)}$	--	40	--	A
Thermal shutdown time[11] $T_{j,start}$ = 25°C: (see timing diagrams on page 11)	$t_{off(SC)}$	--	1.9	--	ms
Output clamp (inductive load switch off) at V_{OUT} = V_{bb} - $V_{ON(CL)}$ I_L= 40 mA:	$V_{ON(CL)}$	41 43	47	52	V
Thermal overload trip temperature	T_{jt}	150	--	--	°C
Thermal hysteresis	ΔT_{jt}	--	10	--	K
Reverse battery (pin 3 to 1)[12]	$-V_{bb}$	--	--	32	V
Reverse battery voltage drop (V_{out} > V_{bb})[13] I_L = -2 A T_j=150 °C:	$-V_{ON(rev)}$	--	600	--	mV
Diagnostic Characteristics					
Open load detection current (on-condition)	$I_{L\ (OL)}$	100	--	900	mA
Input and Status Feedback[14]					
Input resistance see circuit page 7	R_I	2.5	3.5	6	kΩ
Input turn-on threshold voltage	$V_{IN(T+)}$	1.7	--	3.2	V
Input turn-off threshold voltage	$V_{IN(T-)}$	1.5	--	--	V
Input threshold hysteresis	$\Delta V_{IN(T)}$	--	0.5	--	V
Off state input current (pin 2), V_{IN} = 0.4 V	$I_{IN(off)}$	1	--	50	µA
On state input current (pin 2), V_{IN} = 5 V	$I_{IN(on)}$	20	50	90	µA
Delay time for status with open load after switch off (see timing diagrams on page 11)	$t_{d(ST\ OL4)}$	100	520	900	µs
Status output (open drain) Zener limit voltage I_{ST} = +1.6 mA: ST low voltage I_{ST} = +1.6 mA:	 $V_{ST(high)}$ $V_{ST(low)}$	 5.4 --	 6.1 --	 -- 0.4	V

10) Integrated protection functions are designed to prevent IC destruction under fault conditions described in the data sheet. Fault conditions are considered as "outside" normal operating range. Protection functions are not designed for continuous repetitive operation.

11) Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm^2 (one layer, 70µm thick) copper area for V_{bb} connection. PCB is vertical without blown air.

12) Requires 150 Ω resistor in GND connection. The reverse load current through the intrinsic drain-source diode has to be limited by the connected load. Note that the power dissipation is higher compared to normal operating conditions due to the voltage drop across the intrinsic drain-source diode. The temperature protection is not active during reverse current operation! Input and Status currents have to be limited (see max. ratings page 3 and circuit page 7).

13) not subject to production test, specified by design

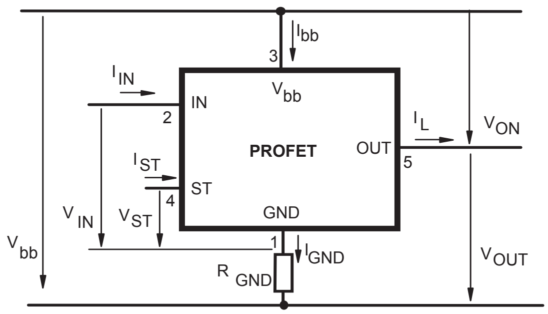
14) If a ground resistor R_{GND} is used, add the voltage drop across this resistor.

Truth Table

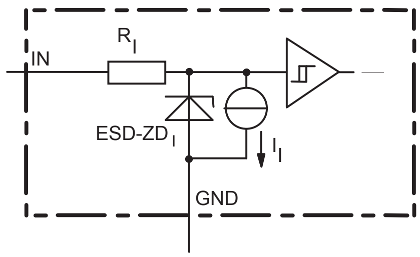
	Input level	Output level	Status BTS 436L2
Normal operation	L H	L H	H H
Open load	L H	Z H	H L
Overtem-perature	L H	L L	H L

L = "Low" Level X = don't care Z = high impedance, potential depends on external circuit
H = "High" Level Status signal after the time delay shown in the diagrams (see fig 5. page 11)

Terms

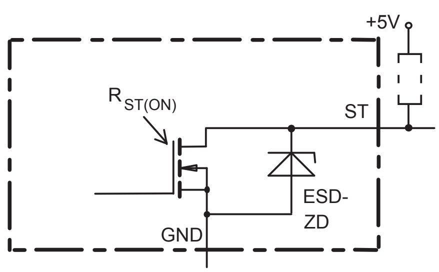


Input circuit (ESD protection)



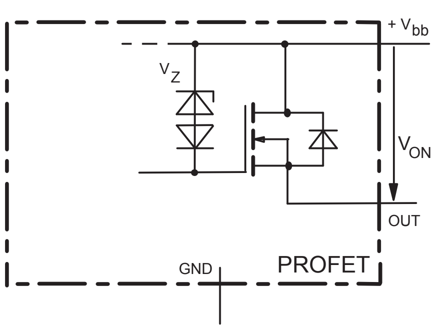
The use of ESD zener diodes as voltage clamp at DC conditions is not recommended

Status output



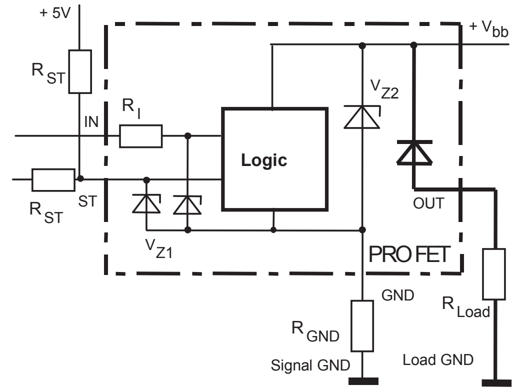
ESD-Zener diode: 6.1 V typ., max 5.0 mA; $R_{ST(ON)} < 375\ \Omega$ at 1.6 mA. The use of ESD zener diodes as voltage clamp at DC conditions is not recommended.

Inductive and overvoltage output clamp



V_{ON} clamped to 47 V typ.

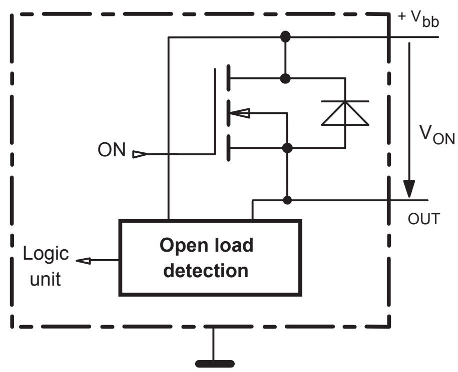
Overvolt. and reverse batt. protection



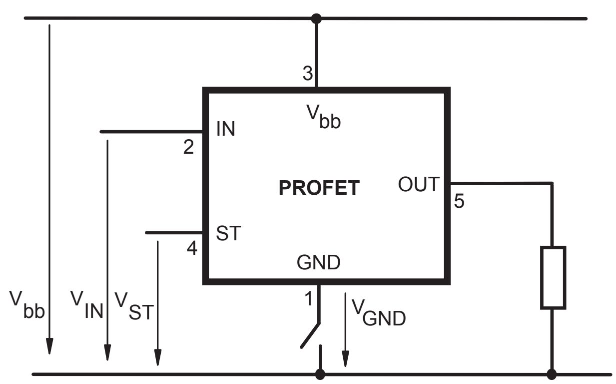
V_{Z1} = 6.1 V typ., V_{Z2} = 47 V typ., R_{GND} = 150 Ω, R_{ST}= 15 kΩ, R_I= 3.5 kΩ typ.
In case of reverse battery the load current has to be limited by the load. Temperature protection is not active

Open-load detection in on-state

Open load, if $V_{ON} < R_{ON} \cdot I_{L(OL)}$; IN high

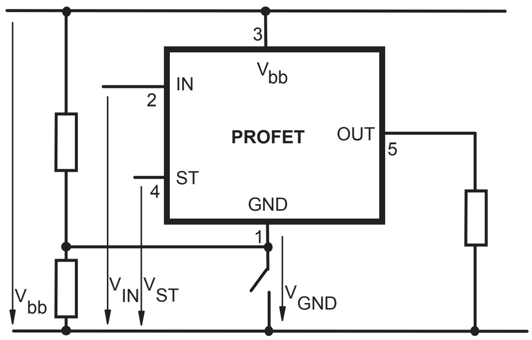


GND disconnect



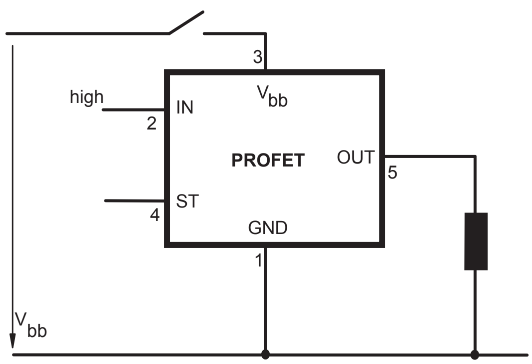
Any kind of load. In case of Input=high is $V_{OUT} \approx V_{IN} - V_{IN(T+)}$.
Due to V_{GND} >0, no V_{ST} = low signal available.

GND disconnect with GND pull up



Any kind of load. If $V_{GND} > V_{IN} - V_{IN(T+)}$ device stays off
Due to V_{GND} >0, no V_{ST} = low signal available.

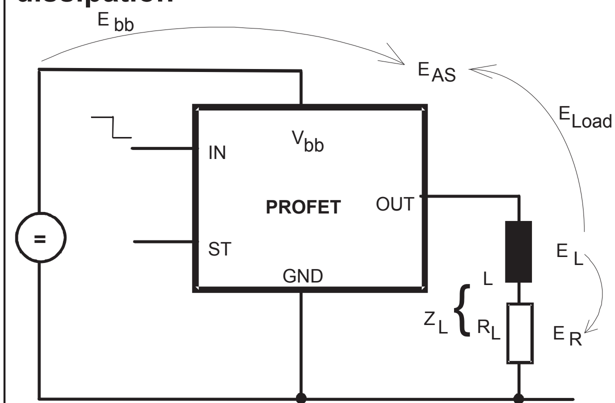
V_{bb} disconnect with energized inductive load



For inductive load currents up to the limits defined by Z_L (max. ratings and diagram on page 8) each switch is protected against loss of V_{bb}.

Consider at your PCB layout that in the case of Vbb disconnection with energized inductive load all the load current flows through the GND connection.

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

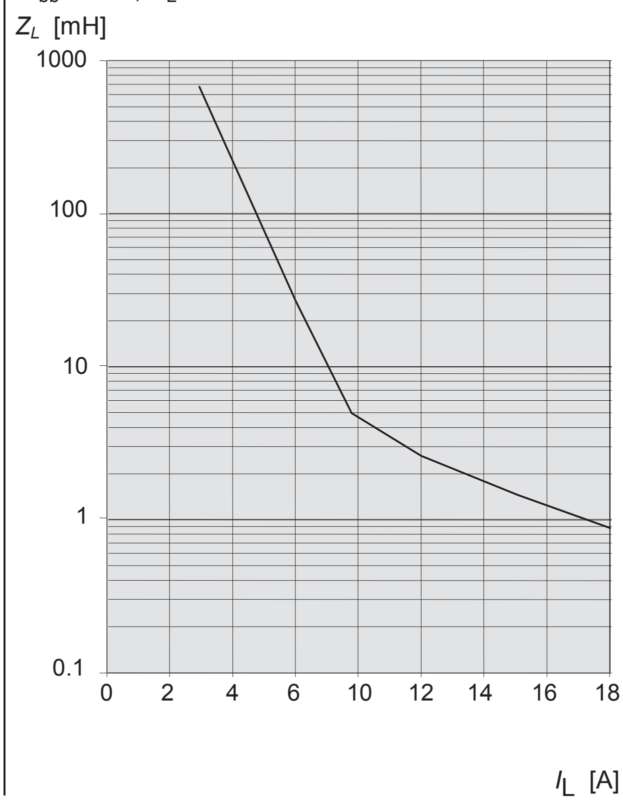
$$E_{AS} = E_{bb} + E_L - E_R = \int V_{ON(CL)} \cdot i_L(t)\, dt,$$

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

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

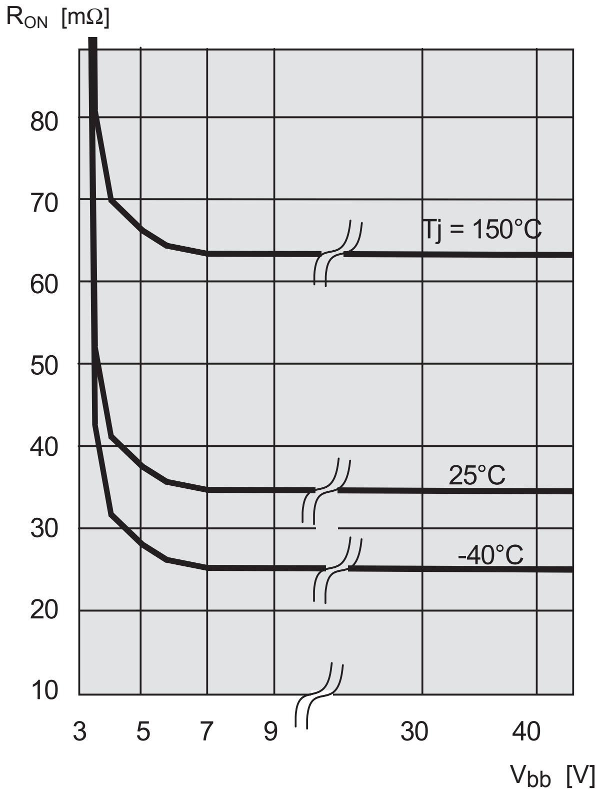
Maximum allowable load inductance for a single switch off

$L = f(I_L)$; $T_{j,start}$ = 150°C, T_C = 150°C const.,
V_{bb} = 12 V, R_L = 0 Ω



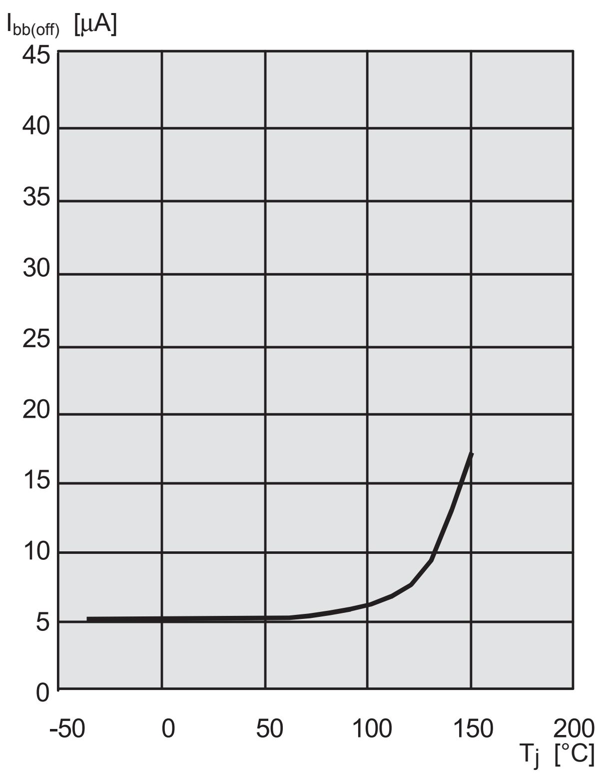
Typ. on-state resistance

$R_{ON} = f(V_{bb}, T_j)$; I_L = 2 A, IN = high



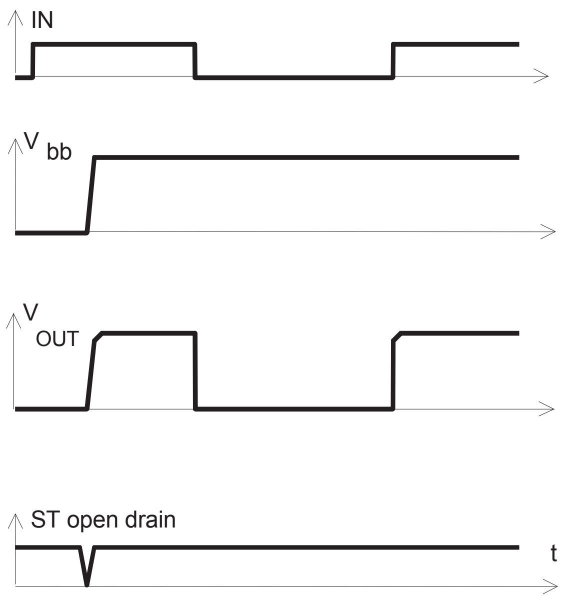
Typ. standby current

$I_{bb(off)} = f(T_j)$; V_{bb} = 9...34 V, IN1,2 = low



Timing diagrams

Figure 1a: V_{bb} turn on:



proper turn on under all conditions

Figure 2a: Switching a resistive load, turn-on/off time and slew rate definition:

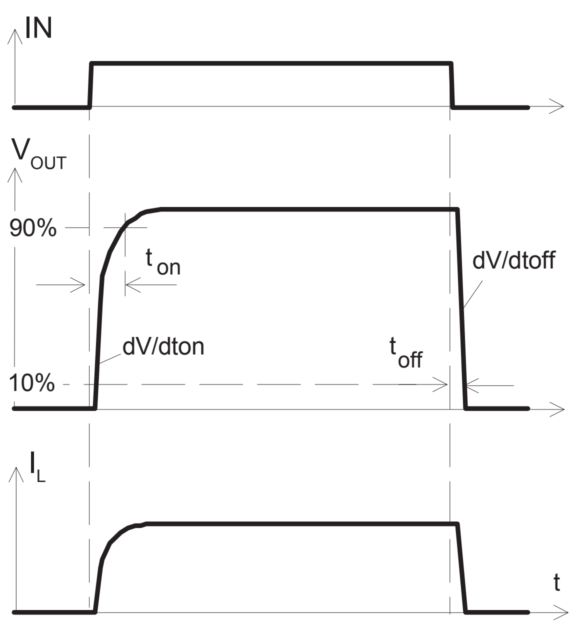
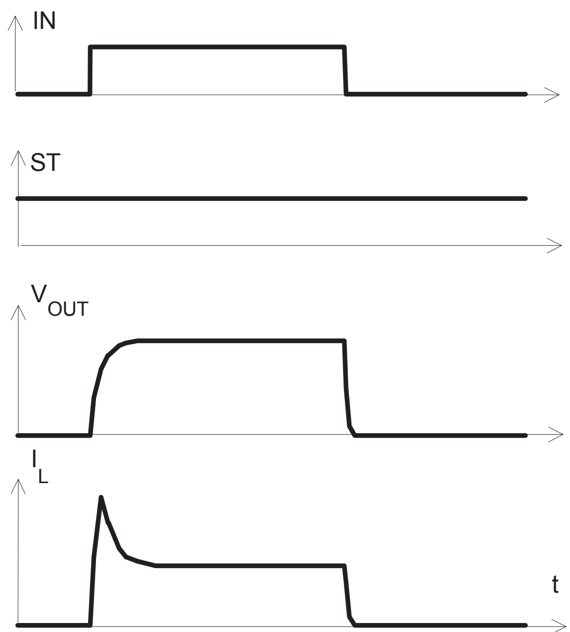
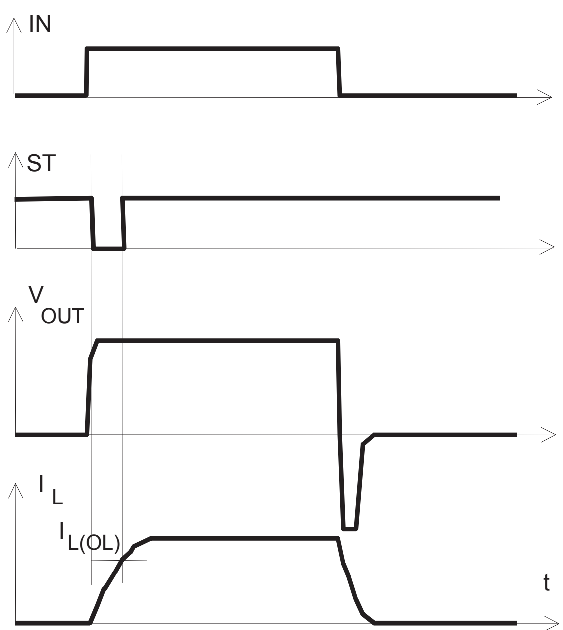


Figure 2b: Switching a lamp,



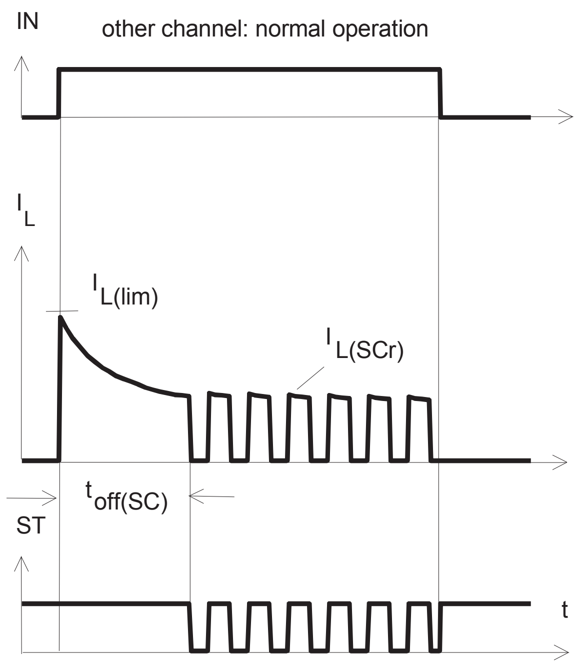
The initial peak current should be limited by the lamp and not by the current limit of the device.

Figure 2c: Switching an inductive load



*) if the time constant of load is too large, open-load-status may occur

Figure 3a: Short circuit
shut down by overtemperature, reset by cooling



Heating up of the chip may require several milliseconds, depending on external conditions

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

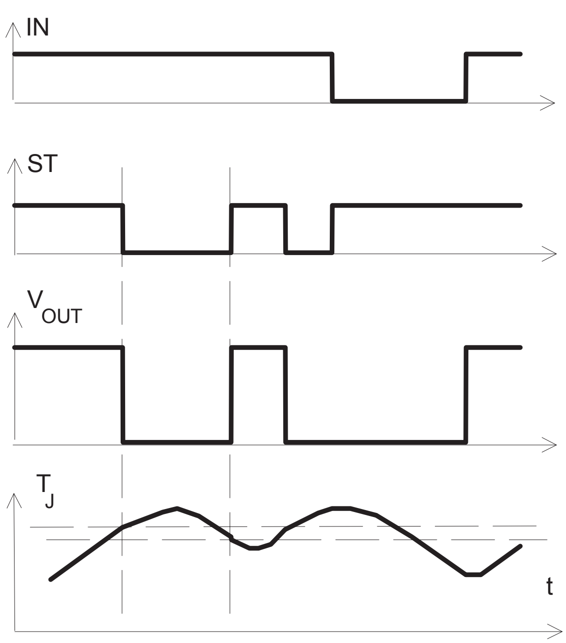
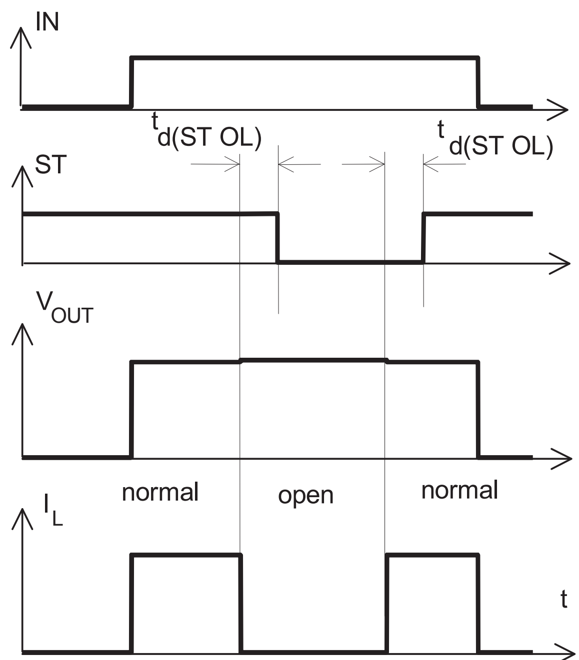
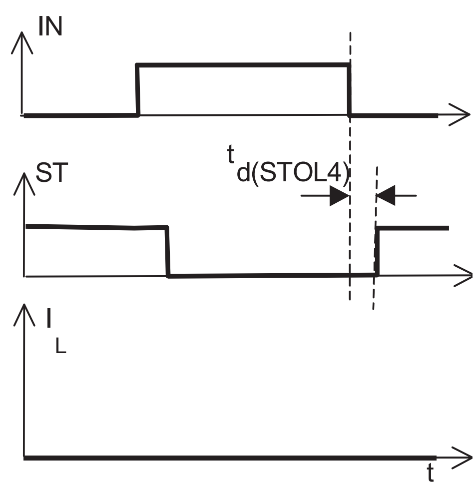


Figure 5a: Open load: detection in ON-state, open load occurs in on-state



$t_{d(ST\ OL)}$ = 10 µs typ.

Figure 5b: Open load: turn on/off to open load

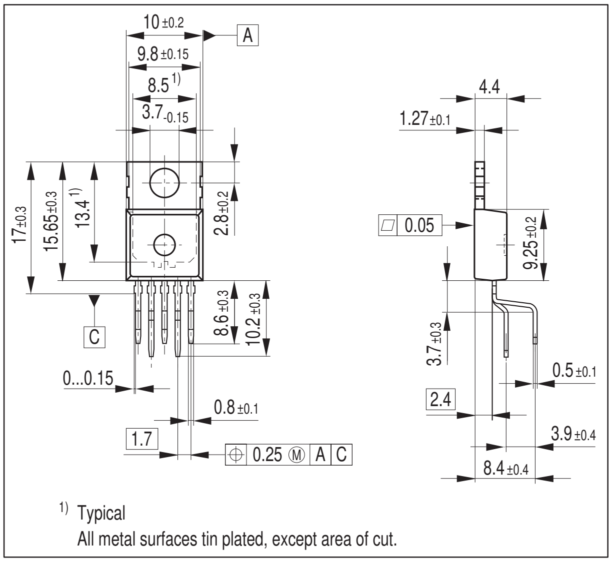


Package and Ordering Code

All dimensions in mm

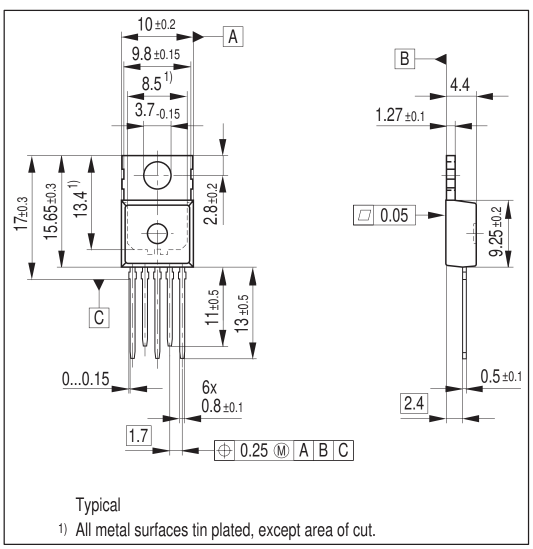
Standard (=staggered): PG-TO220-5-11

Sales code	ITS436L2
Ordering code:	SP000221231



Straight: PG-TO220-5-12

Sales code	ITS436L2 S
Ordering code:	SP000221232



Published by
Infineon Technologies AG,
St.-Martin-Strasse 53,
D-81669 München