ISP752T

Smart power high-side-switch for industrial applications

RoHS

Features

- Overload protection
- Current limitation
- Short circuit protection
- Thermal shutdown with restart
- ESD-protection
- Overvoltage protection (including load dump)
- Fast demagnetization of inductive loads
- Reverse battery protection with external resistor
- CMOS compatible input
- Loss of GND and loss of V_{bb} protection
- Very low standby current
- Green product (RoHS compliant)

Potential applications

- All types of resistive, inductive and capacitive loads
- µC compatible power switch for 12 V, 24 V and 42 V DC industrial applications
- Replaces electromechanical relays and discrete circuits

Product validation

Qualified for industrial applications according to the relevant tests of JEDEC JESD47/20/22.

Description

Parameter	Symbol	Value	Unit
Overvoltage protection	$V_{bb(AZ)}$	62	V
Operating voltage	$V_{bb(on)}$	6 to 52	V
On-state resistance	R_{ON}	200	mΩ
Nominal load current	$I_{L(nom)}$	1.3	A
Operating temperature	T_a	-30 to +85	°C

N channel vertical power FET with charge pump, ground referenced CMOS compatible input, monolithically integrated with embedded protective functions.

Type	Package	Marking
ISP752T	PG-DSO-8	I752T

Table of contents

1 Block diagram

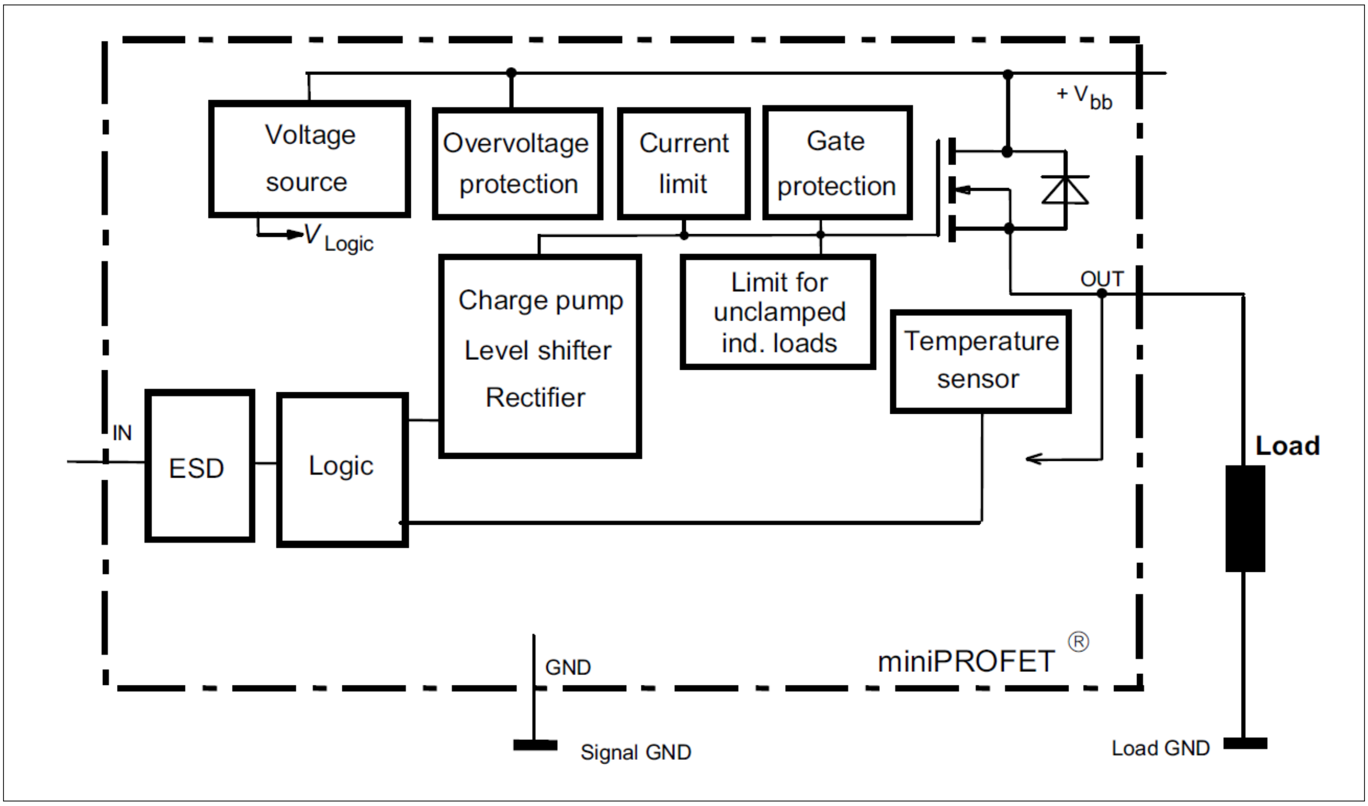


Figure 1 **Block diagram**

2 Pin configuration

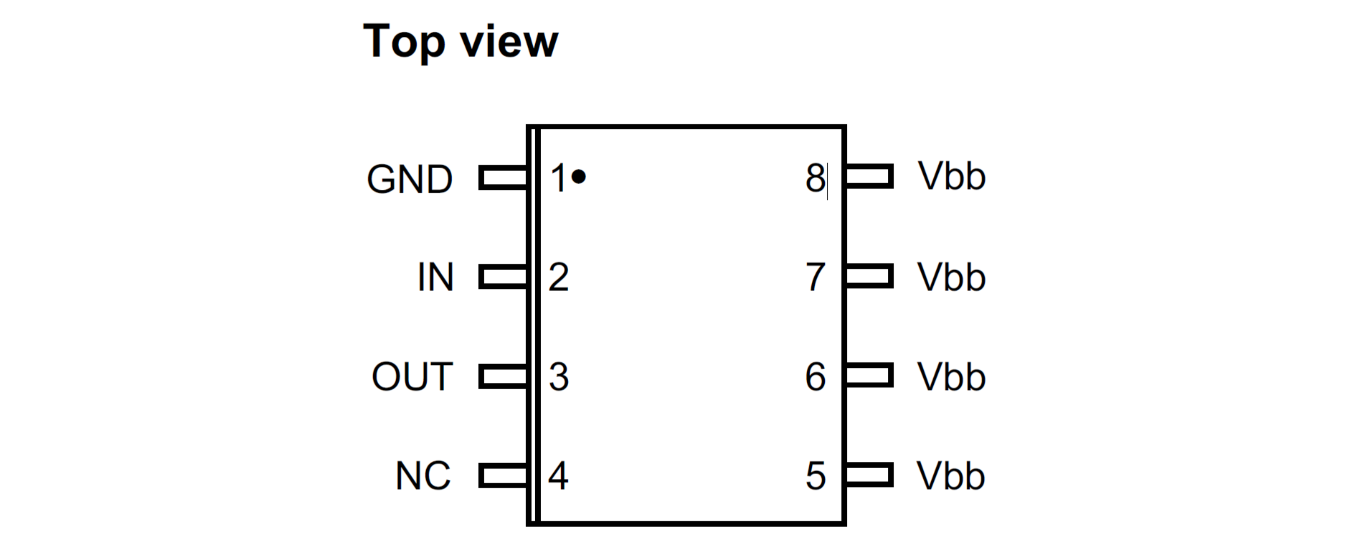


Figure 2 **Pin configuration**

Pin	Symbol	Function
1	GND	Logic ground
2	IN	Input, activates the power switch in case of logic high signal
3	OUT	Output to the load
4	NC	not connected
5	Vbb	Positive power supply voltage
6	Vbb	Positive power supply voltage
7	Vbb	Positive power supply voltage
8	Vbb	Positive power supply voltage

3 General product characteristics

3.1 Absolute maximum ratings

Table 1 Maximum ratings

T_j = 25°C, unless otherwise specified

Parameter	Symbol	Value	Unit	Note or condition
Supply voltage	V_{bb}	52	V	–
Supply voltage for full short circuit protection	$V_{bb(SC)}$	50	V	–
Continuous input voltage	V_{IN}	-10 to +16	V	–
Load current	I_L	self limited	A	short-circuit current, see page *11*
Current through input pin (DC)	I_{IN}	±5	mA	–
Junction temperature	T_j	150	°C	–
Operating temperature	T_a	-30 to +85	°C	–
Storage temperature	T_{stg}	-40 to +105	°C	–
Power dissipation	P_{tot}	1.5	W	[1]
Inductive load switch-off energy dissipation	E_{AS}	125	mJ	[1] [2] single pulse (see page *7*) T_j = 150°C, I_L = 1 A
Load dump protection	$V_{Loaddump}$		V	[2] [3] $V_{LoadDump} = V_A + V_S$ $R_I = 2\ \Omega$, t_d = 400 ms, V_{IN} = low or high, V_A = 13.5 V
$R_L = 13.5\ \Omega$		73.5		
$R_L = 27\ \Omega$		83.5		
Electrostatic Discharge Voltage (Human Body Model)	V_{ESD}		kV	according to ANSI/ESDA/JEDEC JS001 (1.5 kΩ, 100 pF)
OUT		±6		
IN		±1		
all other pins		±4		

1 Device on 50 mm × 50 mm × 1.5 mm epoxy PCB FR4 with 6 cm^2 (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air. (see page *19*)

2 Not subject to production test, specified by design

3 $V_{LoadDump}$ is set up without the DUT connected to the generator per ISO 7637-1 and DIN 40839. Supply voltages higher than $V_{bb(AZ)}$ require an external current limit for the GND pin, e.g. with a 150 Ω resistor in GND connection. A resistor for the protection of the input is integrated.

3.2 Thermal resistance

Table 2 Thermal resistance

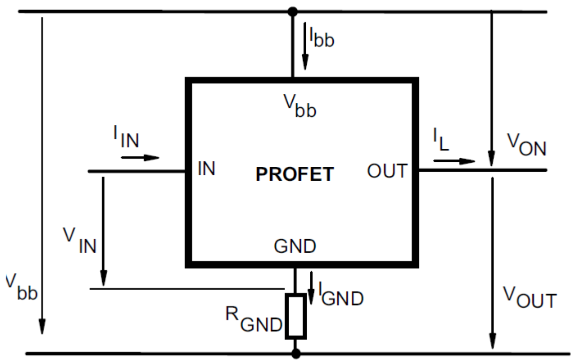
Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Thermal resistance	$R_{th(JA)}$	–			K/W	–
minimum footprint			95	–		
6 cm^2 cooling area [4]			70	83		

[4] Device on 50 mm × 50 mm × 1.5 mm epoxy PCB FR4 with 6 cm^2 (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air. (see page 19)

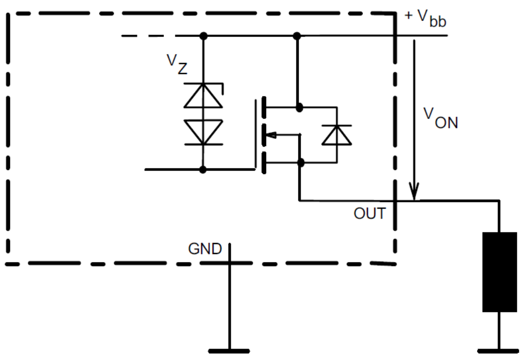
4 Functional description and electrical characteristics

4.1 Functional description

Terms

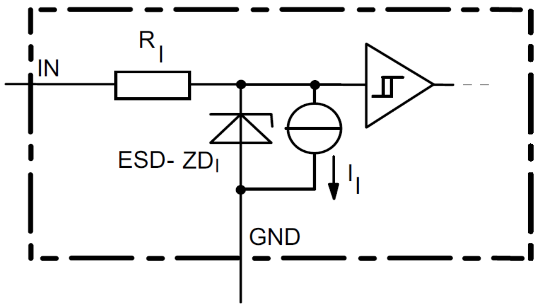


Inductive and overvoltage output clamp



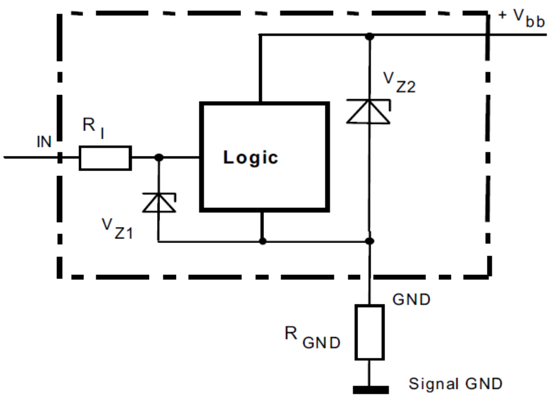
V_{ON} clamped to 59 V min.

Input circuit (ESD protection)



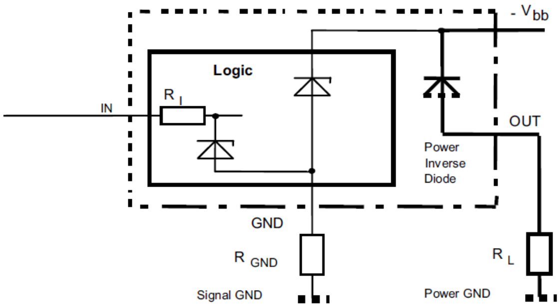
The use of ESD zener diodes as voltage clamp at DC conditions is not recommended

Overvoltage protection of logic part



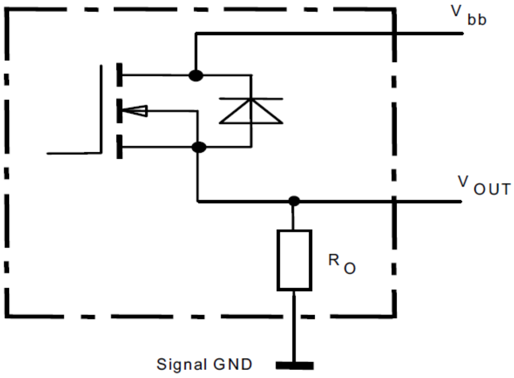
V_{Z1} = 6.1 V typ., V_{Z2} = $V_{bb(AZ)}$ = 62 V min., R_I = 3.5 kΩ typ., R_{GND} = 150 Ω

Reverse battery protection



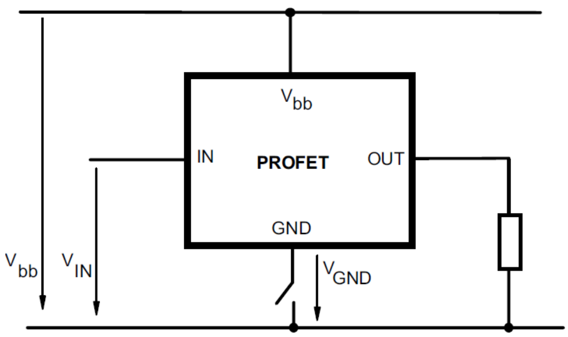
R_{GND} = 150 Ω, R_I = 3.5 kΩ typ., temperature protection is not active during inverse current

Internal output pull down

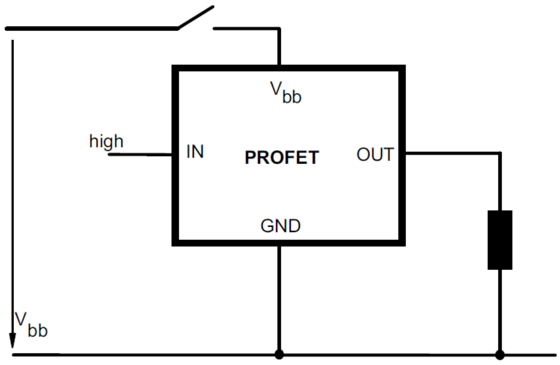


R_O = 200 kΩ typ.

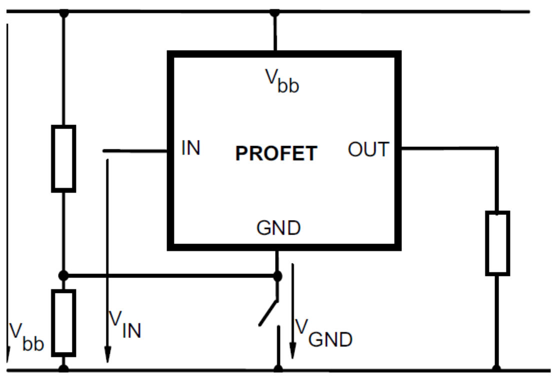
GND disconnect



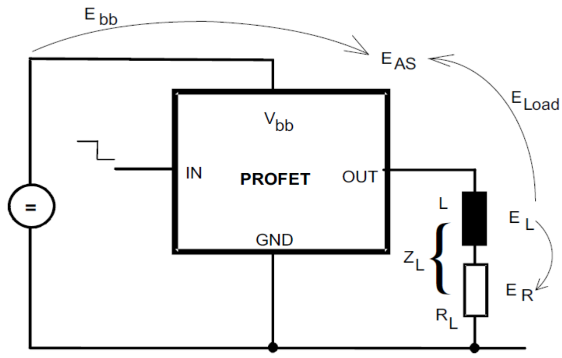
V_{bb} disconnect with charged inductive load



GND disconnect with GND pull up



Inductive load switch-off energy dissipation



Energy stored in load inductance:

$E_L = 1/2 \times L \times I_L^2$

While demagnetizing load inductance, the energy dissipated in PROFET is:

$E_{AS} = E_{bb} + E_L - E_R = V_{ON(CL)} \times I_L(t)\ dt$

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

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

4.2 Electrical characteristics

Table 3 Electrical characteristics

T_j = -40°C to +150°C, V_{bb} = 12 V to 42 V, unless otherwise specified

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Load switching capabilities and characteristics						
On-state resistance	R_{ON}				mΩ	–
T_j = 25°C, I_L = 1 A, V_{bb} = 9 V to 52 V		–	150	200		
T_j = 150°C		–	270	380		
Nominal load current	$I_{L(nom)}$	1.3	1.7	–	A	device on PCB [5] T_C = 85°C, T_j ≤ 150°C
Turn-on time to 90% V_{OUT}	t_{on}	–	80	180	µs	R_L = 47 Ω
Turn-off time to 10% V_{OUT}	t_{off}	–	80	200	µs	R_L = 47 Ω
Slew rate on 10% to 30% V_{OUT}	dV/dt_{on}	–	0.7	2	V/µs	R_L = 47 Ω, V_{bb} = 13.5 V
Slew rate off 70% to 40% V_{OUT}	$-dV/dt_{off}$	–	0.9	2	V/µs	R_L = 47 Ω, V_{bb} = 13.5 V
Operating parameters						
Operating voltage	$V_{bb(on)}$	6	–	52	V	
Undervoltage shutdown of charge pump	$V_{bb(under)}$				V	–
T_j = -40°C to +85°C		–	–	4		
T_j = 150°C		–	–	5.5		
Undervoltage restart of charge pump	$V_{bb(u\ cp)}$	–	4	5.5	V	–
Standby current	$I_{bb(off)}$				µA	–
T_j = -40°C to +85°C, V_{IN} = low		–	–	15		
T_j = +150°C [6], V_{IN} = low		–	–	18		
Leakage output current	$I_{L(off)}$	–	–	5	µA	included in $I_{bb(off)}$ V_{IN} = low
Operating current V_{IN} = high	I_{GND}	–	0.8	2	mA	–
Protection functions [7]						

5 Device on 50 mm × 50 mm × 1.5 mm epoxy PCB FR4 with 6 cm^2 (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air. (see page 19)

6 Higher current due temperature sensor

7 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.

Table 3 Electrical characteristics (continued)

T_j = -40°C to +150°C, V_{bb} = 12 V to 42 V, unless otherwise specified

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Initial peak short circuit current limit (pin 5 to 3)	$I_{L(SCp)}$				A	
T_j = -40°C, V_{bb} = 20 V, t_m = 150 µs		–	–	9		–
T_j = 25°C		–	6.5	–		-
T_j = 150°C		4	–	–		-
T_j = -40°C to +150°C, V_{bb} > 40 V		–	5 [8)]	–		(see page **14**)
Repetitive short circuit current limit T_j = T_{jt}	$I_{L(SCr)}$				A	(see ***Timing diagrams***)
V_{bb} < 40 V		–	6	–		
V_{bb} > 40 V		–	4.5	–		
Output clamp (inductive load switch off)	$V_{ON(CL)}$	59	63	–	V	V_{OUT} = V_{bb} - $V_{ON(CL)}$, I_{bb} = 4 mA
Overvoltage protection	$V_{bb(AZ)}$	62	–	–	V	[9)] I_{bb} = 4 mA
Thermal overload trip temperature	T_{jt}	150	–	–	°C	–
Thermal hysteresis	ΔT_{jt}	–	10	–	K	–
Reverse battery						
Reverse battery	$-V_{bb}$	–	–	52	V	[10)]
Drain-source diode voltage (V_{OUT} > V_{bb})	$-V_{ON}$	–	600	–	mV	T_j = 150°C
Input						
Input turn-on threshold voltage	$V_{IN(T+)}$	–	–	2.2	V	–
Input turn-off threshold voltage	$V_{IN(T-)}$	0.8	–	–	V	–
Input threshold hysteresis	$\Delta V_{IN(T)}$	–	0.4	–	V	–
Off state input current	$I_{IN(off)}$	1	–	25	µA	V_{IN} = 0.7 V
On state input current	$I_{IN(on)}$	3	–	25	µA	V_{IN} = 5 V
Input resistance	R_I	2	3.5	5	kΩ	see page **7**

8 Not subject to production test, specified by design

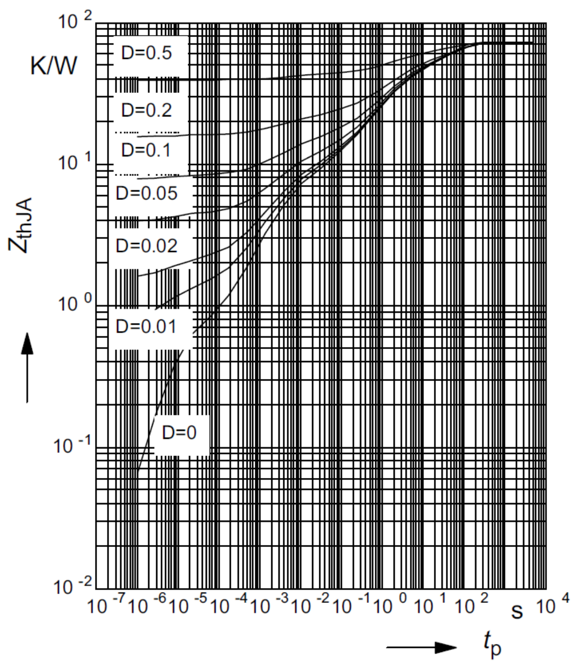
9 See also $V_{ON(CL)}$ in circuit diagram on page ***7***

10 Requires a 150 Ω resistor in GND connection. The reverse load current through the intrinsic drain-source diode has to be limited by the connected load. Power dissipation is higher compared to normal operating conditions due to the voltage drop across the drain-source diode. The temperature protection is not active during reverse current operation! Input current has to be limited (see ***Absolute maximum ratings*** on page 5).

4.3 Typical performance characteristics

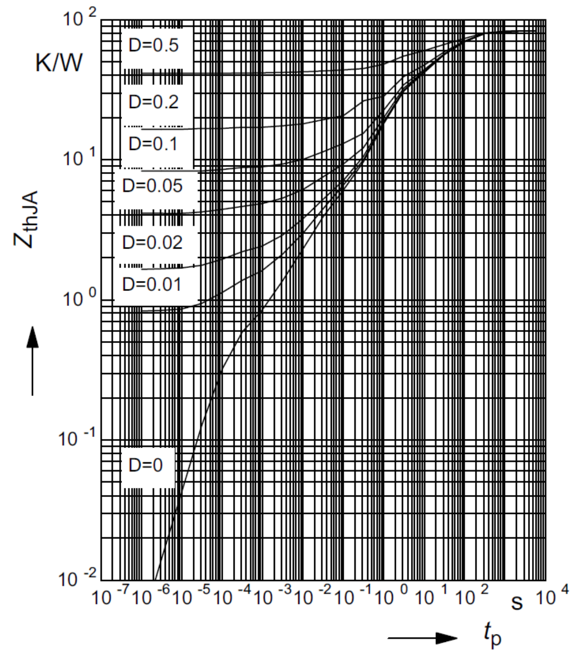
Typ. transient thermal impedance $Z_{thJA} = f(t_p)$ @ 6 cm^2 heatsink area

Parameter: $D = t_p/T$



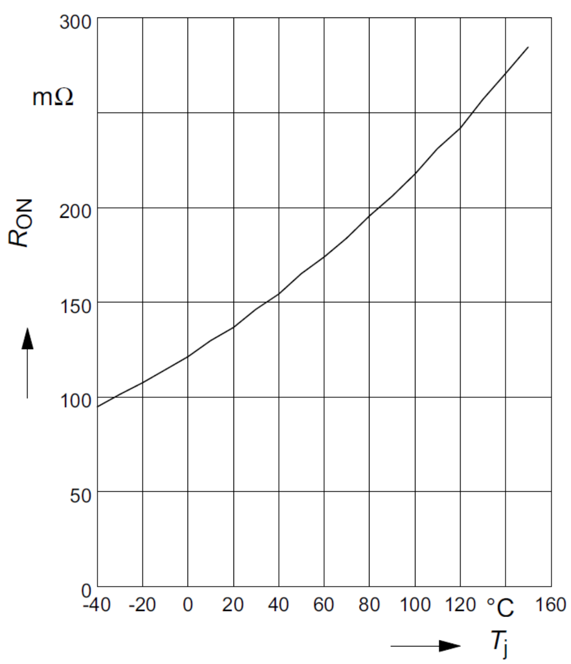
Typ. transient thermal impedance $Z_{thJC} = f(t_p)$ @ minimum footprint

Parameter: $D = t_p/T$



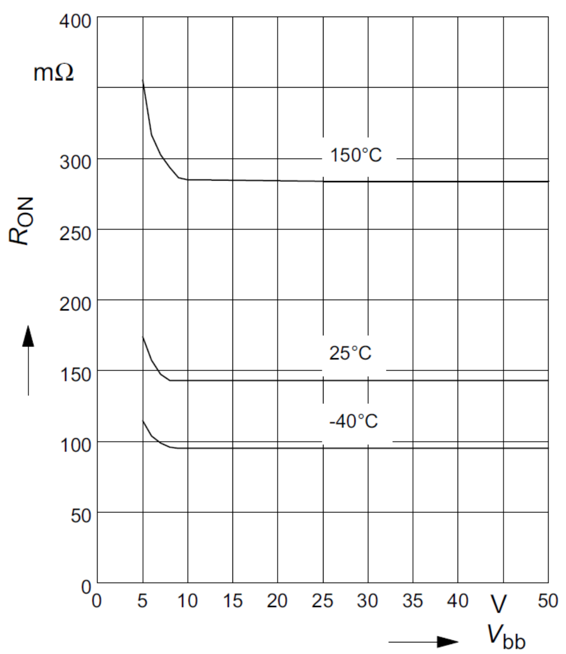
Typ. on-state resistance $R_{ON} = f(T_j)$

V_{bb} = 13.5 V; V_{IN} = high



Typ. on-state resistance $R_{ON} = f(V_{bb})$

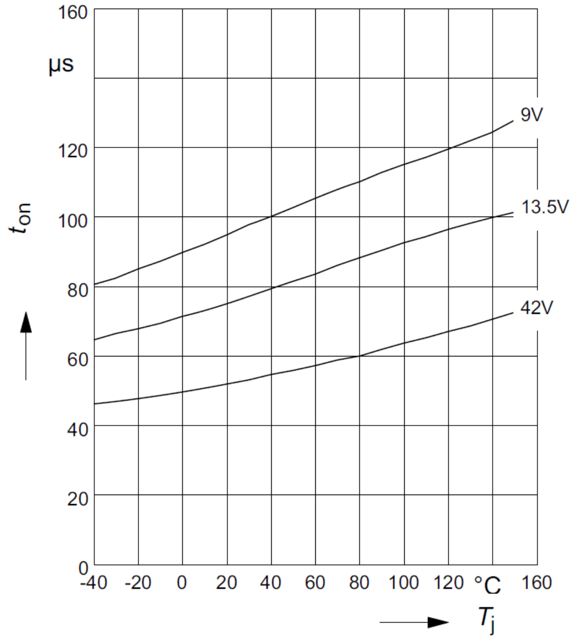
I_L = 1 A; V_{IN} = high



Functional description and electrical characteristics

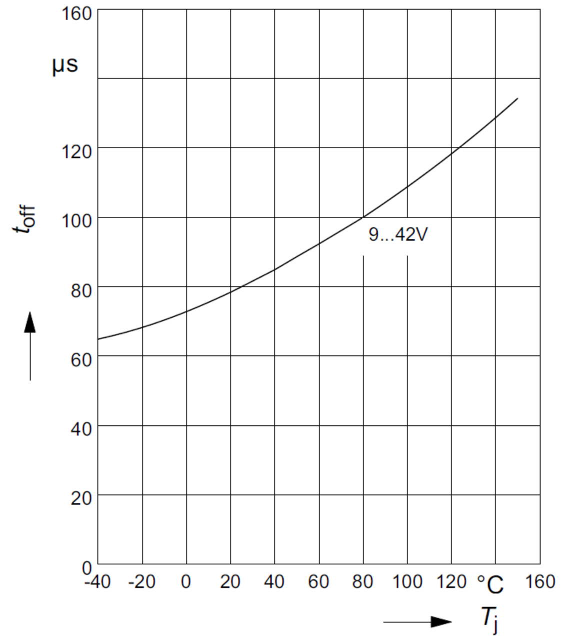
Typ. turn-on time t_{on} = f(T_j)

R_L = 47 Ω



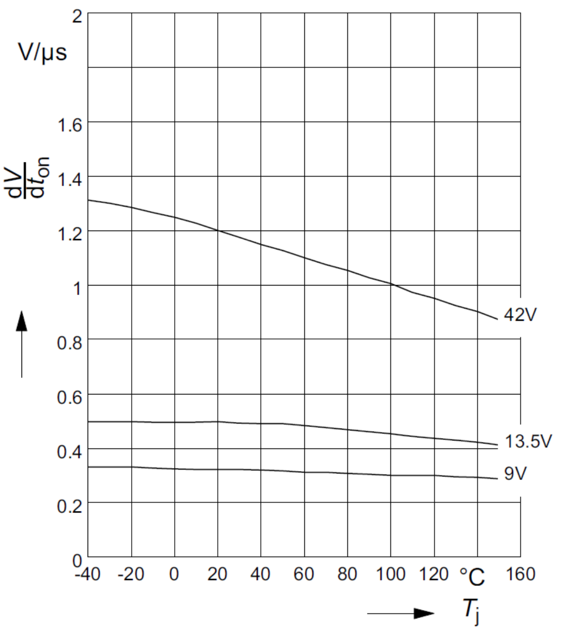
Typ. turn-off time t_{off} = f(T_j)

R_L = 47 Ω



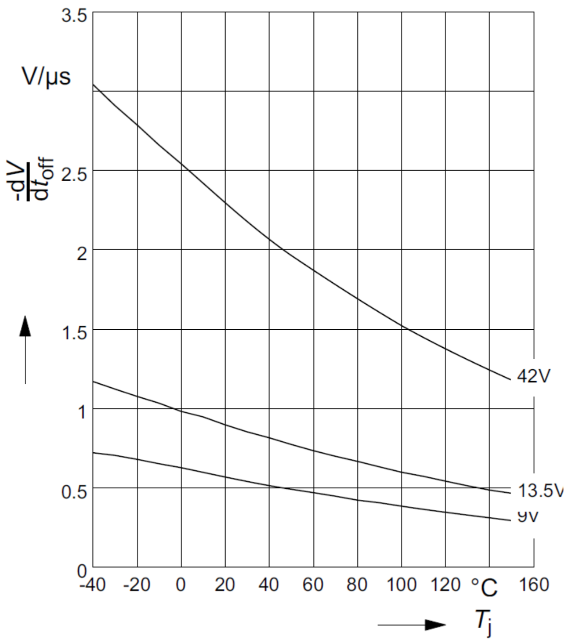
Typ. slew rate on dV/dt_{on} = f(T_j)

R_L = 47 Ω



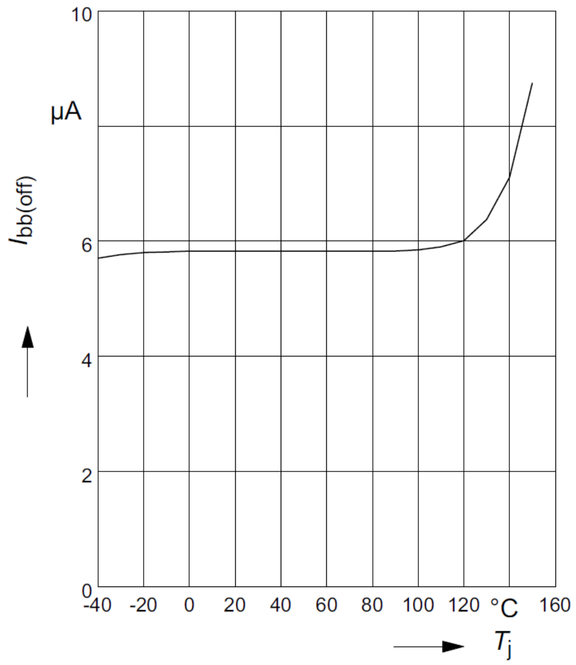
Typ. slew rate off dV/dt_{off} = f(T_j)

R_L = 47 Ω



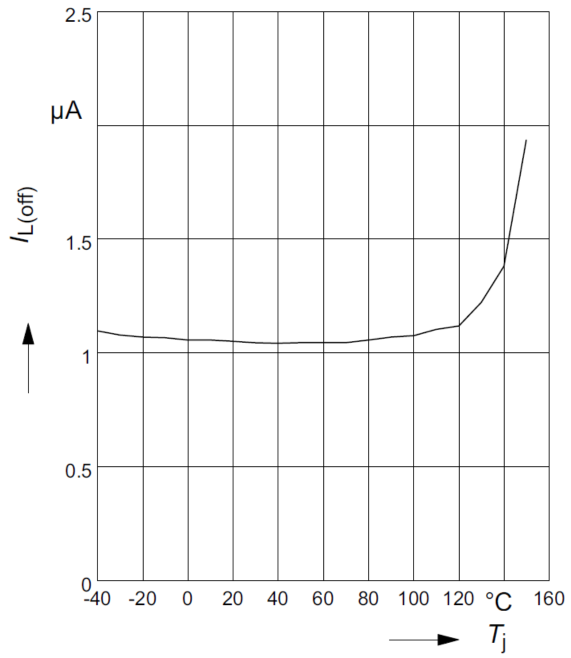
Typ. standby current $I_{bb(off)}$ = f(T_j)

V_{bb} = 42 V; V_{IN} = low

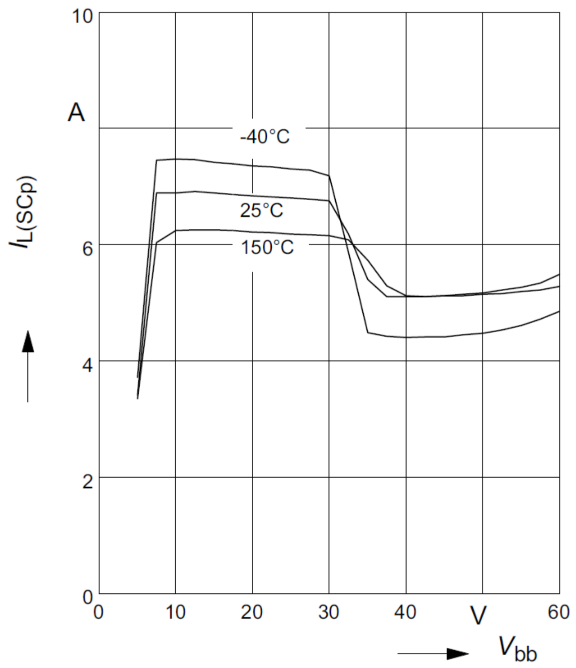


Typ. leakage current $I_{L(off)}$ = f(T_j)

V_{bb} = 42 V; V_{IN} = low

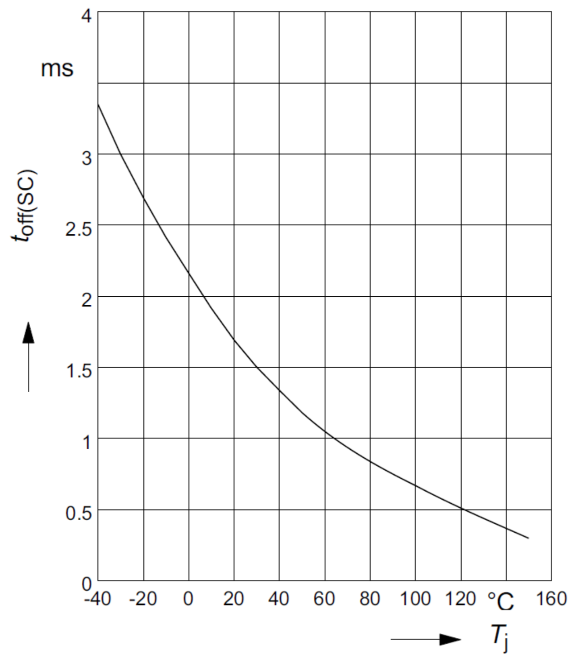


Typ. initial peak short circuit current limit $I_{L(SCp)}$ = f(V_{bb})

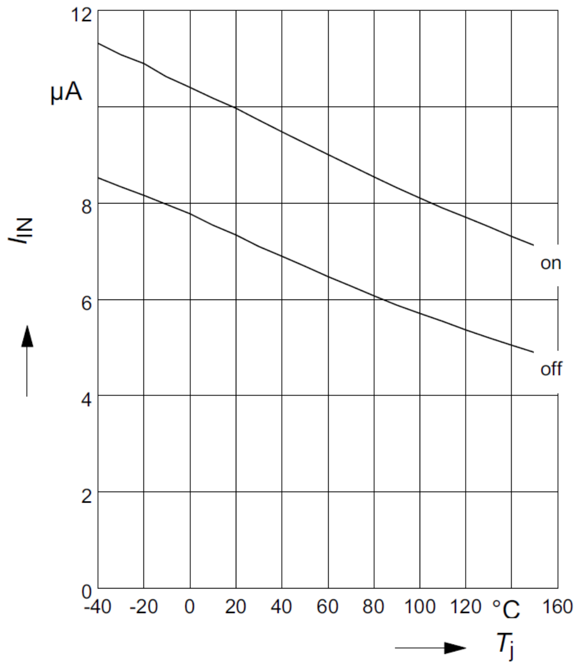


Typ. initial short circuit shutdown time $t_{off(SC)}$ = f($T_{j,start}$)

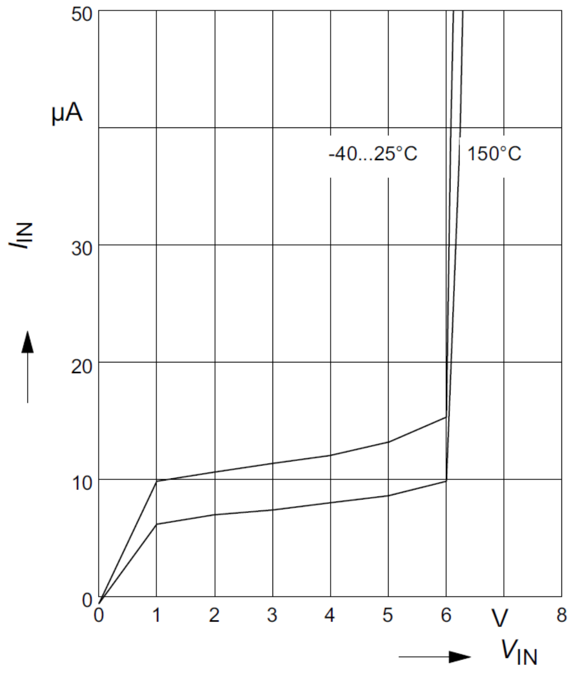
V_{bb} = 20 V



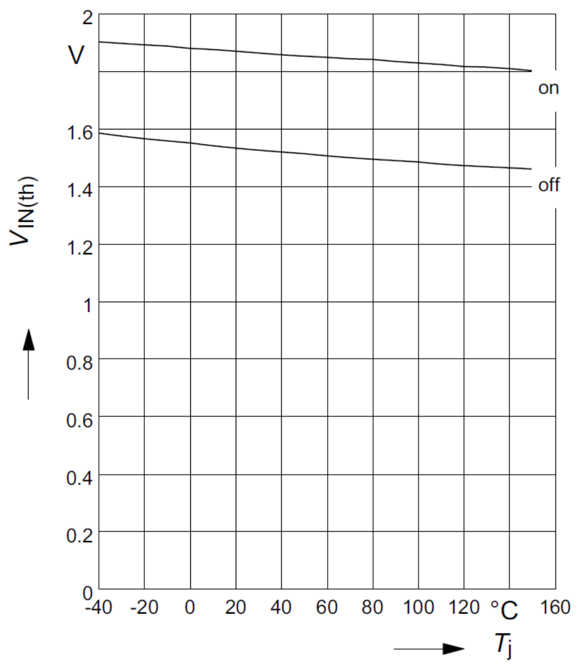
Typ. input current $I_{IN(on/off)}$ = f(T_j)
V_{bb} = 13.5 V; V_{IN} = low/high; V_{INlow} ≤ 0.7 V; V_{INhigh} = 5 V



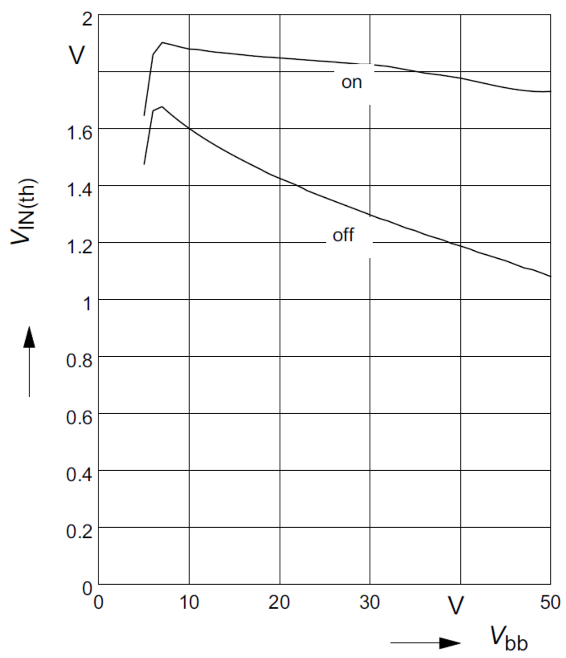
Typ. input current I_{IN} = f(V_{IN})
V_{bb} = 13.5 V



Typ. input threshold voltage $V_{IN(th)}$ = f(T_j)
V_{bb} = 13.5 V

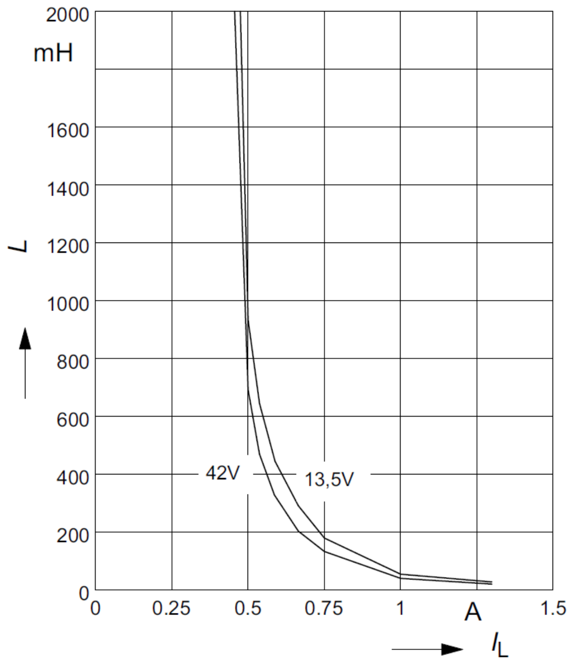


Typ. input threshold voltage $V_{IN(th)}$ = f(V_{bb})
T_j = 25°C



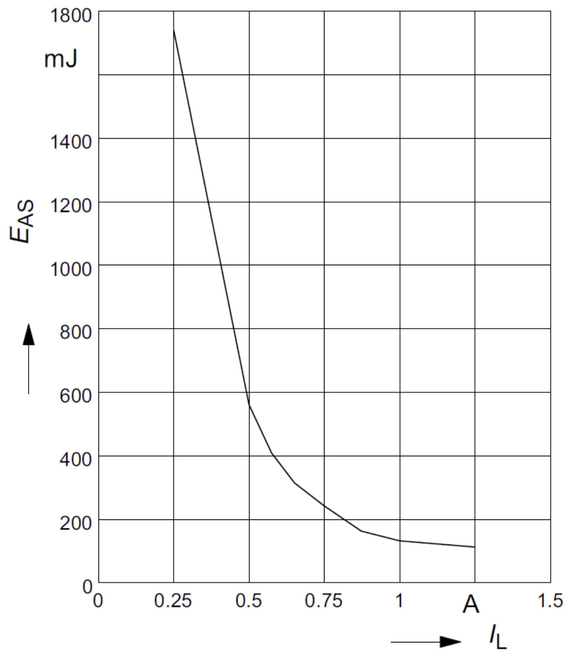
Maximum allowable load inductance for a single switch off $L = f(I_L)$

$T_{jstart} = 150°C$, $R_L = 0\ \Omega$



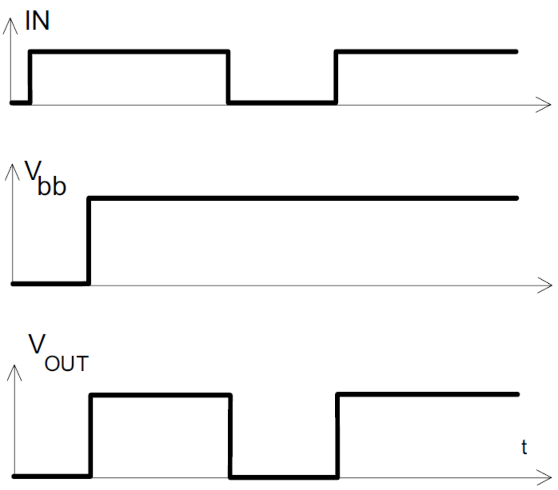
Maximum allowable inductive switch off energy, single pulse $E_{AS} = f(I_L)$

$T_{jstart} = 150°C$, $V_{bb} = 13.5\ V$

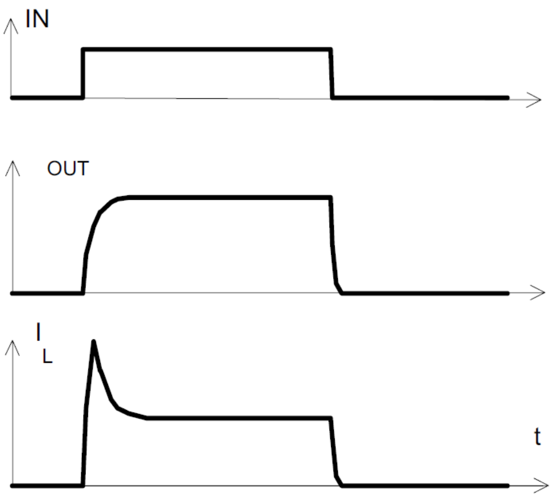


4.4 Timing diagrams

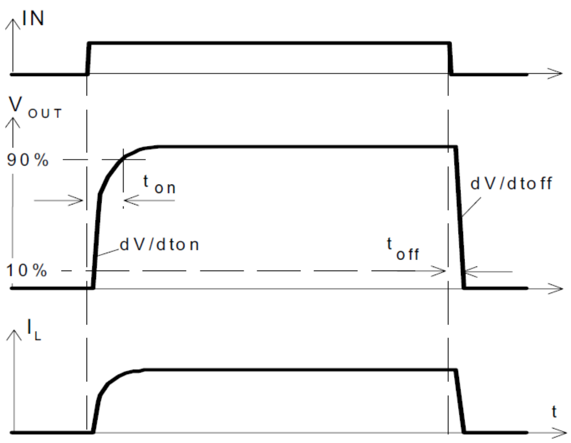
V_{bb} turn on



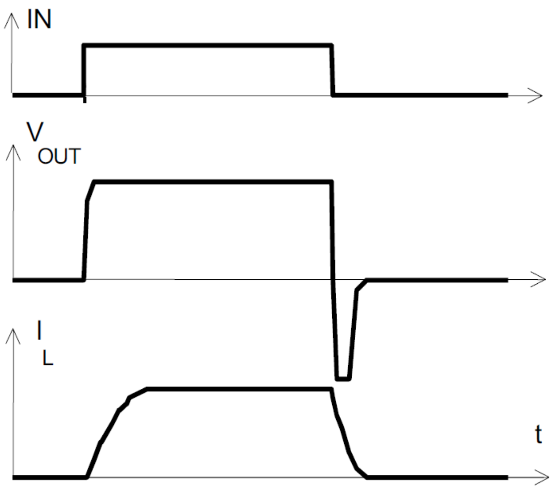
Switching a lamp



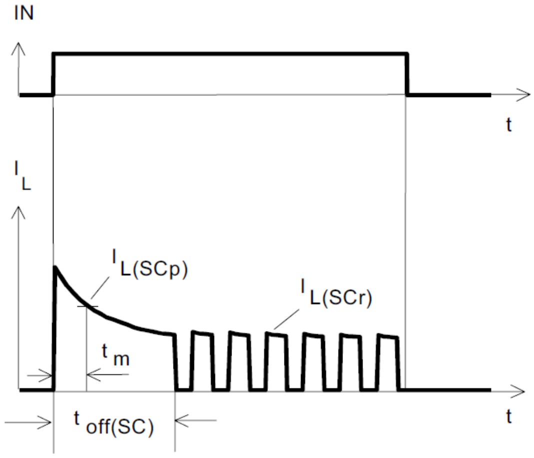
Switching a resistive load, turn-on/off time and slew rate definition



Switching an inductive load

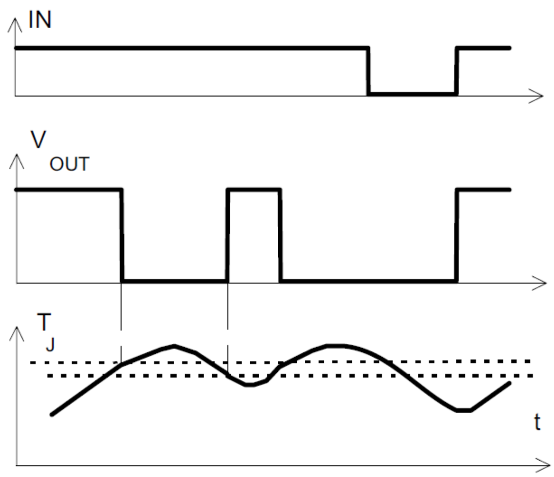


Turn on into short circuit, shut down by overtemperature, restart by cooling

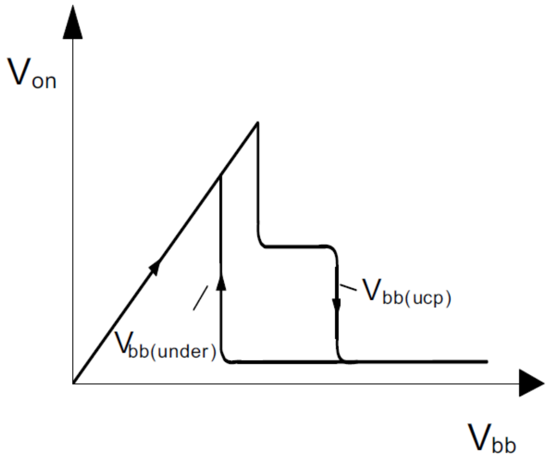


Heating up of the chip may require several milliseconds, depending on external conditions.

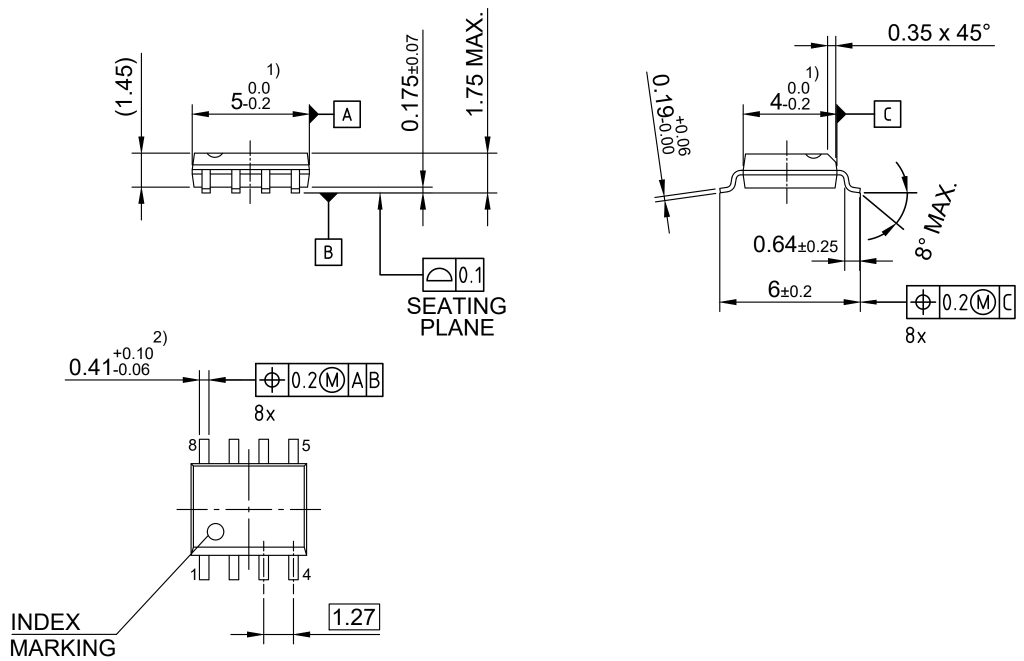
Overtemperature: Reset if $T_j < T_{jt}$



Undervoltage restart of charge pump



5 Package information



1) Does not include plastic or metal protrusion of 0.15 max. per side
2) Lead width can be 0.61 max. in dambar area
All dimensions are in units mm
The drawing is in compliance with ISO 128-30, Projection Method 1 [ ]

Figure 3 PG-DSO-8

Green Product (RoHS compliant)

To meet the world-wide customer requirements for environmentally friendly products and to be compliant with government regulations the device is available as a green product. Green products are RoHS-Compliant (Pb-free finish on leads and suitable for Pb-free soldering according to IPC/JEDEC J-STD-020).

Information on alternative packages

Please visit ***www.infineon.com/packages***.

Revision history

Revision	Date	Changes
1.2	2019-07-25	All pages: • ESD ratings for HBM updated according to ANSI/ESDA/JEDEC JS-001 • Editorial changes
1.1	2008-09-26	All pages: • added new Infineon logo • Initial version of RoHS-compliant derivate of the ISP752T Page 1 and 17: • Added RoHS compliance statement and Green product feature • Package changed to RoHS compliant version Page 18: added Revision history Page 19: update of disclaimer

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