ISP742RI

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
- Open drain diagnostic output
- 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 and 24 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

Table 1 Product summary

Parameter	Symbol	Value	Unit
Overvoltage protection	$V_{bb(AZ)}$	41	V
Operating voltage	$V_{bb(on)}$	5 to 34	V
On-state resistance	R_{ON}	350	mΩ
Nominal load current	$I_{L(nom)}$	0.4	A
Operating temperature	T_a	-30 to +85	°C

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

Description

Type	Package	Marking
ISP742RI	PG-DSO-8	I742RI

Table of contents

1 Block diagram

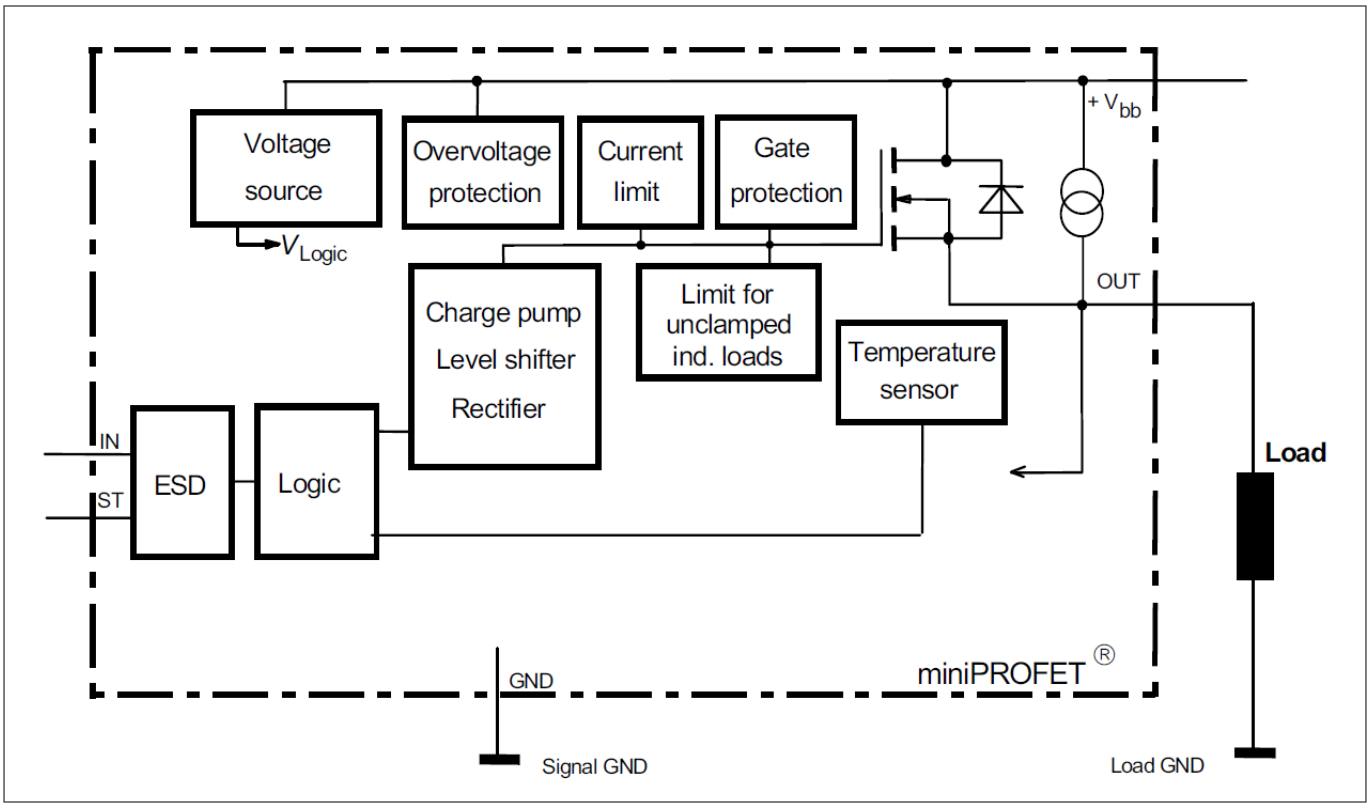


Figure 1 Block diagram

2 Pin configuration

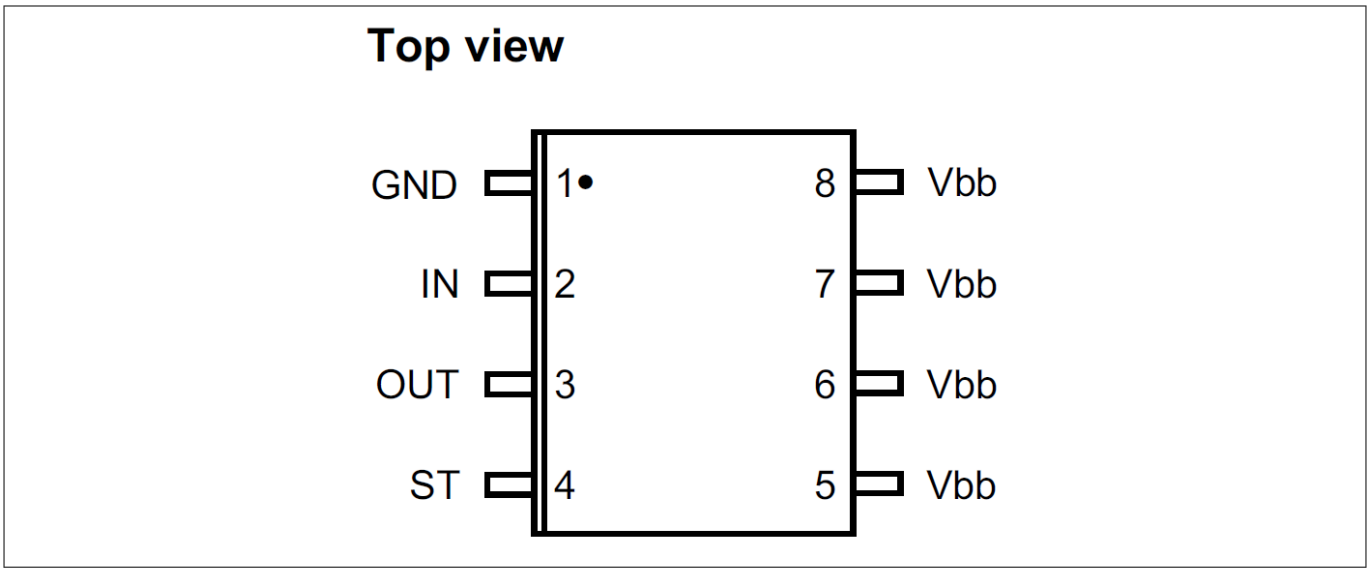


Figure 2 Pin configuration

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	ST	Diagnostic feedback
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 2 Absolute maximum ratings

T_j = 25°C, unless otherwise specified

Parameter	Symbol	Value	Unit	Note or condition
Supply voltage	V_{bb}	40	V	–
Supply voltage for full short circuit protection	$V_{bb(SC)}$	V_{bb}	V	–
Continuous input voltage	V_{IN}	-10 to +16	V	–
Load current	I_L	self limited	A	short-circuit current, see p. ***12***
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 single pulse	E_{AS}	800	mJ	***1) 2)*** (see page ***11***) T_j = 150°C, V_{bb} = 13.5 V, I_L = 0.3 A
Load dump protection	$V_{Loaddump}$	60	V	***2) 3)*** $V_{LoadDump} = V_A + V_S$ R_I = 2 Ω, t_d = 400 ms, V_{IN} = low or high, V_A = 13.5 V, R_L = 45 Ω
Electrostatic Discharge Voltage (Human Body Model) OUT IN	V_{ESD}	 ±6 ±1	kV	according to ANSI/ESDA/JEDEC JS001 (1.5 kΩ, 100 pF)

1 Device on 50 mm × 50 mm × 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air.

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.

Table 2 Absolute maximum ratings (continued)

T_j = 25°C, unless otherwise specified

Parameter	Symbol	Value	Unit	Note or condition
all other pins		±3		

3.2 Thermal resistance

Table 3 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.

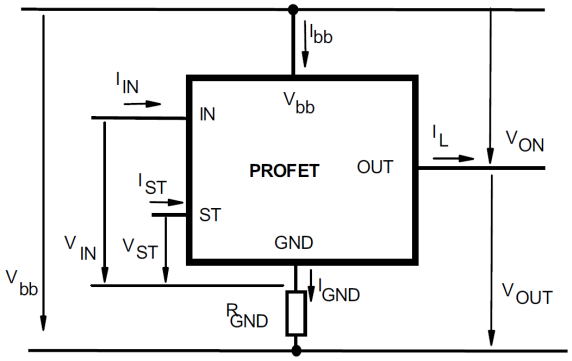
4 Functional description and electrical characteristics

4.1 Functional description

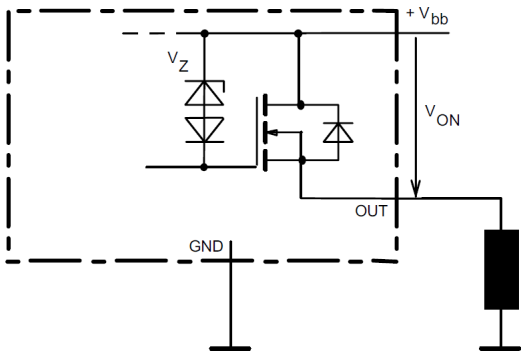
	Input level	Output level	Status
Normal operation	L	L	L
	H	H	L
Short circuit to GND	L	L	L
	H	L [5)]	H
Short circuit to V_{bb} (in off-state)	L	H	H
	H	H	L
Overload	L	L	L
	H	H [6)]	L
Overtemperature	L	L	L
	H	L	H
Open load in off-state	L	H	H
	H	H	L

5 Out = "L": V_{OUT} < 2 V typ.
6 Out = "H": V_{OUT} > 2 V typ.

Terms

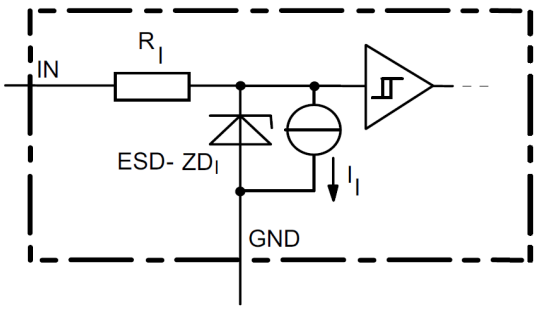


Inductive and overvoltage output clamp



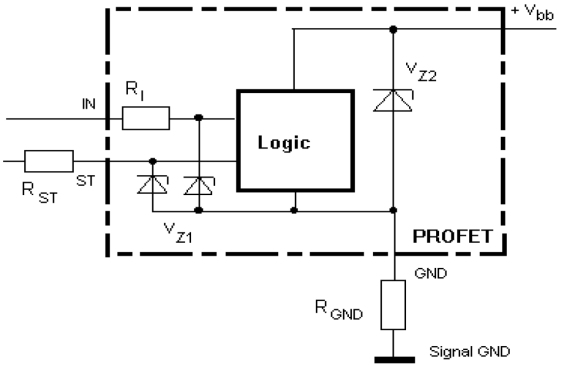
V_{ON} clamped to 47 V typ.

Input circuit (ESD protection)



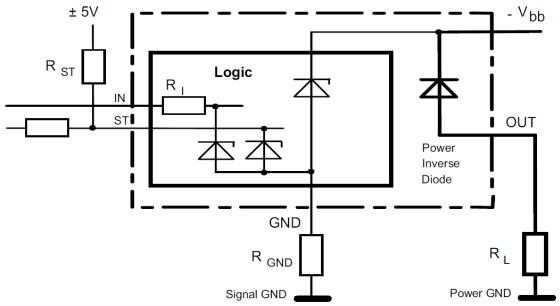
The use of ESD zener diodes as voltage clamp at DC conditions is not recommended

Overvoltage protection of logic part



V_{Z1} = 6.1 V typ., V_{Z2} = $V_{bb(AZ)}$ = 47 V typ., R_I = 3.5 kΩ typ., R_{GND} = 150 Ω

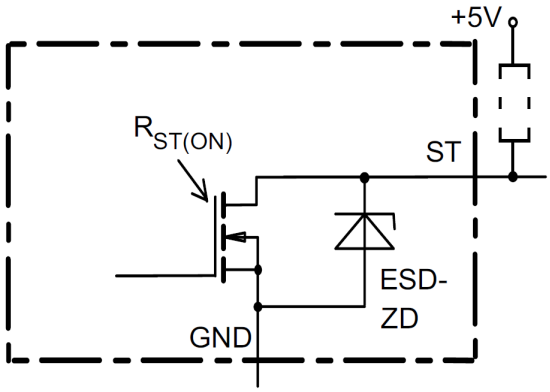
Reverse battery protection



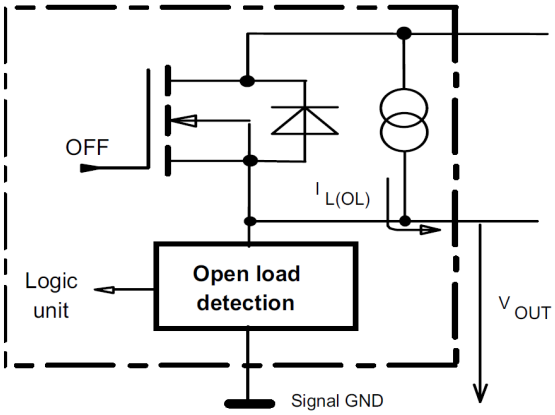
R_{GND} = 150 Ω, R_I = 3.5 kΩ typ.

Temperature protection is not active during inverse current

Status output



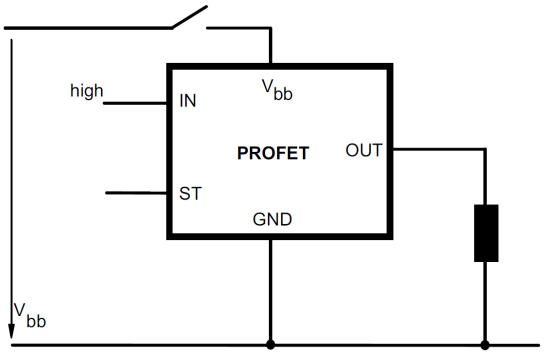
Open-load detection



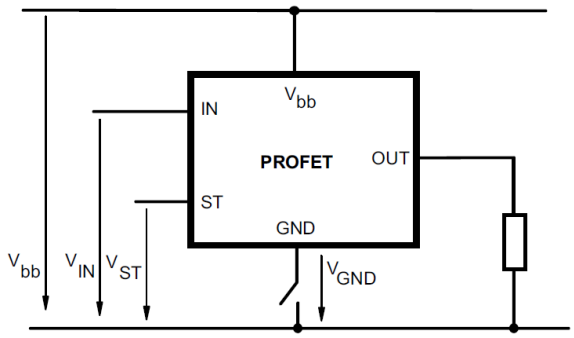
OFF-state diagnostic condition:

V_{OUT} > 3 V typ., IN = low

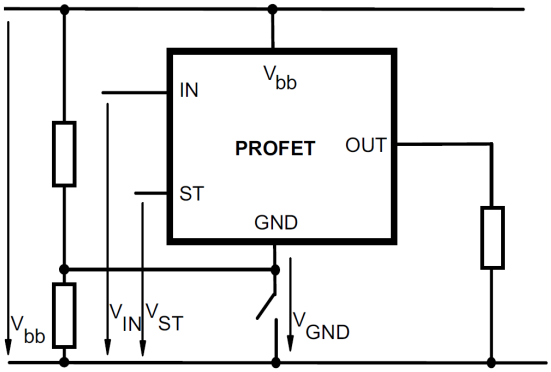
V_{bb} disconnect with charged inductive load



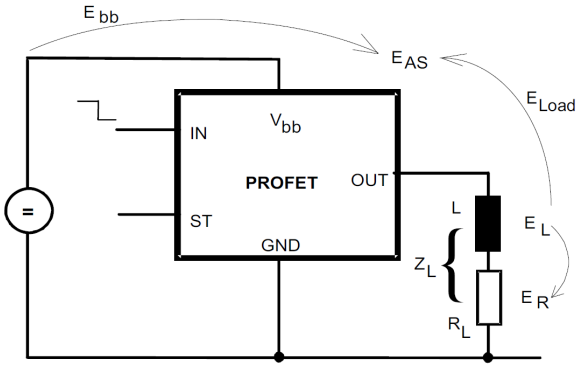
GND disconnect



GND disconnect with GND pull-up



Inductive load switch-off energy dissipation



Energy stored in load inductance:

$E_L = ½ \times L \times I_L^2$

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 $R_L > 0\ \Omega$

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

4.2 Electrical characteristics

Table 4 Electrical characteristics

T_j = -40°C to +150°C, V_{bb} = 13.5 V, unless otherwise specified

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Load switching capabilities and characteristics						
On-state resistance T_j = 25°C, I_L = 0.3 A, V_{bb} = 9 V to 40 V T_j = 150°C	R_{ON}	–	 250 450	 350 700	mΩ	–
Nominal load current; Device on PCB	$I_{L(nom)}$	0.4	–	–	A	7) 8) T_C = 85°C, T_j ≤ 150°C
Turn-on time to 90% V_{OUT}	t_{on}	–	–	140	µs	R_L = 47 Ω, V_{IN} = 0 V to 10 V
Turn-off time to 10% V_{OUT}	t_{off}	–	–	170	µs	R_L = 47 Ω, V_{IN} = 10 V to 0 V
Slew rate on 10% to 30% V_{OUT}	dV/dt_{on}	–	–	2	V/µs	R_L = 47 Ω
Slew rate off 70% to 40% V_{OUT}	$-dV/dt_{off}$	–	–	2	V/µs	R_L = 47 Ω
Operating parameters						
Operating voltage	$V_{bb(on)}$	5	–	34	V	–
Undervoltage shutdown of charge pump	$V_{bb(under)}$	–	–	5	V	–
Undervoltage restart of charge pump	$V_{bb(u\ cp)}$	–	–	5.5	V	–
Standby current	$I_{bb(off)}$	–	–	26	µA	V_{IN} = 0 V
Leakage output current	$I_{L(off)}$	–	–	12	µA	included in $I_{bb(off)}$
Operating current	I_{GND}	–	–	1.3	mA	V_{IN} = high
Protection functions 9)						
Initial peak short circuit current limit (pin 5 to 3) T_j = -40°C, V_{bb} = 20 V T_j = 25°C T_j = 150°C	$I_{L(SCp)}$	 – – 0.4	 – 1.2 –	 2 – –	A	–
Repetitive short circuit current limit	$I_{L(SCr)}$	–	1	–	A	$T_j = T_{jt}$ (see ***Timing diagrams***)

7 Device on 50 mm × 50 mm × 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 µm thick) copper area for drain connection. PCB is vertical without blown air.

8 Nominal load current is limited by current limitation (see page ***12***)

9 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 4 Electrical characteristics (continued)

T_j = -40°C to +150°C, V_{bb} = 13.5 V, unless otherwise specified

Parameter	Symbol	Values			Unit	Note or condition
		Min.	Typ.	Max.		
Output clamp (inductive load switch off)	$V_{ON(CL)}$	41	47	–	V	$V_{OUT} = V_{bb} - V_{ON(CL)}$, I_{bb} = 4 mA
Overvoltage protection	$V_{bb(AZ)}$	41	–	–	V	10) I_{bb} = 4 mA
Thermal overload trip temperature	T_{jt}	150	–	–	°C	–
Thermal hysteresis	ΔT_{jt}	–	10	–	K	–
Reverse battery						
Reverse battery	$-V_{bb}$	–	–	32	V	11)
Drain-source diode voltage	$-V_{ON}$	–	600	–	mV	$V_{OUT} > V_{bb}$ T_j = 150°C
Input and status feedback						
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	$\Delta V_{IN(T)}$	–	0.3	–	V	–
Off state input current	$I_{IN(off)}$	1	–	30	µA	V_{IN} = 0.7 V
On state input current	$I_{IN(on)}$	1	–	30	µA	V_{IN} = 5 V
Status output (open drain), Zener limit voltage	$V_{ST(high)}$	5.4	6.1	–	V	I_{ST} = 1.6. mA
Status output (open drain), ST low voltage	$V_{ST)low)}$				V	I_{ST} = 1.6. mA
T_j = -40°C to +25°C		–	–	0.4		
T_j = 150°C		–	–	0.6		
Status invalid after input slope	$t_{d(ST)}$	–	300	600	µs	12)
Input resistance	R_I	1.5	3.5	5	kΩ	see page 9
Diagnostic characteristics						
Short circuit detection voltage	$V_{OUT(SC)}$	–	2.8	–	V	–
Open load detection voltage	$V_{OUT(OL)}$	–	3	–	V	–
Open load detection current included in standby current $I_{bb(off)}$	$I_{L(OL)}$	–	5	–	µA	–

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

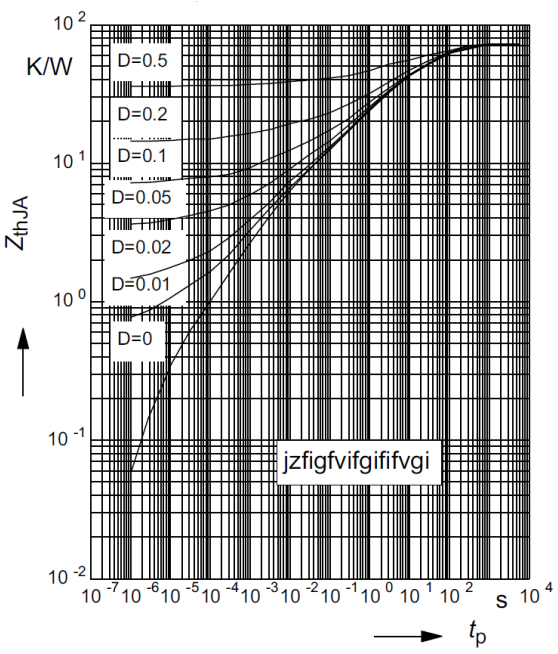
11 Requires a 150 Ω resistor in GND connection. The reverse load current through the intrinsic drain-source diode has to be limited by the connected load. Power dissipation is higher compared to normal operating conditions due to the voltage drop across the drain-source diode. The temperature protection is not active during reverse current operation! Input current has to be limited (see ***Absolute maximum ratings*** on page 6).

12 No delay time after overtemperature switch off and short circuit in on-state

4.3 Typical performance characteristics

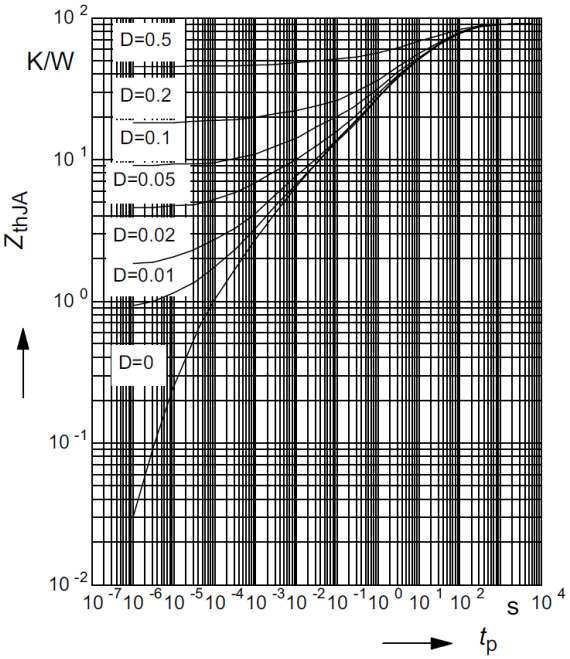
Typ. transient thermal impedance $Z_{thJA} = f(t_p)$ @ 6 cm² heatsink area

Parameter: $D = t_p/T$



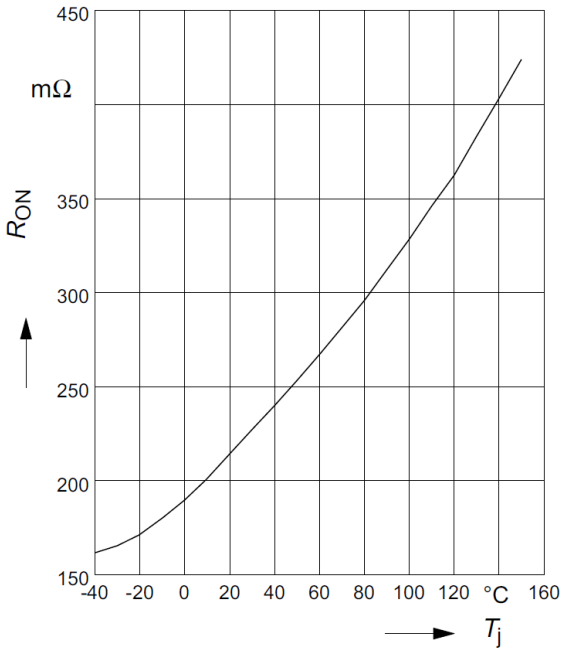
Typ. transient thermal impedance $Z_{thJA} = f(t_p)$ @ minimum footprint

Parameter: $D = t_p/T$



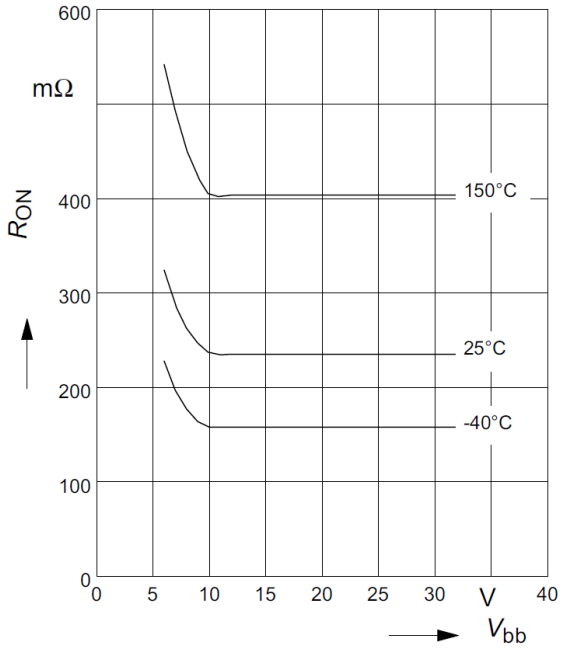
Typ. on-state resistance $R_{ON} = f(T_j)$

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



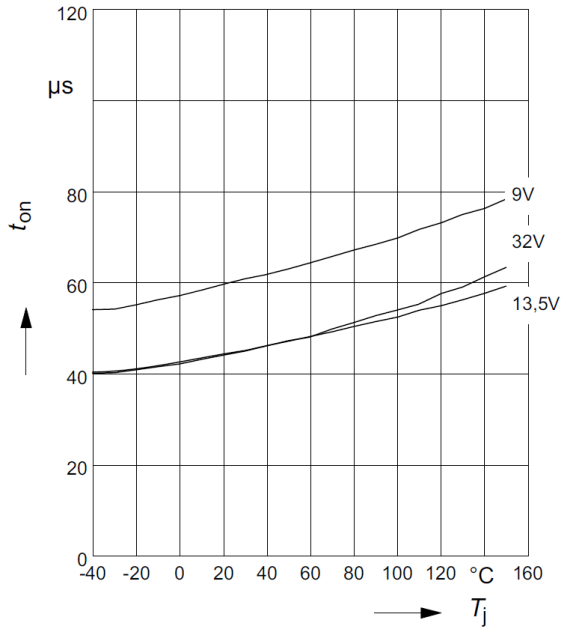
Typ. on-state resistance $R_{ON} = f(V_{bb})$

I_L = 0.3 A; V_{IN} = high



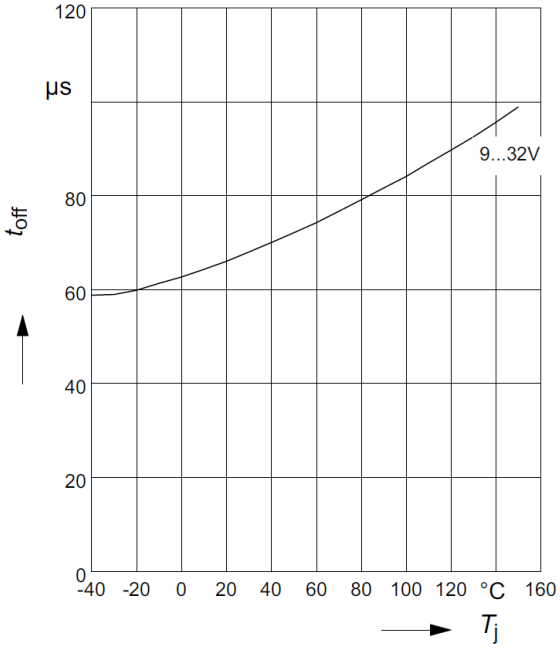
Typ. turn on time $t_{on} = f(T_j)$

$R_L = 47\ \Omega$



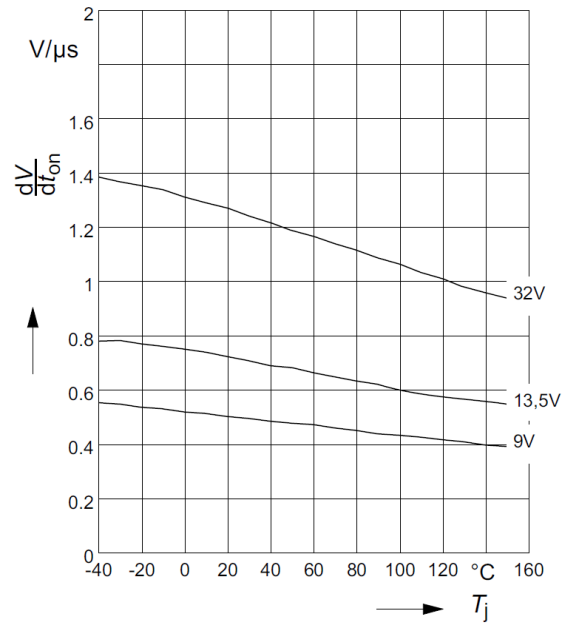
Typ. turn off time $t_{off} = f(T_j)$

$R_L = 47\ \Omega$



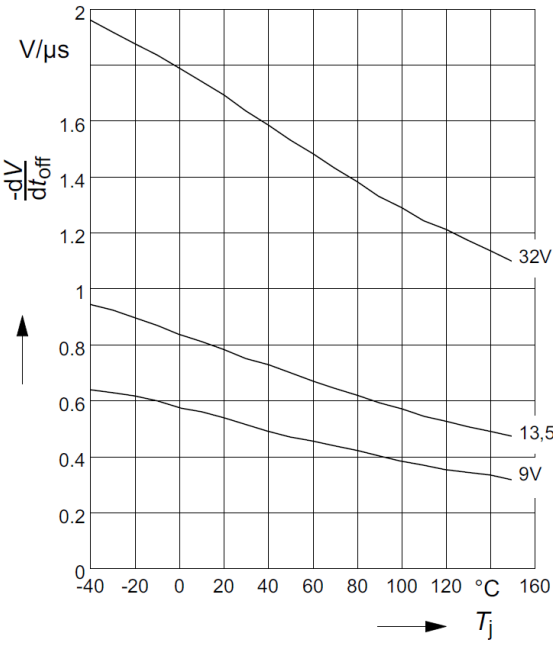
Typ. slew rate on $dV/dt_{on} = f(T_j)$

$R_L = 47\ \Omega$



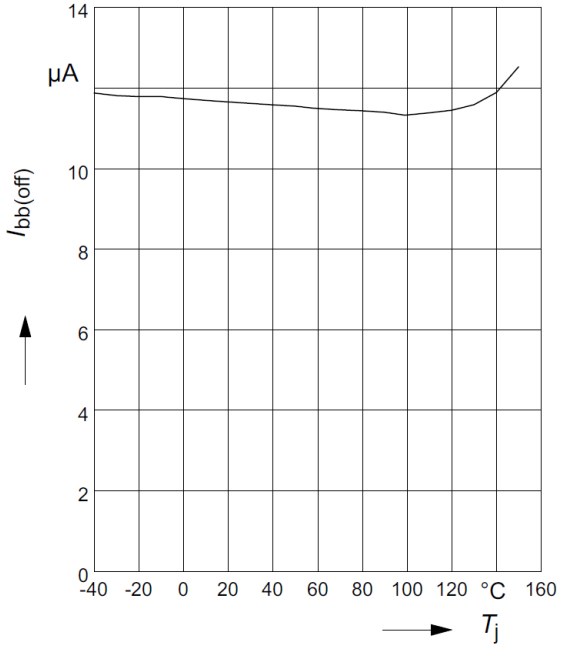
Typ. slew rate off $dV/dt_{off} = f(T_j)$

$R_L = 47\ \Omega$



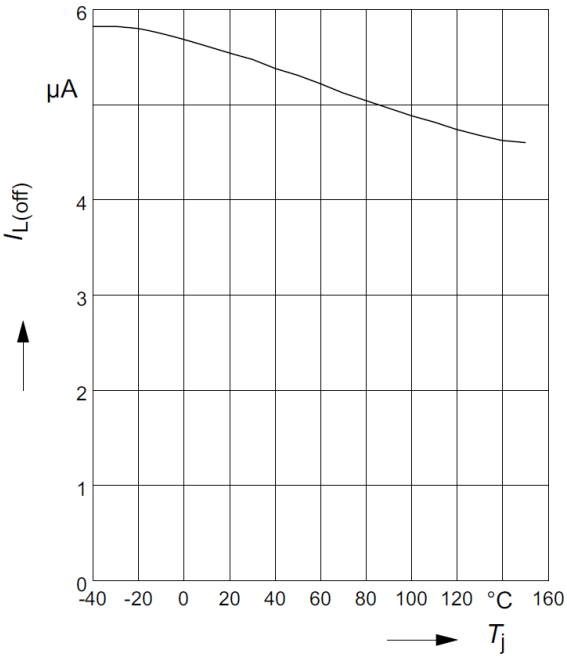
Typ. standby current $I_{bb(off)} = f(T_j)$

V_{bb} = 32 V; V_{IN} = low



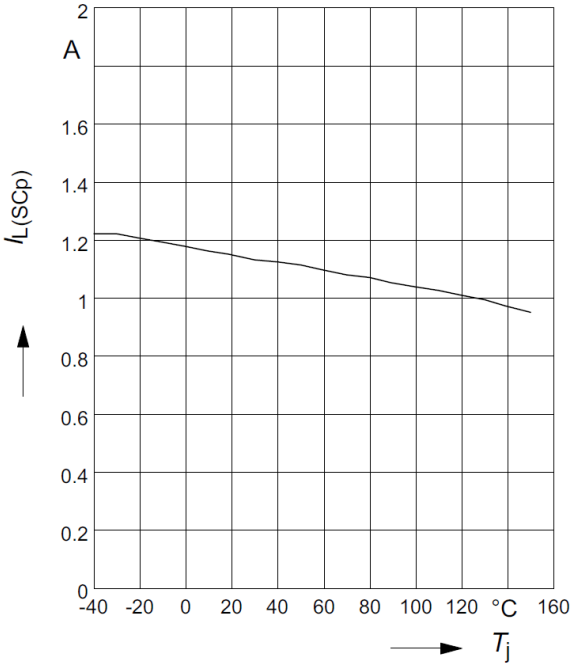
Typ. leakage current $I_{L(off)} = f(T_j)$

V_{bb} = 32 V; V_{IN} = low



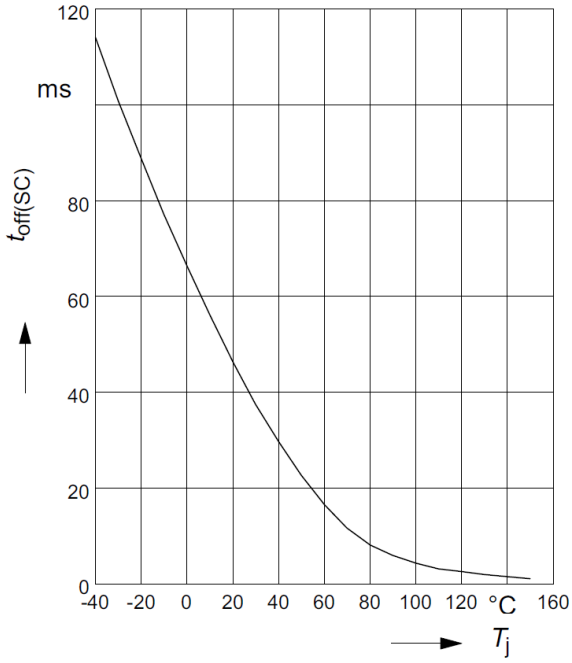
Typ. initial peak short circuit current limit $I_{L(SCp)} = f(T_j)$

V_{bb} = 20 V



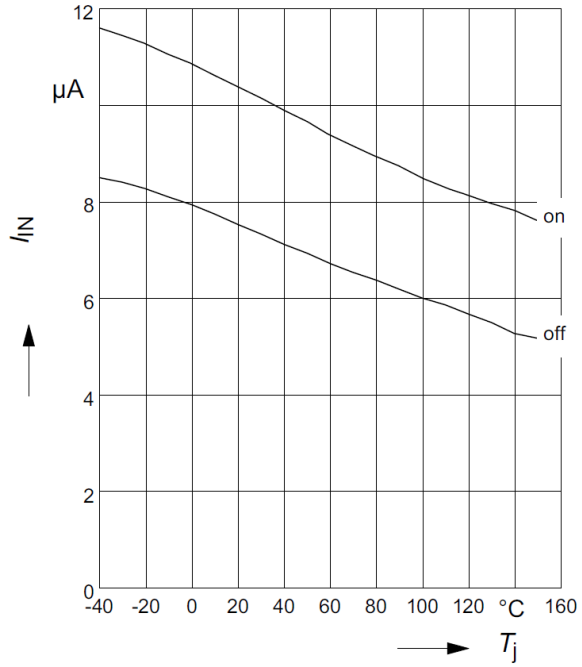
Typ. initial short circuit shutdown time $t_{off(SC)} = f(T_{j,start})$

V_{bb} = 20 V



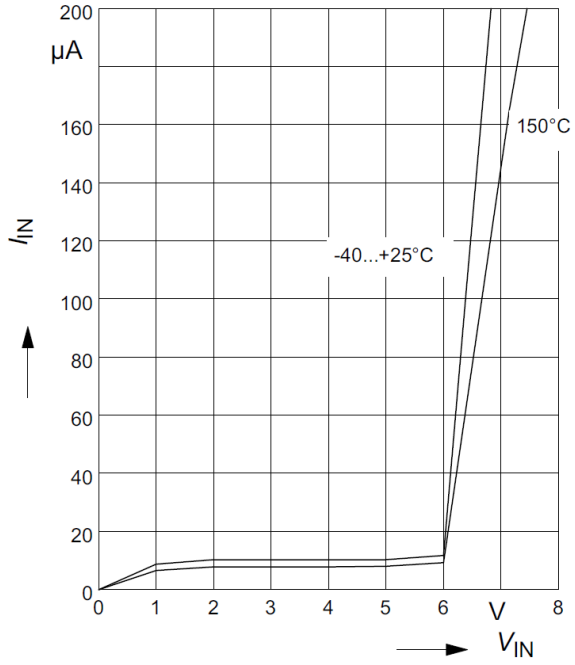
Typ. input current $I_{IN(on/off)} = f(T_j)$

V_{bb} = 13.5 V; V_{IN} = low/high; $V_{INlow} \leq 0.7$ V; V_{INhigh} = 5 V



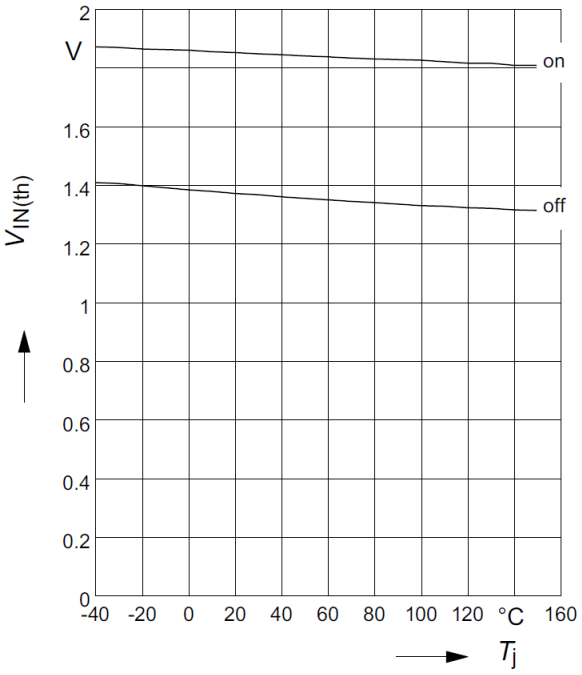
Typ. input current $I_{IN} = f(V_{IN})$

V_{bb} = 13.5 V



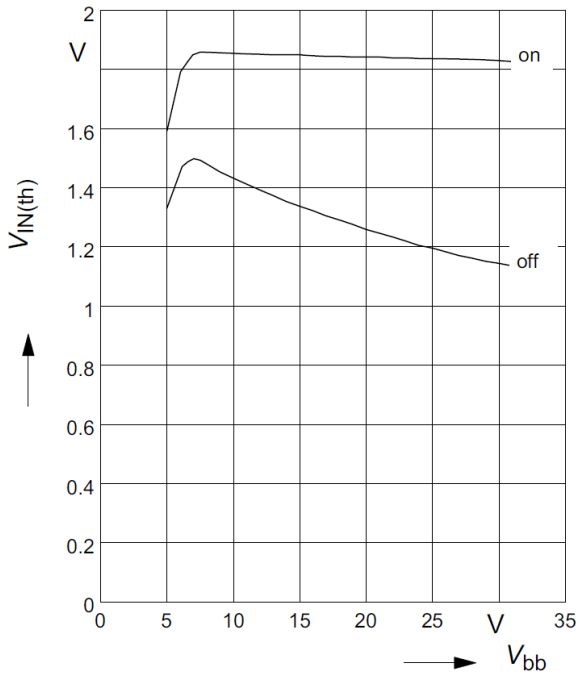
Typ. Input threshold voltage $V_{IN(th)} = f(T_j)$

V_{bb} = 13.5 V



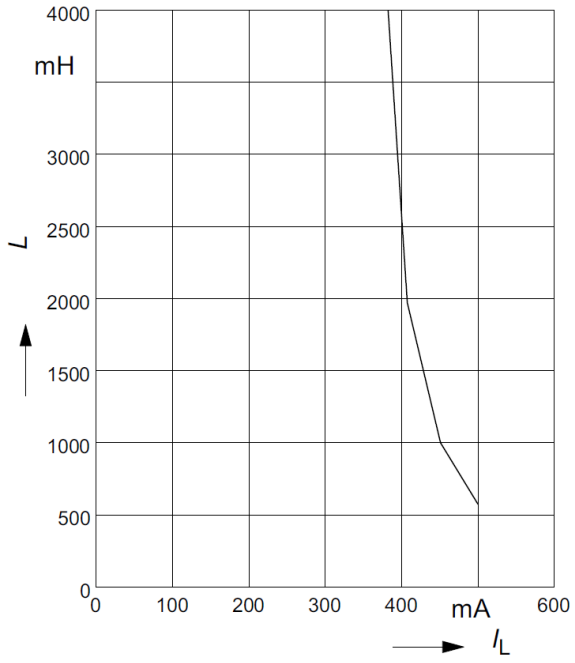
Typ. Input threshold voltage $V_{IN(th)} = f(V_{bb})$

T_j = 25°C



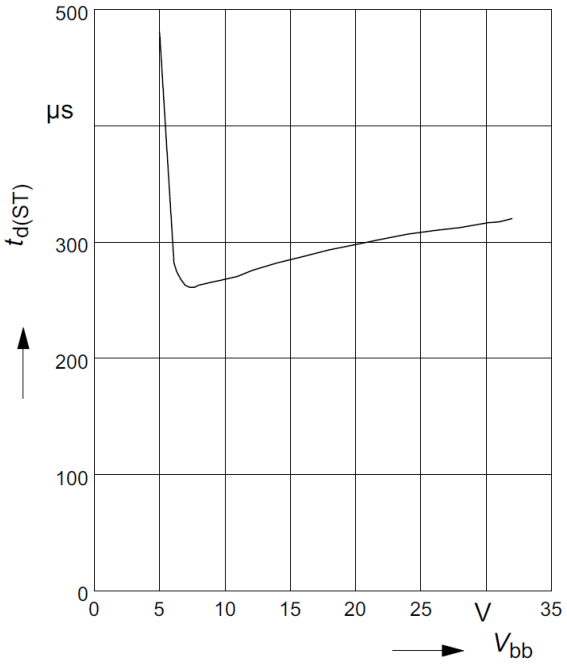
Maximum allowable load inductance for a single switch off $L = f(I_L)$

T_{jstart} = 150°C, V_{bb} = 13.5 V, R_L = 0 Ω



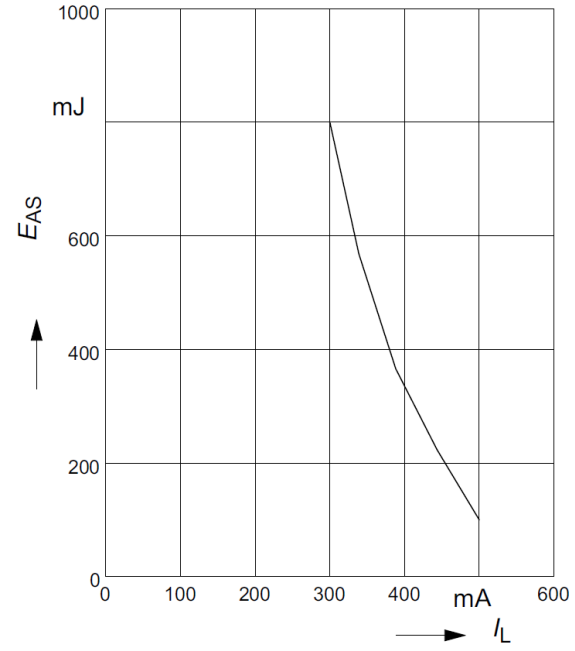
Typ. status delay time $t_{d(ST)} = f(V_{bb})$

T_j = 25°C



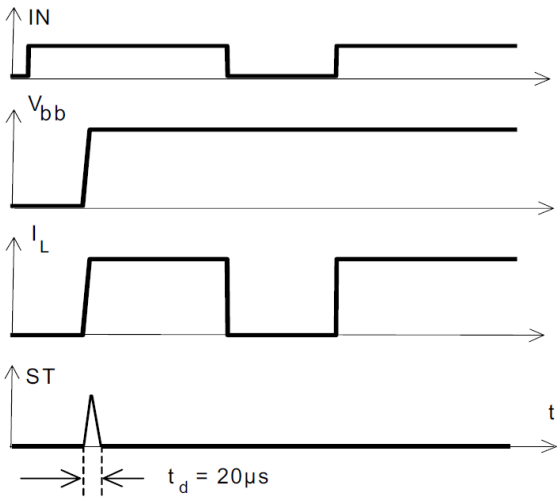
Maximum allowable inductive switch-off energy, single pulse $E_{AS} = f(I_L)$

T_{jstart} = 150°C, V_{bb} = 13.5 V



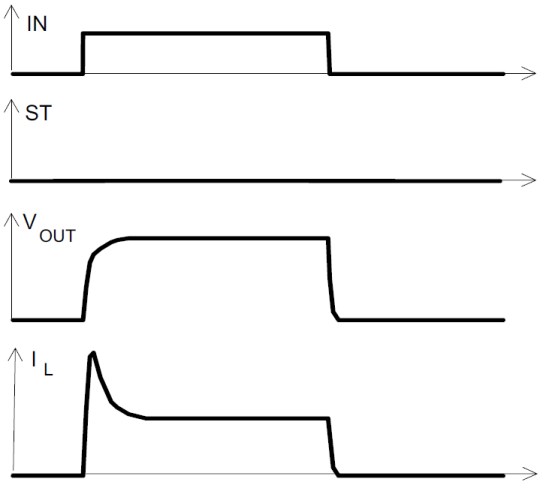
4.4 Timing diagrams

V_{bb} turn on

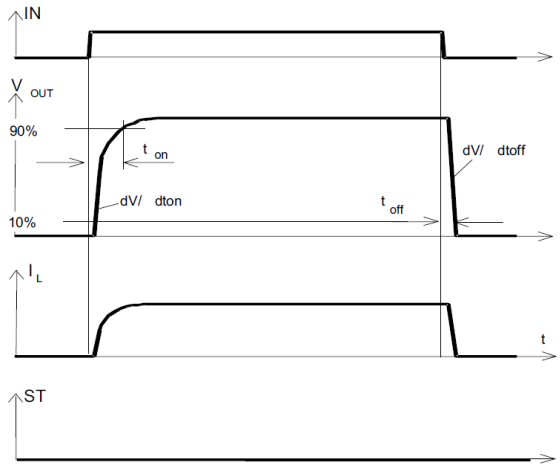


Invalid status during t_d

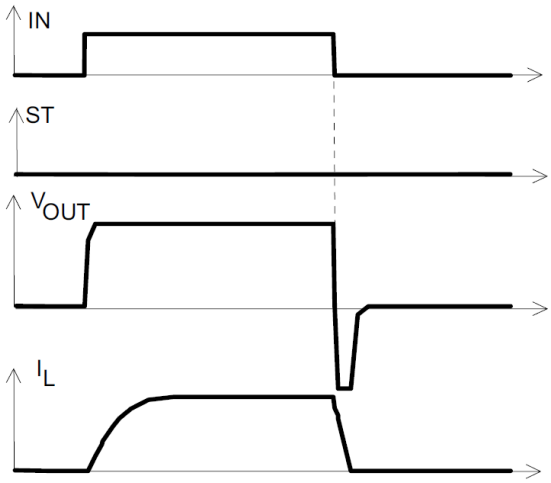
Switching a lamp



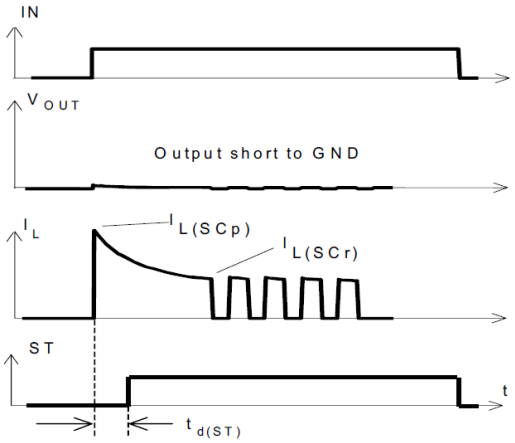
Switching a resistive load, turn-on/off time and slew rate definition



Switching an inductive load

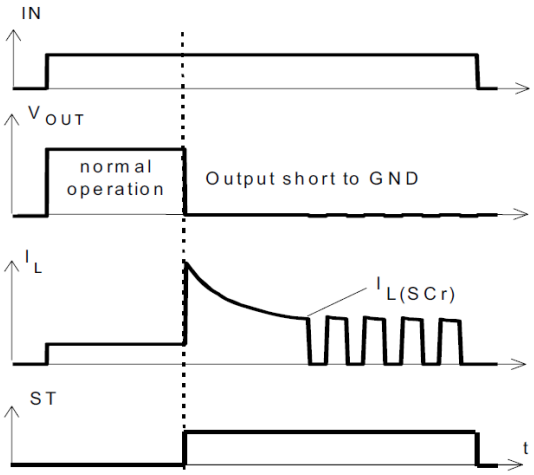


Turn on into short circuit, shut down by overtemperature, restart by cooling

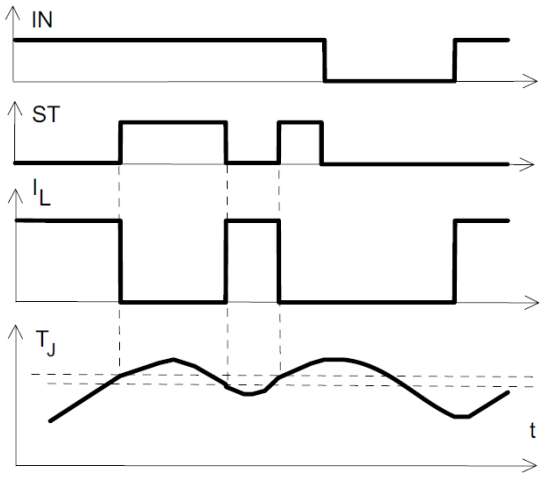


Heating up of the chip may require several milliseconds, depending on external conditions.

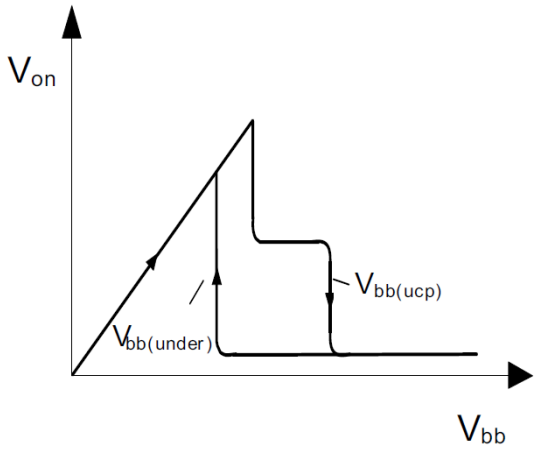
Short circuit in on-state shutdown by overtemperature, restart by cooling



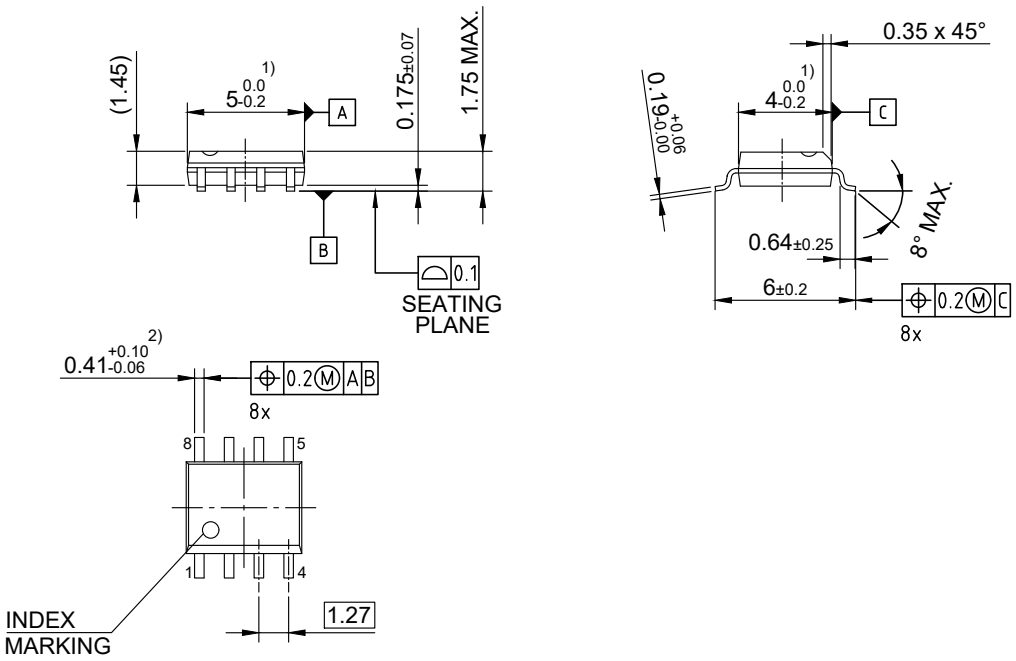
Overtemperature: Reset if $T_j < T_{jt}$



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

Document version	Date of release	Description of changes
1.2	2019-07-25	Datasheet updated: • ESD ratings for HBM updated according to ANSI/ESDA/JEDEC JS-001 • Editorial changes
1.1	2008-09-24	All pages: • Added new Infineon logo • Initial version of RoHS-compliant derivate of the ISP742RI 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

Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2019-07-25

Published by

Infineon Technologies AG

81726 Munich, Germany

Do you have a question about any aspect of this document?

Email: erratum@infineon.com

Document reference
IFX-Z8F64610011

IMPORTANT NOTICE

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics (“Beschaffenheitsgarantie”) .

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer’s compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer’s products and any use of the product of Infineon Technologies in customer’s applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer’s technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

Please note that this product is not qualified according to the AEC Q100 or AEC Q101 documents of the Automotive Electronics Council.

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies’ products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury