ISP752R

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 for overtemperature and short circuit
- Open load detection in OFF-state 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

Table 1   **Product summary**

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

Description

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

Type	Package	Marking
ISP752R	PG-DSO-8	I752R

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   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 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	E_{AS}	125	mJ	[1] [2] single pulse T_j = 150°C, I_L = 1 A (see page *11*)
Load dump protection R_L = 13.5 Ω R_L = 27 Ω	$V_{Loaddump}$	73.5 83.5	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
Electrostatic Discharge Voltage (Human Body Model) OUT IN all other pins	V_{ESD}	±6 ±1 ±4	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 cm^2 (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air (see page *22*)

[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 3 **Thermal resistance**

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

---

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 **22**)
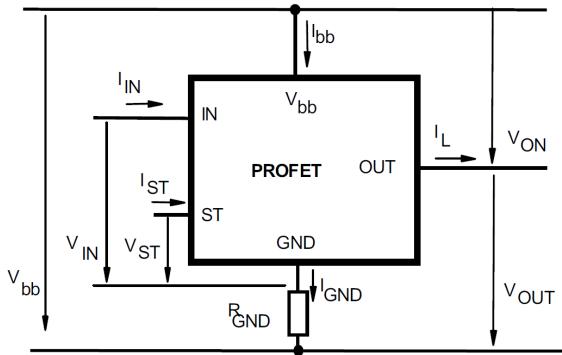
4 Functional description and electrical characteristics

4.1 Functional description

	Input level	Output level	Status
Normal operation	L	L	H
	H	H	H
Short circuit to GND	L	L	H
	H	L[5]	L
Short circuit to V_{bb} (in off-state)	L	H	L
	H	H	H
Overload	L	L	H
	H	H[6]	H
Overtemperature	L	L	H
	H	L	L
Open load in off-state	L	Z[7]	H (L[8])
	H	H	H

---
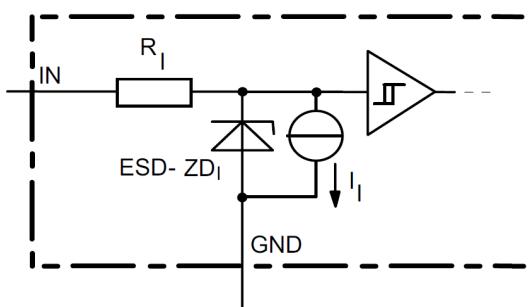
[5] Out = "L": $V_{OUT} < 2.8$ V typ.

[6] Out = "H": $V_{OUT} > 2.8$ V typ.

[7] Z = high impedance, potential depends on external circuit

[8] with external resistor between V_{bb} and OUT

Functional description and electrical characteristics

Terms

Inductive and overvoltage output clamp

V_{ON} clamped to 59 V min.
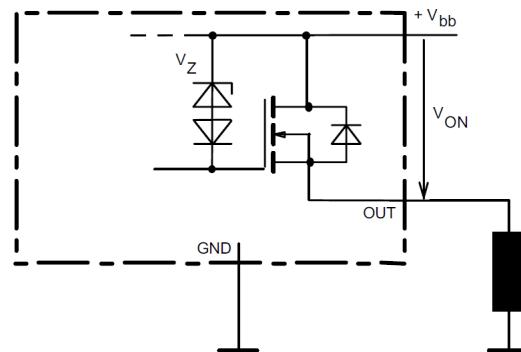
Input circuit (ESD protection)
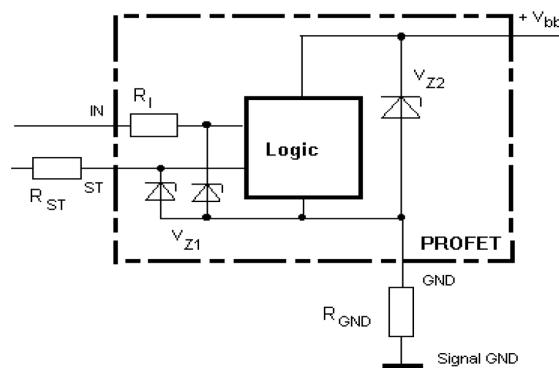
The use of ESD zener diodes as voltage clamp at DC conditions is not recommended

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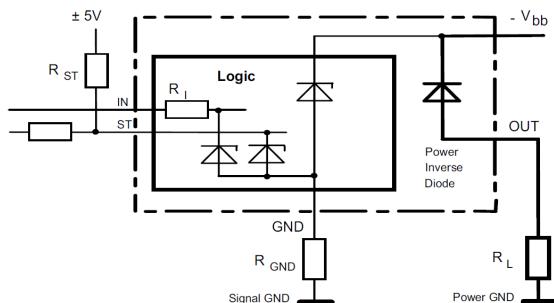
V_{Z1} = 6.1 V typ., V_{Z2} = $V_{bb(AZ)}$ = 62 V min., R_I = 3.5 kΩ typ., R_{GND} = 150 Ω

Functional description and electrical characteristics
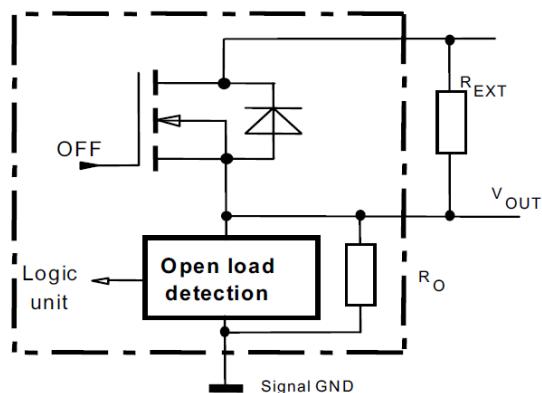
Reverse battery protection

R_{GND} = 150 Ω, R_I = 3.5 kΩ typ.,

Temperature protection is not active during inverse current
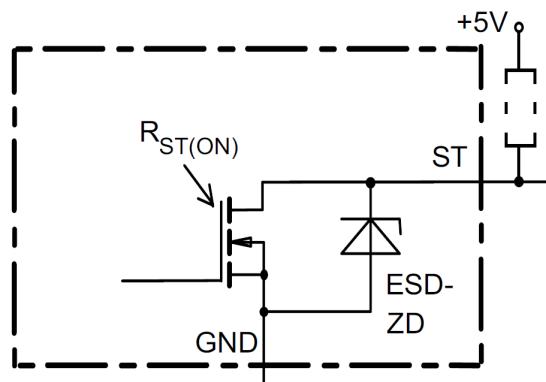
Open-load detection
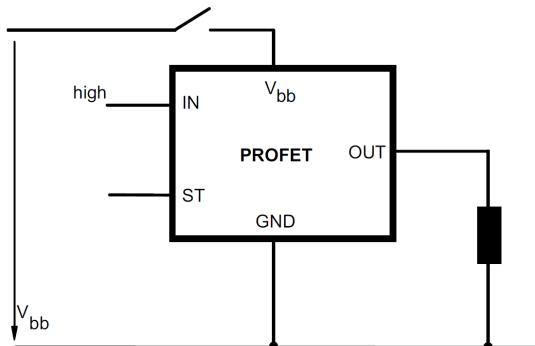
OFF-state diagnostic condition:

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

Status output
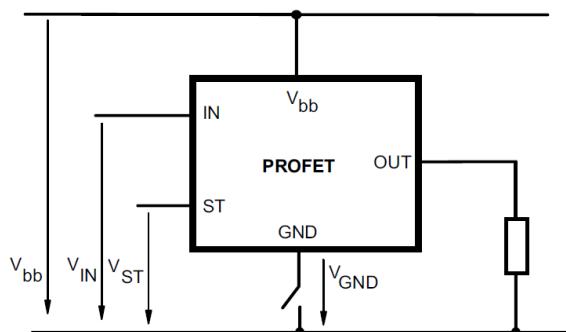
V_{bb} disconnect with charged inductive load
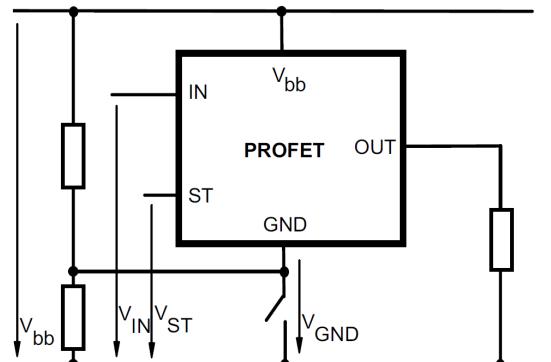
Functional description and electrical characteristics
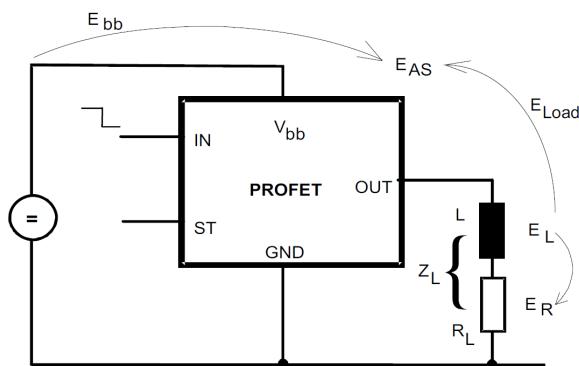
GND disconnect

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 $R_L > 0 \, \Omega$:

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

4.2 Electrical characteristics

Table 4   Electrical characteristics

at 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 [9] 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 shutoff 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 [10], V_{IN} = low		–	–	18		
Leakage output current (included in $I_{bb(off)}$)	$I_{L(off)}$	–	–	5	µA	V_{IN} = low
Operating current	I_{GND}	–	0.8	2	mA	V_{IN} = high
Protection functions [11]						
Initial peak short circuit current limit	$I_{L(SCp)}$				A	(pin 5 to 3)
T_j = -40°C, V_{bb} = 20 V, t_m = 150 µs		–	–	9		–
T_j = 25°C		–	6.5	–		–

---

9   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 (see page **22**)

10   Higher current due temperature sensor

11   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.

Functional description and electrical characteristics

Table 4 **Electrical characteristics (continued)**

at 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.		
T_j = 150°C		4	–	–		–
T_j = -40°C to +150°C, V_{bb} > 40 V (see p. **17**)		–	5[12]	–		–
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	[13] 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	[14]
Drain-source diode voltage (V_{OUT} > V_{bb})	$-V_{ON}$	–	600	–	mV	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	$\Delta V_{IN(T)}$	–	0.4	–	V	–
Off state input current V_{IN} = 0.7 V	$I_{IN(off)}$	1	–	25	µA	–
On state input current	$I_{IN(on)}$	3	–	25	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	–
T_j = -40°C to +25°C, I_{ST} = 1.6 mA		–	–	0.4		
T_j = 150°C, I_{ST} = 1.6 mA		–	–	0.6		
Status invalid after positive input slope	$t_{d(ST+)}$	–	120	160	µs	[15]

---

12 Not subject to production test, specified by design
13 see also $V_{ON(CL)}$ in circuit diagram on page **9**
14 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

Functional description and electrical characteristics

Table 4   Electrical characteristics (continued)

at 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.		
						V_{bb} = 20 V
Status invalid after negative input slope [15]	$t_{d(ST-)}$	–	250	400	µs	–
Input resistance	R_I	2	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	4	V	[16]
Internal output pull down	R_O	–	200	–	kΩ	[17] $V_{OUT(OL)}$ = 4 V (see page **10** and page **19**)

during reverse current operation! Input current has to be limited (see **Absolute maximum ratings** on page 6).

[15]   No delay time after overtemperature switch off and short circuit in on-state
[16]   External pull up resistor required for open load detection in off state
[17]   Not subject to production test, specified by design
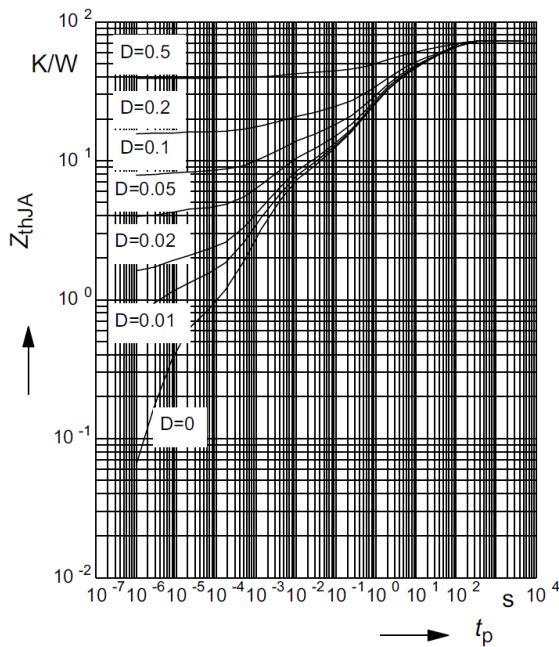
4.3 Typical performance characteristics
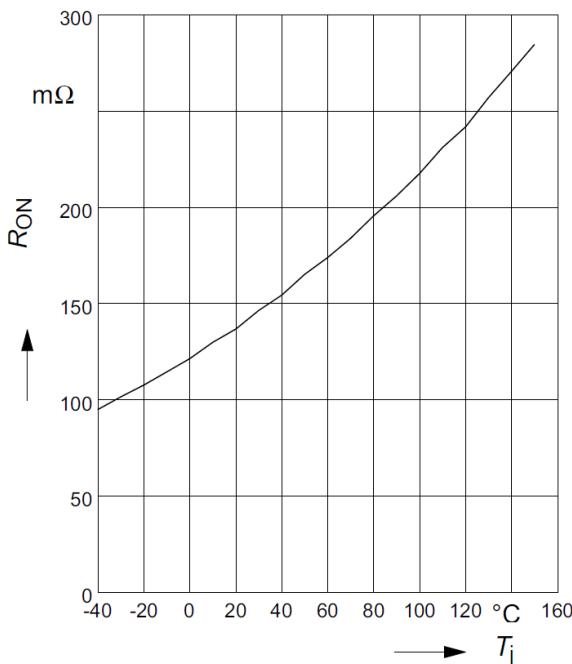
Typ. transient thermal impedance Z_{thJA} = f(t_p) @ 6 cm² heatsink area

$D = t_p/T$

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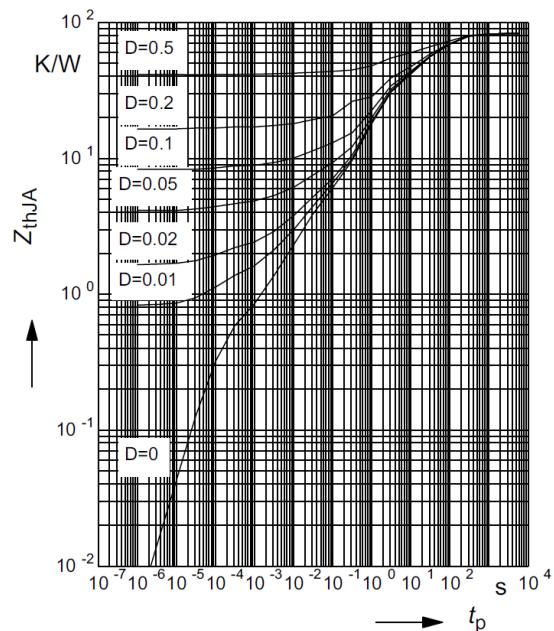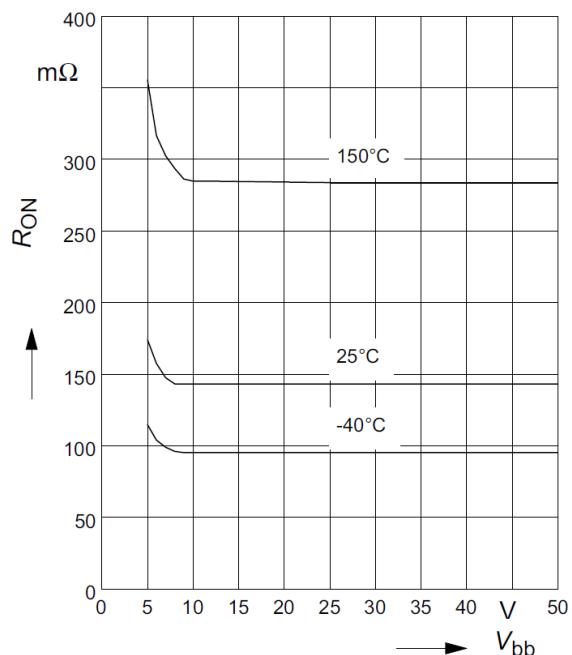
$D = t_p/T$

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

V_{bb} = 13.5 V; V_{IN} = high
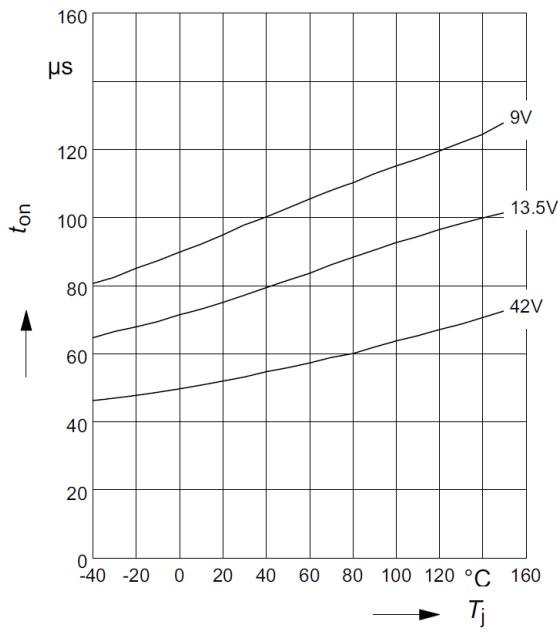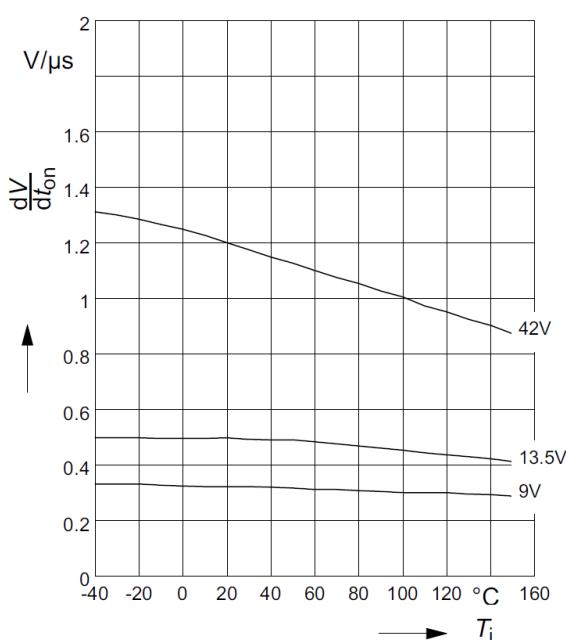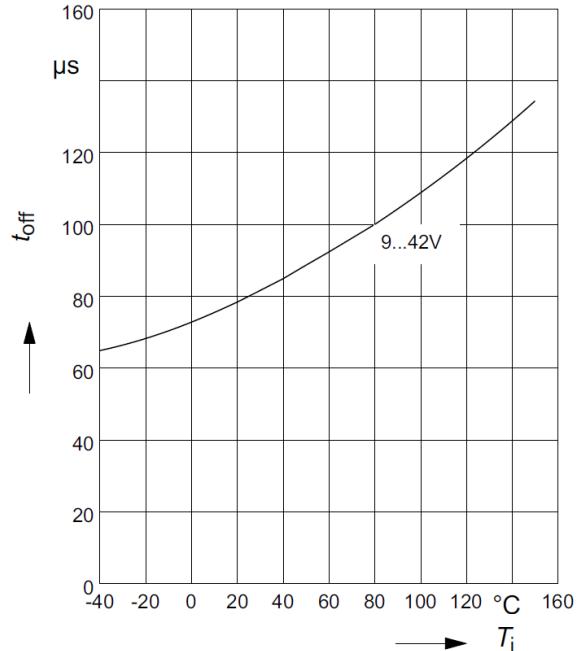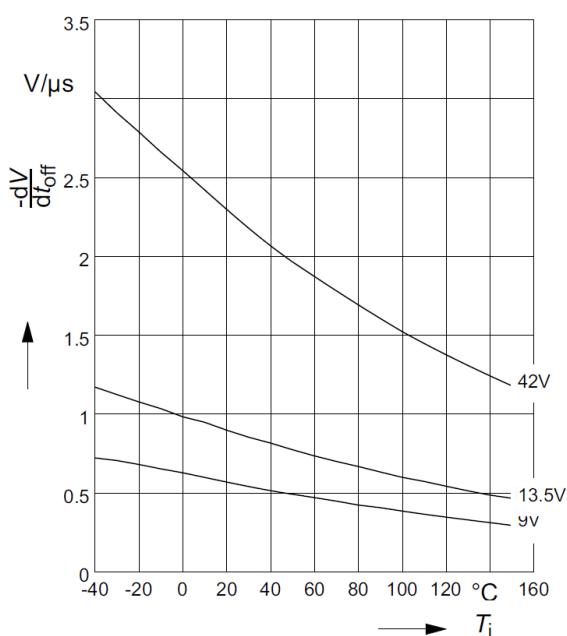
Typ. on-state resistance R_{ON} = f(V_{bb})

I_L = 1 A; V_{IN} = high
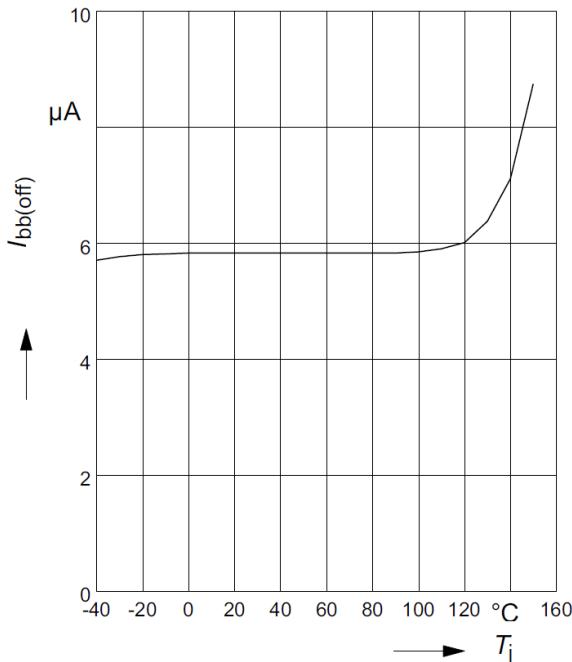
Functional description and electrical characteristics

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

Functional description and electrical characteristics
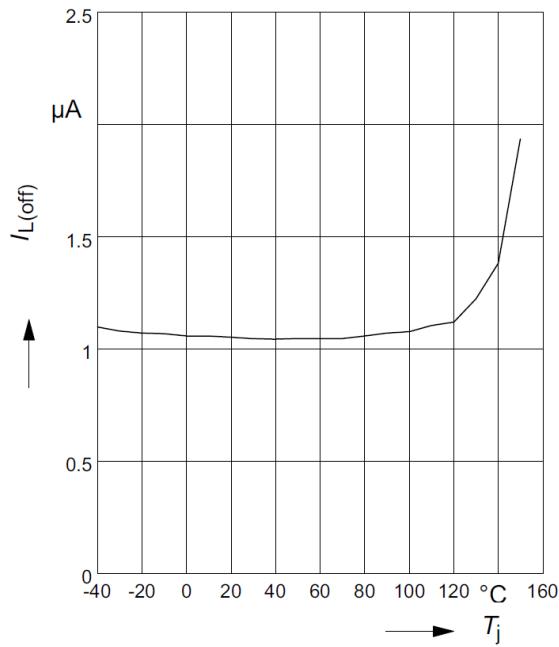
Typ. standby current $I_{bb(off)} = f(T_j)$

$V_{bb} = 42$ V; $V_{IN} =$ low
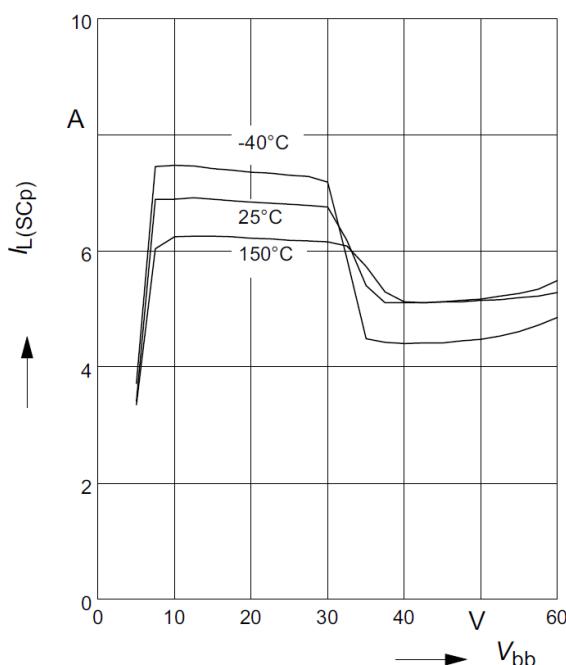
Typ. leakage current $I_{L(off)} = f(T_j)$

$V_{bb} = 42$ V; $V_{IN} =$ low
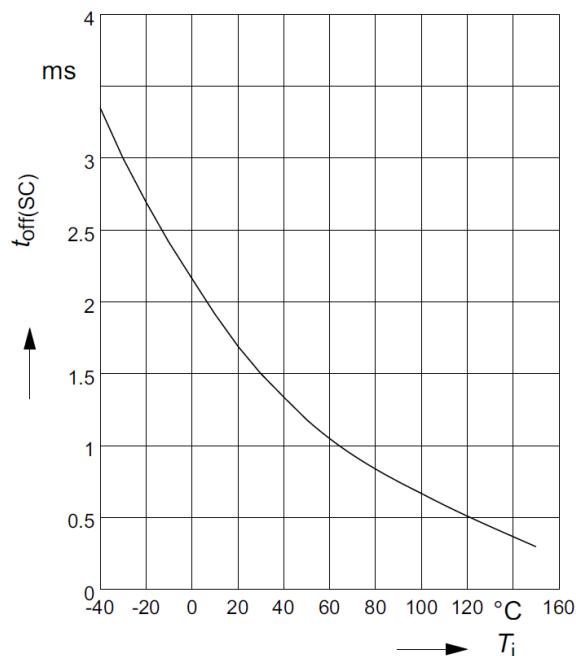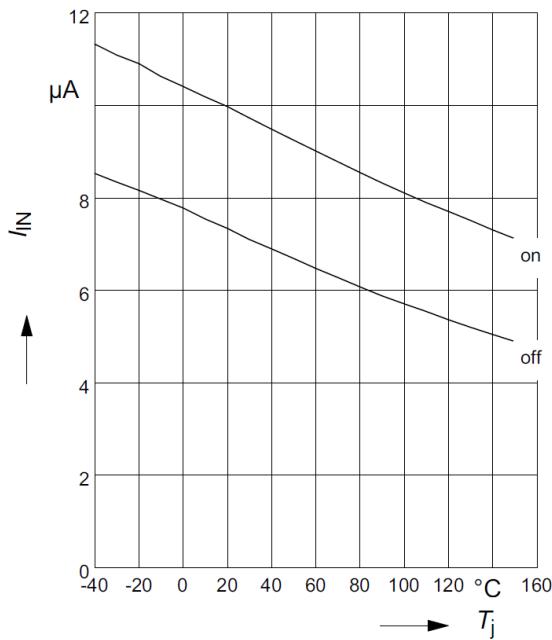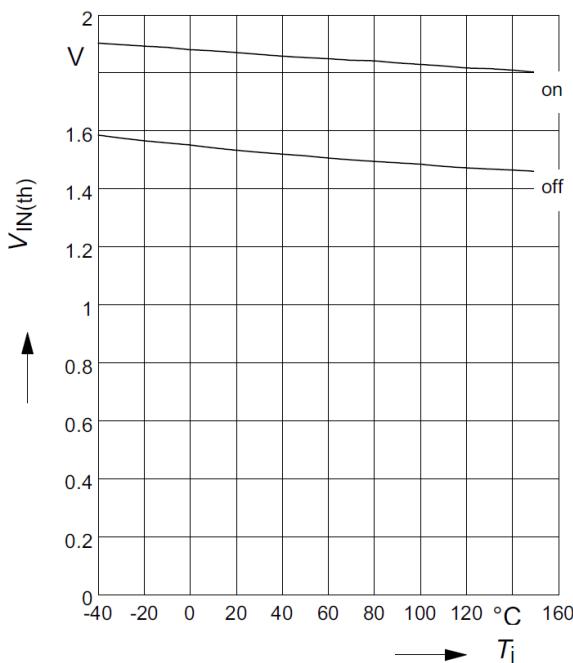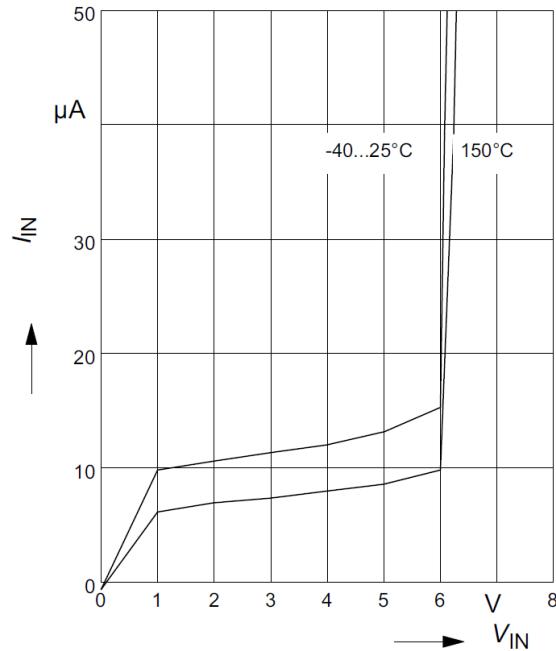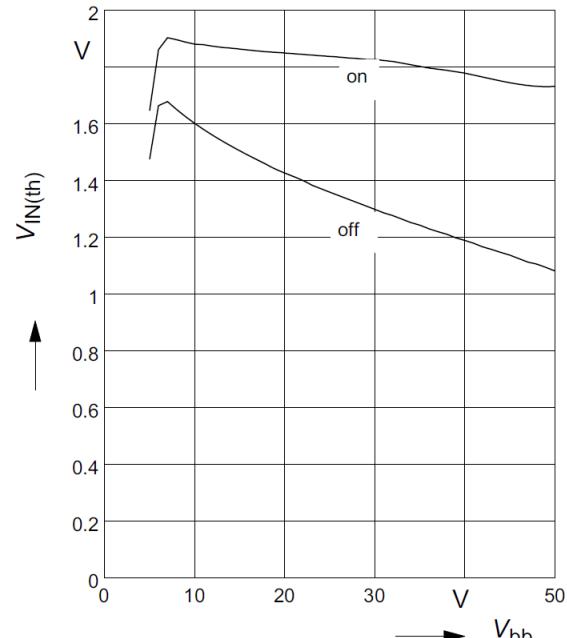
Typ. initial peak short circuit current limit $I_{L(SCp)} = f(V_{bb})$

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

$V_{bb} = 20$ V
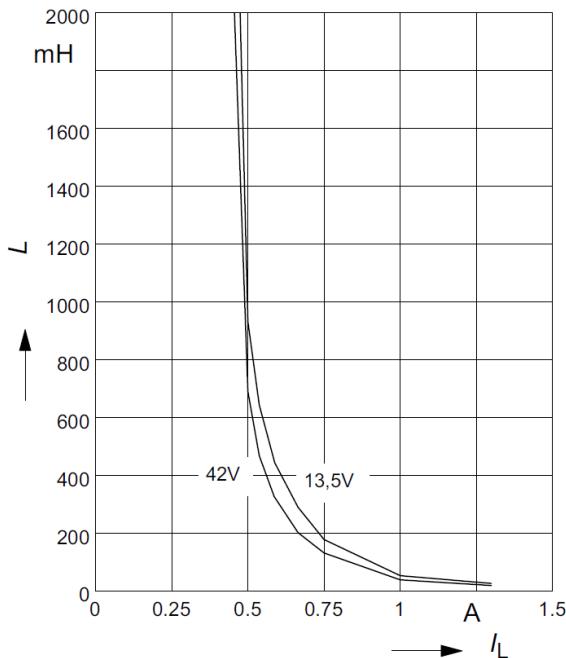
Functional description and electrical characteristics

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 $V_{IN(th)} = f(V_{bb})$

$T_j = 25°C$
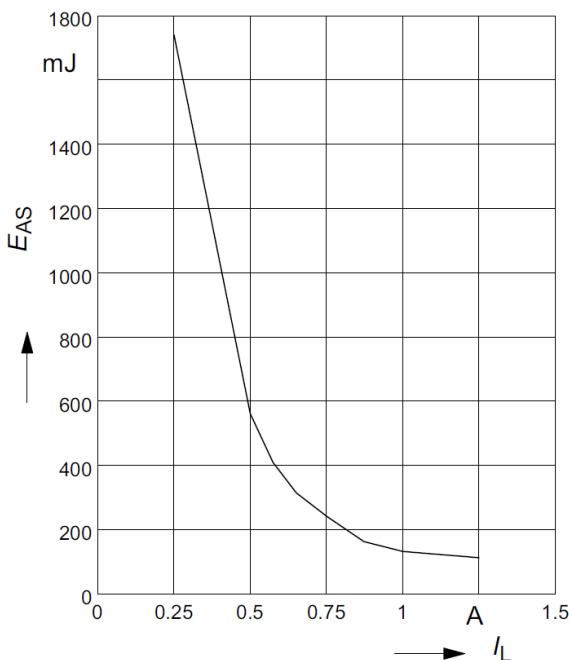
Maximum allowable load inductance for a single switch off $L = f(I_L)$

$T_{jstart} = 150°C$, $R_L = 0$ 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
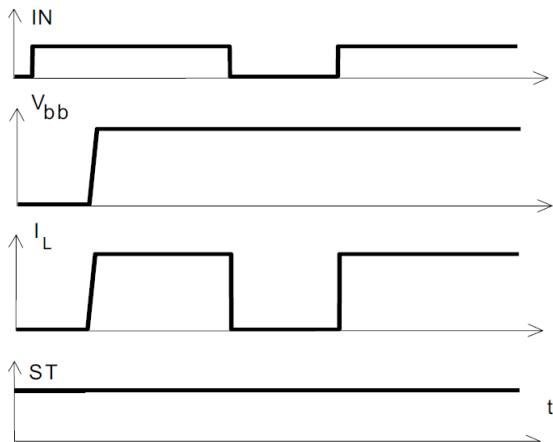
Typ. internal output pull down $R_O = f(V_{bb})$
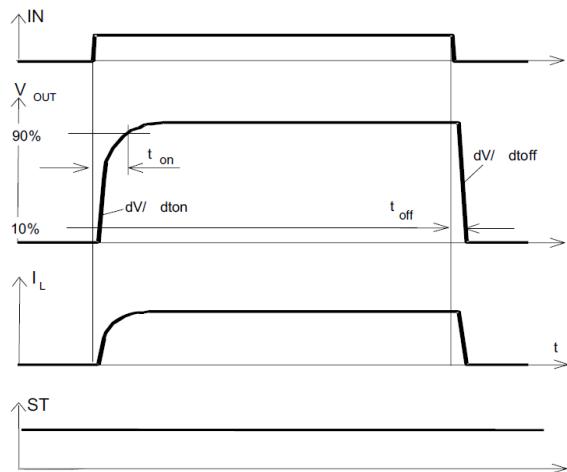
4.4 Timing diagrams
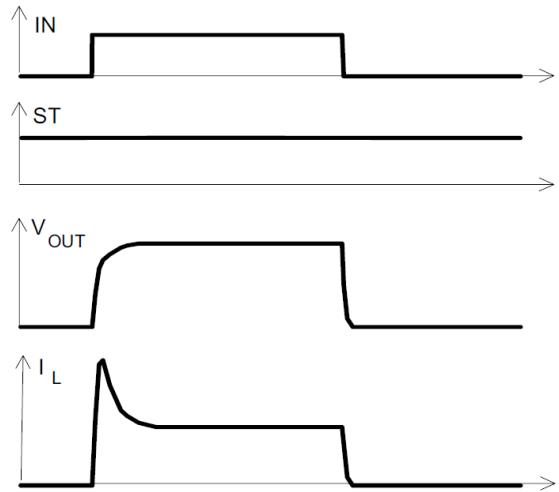
V_{bb} turn on
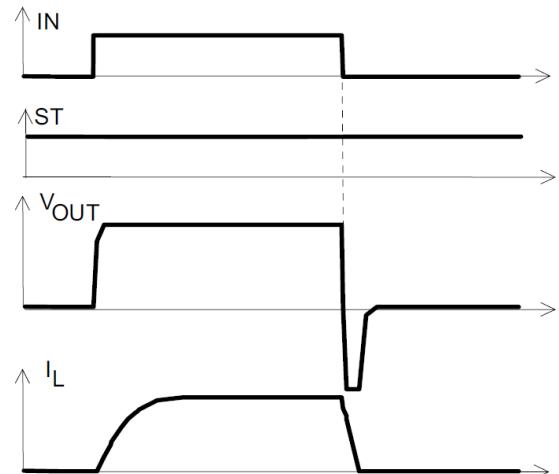
Switching a lamp

Switching a resistive load, turn-on/off time and slew rate definition
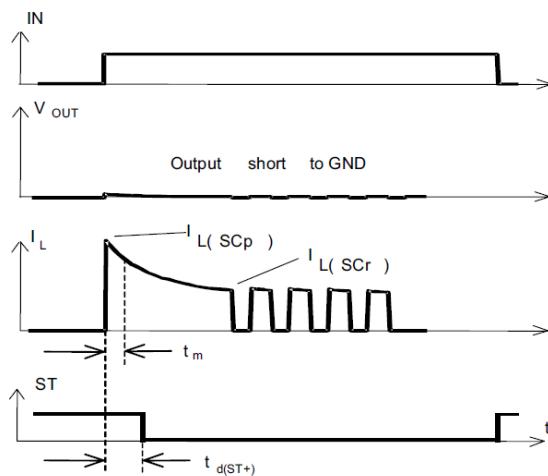
Switching an inductive load
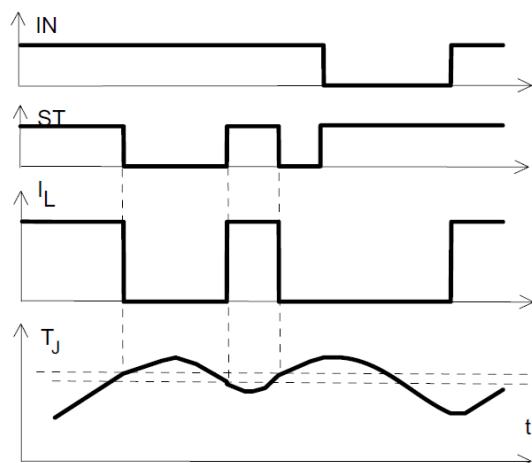
Functional description and electrical characteristics

### Turn on into short circuit, shut down by overtemperature, restart by cooling
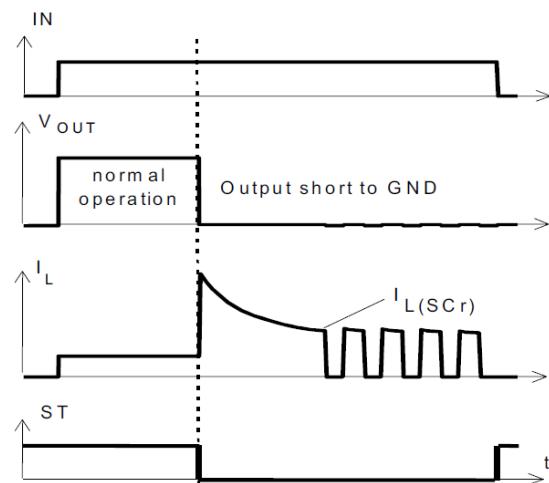
Heating up of the chip may require several milliseconds, depending on external conditions.
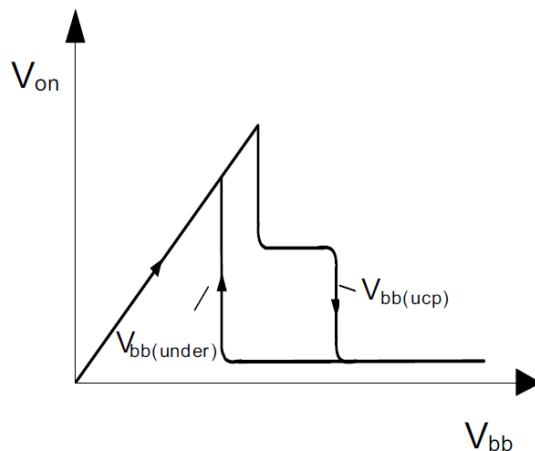
Overtemperature: Reset if $T_j < T_{jt}$

Short circuit in on-state shut down by overtemperature, restart by cooling

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 [⊲⊕]
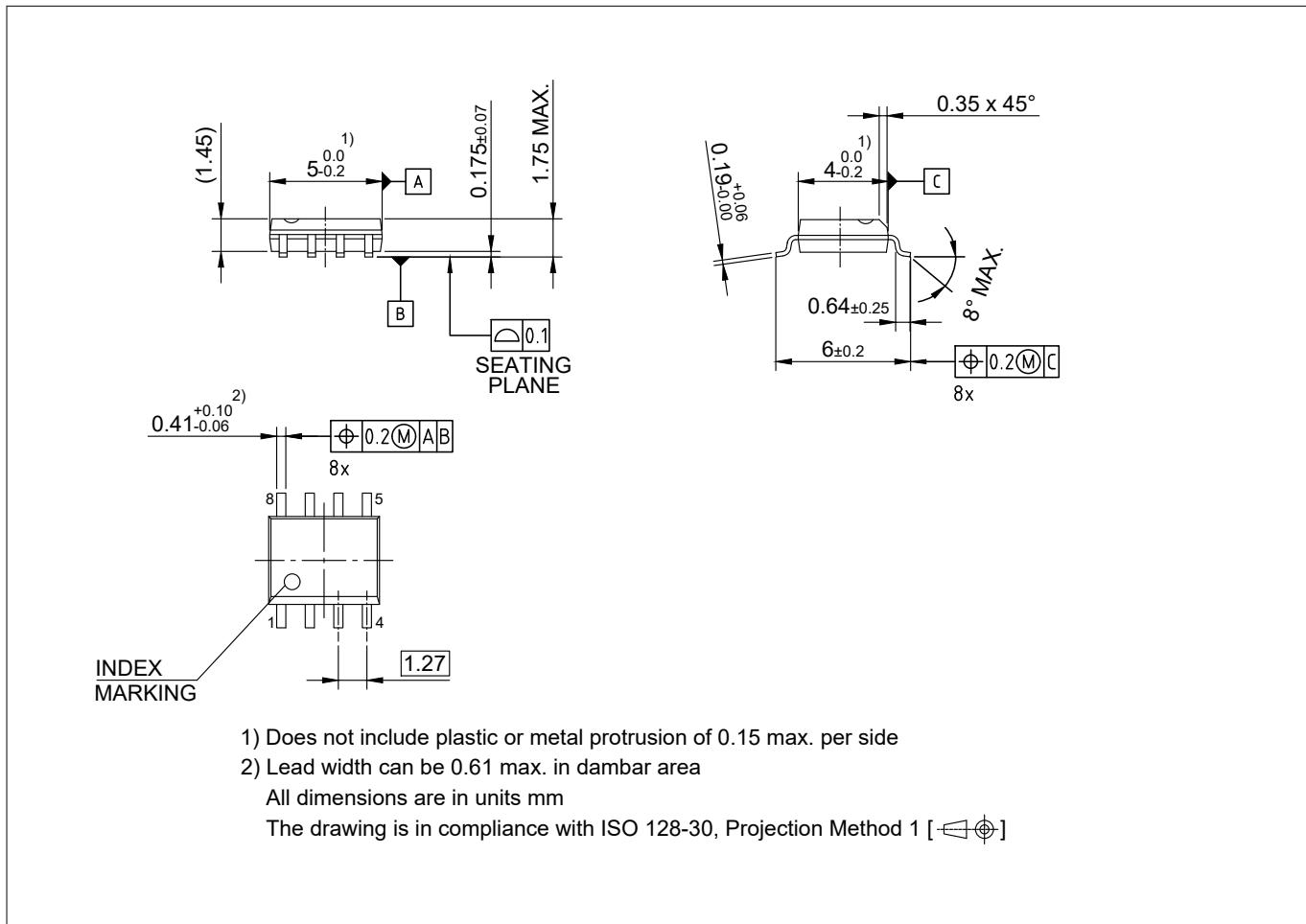
Figure 3   PG-DSO-8

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*.

6 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 JS001 • Editorial changes
1.1	2008-09-26	All pages: • Added new Infineon logo • Initial version of RoHS-compliant derivate of the ISP752R 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.

X-ON Electronics

Largest Supplier of Electrical and Electronic Components

Click to view similar products for Power Switch ICs - Power Distribution *category:*

Click to view products by Infineon *manufacturer:*

Other Similar products are found below :

TCK111G,LF(S FPF1018 DS1222 TCK2065G,LF SZNCP3712ASNT3G MIC2033-05BYMT-T5 MIC2033-12AYMT-T5 MIC2033-05BYM6-T5 SLG5NT1437VTR SZNCP3712ASNT1G DML1008LDS-7 KTS1670EDA-TR KTS1640QGDV-TR KTS1641QGDV-TR U6513A MIC2012YM-TR MP5095GJ-P TPS2021IDRQ1 TPS2104DBVR TPS22958NDGKR MIC2098-1YMT-TR MIC94062YMT TR MIC2015-1.2YM6 TR MIC2075-2YM MIC94068YML-TR SIP32461DB-T2-GE1 NCP335FCT2G FPF1504UCX TCK105G,LF(S AP2411S-13 AP2151DSG-13 AP2172MPG-13 MIC94094YC6-TR MIC94093YC6-TR MIC94064YC6-TR MIC94061YMT-TR MIC2505-1YM MIC94085YFT-TR MIC94042YFL-TR MIC2005-1.2YM6-TR SIP32510DT-T1-GE3 NCP333FCT2G BTS3050TFATMA1 NCP331SNT1G TPS2092DR TPS2063DR MIC2008YML-TR MIC94084YFT-TR MIC2040-1YMM DIO1280WL12