

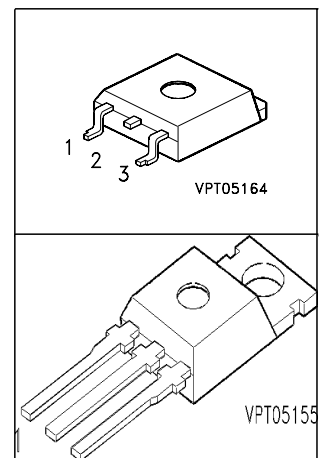
# Smart Lowside Power Switch

## Features

- Logic Level Input
- Input Protection (ESD)
- Thermal shutdown with latch
- Overload protection
- Short circuit protection
- Overvoltage protection
- Current limitation
- Status feedback with external input resistor
- Analog driving possible

## Product Summary

Drain source voltage	$V_{DS}$	60	V
On-state resistance	$R_{DS(on)}$	100	m $\Omega$
Current limit	$I_{D(lim)}$	7	A
Nominal load current	$I_{D(ISO)}$	3.5	A
Clamping energy	$E_{AS}$	1000	mJ

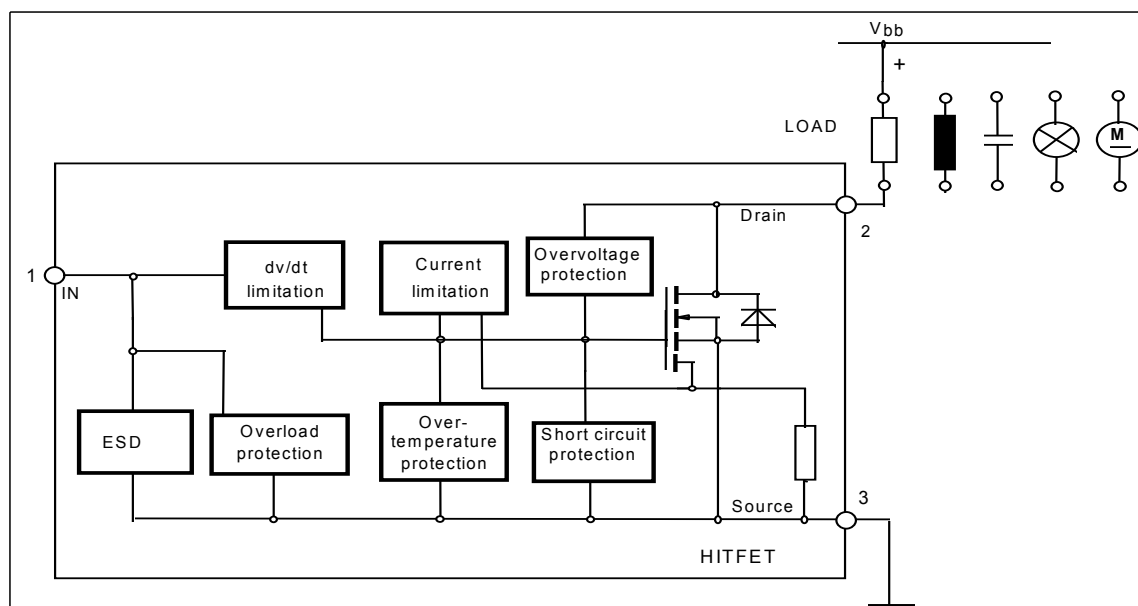


## Application

- All kinds of resistive, inductive and capacitive loads in switching or linear applications
- $\mu$ C compatible power switch for 12 V and 24 V DC applications
- Replaces electromechanical relays and discrete circuits

## General Description

N channel vertical power FET in Smart SIPMOS® chip on chip technology. Fully protected by embedded protected functions.



**Maximum Ratings at T<sub>j</sub> = 25 °C unless otherwise specified**

Parameter	Symbol	Value	Unit
Drain source voltage	V <sub>DS</sub>	60	V
Drain source voltage for short circuit protection	V <sub>DS(SC)</sub>	32	
Continuous input current <sup>1)</sup> -0.2V ≤ V <sub>IN</sub> ≤ 10V V <sub>IN</sub> < -0.2V or V <sub>IN</sub> > 10V	I <sub>IN</sub>	no limit   I <sub>IN</sub>   ≤ 2	mA
Operating temperature	T <sub>j</sub>	- 40 ... +150	°C
Storage temperature	T <sub>stg</sub>	- 55 ... +150	
Power dissipation T <sub>C</sub> = 25 °C	P <sub>tot</sub>	50	W
Unclamped single pulse inductive energy I <sub>D(ISO)</sub> = 3.5 A	E <sub>AS</sub>	1000	mJ
<b>Electrostatic discharge voltage</b> (Human Body Model) according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993	V <sub>ESD</sub>	3000	V
Load dump protection V <sub>LoadDump</sub> <sup>2)</sup> = V <sub>A</sub> + V <sub>S</sub> V <sub>IN</sub> =low or high; V <sub>A</sub> =13.5 V t <sub>d</sub> = 400 ms, R <sub>I</sub> = 2 Ω, I <sub>D</sub> =0,5*3.5A t <sub>d</sub> = 400 ms, R <sub>I</sub> = 2 Ω, I <sub>D</sub> = 3.5A	V <sub>LD</sub>	75 70	
DIN humidity category, DIN 40 040		E	
IEC climatic category; DIN IEC 68-1		40/150/56	

**Thermal resistance**

junction - case:	R <sub>thJC</sub>	2.5	K/W
junction - ambient:	R <sub>thJA</sub>	75	
SMD version, device on PCB: <sup>3)</sup>	R <sub>thJA</sub>	45	

<sup>1</sup>In case of thermal shutdown a minimum sensor holding current of 500 µA has to be guaranteed (see also page 3).

<sup>2</sup>V<sub>LoadDump</sub> is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839

<sup>3</sup> Device on 50mm\*50mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70µm thick) copper area for Drain connection. PCB mounted vertical without blown air.

**Electrical Characteristics**

Parameter at $T_j=25^\circ\text{C}$ , unless otherwise specified	Symbol	Values			Unit
		min.	typ.	max.	
<b>Characteristics</b>					
Drain source clamp voltage $T_j = -40 \dots +150^\circ\text{C}$ , $I_D = 10 \text{ mA}$	$V_{DS(AZ)}$	60	-	73	V
Off state drain current $V_{DS} = 32 \text{ V}$ , $T_j = -40 \dots +150^\circ\text{C}$ , $V_{IN} = 0 \text{ V}$	$I_{DSS}$	-	-	5	$\mu\text{A}$
Input threshold voltage $I_D = 0.7 \text{ mA}$	$V_{IN(th)}$	1.3	1.7	2.2	V
Input current - normal operation, $I_D < I_{D(lim)}$ : $V_{IN} = 10 \text{ V}$	$I_{IN(1)}$	-	30	60	$\mu\text{A}$
Input current - current limitation mode, $I_D = I_{D(lim)}$ : $V_{IN} = 10 \text{ V}$	$I_{IN(2)}$	-	120	300	
Input current - after thermal shutdown, $I_D = 0 \text{ A}$ : $V_{IN} = 10 \text{ V}$	$I_{IN(3)}$	800	2200	4000	
Input holding current after thermal shutdown <sup>1)</sup> $T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	$I_{IN(H)}$	500 300	- -	- -	
On-state resistance $V_{IN} = 5 \text{ V}$ , $I_D = 3.5 \text{ A}$ , $T_j = 25^\circ\text{C}$ $V_{IN} = 5 \text{ V}$ , $I_D = 3.5 \text{ A}$ , $T_j = 150^\circ\text{C}$	$R_{DS(on)}$	- -	90 180	120 240	$\text{m}\Omega$
On-state resistance $V_{IN} = 10 \text{ V}$ , $I_D = 3.5 \text{ A}$ , $T_j = 25^\circ\text{C}$ $V_{IN} = 10 \text{ V}$ , $I_D = 3.5 \text{ A}$ , $T_j = 150^\circ\text{C}$	$R_{DS(on)}$	- -	80 160	100 200	
Nominal load current (ISO 10483) $V_{IN} = 10 \text{ V}$ , $V_{DS} = 0.5 \text{ V}$ , $T_C = 85^\circ\text{C}$	$I_{D(ISO)}$	3.5	-	-	A

<sup>1</sup>If the input current is limited by external components, low drain currents can flow and heat the device. Auto restart behaviour can occur.

**Electrical Characteristics**

Parameter at $T_j=25^\circ\text{C}$ , unless otherwise specified	Symbol	Values			Unit
		min.	typ.	max.	

**Characteristics**

Initial peak short circuit current limit $V_{IN} = 10\text{ V}$ , $V_{DS} = 12\text{ V}$	$I_{D(SCP)}$	-	25	-	A
Current limit <sup>1)</sup> $V_{IN} = 10\text{ V}$ , $V_{DS} = 12\text{ V}$ , $t_m = 350\ \mu\text{s}$ , $T_j = -40\dots+150\ ^\circ\text{C}$	$I_{D(lim)}$	7	10	15	

**Dynamic Characteristics**

Turn-on time $V_{IN}$ to 90% $I_D$ : $R_L = 4.7\ \Omega$ , $V_{IN} = 0$ to $10\text{ V}$ , $V_{bb} = 12\text{ V}$	$t_{on}$	-	40	70	$\mu\text{s}$
Turn-off time $V_{IN}$ to 10% $I_D$ : $R_L = 4.7\ \Omega$ , $V_{IN} = 10$ to $0\text{ V}$ , $V_{bb} = 12\text{ V}$	$t_{off}$	-	70	150	
Slew rate on 70 to 50% $V_{bb}$ : $R_L = 4.7\ \Omega$ , $V_{IN} = 0$ to $10\text{ V}$ , $V_{bb} = 12\text{ V}$	$-dV_{DS}/dt_{on}$	-	1	3	V/ $\mu\text{s}$
Slew rate off 50 to 70% $V_{bb}$ : $R_L = 4.7\ \Omega$ , $V_{IN} = 10$ to $0\text{ V}$ , $V_{bb} = 12\text{ V}$	$dV_{DS}/dt_{off}$	-	1	3	

**Protection Functions**

Thermal overload trip temperature	$T_{jt}$	150	165	-	$^\circ\text{C}$
Unclamped single pulse inductive energy $I_D = 3.5\text{ A}$ , $T_j = 25\ ^\circ\text{C}$ , $V_{bb} = 32\text{ V}$ $I_D = 3.5\text{ A}$ , $T_j = 150\ ^\circ\text{C}$ , $V_{bb} = 32\text{ V}$	$E_{AS}$	1000 225	-- --	-- --	mJ

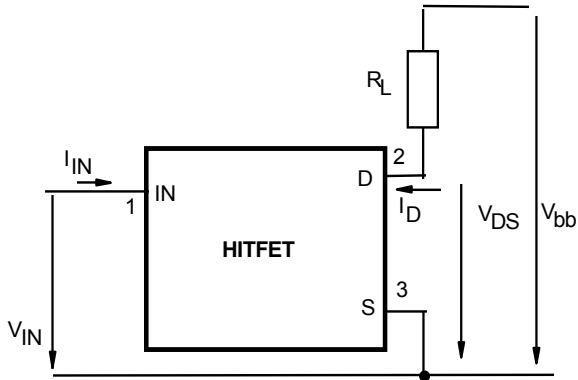
**Inverse Diode**

Inverse diode forward voltage $I_F = 5*3.5\text{A}$ , $t_m = 300\ \mu\text{s}$ , $V_{IN} = 0\text{ V}$	$V_{SD}$	-	1	-	V
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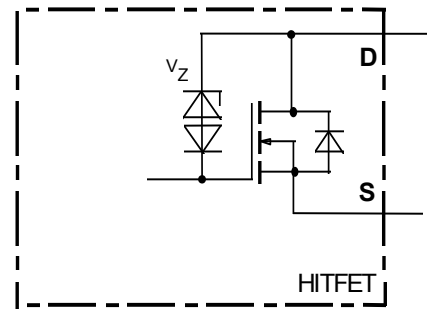
<sup>1</sup>Device switched on into existing short circuit (see diagram Determination of  $I_{D(lim)}$ ). If the device is in on condition and a short circuit occurs, these values might be exceeded for max. 50  $\mu\text{s}$ .

## Block Diagramm

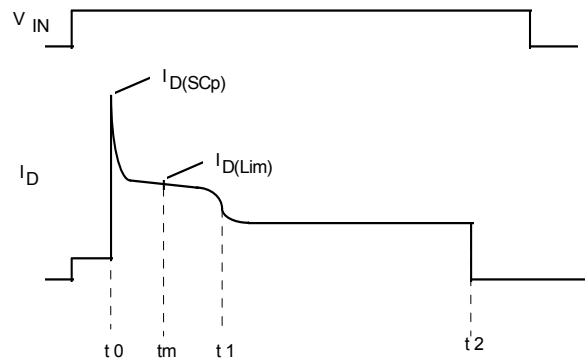
### Terms



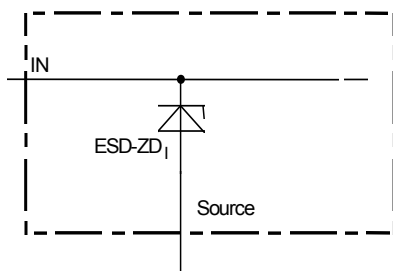
### Inductive and overvoltage output clamp



### Short circuit behaviour



### Input circuit (ESD protection)

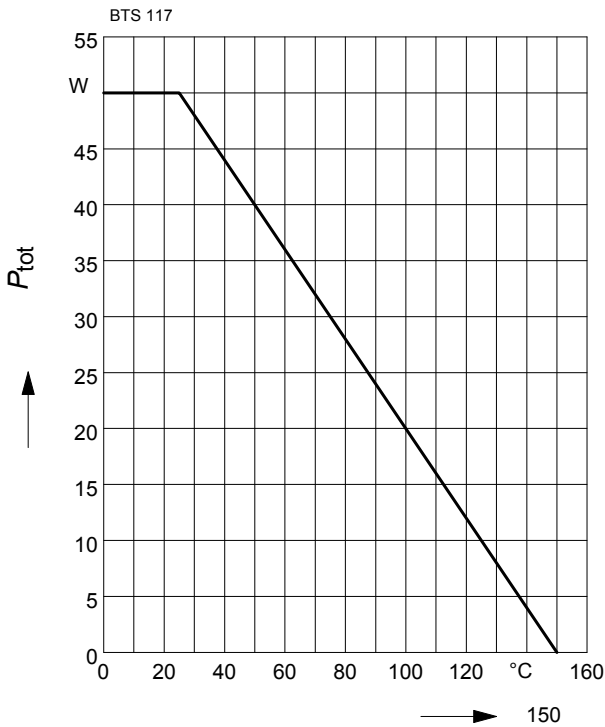


ESD zener diodes are not designed for DC current  $> 2 \text{ mA}$  @  $V_{IN} > 10\text{V}$ .

- $t_0$ : Turn on into a short circuit
- $t_m$ : Measurementpoint for  $I_{D(Lim)}$
- $t_1$ : Activation of the fast temperature sensor and regulation of the drain current to a level where the junction temperature remains constant.
- $t_2$ : Thermal shutdown caused by the second temperature sensor, achieved by an integrating measurement.

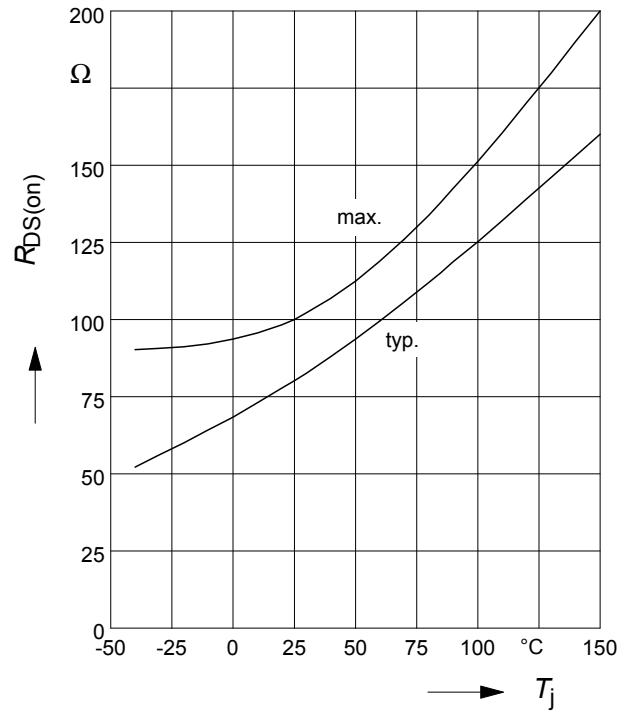
**Maximum allowable power dissipation**

$P_{tot} = f(T_c)$



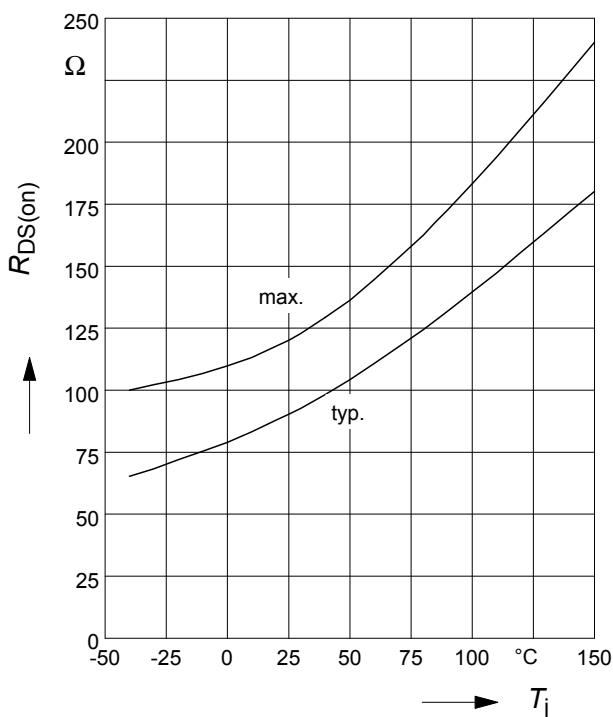
**On-state resistance**

$R_{ON} = f(T_j); I_D=3.5A; V_{IN}=10V$



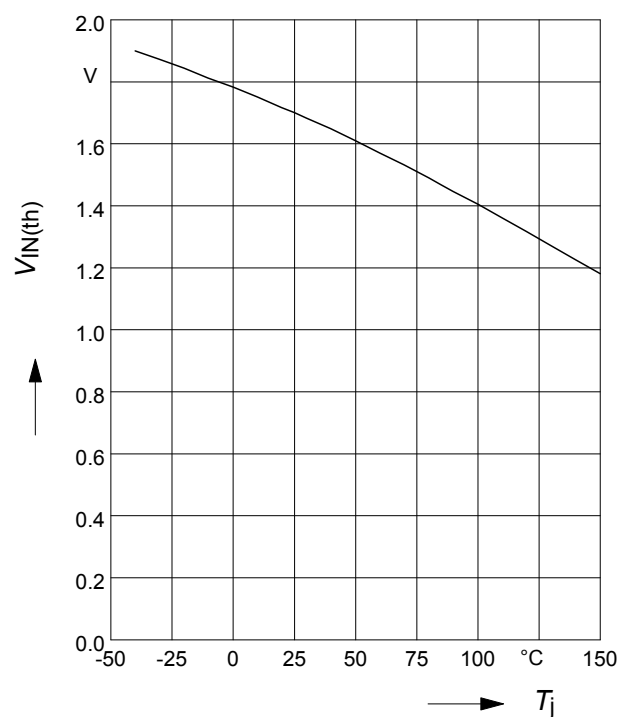
**On-state resistance**

$R_{ON} = f(T_j); I_D= 3.5A; V_{IN}=5V$



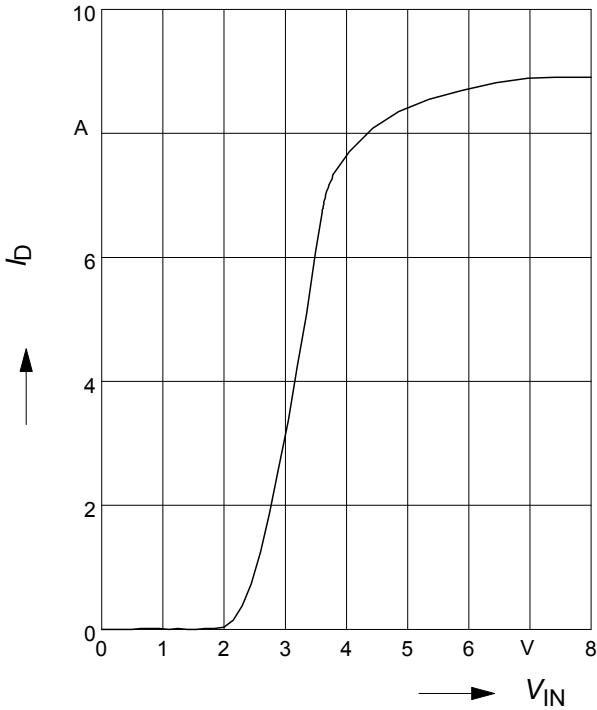
**Typ. input threshold voltage**

$V_{IN(th)} = f(T_j); I_D=0.7mA; V_{DS}=12V$



**Typ. transfer characteristics**

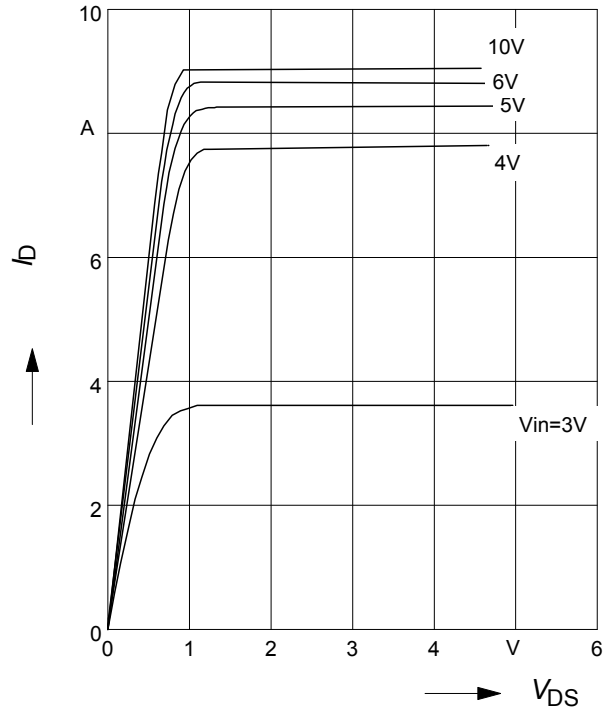
$I_D = f(V_{IN}); V_{DS}=12V; T_j=25^\circ C$



**Typ. output characteristic**

$I_D = f(V_{DS}); T_j=25^\circ C$

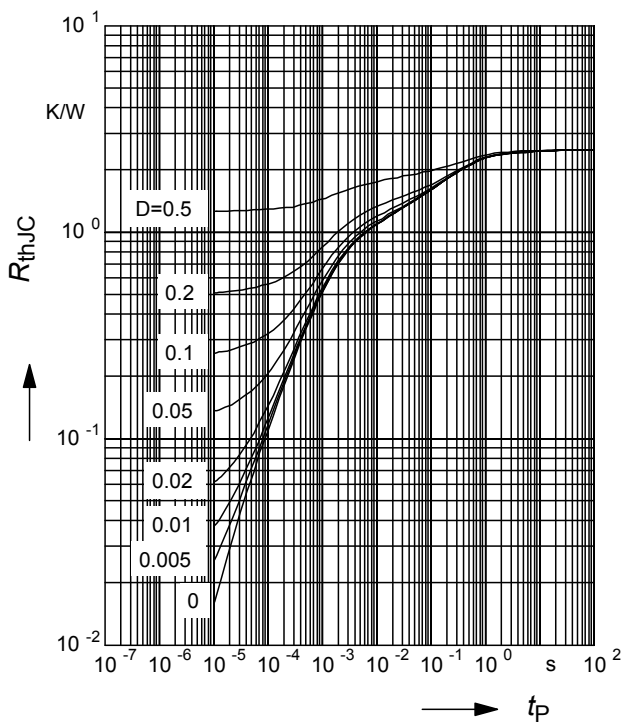
Parameter:  $V_{IN}$



**Transient thermal impedance**

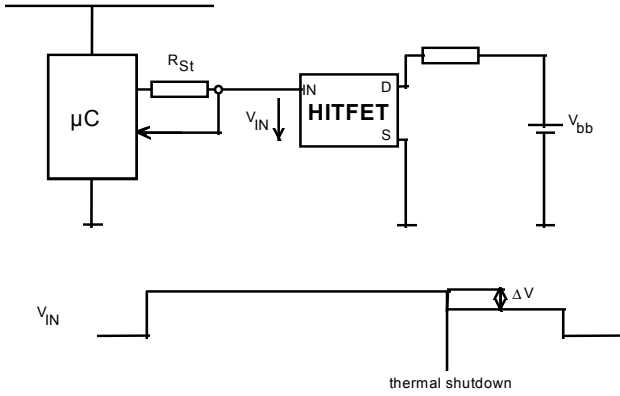
$Z_{thJC} = f(t_p)$

parameter :  $D = t_p/T$



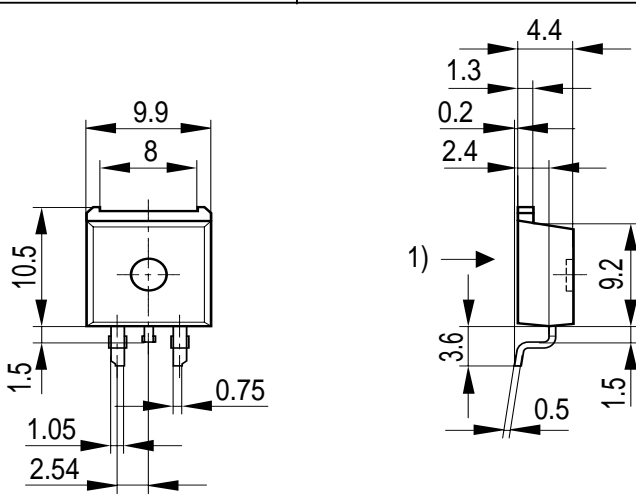
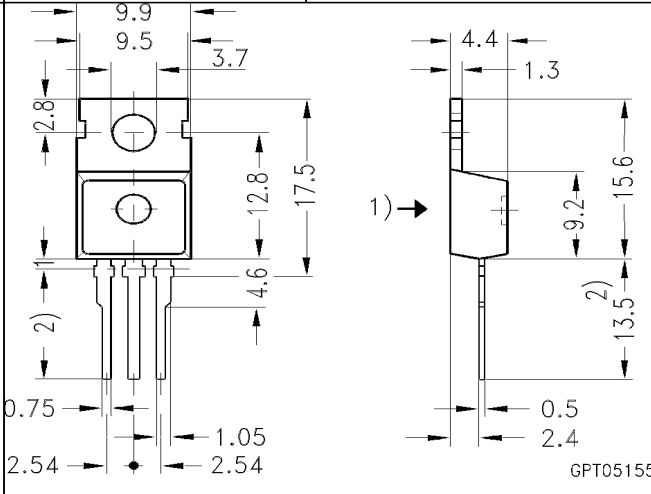
**Application examples:**

**Status signal of thermal shutdown by monitoring input current**



$$\Delta V = R_{ST} * I_{IN(3)}$$



Package	Ordering Code	Package	Ordering Code
P-TO220-3-45	Q67060-S6500-A3	P-TO220-3-1	Q67060-S6500-A2
 <p>1) shear and punch direction no burrs this surface</p>		 <p>1) punch direction, burr max. 0.04 2) dip tinning 3) max. 14.5 by dip tinning press burr max. 0.05</p>	

**Published by**  
**Infineon Technologies AG,**  
**Bereichs Kommunikation**  
**St.-Martin-Strasse 53,**  
**D-81541 München**  
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