

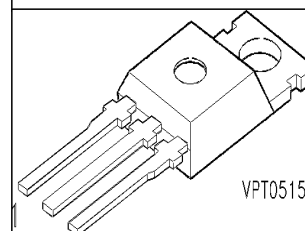
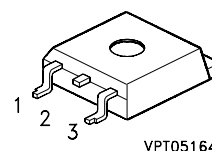
Smart Lowside Power Switch

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 Ω
Current limit	$I_{D(lim)}$	7	A
Nominal load current	$I_{D(ISO)}$	3.5	A
Clamping energy	E_{AS}	1000	mJ

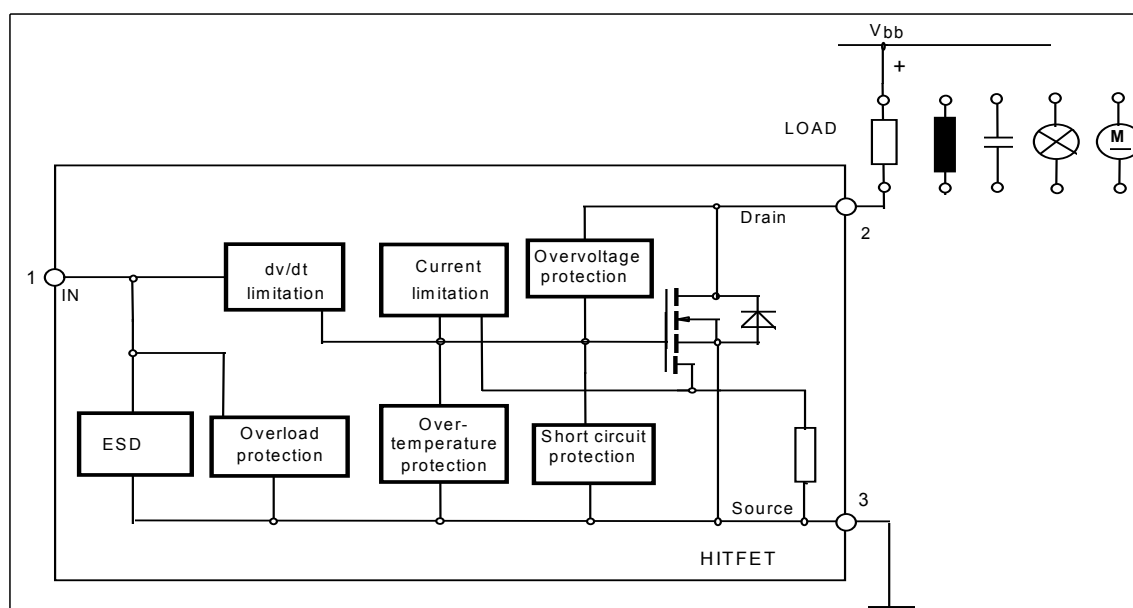


Application

- All kinds of resistive, inductive and capacitive loads in switching or linear applications
- μC 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 $T_j = 25\text{ °C}$ unless otherwise specified

Parameter	Symbol	Value	Unit
Drain source voltage	V_{DS}	60	V
Drain source voltage for short circuit protection	$V_{DS(SC)}$	32	
Continuous input current ¹⁾ $-0.2\text{V} \leq V_{IN} \leq 10\text{V}$ $V_{IN} < -0.2\text{V}$ or $V_{IN} > 10\text{V}$	I_{IN}	no limit $ I_{IN} \leq 2$	mA
Operating temperature	T_j	- 40 ... +150	°C
Storage temperature	T_{stg}	- 55 ... +150	
Power dissipation $T_C = 25\text{ °C}$	P_{tot}	50	W
Unclamped single pulse inductive energy $I_{D(ISO)} = 3.5\text{ A}$	E_{AS}	1000	mJ
Electrostatic discharge voltage (Human Body Model) according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993	V_{ESD}	3000	V
Load dump protection $V_{LoadDump}^{2)} = V_A + V_S$ $V_{IN} = \text{low or high}; V_A = 13.5\text{ V}$ $t_d = 400\text{ ms}, R_l = 2\text{ }\Omega, I_D = 0.5 \cdot 3.5\text{ A}$ $t_d = 400\text{ ms}, R_l = 2\text{ }\Omega, I_D = 3.5\text{ A}$	V_{LD}	75 70	
DIN humidity category, DIN 40 040		E	
IEC climatic category; DIN IEC 68-1		40/150/56	

Thermal resistance

junction - case:	R_{thJC}	2.5	K/W
junction - ambient:	R_{thJA}	75	
SMD version, device on PCB: ³⁾	R_{thJA}	45	

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

²⁾ $V_{LoadDump}$ is setup without the DUT connected to the generator per ISO 7637-1 and DIN 40839

³⁾ Device on 50mm*50mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70 μm thick) copper area for Drain connection. PCB mounted vertical without blown air.

Electrical Characteristics

Parameter at T _j =25°C, unless otherwise specified	Symbol	Values			Unit
		min.	typ.	max.	
Characteristics					
Drain source clamp voltage T _j = - 40 ...+ 150°C, I _D = 10 mA	V _{DS(AZ)}	60	-	73	V
Off state drain current V _{DS} = 32 V, T _j = -40...+150 °C, V _{IN} = 0 V	I _{DSS}	-	-	5	µA
Input threshold voltage I _D = 0.7 mA	V _{IN(th)}	1.3	1.7	2.2	V
Input current - normal operation, I _D <I _{D(lim)} : V _{IN} = 10 V	I _{IN(1)}	-	30	60	µA
Input current - current limitation mode, I _D =I _{D(lim)} : V _{IN} = 10 V	I _{IN(2)}	-	120	300	
Input current - after thermal shutdown, I _D =0 A: V _{IN} = 10 V	I _{IN(3)}	800	2200	4000	
Input holding current after thermal shutdown ¹⁾ T _j = 25 °C T _j = 150 °C	I _{IN(H)}	500 300	- -	- -	
On-state resistance V _{IN} = 5 V, I _D = 3.5 A, T _j = 25 °C V _{IN} = 5 V, I _D = 3.5 A, T _j = 150 °C	R _{DS(on)}	- -	90 180	120 240	mΩ
On-state resistance V _{IN} = 10 V, I _D = 3.5 A, T _j = 25 °C V _{IN} = 10 V, I _D = 3.5 A, T _j = 150 °C	R _{DS(on)}	- -	80 160	100 200	
Nominal load current (ISO 10483) V _{IN} = 10 V, V _{DS} = 0.5 V, T _C = 85 °C	I _{D(ISO)}	3.5	-	-	A

¹⁾ 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 ¹⁾ $V_{IN} = 10\text{ V}$, $V_{DS} = 12\text{ V}$, $t_m = 350\text{ }\mu\text{s}$, $T_j = -40\dots+150\text{ }^\circ\text{C}$	$I_{D(lim)}$	7	10	15	

Dynamic Characteristics

Turn-on time V_{IN} to 90% I_D : $R_L = 4.7\text{ }\Omega$, $V_{IN} = 0$ to 10 V , $V_{bb} = 12\text{ V}$	t_{on}	-	40	70	μs
Turn-off time V_{IN} to 10% I_D : $R_L = 4.7\text{ }\Omega$, $V_{IN} = 10$ to 0 V , $V_{bb} = 12\text{ V}$	t_{off}	-	70	150	
Slew rate on 70 to 50% V_{bb} : $R_L = 4.7\text{ }\Omega$, $V_{IN} = 0$ to 10 V , $V_{bb} = 12\text{ V}$	$-dV_{DS}/dt_{on}$	-	1	3	$\text{V}/\mu\text{s}$
Slew rate off 50 to 70% V_{bb} : $R_L = 4.7\text{ }\Omega$, $V_{IN} = 10$ to 0 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 $I_D = 3.5\text{ A}$, $T_j = 25\text{ }^\circ\text{C}$, $V_{bb} = 32\text{ V}$ $I_D = 3.5\text{ A}$, $T_j = 150\text{ }^\circ\text{C}$, $V_{bb} = 32\text{ V}$	E_{AS}	1000 225	-- --	-- --	mJ

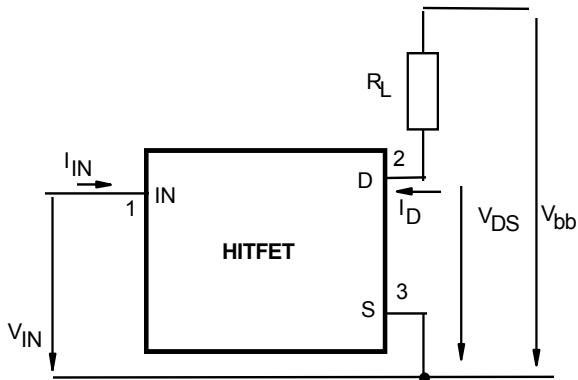
Inverse Diode

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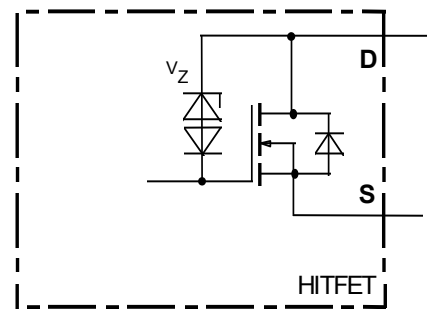
¹⁾Device switched on into existing short circuit (see diagram Determination of $I_{D(lim)}$). If the device is in on condition and a short circuit occurs, these values might be exceeded for max. 50 μs .

Block Diagramm

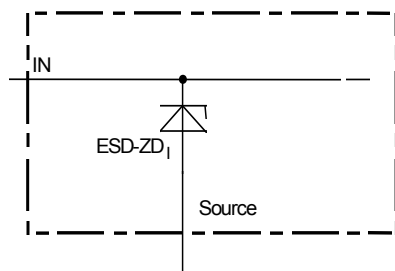
Terms



Inductive and overvoltage output clamp

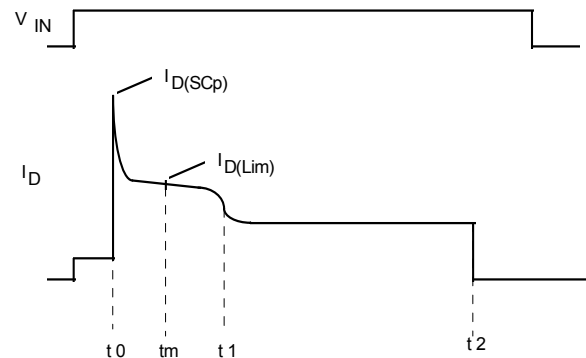


Input circuit (ESD protection)



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

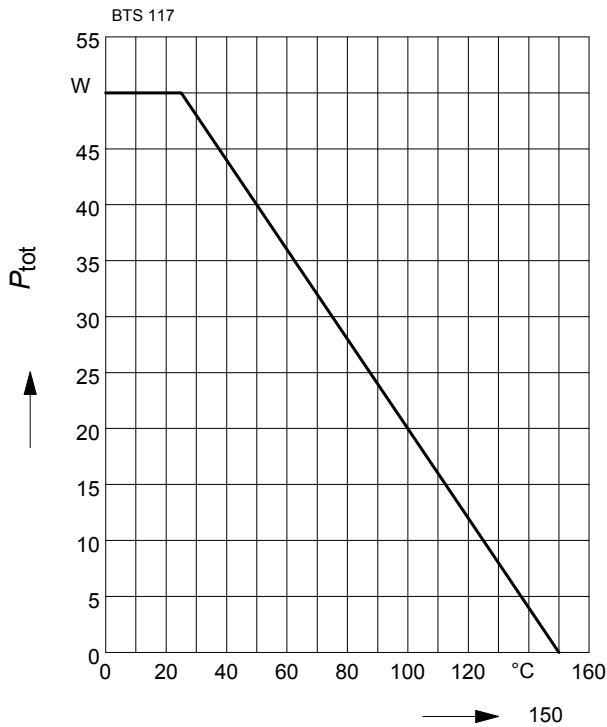
Short circuit behaviour



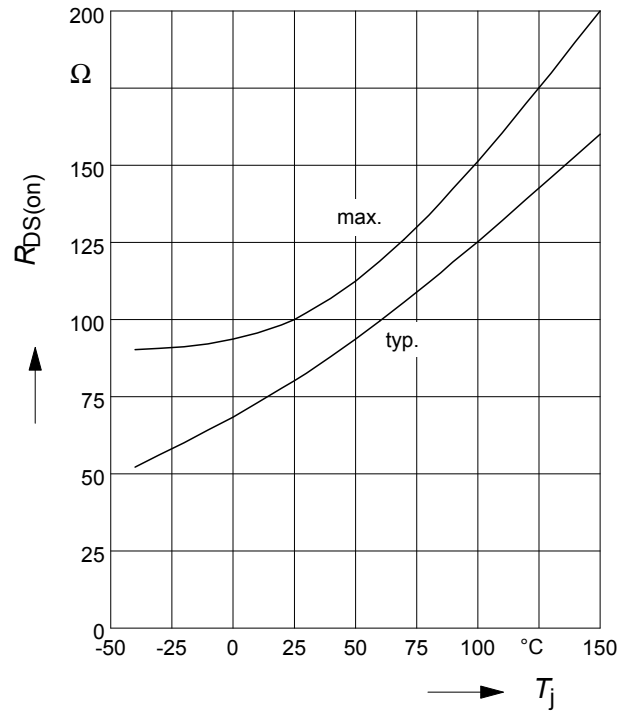
- t_0 : Turn on into a short circuit
- t_m : Measurementpoint for $I_{D(Lim)}$
- t_1 : Activation of the fast temperature sensor and regulation of the drain current to a level where the junction temperature remains constant.
- t_2 : Thermal shutdown caused by the second temperature sensor, achieved by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

Maximum allowable power dissipation

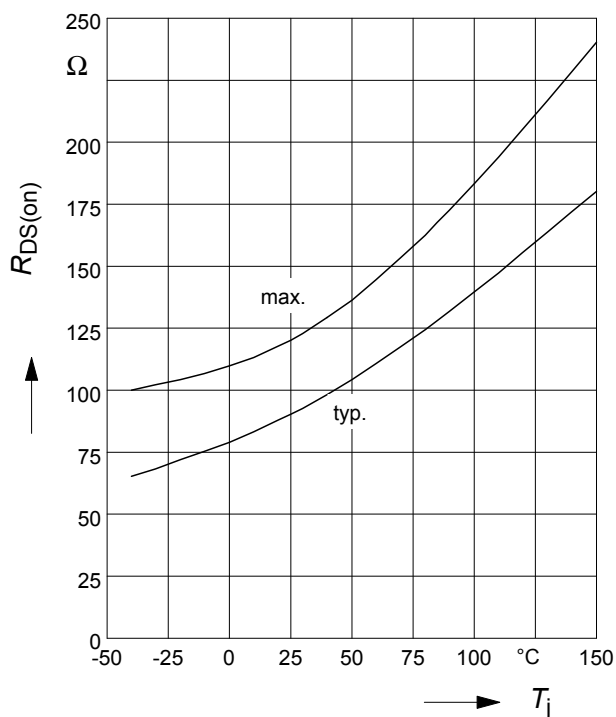
$$P_{\text{tot}} = f(T_c)$$


On-state resistance

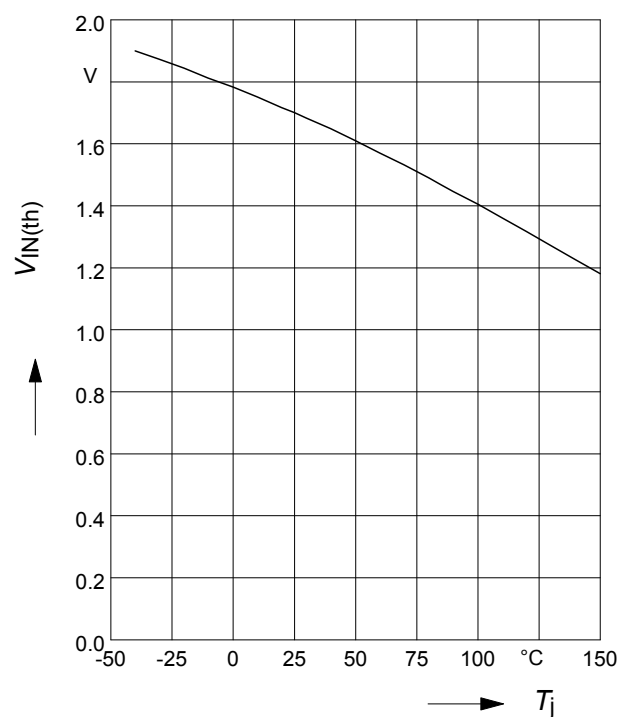
$$R_{\text{ON}} = f(T_j); I_D = 3.5\text{A}; V_{\text{IN}} = 10\text{V}$$

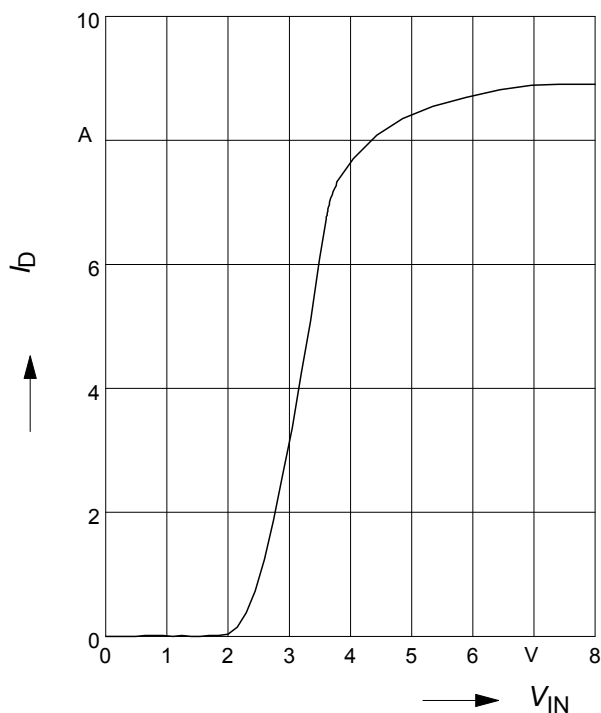

On-state resistance

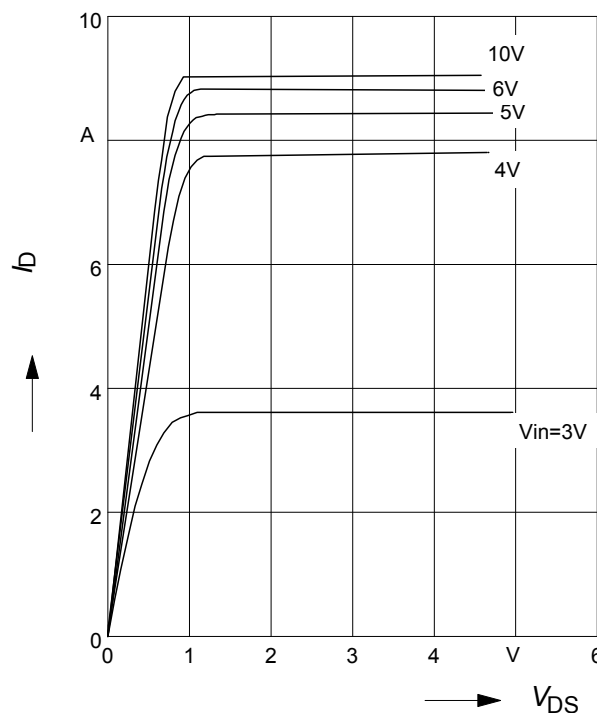
$$R_{\text{ON}} = f(T_j); I_D = 3.5\text{A}; V_{\text{IN}} = 5\text{V}$$

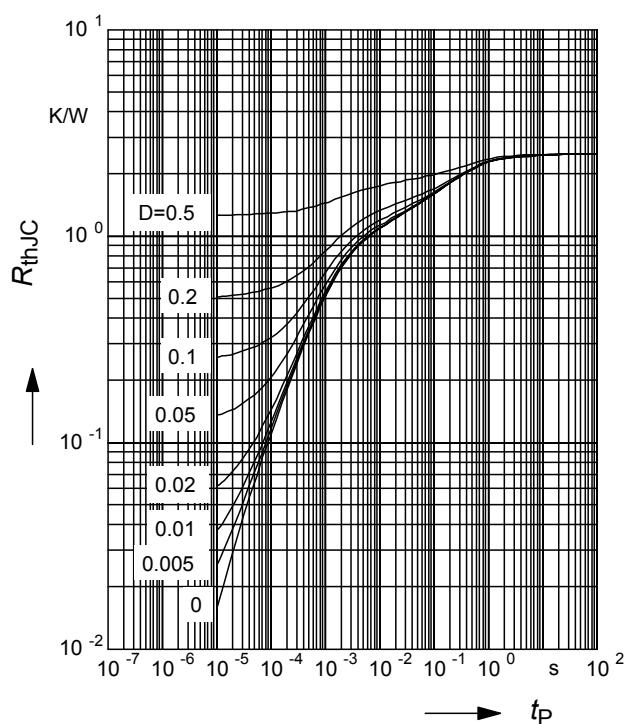

Typ. input threshold voltage

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



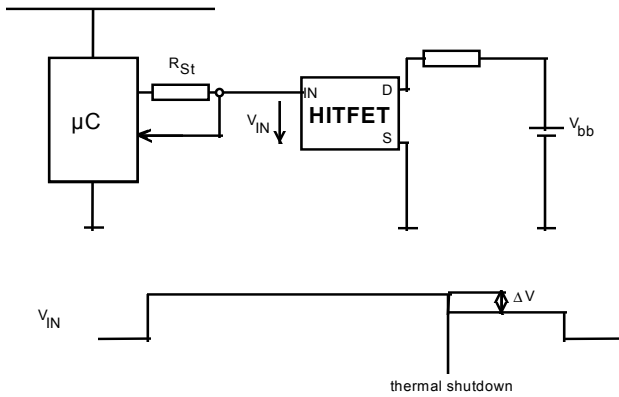
Typ. transfer characteristics
 $I_D = f(V_{IN}); V_{DS}=12V; T_j=25^\circ C$

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

 Parameter: V_{IN}

Transient thermal impedance
 $Z_{thJC} = f(t_p)$

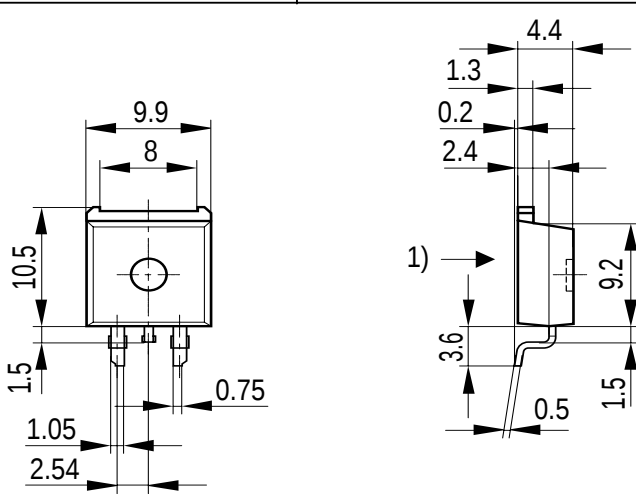
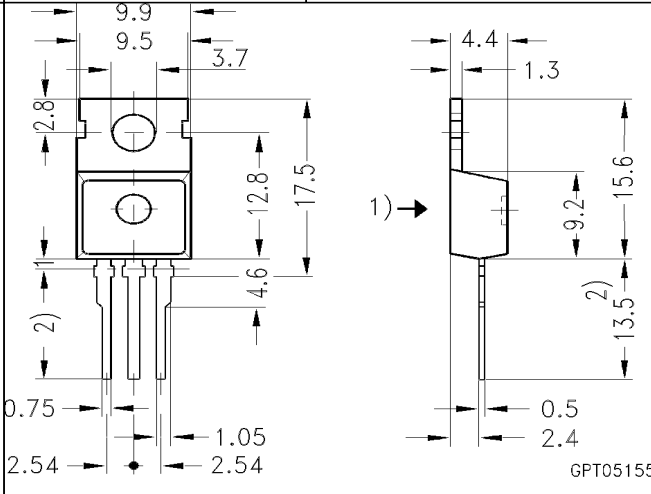
 parameter : $D = t_p/T$


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
 1) shear and punch direction no burrs this surface			
 1) punch direction, burr max. 0.04 2) dip tinning 3) max. 14.5 by dip tinning press burr max. 0.05			

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