

Smart Lowside Power Switch

Features

- Logic Level Input
- Input Protection (ESD)
- Thermal Shutdown
- Overload protection
- Short circuit protection
- Overvoltage protection
- Current limitation
- Maximum current adjustable with external resistor
- Current sense
- Status feedback with external input resistor
- Analog driving possible

Application

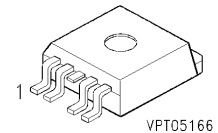
- All kinds of resistive, inductive and capacitive loads in switching or linear applications
- μ C compatible power switch for 12 V and 24 V DC applications
- Replaces electromechanical relays and discrete circuits

General Description

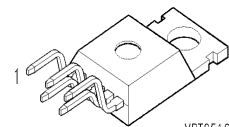
N channel vertical power FET in Smart SIPMOS® chip on chip technology. Fully protected by embedded protected functions.

Product Summary

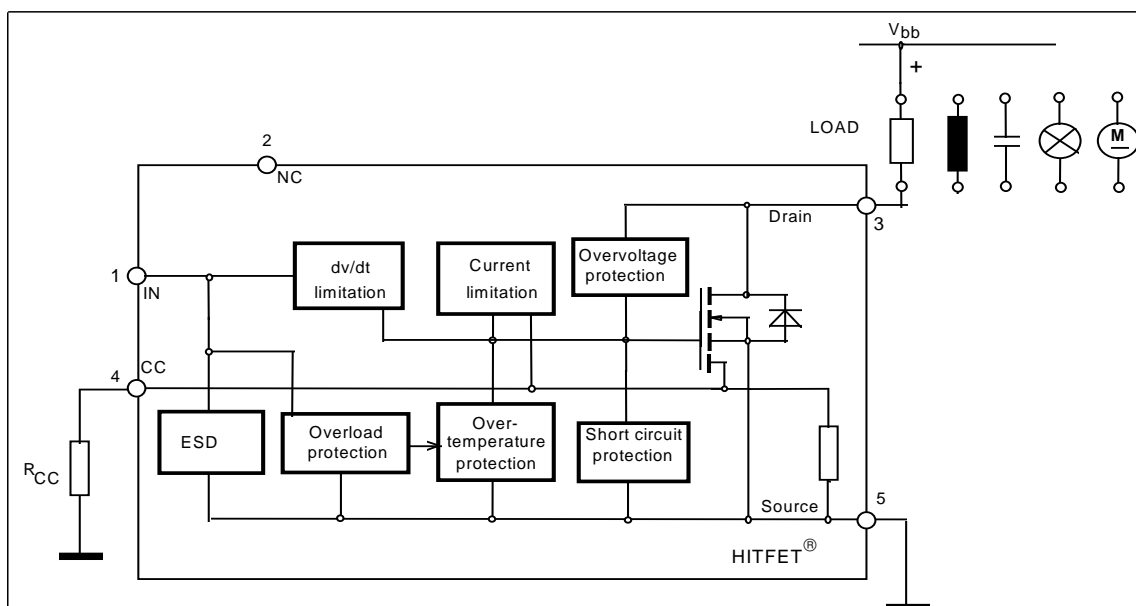
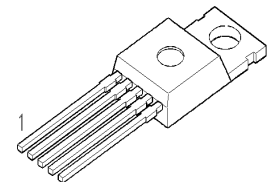
Drain source voltage	V_{DS}	60	V
On-state resistance	$R_{DS(on)}$	28	m Ω
Current limit	$I_{D(lim)}$	6	A
Nominal load current	$I_{D(ISO)}$	12	A
Clamping energy	E_{AS}	4000	mJ



VPT05166



VPT05165



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 $R_{CC} = 0\ \Omega$ without R_{CC}	$V_{DS(SC)}$	15 50	
Continuous input current ¹⁾ $-0.2V \leq V_{IN} \leq 10V$ $V_{IN} < -0.2V$ or $V_{IN} > 10V$	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}	149	W
Unclamped single pulse inductive energy $I_{D(ISO)} = 12\text{ A}$	E_{AS}	4000	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 $V_{LoadDump}^{2)} = V_A + V_S$ $V_{IN} = \text{low or high}; V_A = 13.5\text{ V}$ $t_d = 400\text{ ms}, R_l = 2\ \Omega, I_D = 0,5 \cdot 12A$ $t_d = 400\text{ ms}, R_l = 2\ \Omega, I_D = 12A$	V_{LD}	100 84	
DIN humidity category, DIN 40 040		E	
IEC climatic category; DIN IEC 68-1		40/150/56	

Thermal resistance

junction - case:	R_{thJC}	0.84	K/W
junction - ambient:	R_{thJA}	75	
SMD version, device on PCB: ³⁾	R_{thJA}	45	

¹A sensor holding current of 500 μA has to be guaranteed in the case of thermal shutdown (see also page 3)

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

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

Electrical Characteristics

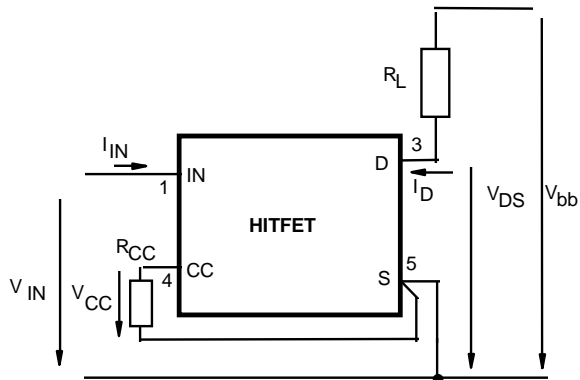
Parameter at $T_j=25^\circ\text{C}$, unless otherwise specified	Symbol	Values			Unit
		min.	typ.	max.	
Characteristics					
Drain source clamp voltage $T_j = -40 \dots +150^\circ\text{C}$, $I_D = 10 \text{ mA}$	$V_{DS(AZ)}$	60	-	73	V
Off state drain current $V_{DS} = 32 \text{ V}$, $T_j = -40 \dots +150^\circ\text{C}$, $V_{IN} = 0 \text{ V}$	I_{DSS}	-	-	20	μA
Input threshold voltage $I_D = 2,7 \text{ mA}$	$V_{IN(th)}$	1.3	1.7	2.2	V
Input current - normal operation, $I_D < I_{D(lim)}$: $V_{IN} = 10 \text{ V}$	$I_{IN(1)}$	-	35	100	μA
Input current - current limitation mode, $I_D = I_{D(lim)}$: $V_{IN} = 10 \text{ V}$	$I_{IN(2)}$	-	270	500	
Input current - after thermal shutdown, $I_D = 0 \text{ A}$: $V_{IN} = 10 \text{ V}$	$I_{IN(3)}$	1000	2500	4000	
Input holding current after thermal shutdown $T_j = 25^\circ\text{C}$ $T_j = 150^\circ\text{C}$	$I_{IN(H)}$	500 300	- -	- -	
On-state resistance $I_D = 12 \text{ A}$, $V_{IN} = 5 \text{ V}$, $T_j = 25^\circ\text{C}$ $I_D = 12 \text{ A}$, $V_{IN} = 5 \text{ V}$, $T_j = 150^\circ\text{C}$	$R_{DS(on)}$	- -	31 52	34 68	$\text{m}\Omega$
On-state resistance $I_D = 12$, $V_{IN} = 10 \text{ V}$, $T_j = 25^\circ\text{C}$ $I_D = 12$, $V_{IN} = 10$, $T_j = 150$	$R_{DS(on)}$	- -	25 45	28 56	
Nominal load current (ISO 10483) $V_{IN} = 10 \text{ V}$, $V_{DS} = 0.5 \text{ V}$, $T_C = 85^\circ\text{C}$	$I_{D(ISO)}$	12			A

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 $V_{IN} = 10\text{ V}$, $V_{DS} = 12\text{ V}$	$I_{D(SCP)}$	-	160	-	A
Current limit 1) $V_{IN} = 10\text{ V}$, $V_{DS} = 12\text{ V}$, $t_m = 350\ \mu\text{s}$, $T_j = -40\dots+150\ ^\circ\text{C}$, without R_{CC} $V_{IN} = 10\text{ V}$, $V_{DS} = 12\text{ V}$, $t_m = 350\ \mu\text{s}$, $T_j = -40\dots+150\ ^\circ\text{C}$, $R_{CC} = 0\ \Omega$	$I_{D(lim)}$	6 100	12 130	25 170	
Dynamic Characteristics					
Turn-on time V_{IN} to 90% I_D : $R_L = 2,2\ \Omega$, $V_{IN} = 0$ to 10 V , $V_{bb} = 12\text{ V}$	t_{on}	-	40	100	μs
Turn-off time V_{IN} to 10% I_D : $R_L = 2,2\ \Omega$, $V_{IN} = 10$ to 0 V , $V_{bb} = 12\text{ V}$	t_{off}	-	70	170	μs
Slew rate on 70 to 50% V_{bb} : $R_L = 2,2\ \Omega$, $V_{IN} = 0$ 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} : $R_L = 2,2\ \Omega$, $V_{IN} = 10$ 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 $I_D = 12\text{ A}$, $T_j = 25\ ^\circ\text{C}$, $V_{bb} = 32\text{ V}$ $I_D = 12\text{ A}$, $T_j = 150\ ^\circ\text{C}$, $V_{bb} = 32\text{ V}$	E_{AS}	4000 900	- -	- -	mJ
Inverse Diode					
Inverse diode forward voltage $I_F = 5 \cdot 12\text{ A}$, $t_m = 300\ \mu\text{s}$, $V_{IN} = 0\text{ V}$	V_{SD}	-	1.13	-	V

¹Device switched on into existing short circuit (see diagram Determination of $I_{D(lim)}$). Dependant on the application, these values might be exceeded for max. 50 μs in case of short circuit occurs while the device is on condition

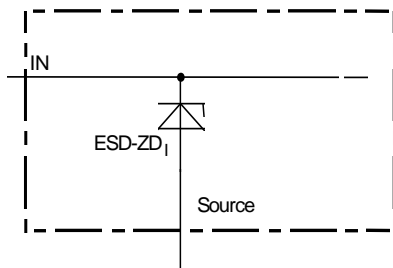
Block Diagramm

Terms



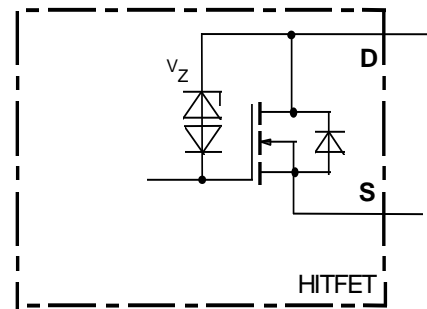
The ground lead impedance of R_{CC} should be as low as possible

Input circuit (ESD protection)

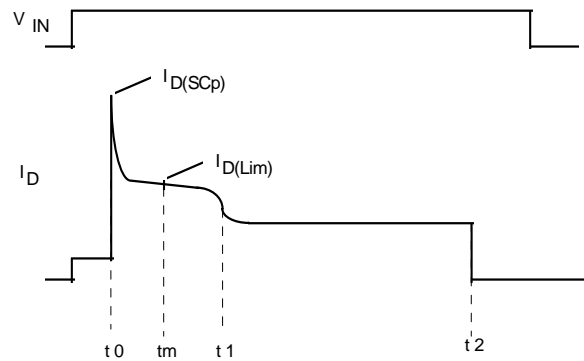


ESD zener diodes are not designed for DC current $> 2 \text{ mA}$ @ $V_{IN} > 10 \text{ V}$.

Inductive and overvoltage output clamp



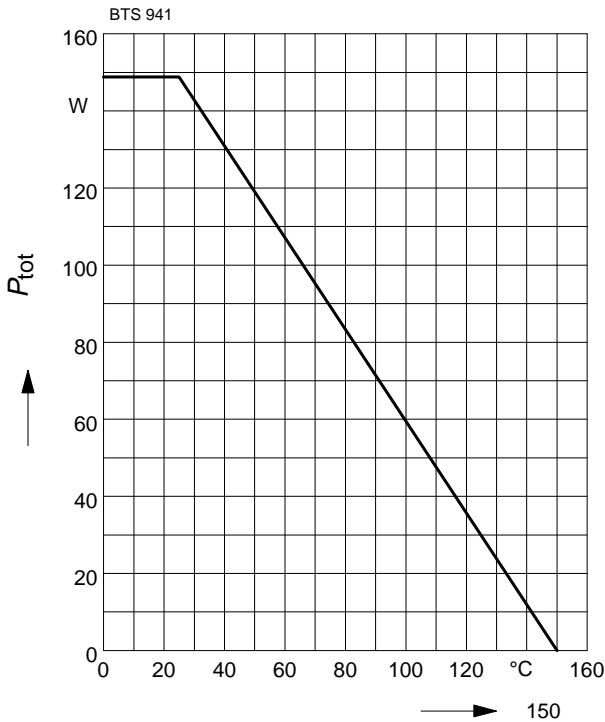
Short circuit behaviour



- 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.

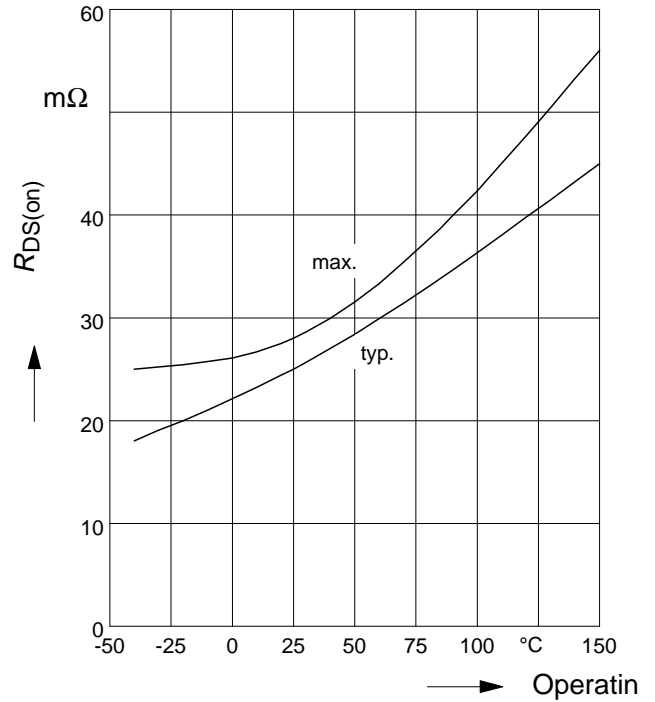
Maximum allowable power dissipation

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



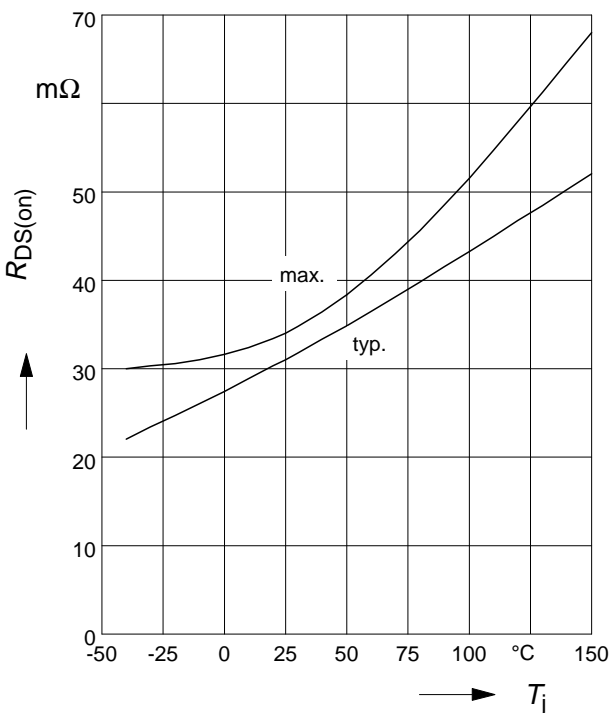
On-state resistance

$$R_{\text{ON}} = f(T_j); I_D=12\text{A}; V_{\text{IN}}=10\text{V}$$



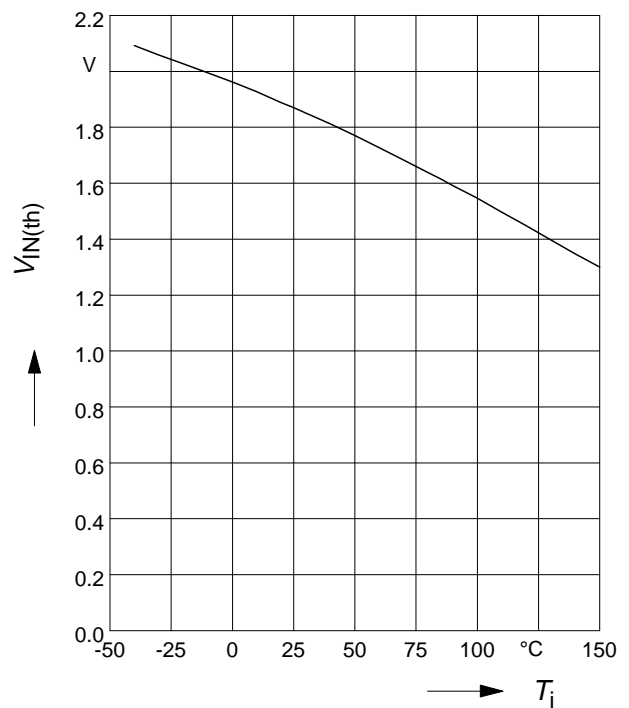
On-state resistance

$$R_{\text{ON}} = f(T_j); I_D=12\text{A}; V_{\text{IN}}=5\text{V}$$



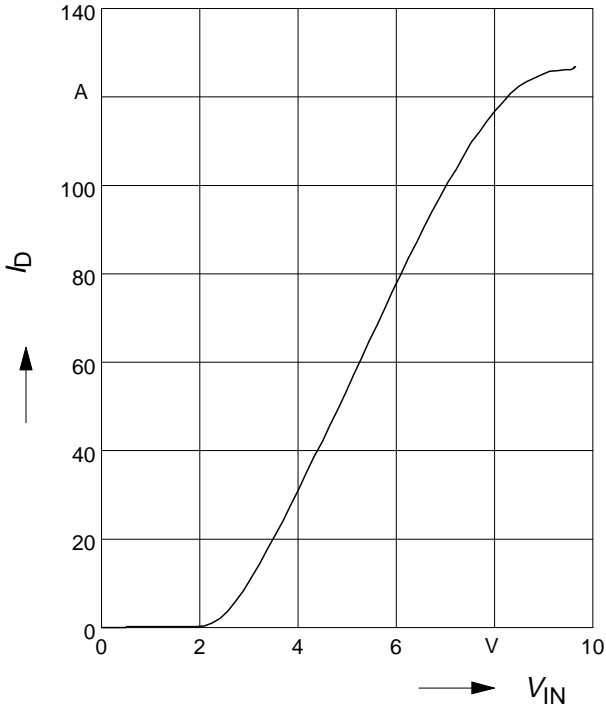
Typ. input threshold voltage

$$V_{\text{IN(th)}} = f(T_j); I_D=2,7\text{A}; V_{\text{DS}}=12\text{V}$$



Typ. transfer characteristics

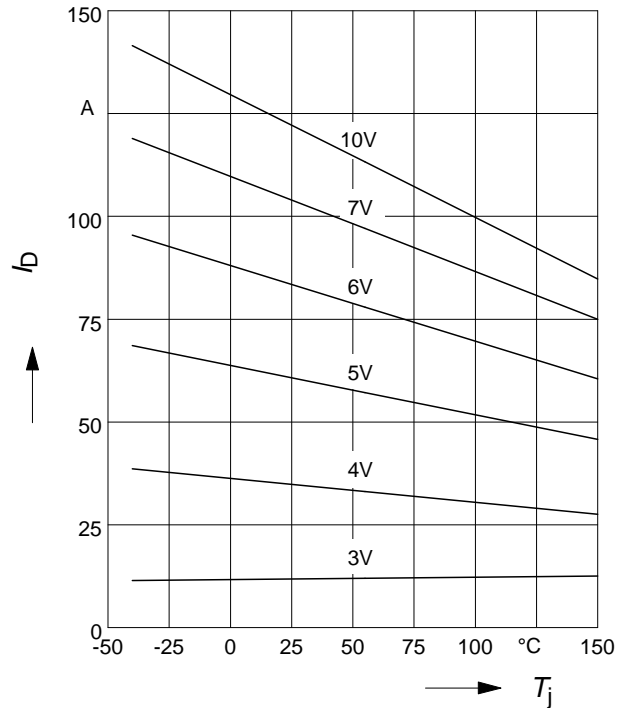
$$I_D = f(V_{IN}); V_{DS}=12V; T_j=25^\circ C$$



Typ. short circuit current

$$I_{Dlim} = f(T_j); R_{CC}=0\Omega, V_{DS}=12V$$

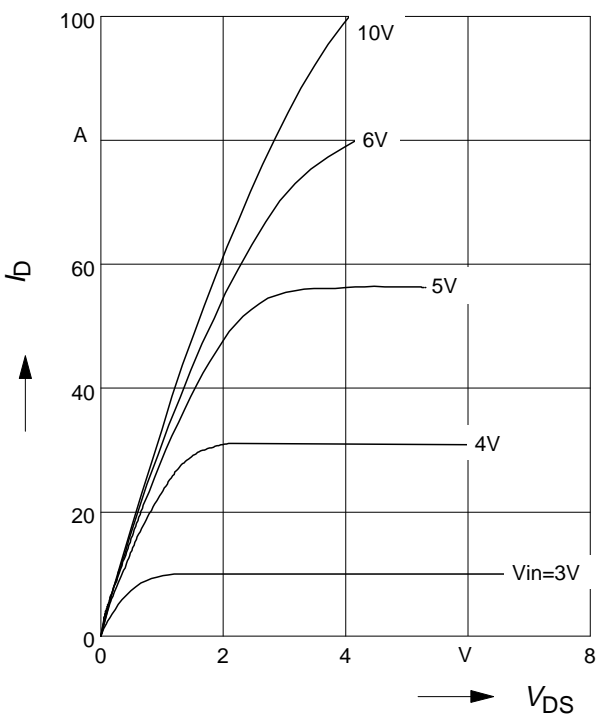
Parameter: V_{IN}



Typ. output characteristic

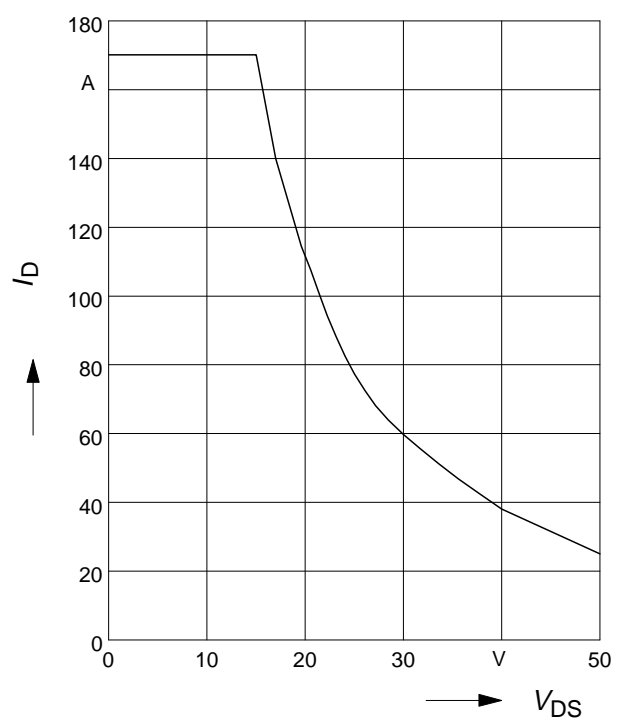
$$I_D = f(V_{DS}); T_j=25^\circ C$$

Parameter: V_{IN}



Safe Operating Area

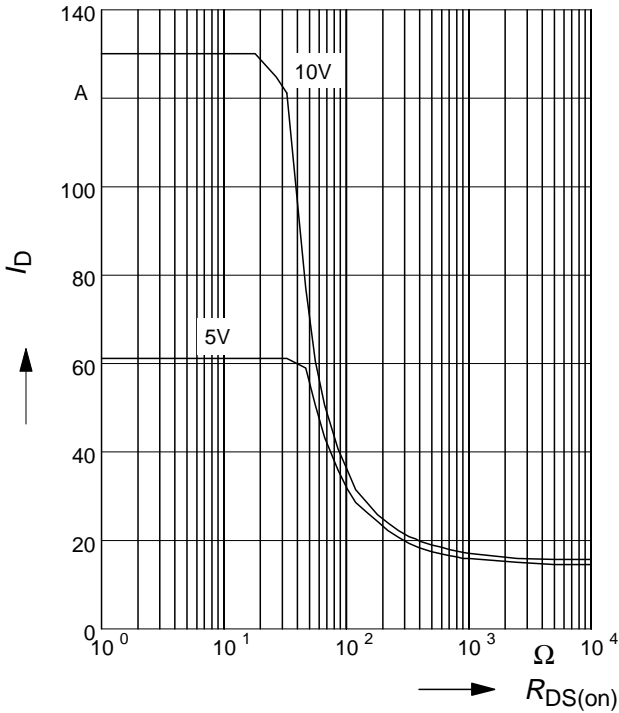
$$I_{D(SC)} = f(V_{DS}); T_j=25^\circ C$$



Typ. current limit versus R_{CC}

$$I_{D(lim)} = f(R_{CC}); T_j = 25^\circ\text{C}$$

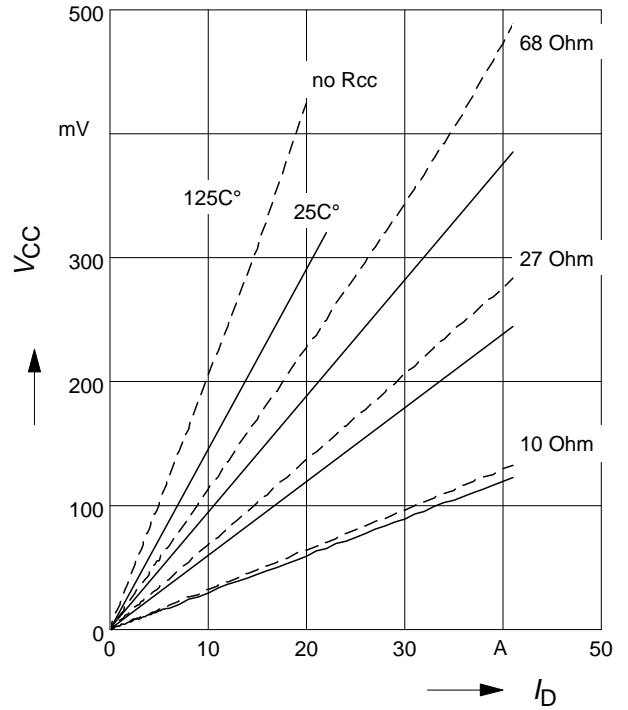
Parameter: V_{IN}



Typ. current sense characteristics

$$V_{CC} = f(I_D); V_{IN} = 10V$$

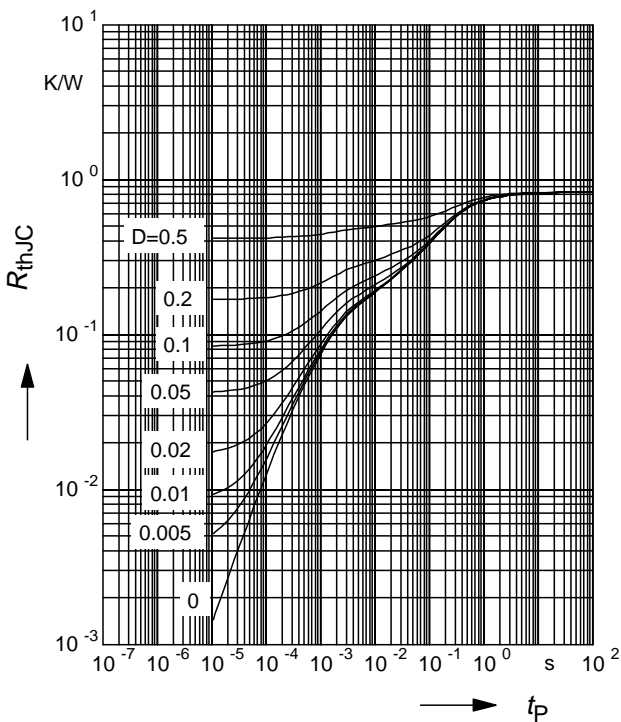
Parameter: R_{CC}, T_j



Transient thermal impedance

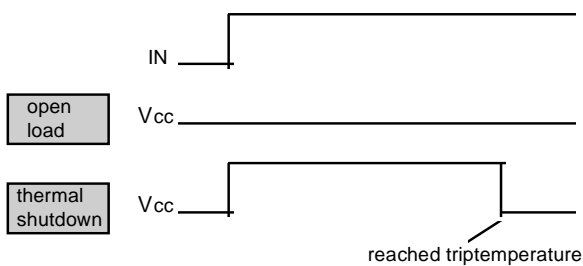
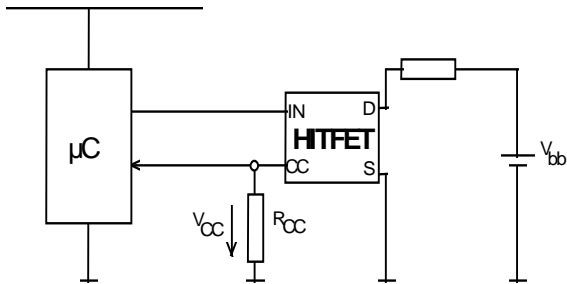
$$Z_{thJC} = f(t_p)$$

Parameter: $D = t_p/T$



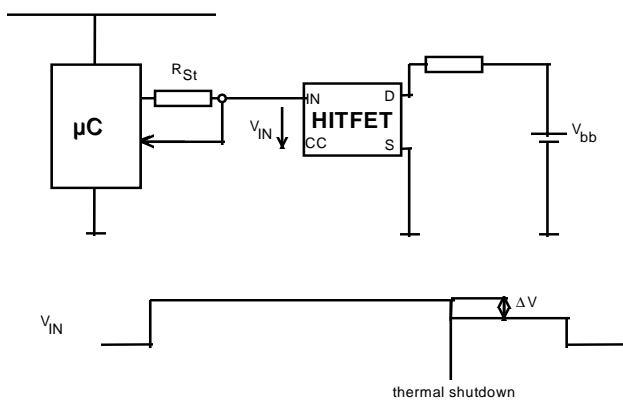
Application examples:

Current Sense Features and Status Signals



The accuracy of V_{cc} is at each temperature about $\pm 10\%$

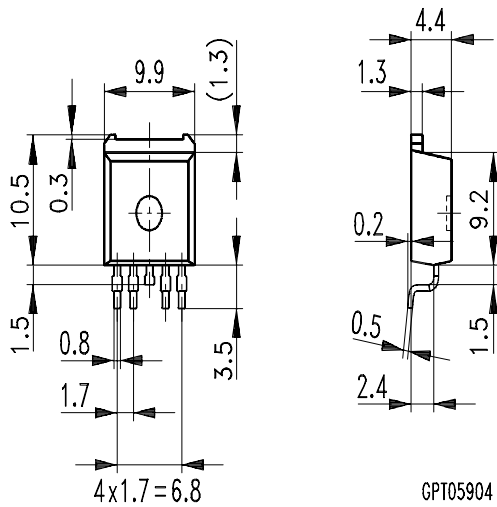
Status signal of thermal shutdown by monitoring input current



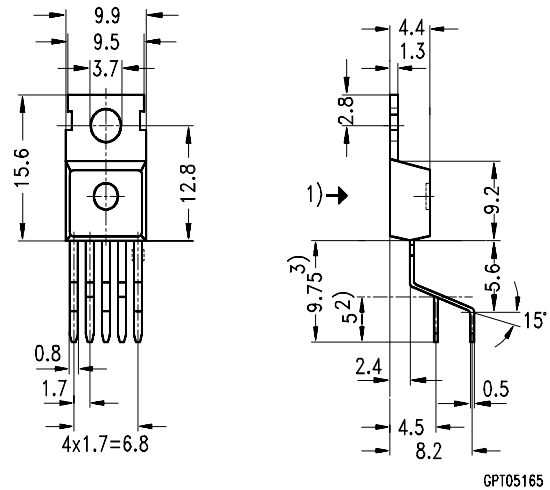
$$\Delta V = R_{ST} * I_{IN(3)}$$

Package and ordering code all dimensions in mm

Ordering code: Q67060-S6702-A4

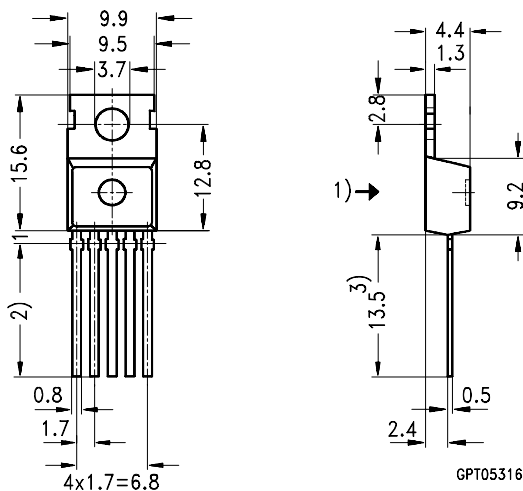


Ordering Code: Q67060-S6702-A2



- 1) shear and punch direction no burrs this surface
- 2) min. length by tinning
- 3) max. 11 mm allowable by tinning

Ordering Code: Q67060-S6702-A3



- 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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