

Smart Lowside Power Switch

Features

- Logic Level Input
- Input Protection (ESD)
- Thermal shutdown with latch
- 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

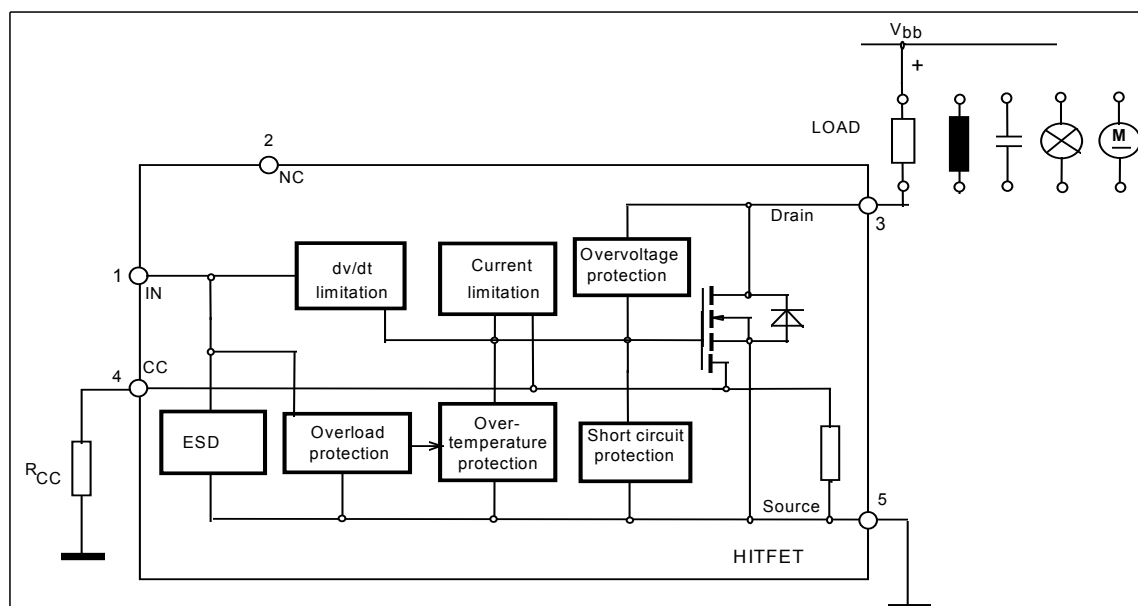
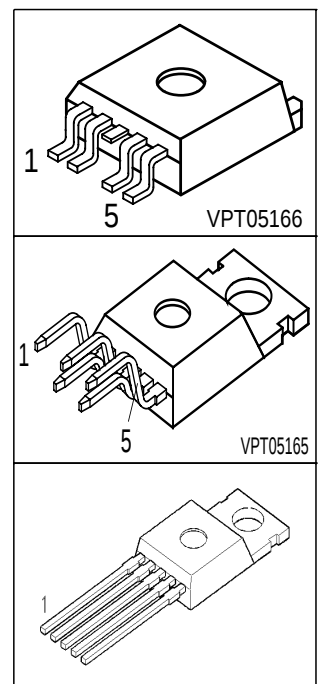
- All kinds of resistive, inductive and capacitive loads in switching or linear applications
- μ C compatible power switch for 12 V and 24 V DC applications
- Replaces electromechanical relays and discrete circuits

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	$R_{DS(on)}$	18	m Ω
Current limit	$I_{D(lim)}$	9.5	A
Nominal load current	$I_{D(ISO)}$	19	A
Clamping energy	E_{AS}	6000	mJ



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}	240	W
Unclamped single pulse inductive energy $I_{D(ISO)} = 19\text{ A}$	E_{AS}	6000	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 $V_{LoadDump}^{2)} = V_A + V_S$ $V_{IN} = \text{low or high}; V_A = 13.5\text{ V}$ $t_d = 400\text{ ms}, R_l = 2\ \Omega, I_D = 0.5 \cdot 19\text{ A}$ $t_d = 400\text{ ms}, R_l = 2\ \Omega, I_D = 19\text{ A}$	V_{LD}	110 92	
DIN humidity category, DIN 40 040		E	
IEC climatic category; DIN IEC 68-1		40/150/56	

Thermal resistance

junction - case:	R_{thJC}	0.7	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}	-	-	25	µA
Input threshold voltage I _D = 3,9 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)}	-	-	100	µA
Input current - current limitation mode, I _D =I _{D(lim)} : V _{IN} = 10 V	I _{IN(2)}	-	400	1000	
Input current - after thermal shutdown, I _D =0 A: V _{IN} = 10 V	I _{IN(3)}	1500	3000	6000	
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 = 19 A, T _j = 25 °C V _{IN} = 5 V, I _D = 19 A, T _j = 150 °C	R _{DS(on)}	- -	18 30	22 44	mΩ
On-state resistance V _{IN} = 10 V, I _D = 19 A, T _j = 25 °C V _{IN} = 10 V, I _D = 19 A, T _j = 150 °C	R _{DS(on)}	- -	14 25	18 36	
Nominal load current (ISO 10483) V _{IN} = 10 V, V _{DS} = 0.5 V, T _C = 85 °C	I _{D(ISO)}	19	-	-	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 $V_{IN} = 10\text{ V}$, $V_{DS} = 12\text{ V}$	$I_{D(SCP)}$	-	175	-	A
Current limit ¹⁾ $V_{IN} = 10\text{ V}$, $V_{DS} = 12\text{ V}$, $t_m = 350\text{ }\mu\text{s}$, $T_j = -40\dots+150\text{ }^\circ\text{C}$, without R_{CC} $V_{IN} = 10\text{ V}$, $V_{DS} = 12\text{ V}$, $t_m = 350\text{ }\mu\text{s}$, $T_j = -40\dots+150\text{ }^\circ\text{C}$, $R_{CC} = 0\text{ }\Omega$	$I_{D(lim)}$	9.5 150	19 220	40 270	

Dynamic Characteristics

Turn-on time V_{IN} to 90% I_D : $R_L = 1\text{ }\Omega$, $V_{IN} = 0$ to 10 V , $V_{bb} = 12\text{ V}$	t_{on}	-	40	100	μs
Turn-off time V_{IN} to 10% I_D : $R_L = 1\text{ }\Omega$, $V_{IN} = 10$ to 0 V , $V_{bb} = 12\text{ V}$	t_{off}	-	70	170	
Slew rate on 70 to 50% V_{bb} : $R_L = 1\text{ }\Omega$, $V_{IN} = 0$ 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} : $R_L = 1\text{ }\Omega$, $V_{IN} = 10$ 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 $I_D = 19\text{ A}$, $T_j = 25\text{ }^\circ\text{C}$, $V_{bb} = 32\text{ V}$ $I_D = 19\text{ A}$, $T_j = 150\text{ }^\circ\text{C}$, $V_{bb} = 32\text{ V}$	E_{AS}	6000 1800	- -	- -	mJ

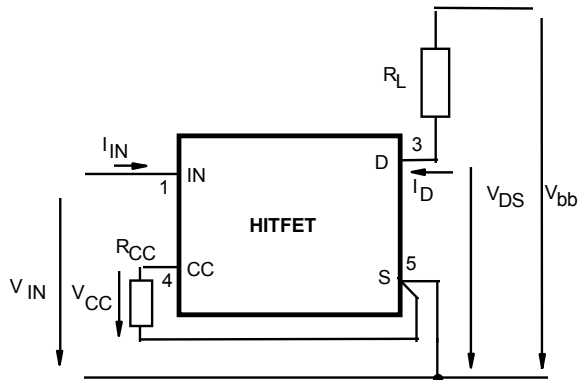
Inverse Diode

Inverse diode forward voltage $I_F = 5 \cdot 19\text{ A}$, $t_m = 300\text{ }\mu\text{s}$, $V_{IN} = 0\text{ V}$	V_{SD}	-	1,1	-	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 .

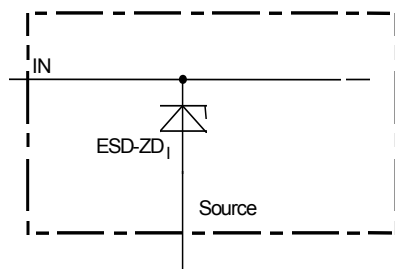
Block Diagramm

Terms



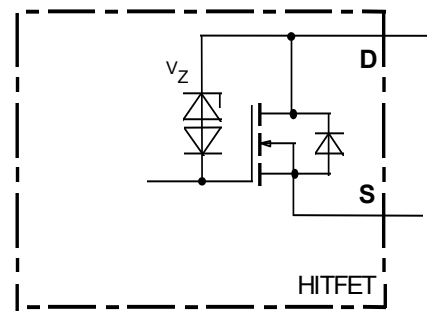
The ground lead impedance of R_{CC} should be as low as possible

Input circuit (ESD protection)

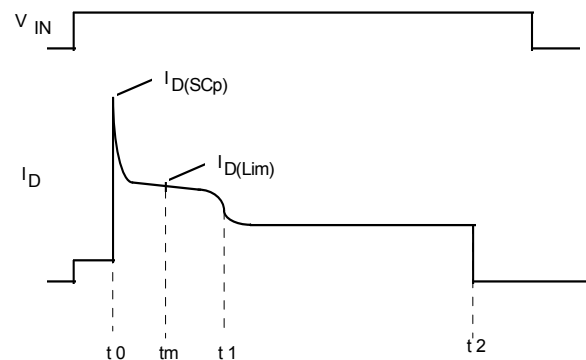


ESD zener diodes are not designed for DC current $> 2 \text{ mA}$ @ $V_{IN} > 10 \text{ V}$.

Inductive and overvoltage output clamp



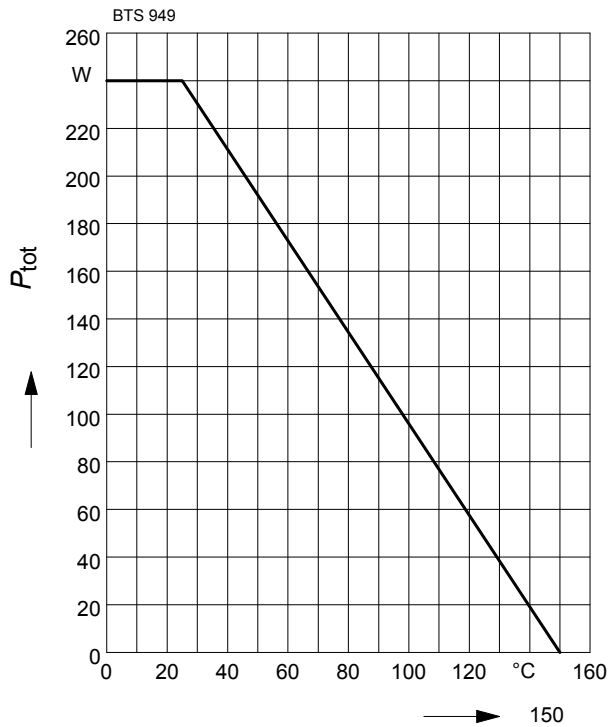
Short circuit behaviour



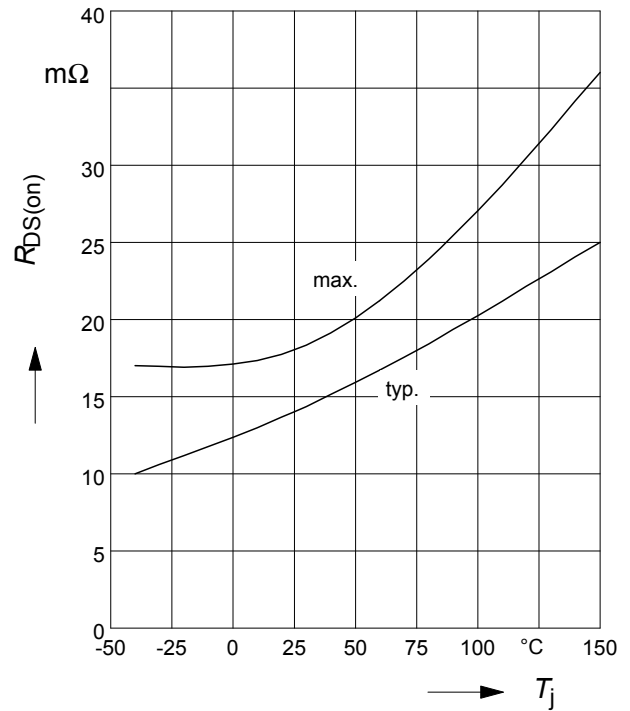
- t_0 : Turn on into a short circuit
- t_m : Measurement point for $I_{D(Lim)}$
- t_1 : Activation of the fast temperature sensor and regulation of the drain current to a level where the junction temperature remains constant.
- t_2 : Thermal shutdown caused by the second temperature sensor, achieved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

Maximum allowable power dissipation

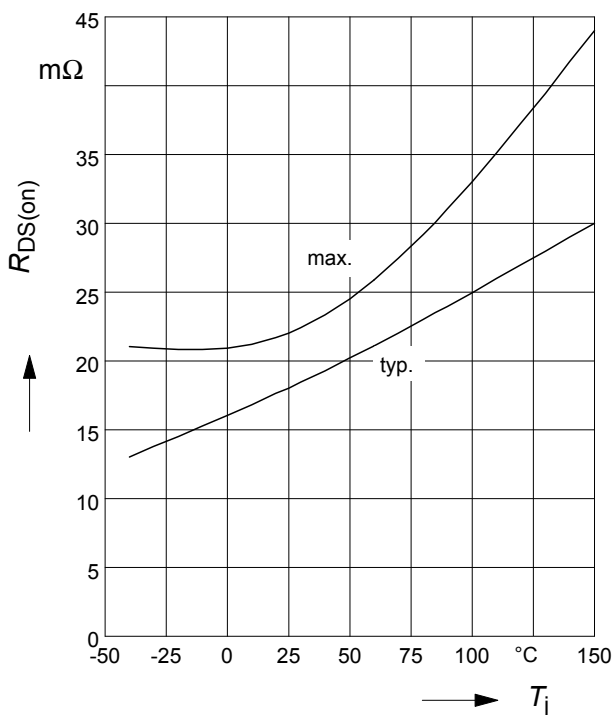
$$P_{\text{tot}} = f(T_c)$$


On-state resistance

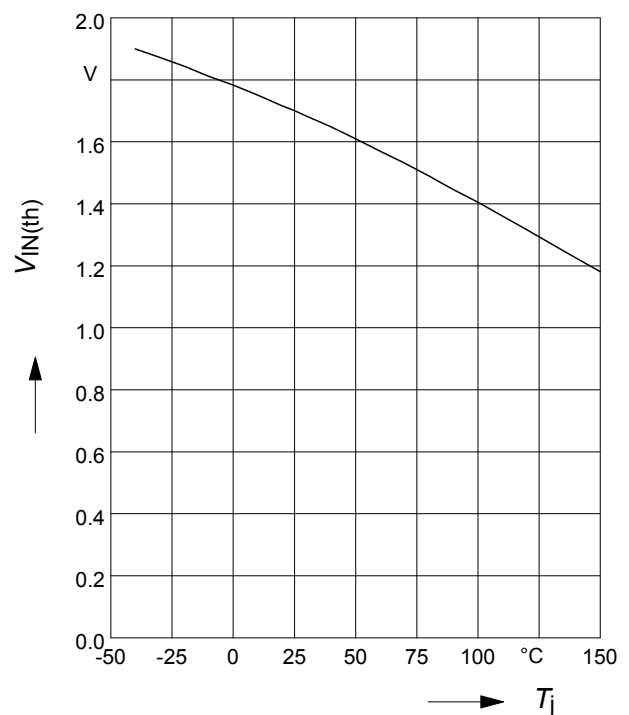
$$R_{\text{ON}} = f(T_j); I_D=19\text{A}; V_{\text{IN}}=10\text{V}$$

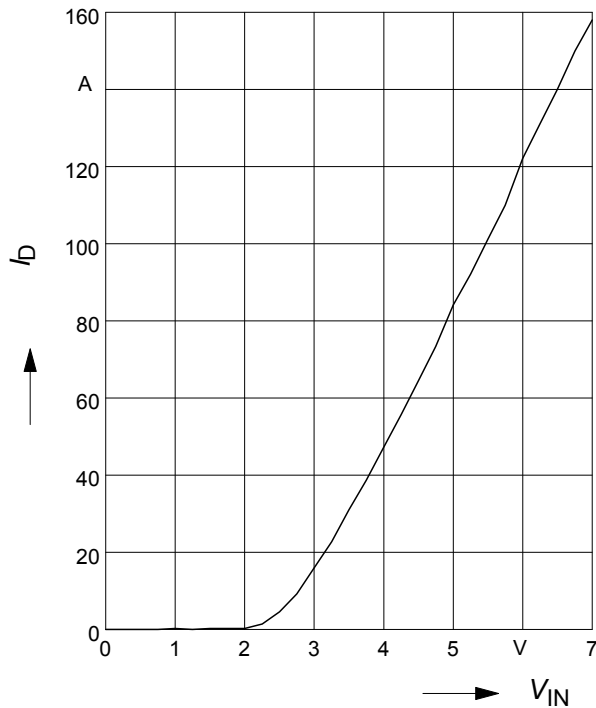

On-state resistance

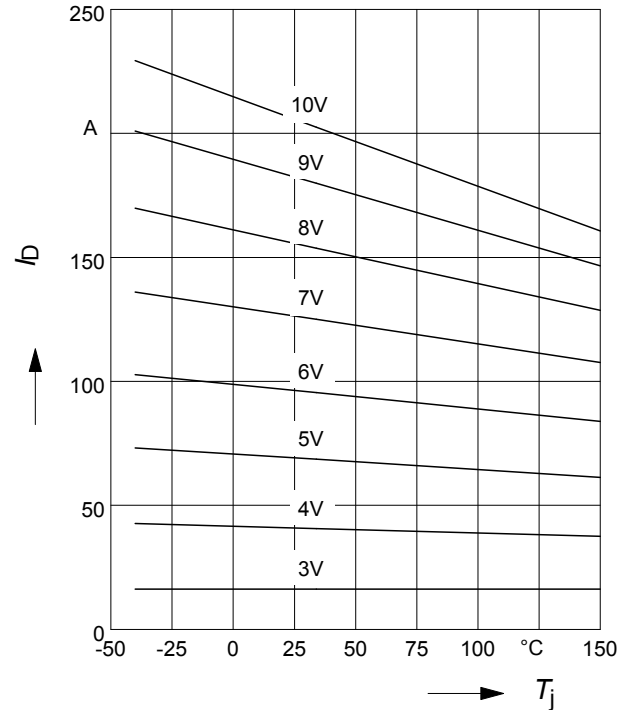
$$R_{\text{ON}} = f(T_j); I_D= 19\text{A}; V_{\text{IN}}=5\text{V}$$

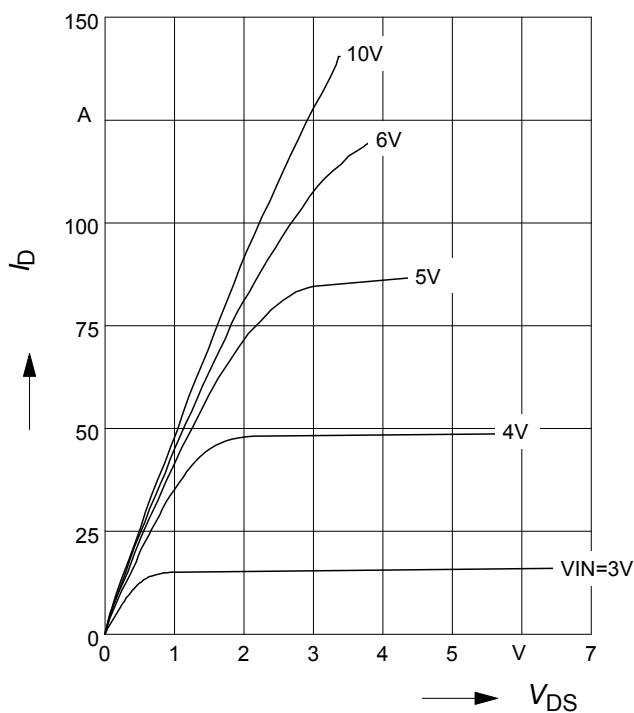
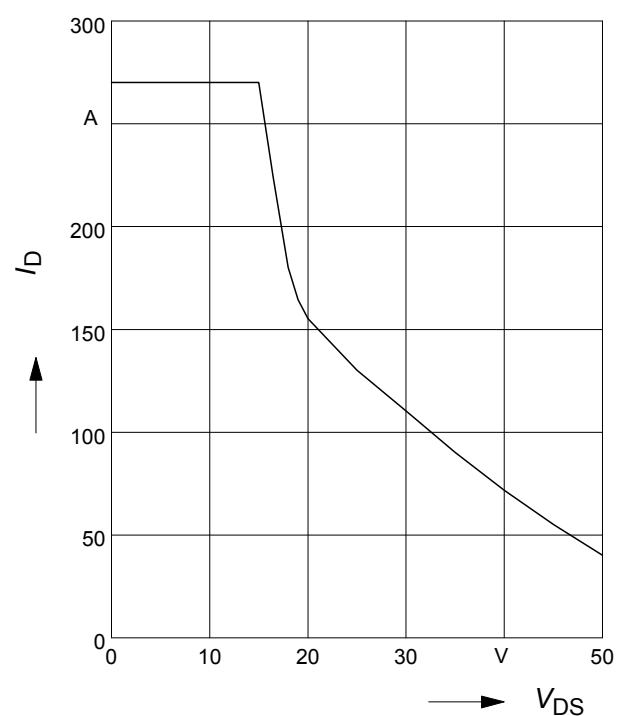

Typ. input threshold voltage

$$V_{\text{IN(th)}} = f(T_j); I_D=3,9\text{A}; V_{\text{DS}}=12\text{V}$$



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

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

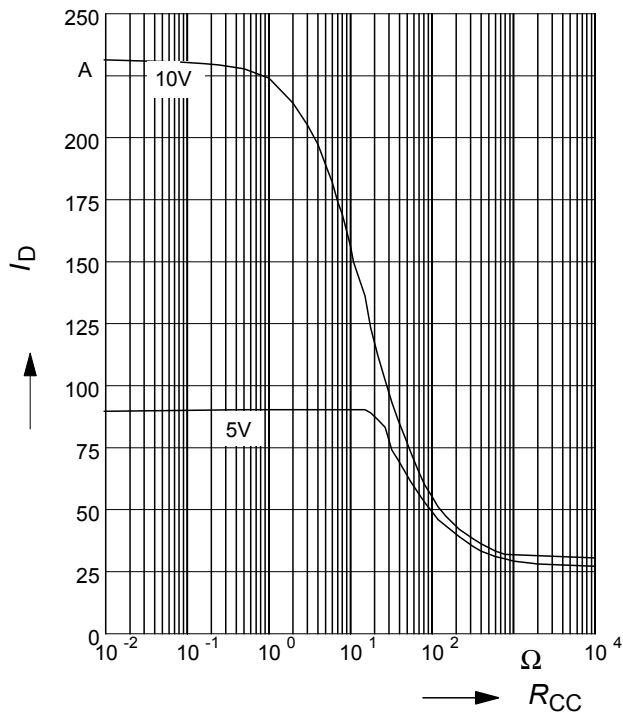
 Parameter: V_{IN}

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}

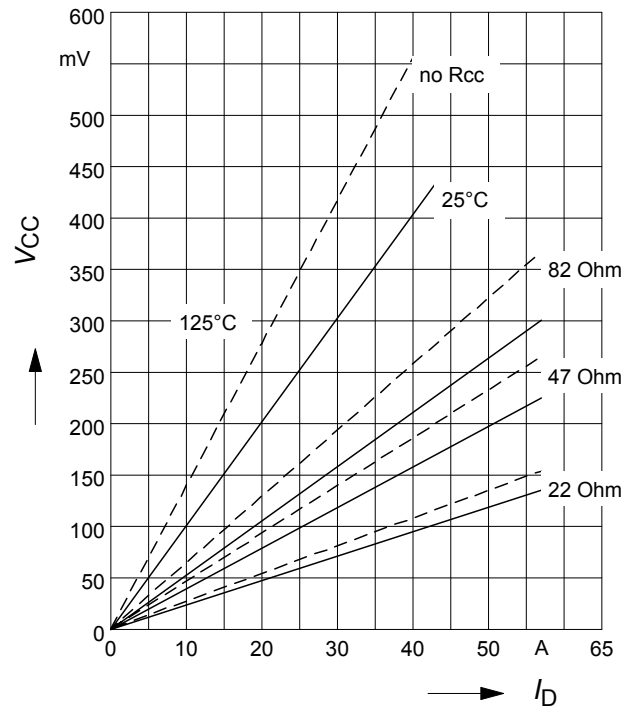
$$I_{D(lim)} = f(R_{CC}); T_j = 25^\circ\text{C}$$

Parameter: V_{IN}


Typ. current sense characteristics

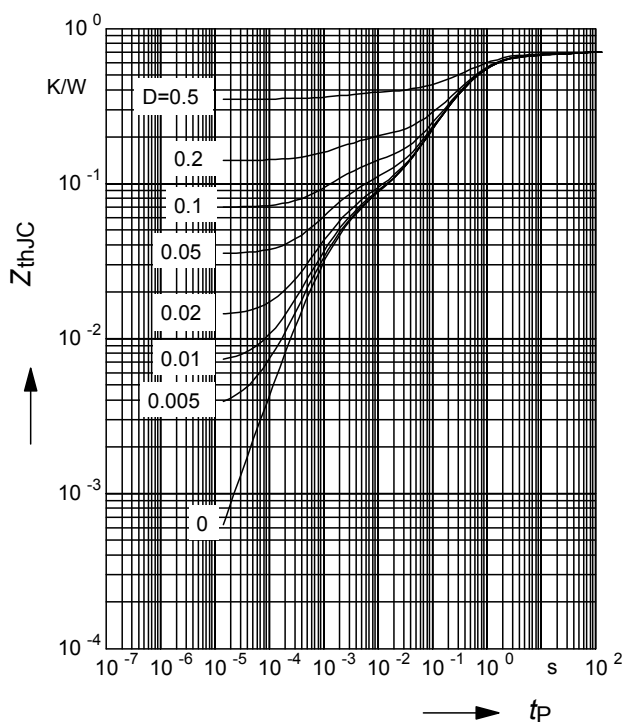
$$V_{CC} = f(I_D); V_{IN} = 10\text{V}$$

Parameter: R_{CC}, T_j


Transient thermal impedance

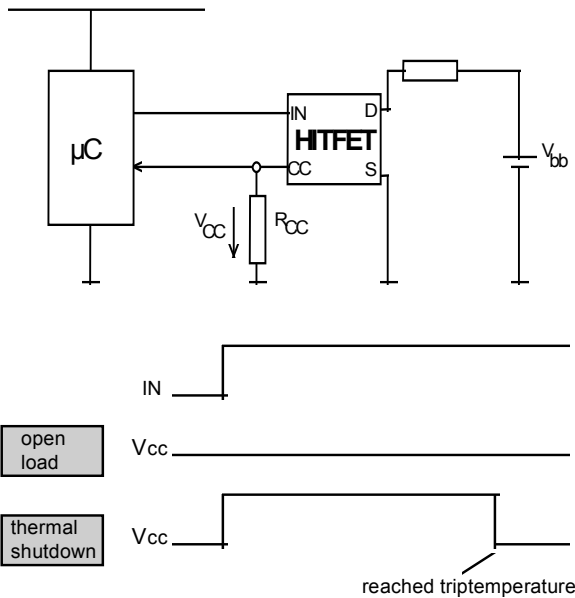
$$Z_{thJC} = f(t_p)$$

parameter : $D = t_p/T$



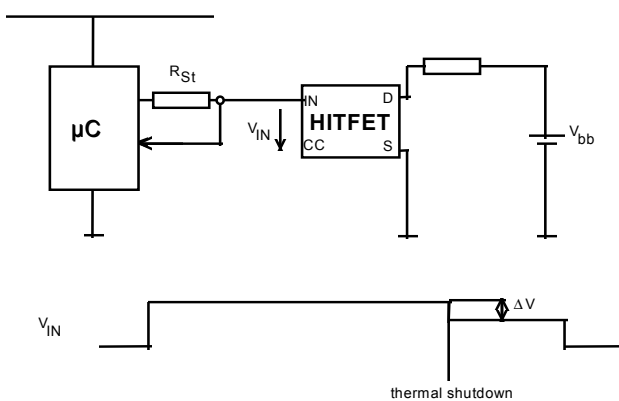
Application examples:

Current Sense Features and Status Signals



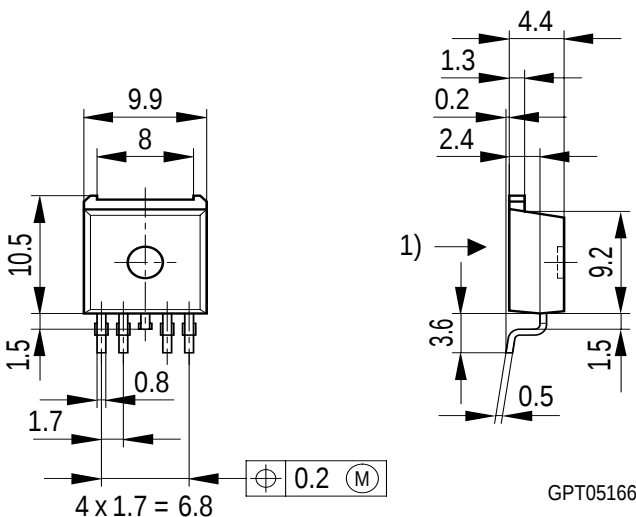
The accuracy of V_{CC} is at each temperature about $\pm 10\%$

Status signal of thermal shutdown by monitoring input current



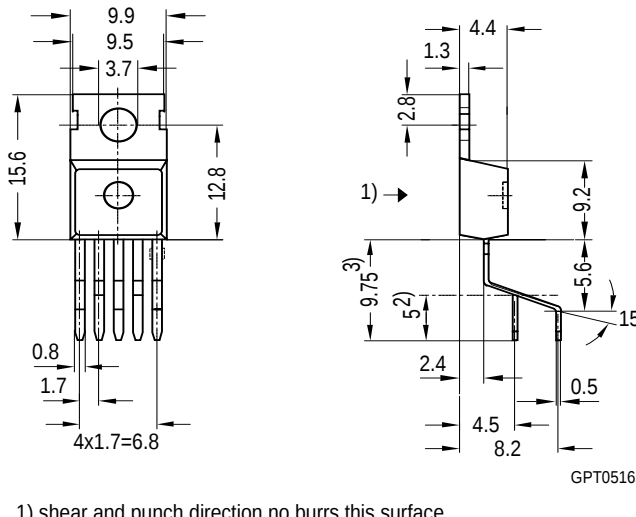
$$\Delta V = R_{ST} * I_{IN(3)}$$

Package	Ordering Code	Package	Ordering Code
P-TO220-5-62	Q67060-S6703-A4	P-TO220-5-3	Q67060-S6703-A2



1) shear and punch direction no burrs this surface

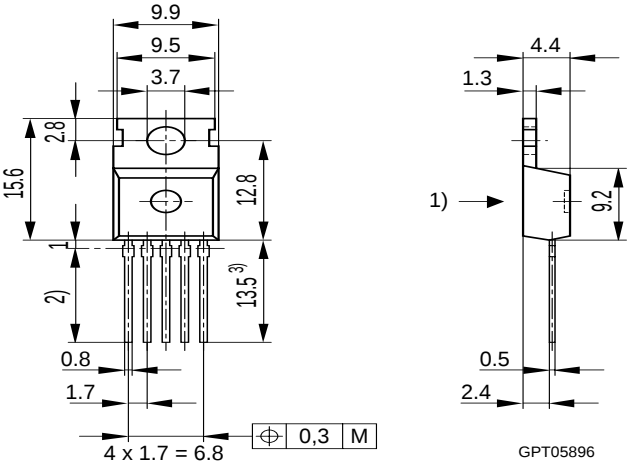
GPT05166



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

GPT05165

Package	Ordering Code
P-TO220-5-43	On request



1) Punch direction, burr max. 0.04
2) Dip tinning
3) Max. 14.5 by dip tinning press burr max. 0.05 radii not dimensioned max. 0.2

GPT05896

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