

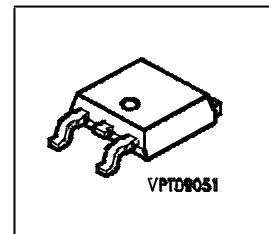
# Smart Lowside Power Switch

## Features

- Logic Level Input
- Input Protection (ESD)
- Thermal shutdown
- Overload protection
- Short circuit protection
- Overvoltage protection
- Current limitation
- Analog driving possible

## Product Summary

Drain source voltage	$V_{DS}$	42	V
On-state resistance	$R_{DS(on)}$	28	m $\Omega$
Nominal load current	$I_{D(Nom)}$	4.6	A
Clamping energy	$E_{AS}$	3.5	J

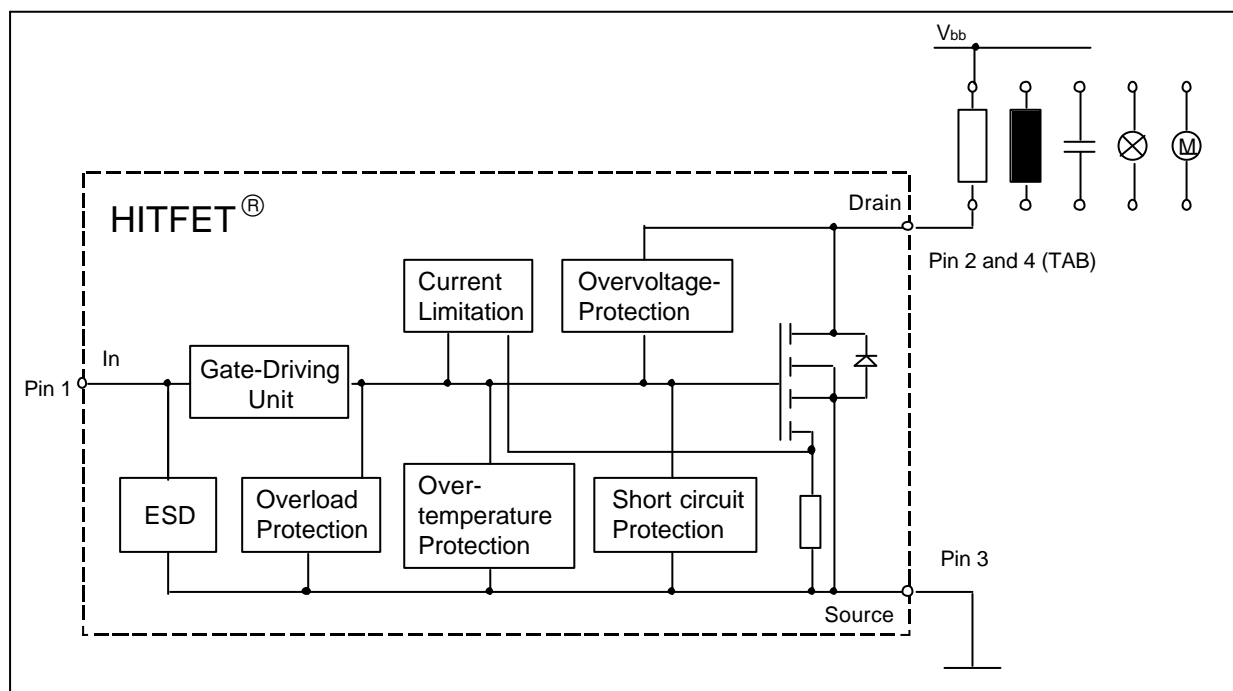


## Application

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

## General Description

N channel vertical power FET in Smart SIPMOS<sup>®</sup> technology. Fully protected by embedded protection functions.



**Maximum Ratings at  $T_j = 25^\circ\text{C}$ , unless otherwise specified**

Parameter	Symbol	Value	Unit
Drain source voltage	$V_{DS}$	42	V
Drain source voltage for short circuit protection $T_j = -40\dots150^\circ\text{C}$	$V_{DS(SC)}$	28	
Continuous input current $-0.2\text{V} \leq V_{IN} \leq 10\text{V}$ $V_{IN} < -0.2\text{V}$ or $V_{IN} > 10\text{V}$	$I_{IN}$	no limit $ I_{IN}  \leq 2$	mA
Operating temperature	$T_j$	-40 ... +150	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 ... +150	
Power dissipation $T_C = 85^\circ\text{C}$ 6cm <sup>2</sup> cooling area , $T_A = 85^\circ\text{C}$	$P_{tot}$	59 1.1	W
Unclamped single pulse inductive energy <sup>1)</sup>	$E_{AS}$	3.5	J
Load dump protection $V_{LoadDump}^{2)} = V_A + V_S$ $V_{IN} = 0$ and 10 V, $t_d = 400$ ms, $R_I = 2 \Omega$ , $R_L = 3 \Omega$ , $V_A = 13.5$ V	$V_{LD}$	67.5	V
<b>Electrostatic discharge voltage</b> (Human Body Model) according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993	$V_{ESD}$	2	kV
DIN humidity category, DIN 40 040		E	
IEC climatic category; DIN IEC 68-1		40/150/56	

**Thermal resistance**

junction - case:	$R_{thJC}$	1.1	K/W
SMD: junction - ambient @ min. footprint	$R_{thJA}$	115	
@ 6 cm <sup>2</sup> cooling area <sup>3)</sup>		55	

<sup>1</sup> Not tested, specified by design.

<sup>2</sup>  $V_{Loaddump}$  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 $T_j = -40 \dots +150$ , $I_D = 10$ mA	$V_{DS(AZ)}$	42	-	55	V
Off-state drain current $T_j = -40 \dots +150^\circ\text{C}$ $V_{DS} = 32$ V, $V_{IN} = 0$ V	$I_{DSS}$	-	1.5	20	$\mu\text{A}$
Input threshold voltage $I_D = 1.2$ mA, $T_j = 25^\circ\text{C}$ $I_D = 1.2$ mA, $T_j = 150^\circ\text{C}$	$V_{IN(th)}$	1.3 0.8	1.7 -	2.2 -	V
On state input current	$I_{IN(on)}$	-	10	30	$\mu\text{A}$
On-state resistance $V_{IN} = 5$ V, $I_D = 4.6$ A, $T_j = 25^\circ\text{C}$ $V_{IN} = 5$ V, $I_D = 4.6$ A, $T_j = 150^\circ\text{C}$	$R_{DS(on)}$	- -	27 54	34 68	$\text{m}\Omega$
On-state resistance $V_{IN} = 10$ V, $I_D = 4.6$ A, $T_j = 25^\circ\text{C}$ $V_{IN} = 10$ V, $I_D = 4.6$ A, $T_j = 150^\circ\text{C}$	$R_{DS(on)}$	- -	23 46	28 56	
Nominal load current $T_j < 150^\circ\text{C}$ , $V_{IN} = 10$ V, $T_A = 85^\circ\text{C}$ , SMD 1)	$I_{D(Nom)}$	4.6	-	-	A
Nominal load current $V_{IN} = 10$ V, $V_{DS} = 0.5$ V, $T_C = 85^\circ\text{C}$ , $T_j < 150^\circ\text{C}$	$I_{D(ISO)}$	12.6	-	-	
Current limit (active if $V_{DS} > 2.5$ V) <sup>2)</sup> $V_{IN} = 10$ V, $V_{DS} = 12$ V, $t_m = 200$ $\mu\text{s}$	$I_{D(lim)}$	30	45	55	

 1@ 6 cm<sup>2</sup> cooling area

 2Device 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  $\mu\text{s}$ .

### Electrical Characteristics

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

### Dynamic Characteristics

Turn-on time $V_{IN}$ to 90% $I_D$ : $R_L = 4.7 \Omega$ , $V_{IN} = 0$ to 10 V, $V_{bb} = 12$ V	$t_{on}$	-	60	120	$\mu\text{s}$
Turn-off time $V_{IN}$ to 10% $I_D$ : $R_L = 4.7 \Omega$ , $V_{IN} = 10$ to 0 V, $V_{bb} = 12$ V	$t_{off}$	-	60	120	$\mu\text{s}$
Slew rate on 70 to 50% $V_{bb}$ : $R_L = 4.7 \Omega$ , $V_{IN} = 0$ to 10 V, $V_{bb} = 12$ V	$-dV_{DS}/dt_{on}$	-	0.3	1.5	V/ $\mu\text{s}$
Slew rate off 50 to 70% $V_{bb}$ : $R_L = 4.7 \Omega$ , $V_{IN} = 10$ to 0 V, $V_{bb} = 12$ V	$dV_{DS}/dt_{off}$	-	0.3	1.5	V/ $\mu\text{s}$

### Protection Functions<sup>1)</sup>

Thermal overload trip temperature	$T_{it}$	150	175	-	$^\circ\text{C}$
Input current protection mode	$I_{IN(Prot)}$	-	220	400	$\mu\text{A}$
Input current protection mode $T_j = 150^\circ\text{C}$	$I_{IN(Prot)}$	-	180	400	$\mu\text{A}$
Unclamped single pulse inductive energy <sup>2)</sup> $I_D = 4.6$ A, $T_j = 25^\circ\text{C}$ , $V_{bb} = 12$ V	$E_{AS}$	3.5	-	-	J

### Inverse Diode

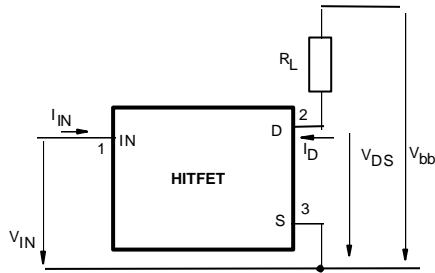
Inverse diode forward voltage $I_F = 51$ A, $t_m = 250 \mu\text{s}$ , $V_{IN} = 0$ V, $t_P = 300 \mu\text{s}$	$V_{SD}$	-	1.0	-	V
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<sup>1)</sup> Integrated protection functions are designed to prevent IC destruction under fault conditions described in the data sheet. Fault conditions are considered as "outside" normal operating range. Protection functions are not designed for continuous repetitive operation.

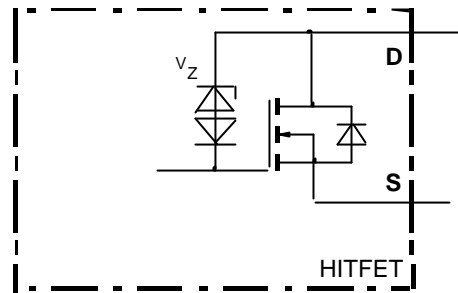
<sup>2)</sup> Not tested, specified by design.

## Block diagram

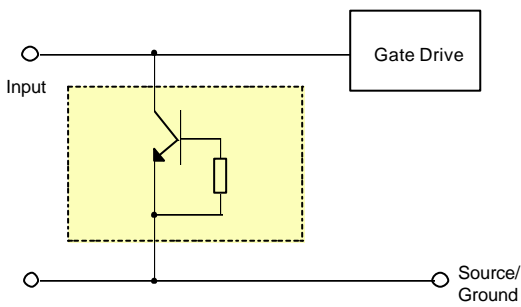
### Terms



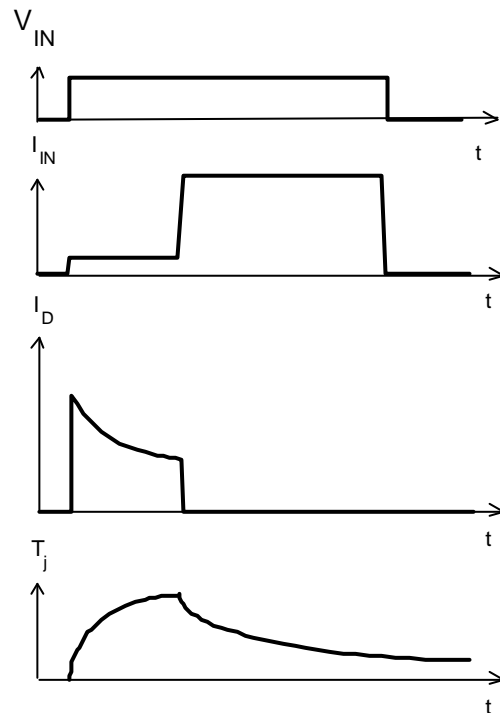
### Inductive and overvoltage output clamp



### Input circuit (ESD protection)



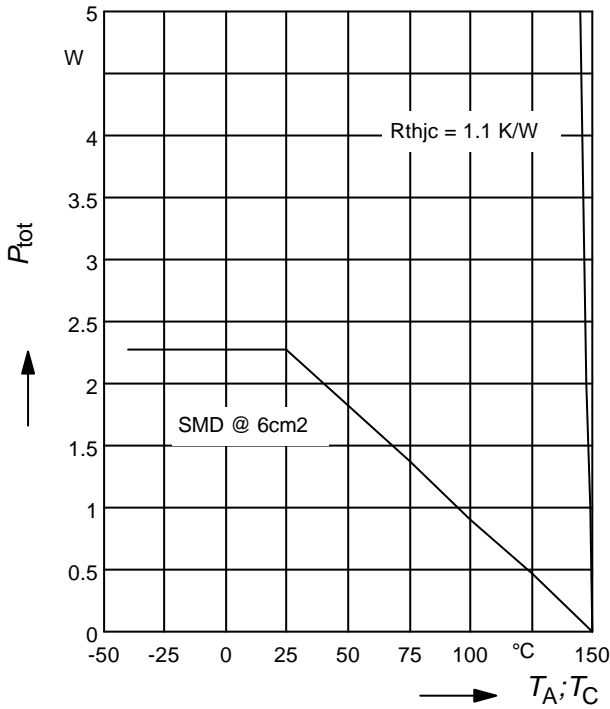
### Short circuit behaviour



**1 Maximum allowable power dissipation**

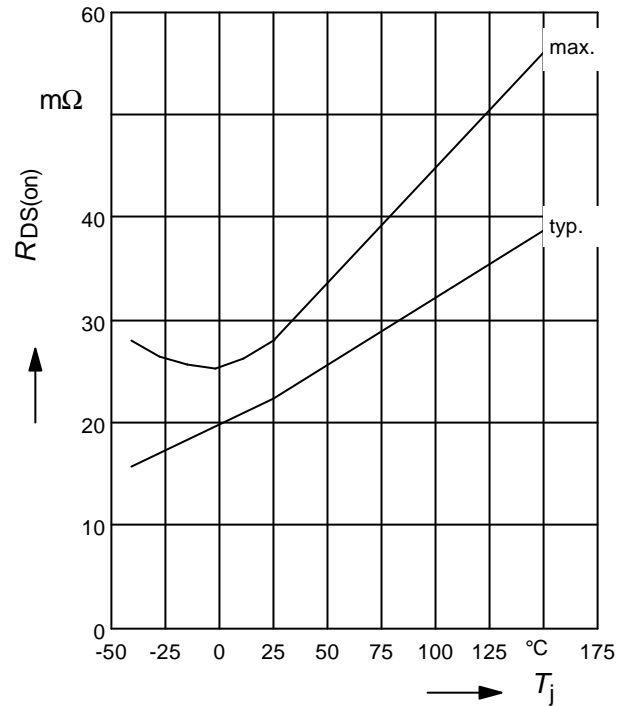
$P_{tot} = f(T_C)$  resp.

$P_{tot} = f(T_A) @ R_{thJA}=55 \text{ K/W}$



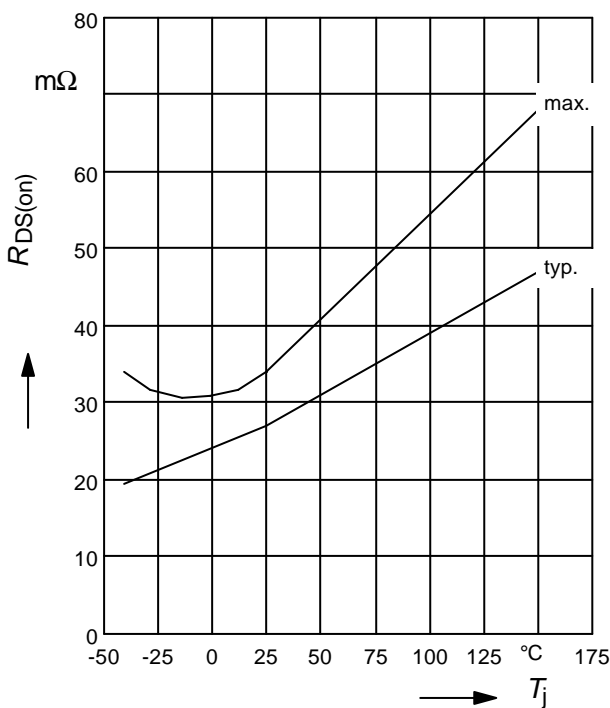
**2 On-state resistance**

$R_{ON} = f(T_j); I_D=12.6A; V_{IN}=10V$



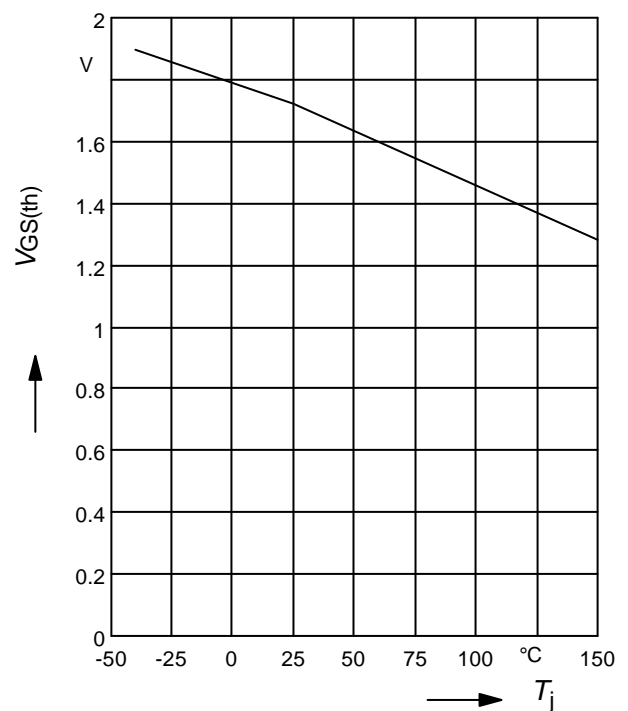
**3 On-state resistance**

$R_{ON} = f(T_j); I_D= 12.6A; V_{IN}=5V$



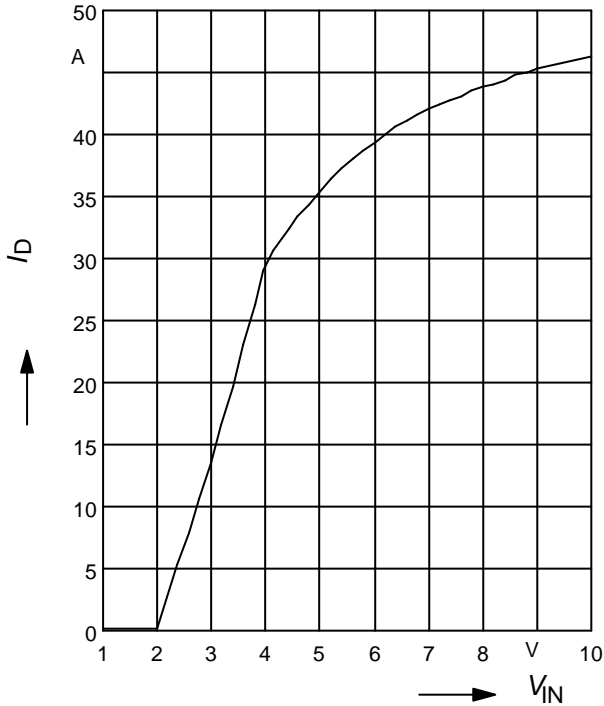
**4 Typ. input threshold voltage**

$V_{IN(th)} = f(T_j); I_D = 1.2 \text{ mA}; V_{DS} = 12V$



**5 Typ. transfer characteristics**

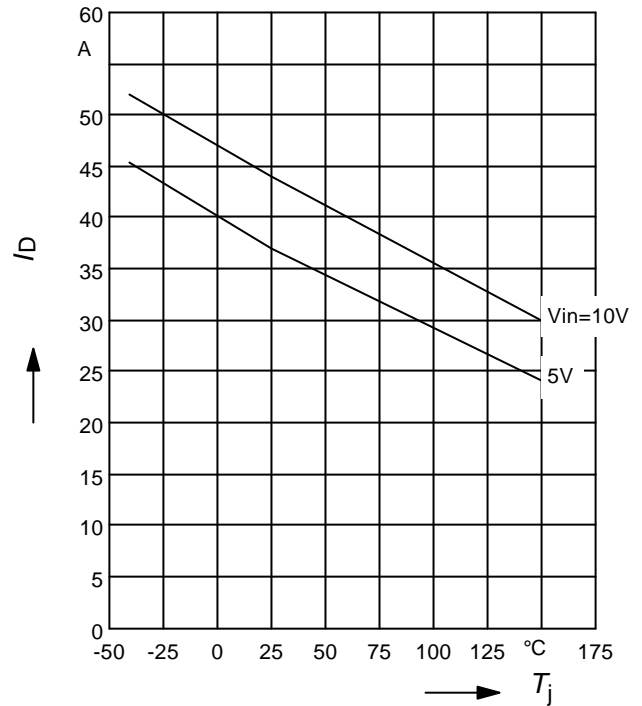
$I_D = f(V_{IN}); V_{DS} = 12V; T_{Jstart} = 25^\circ C$



**6 Typ. short circuit current**

$I_{D(lim)} = f(T_j); V_{DS} = 12V$

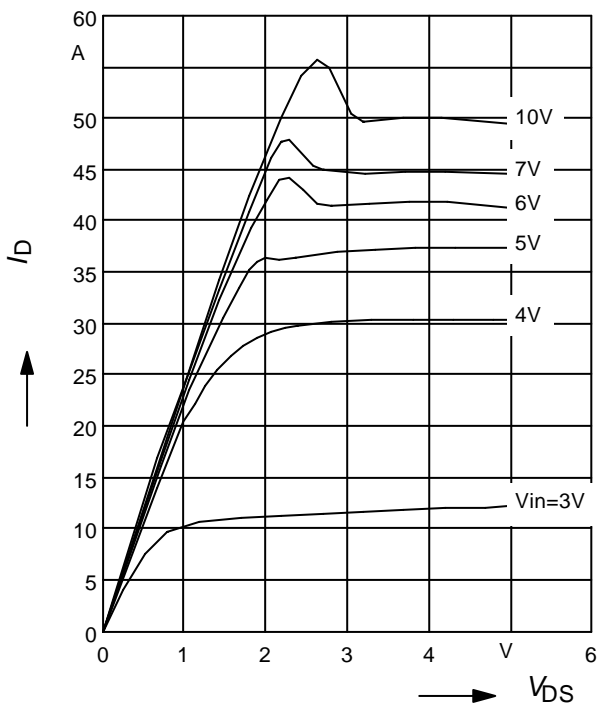
Parameter:  $V_{IN}$



**7 Typ. output characteristics**

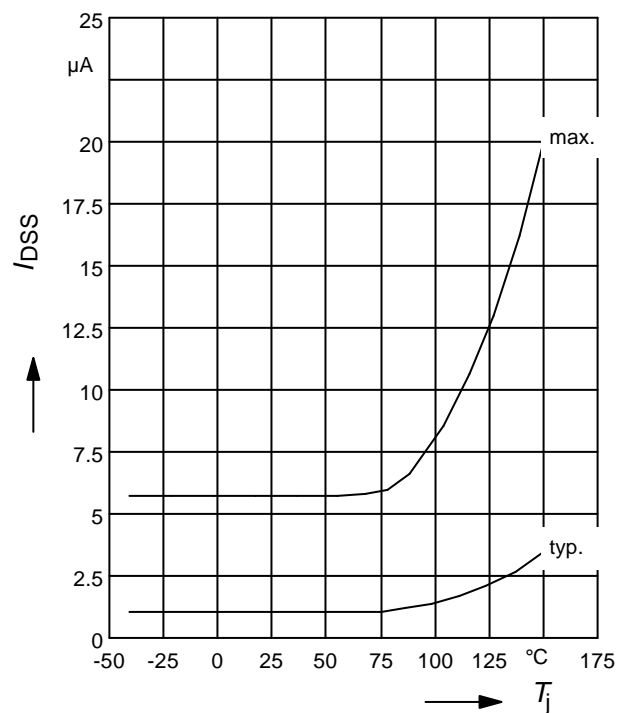
$I_D = f(V_{DS}); T_{Jstart} = 25^\circ C$

Parameter:  $V_{IN}$



**8 Typ. off-state drain current**

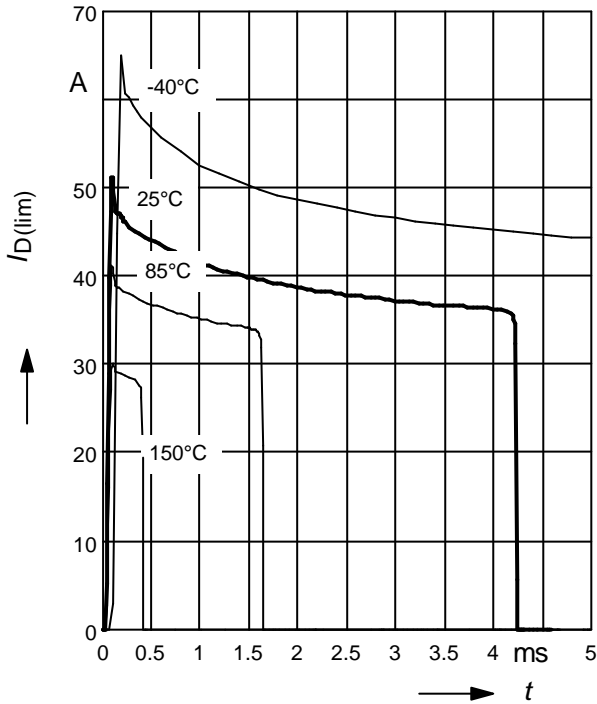
$I_{DSS} = f(T_j)$



**9 Typ. overload current**

$I_{D(lim)} = f(t)$ ,  $V_{bb}=12\text{ V}$ , no heatsink

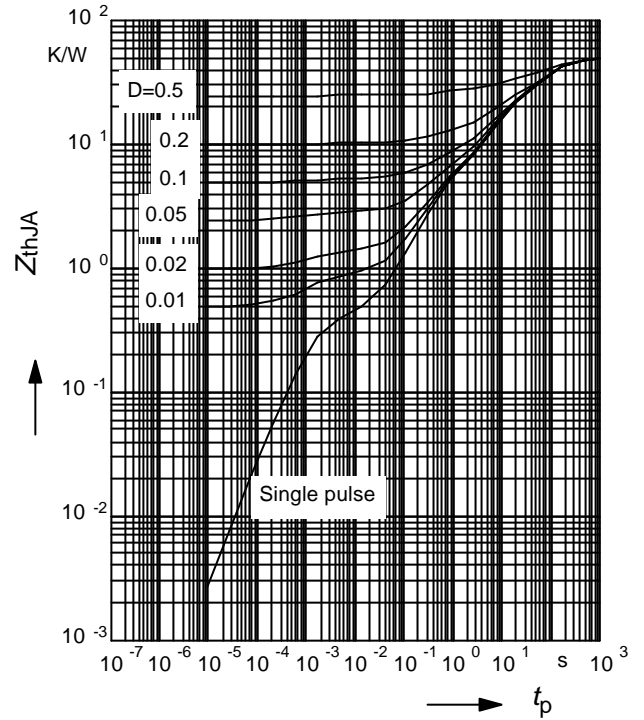
Parameter:  $T_{Jstart}$



**10 Typ. transient thermal impedance**

$Z_{thJA} = f(t_p)$  @  $6\text{ cm}^2$  cooling area

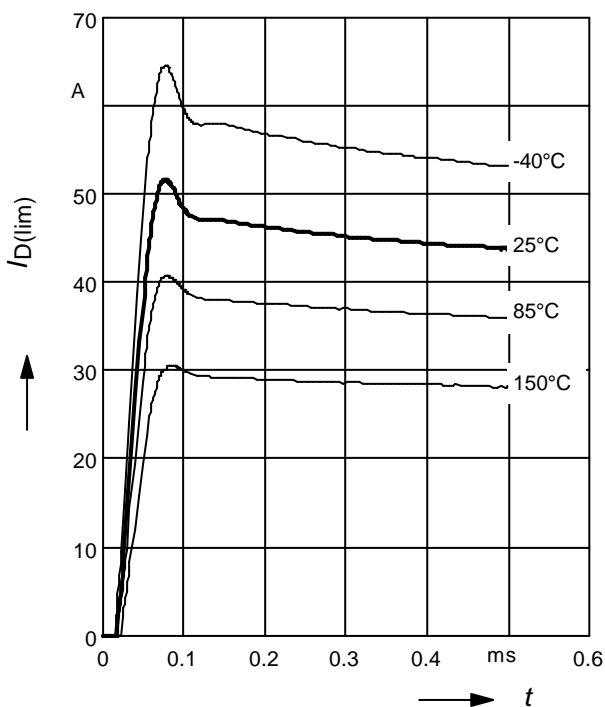
Parameter:  $D = t_p / T$



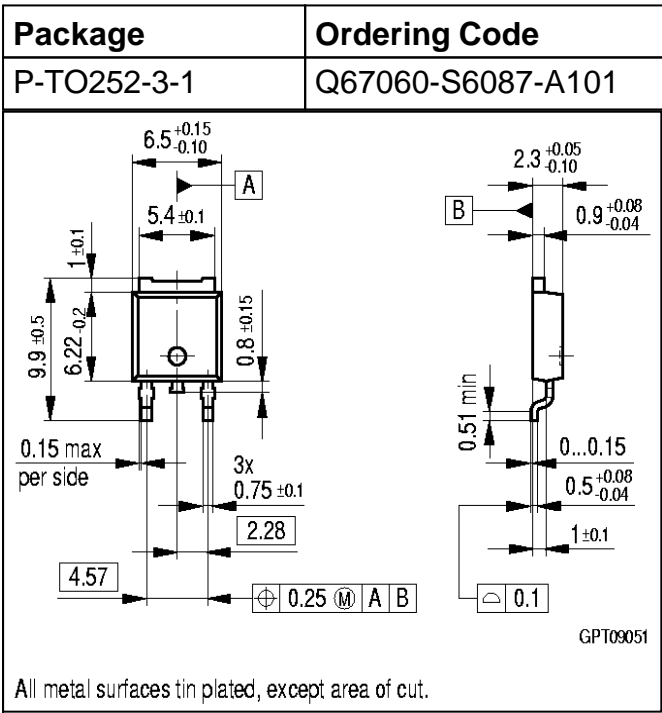
**11 Determination of  $I_{D(lim)}$**

$I_{D(lim)} = f(t)$ ;  $t_m = 200\mu\text{s}$

Parameter:  $T_{Jstart}$







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