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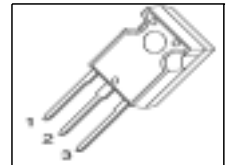
## Cool MOS™ Power Transistor

### Feature

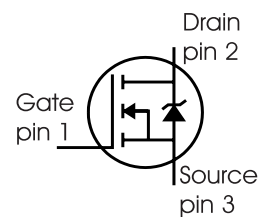
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- High peak current capability
- Improved transconductance
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC<sup>0)</sup> for target applications

$V_{DS} @ T_{jmax}$	650	V
$R_{DS(on)}$	0.19	$\Omega$
$I_D$	20.7	A

PG-TO247



Type	Package	Ordering Code	Marking
SPW20N60C3	PG-TO247	Q67040-S4406	20N60C3



### Maximum Ratings

Parameter	Symbol	Value	Unit
Continuous drain current $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$	$I_D$	20.7 13.1	A
Pulsed drain current, $t_p$ limited by $T_{jmax}$	$I_{D\text{ puls}}$	62.1	
Avalanche energy, single pulse $I_D = 10\text{ A}$ , $V_{DD} = 50\text{ V}$	$E_{AS}$	690	mJ
Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ <sup>1)</sup> $I_D = 20\text{ A}$ , $V_{DD} = 50\text{ V}$	$E_{AR}$	1	
Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$	$I_{AR}$	20	A
Reverse diode dv/dt <sup>4)</sup>	dv/dt	15	V/ns
Gate source voltage static	$V_{GS}$	±20	V
Gate source voltage AC ( $f > 1\text{ Hz}$ )	$V_{GS}$	±30	
Power dissipation, $T_C = 25\text{ °C}$	$P_{tot}$	208	W
Operating and storage temperature	$T_j, T_{stg}$	-55... +150	°C

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480\text{ V}$ , $I_D = 20.7\text{ A}$ , $T_j = 125\text{ °C}$	$dv/dt$	50	V/ns

**Thermal Characteristics**

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.6	K/W
Thermal resistance, junction - ambient, leaded	$R_{thJA}$	-	-	62	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s	$T_{sold}$	-	-	260	°C

**Electrical Characteristics, at  $T_j=25\text{ °C}$  unless otherwise specified**

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{ V}$ , $I_D=0.25\text{ mA}$	600	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{ V}$ , $I_D=20\text{ A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=1000\text{ }\mu\text{A}$ , $V_{GS}=V_{DS}$	2.1	3	3.9	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$ ,	-	0.5	25	$\mu\text{A}$
		$T_j=150\text{ °C}$	-	-	250	
Gate-source leakage current	$I_{GSS}$	$V_{GS}=30\text{ V}$ , $V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}$ , $I_D=13.1\text{ A}$ , $T_j=25\text{ °C}$	-	0.16	0.19	$\Omega$
		$T_j=150\text{ °C}$	-	0.43	-	
Gate input resistance	$R_G$	$f=1\text{ MHz}$ , open Drain	-	0.54	-	

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	$g_{fs}$	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ , $I_D = 13.1\text{A}$	-	17.5	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ , $f = 1\text{MHz}$	-	2400	-	pF
Output capacitance	$C_{oss}$		-	780	-	
Reverse transfer capacitance	$C_{rss}$		-	50	-	
Effective output capacitance, <sup>2)</sup> energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V to } 480\text{V}$	-	83	-	pF
Effective output capacitance, <sup>3)</sup> time related	$C_{o(tr)}$		-	160	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380\text{V}$ , $V_{GS} = 0/13\text{V}$ , $I_D = 20.7\text{A}$ , $R_G = 3.6\Omega$ , $T_j = 125$	-	10	-	ns
Rise time	$t_r$		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	67	100	
Fall time	$t_f$		-	4.5	12	

**Gate Charge Characteristics**

Gate to source charge	$Q_{gs}$	$V_{DD} = 480\text{V}$ , $I_D = 20.7\text{A}$	-	11	-	nC
Gate to drain charge	$Q_{gd}$		-	33	-	
Gate charge total	$Q_g$	$V_{DD} = 480\text{V}$ , $I_D = 20.7\text{A}$ , $V_{GS} = 0\text{ to } 10\text{V}$	-	87	114	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 480\text{V}$ , $I_D = 20.7\text{A}$	-	5.5	-	V

<sup>0</sup>J-STD20 and JESD22

<sup>1</sup>Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV} = E_{AR} \cdot f$ .

<sup>2</sup> $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>3</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>4</sup> $I_{SD} \leq I_D$ ,  $di/dt \leq 400\text{A/us}$ ,  $V_{DClink} = 400\text{V}$ ,  $V_{peak} < V_{BR, DSS}$ ,  $T_j < T_{j,max}$ .

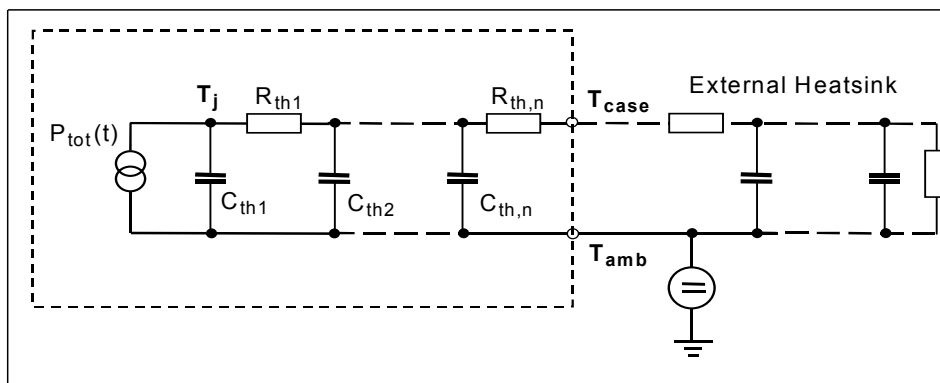
Identical low-side and high-side switch.

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	$I_S$	$T_C=25^{\circ}\text{C}$	-	-	20.7	A
Inverse diode direct current, pulsed	$I_{SM}$		-	-	62.1	
Inverse diode forward voltage	$V_{SD}$	$V_{GS}=0\text{V}$ , $I_F=I_S$	-	1	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=480\text{V}$ , $I_F=I_S$ , $di_F/dt=100\text{A}/\mu\text{s}$	-	500	800	ns
Reverse recovery charge	$Q_{rr}$		-	11	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	70	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$		-	1400	-	$\text{A}/\mu\text{s}$

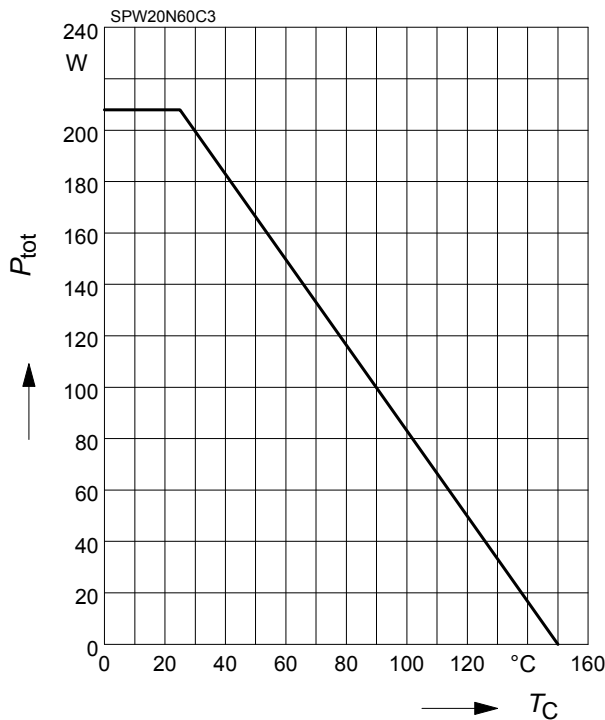
### Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
$R_{th1}$	0.00769	K/W	$C_{th1}$	0.0003763	Ws/K
$R_{th2}$	0.015		$C_{th2}$	0.001411	
$R_{th3}$	0.029		$C_{th3}$	0.001931	
$R_{th4}$	0.114		$C_{th4}$	0.005297	
$R_{th5}$	0.136		$C_{th5}$	0.012	
$R_{th6}$	0.059		$C_{th6}$	0.091	



### 1 Power dissipation

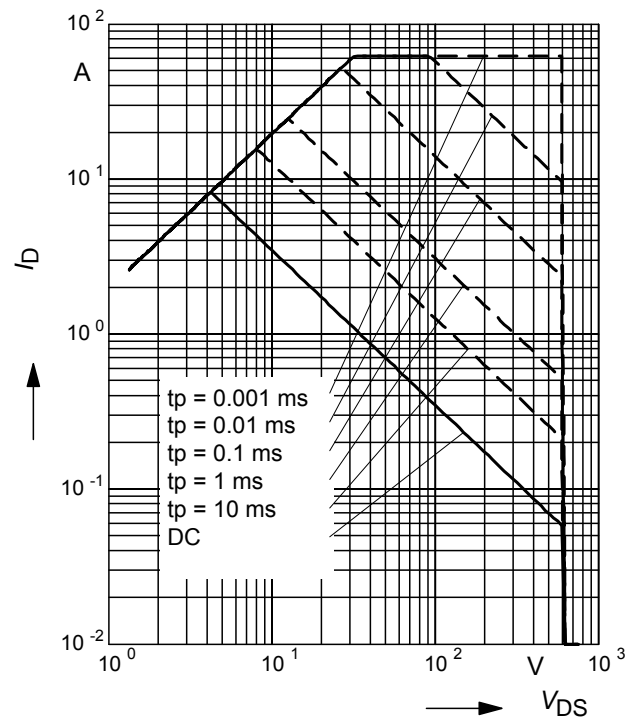
$$P_{\text{tot}} = f(T_C)$$



### 2 Safe operating area

$$I_D = f(V_{DS})$$

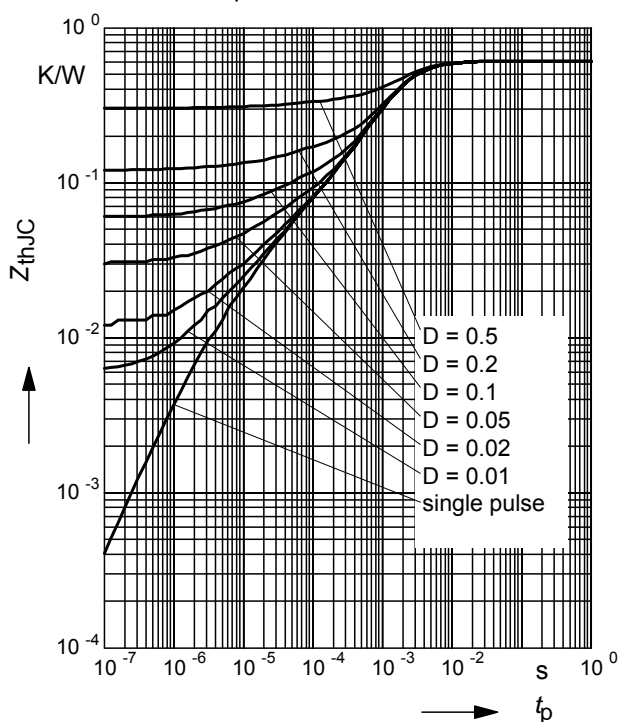
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



### 3 Transient thermal impedance

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

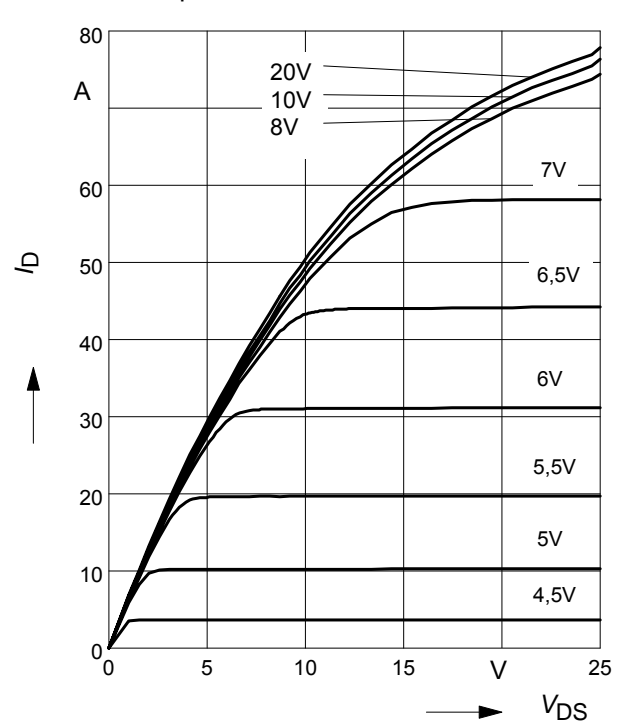
parameter:  $D = t_p/T$



### 4 Typ. output characteristic

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

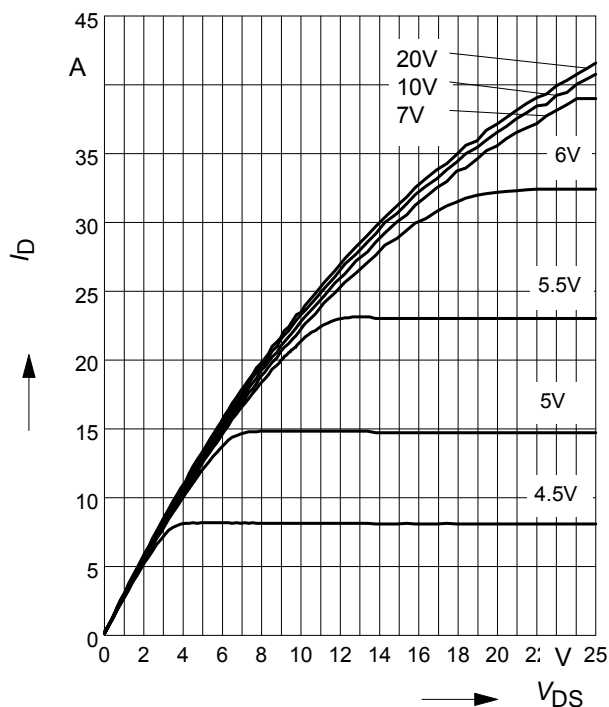
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



**5 Typ. output characteristic**

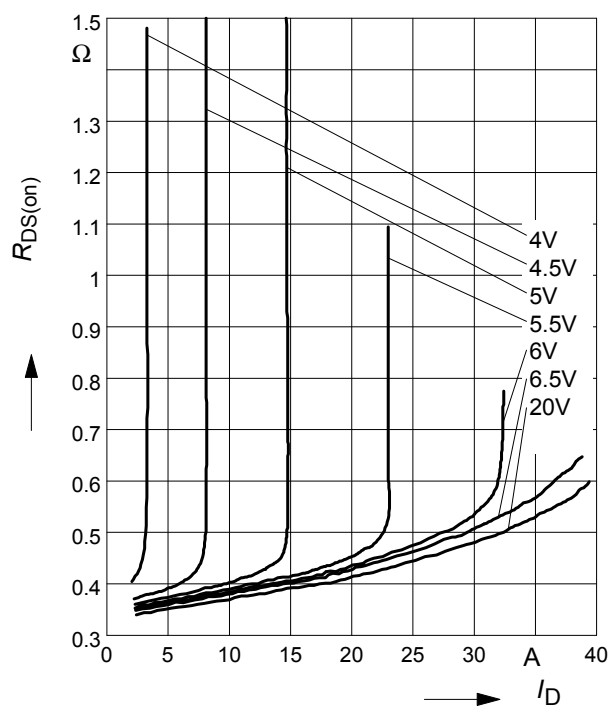
$$I_D = f(V_{DS}); T_j = 150^\circ\text{C}$$

parameter:  $t_p = 10\ \mu\text{s}$ ,  $V_{GS}$


**6 Typ. drain-source on resistance**

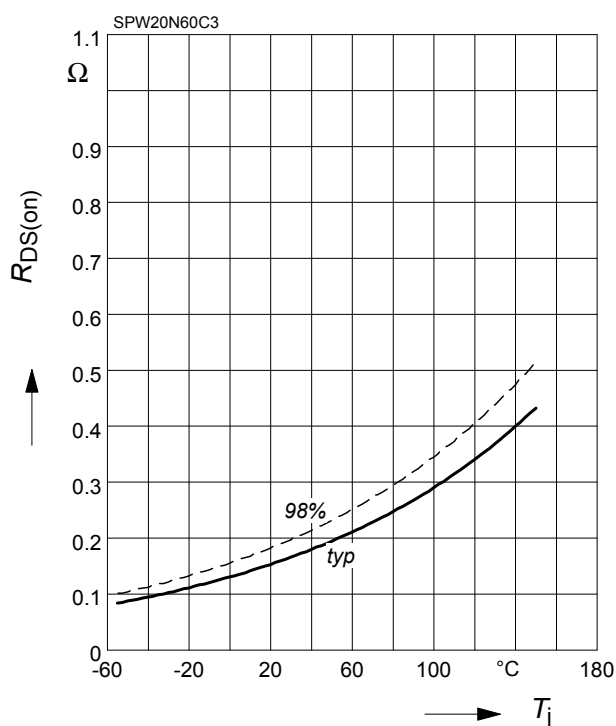
$$R_{DS(on)} = f(I_D)$$

parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$


**7 Drain-source on-state resistance**

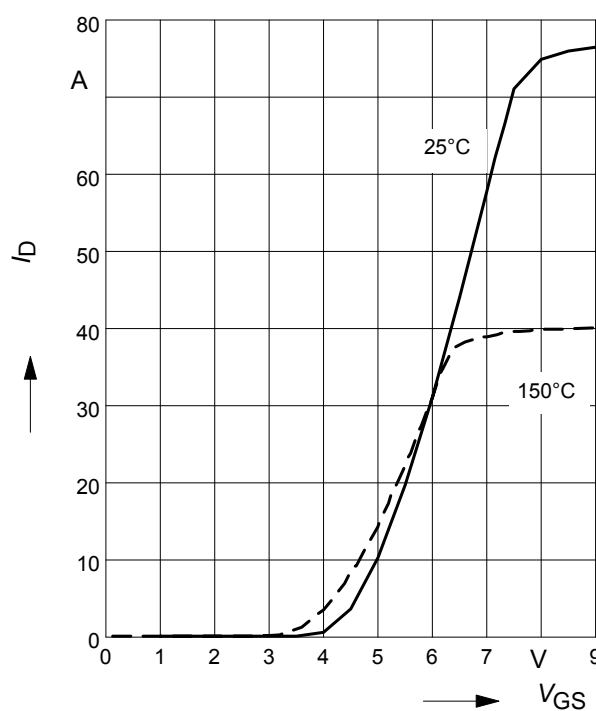
$$R_{DS(on)} = f(T_j)$$

parameter:  $I_D = 13.1\ \text{A}$ ,  $V_{GS} = 10\ \text{V}$


**8 Typ. transfer characteristics**

$$I_D = f(V_{GS}); V_{DS} \geq 2 \times I_D \times R_{DS(on)\text{max}}$$

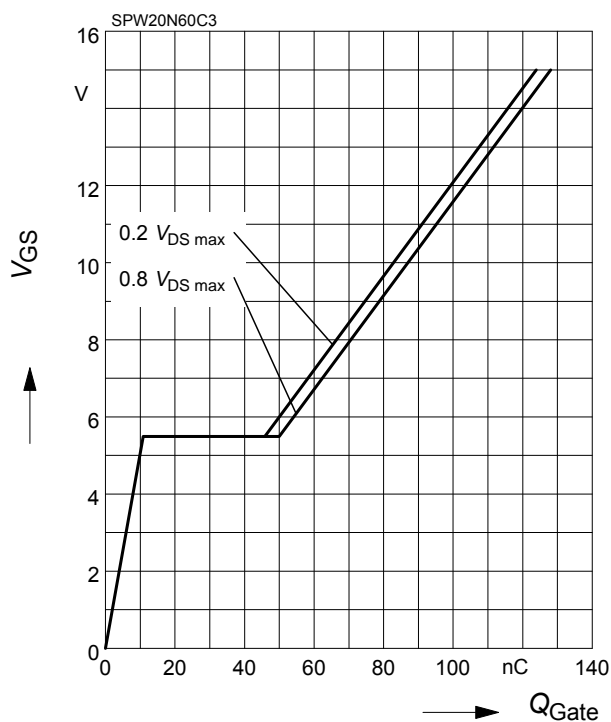
parameter:  $t_p = 10\ \mu\text{s}$



**9 Typ. gate charge**

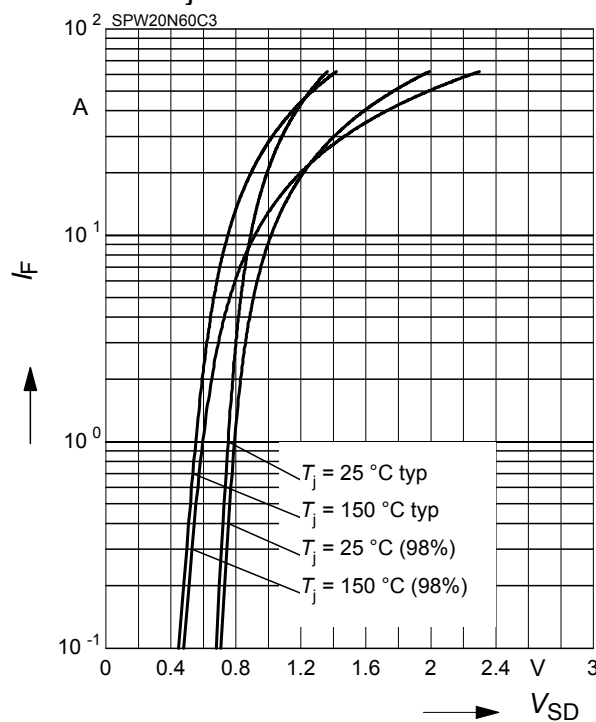
$$V_{GS} = f(Q_{Gate})$$

parameter:  $I_D = 20.7$  A pulsed


**10 Forward characteristics of body diode**

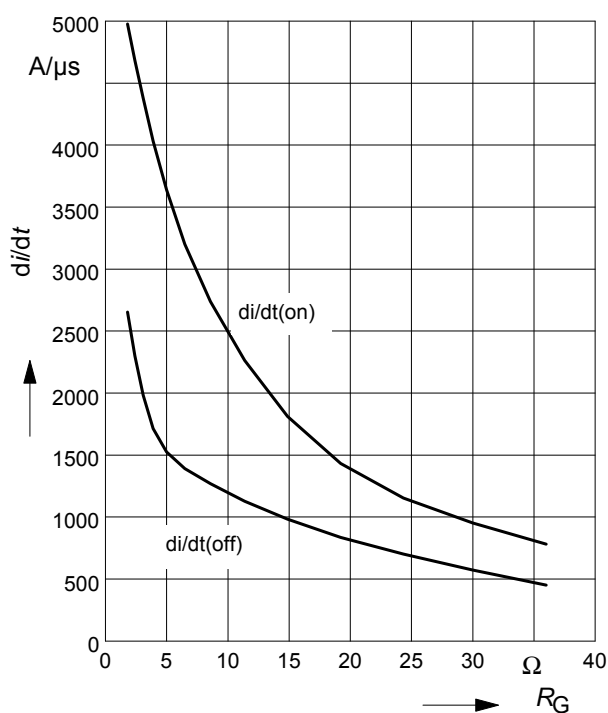
$$I_F = f(V_{SD})$$

parameter:  $T_j$ ,  $t_p = 10$   $\mu$ s


**11 Typ. drain current slope**

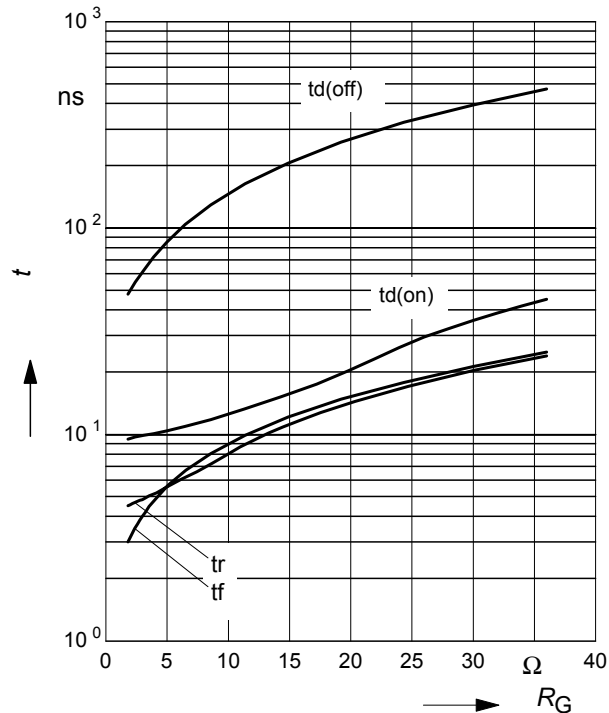
$di/dt = f(R_G)$ , inductive load,  $T_j = 125$  °C

par.:  $V_{DS} = 380$  V,  $V_{GS} = 0/+13$  V,  $I_D = 20.7$  A


**12 Typ. switching time**

$t = f(R_G)$ , inductive load,  $T_j = 125$  °C

par.:  $V_{DS} = 380$  V,  $V_{GS} = 0/+13$  V,  $I_D = 20.7$  A

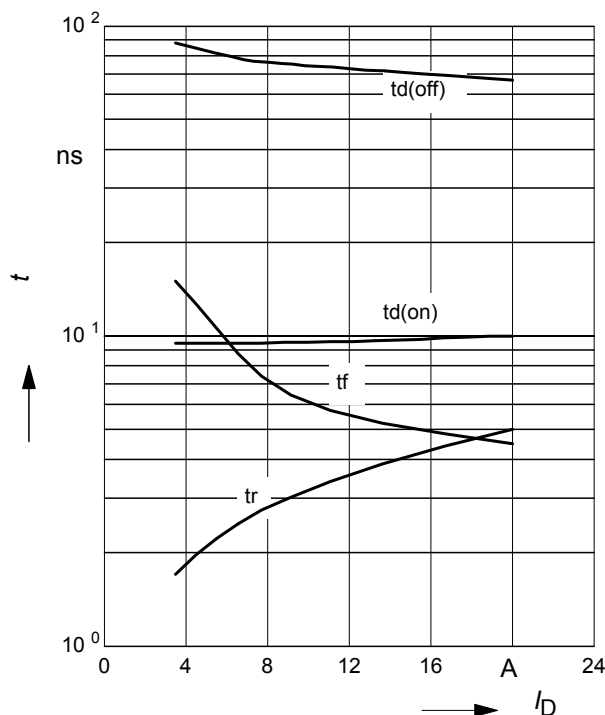




### 13 Typ. switching time

$t = f(I_D)$ , inductive load,  $T_j = 125^\circ\text{C}$

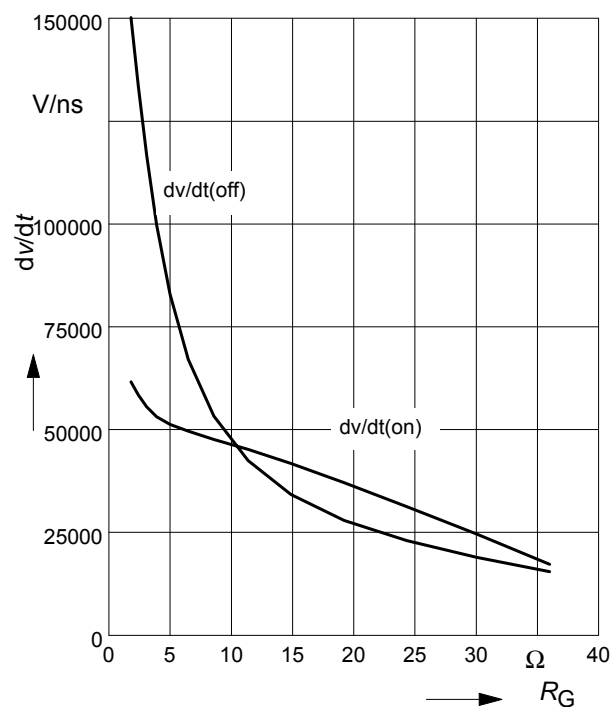
par.:  $V_{DS} = 380\text{V}$ ,  $V_{GS} = 0/+13\text{V}$ ,  $R_G = 3.6\Omega$



### 14 Typ. drain source voltage slope

$dv/dt = f(R_G)$ , inductive load,  $T_j = 125^\circ\text{C}$

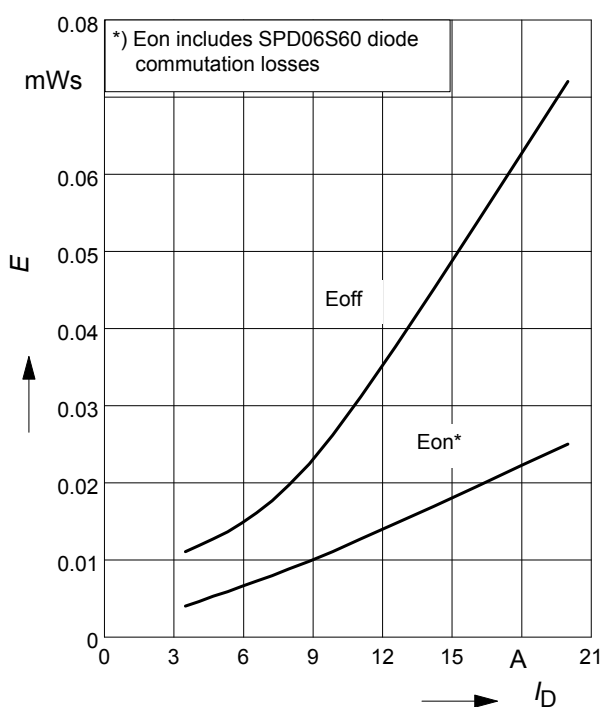
par.:  $V_{DS} = 380\text{V}$ ,  $V_{GS} = 0/+13\text{V}$ ,  $I_D = 20.7\text{A}$



### 15 Typ. switching losses

$E = f(I_D)$ , inductive load,  $T_j = 125^\circ\text{C}$

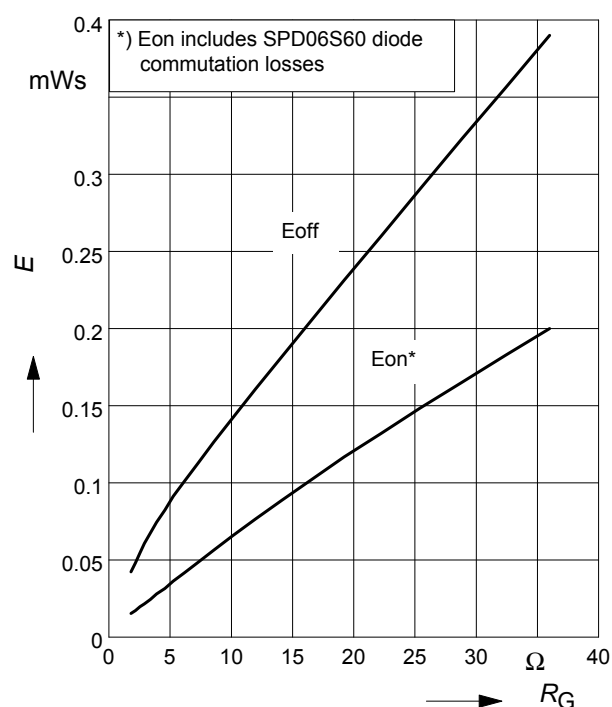
par.:  $V_{DS} = 380\text{V}$ ,  $V_{GS} = 0/+13\text{V}$ ,  $R_G = 3.6\Omega$



### 16 Typ. switching losses

$E = f(R_G)$ , inductive load,  $T_j = 125^\circ\text{C}$

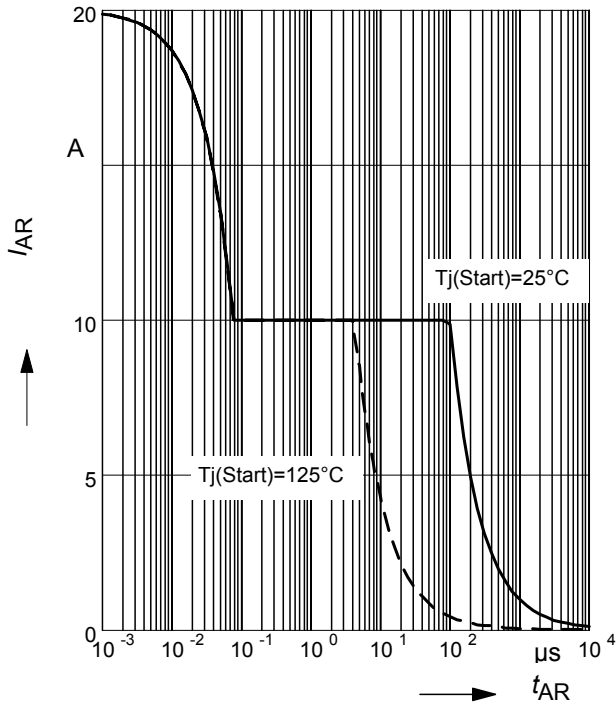
par.:  $V_{DS} = 380\text{V}$ ,  $V_{GS} = 0/+13\text{V}$ ,  $I_D = 20.7\text{A}$



### 17 Avalanche SOA

$$I_{AR} = f(t_{AR})$$

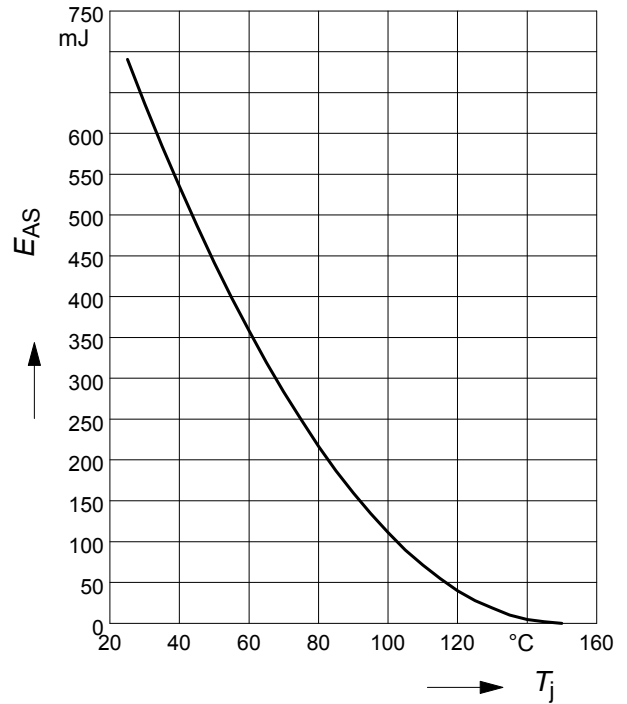
par.:  $T_j \leq 150^\circ\text{C}$



### 18 Avalanche energy

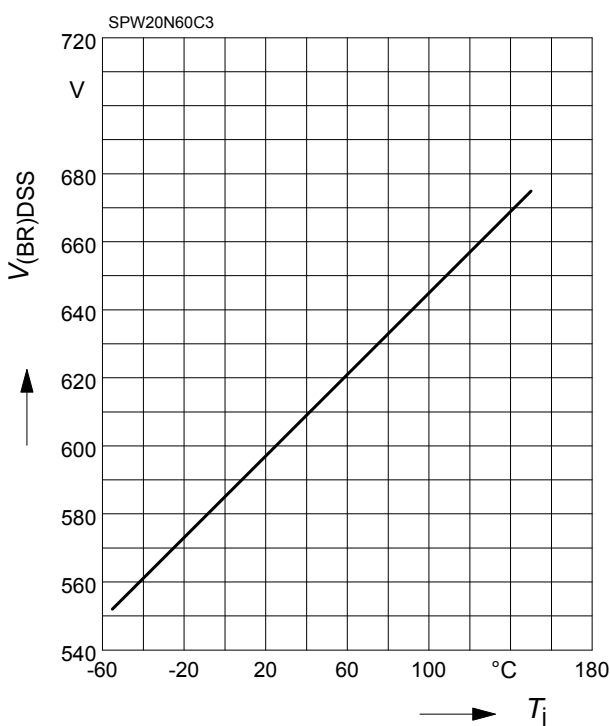
$$E_{AS} = f(T_j)$$

par.:  $I_D = 10\text{ A}$ ,  $V_{DD} = 50\text{ V}$



### 19 Drain-source breakdown voltage

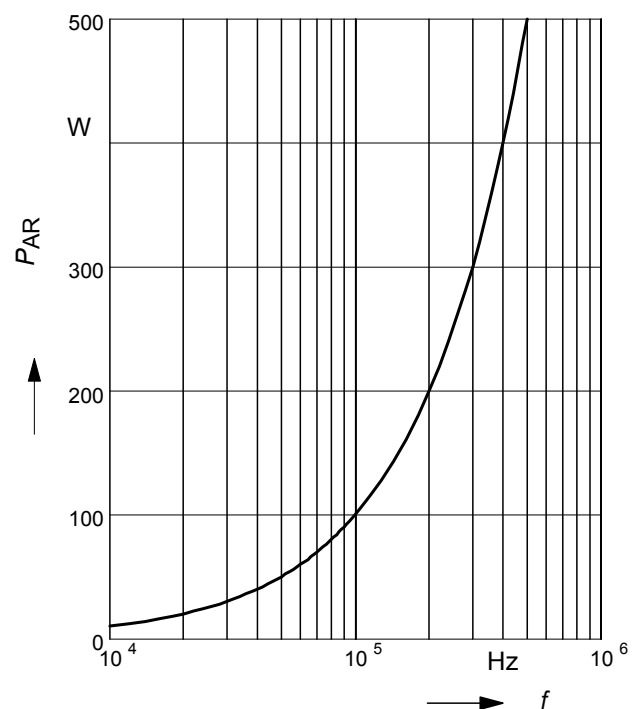
$$V_{(BR)DSS} = f(T_j)$$



### 20 Avalanche power losses

$$P_{AR} = f(f)$$

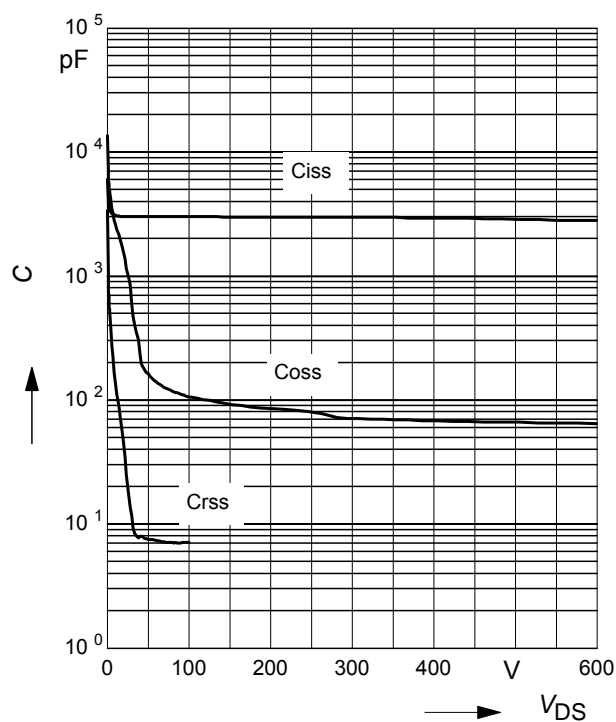
parameter:  $E_{AR}=1\text{ mJ}$



## 21 Typ. capacitances

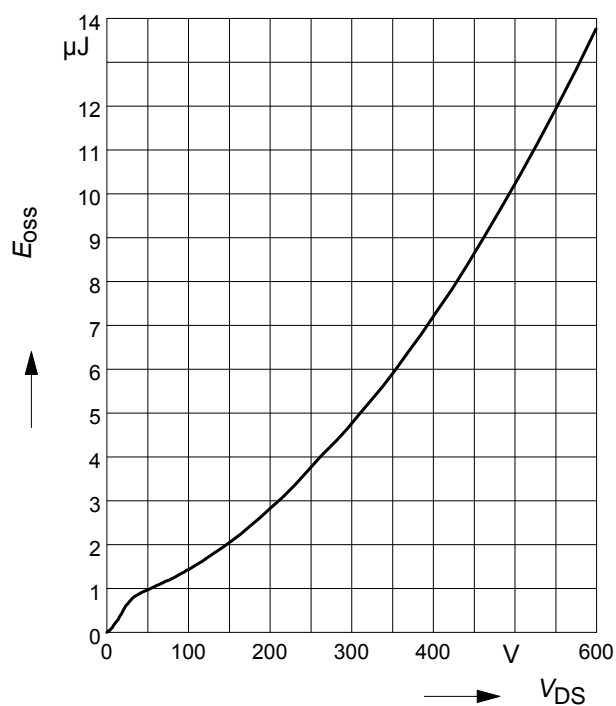
$$C = f(V_{DS})$$

parameter:  $V_{GS}=0V$ ,  $f=1\text{ MHz}$

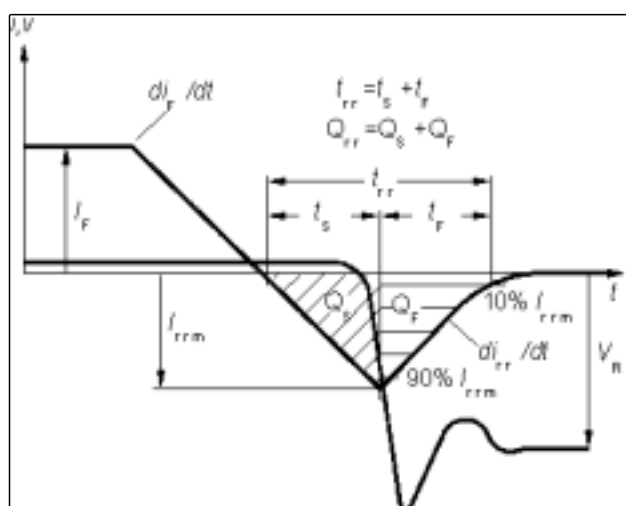


## 22 Typ. $C_{oss}$ stored energy

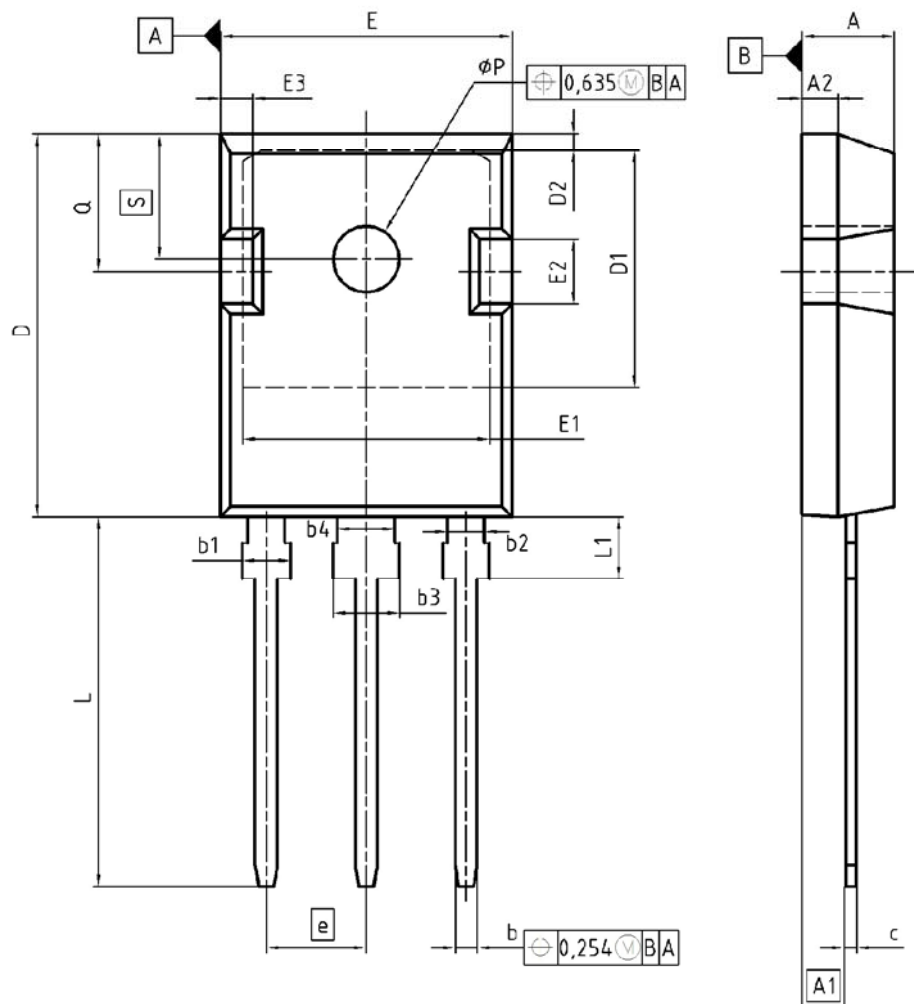
$$E_{oss} = f(V_{DS})$$



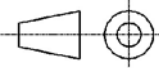
## Definition of diodes switching characteristics



PG-TO-247-3-1



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.16	0.193	0.203
A1	2.27	2.53	0.089	0.099
A2	1.85	2.11	0.073	0.083
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.82	21.10	0.820	0.831
D1	16.25	17.65	0.640	0.695
D2	1.05	1.35	0.041	0.053
E	15.70	16.03	0.618	0.631
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.68	2.60	0.066	0.102
e	5.44		0.214	
N	3		3	
L	19.80	20.31	0.780	0.799
L1	4.17	4.47	0.164	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

DOCUMENT NO. Z8B00003327
SCALE 0 5 5 7.5mm
EUROPEAN PROJECTION 
ISSUE DATE 17-12-2007
REVISION 03

**Published by**  
**Infineon Technologies AG**  
**81726 Munich, Germany**  
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