

## Cool MOS™ Power Transistor

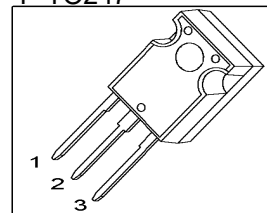
### Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme  $dv/dt$  rated
- Ultra low effective capacitances
- Improved noise immunity

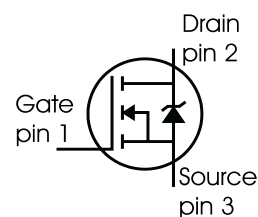
### Product Summary

$V_{DS}$	600	V
$R_{DS(on)}$	0.19	$\Omega$
$I_D$	20	A

P-TO247



Type	Package	Ordering Code	Marking
SPW20N60C2	P-TO247	Q67040-S4321	20N60C2



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

Parameter	Symbol	Value	Unit
Continuous drain current	$I_D$	20	A
$T_C = 25^\circ\text{C}$		20	
$T_C = 100^\circ\text{C}$		13	
Pulsed drain current, $t_p$ limited by $T_{jmax}$	$I_{D\text{ puls}}$	40	
Avalanche energy, single pulse	$E_{AS}$	690	mJ
$I_D=10\text{A}$ , $V_{DD}=50\text{V}$			
Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}^{1)}$	$E_{AR}$	1	
$I_D=20\text{A}$ , $V_{DD}=50\text{V}$			
Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$	$I_{AR}$	20	A
Reverse diode $dv/dt$	$dv/dt$	6	V/ns
$I_S=20\text{A}$ , $V_{DS} < V_{DD}$ , $di/dt=100\text{A}/\mu\text{s}$ , $T_{jmax}=150^\circ\text{C}$			
Gate source voltage	$V_{GS}$	$\pm 20$	V
Power dissipation, $T_C = 25^\circ\text{C}$	$P_{tot}$	208	W
Operating and storage temperature	$T_j, T_{stg}$	-55... +150	$^\circ\text{C}$

## Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Characteristics					
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.6	K/W
Thermal resistance, junction - ambient, leaded	$R_{thJA}$	-	-	62	
Linear derating factor		-	-	1.67	W/K
Soldering temperature, 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

### Static Characteristics

Drain-source breakdown voltage $V_{GS}=0V, I_D=0.25mA$	$V_{(BR)DSS}$	600	-	-	V
Drain-source avalanche breakdown voltage $V_{GS}=0V, I_D=20A$	$V_{(BR)DS}$	-	700	-	
Gate threshold voltage, $V_{GS} = V_{DS}$ $I_D=1mA$	$V_{GS(th)}$	3.5	4.5	5.5	
Zero gate voltage drain current $V_{DS} = 600V, V_{GS} = 0V, T_j = 25\text{ °C}$ $V_{DS} = 600V, V_{GS} = 0V, T_j = 150\text{ °C}$	$I_{DSS}$	-	0.1	1	μA
		-	-	100	
Gate-source leakage current $V_{GS}=20V, V_{DS}=0V$	$I_{GSS}$	-	-	100	nA
Drain-source on-state resistance $V_{GS}=10V, I_D=13A, T_j=25\text{ °C}$	$R_{DS(on)}$	-	0.16	0.19	Ω
Gate input resistance $f = 1\text{ MHz, open drain}$	$R_G$	-	0.54	-	

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

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Transconductance	$g_{fs}$	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(ON)max}$ $I_D = 13A$	-	12	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0V, V_{DS} = 25V,$ $f = 1MHz$	-	3000	-	pF
Output capacitance	$C_{oss}$		-	1170	-	
Reverse transfer capacitance	$C_{rss}$		-	28	-	
Effective output capacitance, 1) energy related	$C_{o(er)}$	$V_{GS} = 0V,$ $V_{DS} = 0V$ to $480V$	-	83	-	pF
Effective output capacitance, 2) time related	$C_{o(tr)}$		-	160	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380V, V_{GS} = 0/13V,$ $I_D = 20A, R_G = 3.6\Omega,$ $T_j = 125^{\circ}C$	-	21	-	ns
Rise time	$t_r$		-	51	-	
Turn-off delay time	$t_{d(off)}$		-	56	84	
Fall time	$t_f$		-	6	9	

#### Gate Charge Characteristics

Gate to source charge	$Q_{gs}$	$V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$	-	21	-	nC
Gate to drain charge	$Q_{gd}$		-	46	-	
Gate charge total	$Q_g$	$V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$ , $V_{GS} = 0$ to $10\text{V}$	-	79	103	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$	-	8	-	V

<sup>1</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%  $V_{DSS}$ .

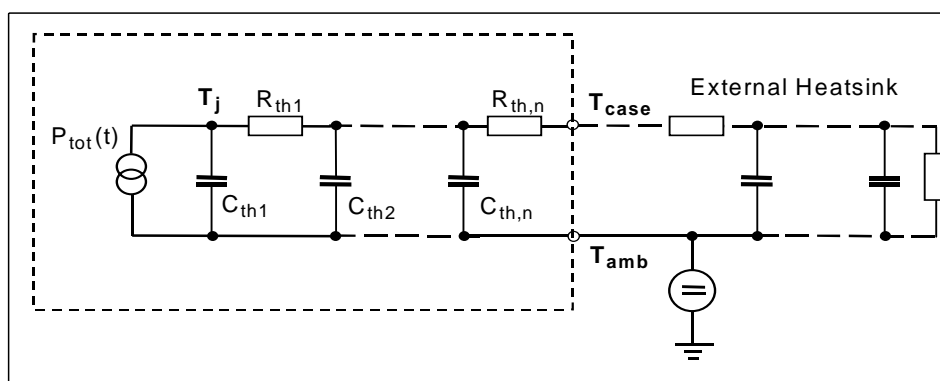
<sup>2</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Inverse diode continuous forward current	$I_S$	$T_C=25^{\circ}\text{C}$	-	-	20	A
Inverse diode direct current, pulsed	$I_{SM}$		-	-	40	
Inverse diode forward voltage	$V_{SD}$	$V_{GS}=0\text{V}$ , $I_F=I_S$	-	1	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=350\text{V}$ , $I_F=I_S$ , $di_F/dt=100\text{A}/\mu\text{s}$	-	610	1040	ns
Reverse recovery charge	$Q_{rr}$		-	12	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	48	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$		-	1500	-	$\text{A}/\mu\text{s}$

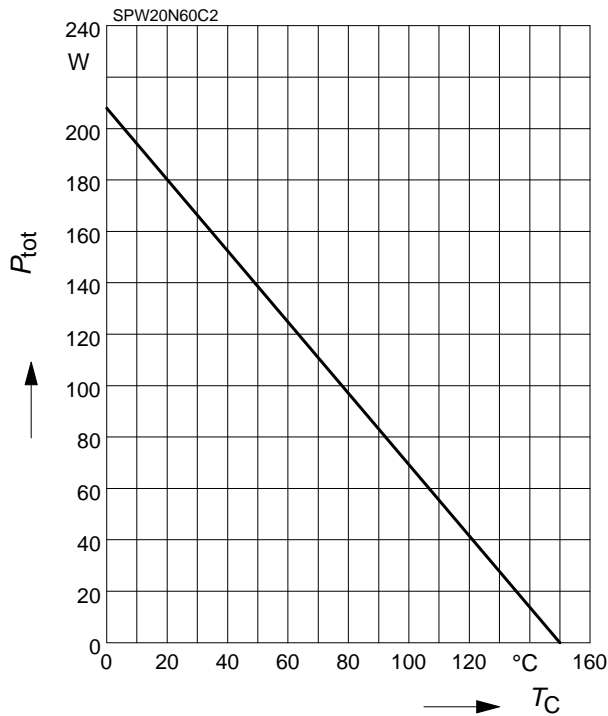
### Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
$R_{th1}$	0.007416	K/W	$C_{th1}$	0.0004409	Ws/K
$R_{th2}$	0.016		$C_{th2}$	0.001462	
$R_{th3}$	0.021		$C_{th3}$	0.0024	
$R_{th4}$	0.06		$C_{th4}$	0.003031	
$R_{th5}$	0.083		$C_{th5}$	0.02	
$R_{th6}$	0.038		$C_{th6}$	0.146	



### 1 Power dissipation

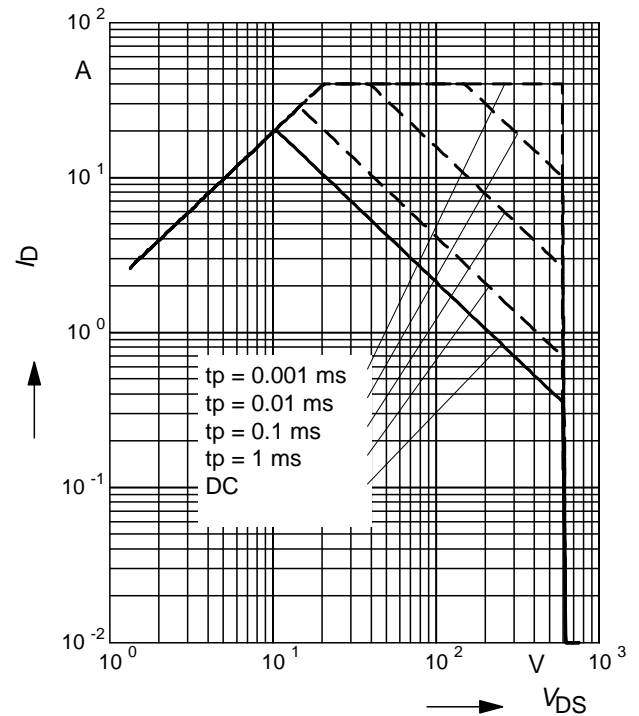
$$P_{\text{tot}} = f(T_C)$$



### 2 Safe operating area

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

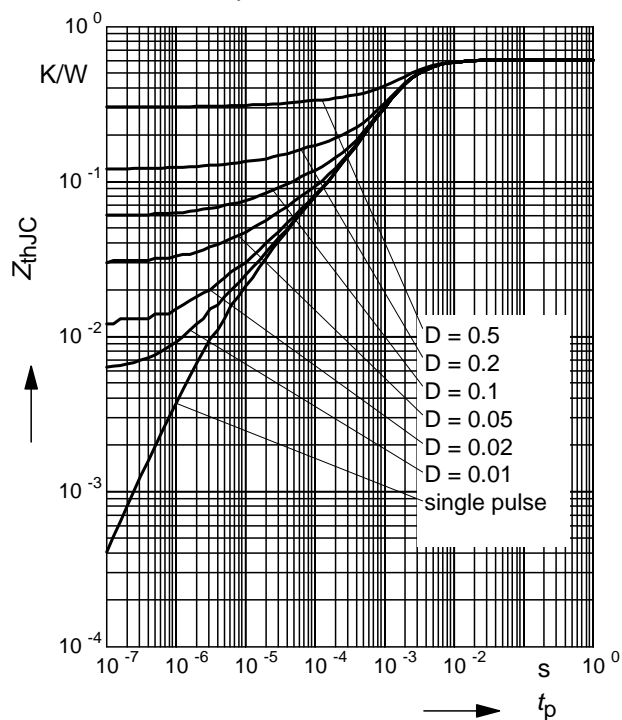
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



### 3 Transient thermal impedance

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

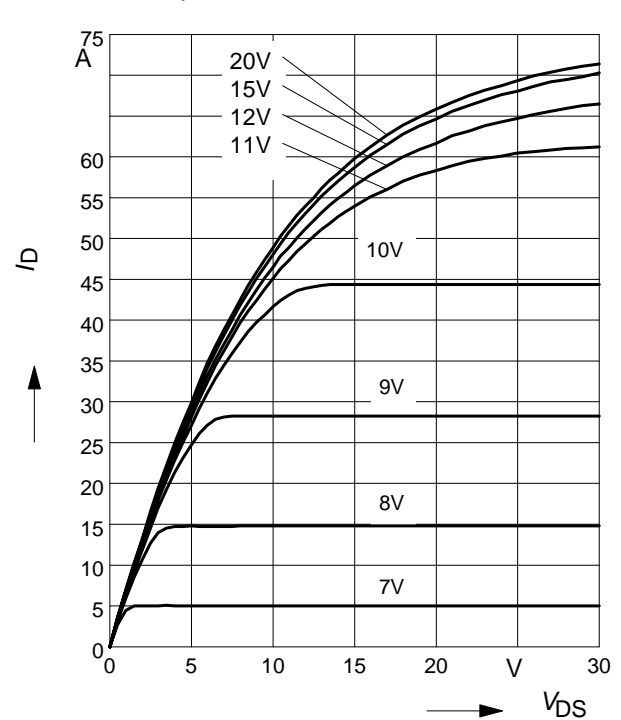
parameter:  $D = t_p/T$



### 4 Typ. output characteristic

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

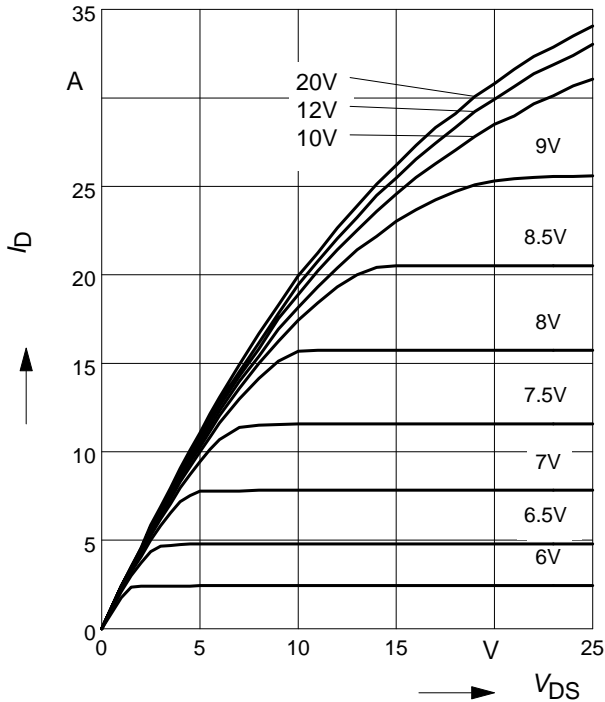
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



### 5 Typ. output characteristic

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

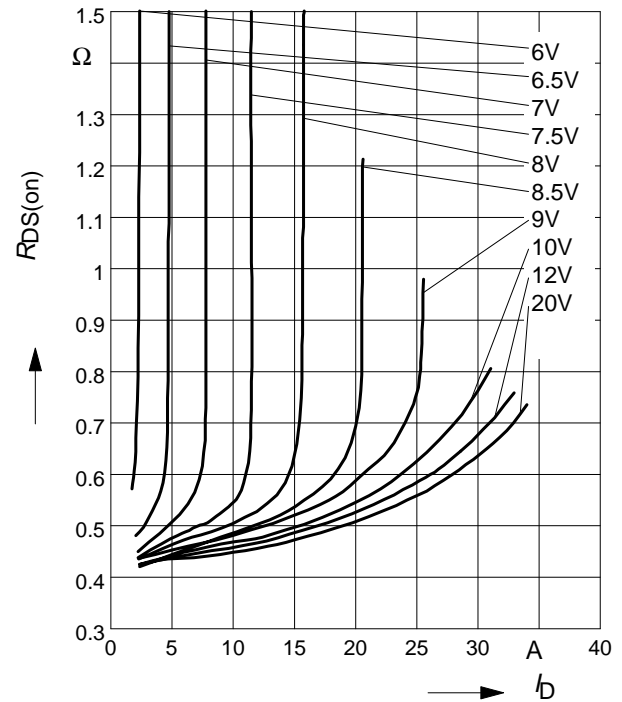
parameter:  $t_p = 10 \mu\text{s}$ ,  $V_{GS}$



### 6 Typ. drain-source on resistance

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

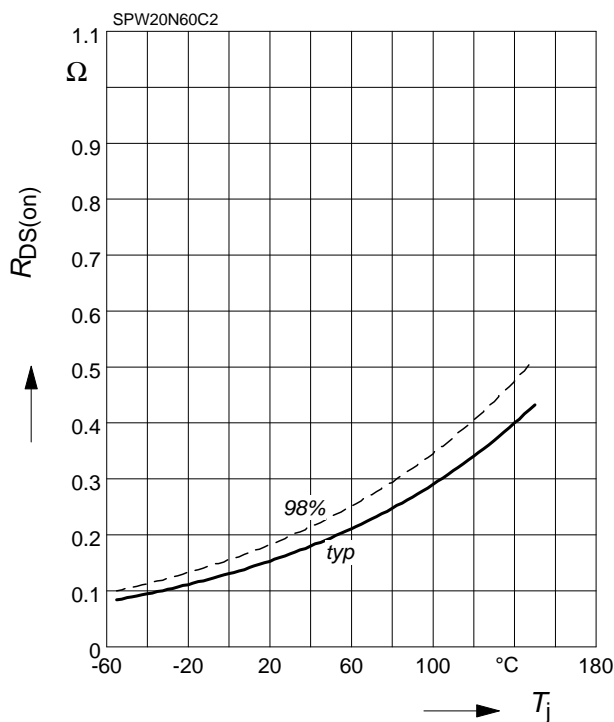
parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$



### 7 Drain-source on-state resistance

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

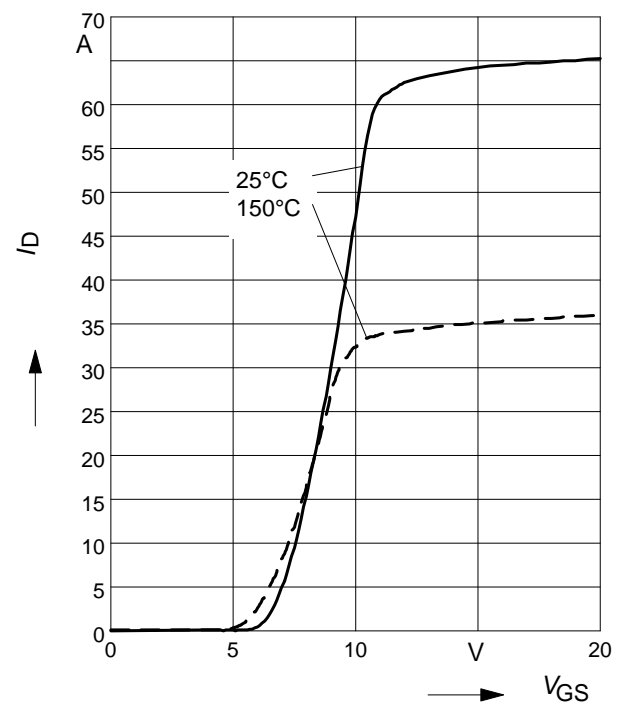
parameter:  $I_D = 13 \text{ A}$ ,  $V_{GS} = 10 \text{ V}$



### 8 Typ. transfer characteristics

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

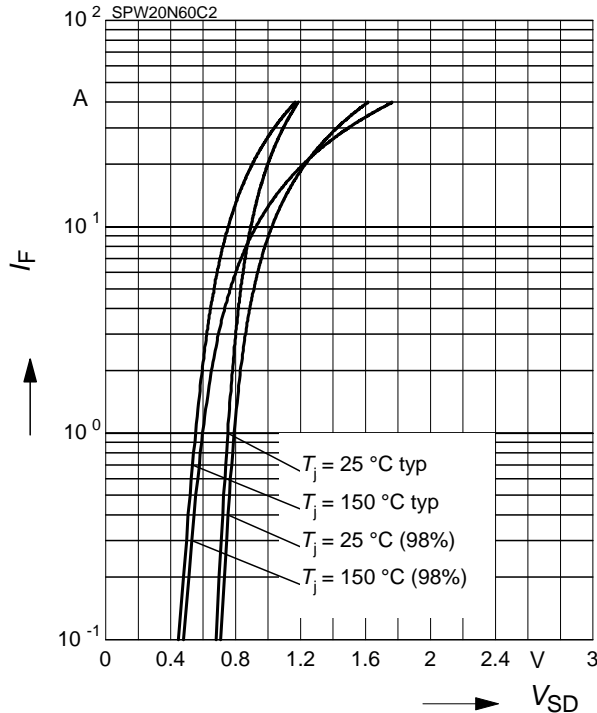
parameter:  $t_p = 10 \mu\text{s}$



## 9 Forward characteristics of body diode

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

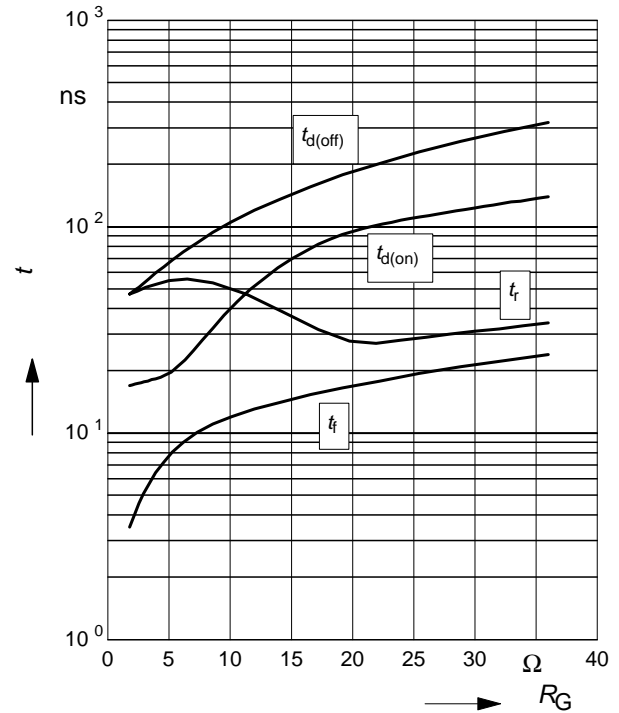
parameter:  $T_j$ ,  $t_p = 10 \mu s$



## 10 Typ. switching time

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

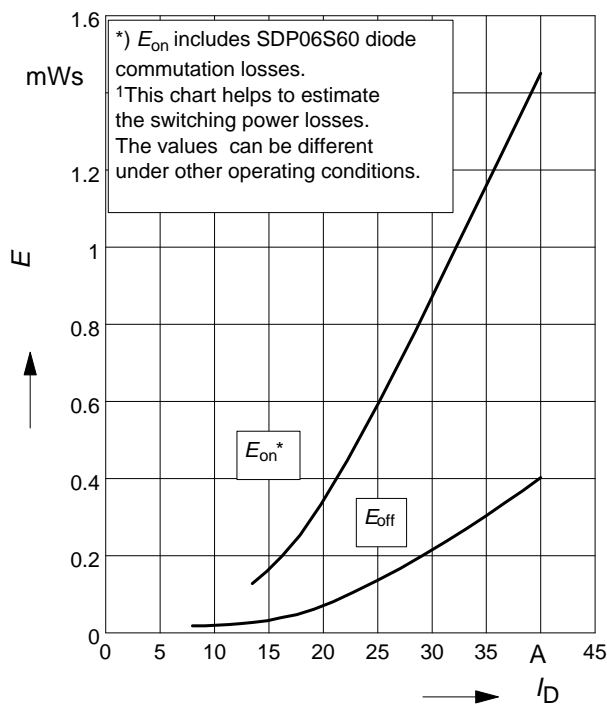
par.:  $V_{DS}=380\text{V}$ ,  $V_{GS}=0/+13\text{V}$ ,  $I_D=20\text{A}$



## 11 Typ. switching losses<sup>1)</sup>

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

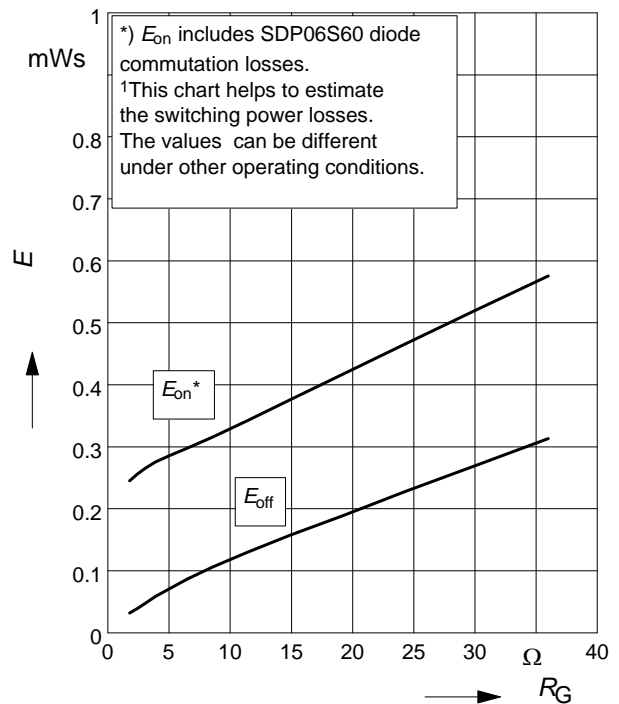
par.:  $V_{DS}=380\text{V}$ ,  $V_{GS}=0/+13\text{V}$ ,  $R_G=3.6\Omega$



## 12 Typ. switching losses<sup>1)</sup>

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

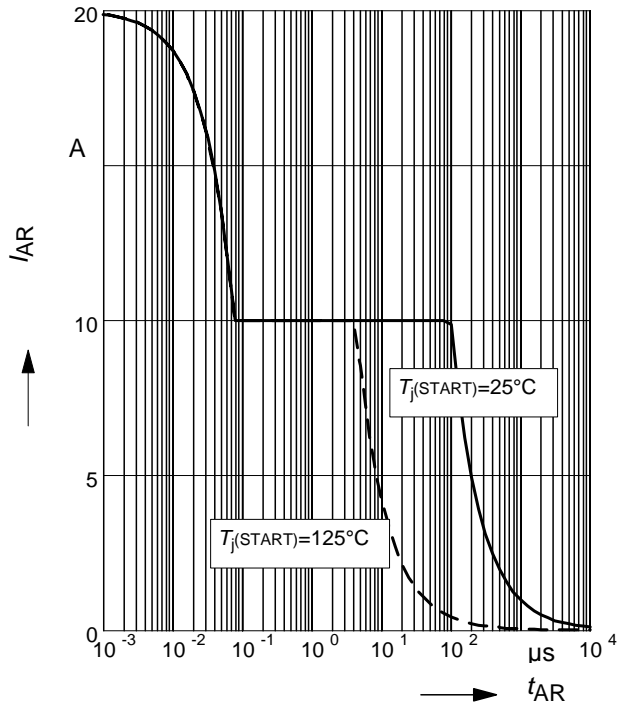
par.:  $V_{DS}=380\text{V}$ ,  $V_{GS}=0/+13\text{V}$ ,  $I_D=20\text{A}$



### 13 Avalanche SOA

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

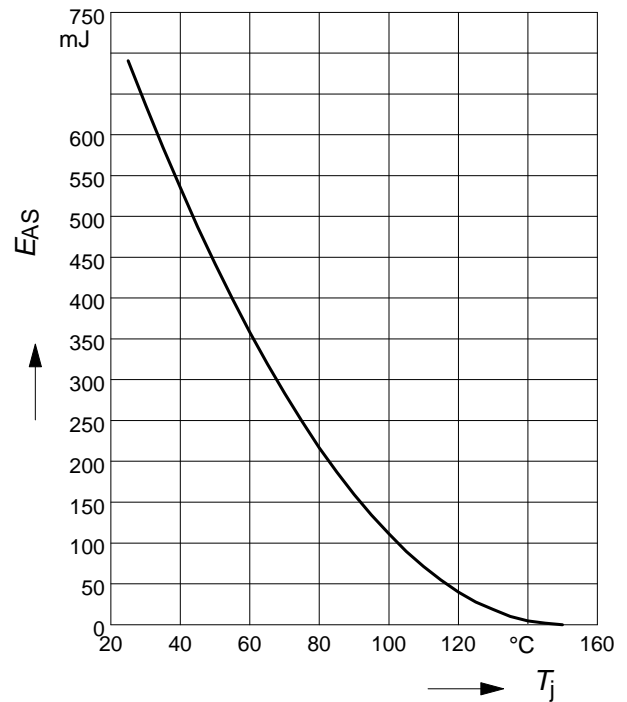
par.:  $T_j \leq 150^\circ\text{C}$



### 14 Avalanche energy

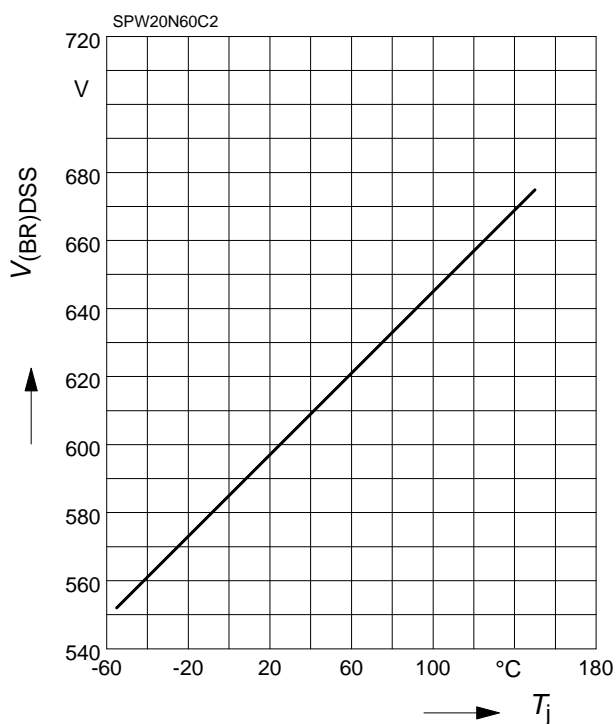
$$E_{AS} = f(T_j)$$

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



### 15 Drain-source breakdown voltage

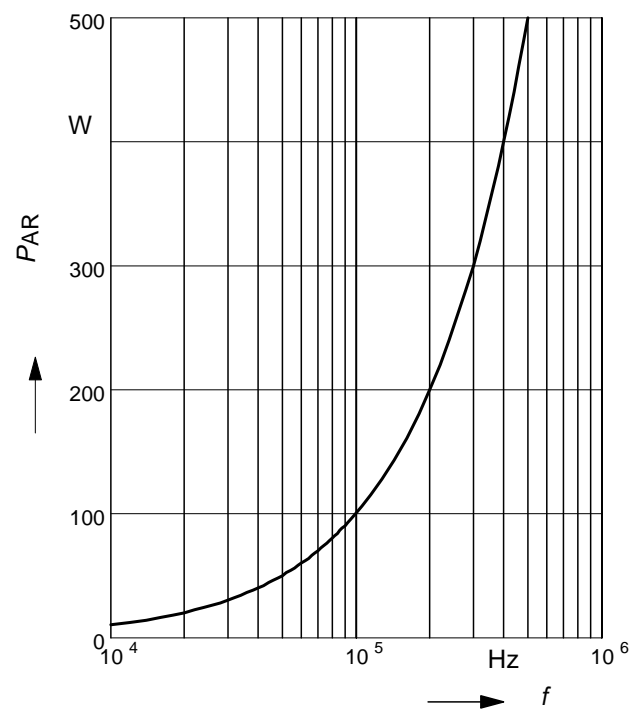
$$V_{(BR)DSS} = f(T_j)$$



### 16 Avalanche power losses

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

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

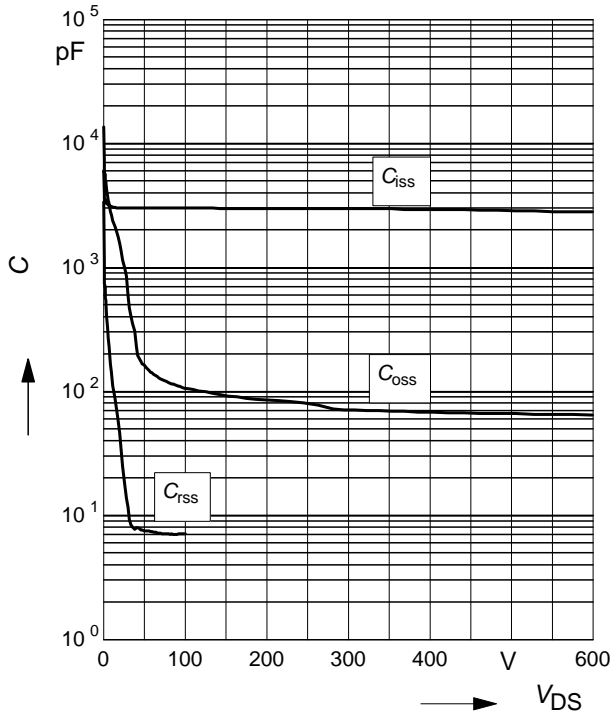




### 17 Typ. capacitances

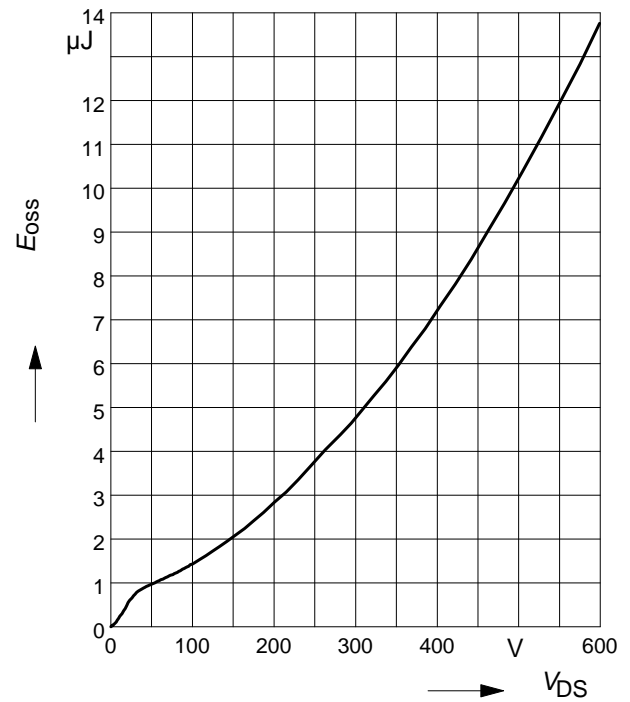
$$C = f(V_{DS})$$

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

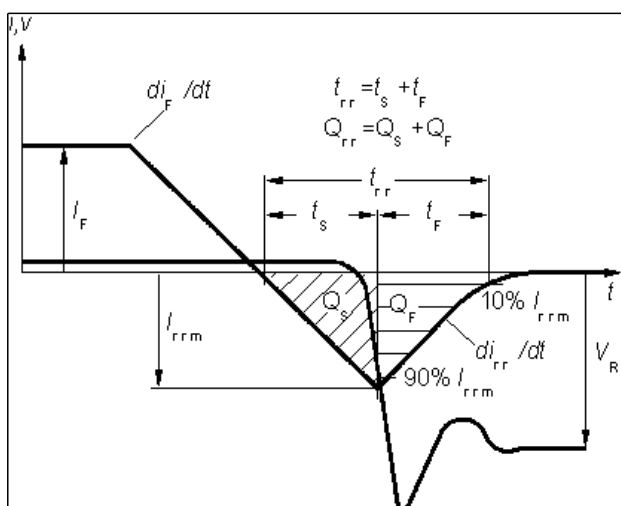


### 18 Typ. $C_{oss}$ stored energy

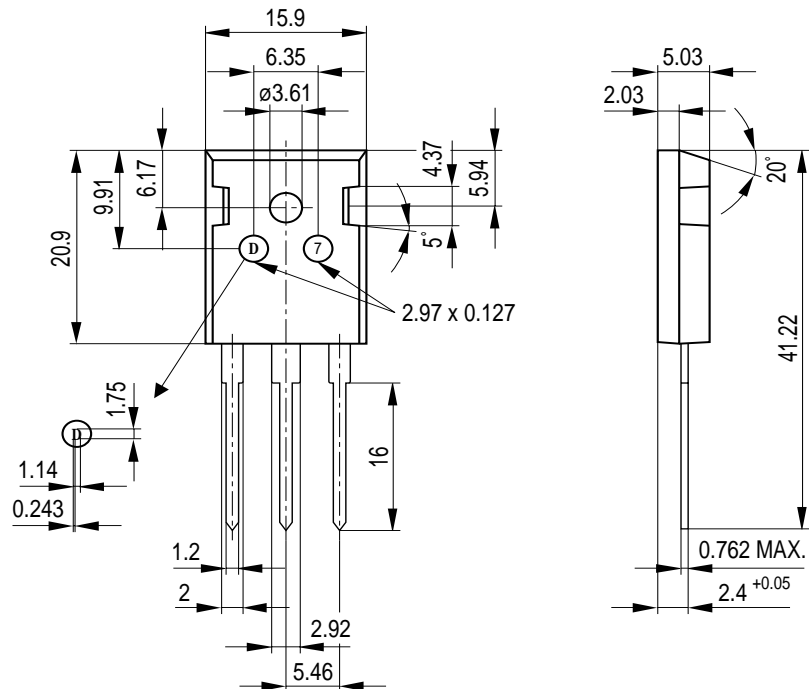
$$E_{oss}=f(V_{DS})$$



### Definition of diodes switching characteristics



P-TO-247-3-1



General tolerance unless otherwise specified: Leadframe parts:  $\pm 0.05$   
Package parts:  $\pm 0.12$

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