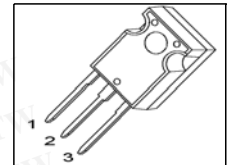


**Cool MOS™ Power Transistor**
**Feature**

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

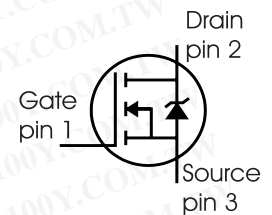
$V_{DS}$	600	V
$R_{DS(on)}$	0.19	$\Omega$
$I_D$	20	A

P-TO247



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Type	Package	Ordering Code	Marking
SPW20N60S5	P-TO247	Q67040-S4238	20N60S5


**Maximum Ratings**

Parameter	Symbol	Value	Unit
Continuous drain current $T_C = 25\text{ }^\circ\text{C}$ $T_C = 100\text{ }^\circ\text{C}$	$I_D$	20 13	A
Pulsed drain current, $t_p$ limited by $T_{jmax}$	$I_D$ puls	40	
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
Gate source voltage	$V_{GS}$	$\pm 20$	V
Gate source voltage AC ( $f > 1\text{ Hz}$ )	$V_{GS}$	$\pm 30$	
Power dissipation, $T_C = 25\text{ }^\circ\text{C}$	$P_{tot}$	208	W
Operating and storage temperature	$T_j, T_{stg}$	-55... +150	$^\circ\text{C}$

**Maximum Ratings**

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480\text{ V}$ , $I_D = 20\text{ A}$ , $T_j = 125\text{ °C}$	$dv/dt$	20	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	$R_{thJA}$	-	-	50	
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**

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	$V_{GS(th)}$	$I_D=1000\mu\text{A}$ , $V_{GS}=V_{DS}$	3.5	4.5	5.5	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=600\text{V}$ , $V_{GS}=0\text{V}$ , $T_j=25\text{ °C}$ , $T_j=150\text{ °C}$	-	0.5	5	$\mu\text{A}$
Gate-source leakage current	$I_{GSS}$	$V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$ , $I_D=13\text{A}$ , $T_j=25\text{ °C}$ $T_j=150\text{ °C}$	-	0.16	0.19	$\Omega$
Gate input resistance	$R_G$	$f=1\text{MHz}$ , open Drain	-	12	-	

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
<b>Characteristics</b>						
Transconductance	$g_{fs}$	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ , $I_D = 13\text{A}$	-	12	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ ,	-	3000	-	pF
Output capacitance	$C_{oss}$	$f = 1\text{MHz}$	-	1170	-	
Reverse transfer capacitance	$C_{rss}$		-	28	-	
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	$t_{d(on)}$	$V_{DD} = 350\text{V}$ , $V_{GS} = 0/10\text{V}$ ,	-	120	-	ns
Rise time	$t_r$	$I_D = 20\text{A}$ , $R_G = 3.6\Omega$	-	25	-	
Turn-off delay time	$t_{d(off)}$		-	130	195	
Fall time	$t_f$		-	30	45	

**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	$Q_{gd}$		-	47	-	
Gate charge total	$Q_g$	$V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$ , $V_{GS} = 0\text{ to } 10\text{V}$	-	79	103	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$ , $I_D = 20\text{A}$	-	8	-	V

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

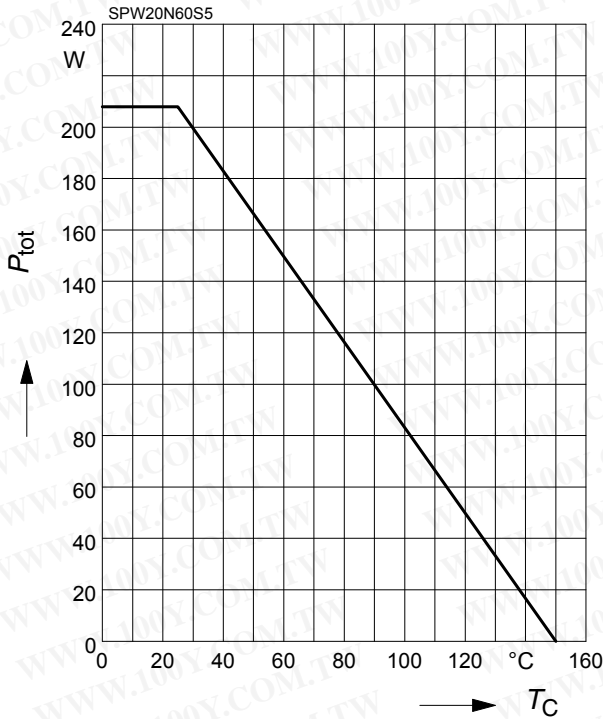
<sup>3</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

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**1 Power dissipation**

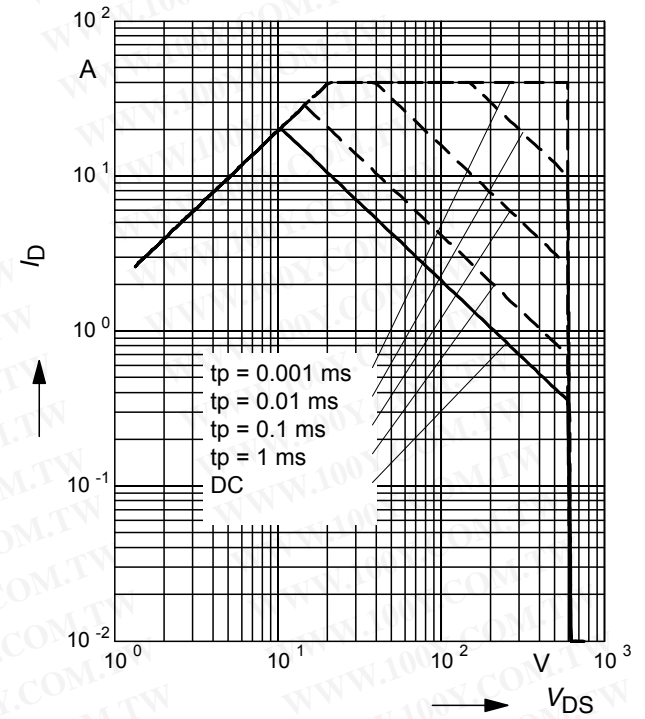
$P_{tot} = f(T_C)$



**2 Safe operating area**

$I_D = f(V_{DS})$

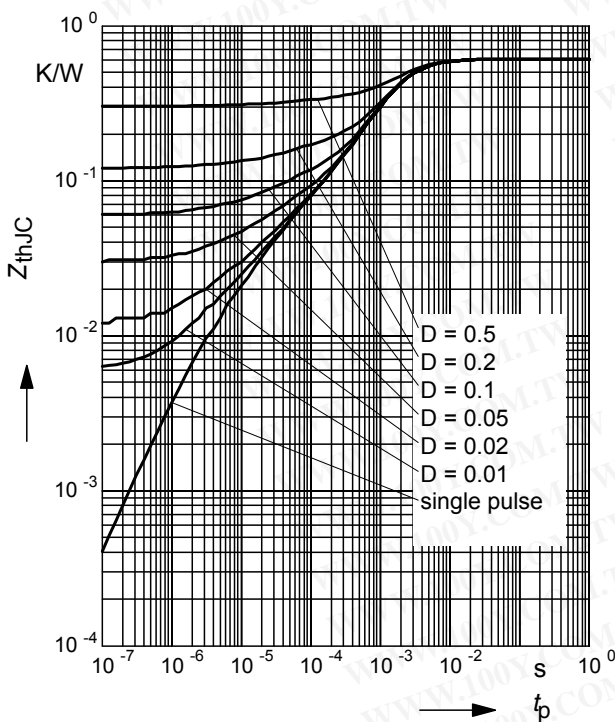
parameter :  $D = 0$  ,  $T_C = 25^\circ C$



**3 Transient thermal impedance**

$Z_{thJC} = f(t_p)$

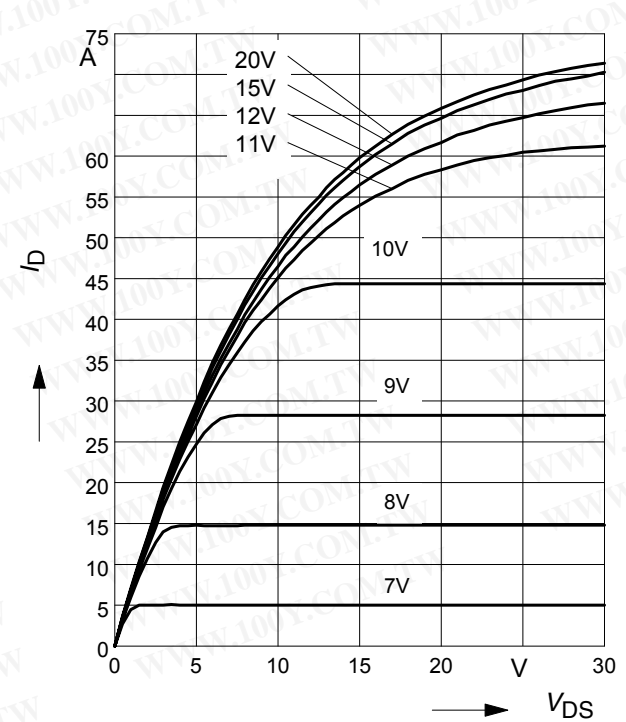
parameter:  $D = t_p/T$



**4 Typ. output characteristic**

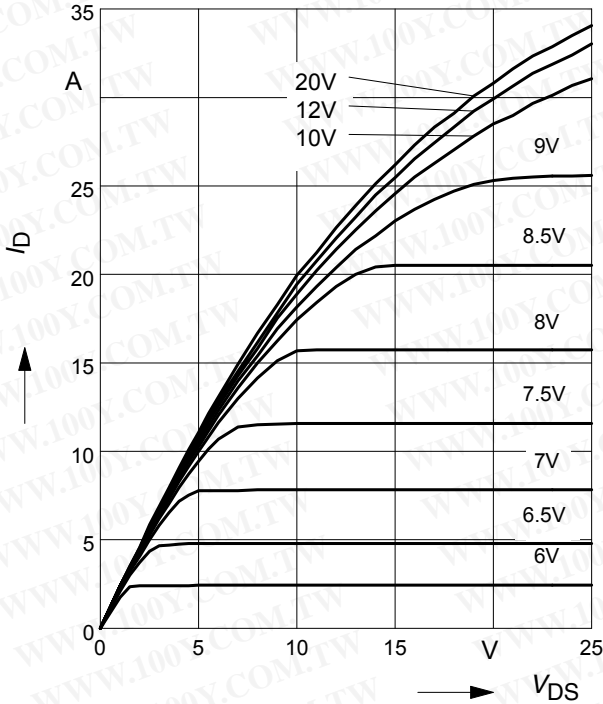
$I_D = f(V_{DS})$ ;  $T_j = 25^\circ C$

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



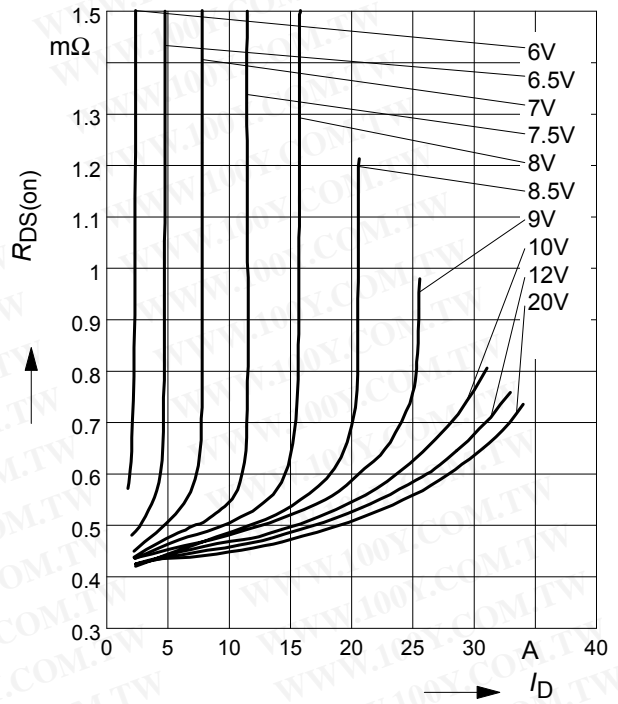
**5 Typ. output characteristic**

$I_D = f(V_{DS}); T_j = 150^\circ\text{C}$   
 parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



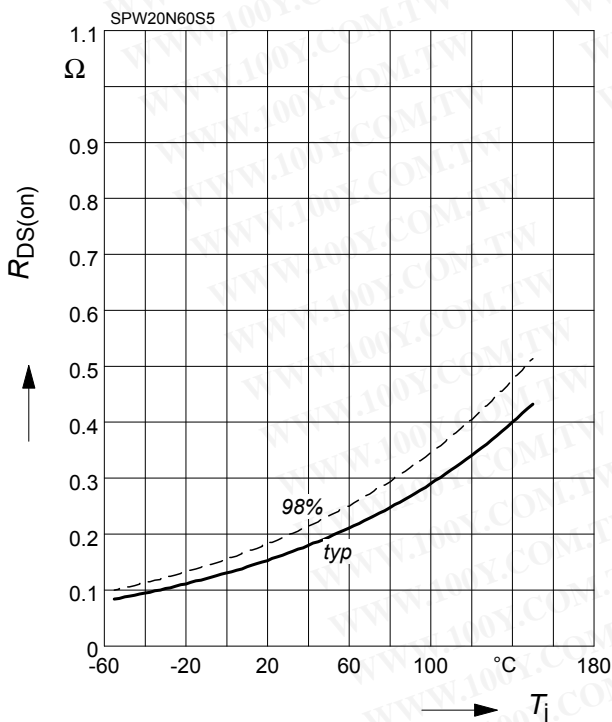
**6 Typ. drain-source on resistance**

$R_{DS(on)} = f(I_D)$   
 parameter:  $T_j = 150^\circ\text{C}, V_{GS}$



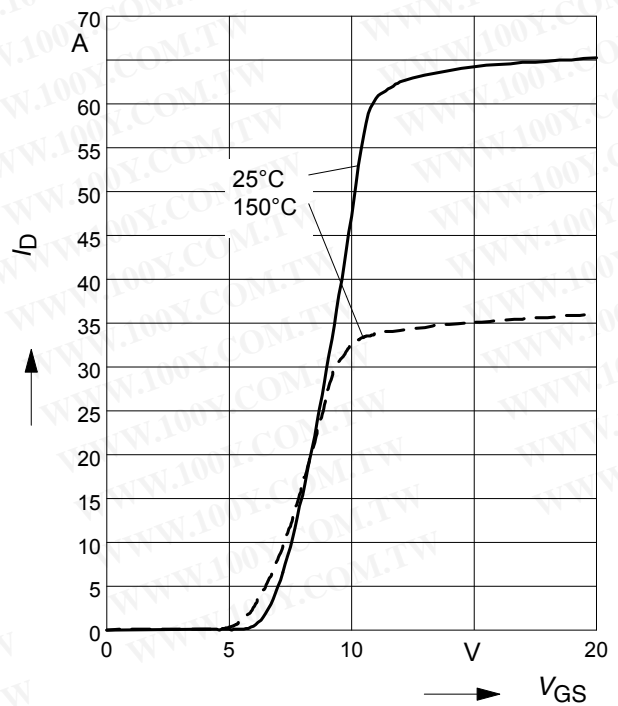
**7 Drain-source on-state resistance**

$R_{DS(on)} = f(T_j)$   
 parameter:  $I_D = 13 \text{ A}, V_{GS} = 10 \text{ V}$



**8 Typ. transfer characteristics**

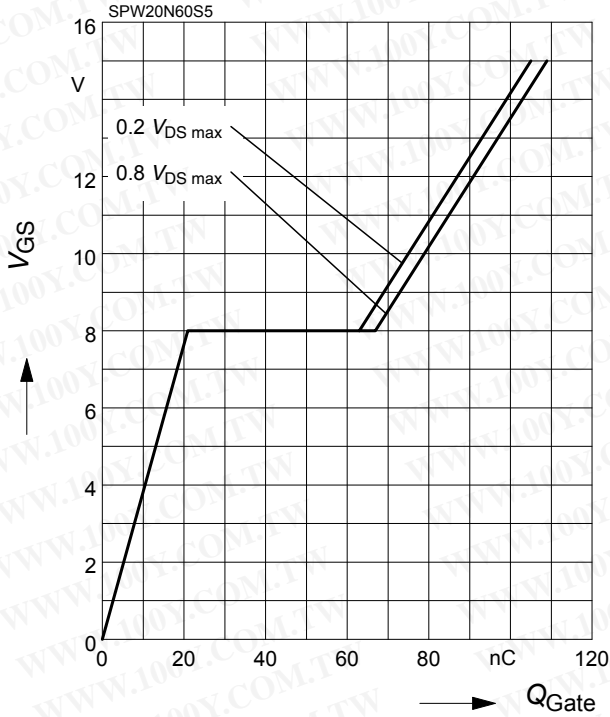
$I_D = f(V_{GS}); V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$   
 parameter:  $t_p = 10 \mu\text{s}$



**9 Typ. gate charge**

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

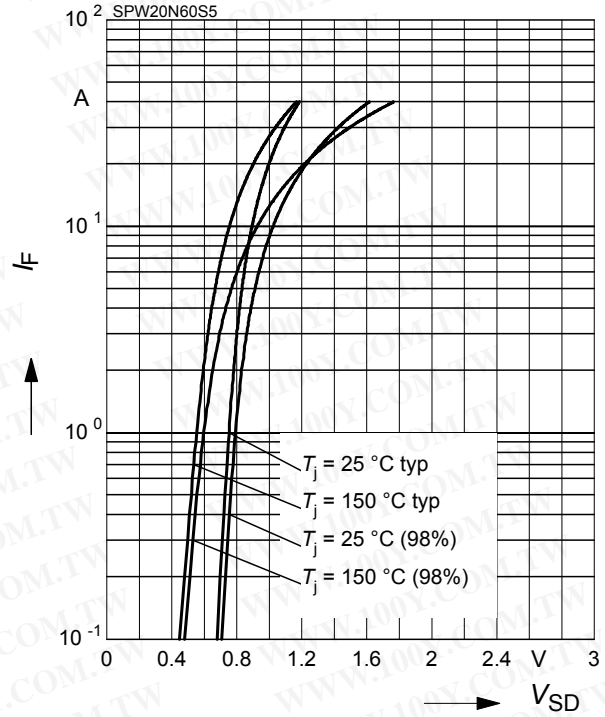
parameter:  $I_D = 20$  A pulsed



**10 Forward characteristics of body diode**

$I_F = f(V_{SD})$

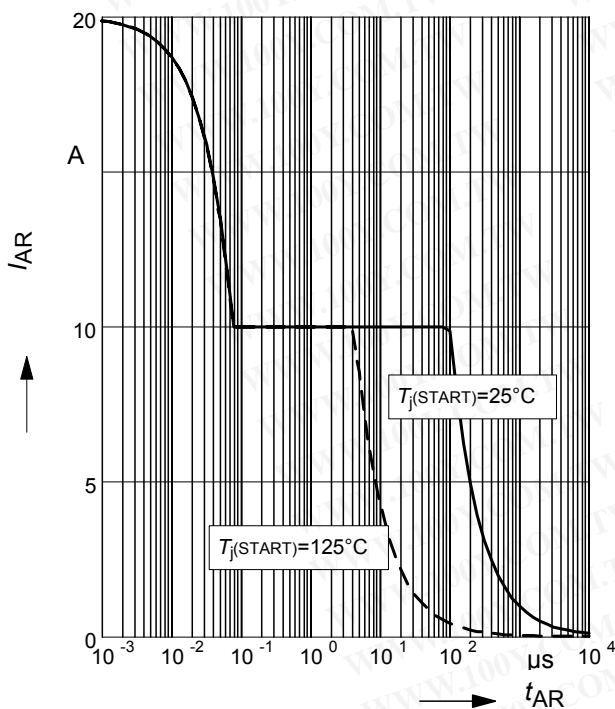
parameter:  $T_j, t_p = 10 \mu s$



**11 Avalanche SOA**

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

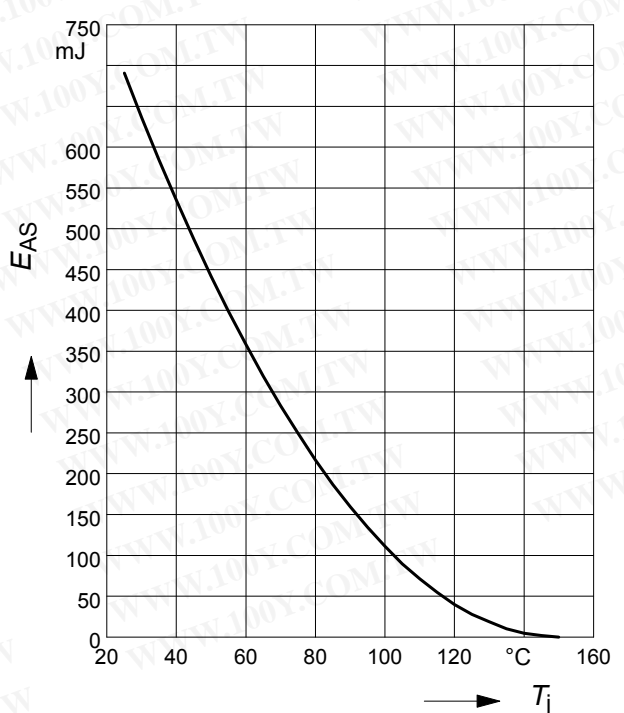
par.:  $T_j \leq 150^\circ C$



**12 Avalanche energy**

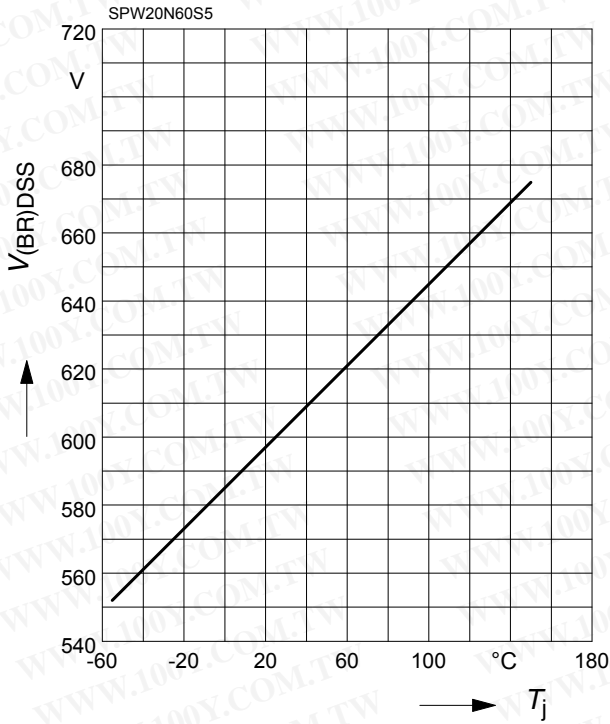
$E_{AS} = f(T_j)$

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



**13 Drain-source breakdown voltage**

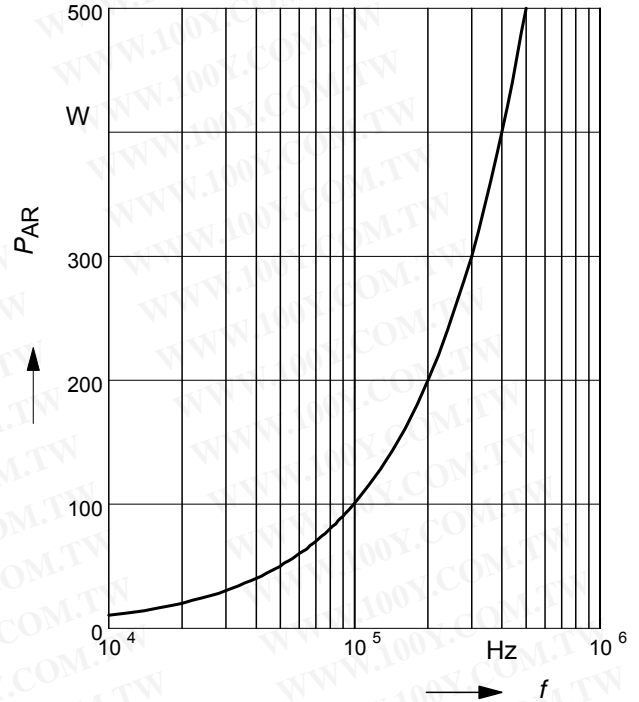
$$V_{(BR)DSS} = f(T_j)$$



**14 Avalanche power losses**

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

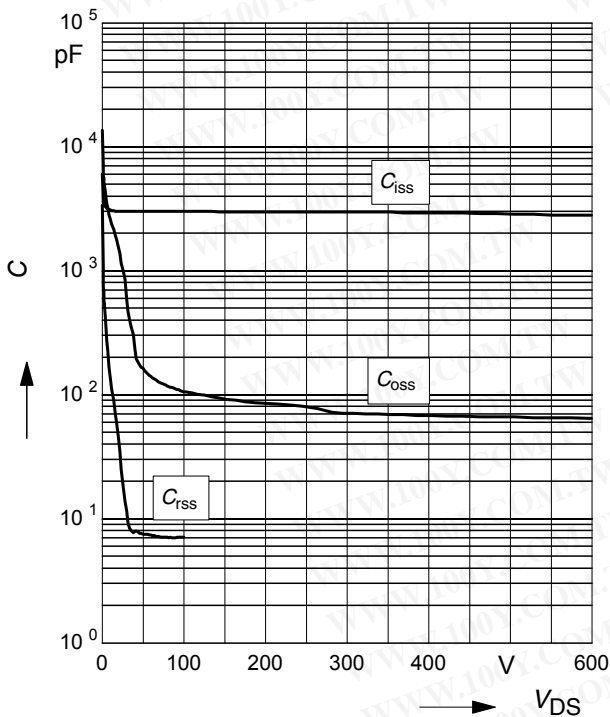
parameter:  $E_{AR}=1mJ$



**15 Typ. capacitances**

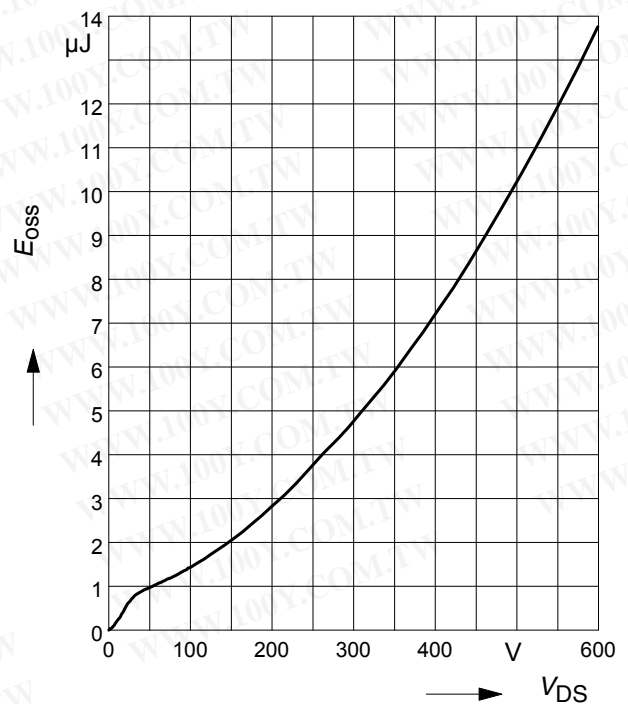
$$C = f(V_{DS})$$

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

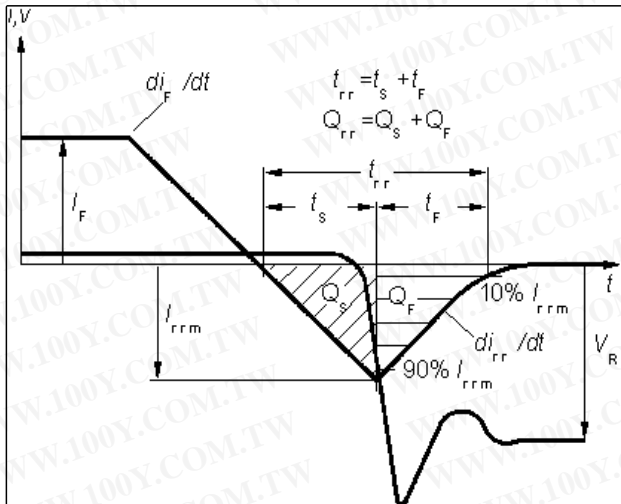


**16 Typ.  $C_{oss}$  stored energy**

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



Definition of diodes switching characteristics



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