

## Cool MOS™ Power Transistor

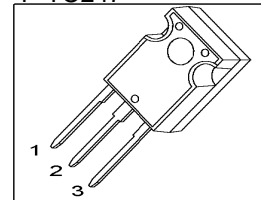
### Feature

- New revolutionary high voltage technology
- Worldwide best  $R_{DS(on)}$  in TO 247
- Ultra low gate charge
- Periodic avalanche rated
- Extreme  $dv/dt$  rated
- Ultra low effective capacitances
- Improved noise immunity

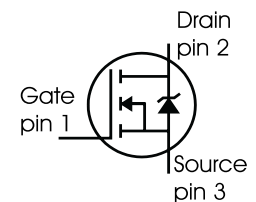
### Product Summary

$V_{DS}$	600	V
$R_{DS(on)}$	0.07	$\Omega$
$I_D$	47	A

P-TO247



Type	Package	Ordering Code	Marking
SPW47N60C2	P-TO247	Q67040-S4323	47N60C2



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

Parameter	Symbol	Value	Unit
Continuous drain current	$I_D$		A
$T_C = 25^\circ\text{C}$		47	
$T_C = 100^\circ\text{C}$		30	
Pulsed drain current, $t_b$ limited by $T_{jmax}$	$I_{D\ puls}$	94	
Avalanche energy, single pulse	$E_{AS}$	1800	mJ
$I_D=10\text{A}, V_{DD}=50\text{V}$			
Avalanche energy, repetitive $t_{AR}$ limited by $T_{jmax}$ <sup>1)</sup>	$E_{AR}$	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
$I_S=47\text{A}, V_{DS} < V_{DD}, di/dt=100\text{A}/\mu\text{s}, T_{jmax}=150^\circ\text{C}$			
Gate source voltage	$V_{GS}$	$\pm 20$	V
Power dissipation, $T_C = 25^\circ\text{C}$	$P_{tot}$	415	W
Operating and storage temperature	$T_j, T_{stg}$	-55... +150	$^\circ\text{C}$

**Thermal Characteristics**

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>Characteristics</b>					
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.3	K/W
Thermal resistance, junction - ambient, leaded	$R_{thJA}$	-	-	62	
Linear derating factor		-	-	3.33	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, $V_{GS} = V_{DS}$ $I_D=2.7mA$	$V_{GS(th)}$	3.5	4.5	5.5	
Zero gate voltage drain current $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}, T_j = 25\text{ °C}$ $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}, T_j = 150\text{ °C}$	$I_{DSS}$	-	0.5	25	$\mu A$
		-	-	250	
Gate-source leakage current $V_{GS}=20V, V_{DS}=0V$	$I_{GSS}$	-	-	100	nA
Drain-source on-state resistance $V_{GS}=10V, I_D=30A, T_j=25\text{ °C}$	$R_{DS(on)}$	-	0.06	0.07	$\Omega$
Gate input resistance $f = 1\text{ MHz}, \text{open drain}$	$R_G$	-	0.62	-	

<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	$g_{fs}$	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ $I_D = 30\text{A}$	-	30	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ , $f = 1\text{MHz}$	-	8800	-	pF
Output capacitance	$C_{oss}$		-	3150	-	
Reverse transfer capacitance	$C_{rss}$		-	36	-	
Effective output capacitance, 1) energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V to } 480\text{V}$	-	233	-	pF
Effective output capacitance, 2) time related	$C_{o(tr)}$		-	470	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380\text{V}$ , $V_{GS} = 0/13\text{V}$ , $I_D = 47\text{A}$ , $R_G = 1.8\Omega$ , $T_j = 125\text{ }^\circ\text{C}$	-	28	-	ns
Rise time	$t_r$		-	9.5	-	
Turn-off delay time	$t_{d(off)}$		-	103	155	
Fall time	$t_f$		-	9.6	14.4	

**Gate Charge Characteristics**

Gate to source charge	$Q_{gs}$	$V_{DD} = 350\text{V}$ , $I_D = 47\text{A}$	-	56	-	nC
Gate to drain charge	$Q_{gd}$		-	123	-	
Gate charge total	$Q_g$	$V_{DD} = 350\text{V}$ , $I_D = 47\text{A}$ , $V_{GS} = 0\text{ to } 10\text{V}$	-	220	286	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$ , $I_D = 47\text{A}$	-	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%  $V_{DSS}$ .

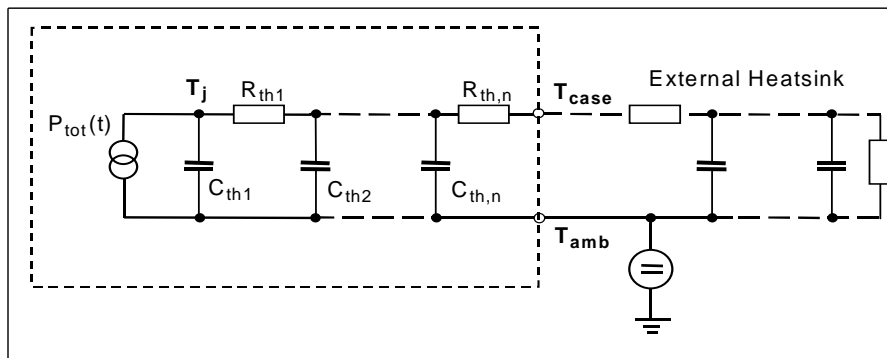
<sup>2</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
<b>Characteristics</b>						
Inverse diode continuous forward current	$I_S$	$T_C=25^\circ\text{C}$	-	-	47	A
Inverse diode direct current, pulsed	$I_{SM}$		-	-	94	
Inverse diode forward voltage	$V_{SD}$	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=350\text{V}, I_F=I_S,$	-	650	1100	ns
Reverse recovery charge	$Q_{rr}$	$di_F/dt=100\text{A}/\mu\text{s}$	-	24	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	62	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$		-	2500	-	$\text{A}/\mu\text{s}$

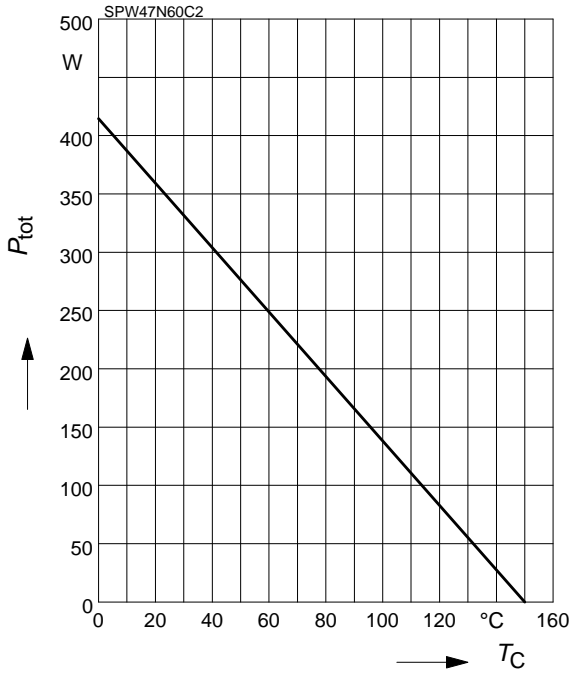
**Typical Transient Thermal Characteristics**

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
$R_{th1}$	0.002694	K/W	$C_{th1}$	0.001219	Ws/K
$R_{th2}$	0.006036		$C_{th2}$	0.004011	
$R_{th3}$	0.00791		$C_{th3}$	0.006484	
$R_{th4}$	0.023		$C_{th4}$	0.008028	
$R_{th5}$	0.035		$C_{th5}$	0.05	
$R_{th6}$	0.018		$C_{th6}$	0.316	



**1 Power dissipation**

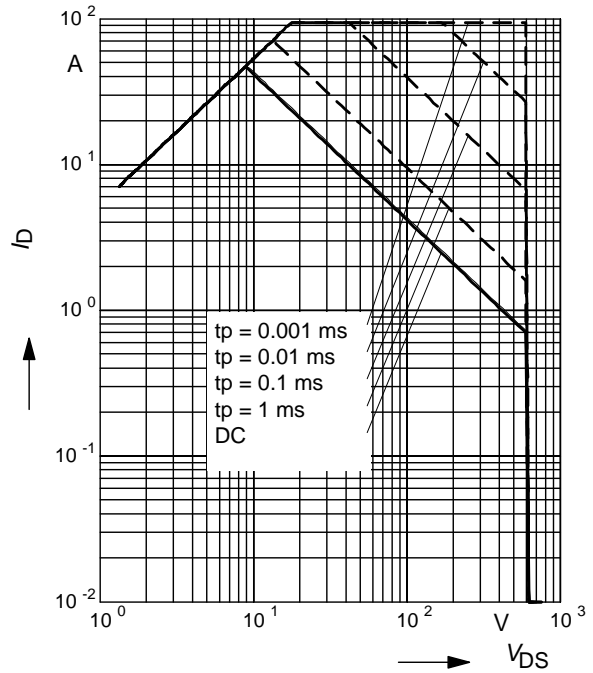
$$P_{tot} = f(T_C)$$



**2 Safe operating area**

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

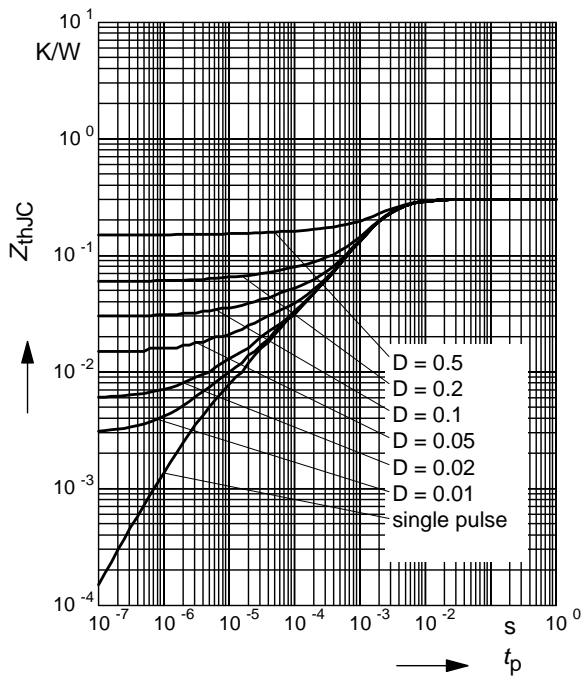
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



**3 Transient thermal impedance**

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

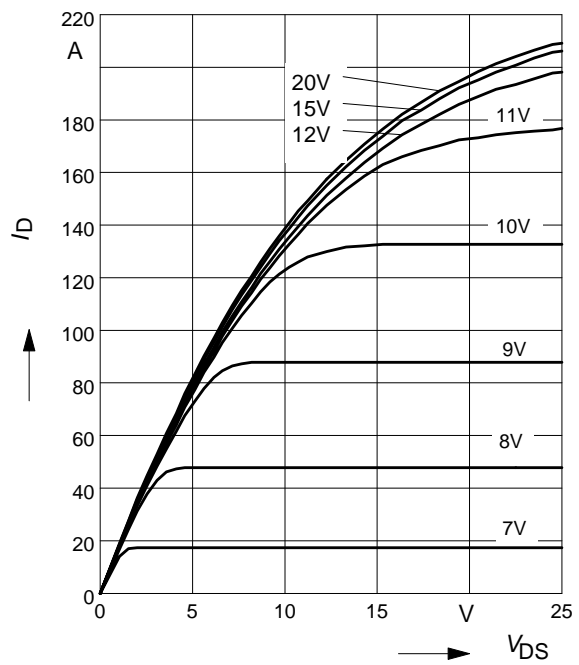
parameter:  $D = t_p/T$



**4 Typ. output characteristic**

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

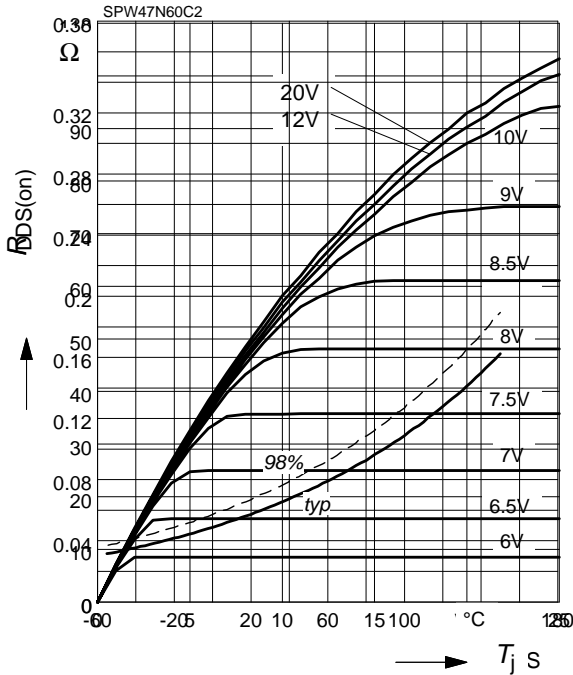
parameter:  $t_p = 10 \mu\text{s}$  ,  $V_{GS}$



**3 Typ. static on-state resistance**

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

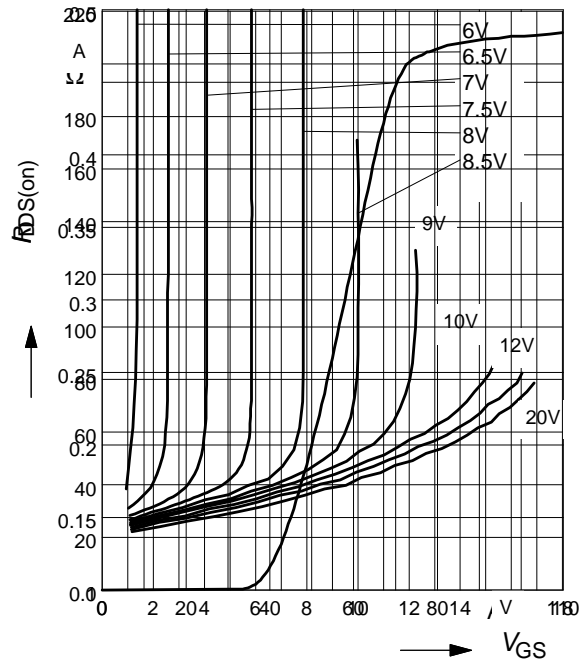
parameter:  $I_D = 100\text{A}$ ,  $V_{GS} = 10\text{V}$



**6 Typ. transfer characteristic**

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

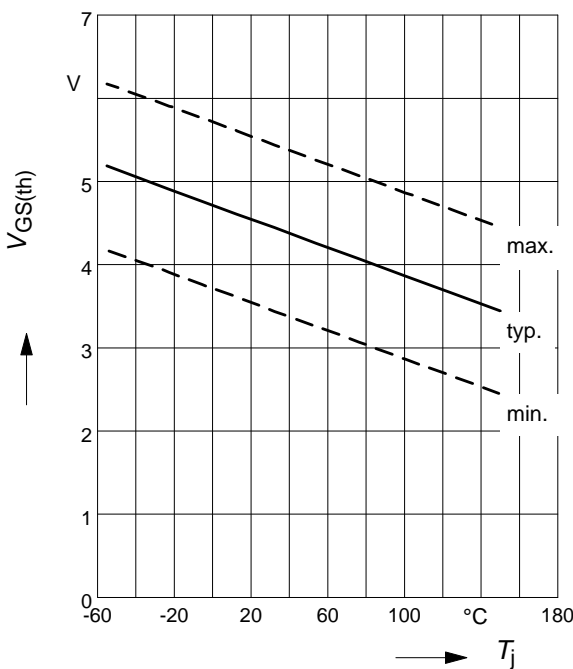
parameter:  $T_j = 150^\circ\text{C}$ ,  $V_{GS}$



**9 Gate threshold voltage**

$$V_{GS(th)} = f(T_j)$$

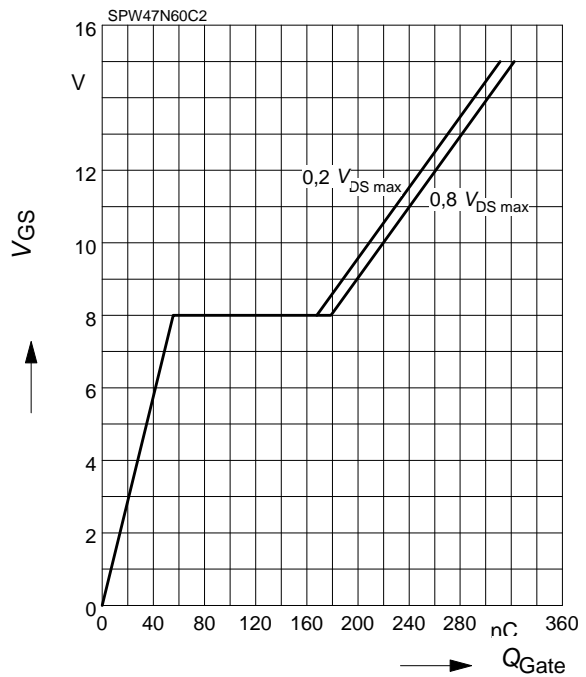
parameter:  $V_{GS} = V_{DS}$ ,  $I_D = 2.7\text{mA}$



**10 Typ. gate charge**

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

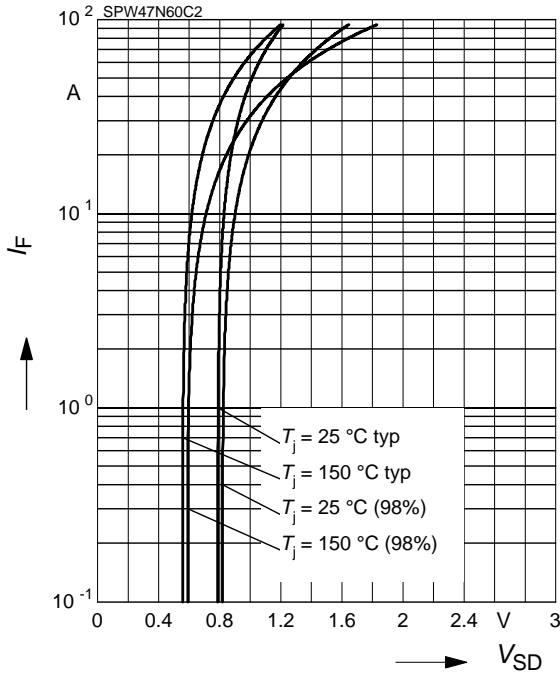
parameter:  $I_D = 47\text{A}$  pulsed



**11 Forward characteristics of body diode**

$I_F = f(V_{SD})$

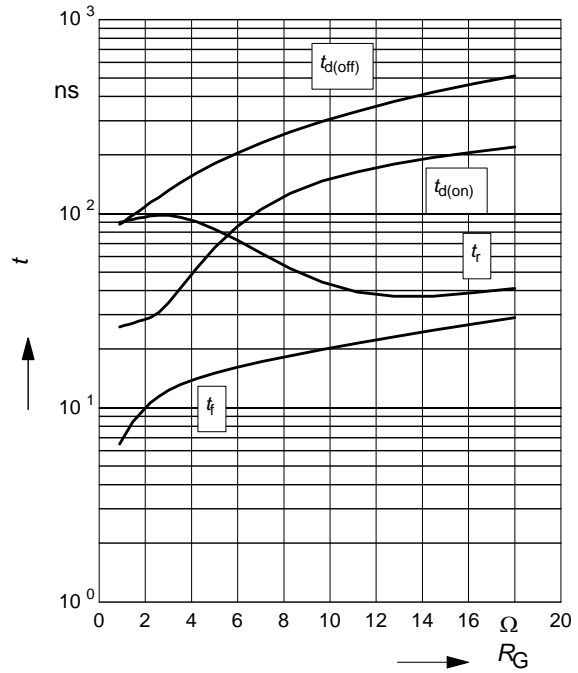
parameter:  $T_j$ ,  $t_p = 10 \mu s$



**12 Typ. switching time**

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

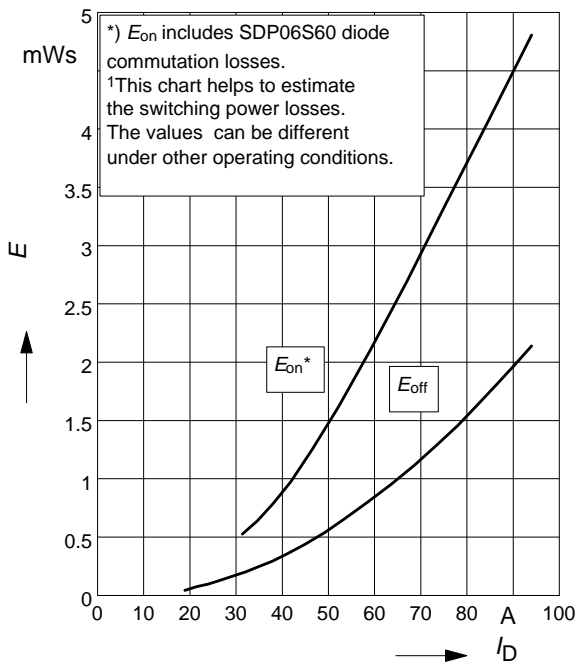
par.:  $V_{DS}=380V$ ,  $V_{GS}=0/+13V$ ,  $I_D=47 A$



**13 Typ. switching losses<sup>1)</sup>**

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

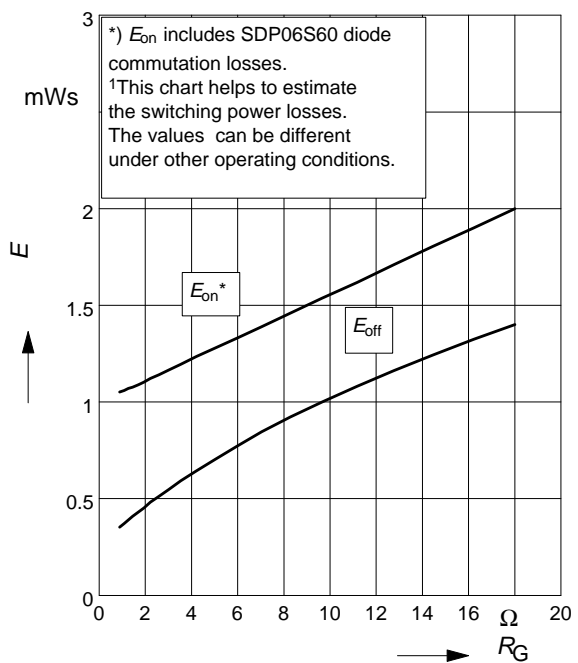
par.:  $V_{DS}=380V$ ,  $V_{GS}=0/+13V$ ,  $R_G=1.8\Omega$



**14 Typ. switching losses<sup>1)</sup>**

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

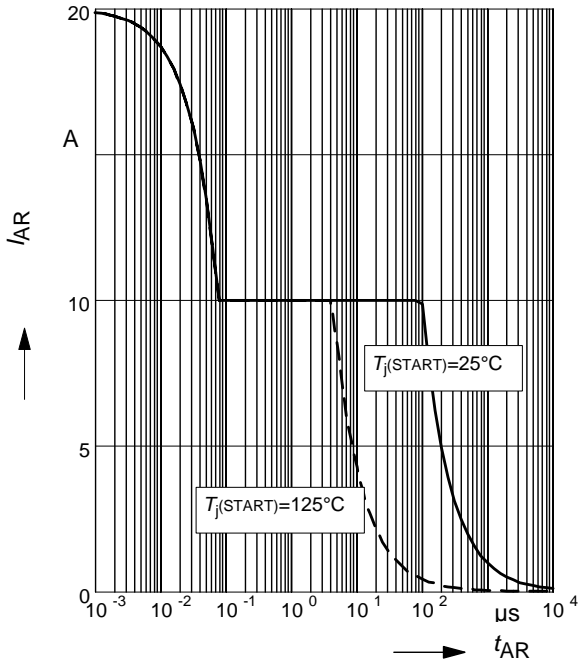
par.:  $V_{DS}=380V$ ,  $V_{GS}=0/+13V$ ,  $I_D=47 A$



**15 Avalanche SOA**

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

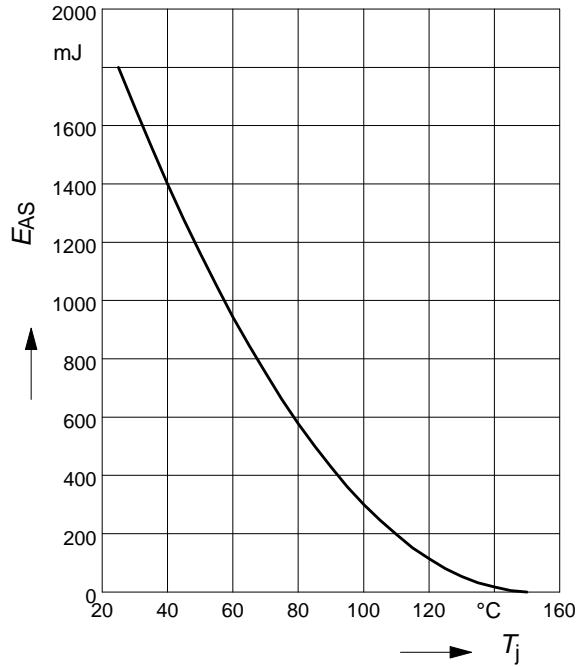
par.:  $T_j \leq 150\text{ }^\circ\text{C}$



**16 Avalanche energy**

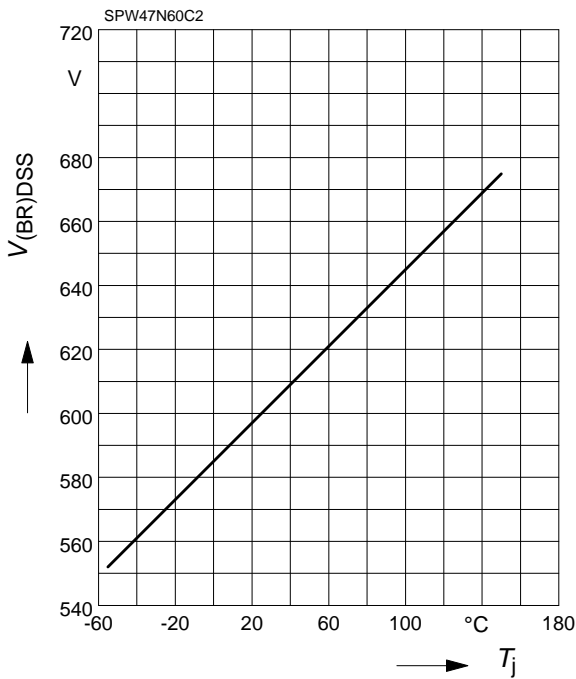
$E_{AS} = f(T_j)$

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



**17 Drain-source breakdown voltage**

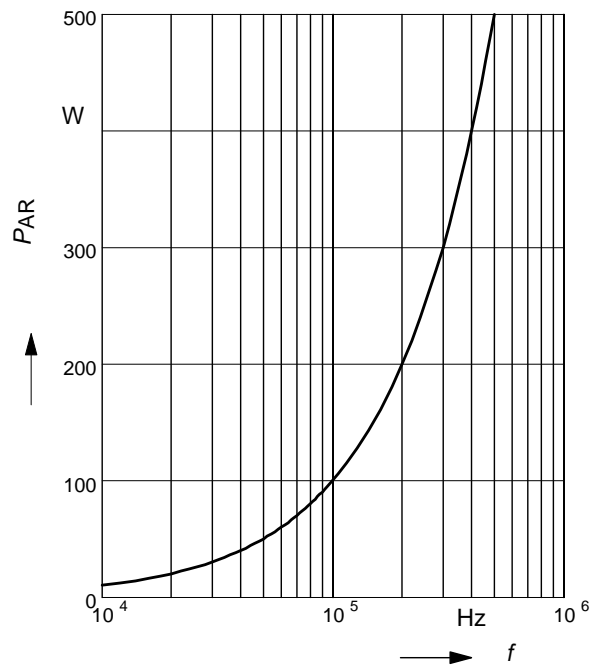
$V_{(BR)DSS} = f(T_j)$



**18 Avalanche power losses**

$P_{AR} = f(f)$

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

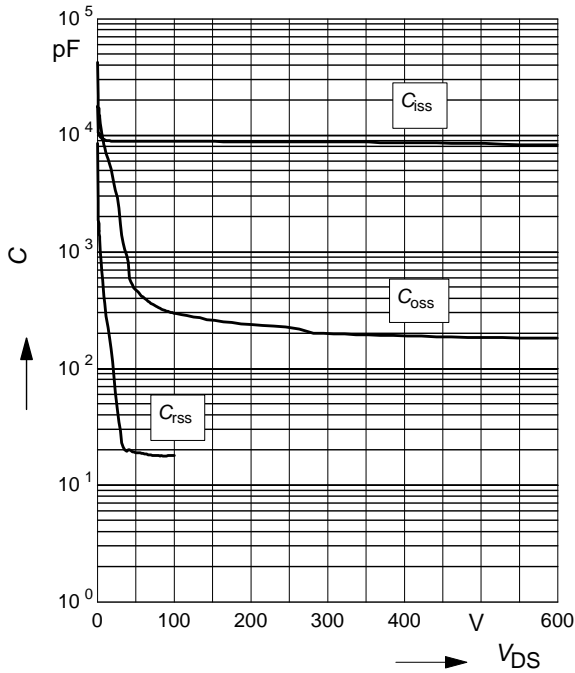




**19 Typ. capacitances**

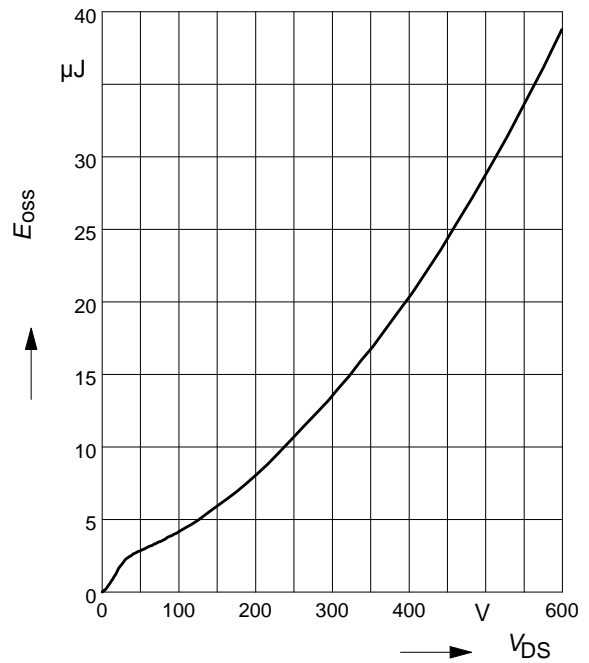
$$C = f(V_{DS})$$

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

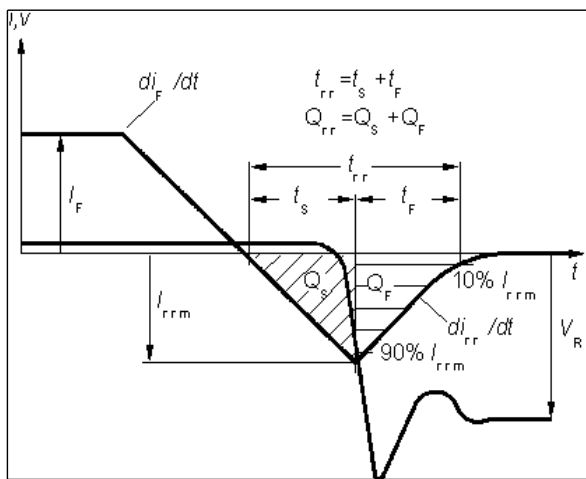


**20 Typ. C<sub>oss</sub> stored energy**

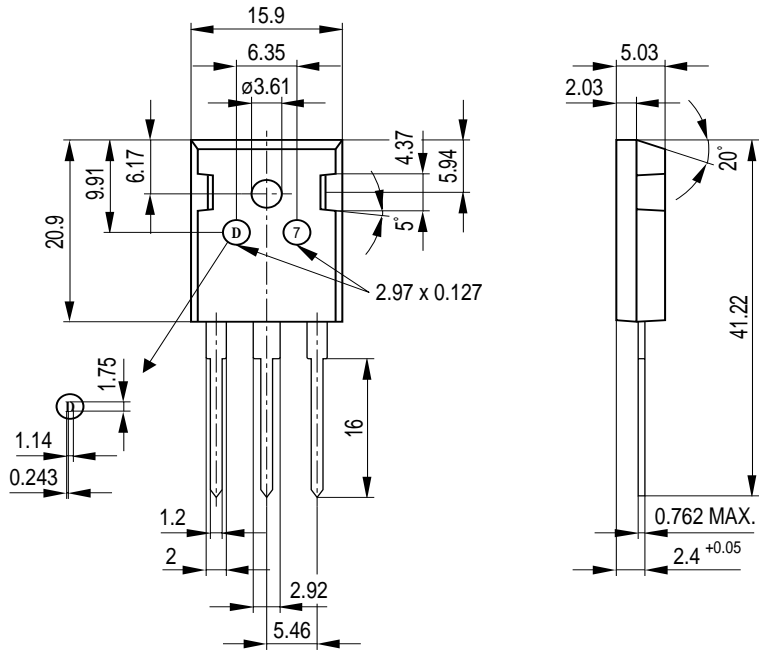
$$E_{oss} = f(V_{DS})$$



**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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