

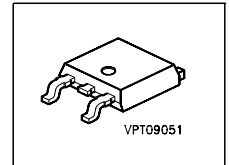
Cool MOS™ Power Transistor

Feature

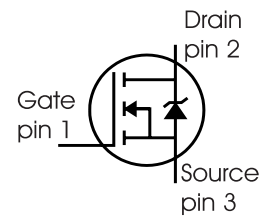
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance

V_{DS}	800	V
$R_{DS(on)}$	1.3	Ω
I_D	4	A

P-TO252-3-1



Type	Package	Ordering Code	Marking
SPD04N80C3	P-TO252-3-1	Q47040-S4563	04N80C3



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

Parameter	Symbol	Value	Unit
Continuous drain current $T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$	I_D	4 2.5	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\ puls}$	12	
Avalanche energy, single pulse $I_D=0.8\text{A}, V_{DD}=50\text{V}$	E_{AS}	170	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ¹⁾ $I_D=4\text{A}, V_{DD}=50\text{V}$	E_{AR}	0.1	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	4	A
Gate source voltage	V_{GS}	± 20	V
Power dissipation, $T_C = 25^\circ\text{C}$	P_{tot}	63	W
Operating and storage temperature	T_j, T_{stg}	-55... +150	$^\circ\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 640\text{ V}, I_D = 4\text{ A}, T_j = 125\text{ °C}$	dv/dt	50	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	2	K/W
SMD version, device on PCB: @ min. footprint	R_{thJA}	-	-	75	
@ 6 cm ² cooling area ²⁾		-	-	50	
Soldering temperature, 1.6 mm (0.063 in.) from case for 10s ³⁾	T_{sold}	-	-	260	°C

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0V, I_D=0.25mA$	800	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0V, I_D=4A$	-	870	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=240\mu A, V_{GS}=V_{DS}$	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=800V, V_{GS}=0V,$ $T_j=25\text{ °C},$ $T_j=150\text{ °C}$	-	0.5	10	μA
			-	-	100	
Gate-source leakage current	I_{GSS}	$V_{GS}=20V, V_{DS}=0V$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10V, I_D=2.5A,$ $T_j=25\text{ °C}$ $T_j=150\text{ °C}$	-	1.1	1.3	Ω
			-	3	-	
Gate input resistance	R_G	$f=1MHz, \text{open Drain}$	-	0.7	-	

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 2.5\text{A}$	-	3	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$	-	570	-	pF
Output capacitance	C_{oss}		-	240	-	
Reverse transfer capacitance	C_{rss}		-	12	-	
Effective output capacitance, ⁴⁾ energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 480\text{V}$	-	15.6	-	pF
Effective output capacitance, ⁵⁾ time related	$C_{o(tr)}$		-	33.7	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 400\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 4\text{A}$, $R_G = 22\Omega$	-	25	-	ns
Rise time	t_r		-	15	-	
Turn-off delay time	$t_{d(off)}$		-	65	75	
Fall time	t_f		-	12	16	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD} = 640\text{V}$, $I_D = 4\text{A}$	-	2.4	-	nC
Gate to drain charge	Q_{gd}		-	11	-	
Gate charge total	Q_g	$V_{DD} = 640\text{V}$, $I_D = 4\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$	-	20	26	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 640\text{V}$, $I_D = 4\text{A}$	-	6	-	V

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

²Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air.

³Soldering temperature for TO-263: 220°C, reflow

⁴ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

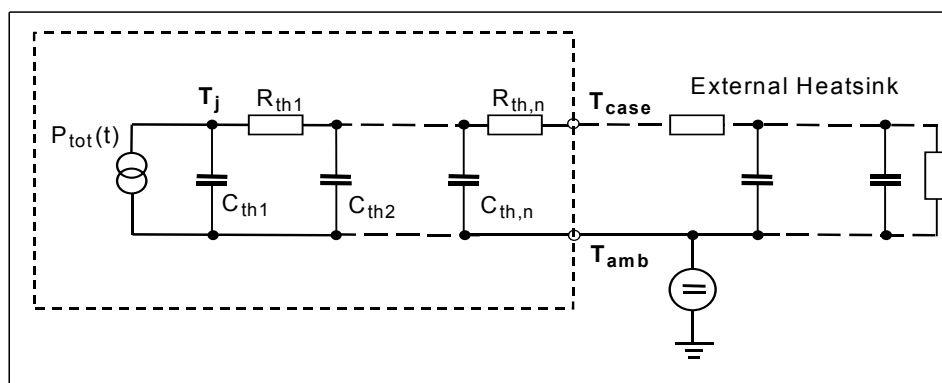
⁵ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	I_S	$T_C=25^\circ\text{C}$	-	-	4	A
Inverse diode direct current, pulsed	I_{SM}		-	-	12	
Inverse diode forward voltage	V_{SD}	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R=640\text{V}, I_F=I_S,$	-	520	-	ns
Reverse recovery charge	Q_{rr}	$di_F/dt=100\text{A}/\mu\text{s}$	-	4	-	μC
Peak reverse recovery current	I_{rrm}		-	12	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	300	-	$\text{A}/\mu\text{s}$

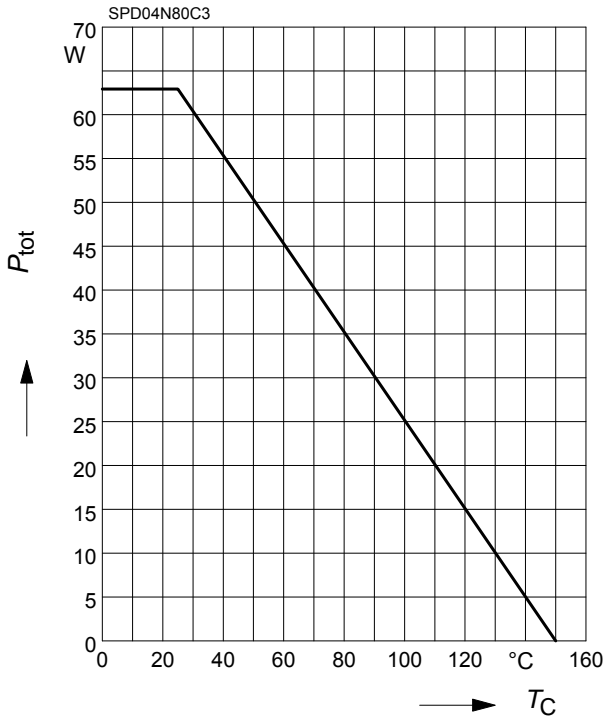
Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
R_{th1}	0.033	K/W	C_{th1}	0.00008691	Ws/K
R_{th2}	0.063		C_{th2}	0.0003336	
R_{th3}	0.113		C_{th3}	0.0004755	
R_{th4}	0.432		C_{th4}	0.001405	
R_{th5}	0.423		C_{th5}	0.003503	
R_{th6}	0.14		C_{th6}	0.036	



1 Power dissipation

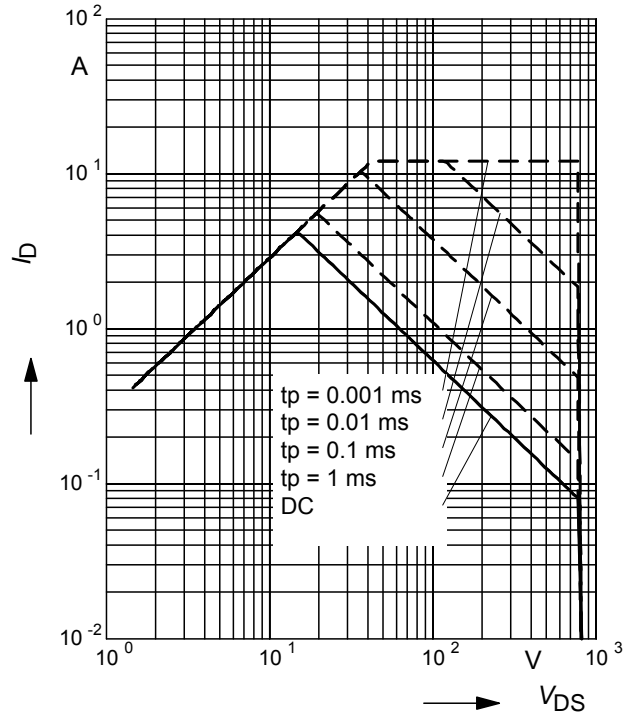
$P_{tot} = f(T_C)$



2 Safe operating area

$I_D = f(V_{DS})$

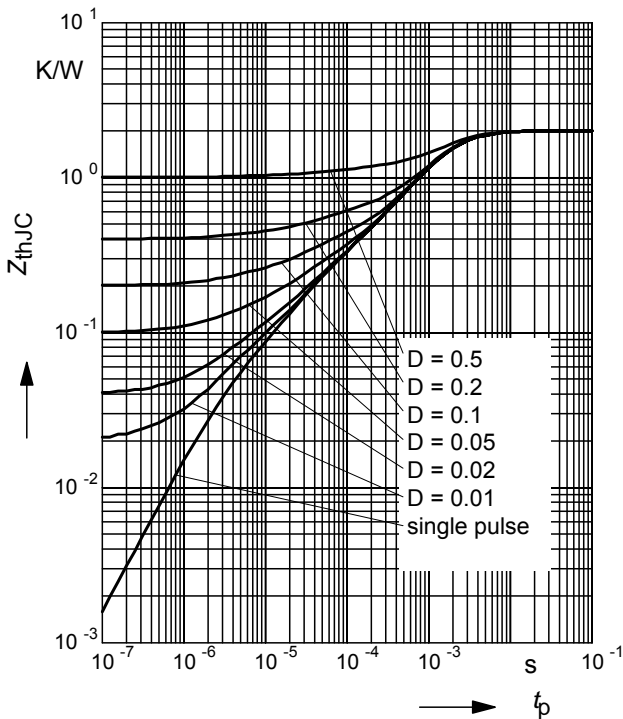
parameter : $D = 0$, $T_C = 25^\circ C$



3 Transient thermal impedance

$Z_{thJC} = f(t_p)$

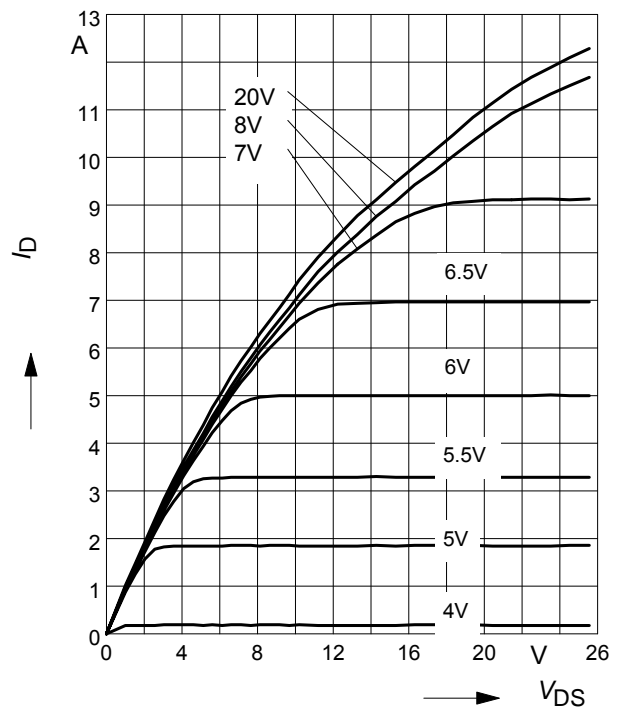
parameter: $D = t_p/T$



4 Typ. output characteristic

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

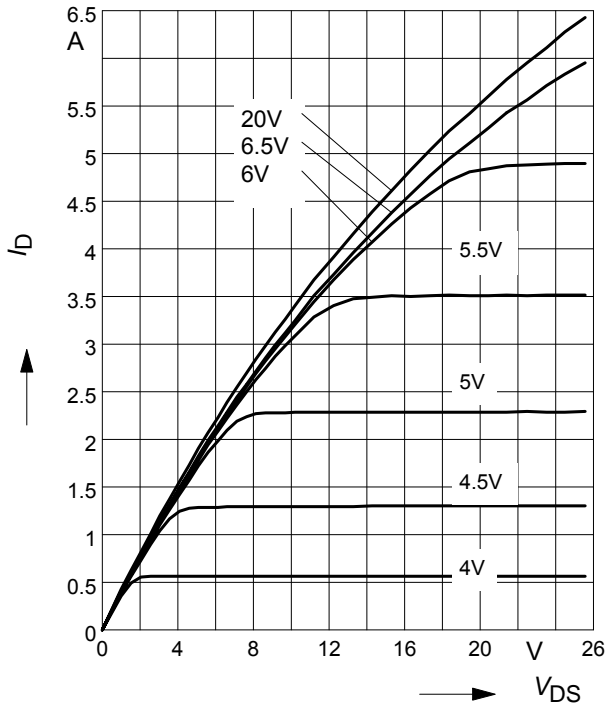
parameter: $t_p = 10 \mu s$, V_{GS}



5 Typ. output characteristic

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

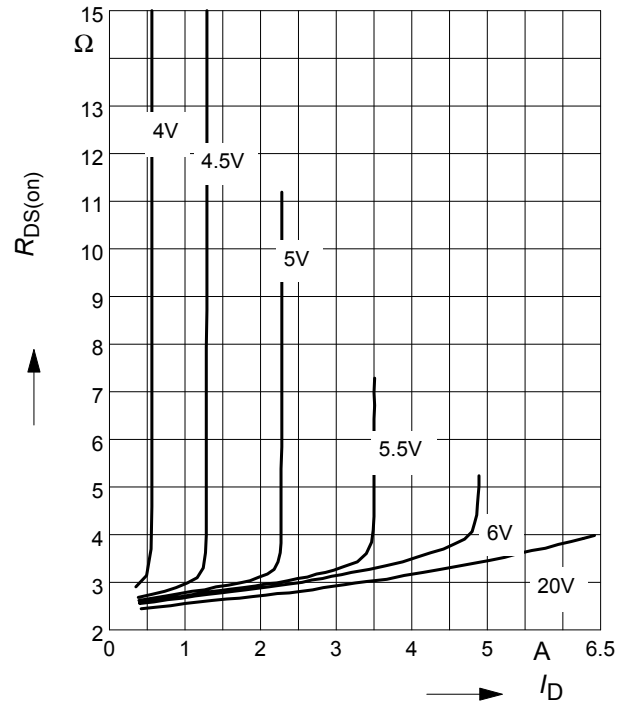
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



6 Typ. drain-source on resistance

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

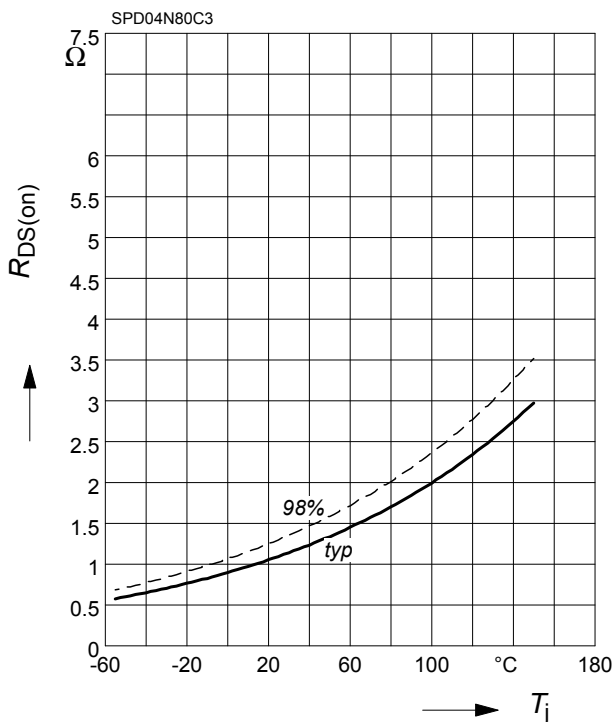
parameter: $T_j = 150^\circ\text{C}, V_{GS}$



7 Drain-source on-state resistance

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

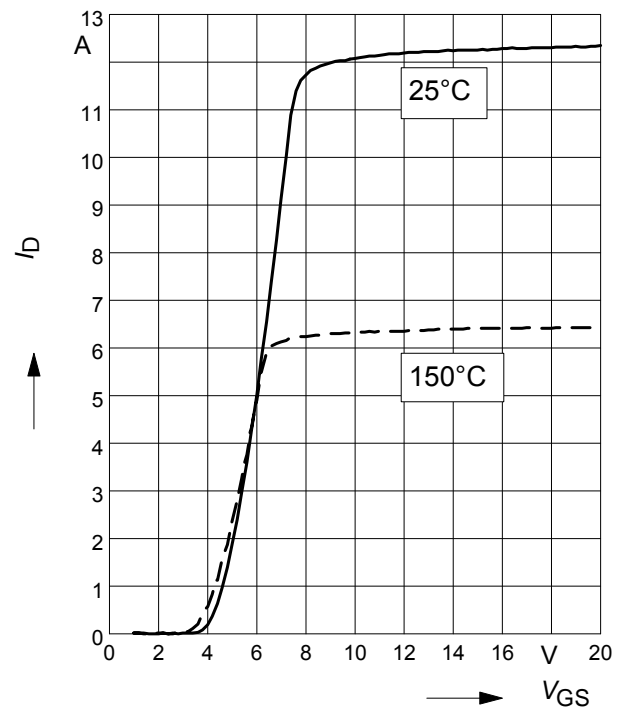
parameter: $I_D = 2.5 \text{ A}, V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

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

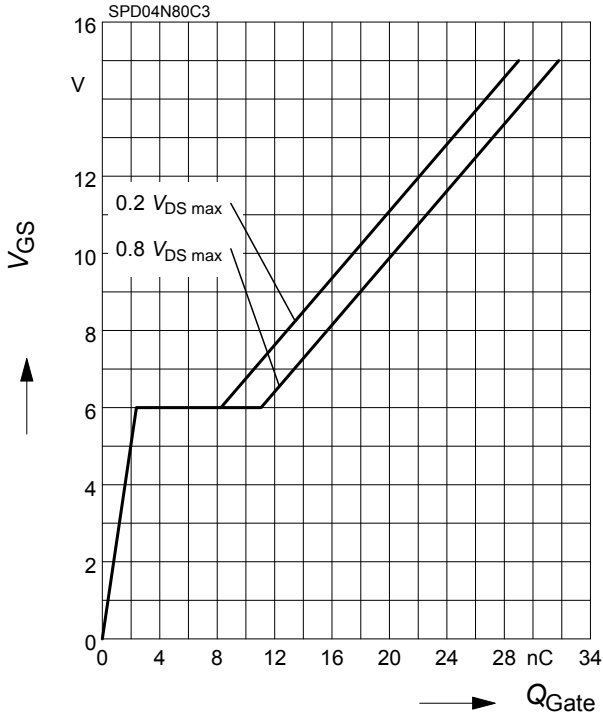
parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

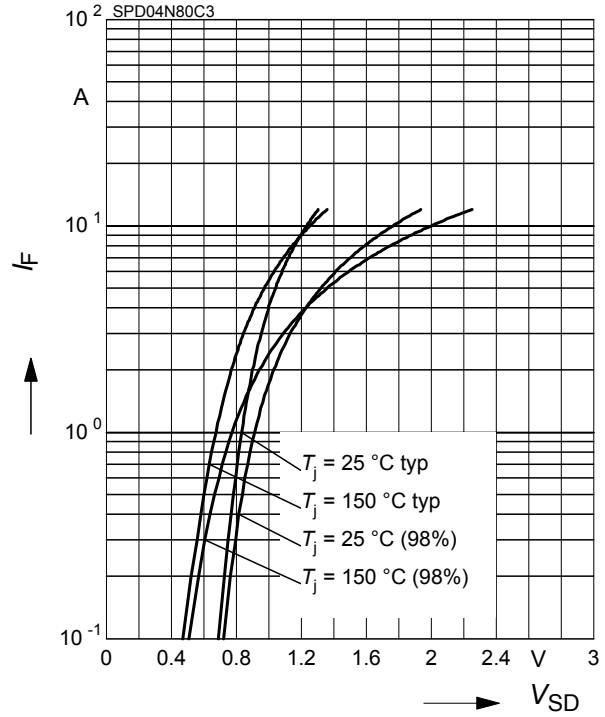
parameter: $I_D = 4$ A pulsed



10 Forward characteristics of body diode

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

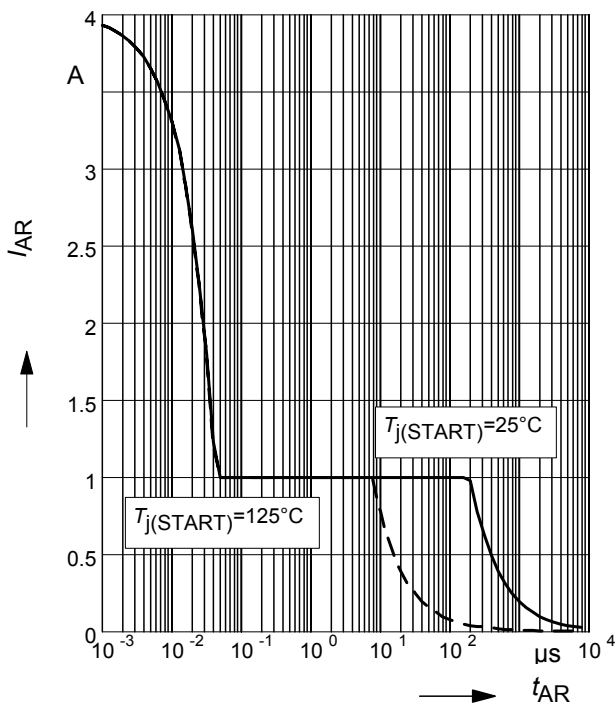
parameter: $T_j, t_p = 10$ μ s



11 Avalanche SOA

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

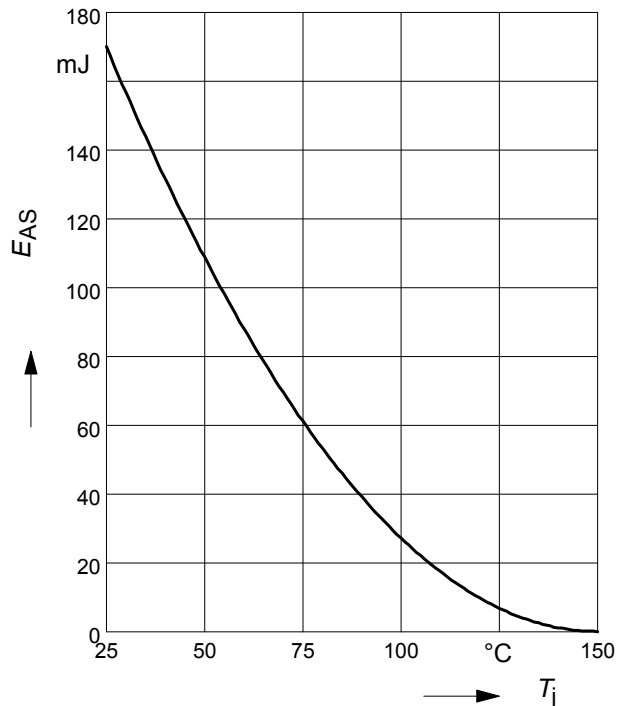
par.: $T_j \leq 150$ °C



12 Avalanche energy

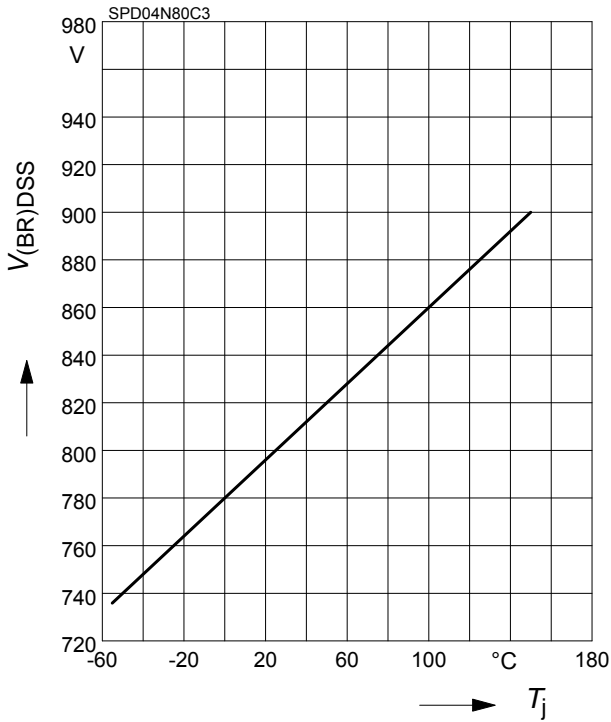
$$E_{AS} = f(T_j)$$

par.: $I_D = 0.8$ A, $V_{DD} = 50$ V



13 Drain-source breakdown voltage

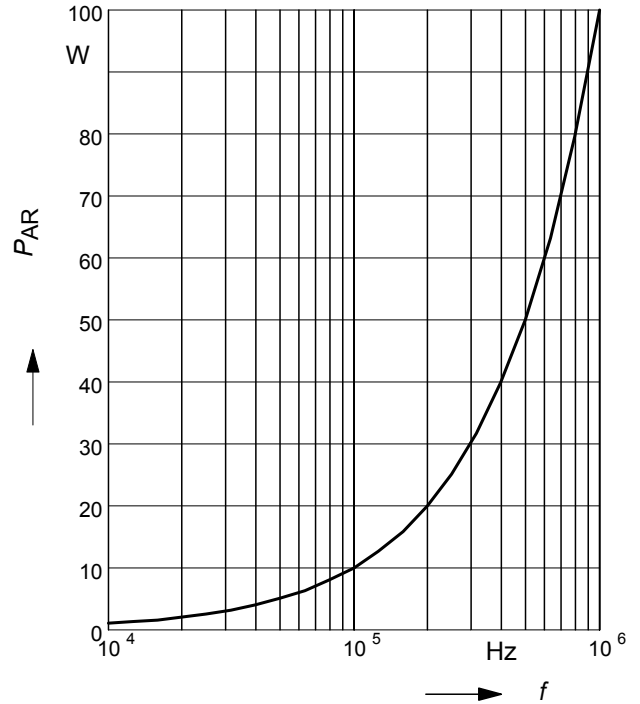
$$V_{(BR)DSS} = f(T_j)$$



14 Avalanche power losses

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

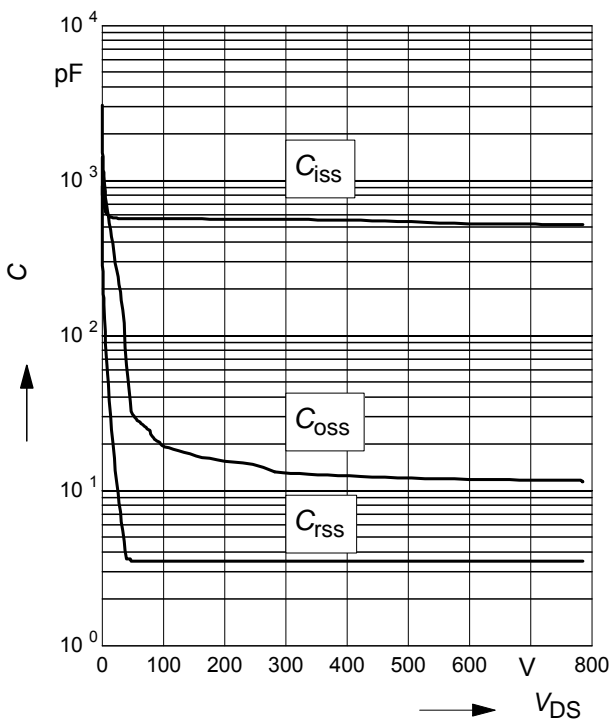
parameter: $E_{AR}=0.1\text{mJ}$



15 Typ. capacitances

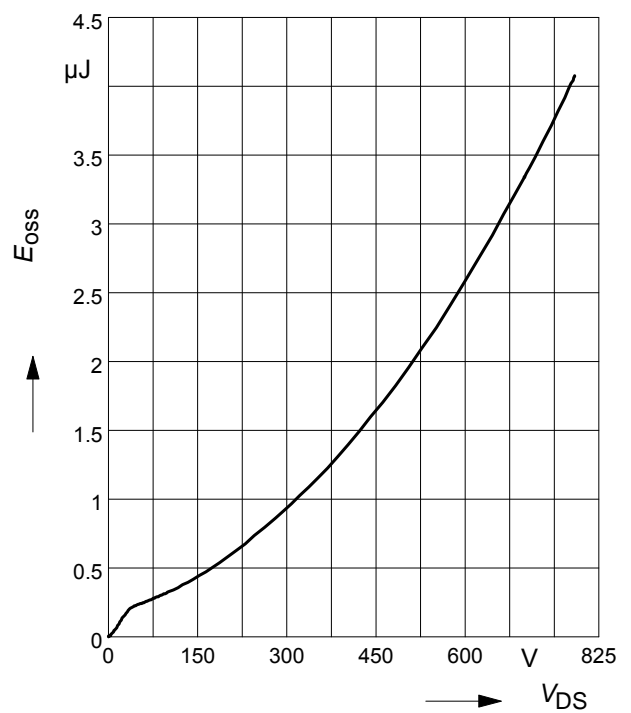
$$C = f(V_{DS})$$

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

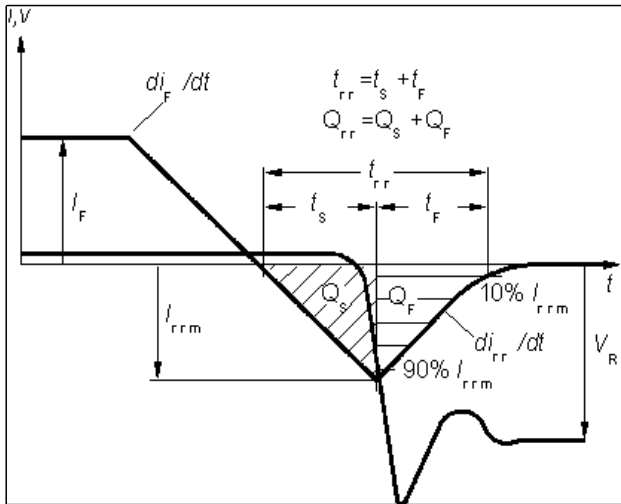


16 Typ. C_{OSS} stored energy

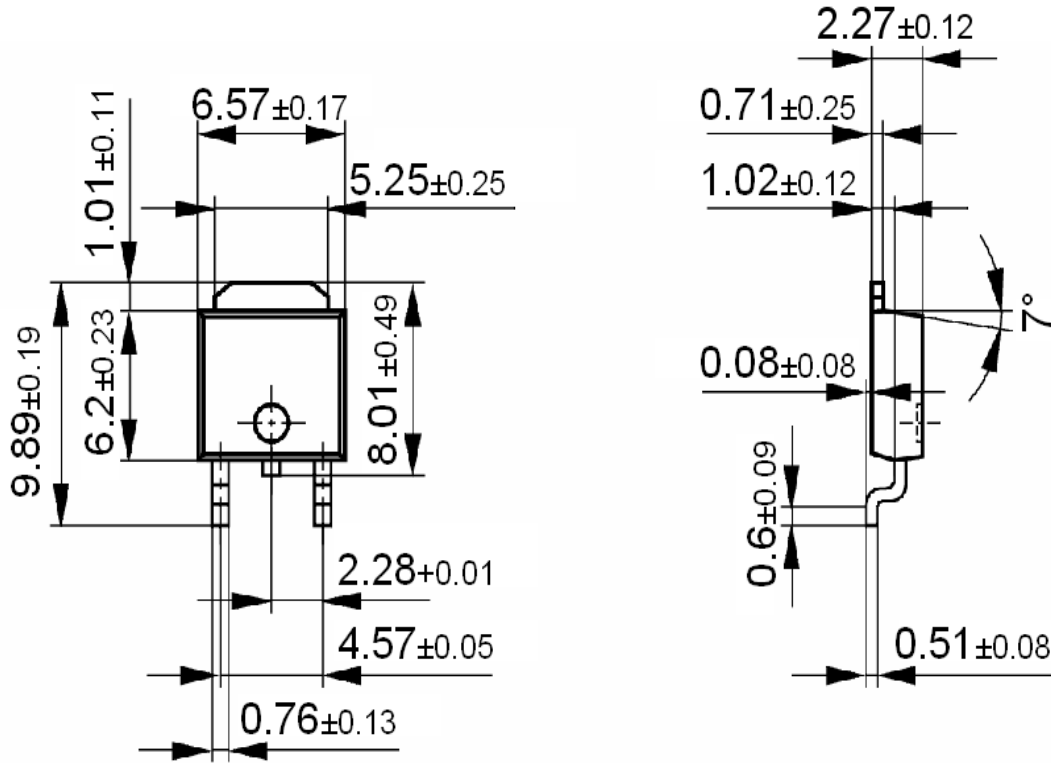
$$E_{OSS} = f(V_{DS})$$



Definition of diodes switching characteristics



P-TO-252-3-1 (D-PAK)



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