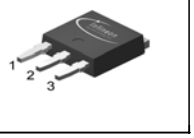
Cool MOS™ Power Transistor

V_{DS} @ T_{jmax}	650	V
$R_{DS(on)}$	0.95	Ω
I_D	4.5	A

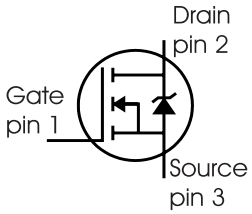
PG-TO251-3-11



Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme d*v*/d*t* rated
- High peak current capability
- Improved transconductance
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC[0)] for target applications

Type	Package	Marking
SPS04N60C3	PG-TO251-3-11	04N60C3



Maximum Ratings

Parameter	Symbol	Value	Unit
Continuous drain current T_C = 25 °C T_C = 100 °C	I_D	 4.5 2.8	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\ puls}$	13.5	
Avalanche energy, single pulse I_D = 3.4 A, V_{DD} = 50 V	E_{AS}	130	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax}[1] I_D = 4.5 A, V_{DD} = 50 V	E_{AR}	0.4	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	4.5	A
Gate source voltage static	V_{GS}	±20	V
Gate source voltage AC (f >1Hz)	V_{GS}	±30	
Power dissipation, T_C = 25°C	P_{tot}	50	W
Operating and storage temperature	T_j, T_{stg}	-55... +150	°C
Reverse diode dv/dt [5)]	dv/dt	15	V/ns

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope V_{DS} = 480 V, I_D = 4.5 A, T_j = 125 °C	dv/dt	50	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	2.5	K/W
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	75	
SMD version, device on PCB: @ min. footprint @ 6 cm^2 cooling area [2)]	R_{thJA}	 - -	 - -	 75 50	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s	T_{sold}	-	-	260	°C

Electrical Characteristics, at T_j=25°C unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	V_{GS}=0V, I_D=0.25mA	600	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	V_{GS}=0V, I_D=4.5A	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	I_D=200µA, V_{GS}=V_{DS}	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	V_{DS}=600V, V_{GS}=0V, T_j=25°C, T_j=150°C	 - -	 0.5 -	 1 50	µA
Gate-source leakage current	I_{GSS}	V_{GS}=30V, V_{DS}=0V	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS}=10V, I_D=2.8A, T_j=25°C T_j=150°C	 - -	 0.85 2.3	 0.95 -	Ω
Gate input resistance	R_G	f=1MHz, open Drain	-	0.95	-	

Electrical Characteristics , at T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS}\geq 2*I_D*R_{DS(on)max}$, I_D=2.8A	-	4.4	-	S
Input capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	-	490	-	pF
Output capacitance	C_{oss}		-	160	-	
Reverse transfer capacitance	C_{rss}		-	15	-	
Effective output capacitance,[3] energy related	$C_{o(er)}$	V_{GS}=0V, V_{DS}=0V to 480V	-	20	-	pF
Effective output capacitance,[4] time related	$C_{o(tr)}$		-	35	-	
Turn-on delay time	$t_{d(on)}$	V_{DD}=380V, V_{GS}=0/10V, I_D=4.5A, R_G=18Ω	-	6	-	ns
Rise time	t_r		-	2.5	-	
Turn-off delay time	$t_{d(off)}$		-	58.5	80	
Fall time	t_f		-	9.5	14	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	V_{DD}=480V, I_D=4.5A	-	2.2	-	nC
Gate to drain charge	Q_{gd}		-	8.8	-	
Gate charge total	Q_g	V_{DD}=480V, I_D=4.5A, V_{GS}=0 to 10V	-	19	25	
Gate plateau voltage	$V_{(plateau)}$	V_{DD}=480V, I_D=4.5A	-	5	-	V

[0] J-STD20 and JESD22

[1] Repetitve avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR}*f$.

[2] Device 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.

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

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

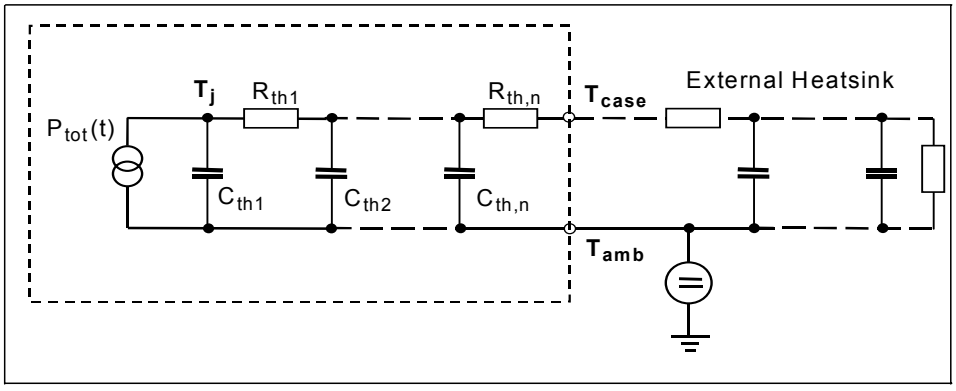
[5] I_{SD}<=I_D, di/dt<=400A/us, V_{DClink}=400V, V_{peak}<$V_{BR, DSS}$, T_j<$T_{j,max}$.
Identical low-side and high-side switch.

Electrical Characteristics, at T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	I_S	T_C=25°C	-	-	4.5	A
Inverse diode direct current, pulsed	I_{SM}		-	-	13.5	
Inverse diode forward voltage	V_{SD}	V_{GS}=0V, I_F=I_S	-	1	1.2	V
Reverse recovery time	t_{rr}	V_R=480V, I_F=I_S , di_F/dt=100A/µs	-	300	500	ns
Reverse recovery charge	Q_{rr}		-	2.6	-	µC
Peak reverse recovery current	I_{rrm}		-	18	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	-	900	A/µs

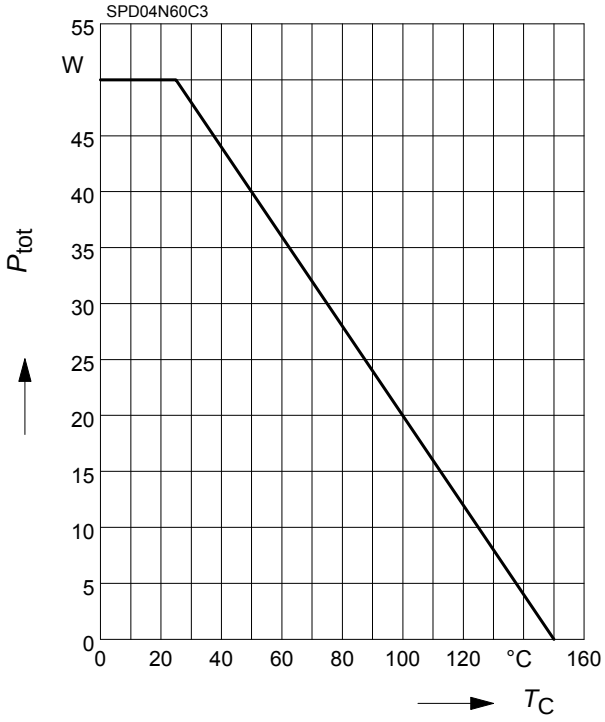
Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
R_{th1}	0.039	K/W	C_{th1}	0.00007347	Ws/K
R_{th2}	0.074		C_{th2}	0.0002831	
R_{th3}	0.132		C_{th3}	0.0004062	
R_{th4}	0.555		C_{th4}	0.001215	
R_{th5}	0.529		C_{th5}	0.00276	
R_{th6}	0.169		C_{th6}	0.029	



1 Power dissipation

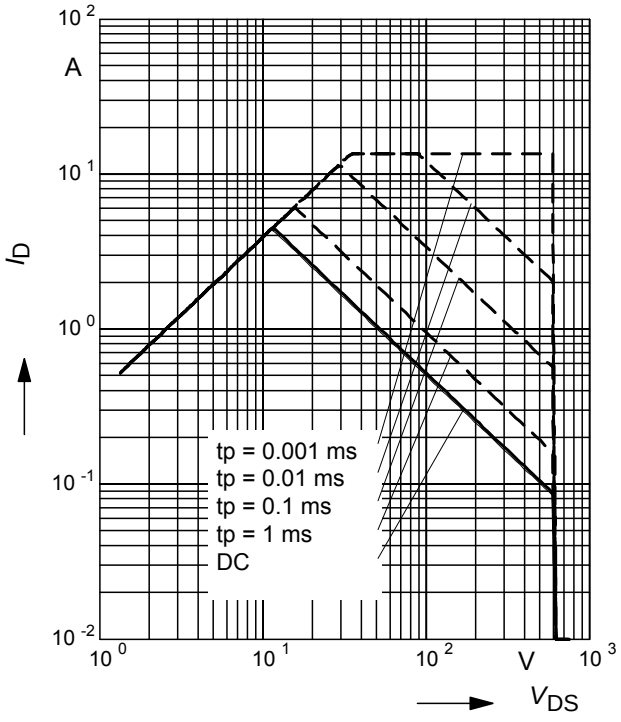
$P_{tot} = f(T_C)$



2 Safe operating area

$I_D = f(V_{DS})$

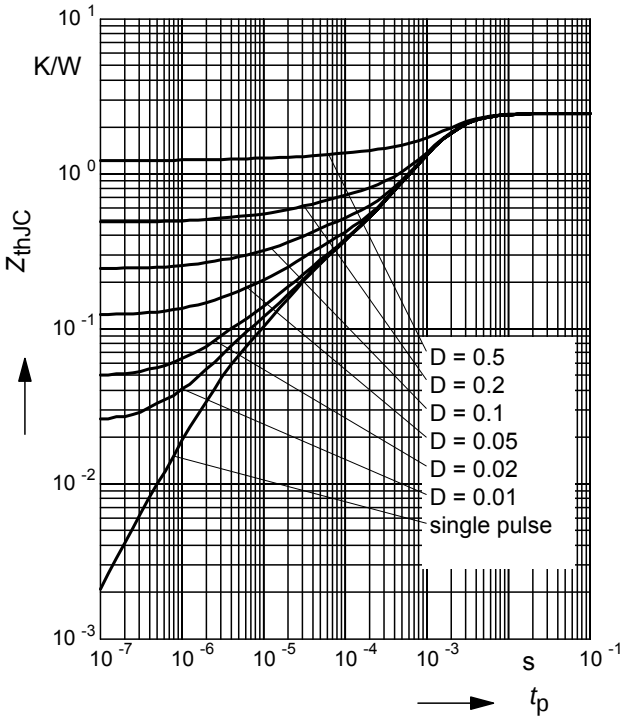
parameter : $D = 0$, T_C=25°C



3 Transient thermal impedance

$Z_{thJC} = f(t_p)$

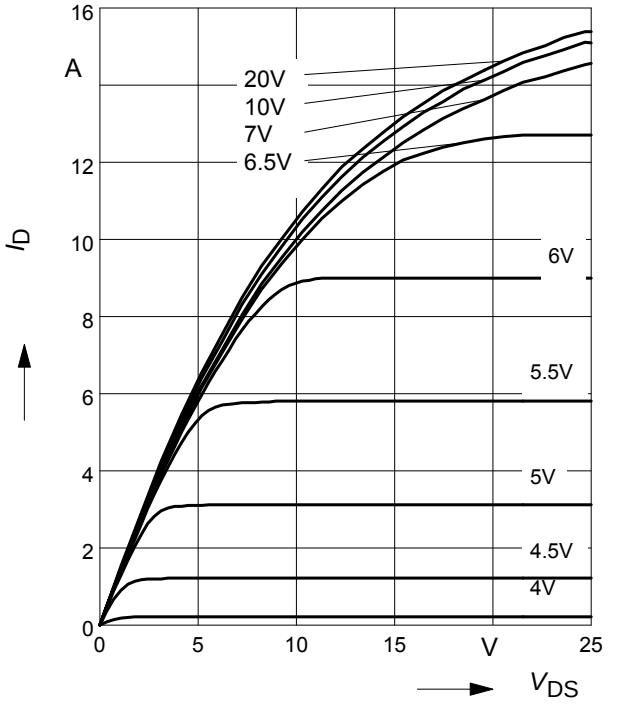
parameter: $D = t_p/T$



4 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=25°C

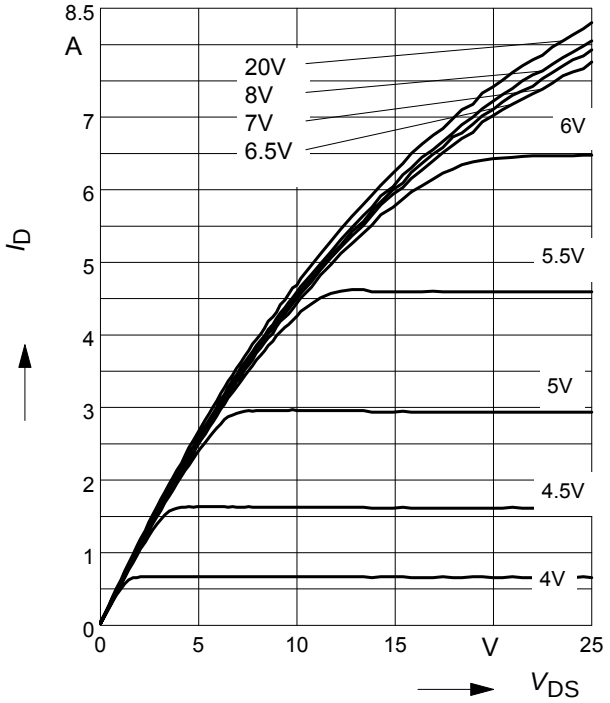
parameter: t_p = 10 µs, V_{GS}



5 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=150°C

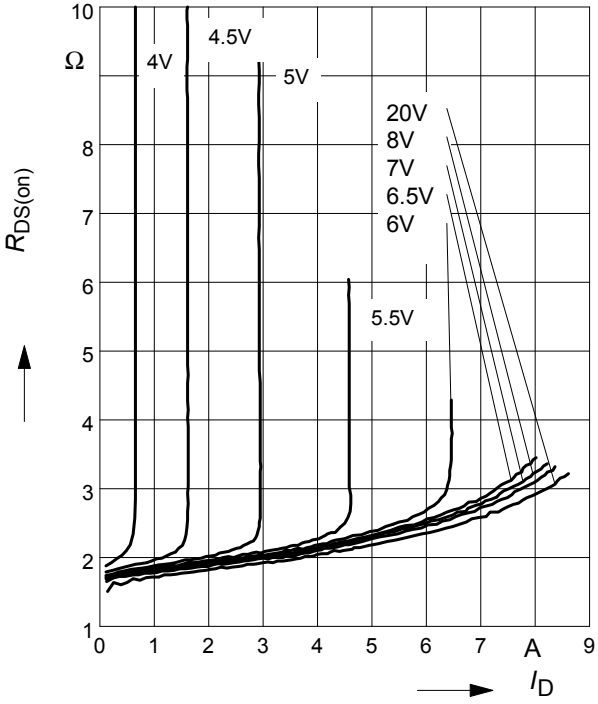
parameter: t_p = 10 µs, V_{GS}



6 Typ. drain-source on resistance

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

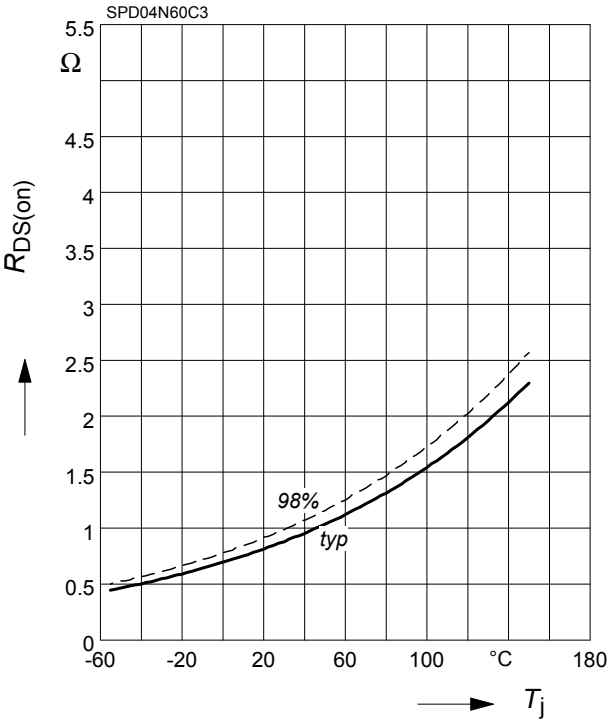
parameter: T_j=150°C, V_{GS}



7 Drain-source on-state resistance

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

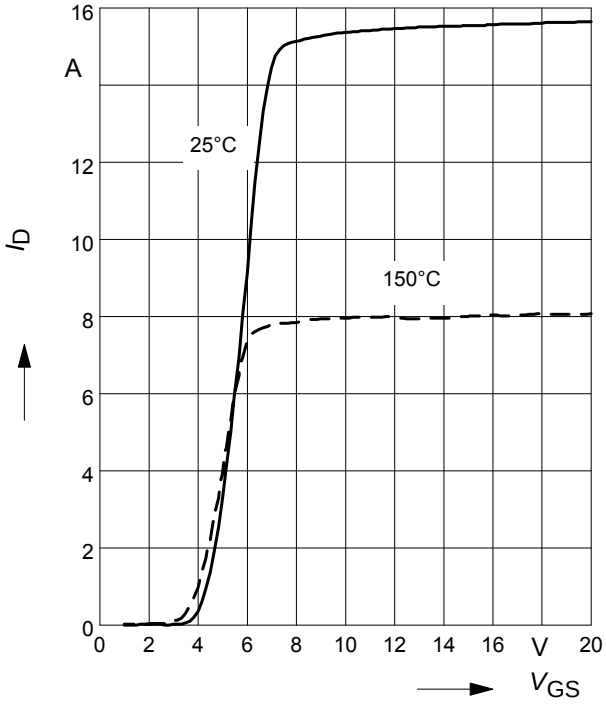
parameter : I_D = 2.8 A, V_{GS} = 10 V



8 Typ. transfer characteristics

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

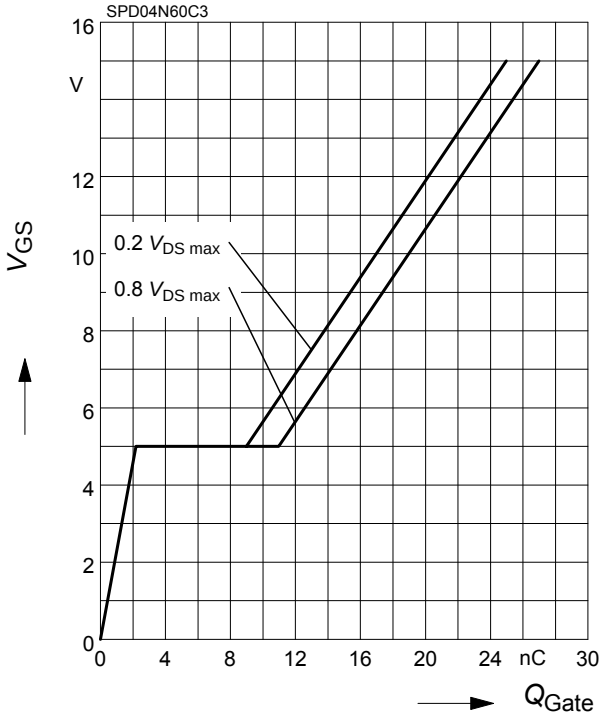
parameter: t_p = 10 µs



9 Typ. gate charge

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

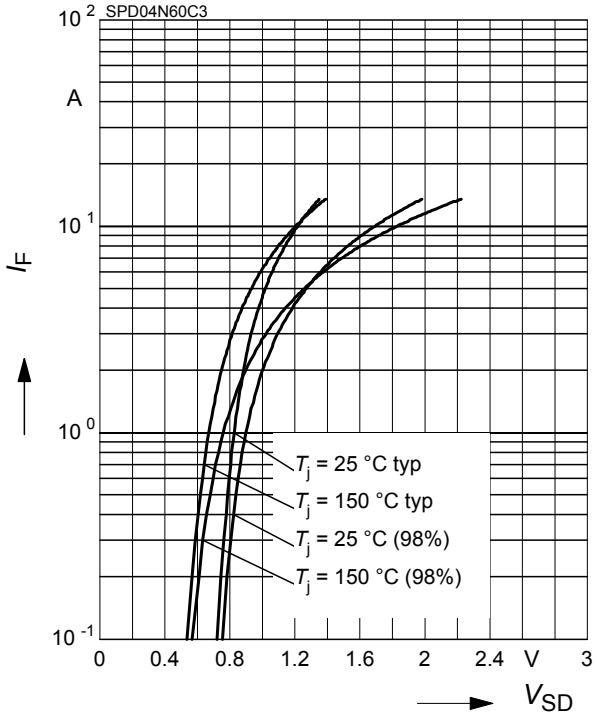
parameter: I_D = 4.5 A pulsed



10 Forward characteristics of body diode

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

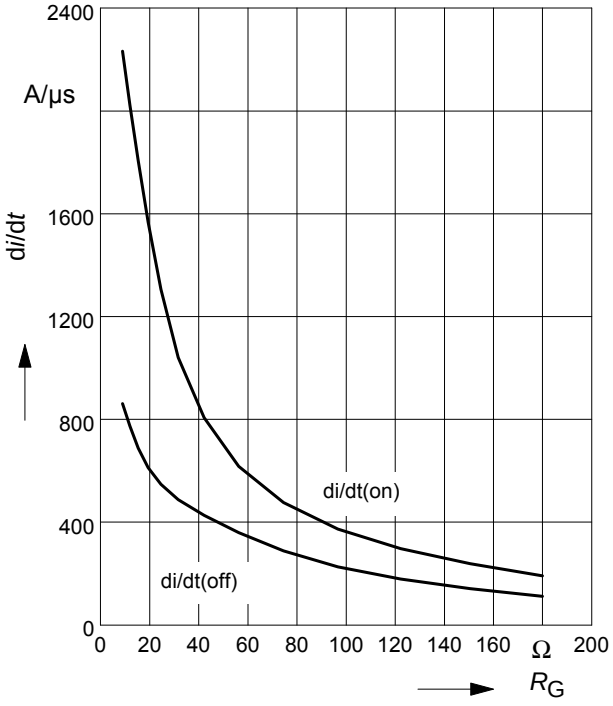
parameter: T_j , tp = 10 µs



11 Typ. drain current slope

d*i*/d*t* = f(R_G), inductive load, T_j = 125°C

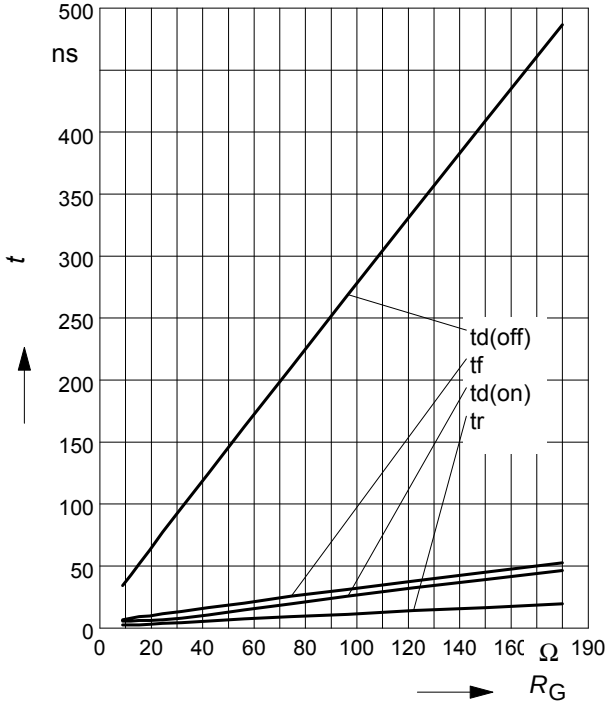
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=4.5A



12 Typ. switching time

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

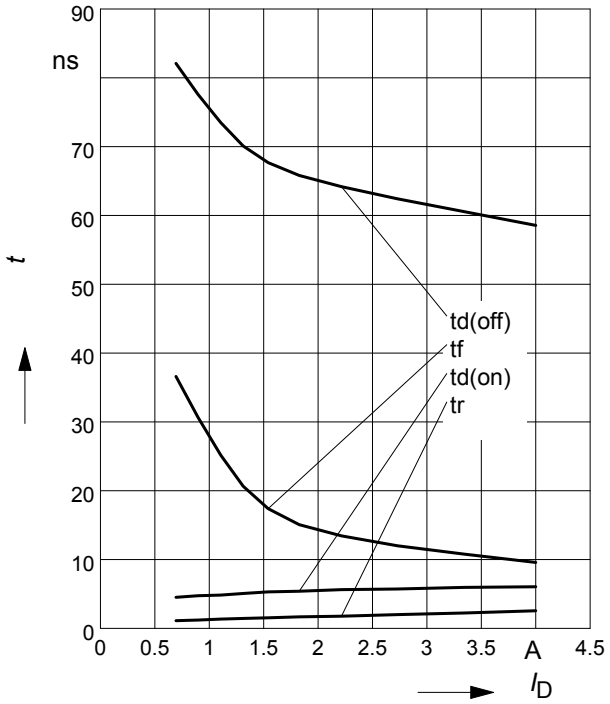
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=4.5 A



13 Typ. switching time

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

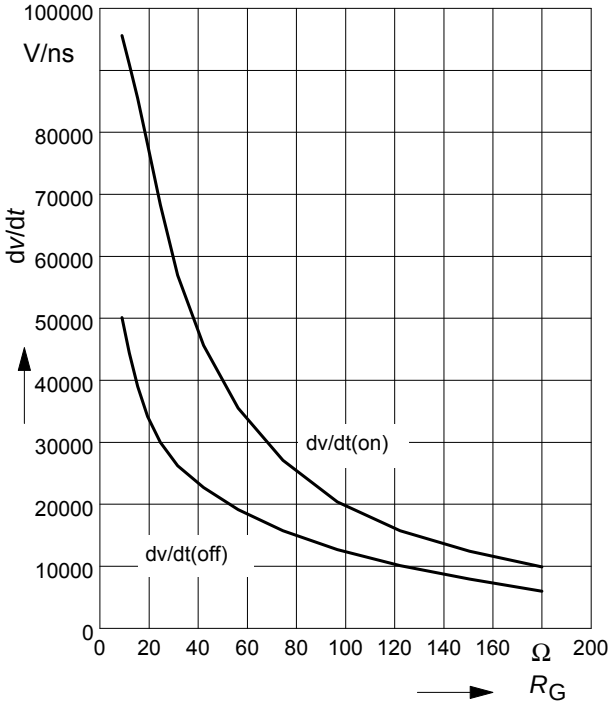
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=18Ω



14 Typ. drain source voltage slope

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

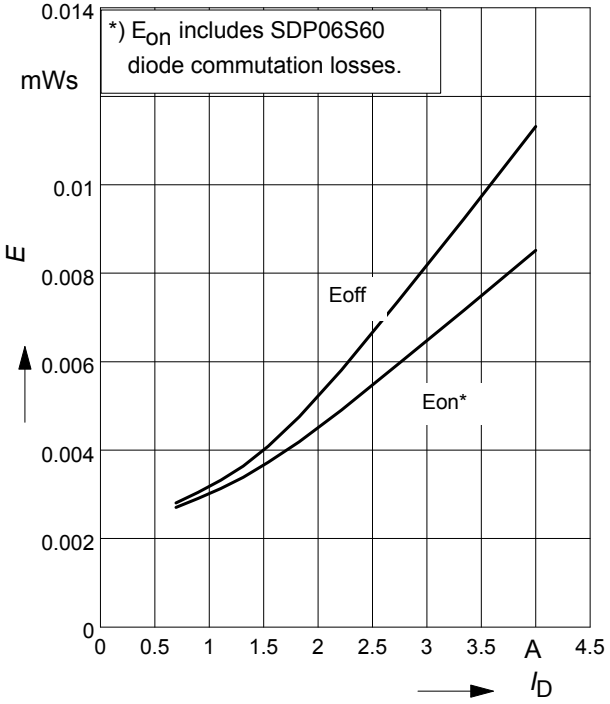
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=4.5A



15 Typ. switching losses

$E = f(I_D)$, inductive load, T_j=125°C

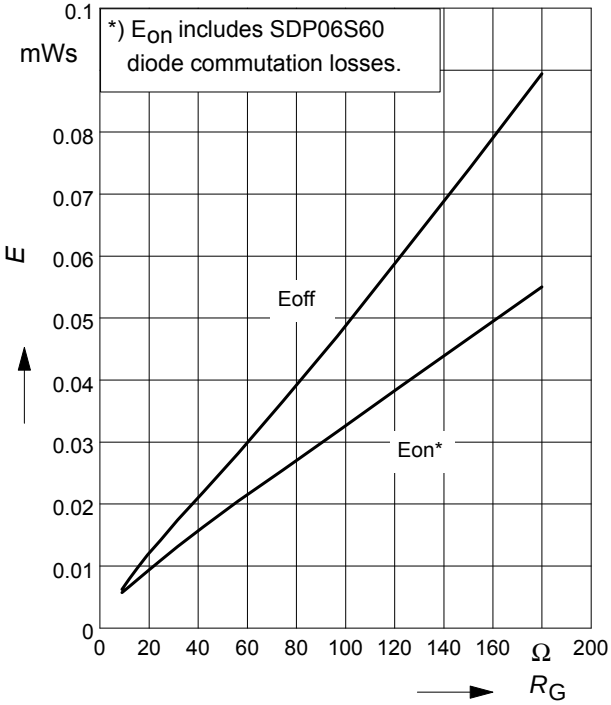
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=18Ω



16 Typ. switching losses

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

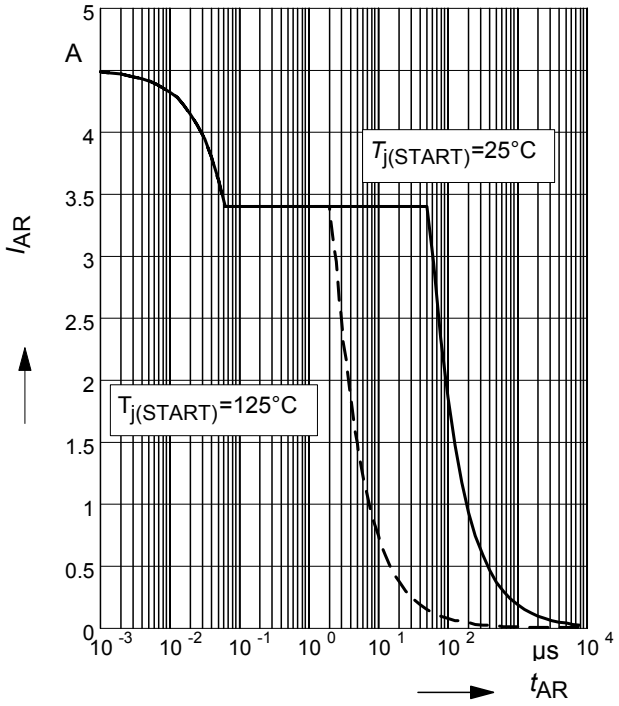
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=4.5A



17 Avalanche SOA

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

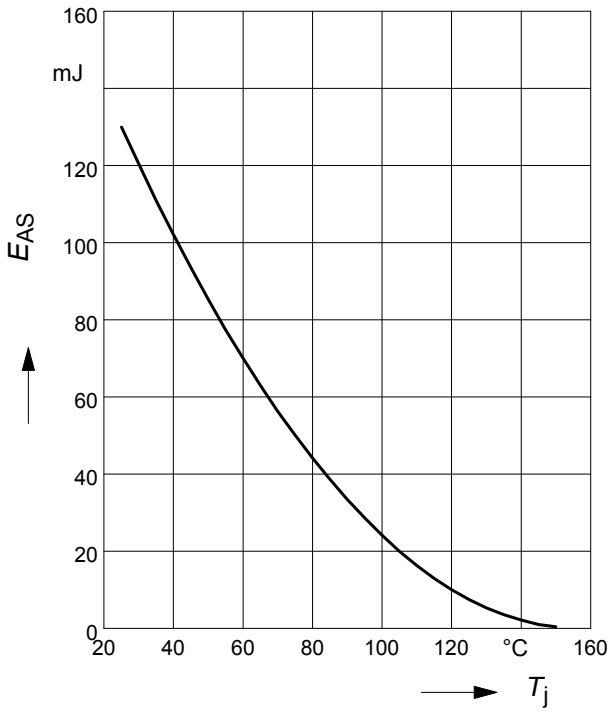
par.: $T_j \leq 150$ °C



18 Avalanche energy

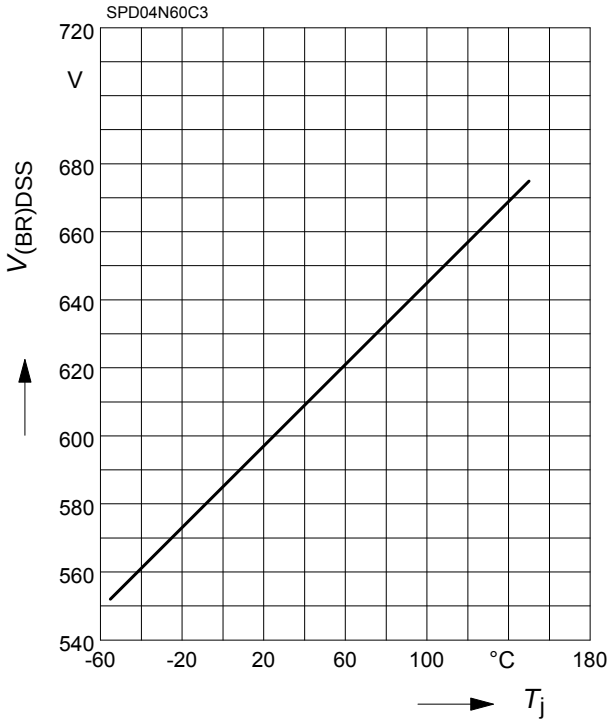
$E_{AS} = f(T_j)$

par.: I_D = 3.4 A, V_{DD} = 50 V



19 Drain-source breakdown voltage

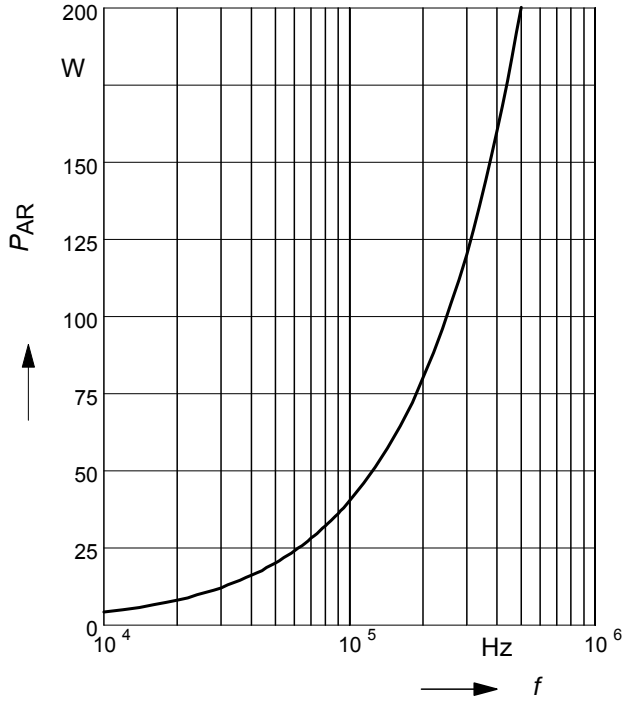
$V_{(BR)DSS} = f(T_j)$



20 Avalanche power losses

$P_{AR} = f(f)$

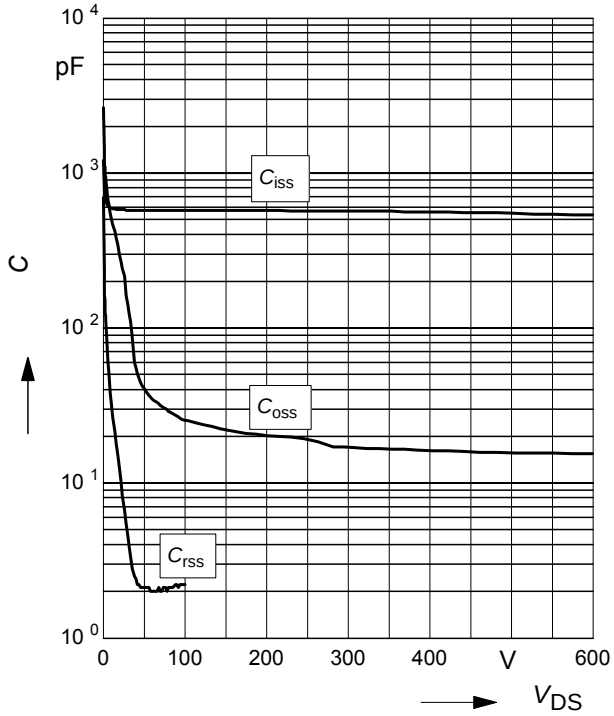
parameter: E_{AR}=0.4mJ



21 Typ. capacitances

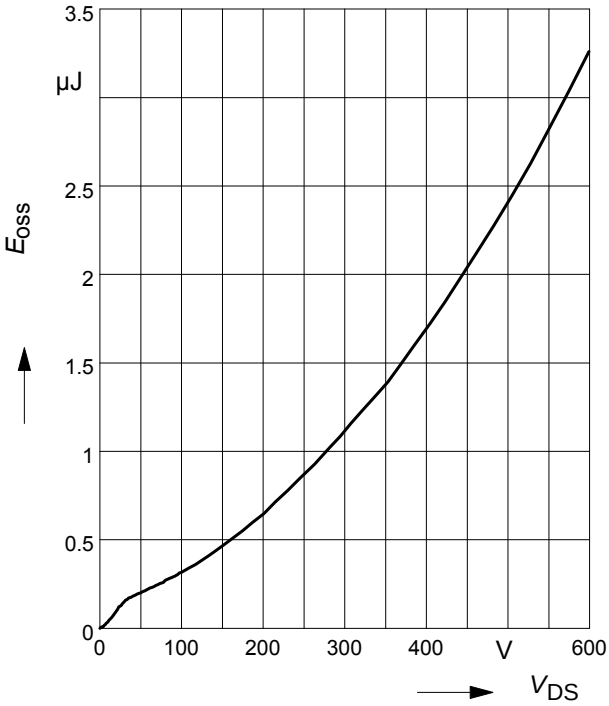
$C = f(V_{DS})$

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

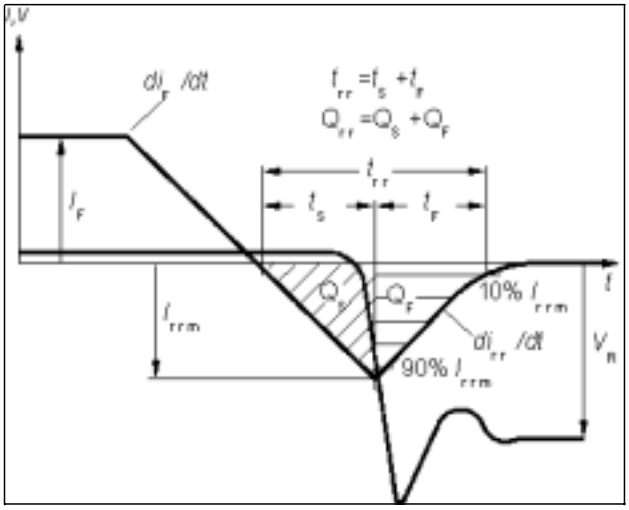


22 Typ. C_{oss} stored energy

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



Definition of diodes switching characteristics



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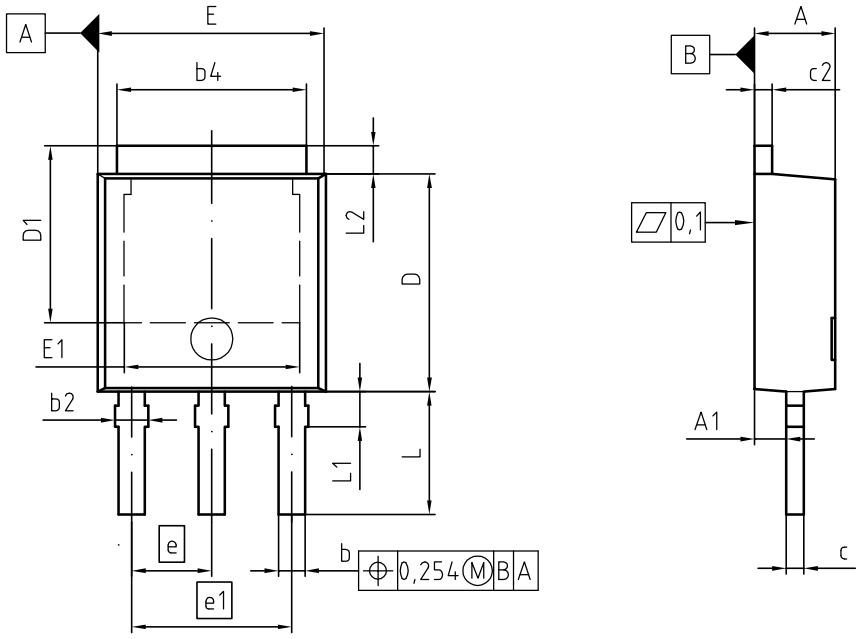

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.18	2.39	0.086	0.094
A1	0.80	1.14	0.031	0.045
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b4	4.95	5.50	0.195	0.217
c	0.46	0.58	0.018	0.023
c2	0.46	0.89	0.018	0.035
D	5.97	6.22	0.235	0.245
D1	5.04	5.44	0.198	0.214
E	6.35	6.73	0.250	0.265
E1	4.90	5.10	0.193	0.201
e	2.29		0.090	
e1	4.57		0.180	
N	3		3	
L	3.40	3.60	0.134	0.142
L1	0.90	1.10	0.035	0.043
L2	0.90	1.10	0.035	0.043

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SCALE
0 2.0 0 2.0 4mm

EUROPEAN PROJECTION

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