Cool MOS™ Power Transistor

Feature

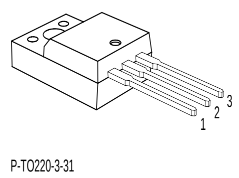
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved noise immunity
- Enhanced 30V V_{GS} rating
- Fully isolated package (2500 VAC; 1 minute)

COOLMOS Power Semiconductors

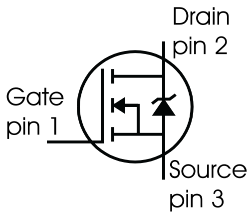
Product Summary

V_{DS}	600	V
$R_{DS(on)}$	0.38	Ω
I_D	5.5	A

P-TO220-3-31



Type	Package	Ordering Code	Marking
SPA11N60C2	P-TO220-3-31	Q67040-S4332	11N60C2



Maximum Ratings, at T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Value	Unit
Continuous drain current T_C = 25 °C T_C = 100 °C	I_D	 5.5 3.5	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\,puls}$	22	
Avalanche energy, single pulse I_D=5.5A, V_{DD}=50V	E_{AS}	340	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} 1) I_D=11A, V_{DD}=50V	E_{AR}	0.6	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	11	A
Reverse diode dv/dt I_S=11A, $V_{DS} < V_{DD}$, di/dt=100A/µs, T_{jmax}=150°C	dv/dt	6	V/ns
Gate source voltage	V_{GS}	±20	V
Power dissipation T_C = 25 °C	P_{tot}	33	W
Operating and storage temperature	T_j , T_{stg}	-55... +150	°C

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Characteristics					
Thermal resistance, junction - case	R_{thJC}	-	-	3.8	K/W
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	80	
Linear derating factor		-	-	0.26	W/K
Soldering temperature, 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	min.	typ.	max.	Unit
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=11A	$V_{(BR)DS}$	-	700	-	
Gate threshold voltage, $V_{GS} = V_{DS}$ I_D=0.5mA	$V_{GS(th)}$	3.5	4.5	5.5	
Zero gate voltage drain current	I_{DSS}				µA
V_{DS} = 600 V, V_{GS} = 0 V, T_j = 25 °C		-	-	25	
V_{DS} = 600 V, V_{GS} = 0 V, T_j = 150 °C		-	-	250	
Gate-source leakage current V_{GS}=20V, V_{DS}=0V	I_{GSS}	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$				Ω
V_{GS}=10V, I_D=7A, T_j=25°C		-	0.34	0.38	
V_{GS}=10V, I_D=11A, T_j=150°C		-	1.1	1.22	
Gate input resistance f = 1 MHz, open drain	R_G	-	0.86	-	

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

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Transconductance	g_{fs}	V_{DS}≥2*I_D*$R_{DS(on)max}$, I_D=3.5A	3	6	-	S
Input capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	-	1460	-	pF
Output capacitance	C_{oss}		-	610	-	
Reverse transfer capacitance	C_{rss}		-	21	-	
Effective output capacitance,[1] energy related	$C_{o(er)}$	V_{GS}=0V, V_{DS}=0V to 480V	-	45	-	pF
Effective output capacitance,[2] time related	$C_{o(tr)}$		-	85	-	
Turn-on delay time	$t_{d(on)}$	V_{DD}=380V, V_{GS}=0/13V, I_D=11A, R_G=6.8Ω, T_j=125°C	-	13	-	ns
Rise time	t_r		-	40	-	
Turn-off delay time	$t_{d(off)}$		-	48	72	
Fall time	t_f		-	9	13.5	
Gate Charge Characteristics						
Gate to source charge	Q_{gs}	V_{DD}=350V, I_D=11A	-	10.5	-	nC
Gate to drain charge	Q_{gd}		-	24	-	
Gate charge total	Q_g	V_{DD}=350V, I_D=11A, V_{GS}=0 to 10V	-	41.5	54	
Gate plateau voltage	$V_{(plateau)}$	V_{DD}=350V, I_D=11A	-	8	-	V

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

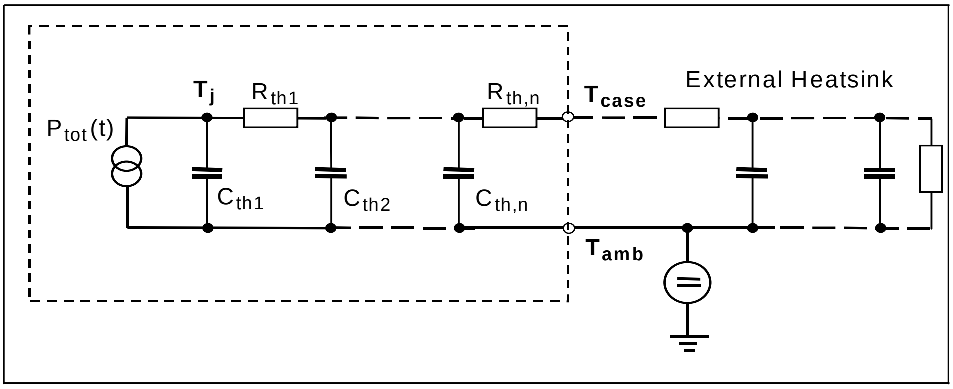
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Reverse Diode						
Inverse diode continuous forward current	I_S	T_C=25°C	-	-	5.5	A
Inverse diode direct current, pulsed	I_{SM}		-	-	22	
Inverse diode forward voltage	V_{SD}	V_{GS}=0V, I_F=I_S	-	1	1.2	V
Reverse recovery time	t_{rr}	V_R=350V, I_F=I_S ,	-	650	1105	ns
Reverse recovery charge	Q_{rr}	di_F/dt=100A/µs	-	7.9	-	µC
Peak reverse recovery current	I_{rrm}		-	30	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	600	-	A/µs

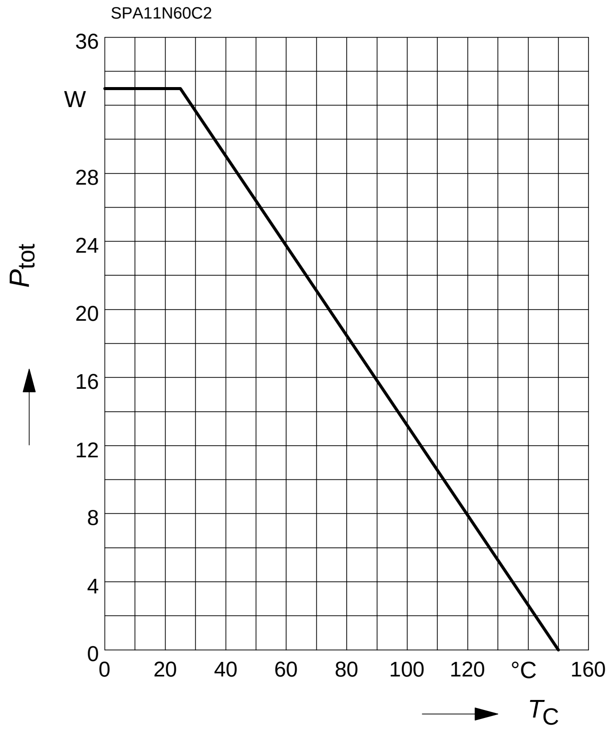
Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Transient thermal impedance					
Thermal resistance			Thermal capacitance		
R_{th1}	0.15	K/W	C_{th1}	0.000188	Ws/K
R_{th2}	0.03		C_{th2}	0.000708	
R_{th3}	0.043		C_{th3}	0.00098	
R_{th4}	0.119		C_{th4}	0.00173	
R_{th5}	0.35		C_{th5}	0.011	
R_{th6}	2.499		C_{th6}	0.412	



1 Power dissipation

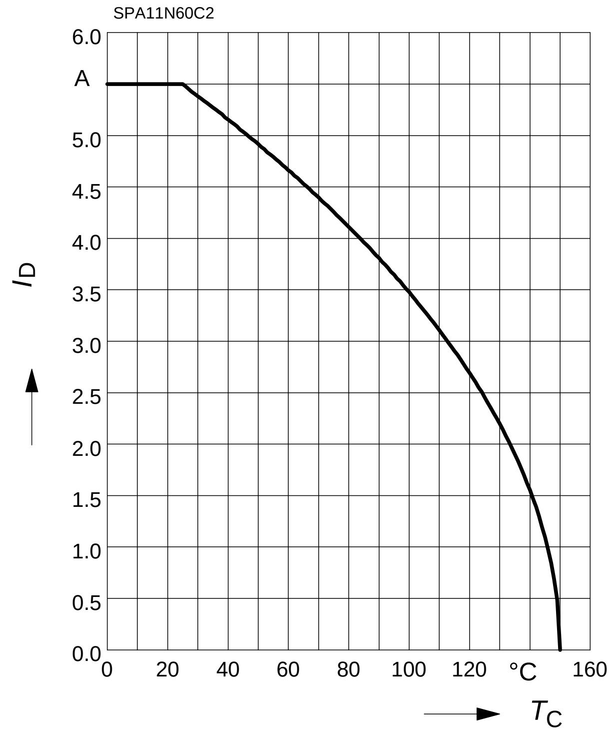
$P_{tot} = f\,(T_C)$



2 Drain current

$I_D = f\,(T_C)$

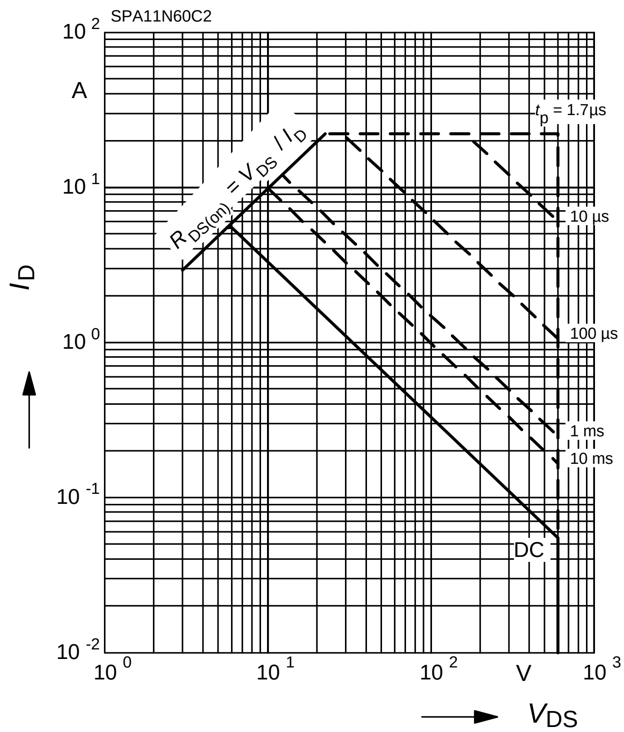
parameter: $V_{GS} \geq 10$ V



3 Safe operating area

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

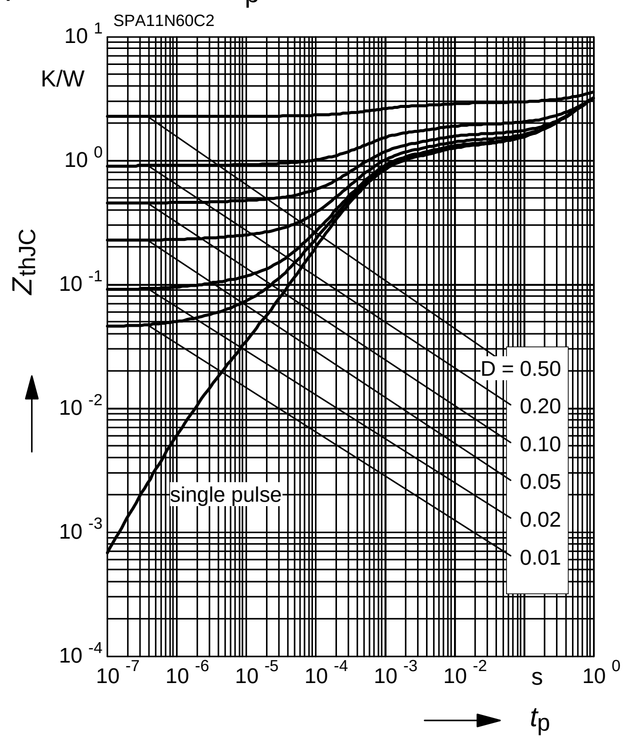
parameter : $D = 0$, T_C=25°C



4 Transient thermal impedance

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

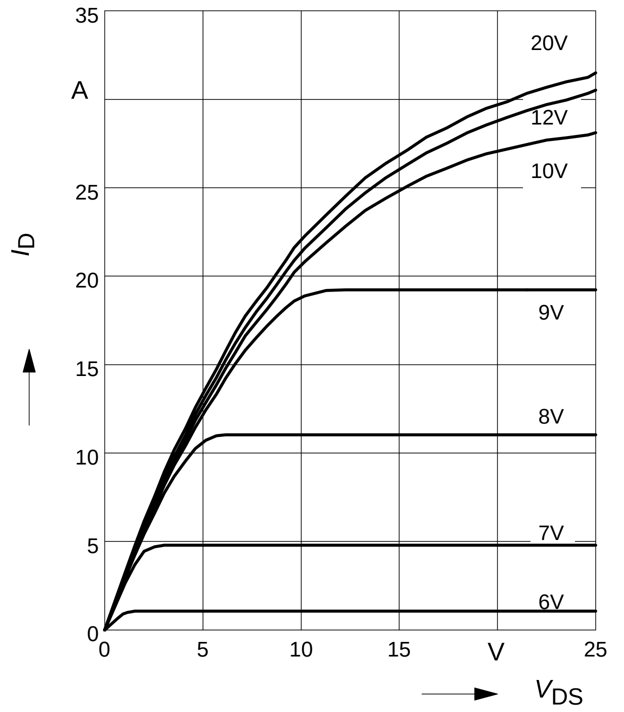
parameter : $D = t_p/T$



5 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=25°C

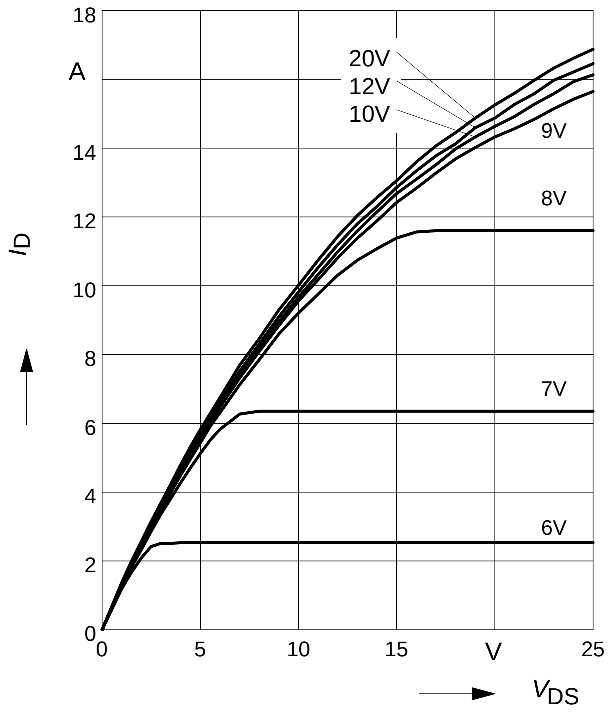
parameter: t_p = 10 µs, V_{GS}



6 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=150°C

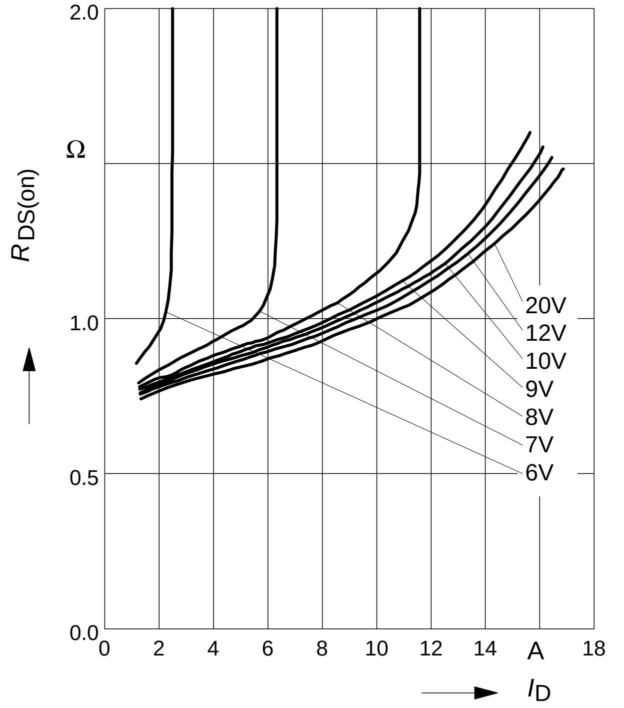
parameter: t_p = 10 µs, V_{GS}



7 Typ. drain-source on resistance

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

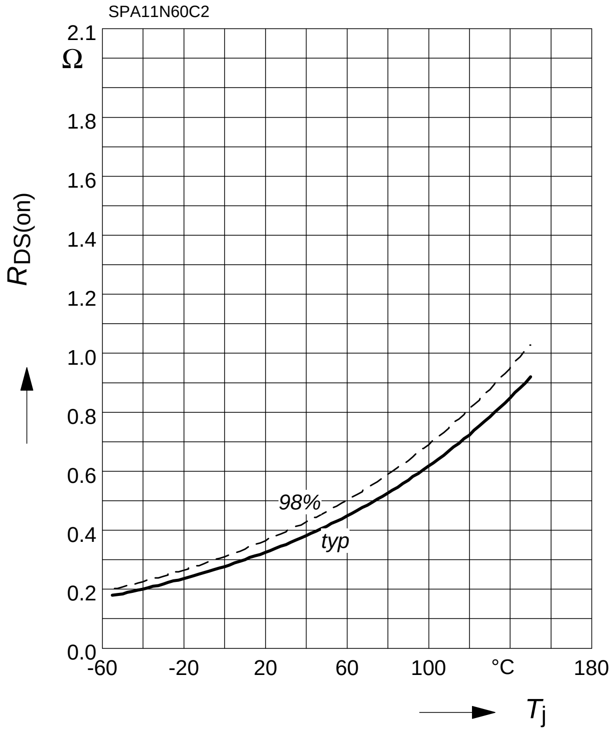
parameter: T_j=150°C, V_{GS}



8 Drain-source on-state resistance

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

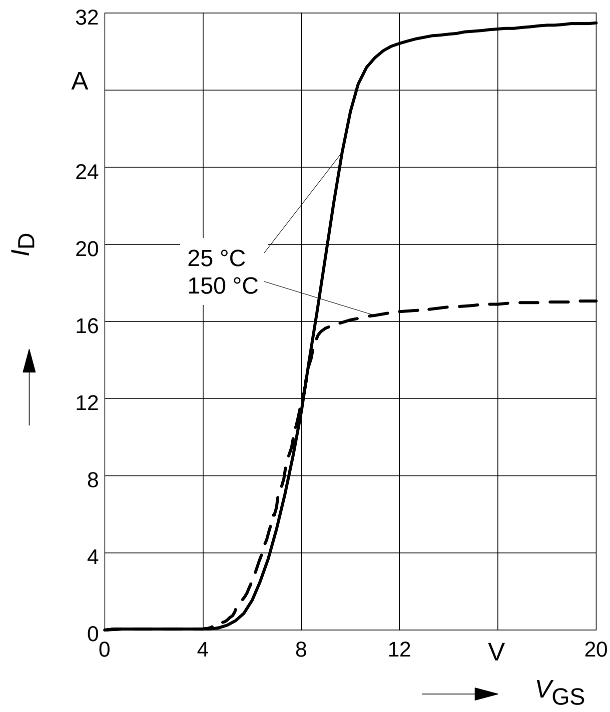
parameter : I_D = 7 A, V_{GS} = 10 V



9 Typ. transfer characteristics

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

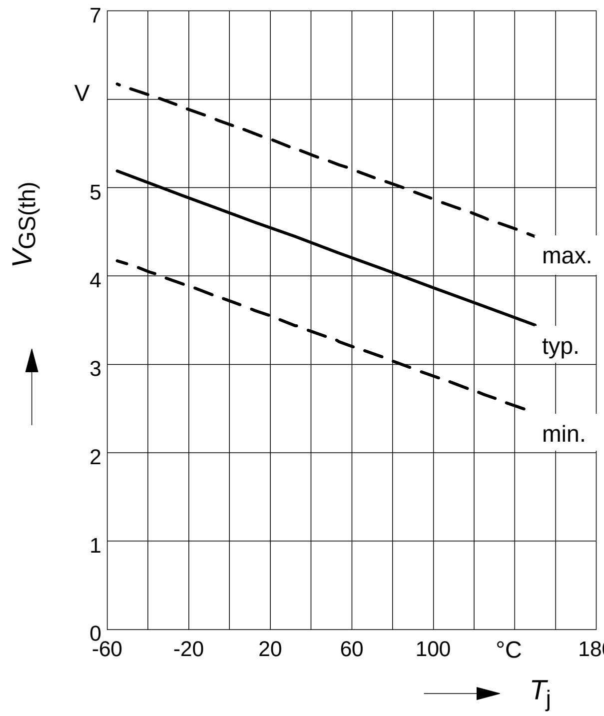
parameter: t_p = 10 µs



10 Gate threshold voltage

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

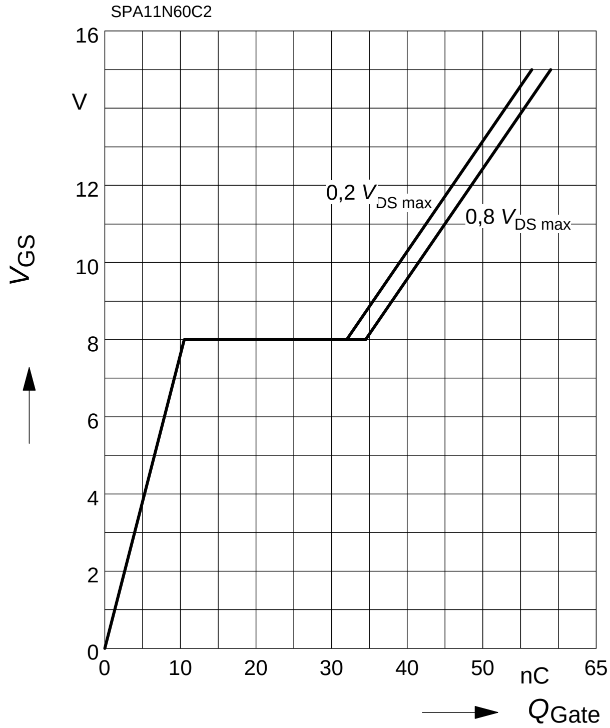
parameter: $V_{GS} = V_{DS}$, I_D = 0.5 mA



11 Typ. gate charge

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

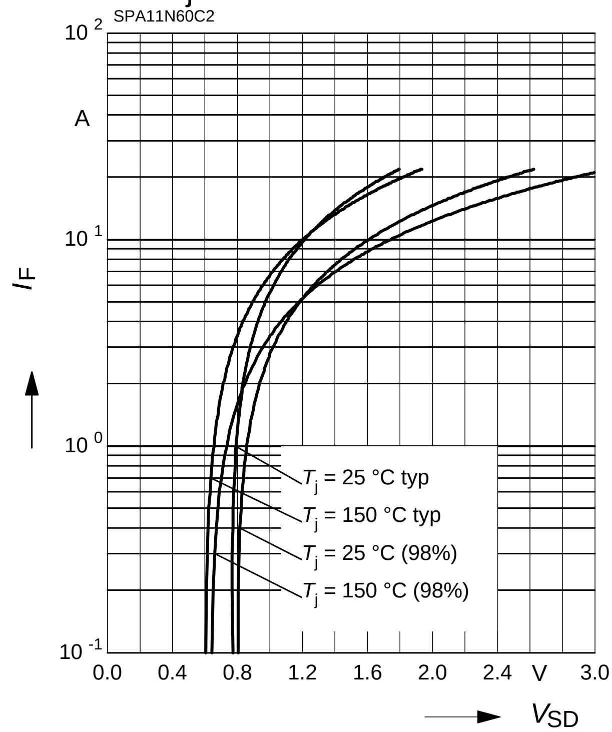
parameter: I_D = 11 A pulsed



11 Forward characteristics of body diode

$I_F = f(V_{SD})$

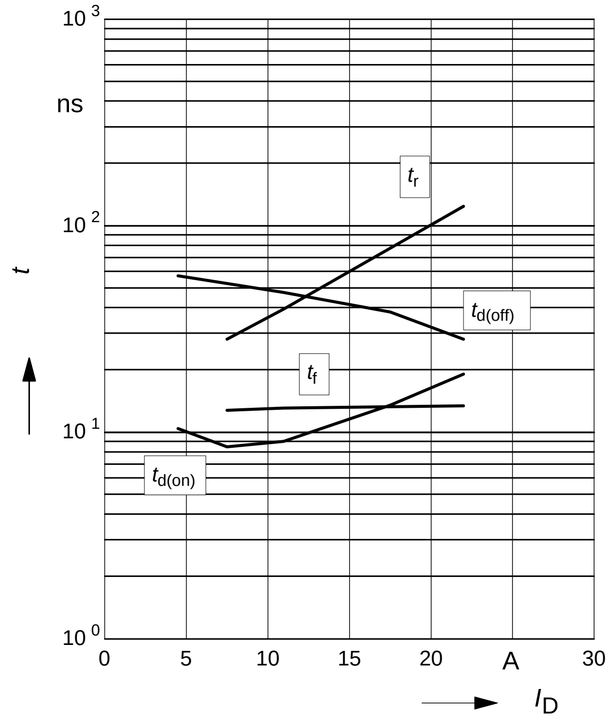
parameter: T_j , t_p = 10 µs



12 Typ. switching time

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

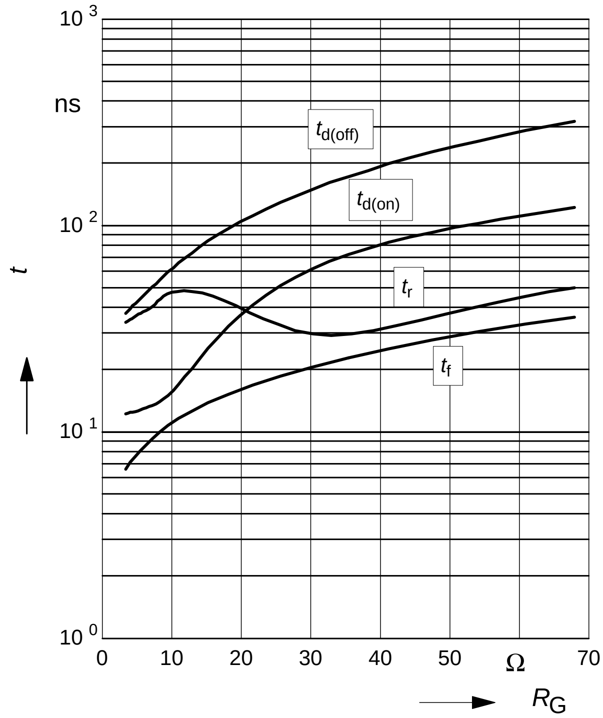
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=6.8Ω



13 Typ. switching time

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

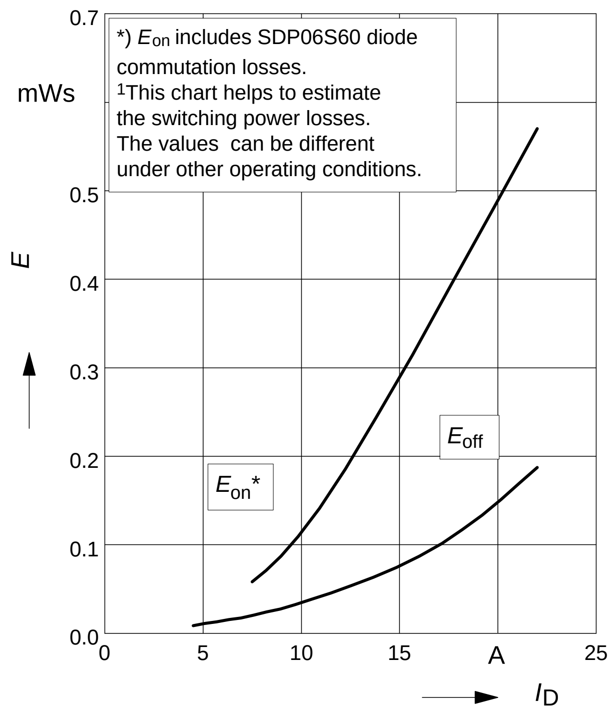
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11 A



14 Typ. switching losses[1)]

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

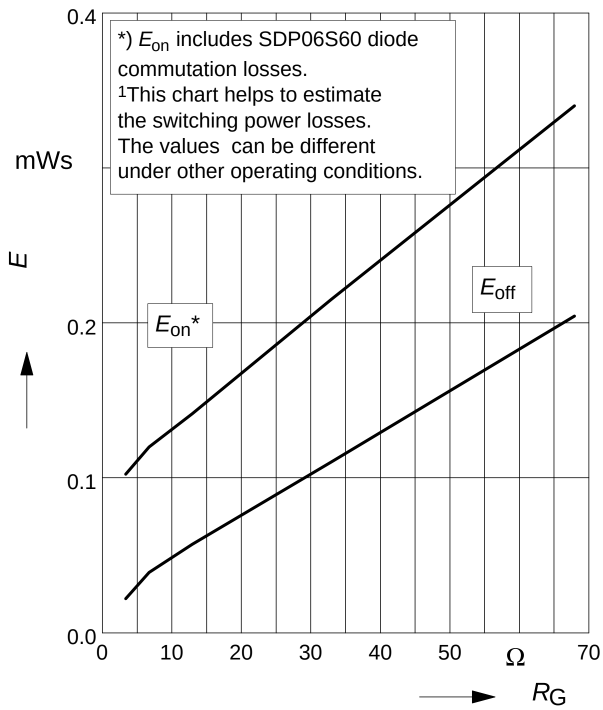
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=6.8Ω



15 Typ. switching losses[1)]

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

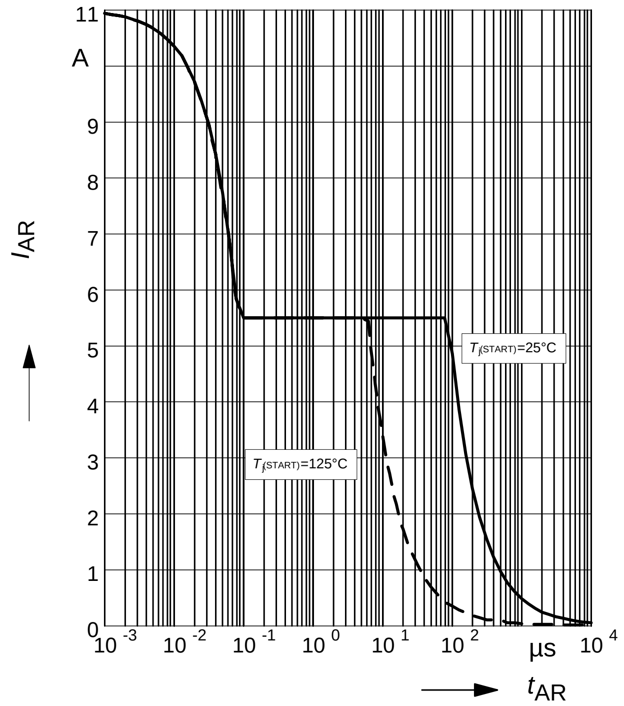
par.: V_{DS}=380V, V_{GS}=0/+13V,I_D=11A



16 Avalanche SOA

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

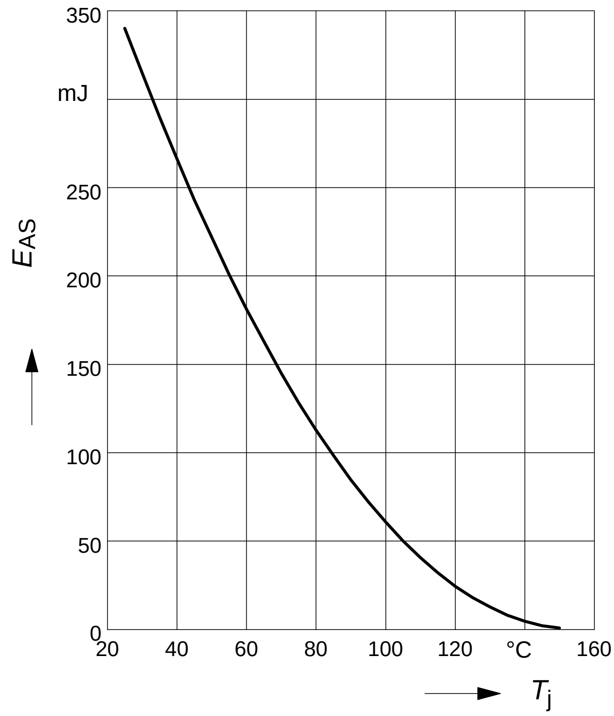
par.: $T_j \leq 150$ °C



17 Avalanche energy

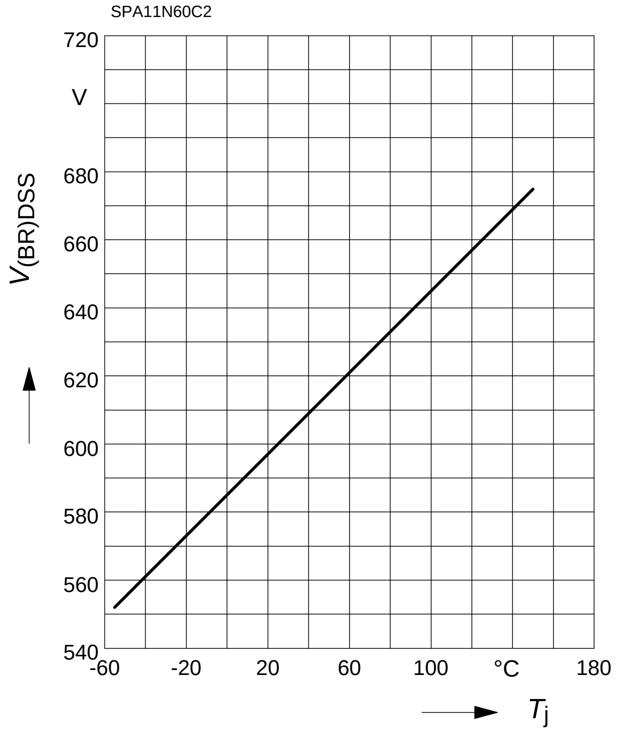
$E_{AS} = f\,(T_j)$

par.: I_D = 5.5 A, V_{DD} = 50 V



18 Drain-source breakdown voltage

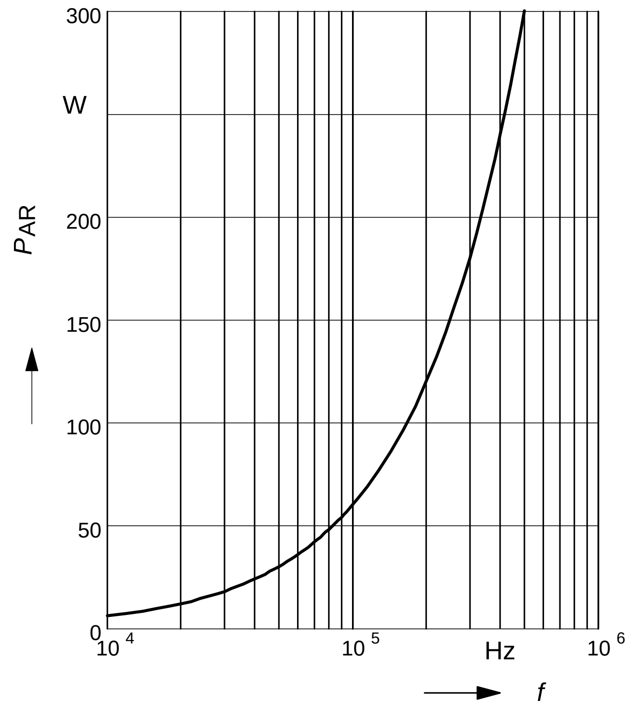
$V_{(BR)DSS} = f\,(T_j)$



19 Avalanche power losses

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

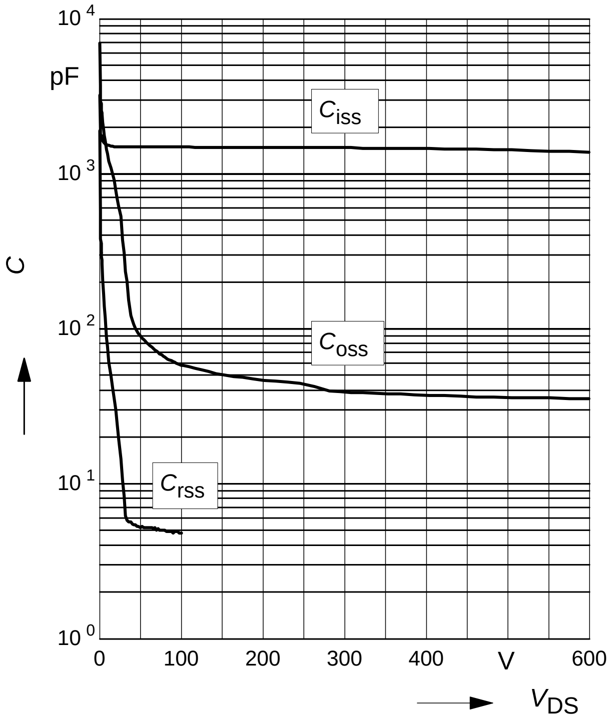
parameter: E_{AR}=0.6mJ



20 Typ. capacitances

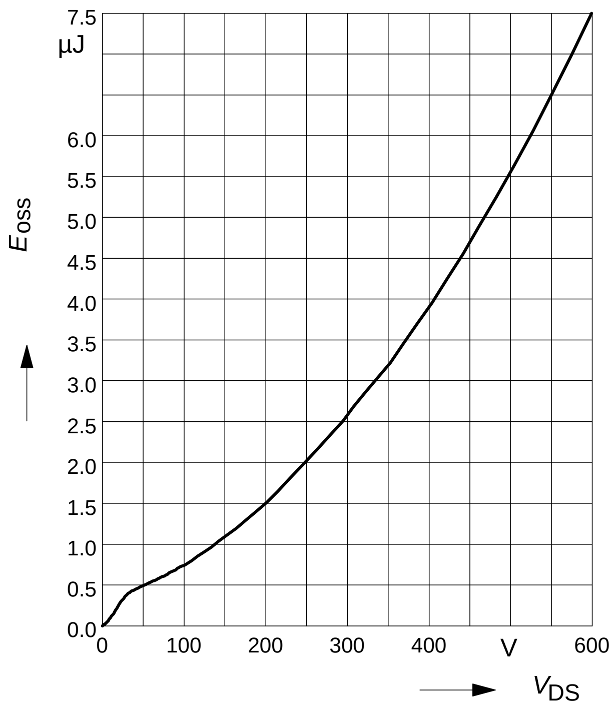
$C = f(V_{DS})$

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

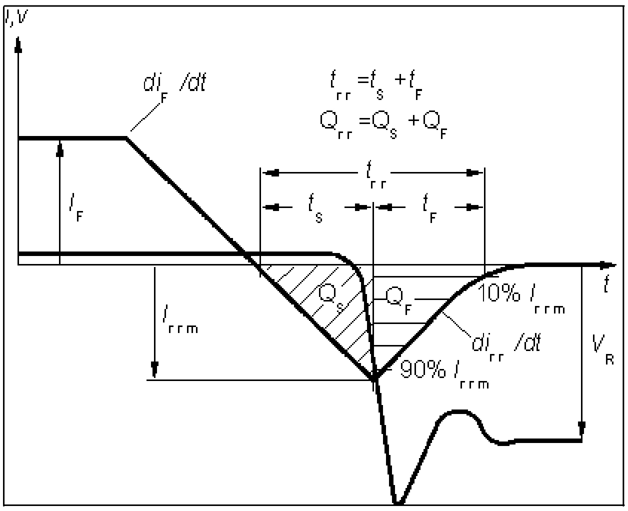


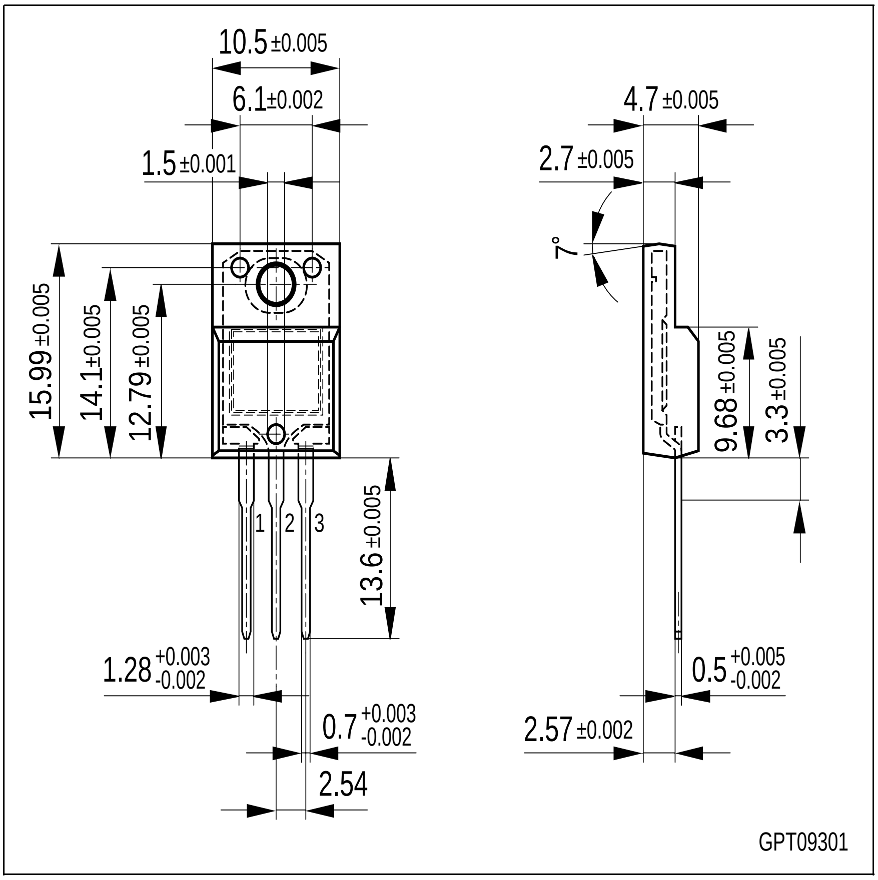
21 Typ. C_{oss} stored energy

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



Definition of diodes switching characteristics





Please refer to mounting instructions (application note AN-TO220-3-31-01)

Published by
Infineon Technologies AG,
Bereichs Kommunikation
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