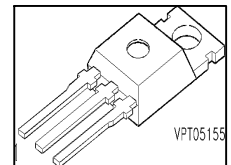


Cool MOS™ Power Transistor
Feature

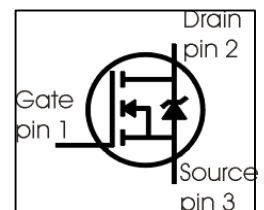
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- High peak current capability
- Intrinsic fast-recovery body diode
- Extreme low reverse recovery charge
- Pb-free lead palting; RoHS compliant, Halogen free mold compound
- Qualified for industrial grade applications according to JEDEC⁰⁾

$V_{DS} @ T_{jmax}$	650	V
$R_{DS(on)}$	0.44	Ω
I_D	11	A

PG-TO220



Type	Package	Ordering Code	Marking
SPP11N60CFD	PG-TO220	Q67040-S4618	11N60CFD


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	11 7	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\text{ puls}}$	28	
Avalanche energy, single pulse $I_D = 5.5\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AS}	340	mJ
Avalanche energy, repetitive t_{AR} limited by $T_{jmax}^{1)}$ $I_D = 11\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AR}	0.6	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	11	A
Reverse diode dv/dt $I_S = 11\text{ A}$, $V_{DS} = 480\text{ V}$, $T_j = 125\text{ }^\circ\text{C}$	dv/dt	40	V/ns
Gate source voltage	V_{GS}	± 20	V
Gate source voltage AC ($f > 1\text{ Hz}$)	V_{GS}	± 30	
Power dissipation, $T_C = 25\text{ }^\circ\text{C}$	P_{tot}	125	W
Operating and storage temperature	T_j, T_{stg}	-55... +150	$^\circ\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480 \text{ V}$, $I_D = 11 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$	dv/dt	80	V/ns
Maximum diode commutation speed $V_{DS} = 480 \text{ V}$, $I_D = 11 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$	di/dt	600	A/ μs

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	1	K/W
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s	T_{sold}	-	-	260	$^\circ\text{C}$

Electrical Characteristics, at $T_j=25^\circ\text{C}$ 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	$V_{(BR)DS}$	$V_{GS}=0\text{V}$, $I_D=11\text{A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=500\mu\text{A}$, $V_{GS}=V_{DS}$	3	4	5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$, $T_j=150^\circ\text{C}$	-	1.1	-	μA
			-	900	-	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=7\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.38	0.44	Ω
			-	1.02	-	
Gate input resistance	R_G	$f=1\text{MHz}$, open Drain	-	0.86	-	

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 7\text{A}$	-	8.3	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$	-	1200	-	pF
Output capacitance	C_{oss}		-	390	-	
Reverse transfer capacitance	C_{rss}		-	30	-	
Effective output capacitance, ²⁾ energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 480\text{V}$	-	45	-	pF
Effective output capacitance, ³⁾ time related	$C_{o(tr)}$		-	85	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 11\text{A}$, $R_G = 6.8\Omega$	-	34	-	ns
Rise time	t_r		-	18	-	
Turn-off delay time	$t_{d(off)}$		-	43	-	
Fall time	t_f		-	7	-	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD} = 480\text{V}$, $I_D = 11\text{A}$	-	9	-	nC
Gate to drain charge	Q_{gd}		-	23	-	
Gate charge total	Q_g	$V_{DD} = 480\text{V}$, $I_D = 11\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$	-	48	64	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 480\text{V}$, $I_D = 11\text{A}$	-	7	-	V

⁰J-STD20 and JESD22

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

² $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

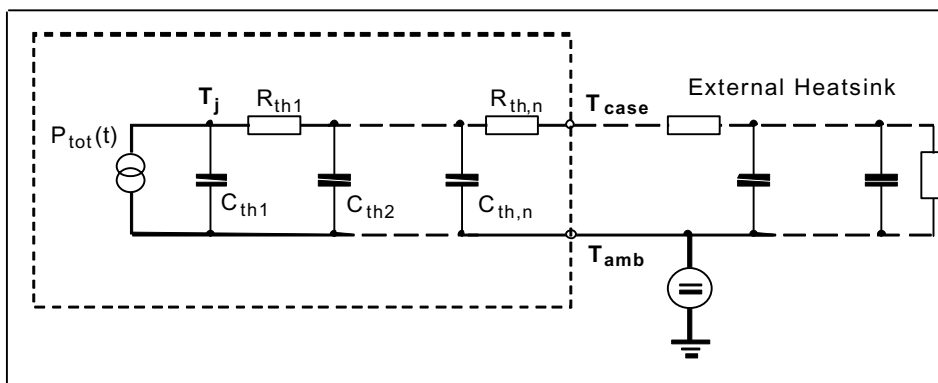
³ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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	$T_C=25^\circ\text{C}$	-	-	11	A
Inverse diode direct current, pulsed	I_{SM}		-	-	28	
Inverse diode forward voltage	V_{SD}	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R=480\text{V}, I_F=I_S,$	-	140	-	ns
Reverse recovery charge	Q_{rr}	$di_F/dt=100\text{A}/\mu\text{s}$	-	0.7	-	μC
Peak reverse recovery current	I_{rrm}		-	11	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	1200	-	$\text{A}/\mu\text{s}$

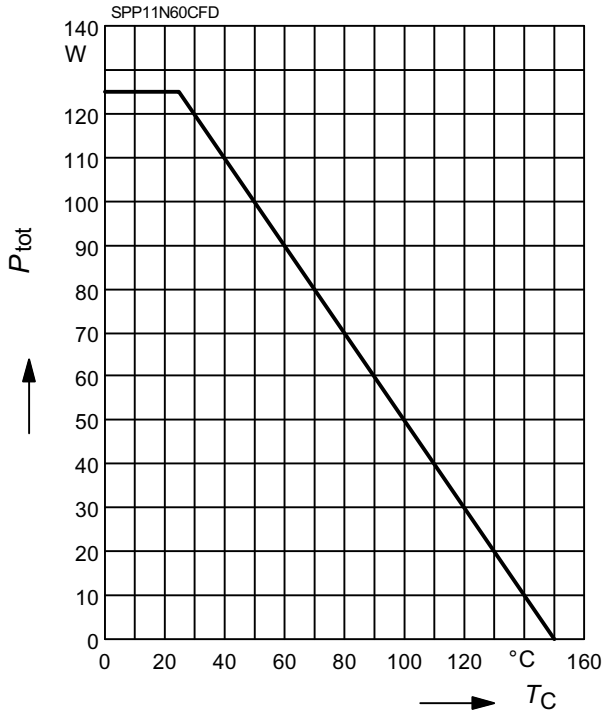
Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
R_{th1}	0.015	K/W	C_{th1}	0.0001878	Ws/K
R_{th2}	0.03		C_{th2}	0.0007106	
R_{th3}	0.056		C_{th3}	0.000988	
R_{th4}	0.197		C_{th4}	0.002791	
R_{th5}	0.216		C_{th5}	0.007285	
R_{th6}	0.083		C_{th6}	0.063	



1 Power dissipation

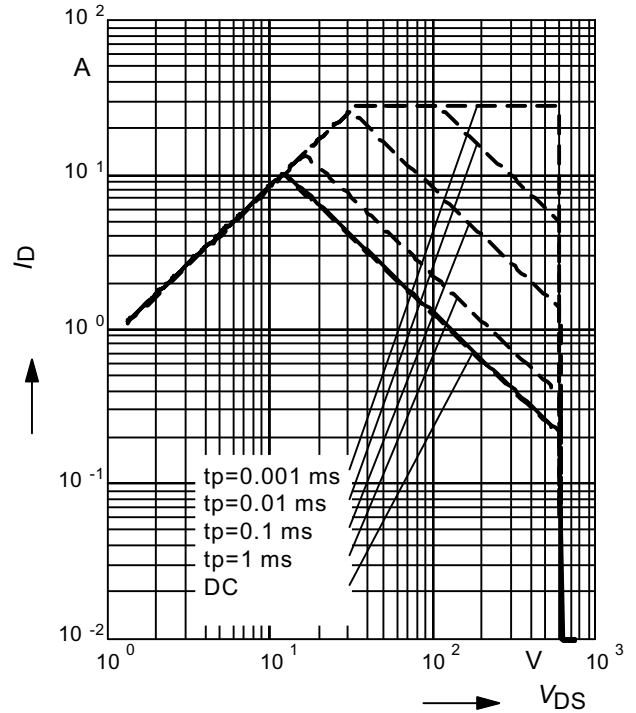
$P_{tot} = f(T_C)$



2 Safe operating area

$I_D = f(V_{DS})$

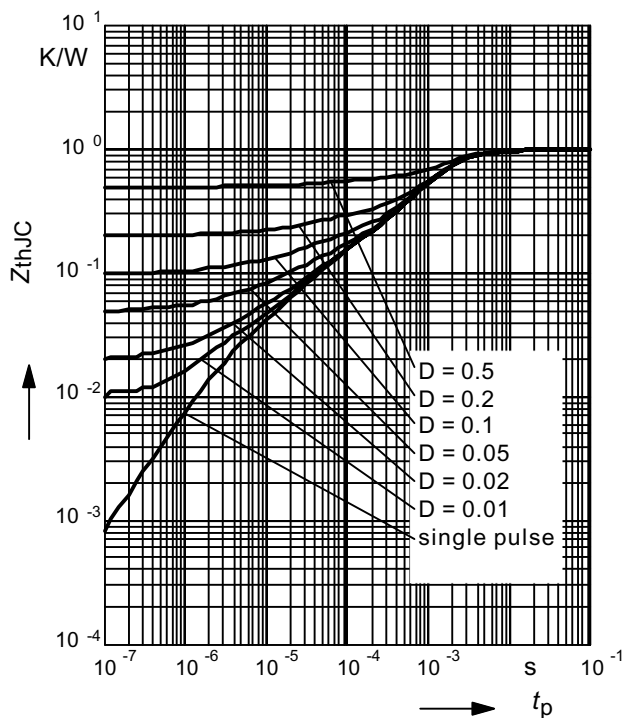
parameter : $D = 0, T_C = 25^\circ C$



3 Transient thermal impedance

$Z_{thJC} = f(t_p)$

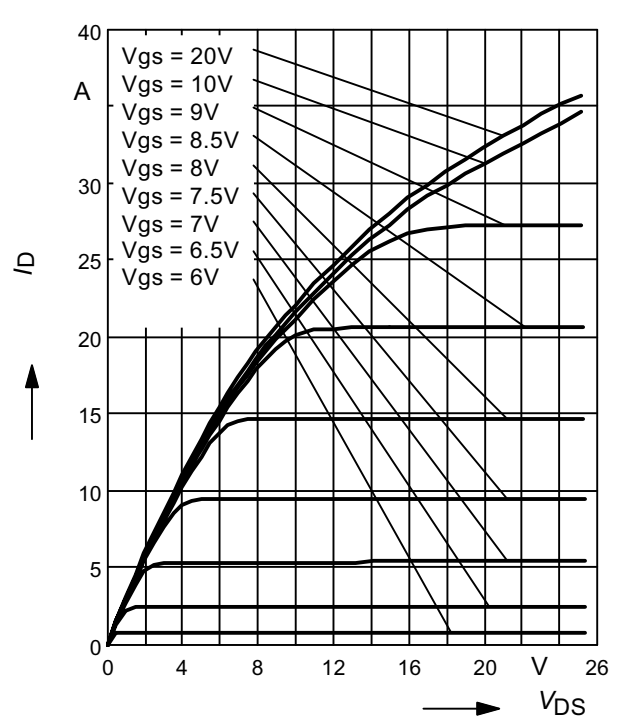
parameter: $D = t_p/T$



4 Typ. output characteristic

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

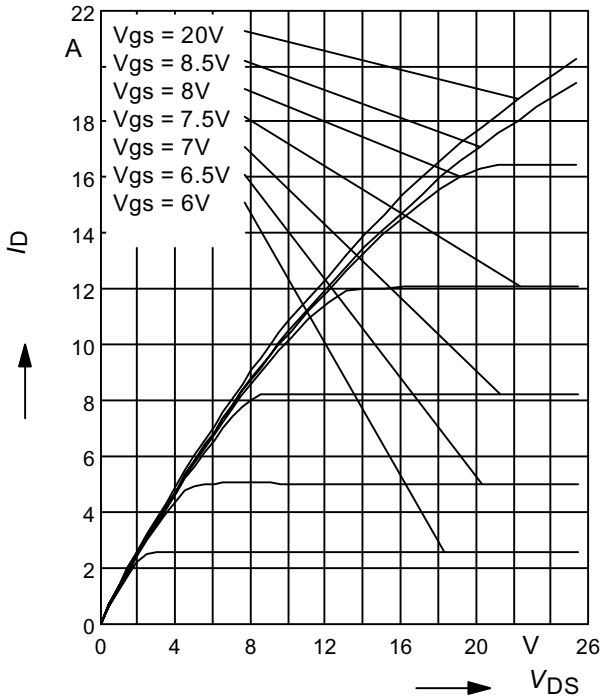
parameter: $t_p = 10 \mu s, V_{GS}$



5 Typ. output characteristic

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

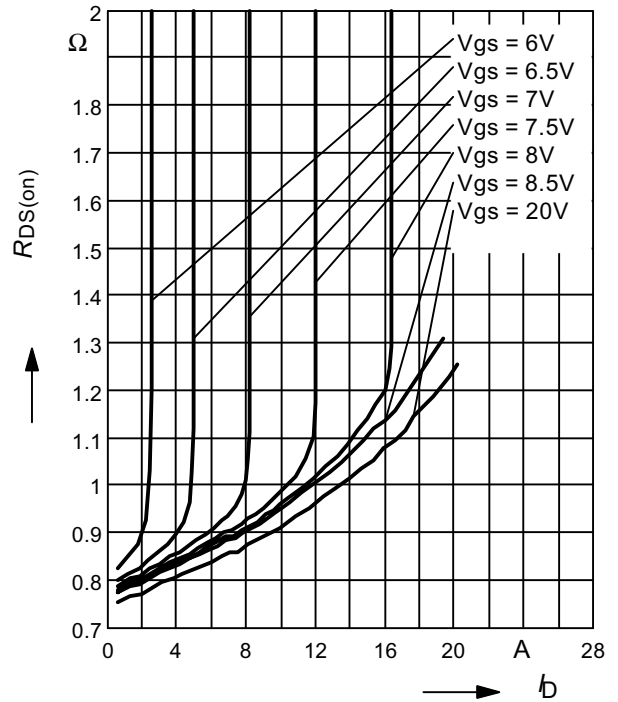
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



6 Typ. drain-source on resistance

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

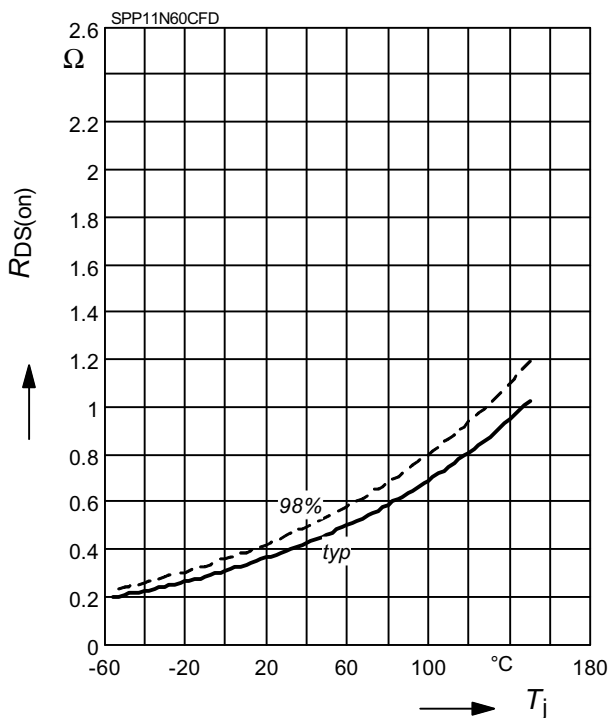
parameter: $T_j = 150^\circ\text{C}, V_{GS}$



7 Drain-source on-state resistance

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

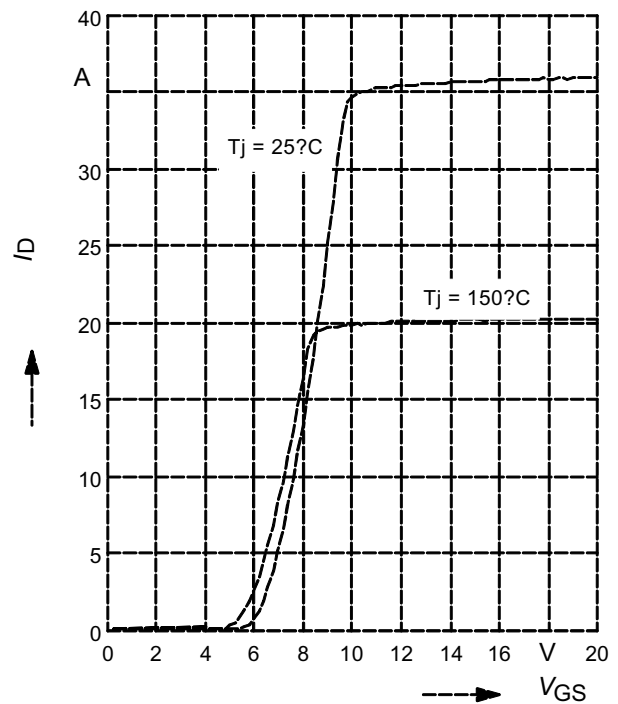
parameter: $I_D = 7 \text{ A}, V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

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

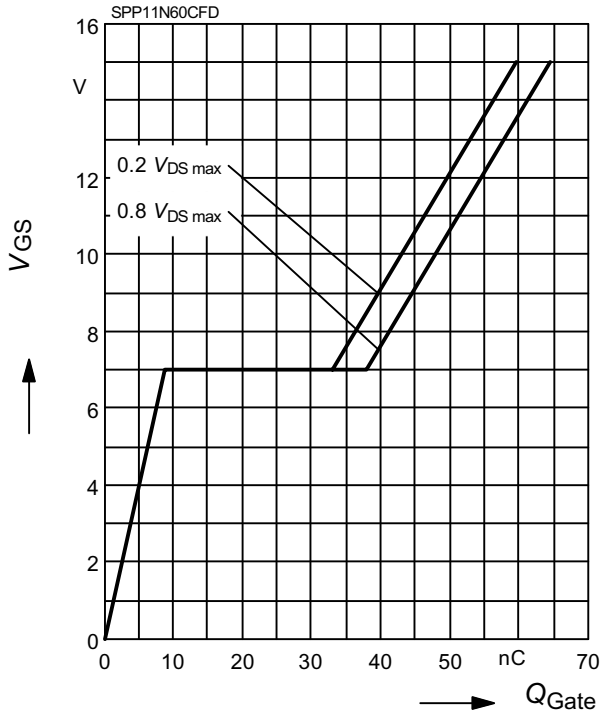
parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

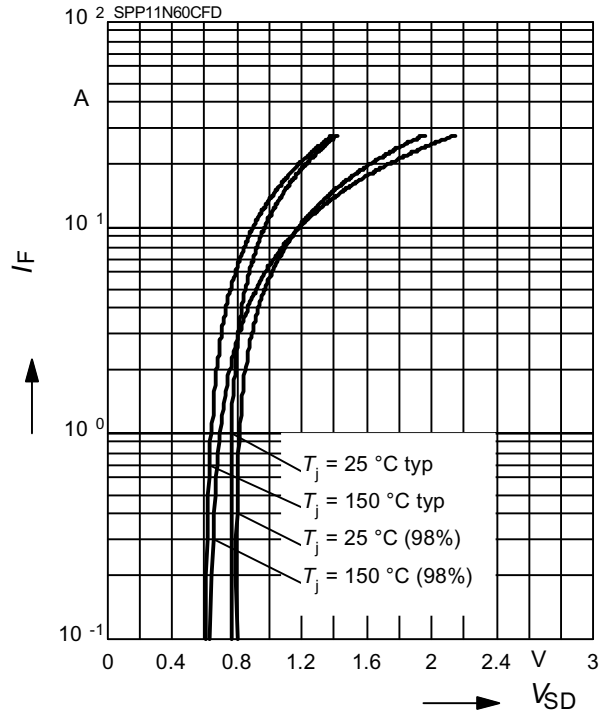
parameter: $I_D = 11\text{ A pulsed}$



10 Forward characteristics of body diode

$I_F = f(V_{SD})$

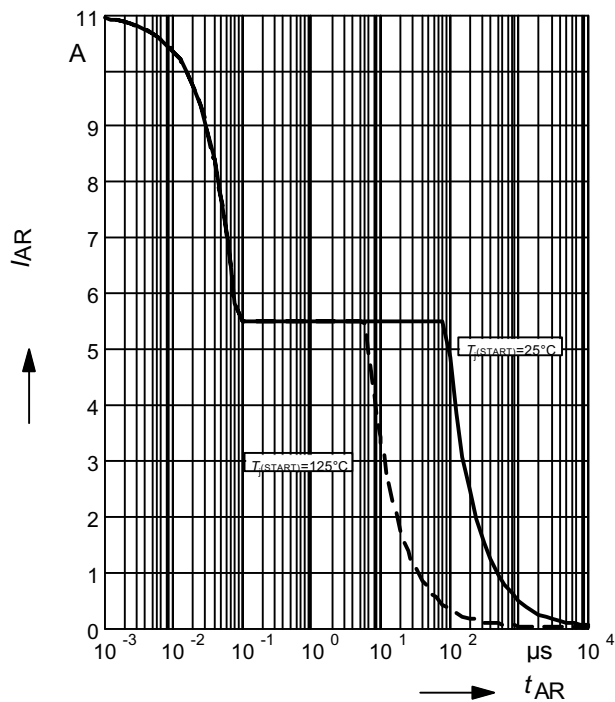
parameter: $T_j, t_p = 10\ \mu\text{s}$



11 Avalanche SOA

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

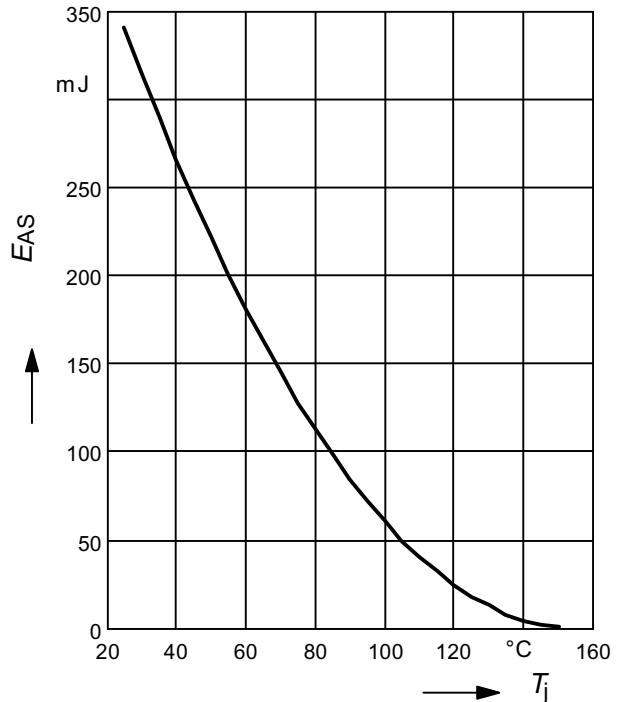
par.: $T_j \leq 150\ \text{°C}$



12 Avalanche energy

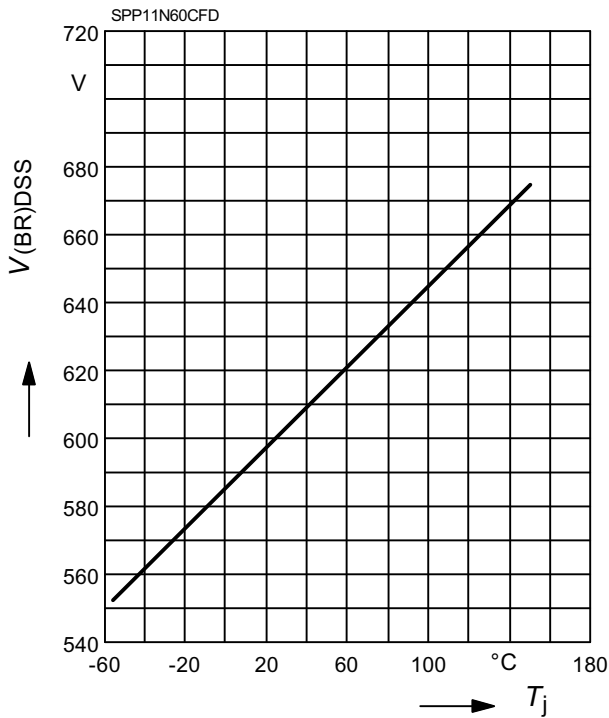
$E_{AS} = f(T_j)$

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



13 Drain-source breakdown voltage

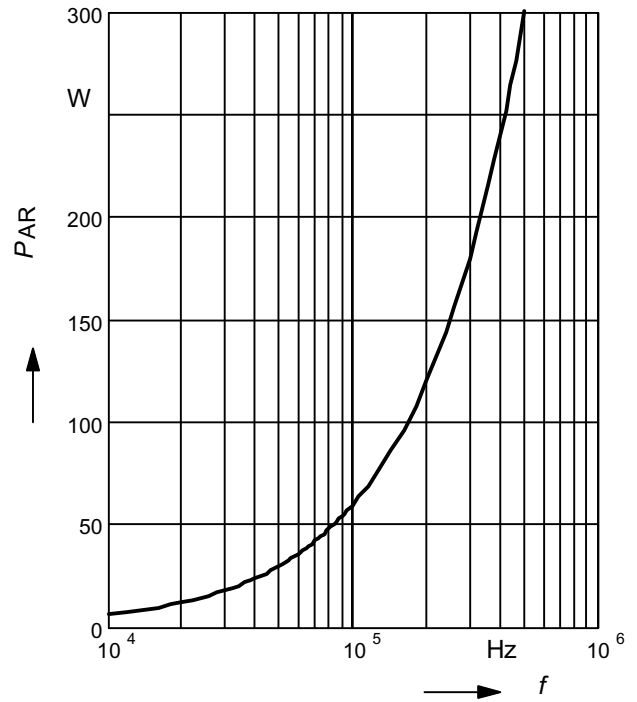
$$V_{(BR)DSS} = f(T_j)$$



14 Avalanche power losses

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

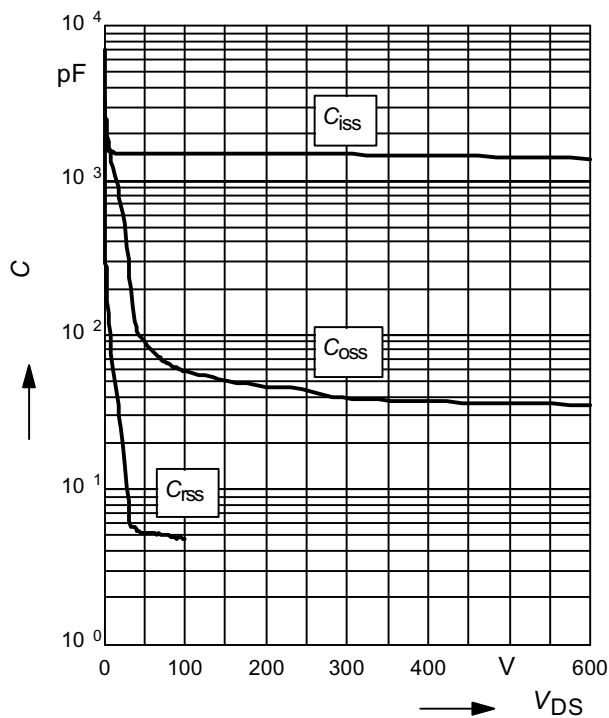
parameter: $E_{AR}=0.6mJ$



15 Typ. capacitances

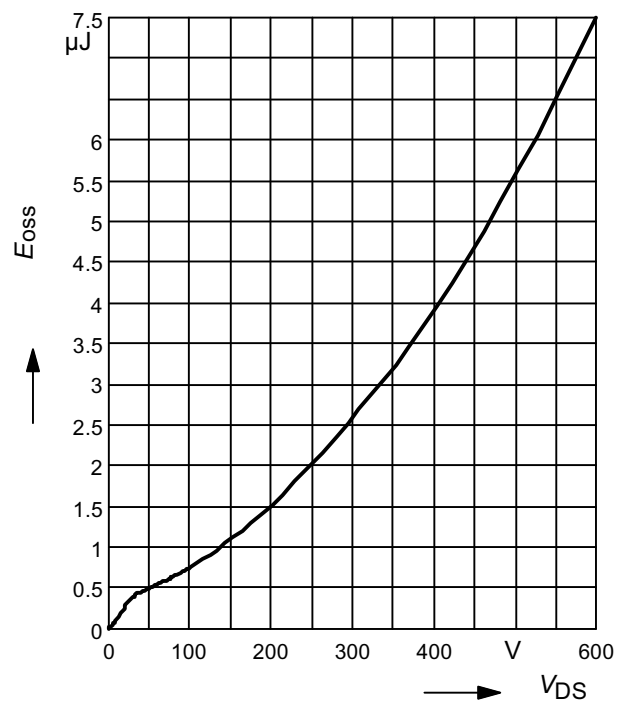
$$C = f(V_{DS})$$

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



16 Typ. C_{OSS} stored energy

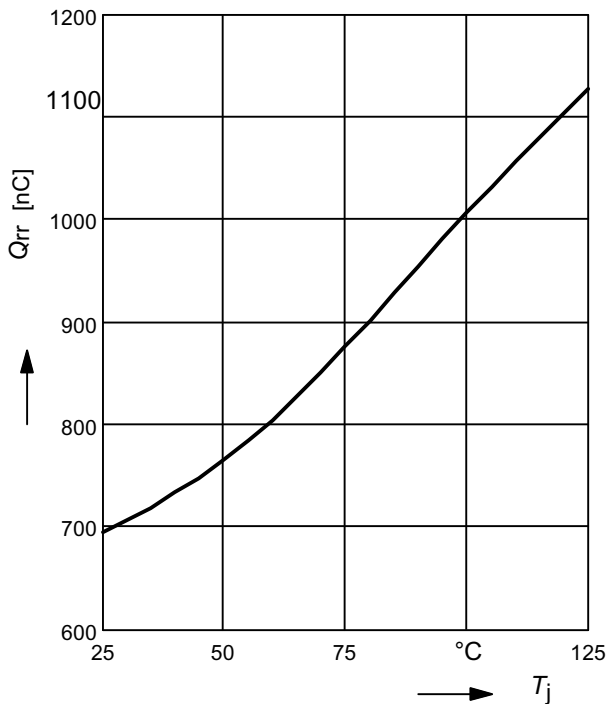
$$E_{Oss}=f(V_{DS})$$



17 Typ. reverse recovery charge

$$Q_{rr} = f(T_j)$$

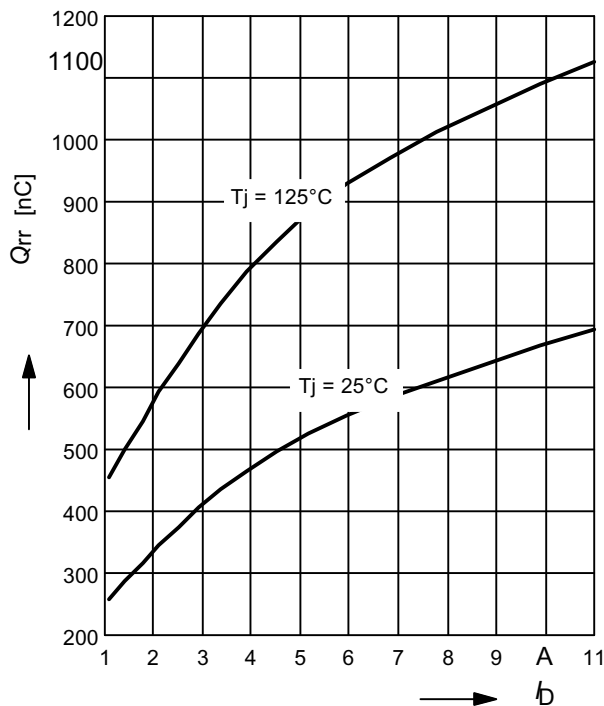
parameter: $I_D = 11\text{ A}$



18 Typ. reverse recovery charge

$$Q_{rr} = f(I_D)$$

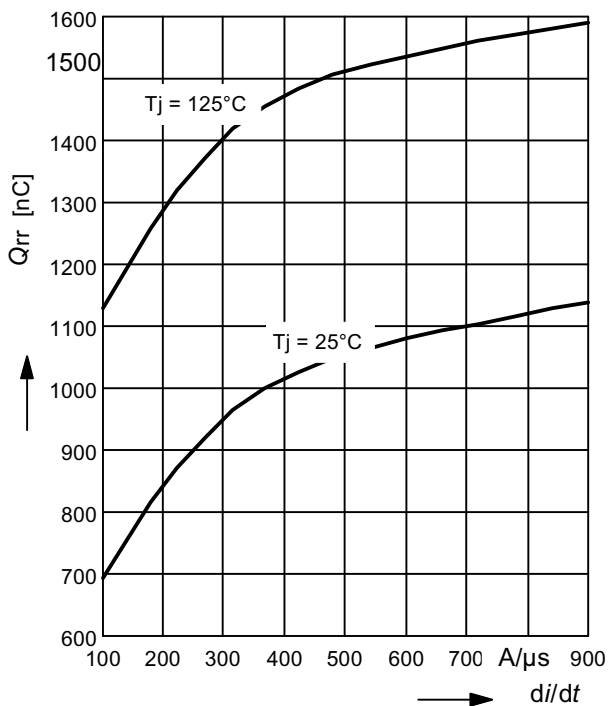
parameter: $di/dt = 100\text{ A}/\mu\text{s}$



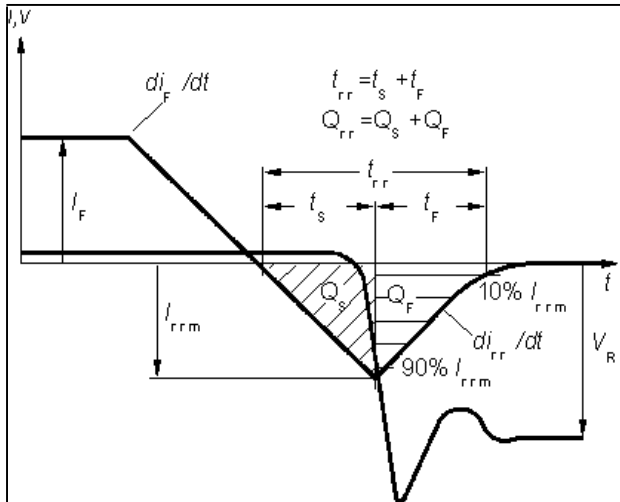
19 Typ. reverse recovery charge

$$Q_{rr} = f(di/dt)$$

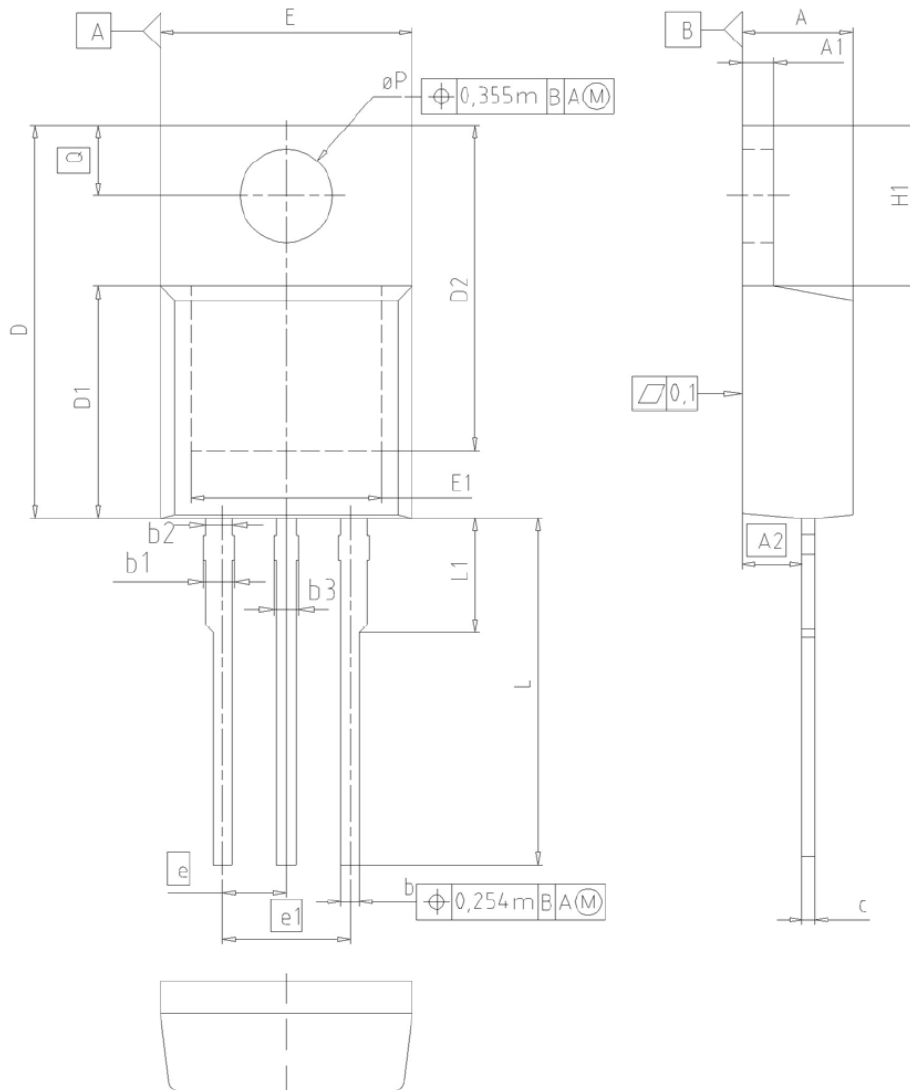
parameter: $I_D = 11\text{ A}$



Definition of diodes switching characteristics



PG-TO-220-3-1, PG-TO220-3-21



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
ϕP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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