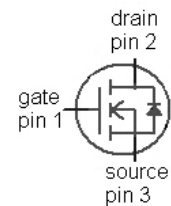
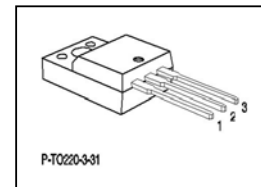


CoolMOS™ Power Transistor
Features

- New revolutionary high voltage technology
- Intrinsic fast-recovery body diode
- Extremely low reverse recovery charge
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Periodic avalanche rated
- Qualified according to JEDEC⁰⁾ for target applications

Product Summary

V_{DS}	600	V
$R_{DS(on),max}$	0.44	Ω
$I_D^{1)}$	11	A

PG-TO220-3-31


Type	Package	Ordering Code	Marking
SPA11N60CFD	TO-220-3-31	SP000216317	11N60CFD

Maximum ratings, at $T_j=25\text{ °C}$, unless otherwise specified

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current ¹⁾	I_D	$T_C=25\text{ °C}$	11	A
		$T_C=100\text{ °C}$	7	
Pulsed drain current ²⁾	$I_{D,pulse}$	$T_C=25\text{ °C}$	28	
Avalanche energy, single pulse	E_{AS}	$I_D=5.5\text{ A}$, $V_{DD}=50\text{ V}$	340	mJ
Avalanche energy, repetitive ^{2),3)}	E_{AR}	$I_D=11\text{ A}$, $V_{DD}=50\text{ V}$	0.6	
Avalanche current, repetitive ^{2),3)}	I_{AR}		11	A
Drain source voltage slope	dv/dt	$I_D=11\text{ A}$, $V_{DS}=480\text{ V}$, $T_j=125\text{ °C}$	80	V/ns
Reverse diode dv/dt	dv/dt	$I_S=11\text{ A}$, $V_{DS}=480\text{ V}$, $T_j=125\text{ °C}$	40	V/ns
Maximum diode commutation speed	di/dt		600	A/ μ s
Gate source voltage	V_{GS}	static	± 20	V
		AC ($f>1\text{ Hz}$)	± 30	
Power dissipation	P_{tot}	$T_C=25\text{ °C}$	33	W
Operating and storage temperature	T_j, T_{stg}		-55 ... 150	$^{\circ}\text{C}$

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Thermal characteristics

Thermal resistance, junction - case	R_{thJC}		-	-	3.8	K/W
Thermal resistance, junction - ambient	R_{thJA}	leaded	-	-	62	
Soldering temperature, wave soldering	T_{sold}	1.6 mm (0.063 in.) from case for 10 s	-	-	260	°C

Electrical characteristics, at $T_j=25\text{ °C}$, unless otherwise specified

Static characteristics

Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{ V}$, $I_D=250\text{ }\mu\text{A}$	600	-	-	V
Avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{ V}$, $I_D=11\text{ A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}$, $I_D=1.9\text{ mA}$	3	4	5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$	-	1.1	-	μA
		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$	-	900	-	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}$, $I_D=7\text{ A}$, $T_j=25\text{ °C}$	-	0.38	0.44	Ω
		$V_{GS}=10\text{ V}$, $I_D=7\text{ A}$, $T_j=150\text{ °C}$	-	1.02	-	
Gate resistance	R_G	$f=1\text{ MHz}$, open drain	-	0.86	-	
Transconductance	g_{fs}	$ V_{DS} >2 I_D R_{DS(on)max}$, $I_D=7\text{ A}$	-	8.3	-	S

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Dynamic characteristics

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, energy related ⁴⁾	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	45	-	
Effective output capacitance, time related ⁵⁾	$C_{o(tr)}$		-	85	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=480\text{ V}, V_{GS}=10\text{ V}, I_D=11\text{ A}, R_G=6.8\ \Omega$	-	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}	$V_{DD}=480\text{ V}, I_D=11\text{ A}, V_{GS}=0\text{ to }10\text{ V}$	-	9	-	nC
Gate to drain charge	Q_{gd}		-	23	-	
Gate charge total	Q_g		-	48	64	
Gate plateau voltage	$V_{plateau}$		-	7.5	-	V

⁰⁾ J-STD20 and JESD22

¹⁾ Limited only by maximum temperature.

²⁾ Pulse width t_p limited by $T_{j,max}$
³⁾ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR} \cdot f$.

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} .

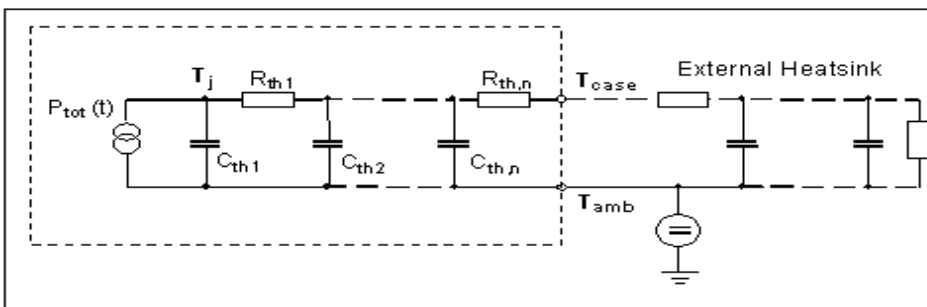
Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Reverse Diode

Diode continuous forward current ¹⁾	I_S	$T_C=25\text{ }^\circ\text{C}$	-	-	11	A
Diode pulse current ²⁾	$I_{S,pulse}$		-	-	28	
Diode forward voltage	V_{SD}	$V_{GS}=0\text{ V}, I_F=11\text{ A}, T_j=25\text{ }^\circ\text{C}$	-	1.0	1.2	V
Reverse recovery time	t_{rr}	$V_R=480\text{ V}, I_F=I_S, di_F/dt=100\text{ A}/\mu\text{s}$	-	140	-	ns
Reverse recovery charge	Q_{rr}		-	0.7	-	μC
Peak reverse recovery current	I_{rrm}		-	11	-	A

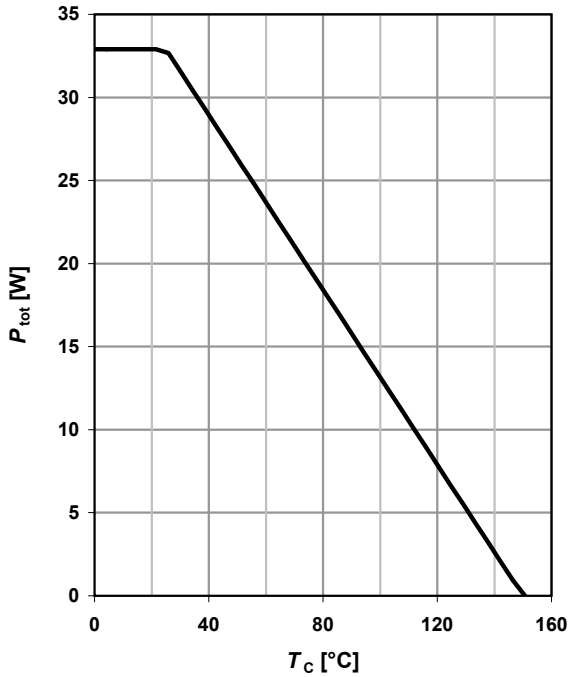
Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
R_{th1}	0.0178	K/W	C_{th1}	0.0000989	Ws/K
R_{th2}	0.0931		C_{th2}	0.000939	
R_{th3}	0.228		C_{th3}	0.00303	
R_{th4}	0.559		C_{th4}	0.0245	
R_{th5}	1.58		C_{th5}	0.951	



1 Power dissipation

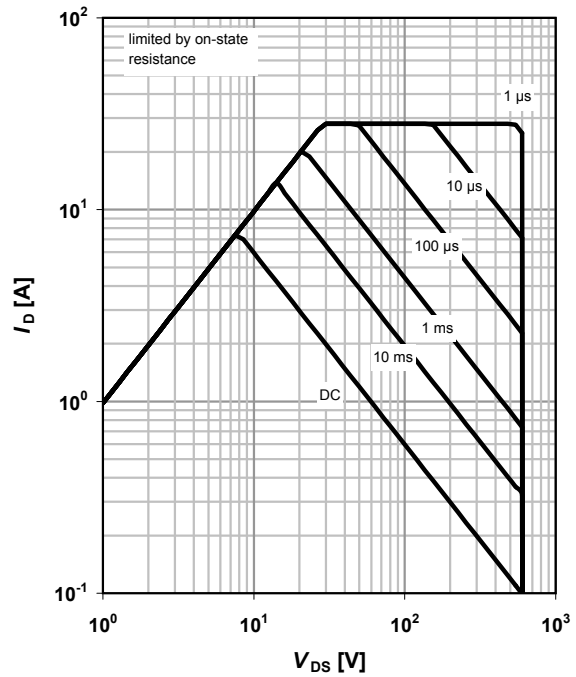
$P_{tot}=f(T_C)$



2 Safe operating area

$I_D=f(V_{DS}); T_C=25\text{ °C}; D=0$

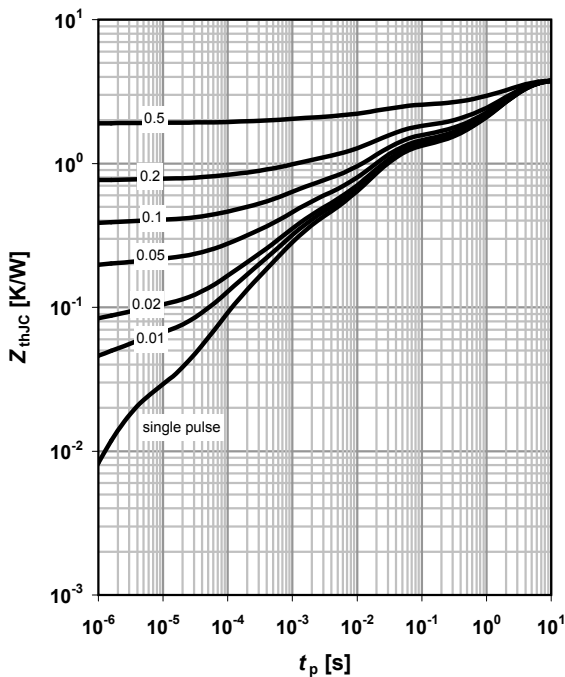
parameter: t_p



3 Max. transient thermal impedance

$I_D=f(V_{DS}); T_J=25\text{ °C}$

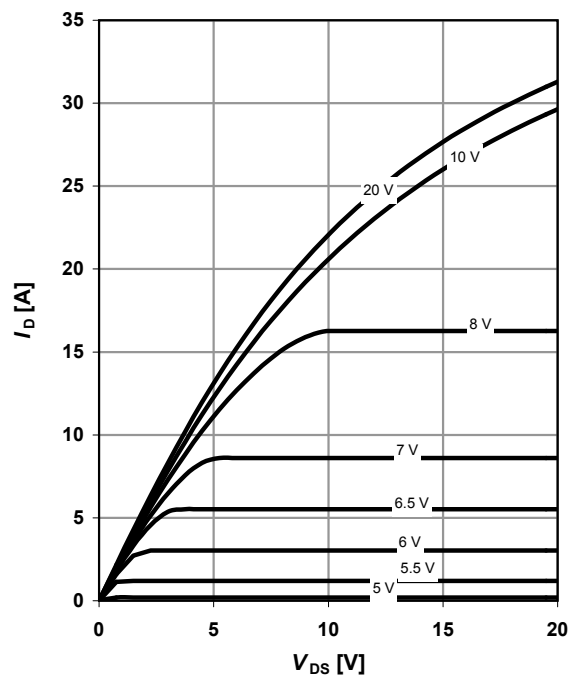
parameter: $D=t_p/T$



4 Typ. output characteristics

$I_D=f(V_{DS}); T_J=25\text{ °C}$

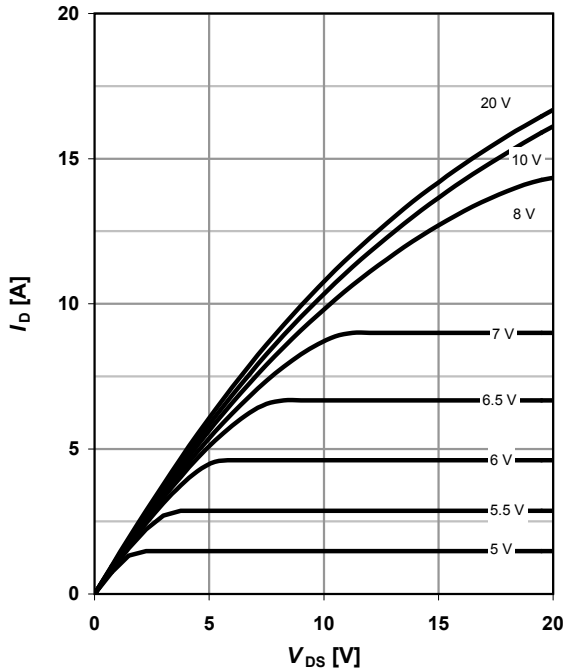
parameter: $t_p = 10\mu\text{s } V_{GS}$



5 Typ. output characteristics

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

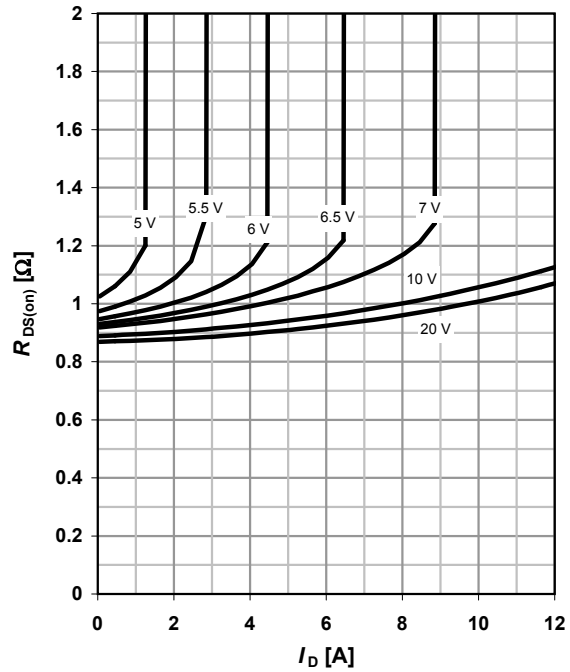
parameter: $t_p = 10\mu\text{s } V_{GS}$



6 Typ. drain-source on-state resistance

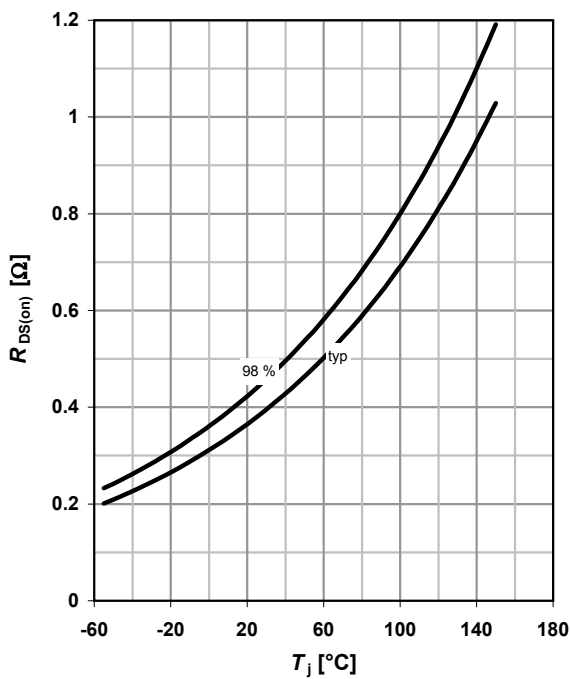
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter: V_{GS}



7 Drain-source on-state resistance

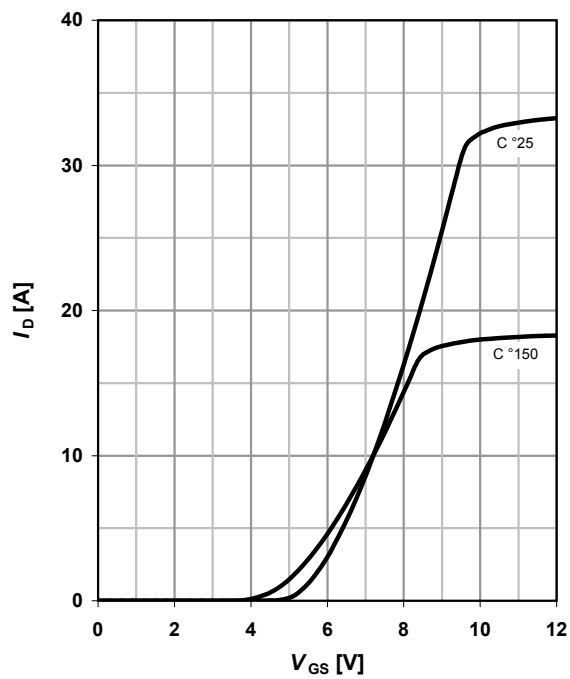
$R_{DS(on)} = f(T_j); I_D = 7\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

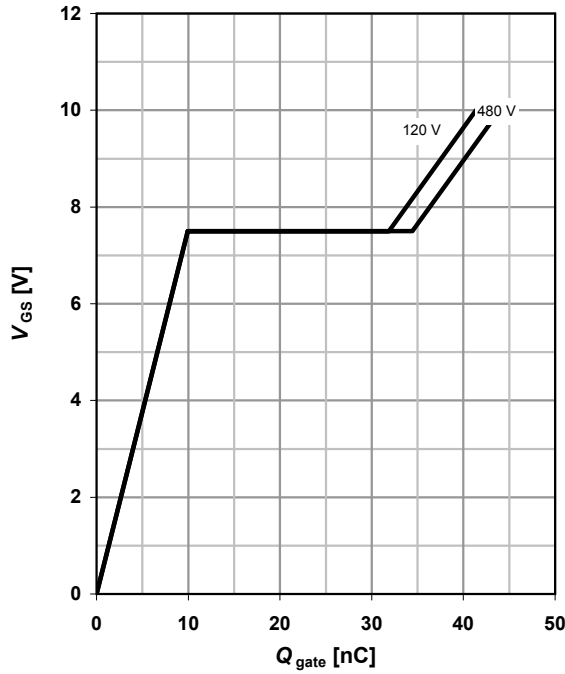
parameter: T_j



9 Typ. gate charge

$V_{GS}=f(Q_{gate}); I_D=11\text{ A pulsed}$

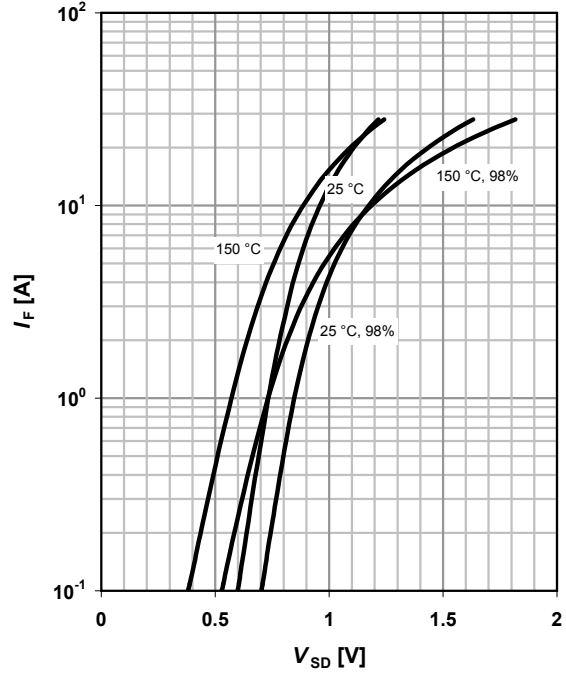
parameter: V_{DD}



10 Forward characteristics of reverse diode

$I_F=f(V_{SD})$

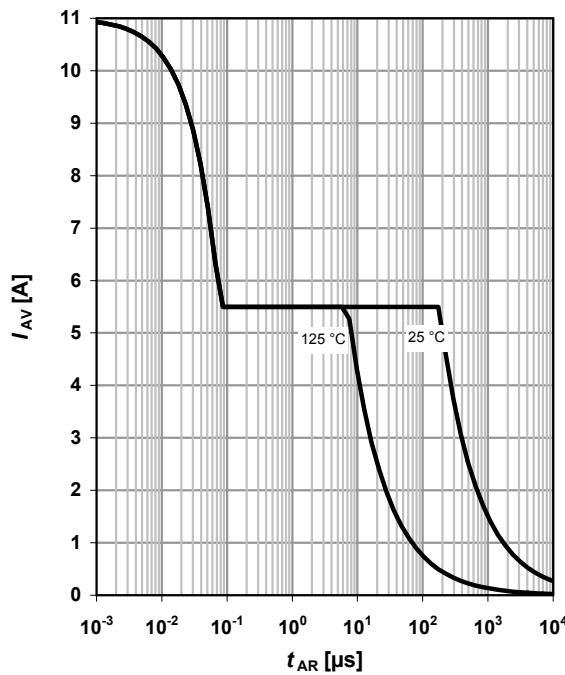
parameter: T_j



11 Avalanche SOA

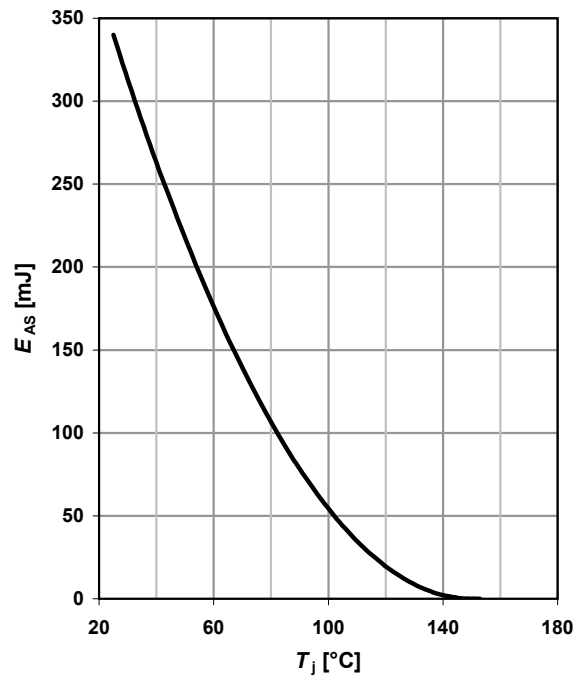
$I_{AR}=f(t_{AR})$

parameter: $T_{j(start)}$



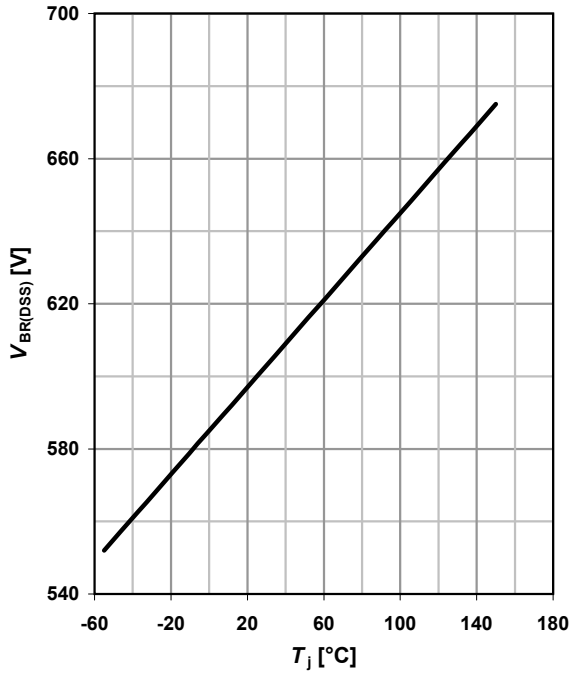
12 Avalanche energy

$E_{AS}=f(T_j); I_D=5.5\text{ A}; V_{DD}=50\text{ V}$



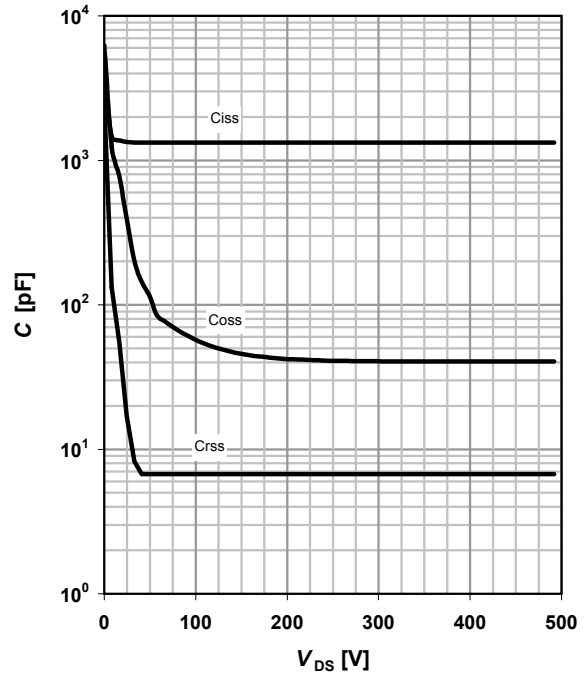
13 Drain-source breakdown voltage

$V_{BR(DSS)} = f(T_j); I_D = 10 \text{ mA}$



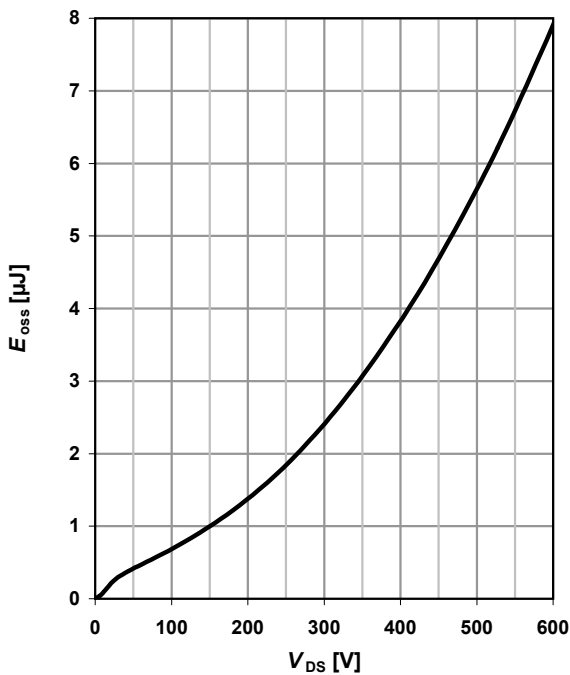
14 Typ. capacitances

$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$



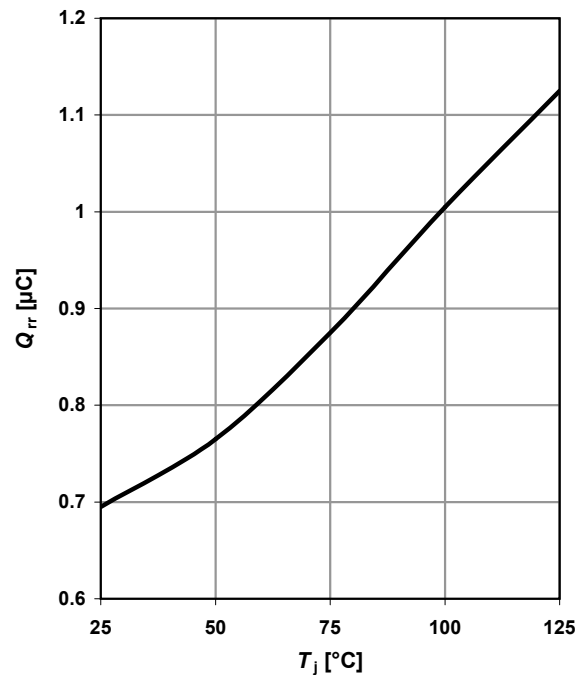
15 Typ. C_{oss} stored energy

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



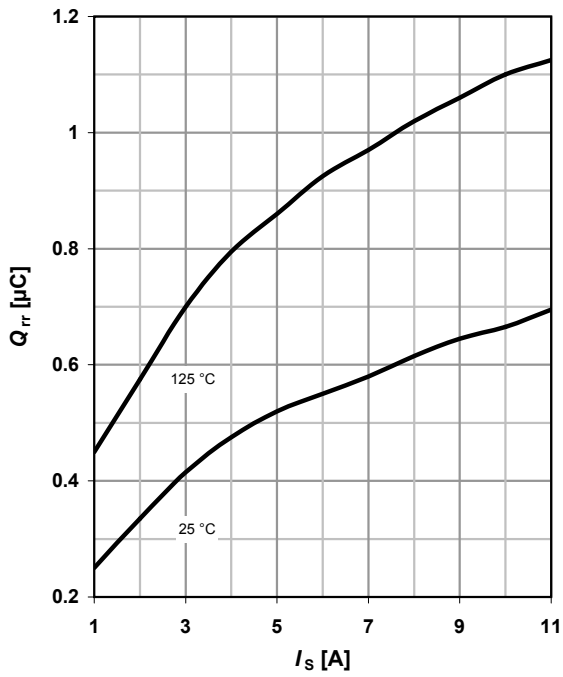
16 Typ. reverse recovery charge

$Q_{rr} = f(T_j); \text{parameter: } I_D = 11 \text{ A}$



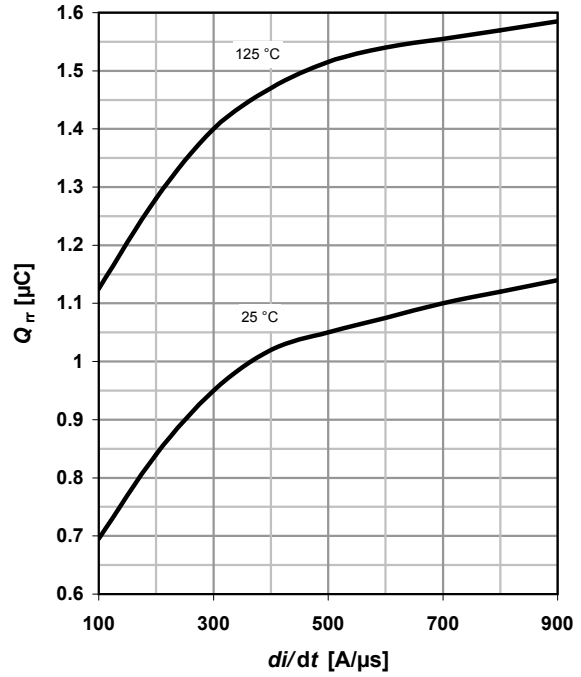
17 Typ. reverse recovery charge

$Q_{rr}=f(I_S)$; parameter: $di/dt=100\text{ A}/\mu\text{s}$

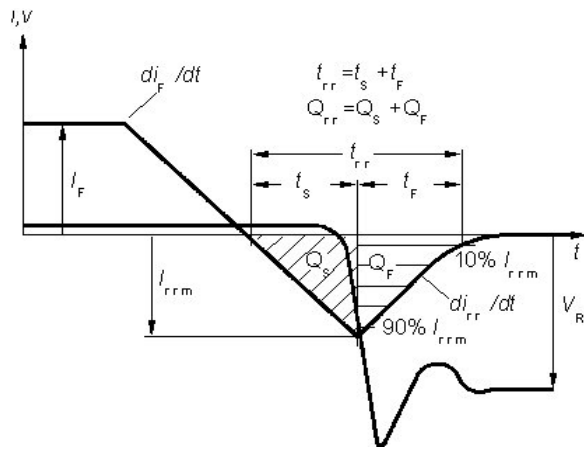


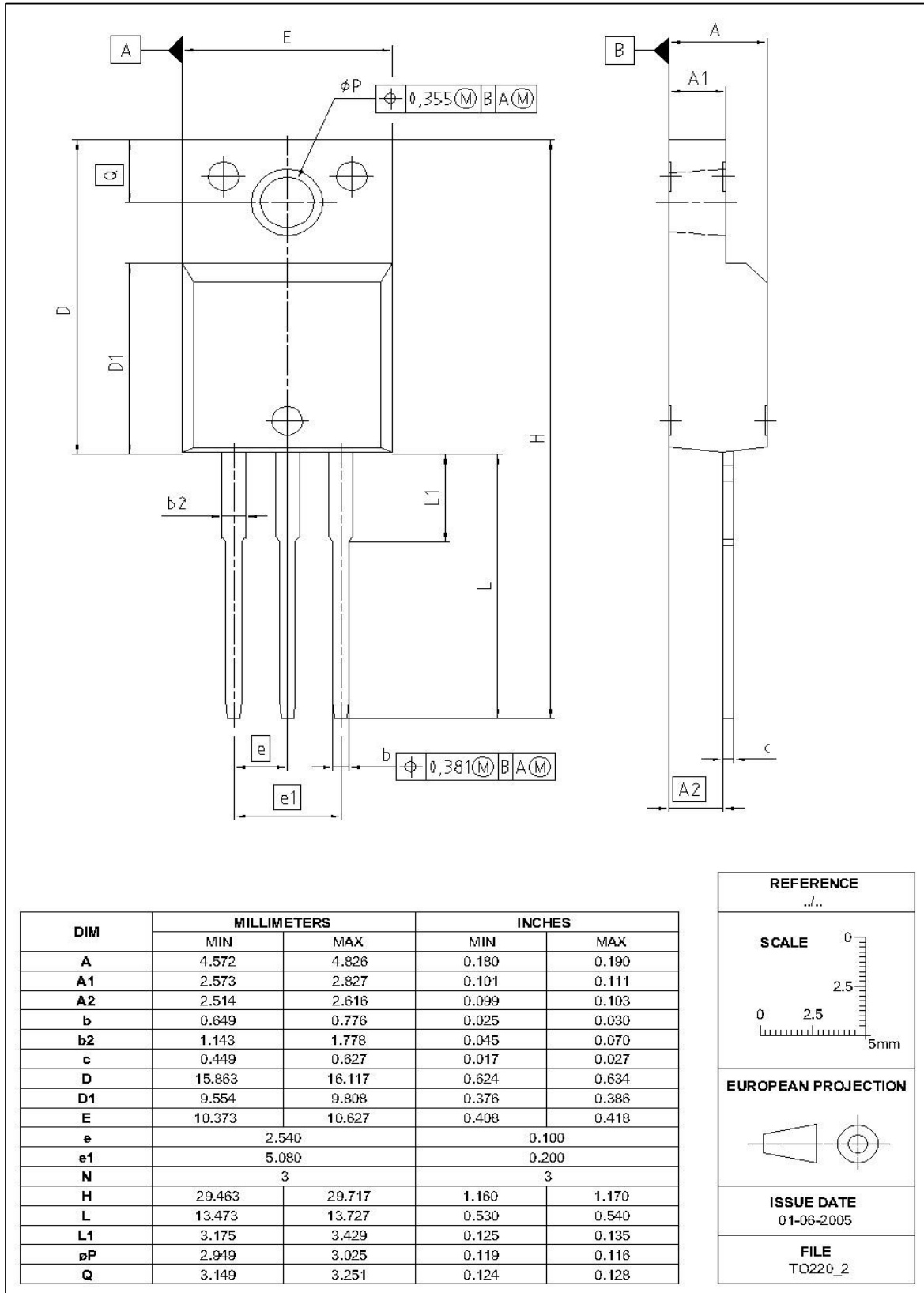
18 Typ. reverse recovery charge

$Q_{rr}=f(di/dt)$; parameter: $I_D=11\text{ A}$



Definition of diode switching characteristics





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