

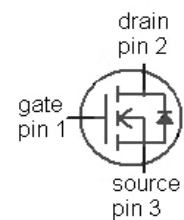
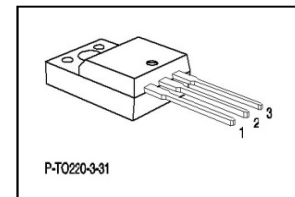
CoolMOS™ Power Transistor
Features

- 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 for industrial grade applications according to JEDEC⁰⁾
- Pb-free lead plating; RoHS compliant

Type	Package	Ordering Code	Marking
SPA20N60CFD	PG-TO220-3-31	SP000216361	20N60CFD

Product Summary

V_{DS}	600	V
$R_{DS(on),max}$	0.22	Ω
$I_D^{1)}$	20.7	A

PG-TO220-3-31

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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current ¹⁾	I_D	$T_C=25\text{ }^\circ\text{C}$	20.7	A
		$T_C=100\text{ }^\circ\text{C}$	13.1	
Pulsed drain current ²⁾	$I_{D,pulse}$	$T_C=25\text{ }^\circ\text{C}$	52	
Avalanche energy, single pulse	E_{AS}	$I_D=10\text{ A}$, $V_{DD}=50\text{ V}$	690	mJ
Avalanche energy, repetitive $t_{AR}^{2),3)}$	E_{AR}	$I_D=20\text{ A}$, $V_{DD}=50\text{ V}$	1	
Avalanche current, repetitive $t_{AR}^{2),3)}$	I_{AR}		20	A
Drain source voltage slope	dv/dt	$I_D=20.7\text{ A}$, $V_{DS}=480\text{ V}$, $T_j=125\text{ }^\circ\text{C}$	80	V/ns
Reverse diode dv/dt	dv/dt	$I_S=20.7\text{ A}$, $V_{DS}=480\text{ V}$, $T_j=125\text{ }^\circ\text{C}$	40	V/ns
Maximum diode commutation speed	di/dt		900	A/ μs
Gate source voltage	V_{GS}	static	± 20	V
		AC ($f>1\text{ Hz}$)	± 30	
Power dissipation	P_{tot}	$T_C=25\text{ }^\circ\text{C}$	35	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}		-	-	3.6	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	$V_{(BR)DS}$	$V_{GS}=0\text{ V}, I_D=20\text{ A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=1000\mu\text{A}$	3	4	5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$	-	2.1	-	μA
		$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ °C}$	-	1700	-	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}, I_D=13.1\text{ A}, T_j=25\text{ °C}$	-	0.19	0.22	Ω
		$V_{GS}=10\text{ V}, I_D=13.1\text{ A}, T_j=150\text{ °C}$	-	0.43	-	
Gate resistance	R_G	$f=1\text{ MHz}, \text{open drain}$	-	0.54	-	
Transconductance	g_{fs}	$ V_{DS} >2 I_D R_{DS(on)max}, I_D=13.1\text{ A}$	-	17.5	-	S

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Dynamic characteristics

Input capacitance	C_{iss}	$V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$ $f=1\text{ MHz}$	-	2400	-	pF
Output capacitance	C_{oss}		-	780	-	
Reverse transfer capacitance	C_{rss}		-	50	-	
Effective output capacitance, energy related ⁴⁾	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	83	-	
Effective output capacitance, time related ⁵⁾	$C_{o(tr)}$		-	160	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=380\text{ V},$ $V_{GS}=10\text{ V}, I_D=20.7\text{ A},$ $R_G=3.6\ \Omega$	-	12	-	ns
Rise time	t_r		-	15	-	
Turn-off delay time	$t_{d(off)}$		-	59	-	
Fall time	t_f		-	6.4	-	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD}=480\text{ V},$ $I_D=20.7\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	15	-	nC
Gate to drain charge	Q_{gd}		-	54	-	
Gate charge total	Q_g		-	95	124	
Gate plateau voltage	$V_{plateau}$		-	7.0	-	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} .

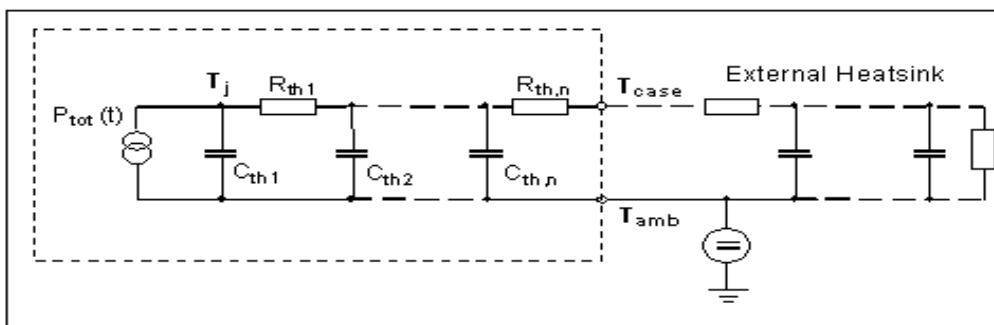
Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Reverse Diode

Diode continuous forward current ¹⁾	I_S	$T_C=25\text{ °C}$	-	-	20.7	A
Diode pulse current ²⁾	$I_{S,pulse}$		-	-	52	
Diode forward voltage	V_{SD}	$V_{GS}=0\text{ V}, I_F=20.7\text{ A}, T_J=25\text{ °C}$	-	1.0	1.2	V
Reverse recovery time	t_{rr}	$V_R=480\text{ V}, I_F=I_S, di_F/dt=100\text{ A}/\mu\text{s}$	-	150	-	ns
Reverse recovery charge	Q_{rr}		-	1	-	μC
Peak reverse recovery current	I_{rrm}		-	13	-	A

Typical Transient Thermal Characteristics

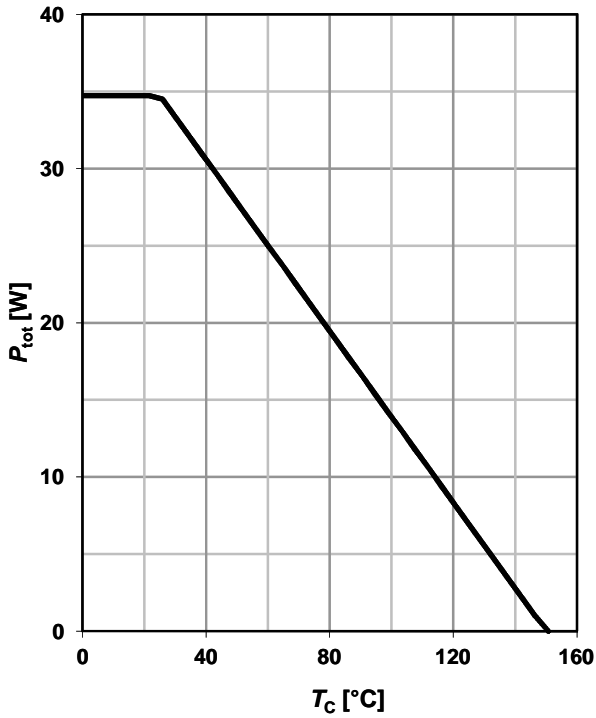
Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
R_{th1}	0.00862	K/W	C_{th1}	0.000205	Ws/K
R_{th2}	0.0471		C_{th2}	0.00198	
R_{th3}	0.119		C_{th3}	0.0068	
R_{th4}	0.476		C_{th4}	0.0482	
R_{th5}	1.57		C_{th5}	0.957	
			C_{th6}	0.1	



⁵⁾ C_{th6} models the additional heat capacitance of the package in case of non-ideal cooling. It is not needed if $R_{thCA}=0\text{ K/W}$.

1 Power dissipation

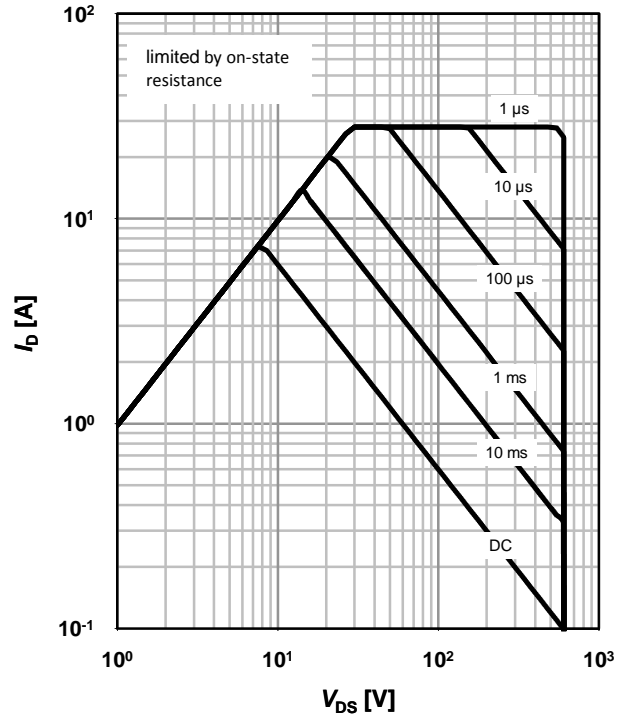
$P_{TOT}=f(T_C)$



2 Safe operating area

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

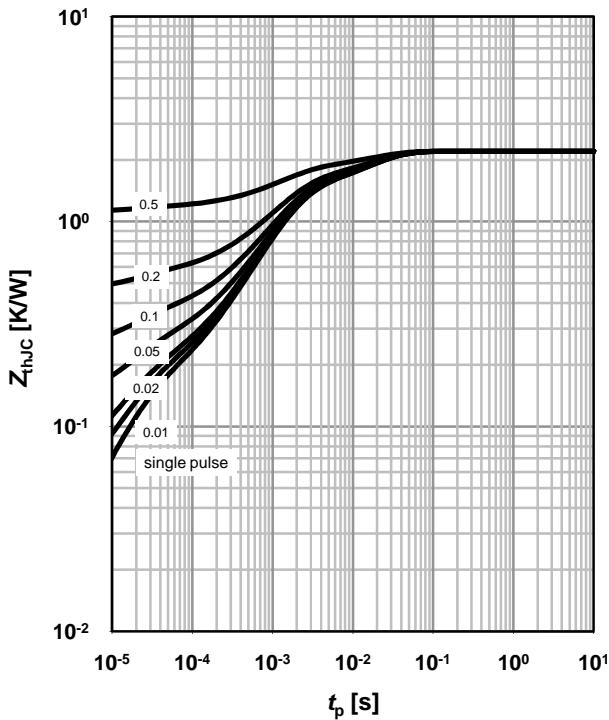
parameter: t_p



3 Max. transient thermal impedance

$Z_{thJC}=f(t_p)$

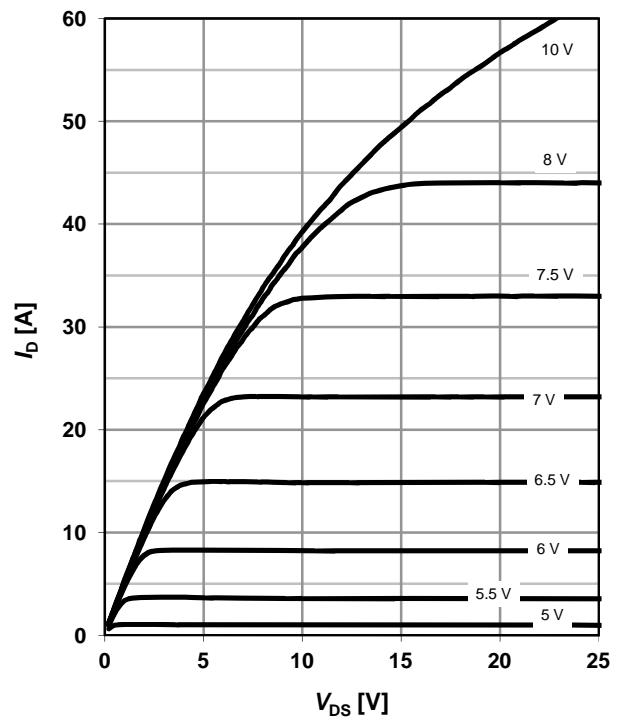
parameter: $D=t_p/T$



4 Typ. output characteristics

$I_D=f(V_{DS}); T_j=25\text{ °C}$

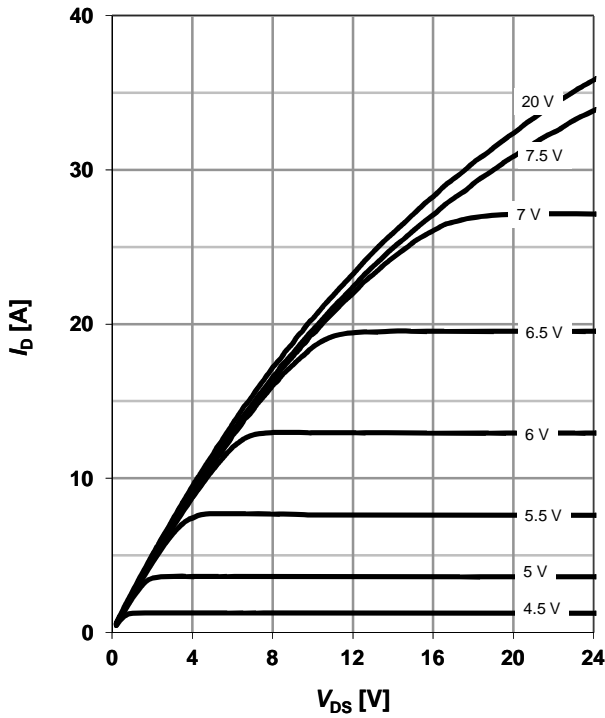
parameter: V_{GS}



5 Typ. output characteristics

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

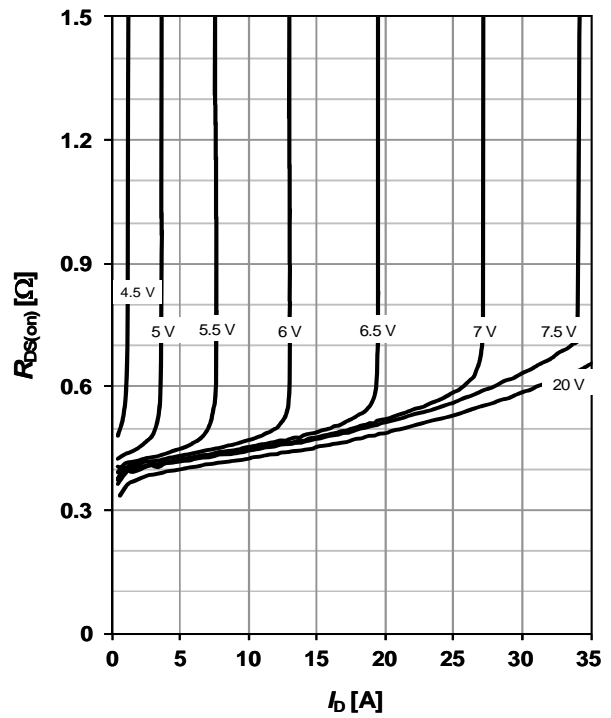
parameter: V_{GS}



6 Typ. drain-source on-state resistance

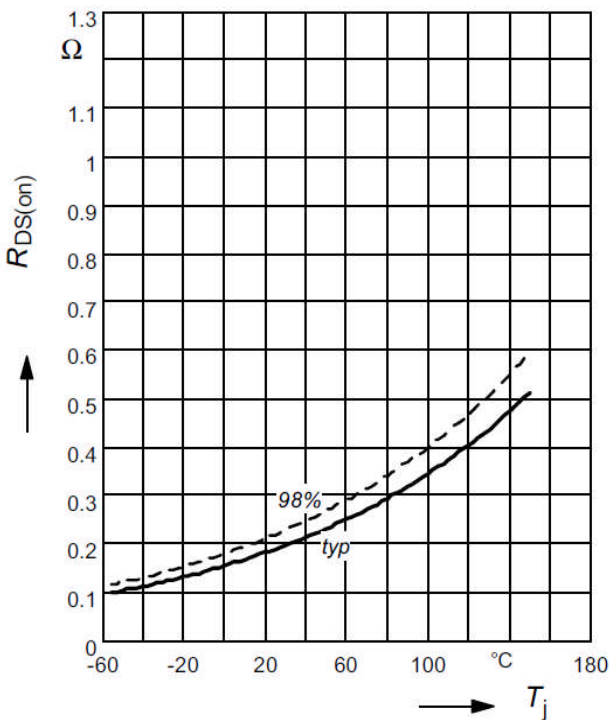
$R_{DS(on)}=f(I_D); T_j=150^\circ\text{C}$

parameter: V_{GS}



7 Drain-source on-state resistance

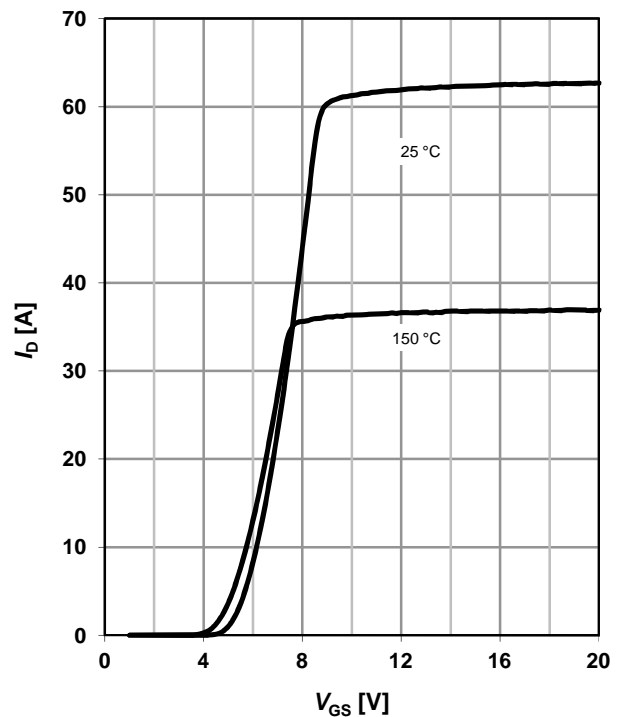
$R_{DS(on)}=f(T_j); I_D=13.1\text{ A}; V_{GS}=10\text{ V}$



8 Typ. transfer characteristics

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

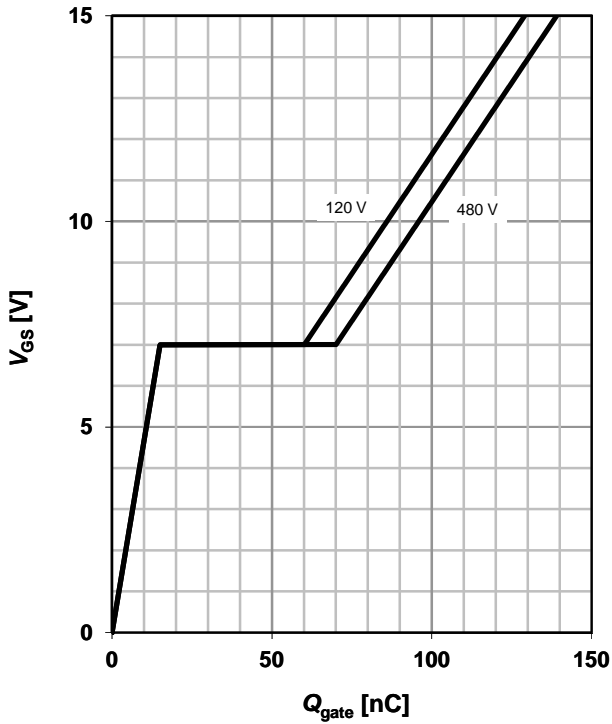
parameter: T_j



9 Typ. gate charge

$V_{GS}=f(Q_{gate}); I_D=20.7\text{ A pulsed}$

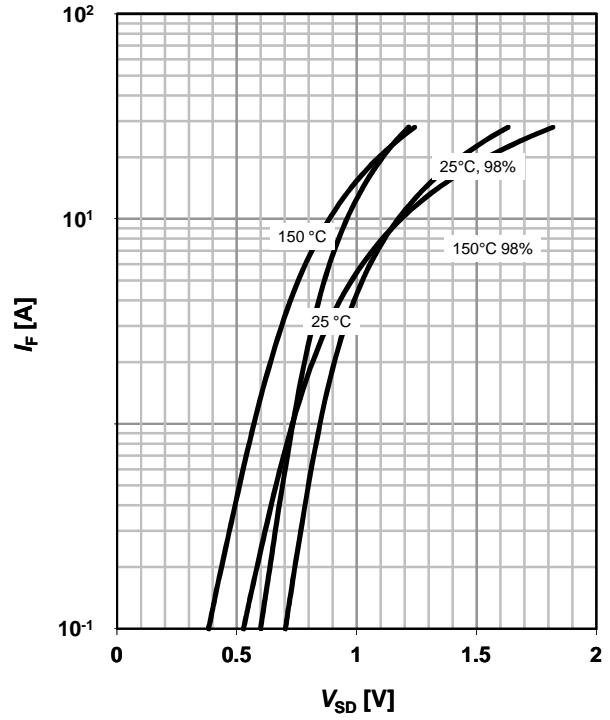
parameter: V_{DD}



10 Forward characteristics of reverse diode

$I_F=f(V_{SD})$

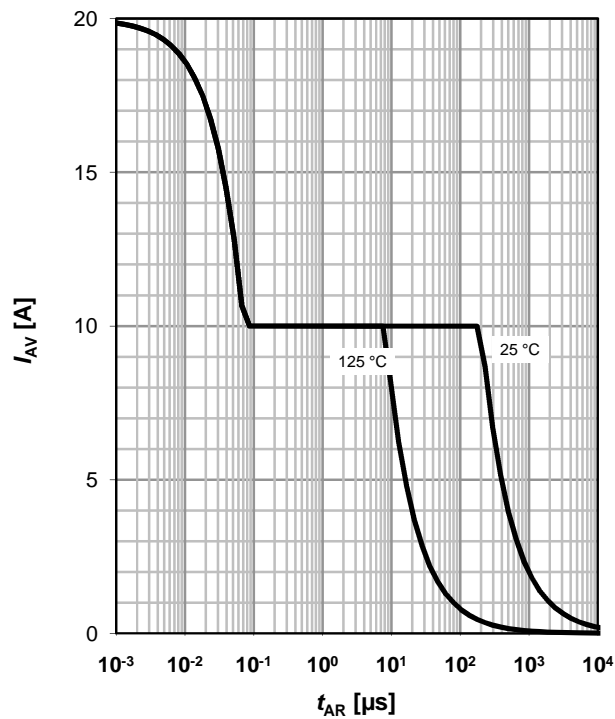
parameter: T_j



11 Avalanche SOA

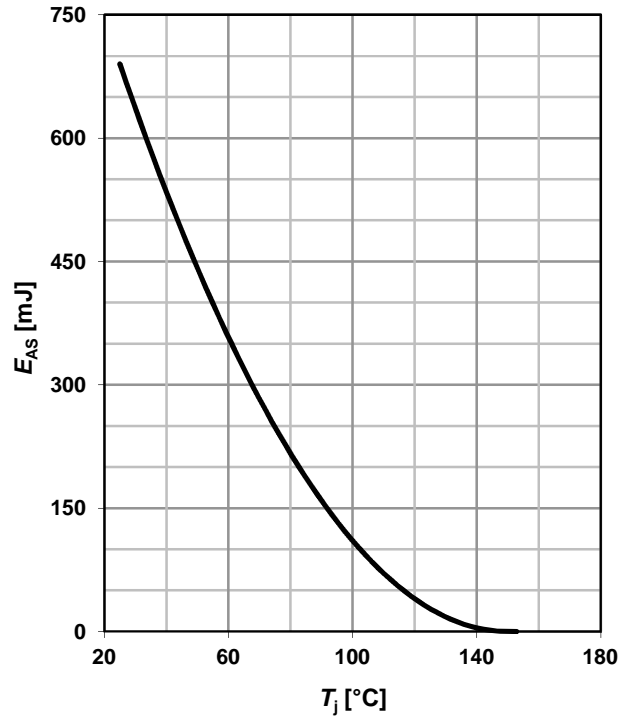
$I_{AR}=f(t_{AR})$

parameter: $T_{j(\text{start})}$



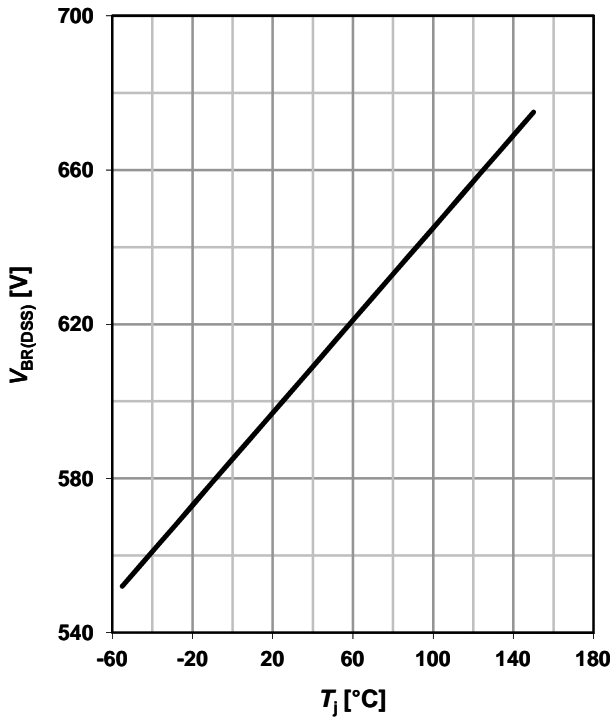
12 Avalanche energy

$E_{AS}=f(T_j); I_D=10\text{ A}; V_{DD}=50\text{ V}$



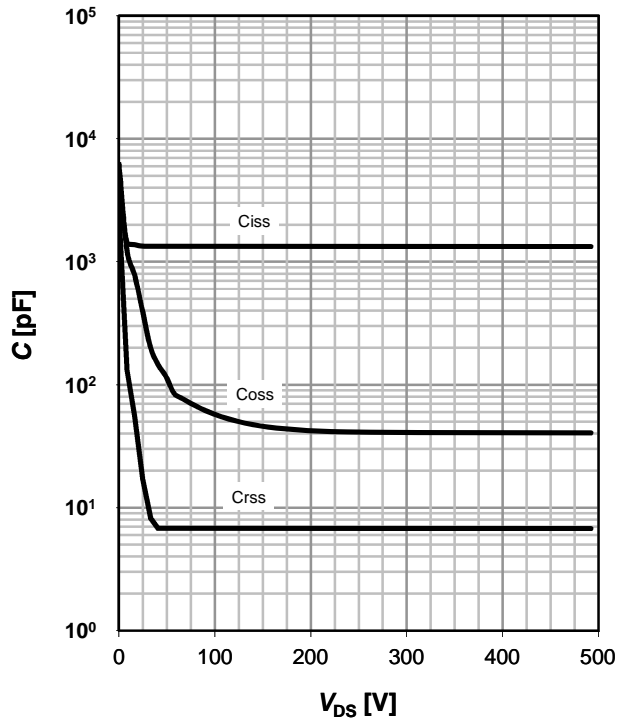
13 Drain-source breakdown voltage

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



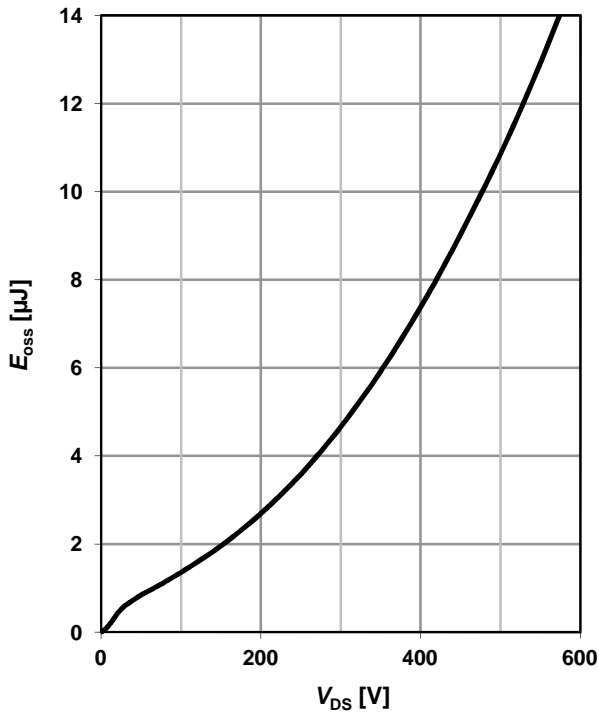
14 Typ. capacitances

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



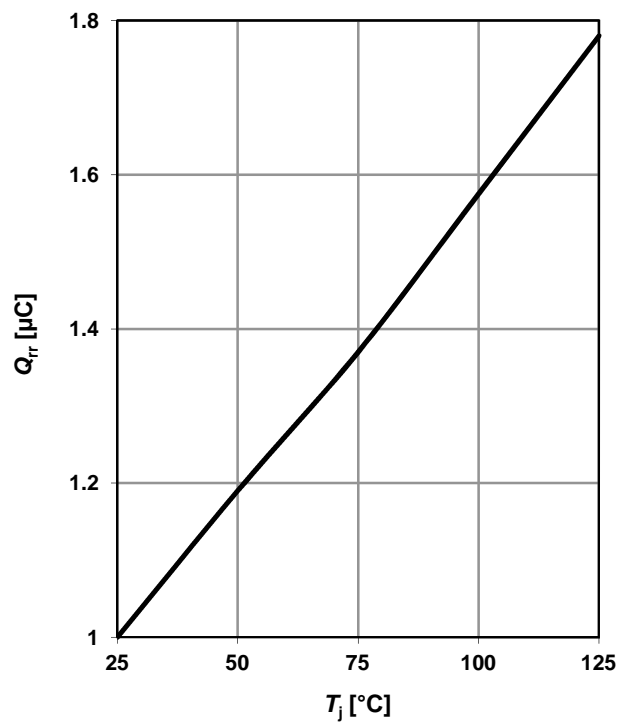
15 Typ. C_{oss} stored energy

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



16 Typ. reverse recovery charge

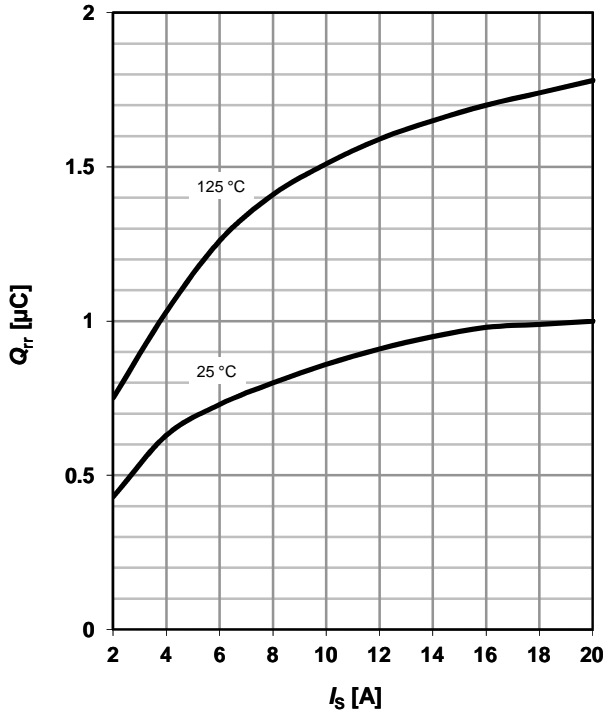
$$Q_{rr} = f(T_j); I_S = 20.7\text{ A}$$



17 Typ. reverse recovery charge

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

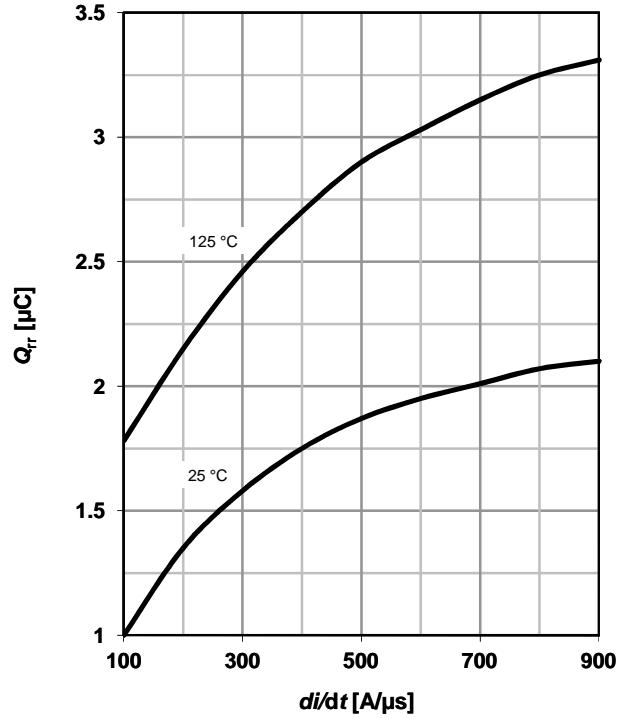
parameter: T_j



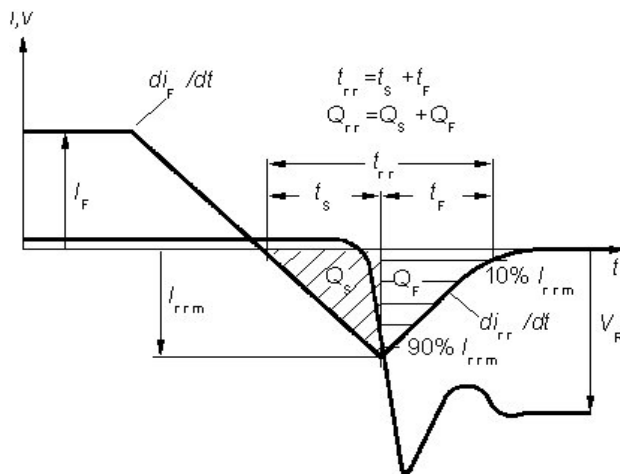
18 Typ. reverse recovery charge

$Q_{rr}=f(di/dt); I_D=20.7 A$

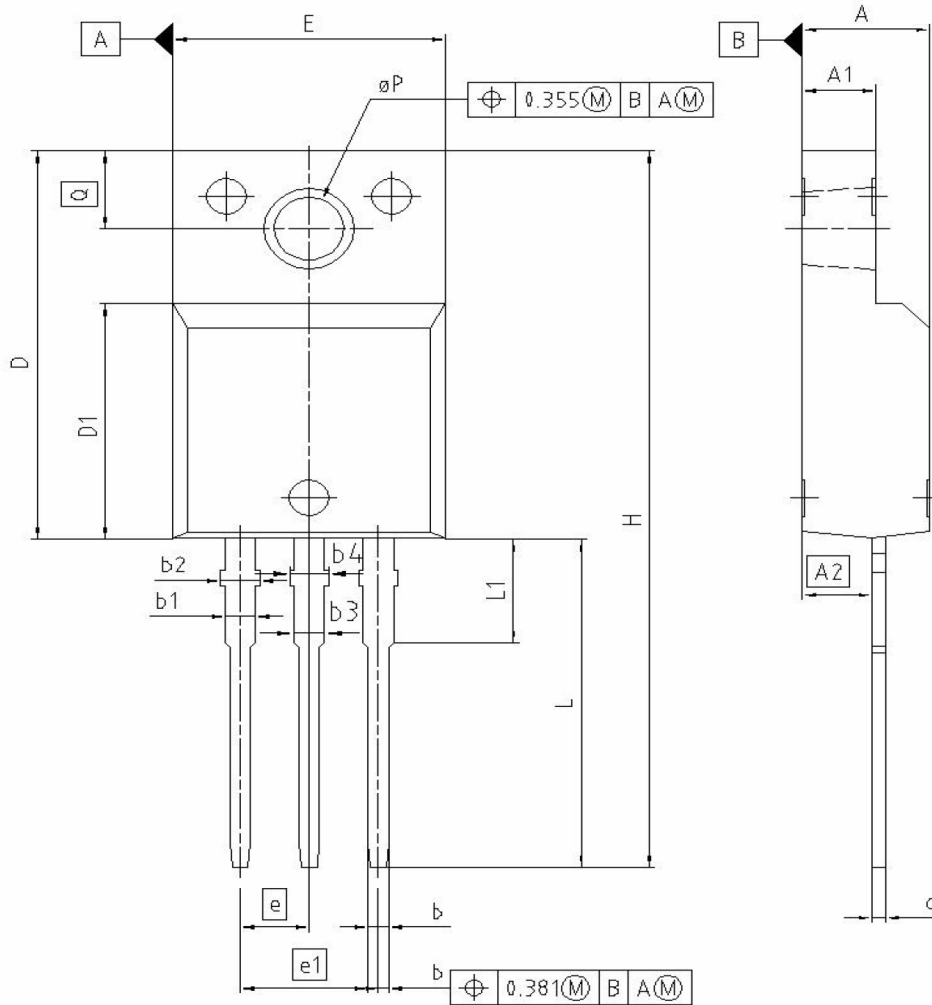
parameter: T_j



Definition of diode switching characteristics



PG-TO220-3-31: Outline



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.55	4.85	0.179	0.191
A1	2.55	2.85	0.100	0.112
A2	2.42	2.72	0.095	0.107
b	0.65	0.85	0.026	0.033
b1	0.95	1.33	0.037	0.052
b2	0.95	1.51	0.037	0.059
b3	0.65	1.33	0.026	0.052
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.85	16.15	0.624	0.636
D1	9.53	9.83	0.375	0.387
E	10.35	10.65	0.407	0.419
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H	29.45	29.75	1.159	1.171
L	13.45	13.75	0.530	0.541
L1	3.15	3.45	0.124	0.136
pP	2.95	3.20	0.116	0.126
Q	3.15	3.50	0.124	0.138

REFERENCE
SCALE
0 2.5 5mm
EUROPEAN PROJECTION
ISSUE DATE
08-01-2007
FILE
TO220_2

Dimensions in mm

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