

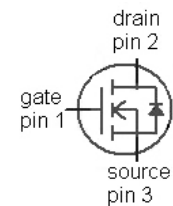
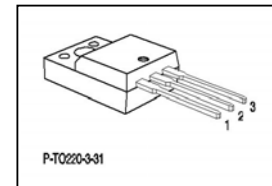
CoolMOS™ Power Transistor
Features

- 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
- Pb-free lead plating; RoHS compliant

Product Summary

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

PG-TO220-3-31



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

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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current ¹⁾	I_D	$T_C=25\text{ °C}$	20.7	A
		$T_C=100\text{ °C}$	13.1	
Pulsed drain current ²⁾	$I_{D,pulse}$	$T_C=25\text{ °C}$	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	$I_D=20.7\text{ A}$, $V_{DS}=480\text{ V}$, $T_j=125\text{ °C}$	80	V/ns
Reverse diode dv/dt	dv/dt	$I_S=20.7\text{ A}$, $V_{DS}=480\text{ V}$, $T_j=125\text{ °C}$	40	V/ns
Maximum diode commutation speed	di/dt	$T_j=125\text{ °C}$	900	A/ μ s
Gate source voltage	V_{GS}	static	± 20	V
		AC ($f > 1\text{ Hz}$)	± 30	
Power dissipation	P_{tot}	$T_C=25\text{ °C}$	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	$f=1\text{ MHz}$, 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 $P_{AV}=E_{AR} \cdot f$.

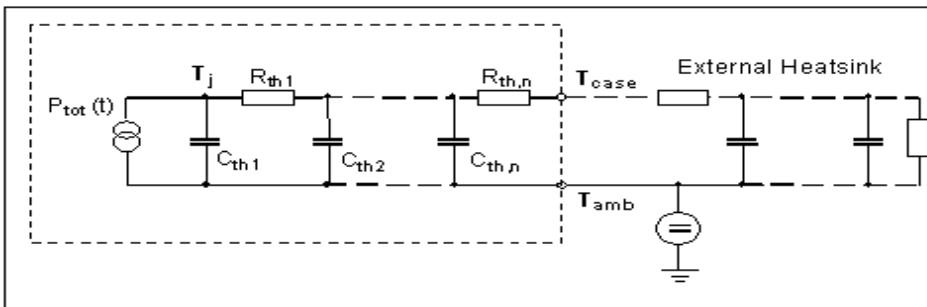
⁴⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

Typical Transient Thermal Characteristics

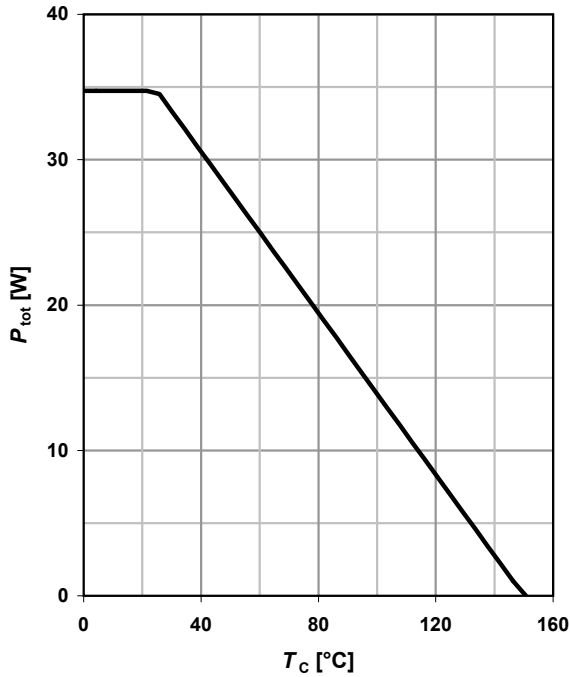
Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
R_{th1}	0.00862	K/W	C_{th1}	0.000205	Ws/K
R_{th2}	0.0471		C_{th2}	0.00198	
R_{th3}	0.119		C_{th3}	0.0068	
R_{th4}	0.476		C_{th4}	0.0482	
R_{th5}	1.57		C_{th5}	0.957	
			C_{th6}	0.1	



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

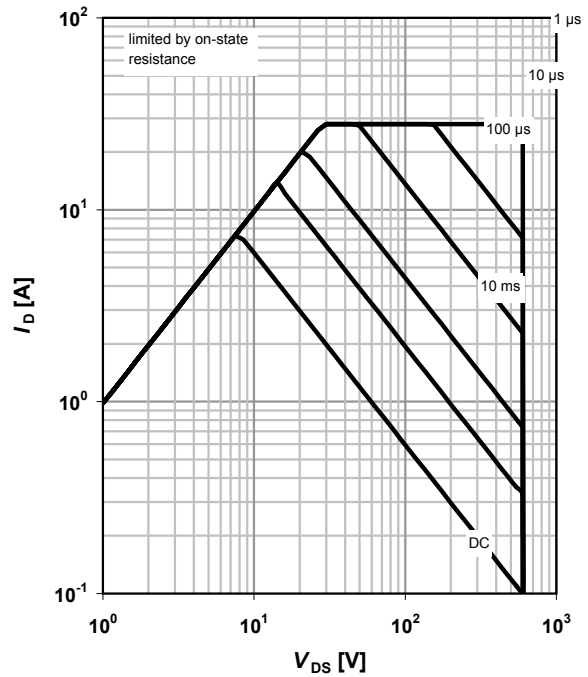
$$P_{TOT} = f(T_C)$$



2 Safe operating area

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

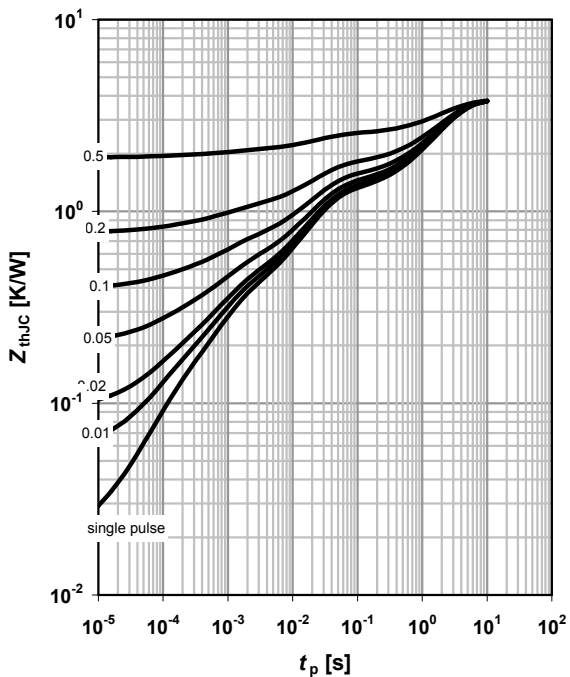
parameter: t_p



3 Max. transient thermal impedance

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

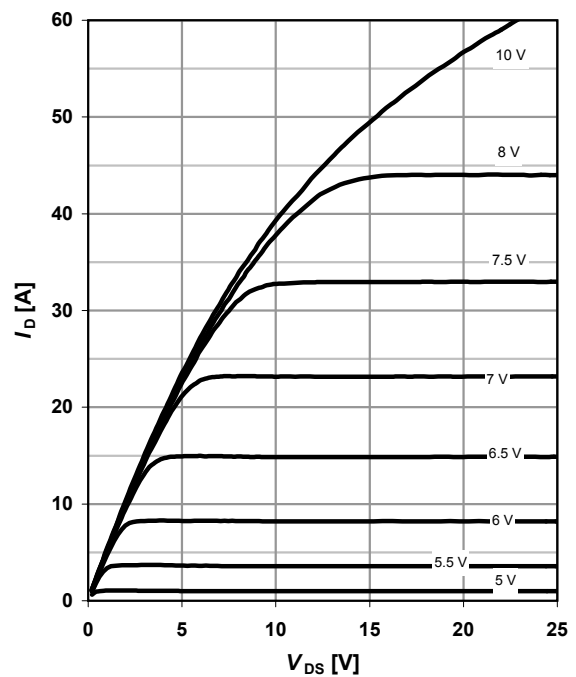
parameter: $D = t_p / T$



4 Typ. output characteristics

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

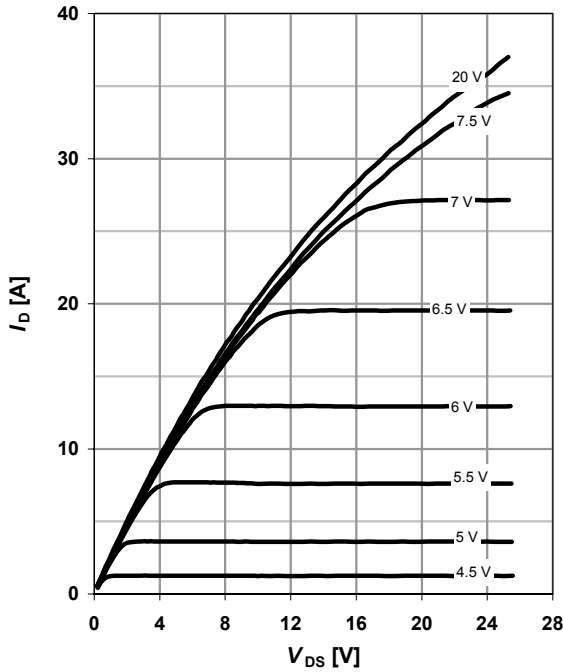
parameter: V_{GS}



5 Typ. output characteristics

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

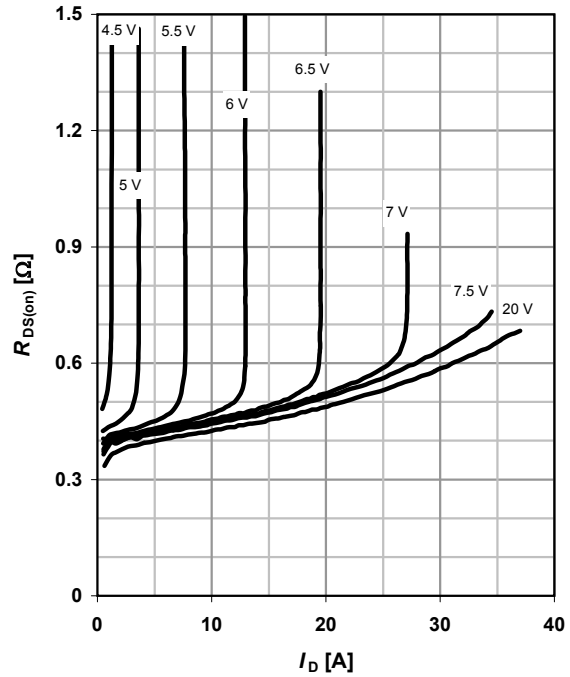
parameter: V_{GS}



6 Typ. drain-source on-state resistance

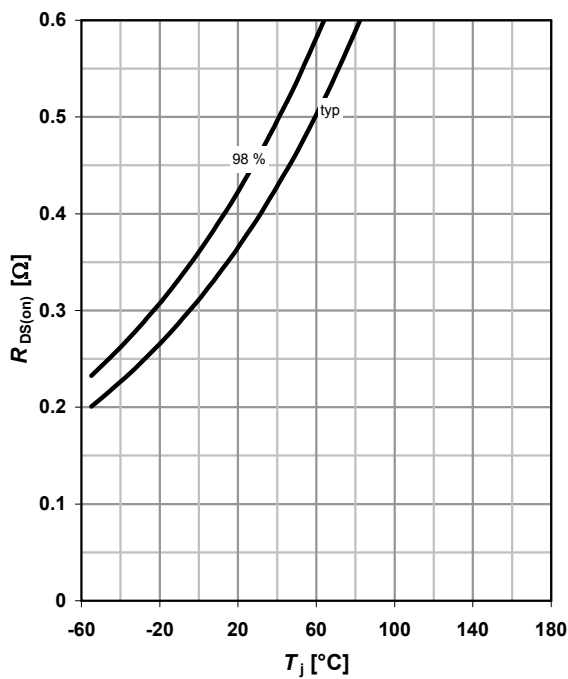
$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$

parameter: V_{GS}



7 Drain-source on-state resistance

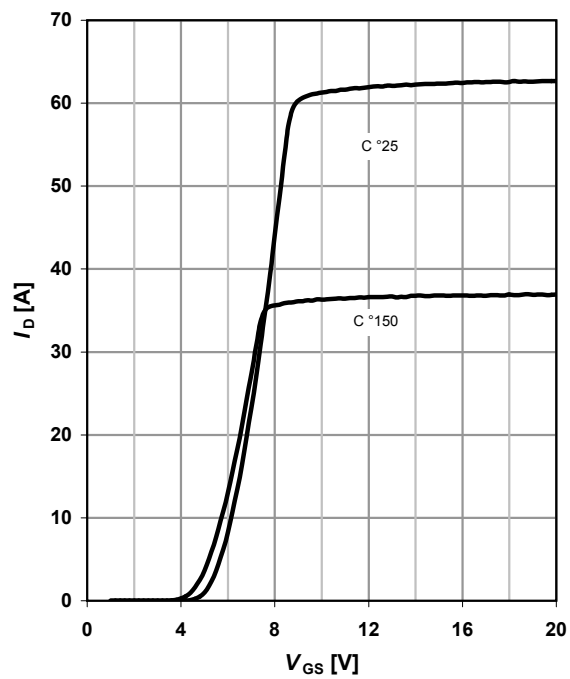
$R_{DS(on)} = f(T_j); I_D = 13.1\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

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

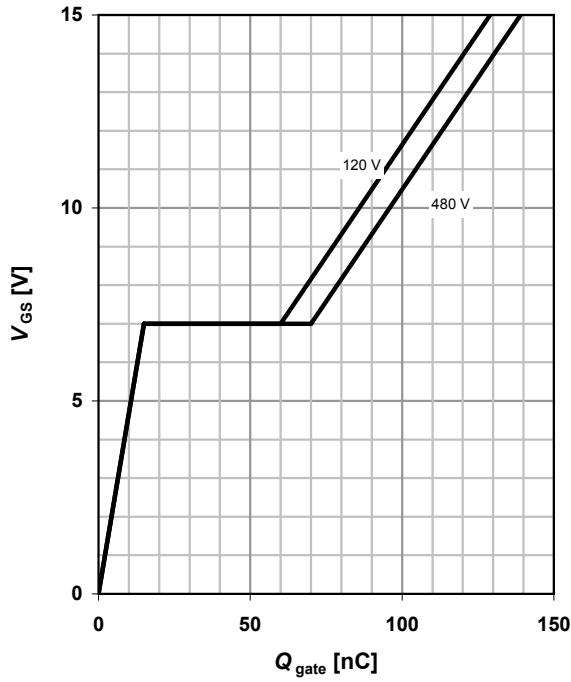
parameter: T_j



9 Typ. gate charge

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

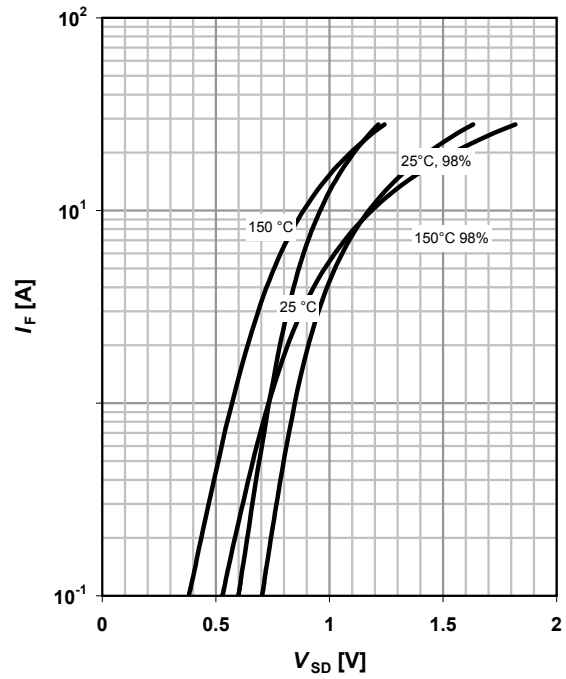
parameter: V_{DD}



10 Forward characteristics of reverse diode

$I_F=f(V_{SD})$

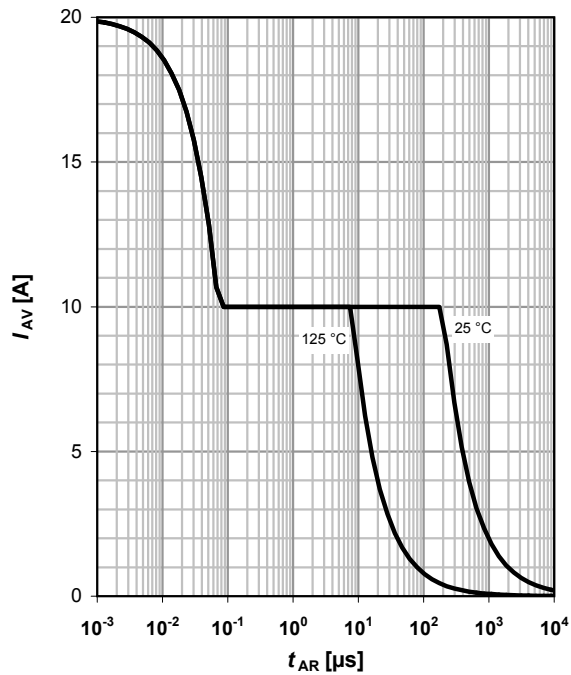
parameter: T_j



11 Avalanche SOA

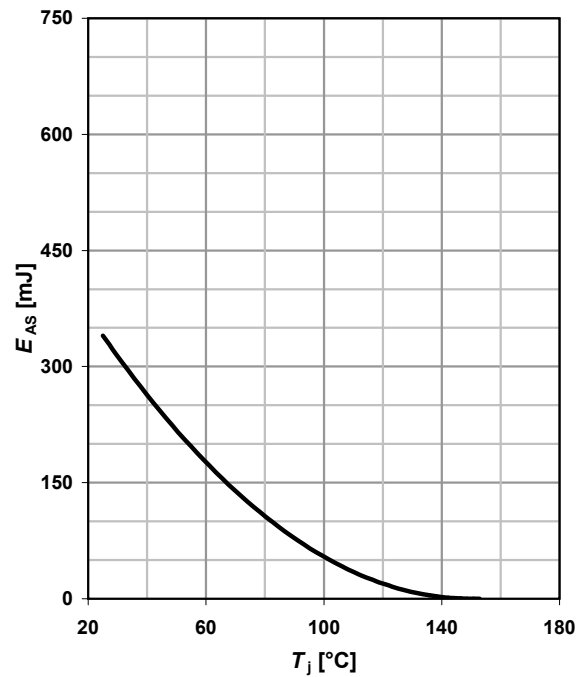
$I_{AR}=f(t_{AR})$

parameter: $T_{j(start)}$



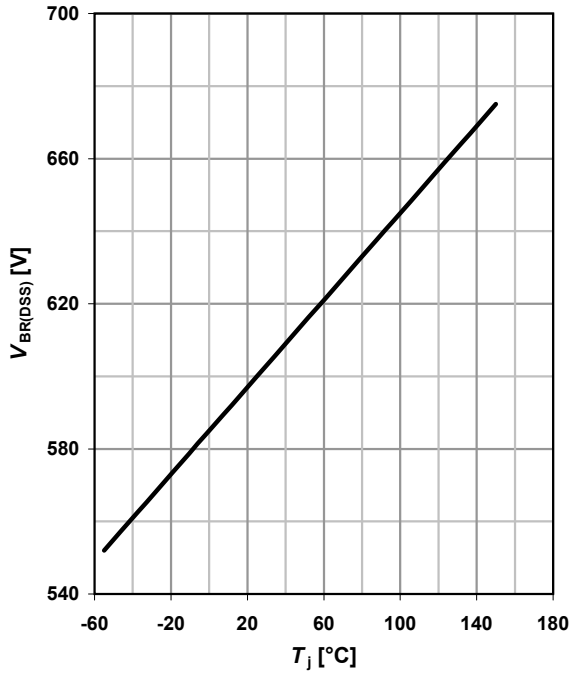
12 Avalanche energy

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



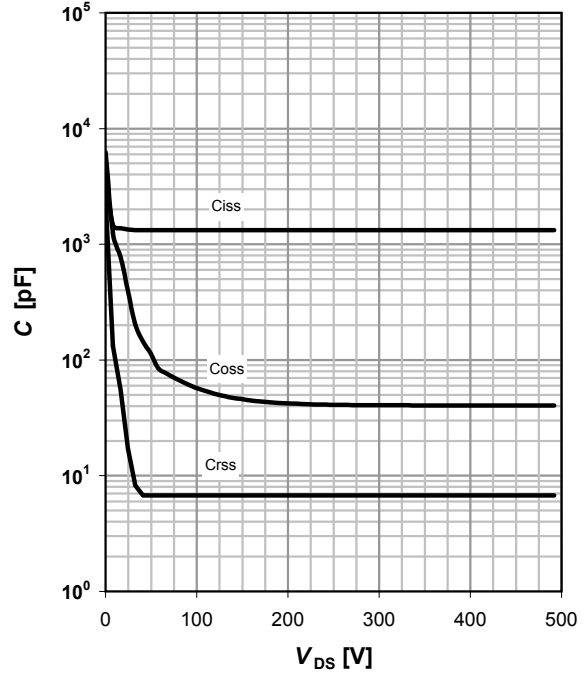
13 Drain-source breakdown voltage

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



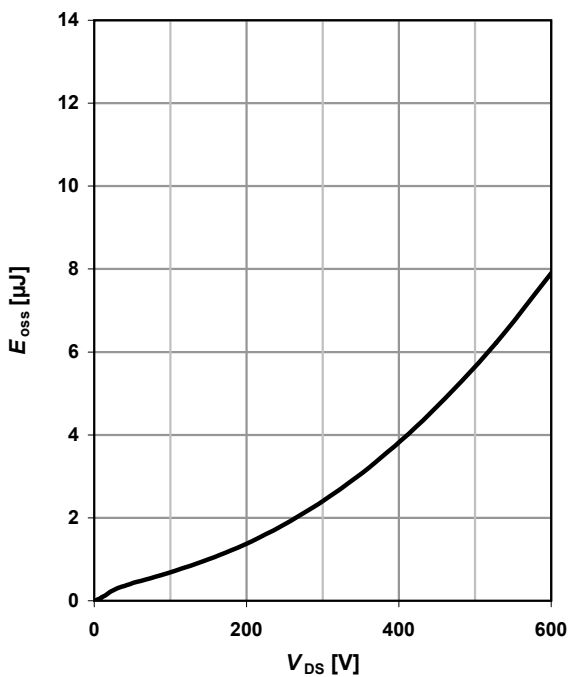
14 Typ. capacitances

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



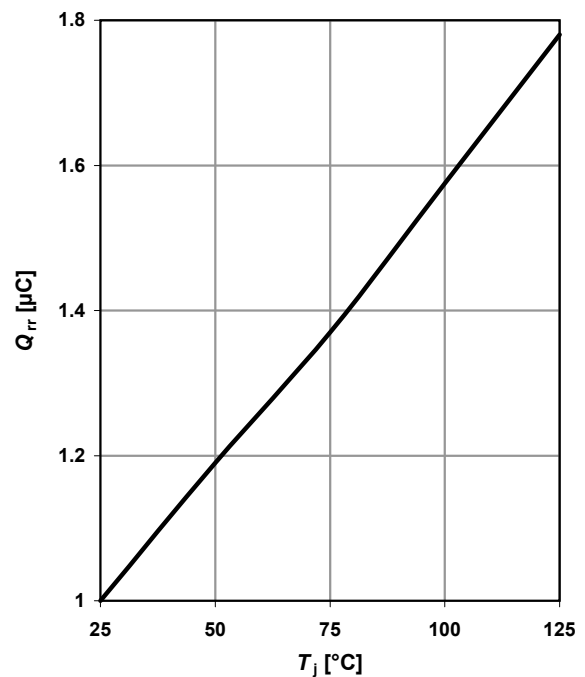
15 Typ. C_{oss} stored energy

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



16 Typ. reverse recovery charge

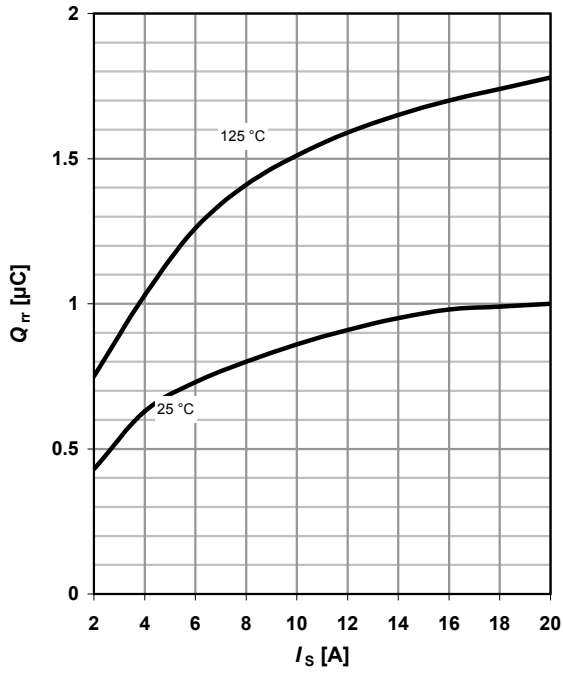
$Q_{rr} = f(T_j); I_S = 20.7\text{ A}$



17 Typ. reverse recovery charge

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

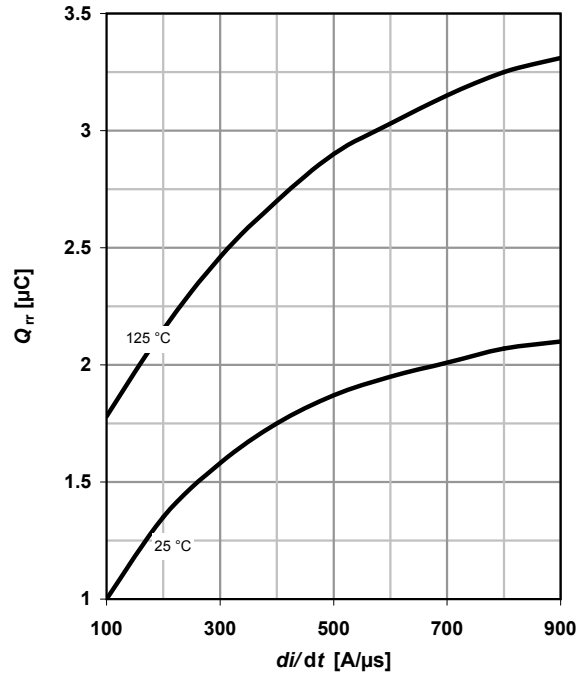
parameter: T_j



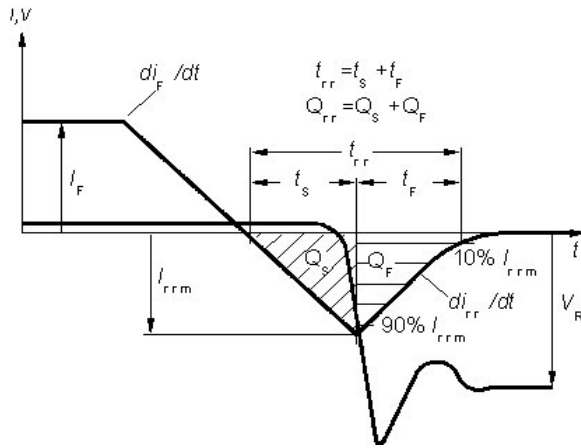
18 Typ. reverse recovery charge

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

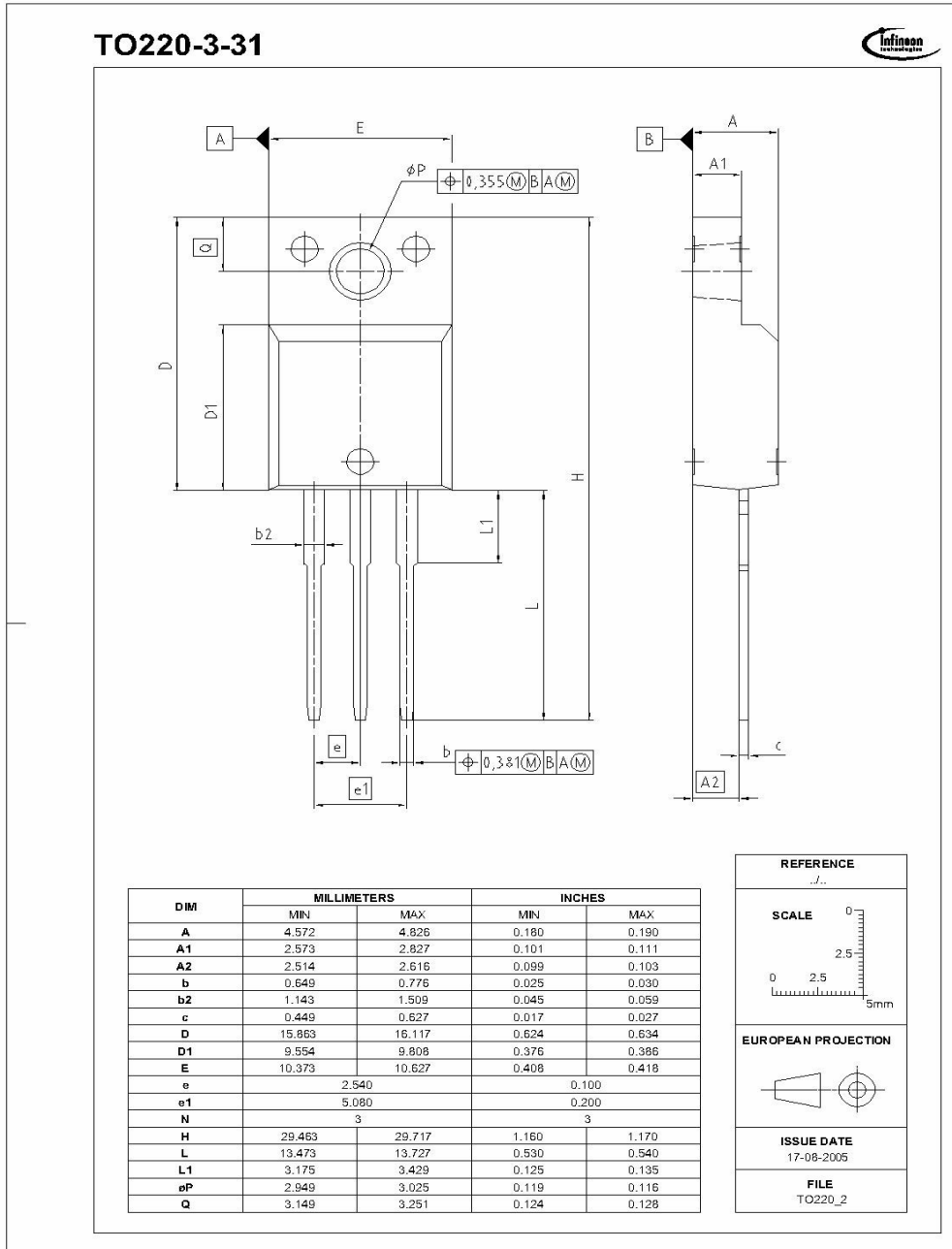
parameter: T_j



Definition of diode switching characteristics



PG-TO220-3-31: Outline



Dimensions in mm

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