

**CoolMOS™ Power Transistor**
**Features**

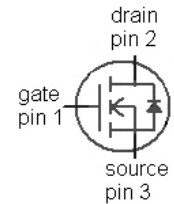
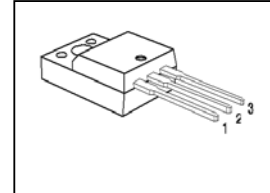
- Intrinsic fast-recovery body diode
- Extremely low reverse recovery charge
- Ultra low gate charge
- Extreme  $dv/dt$  rated
- High peak current capability
- Qualified according to JEDEC<sup>1)</sup> for target applications

**CoolMOS CFD designed for:**

- Softswitching PWM Stages
- LCD & CRT TV

**Product Summary**

$V_{DS} @ T_{jmax}$	650	V
$R_{DS(on),max}$	0.330	$\Omega$
$I_D$	13.4	A

**PG-TO220FP**


Type	Package	Marking
SPA15N60CFD	PG-TO220FP	15N60CFD

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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current <sup>2)</sup>	$I_D$	$T_C=25\text{ }^\circ\text{C}$	13.4	A
		$T_C=100\text{ }^\circ\text{C}$	8.4	
Pulsed drain current <sup>3)</sup>	$I_{D,pulse}$	$T_C=25\text{ }^\circ\text{C}$	33	
Avalanche energy, single pulse	$E_{AS}$	$I_D=6.7\text{ A}$ , $V_{DD}=50\text{ V}$	460	mJ
Avalanche energy, repetitive <sup>3),4)</sup>	$E_{AR}$	$I_D=13.4\text{ A}$ , $V_{DD}=50\text{ V}$	0.8	
Avalanche current, repetitive <sup>3),4)</sup>	$I_{AR}$		13.4	A
Drain source voltage slope	$dv/dt$	$I_D=13.4\text{ A}$ , $V_{DS}=480\text{ V}$ , $T_j=125\text{ }^\circ\text{C}$	80	V/ns
Reverse diode $dv/dt$	$dv/dt$	$I_S=13.4\text{ A}$ , $V_{DS}=480\text{ V}$ ,	40	V/ns
Maximum diode commutation speed	$di/dt$	$T_j=125\text{ }^\circ\text{C}$	600	
Gate source voltage	$V_{GS}$	static	$\pm 20$	V
		AC ( $f > 1\text{ Hz}$ )	$\pm 30$	
Power dissipation	$P_{tot}$	$T_C=25\text{ }^\circ\text{C}$	34	W
Operating and storage temperature	$T_j, T_{stg}$		-55 ... 150	$^\circ\text{C}$
Mounting torque		M2.5 screws	50	Ncm

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

**Thermal characteristics**

Thermal resistance, junction - case	$R_{thJC}$		-	-	3.7	K/W
Thermal resistance, junction - ambient	$R_{thJA}$	leaded	-	-	62	
Soldering temperature, wave soldering only allowed at leads	$T_{sold}$	1.6 mm (0.063 in.) from case for 10 s	-	-	260	°C

**Electrical characteristics, at  $T_j=25\text{ }^\circ\text{C}$ , 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	$V_{(BR)DS}$	$V_{GS}=0\text{ V}, I_D=13.4\text{ A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=750\text{ }\mu\text{A}$	3	4	5	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ }^\circ\text{C}$	-	1.4	-	$\mu\text{A}$
		$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ }^\circ\text{C}$	-	1200	-	
Gate-source leakage current	$I_{GSS}$	$V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}, I_D=9.4\text{ A}, T_j=25\text{ }^\circ\text{C}$	-	0.28	0.33	$\Omega$
		$V_{GS}=10\text{ V}, I_D=9.4\text{ A}, T_j=150\text{ }^\circ\text{C}$	-	0.78	-	
Gate resistance	$R_G$	$f=1\text{ MHz}$ , open drain	-	1.3	-	
Transconductance	$g_{fs}$	$ V_{DS} >2 I_D R_{DS(on)max}, I_D=9.4\text{ A}$	-	8	-	S

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

**Dynamic characteristics**

Input capacitance	$C_{iss}$	$V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$ $f=1\text{ MHz}$	-	1820	-	pF
Output capacitance	$C_{oss}$		-	520	-	
Reverse transfer capacitance	$C_{rss}$		-	21	-	
Effective output capacitance, energy related <sup>5)</sup>	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	61	-	
Effective output capacitance, time related <sup>6)</sup>	$C_{o(tr)}$		-	110	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=13.4\text{ A},$ $R_G=3.6\ \Omega$	-	43	-	ns
Rise time	$t_r$		-	24	-	
Turn-off delay time	$t_{d(off)}$		-	47	-	
Fall time	$t_f$		-	5	-	

**Gate Charge Characteristics**

Gate to source charge	$Q_{gs}$	$V_{DD}=480\text{ V},$ $I_D=13.4\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	11	-	nC
Gate to drain charge	$Q_{gd}$		-	38	-	
Gate charge total	$Q_g$		-	63	84	
Gate plateau voltage	$V_{plateau}$		-	7.3	-	V

<sup>1)</sup> J-STD20 and JESD22

<sup>2)</sup> Limited only by maximum temperature

<sup>3)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>4)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

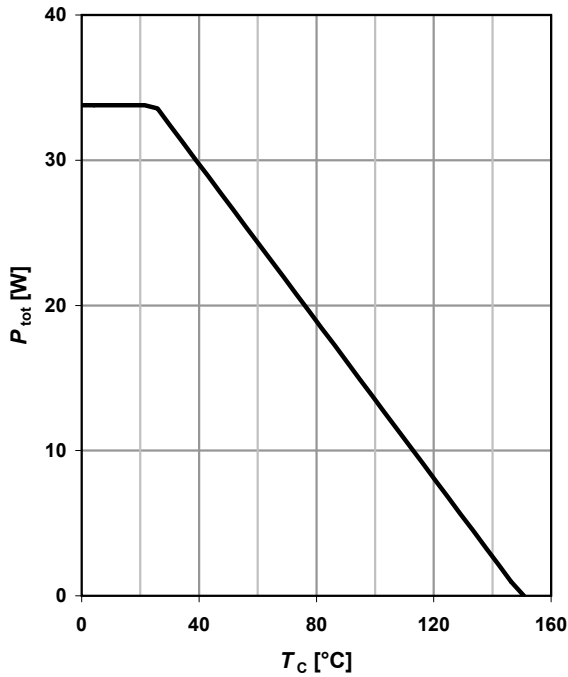
<sup>5)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>6)</sup>  $C_{o(tr)}$  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.	
<b>Reverse Diode</b>						
Diode continuous forward current <sup>2)</sup>	$I_S$	$T_C=25\text{ °C}$	-	-	13.4	A
Diode pulse current <sup>3)</sup>	$I_{S,pulse}$		-	-	33	
Diode forward voltage	$V_{SD}$	$V_{GS}=0\text{ V}, I_F=I_S,$ $T_j=25\text{ °C}$	-	1.0	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=480\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$	-	147	-	ns
Reverse recovery charge	$Q_{rr}$		-	1	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	12	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$	$T_j=25\text{ °C}$	-	1200	-	$\text{A}/\mu\text{s}$

**1 Power dissipation**

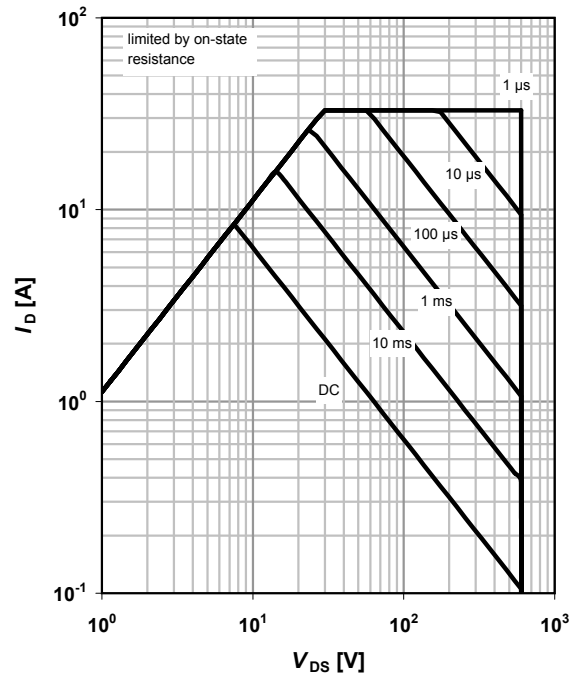
$$P_{tot} = f(T_C)$$



**2 Safe operating area**

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

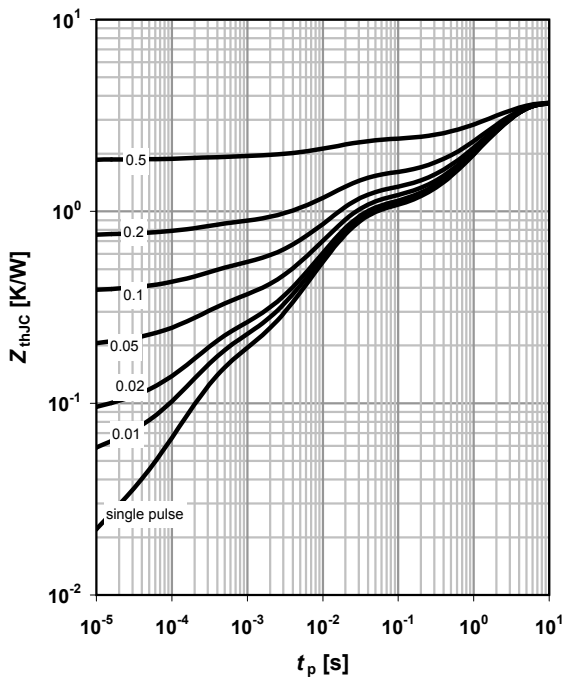
parameter:  $t_p$



**3 Max. transient thermal impedance**

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

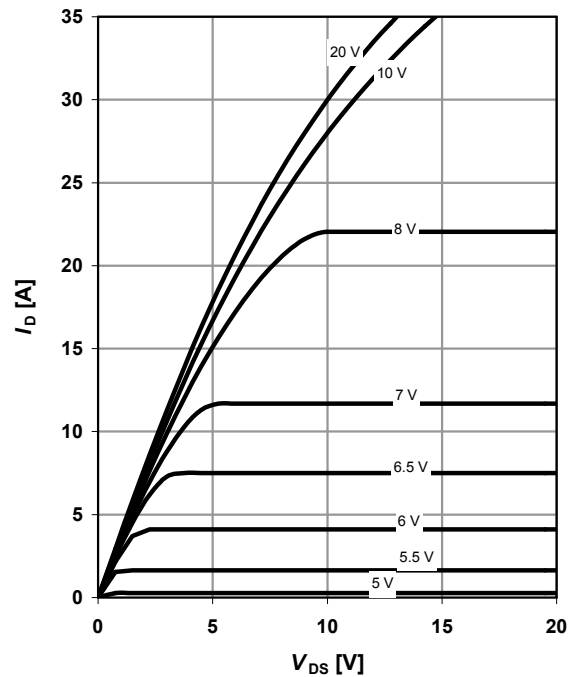
parameter:  $D = t_p / T$



**4 Typ. output characteristics**

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

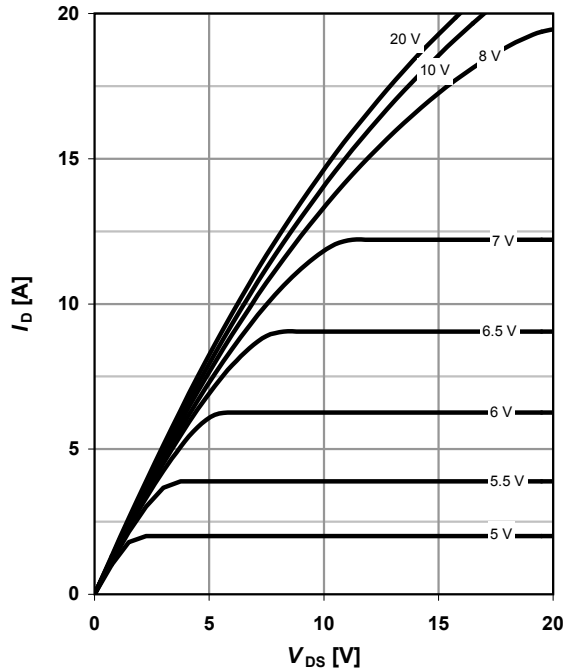
parameter:  $V_{GS}$



**5 Typ. output characteristics**

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

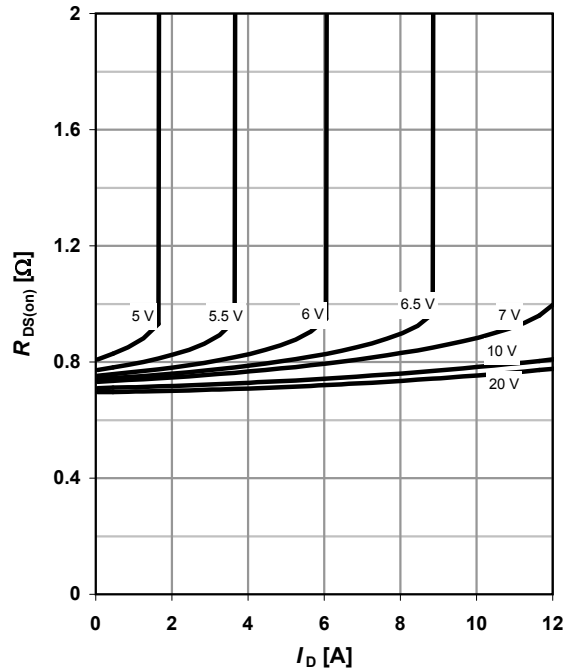
parameter:  $V_{GS}$



**6 Typ. drain-source on-state resistance**

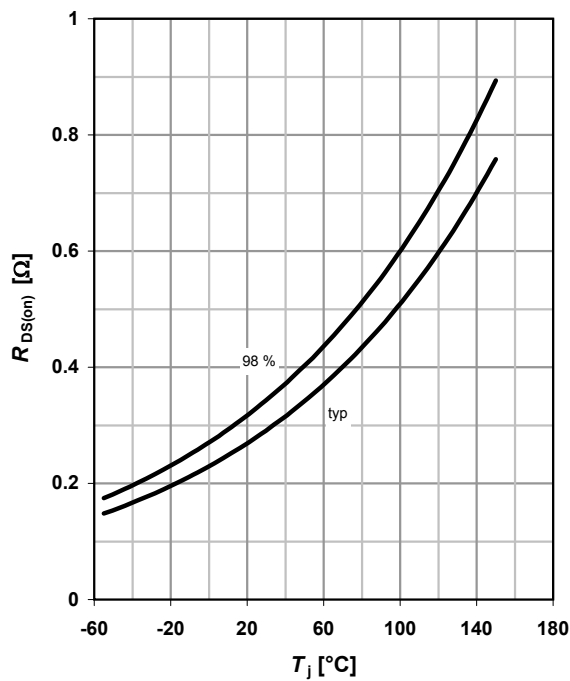
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter:  $V_{GS}$



**7 Drain-source on-state resistance**

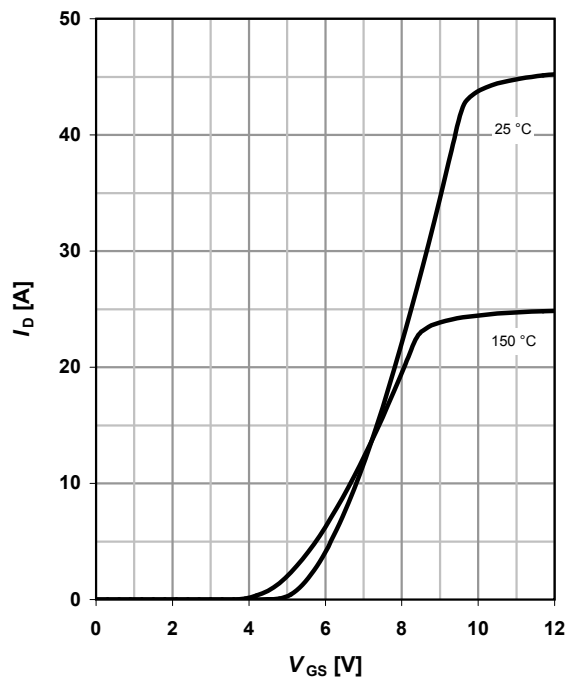
$R_{DS(on)} = f(T_j); I_D = 9.4\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

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

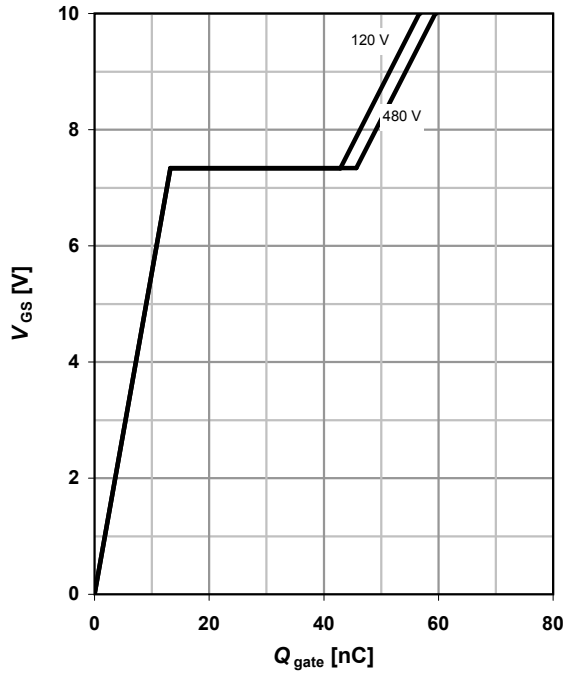
parameter:  $T_j$



**9 Typ. gate charge**

$V_{GS}=f(Q_{gate}); I_D=13.4 \text{ A pulsed}$

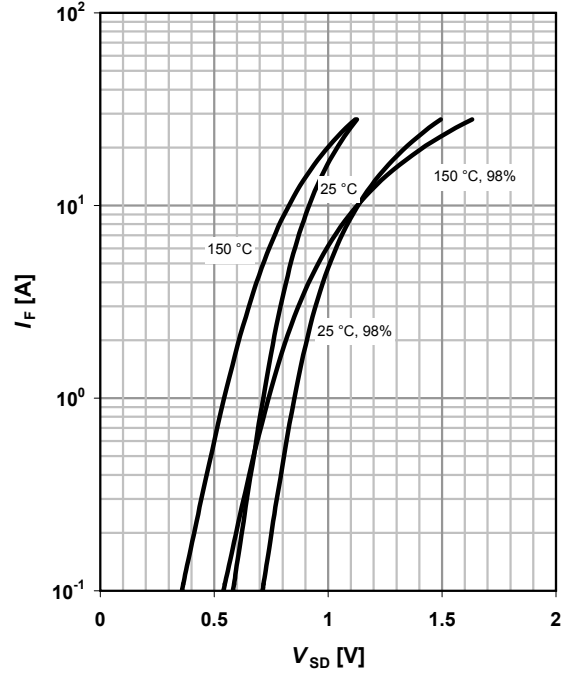
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

$I_F=f(V_{SD})$

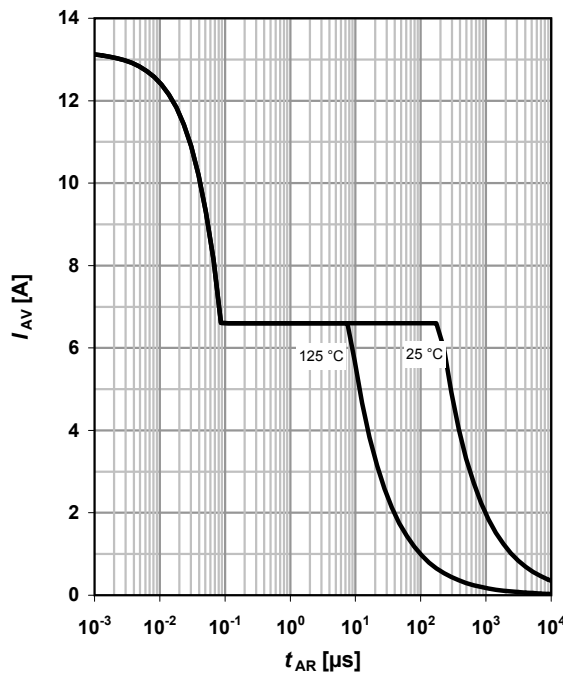
parameter:  $T_j$



**11 Avalanche SOA**

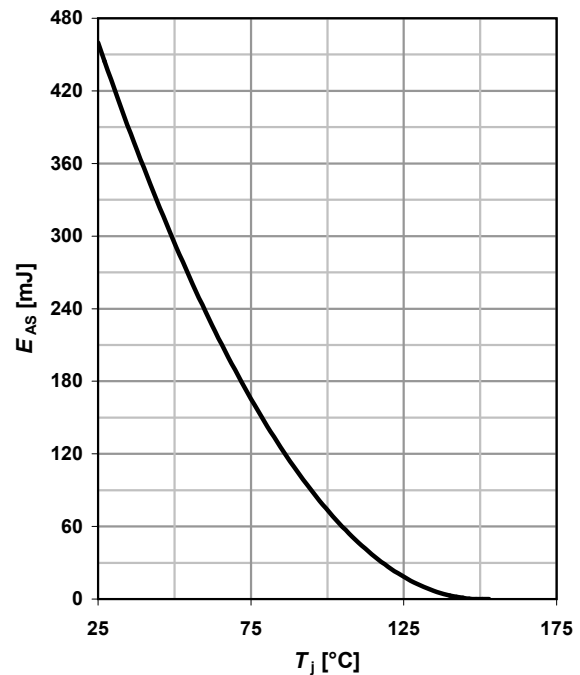
$I_{AR}=f(t_{AR})$

parameter:  $T_{j(start)}$



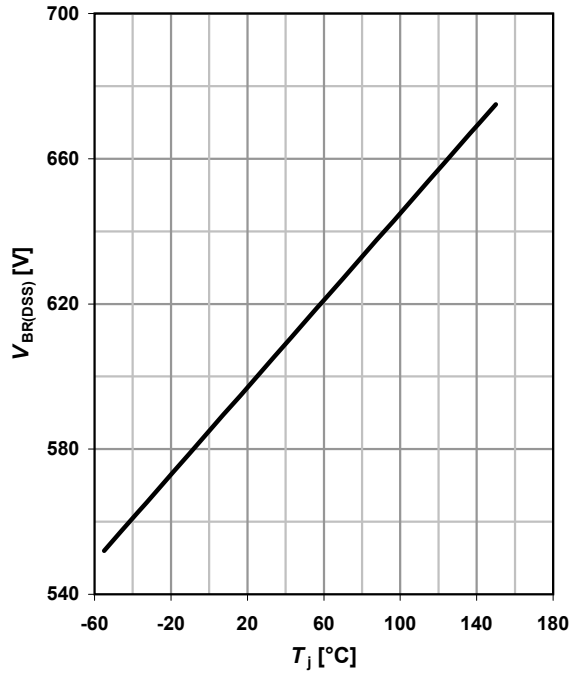
**12 Avalanche energy**

$E_{AS}=f(T_j); I_D=6.7 \text{ A}; V_{DD}=50 \text{ V}$



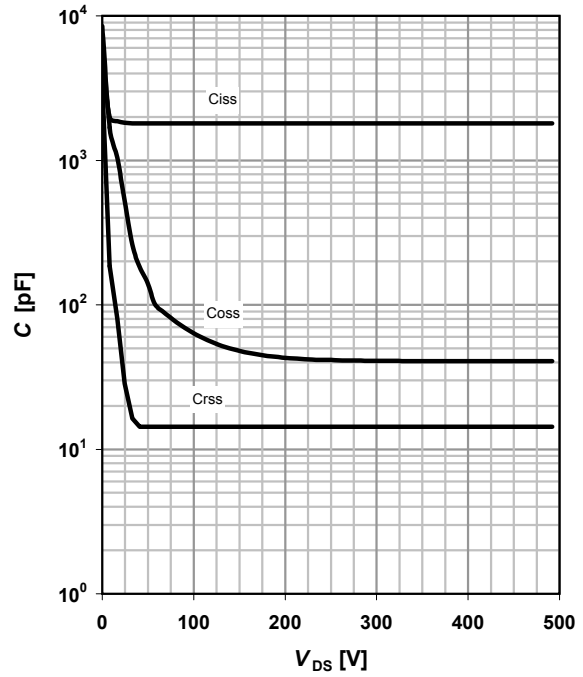
**13 Drain-source breakdown voltage**

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



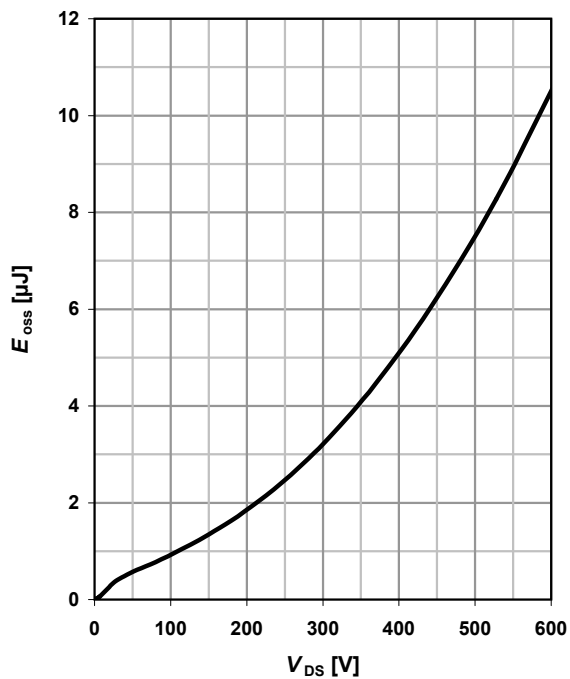
**14 Typ. capacitances**

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



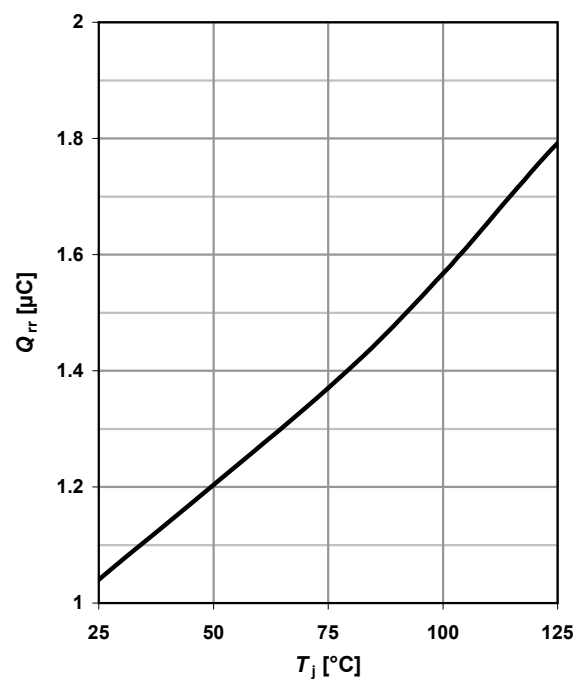
**15 Typ.  $C_{oss}$  stored energy**

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



**16 Typ. reverse recovery charge**

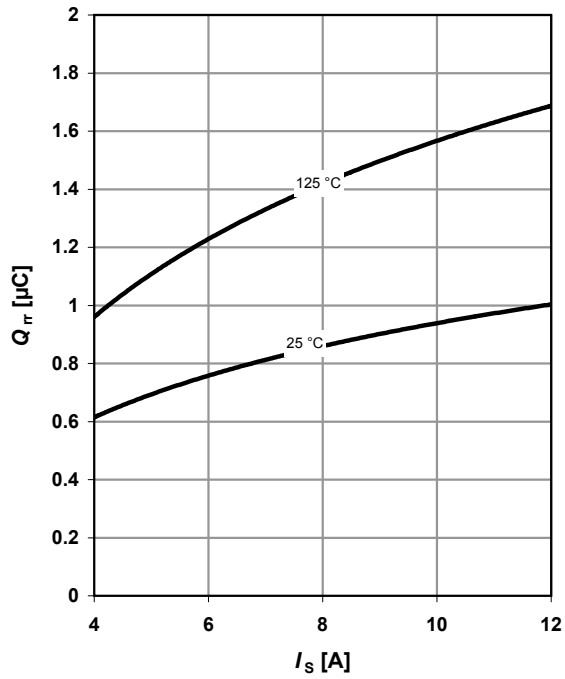
$$Q_{rr} = f(T_j); \text{parameter: } I_D = 13.4 \text{ A}$$





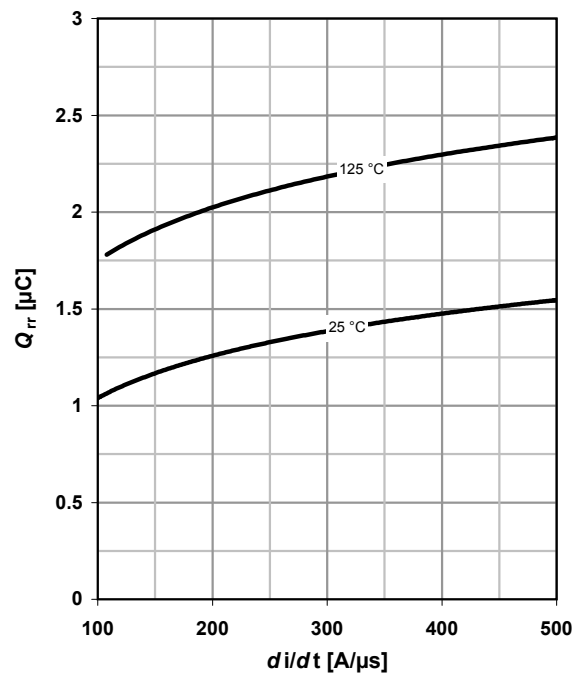
17 Typ. reverse recovery charge

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

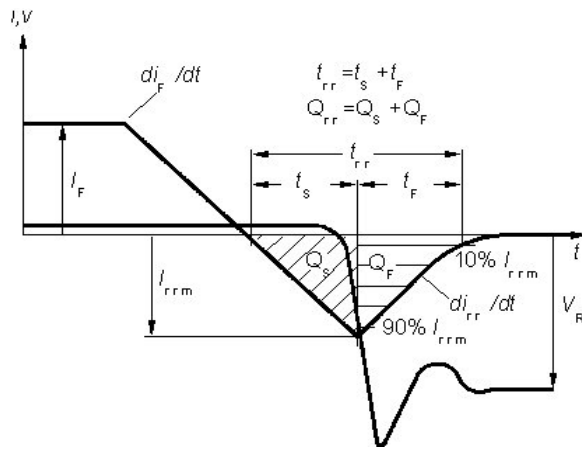


18 Typ. reverse recovery charge

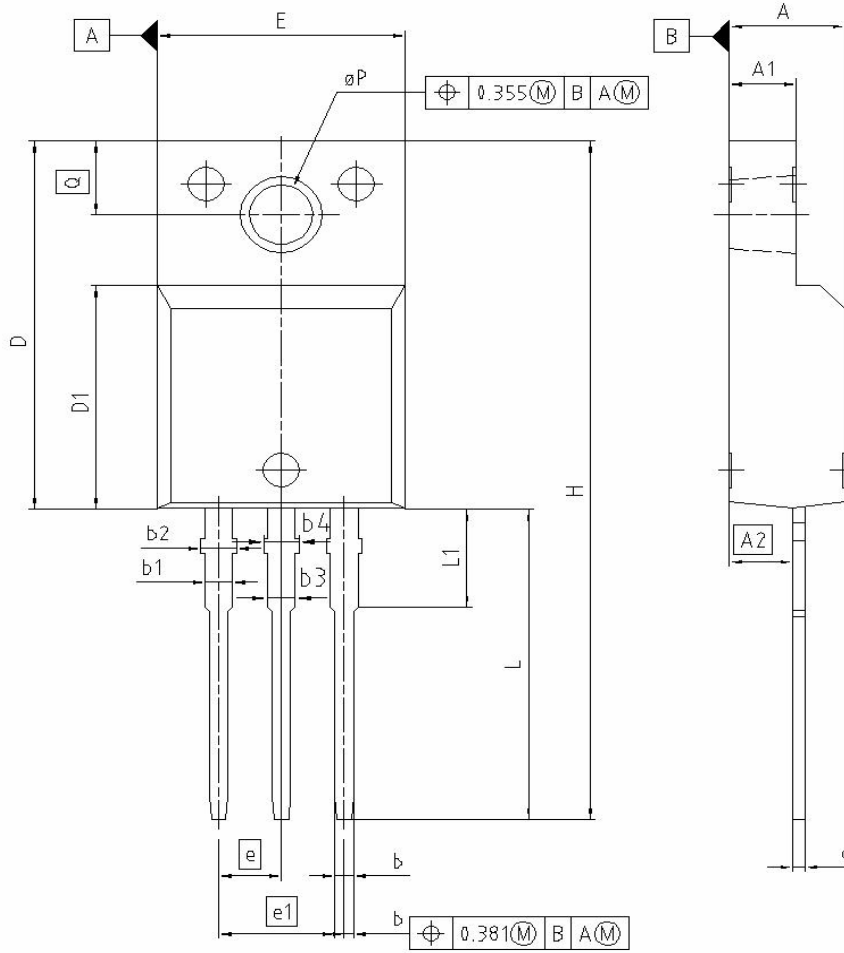
$Q_{rr}=f(di/dt)$ ; parameter:  $I_D=13.4\text{ A}$



Definition of diode switching characteristics



PG-TO-220-3--31; -3-111: Outlines/Fully isolated package (2500VAC; 1minute)

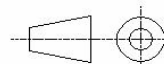


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.55	4.85	0.179	0.191
A1	2.55	2.85	0.100	0.112
A2	2.42	2.72	0.095	0.107
b	0.65	0.85	0.026	0.033
b1	0.95	1.33	0.037	0.052
b2	0.95	1.51	0.037	0.059
b3	0.65	1.33	0.026	0.052
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.85	16.15	0.624	0.636
D1	9.53	9.83	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
øP	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/ inches

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