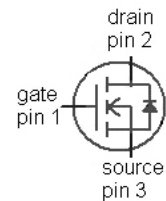
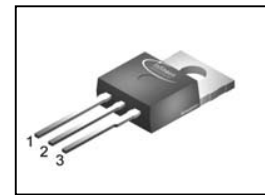


CoolMOS™ Power Transistor
Features

- Intrinsic fast-recovery body diode
- Extremely low reverse recovery charge
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified for industrial grade applications according to JEDEC¹⁾
- **CoolMOS CFD designed for**
 - Softswitching PWM Stages
 - LCD & CRT TV

Product Summary

$V_{DS} @ T_{jmax}$	650	V
$R_{DS(on),max}$	0.185	Ω
I_D	21.7	A

PG-TO220


Type	Package	Marking
SPP24N60CFD	PG-TO220	24N60CFD

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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current	I_D	$T_C=25^\circ\text{C}$	21.7	A
		$T_C=100^\circ\text{C}$	13.7	
Pulsed drain current ²⁾	$I_{D,pulse}$	$T_C=25^\circ\text{C}$	55	
Avalanche energy, single pulse	E_{AS}	$I_D=10\text{A}, V_{DD}=50\text{V}$	780	mJ
Avalanche energy, repetitive ^{2),3)}	E_{AR}	$I_D=20\text{A}, V_{DD}=50\text{V}$	1	
Avalanche current, repetitive ^{2),3)}	I_{AR}		20	A
Drain source voltage slope	dv/dt	$I_D=21.7\text{A}, V_{DS}=480\text{V}, T_j=125^\circ\text{C}$	80	V/ns
Reverse diode dv/dt	dv/dt	$I_S=21.7\text{A}, V_{DS}=480\text{V}, T_j=125^\circ\text{C}$	40	V/ns
Maximum diode commutation speed	di/dt		600	A/ μs
Gate source voltage	V_{GS}	static	± 20	V
		AC ($f > 1\text{ Hz}$)	± 30	
Power dissipation	P_{tot}	$T_C=25^\circ\text{C}$	240	W
Operating and storage temperature	T_j, T_{stg}		-55 ... 150	$^\circ\text{C}$
Mounting torque		M3 & M3.5 screws	60	Ncm

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Thermal characteristics

Thermal resistance, junction - case	R_{thJC}		-	-	0.52	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 $T_j=25\text{ °C}$, 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	$V_{(BR)DS}$	$V_{GS}=0\text{ V}, I_D=21.7\text{ A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=1.2\text{ mA}$	3	4	5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$	-	2.5	-	μA
		$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ °C}$	-	2600	-	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}, I_D=15.4\text{ A}, T_j=25\text{ °C}$	-	0.15	0.185	Ω
		$V_{GS}=10\text{ V}, I_D=15.4\text{ A}, T_j=150\text{ °C}$	-	0.42	-	
Gate resistance	R_G	$f=1\text{ MHz}$, open drain	-	0.8	-	
Transconductance	g_{fs}	$ V_{DS} >2 I_D R_{DS(on)max}, I_D=15.4\text{ A}$	-	14.0	-	S

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Dynamic characteristics

Input capacitance	C_{iss}	$V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$ $f=1\text{ MHz}$	-	3160	-	pF
Output capacitance	C_{oss}		-	900	-	
Reverse transfer capacitance	C_{rss}		-	34	-	
Effective output capacitance, energy related ⁴⁾	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	103	-	
Effective output capacitance, time related ⁵⁾	$C_{o(tr)}$		-	188	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=21.7\text{ A},$ $R_G=6.8\ \Omega$	-	50	-	ns
Rise time	t_r		-	24	-	
Turn-off delay time	$t_{d(off)}$		-	100	-	
Fall time	t_f		-	9	-	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD}=480\text{ V},$ $I_D=21.7\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	15	-	nC
Gate to drain charge	Q_{gd}		-	67	-	
Gate charge total	Q_g		-	110	143	
Gate plateau voltage	$V_{plateau}$		-	7.3	-	V

¹⁾ J-STD20 and JESD22

²⁾ Pulse width t_p limited by $T_{j,max}$

³⁾ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR} \cdot f$.

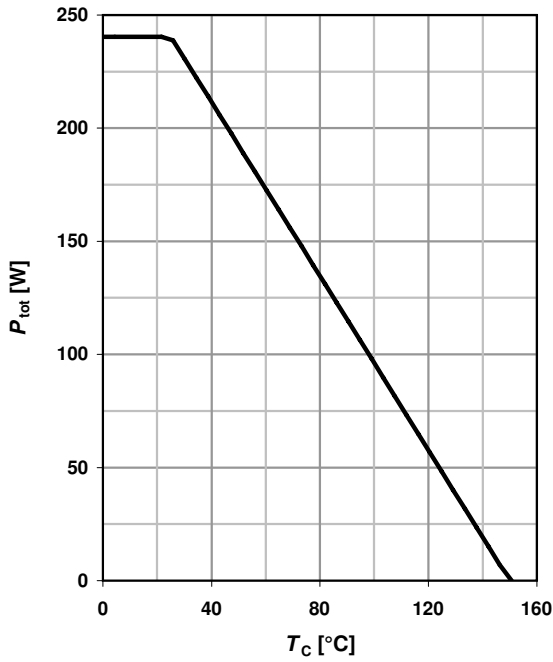
⁴⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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	I_S	$T_C=25\text{ }^\circ\text{C}$	-	-	21.7	A
Diode pulse current ²⁾	$I_{S,pulse}$		-	-	55	
Diode forward voltage	V_{SD}	$V_{GS}=0\text{ V}, I_F=I_S,$ $T_j=25\text{ }^\circ\text{C}$	-	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}		-	0.9	-	μC
Peak reverse recovery current	I_{rrm}		-	11	-	A

1 Power dissipation

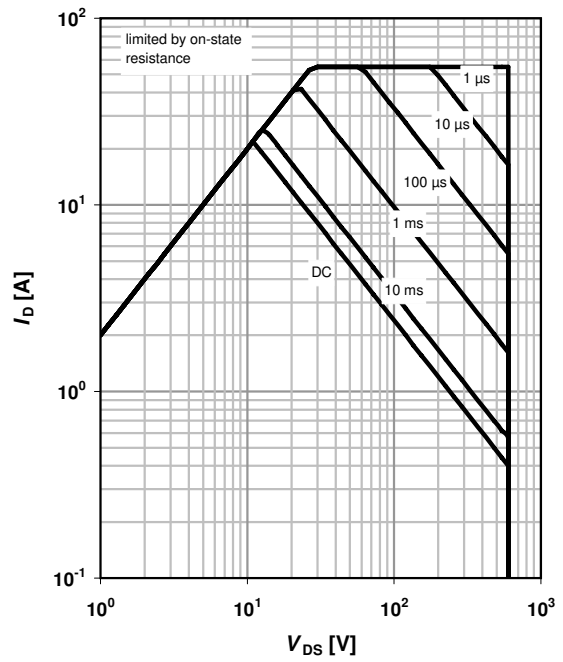
$P_{tot}=f(T_C)$



2 Safe operating area

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

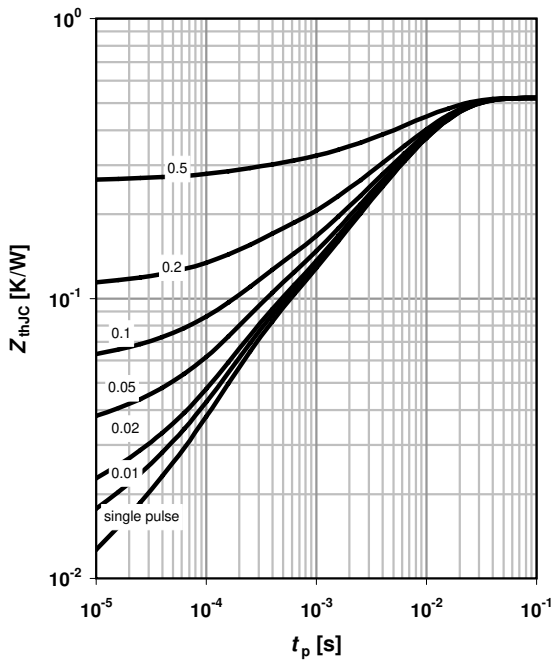
parameter: t_p



3 Max. transient thermal impedance

$I_D=f(V_{DS}); T_j=25\text{ °C}$

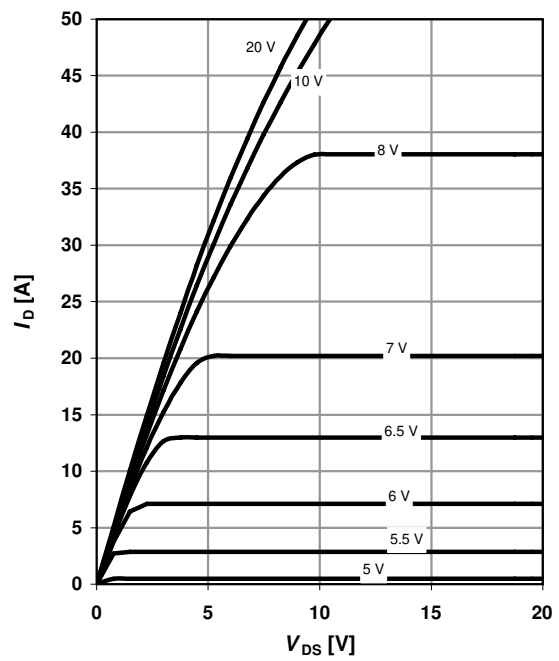
parameter: $D=t_p/T$



4 Typ. output characteristics

$I_D=f(V_{DS}); T_j=25\text{ °C}$

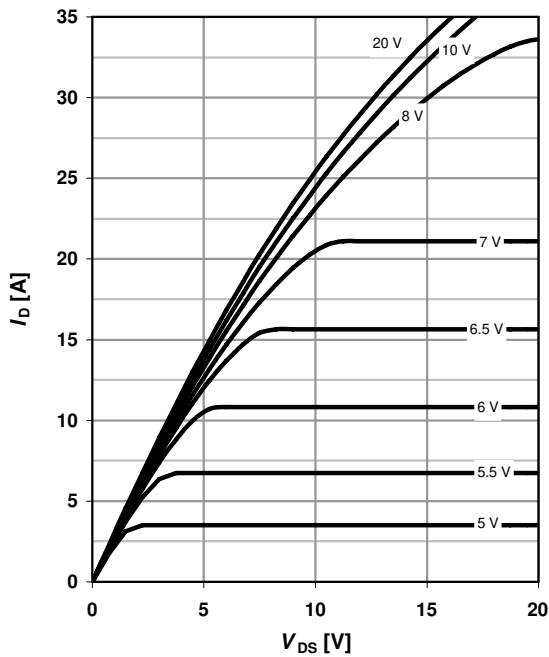
parameter: V_{GS}



5 Typ. output characteristics

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

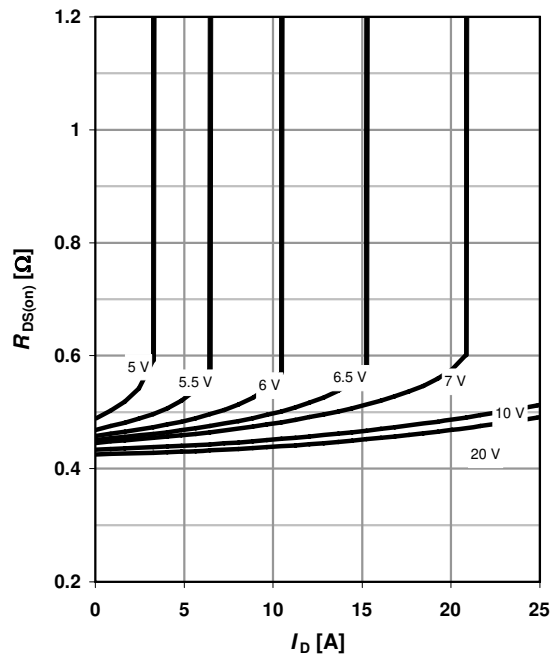
parameter: V_{GS}



6 Typ. drain-source on-state resistance

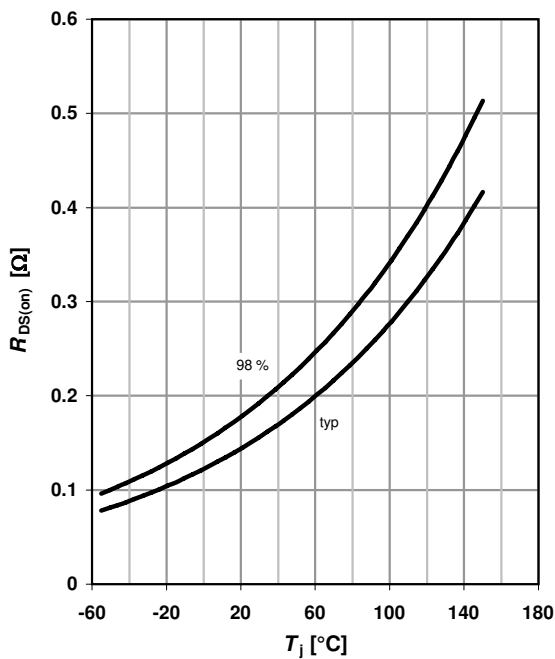
$R_{DS(on)} = f(I_D); T_j = 150\text{ °C}$

parameter: V_{GS}



7 Drain-source on-state resistance

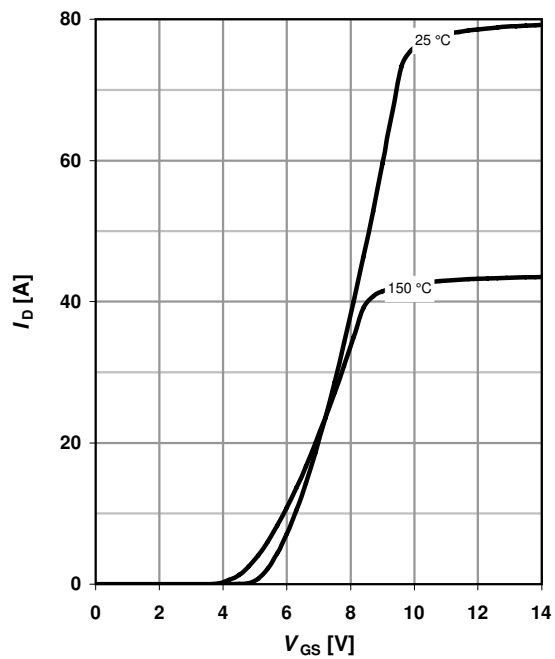
$R_{DS(on)} = f(T_j); I_D = 15.4\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

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

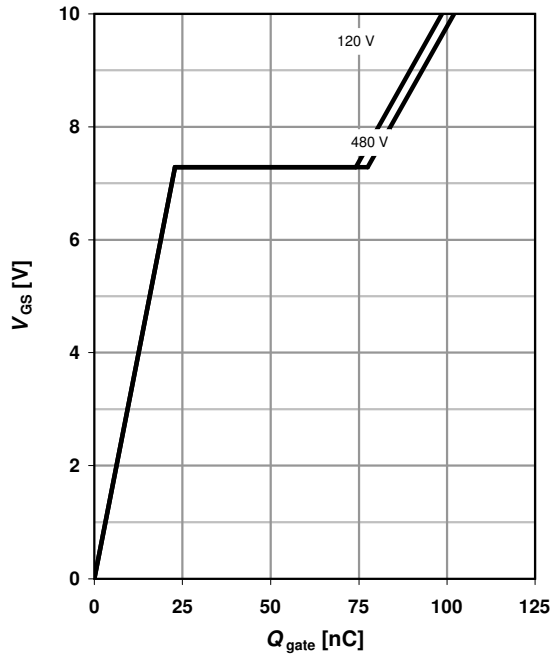
parameter: T_j



9 Typ. gate charge

$V_{GS}=f(Q_{gate}); I_D=21.7 \text{ A pulsed}$

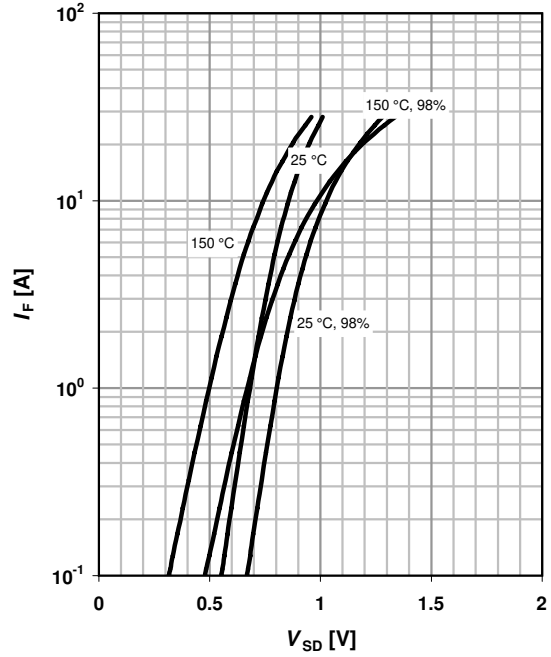
parameter: V_{DD}



10 Forward characteristics of reverse diode

$I_F=f(V_{SD})$

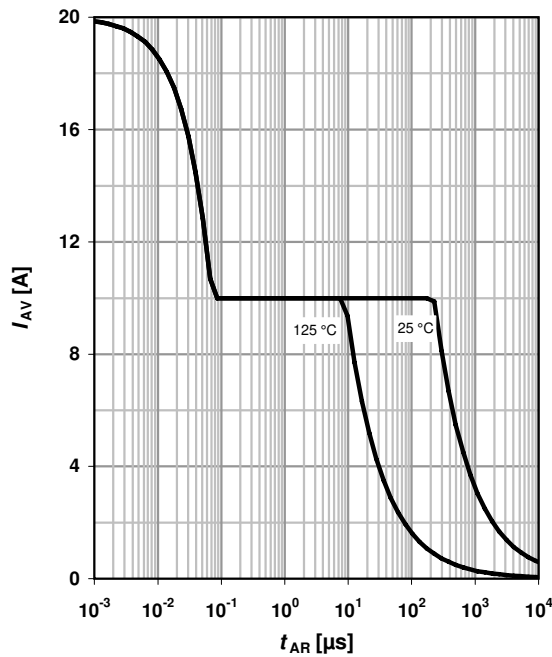
parameter: T_j



11 Avalanche SOA

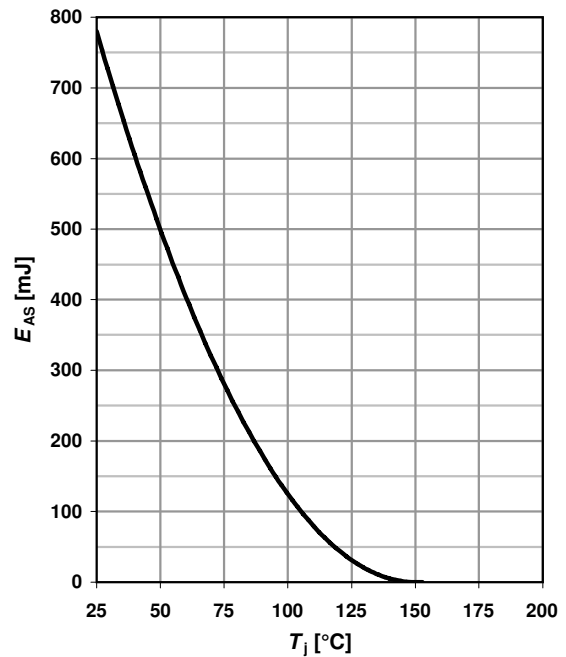
$I_{AR}=f(t_{AR})$

parameter: $T_{j(start)}$



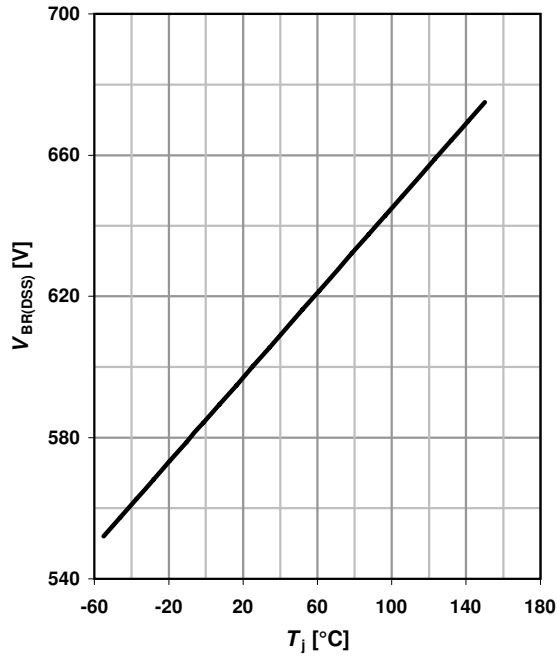
12 Avalanche energy

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



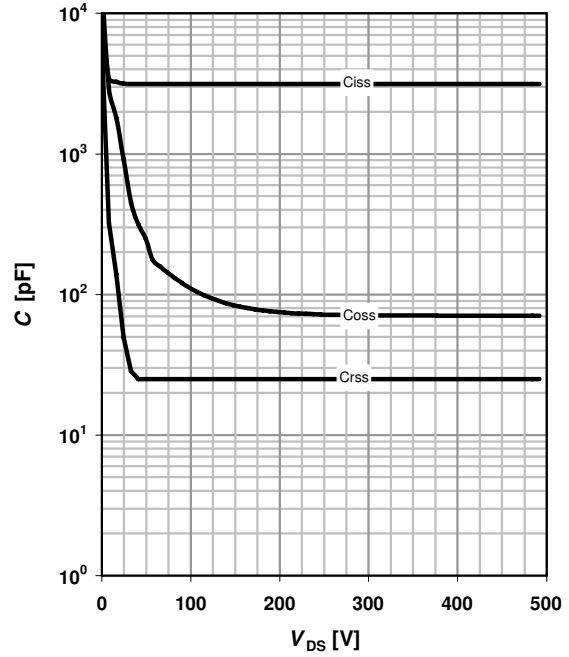
13 Drain-source breakdown voltage

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



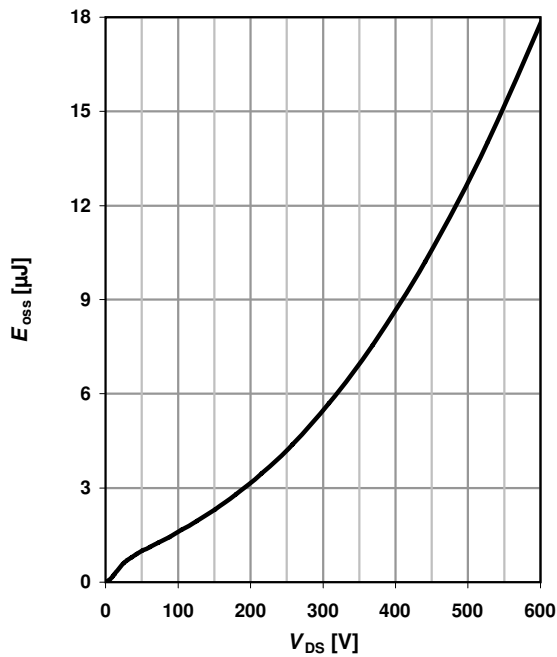
14 Typ. capacitances

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



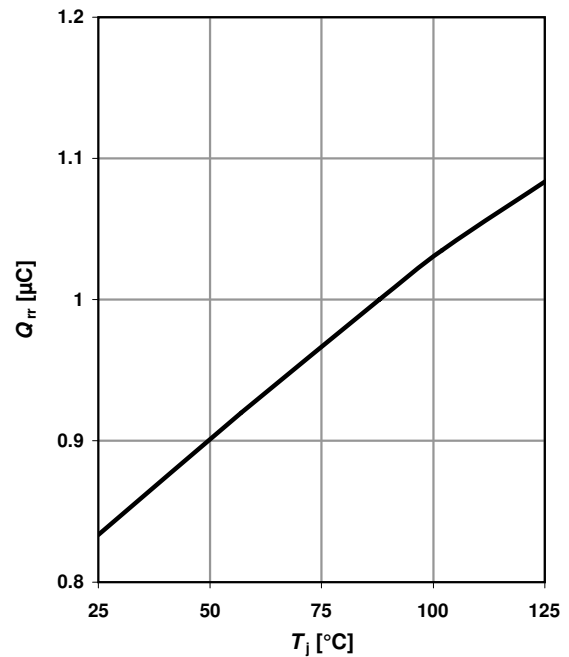
15 Typ. C_{oss} stored energy

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



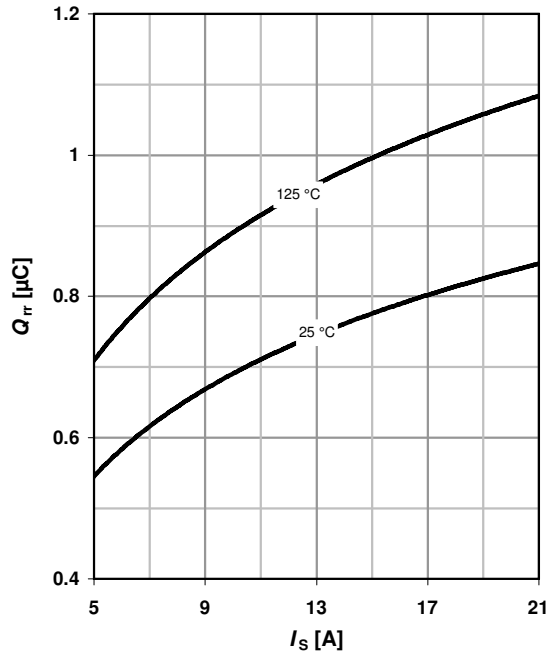
16 Typ. reverse recovery charge

$Q_{rr}=f(T_j); \text{parameter: } I_D=21.7\text{ A}$



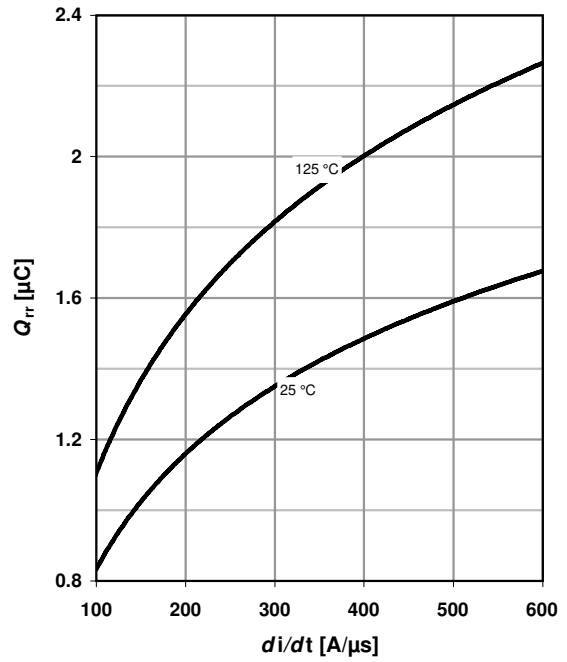
17 Typ. reverse recovery charge

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

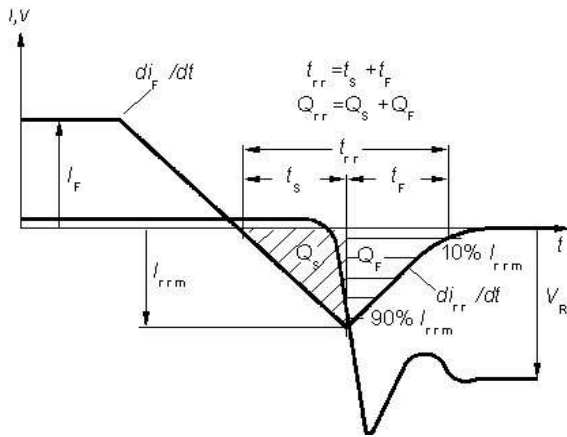


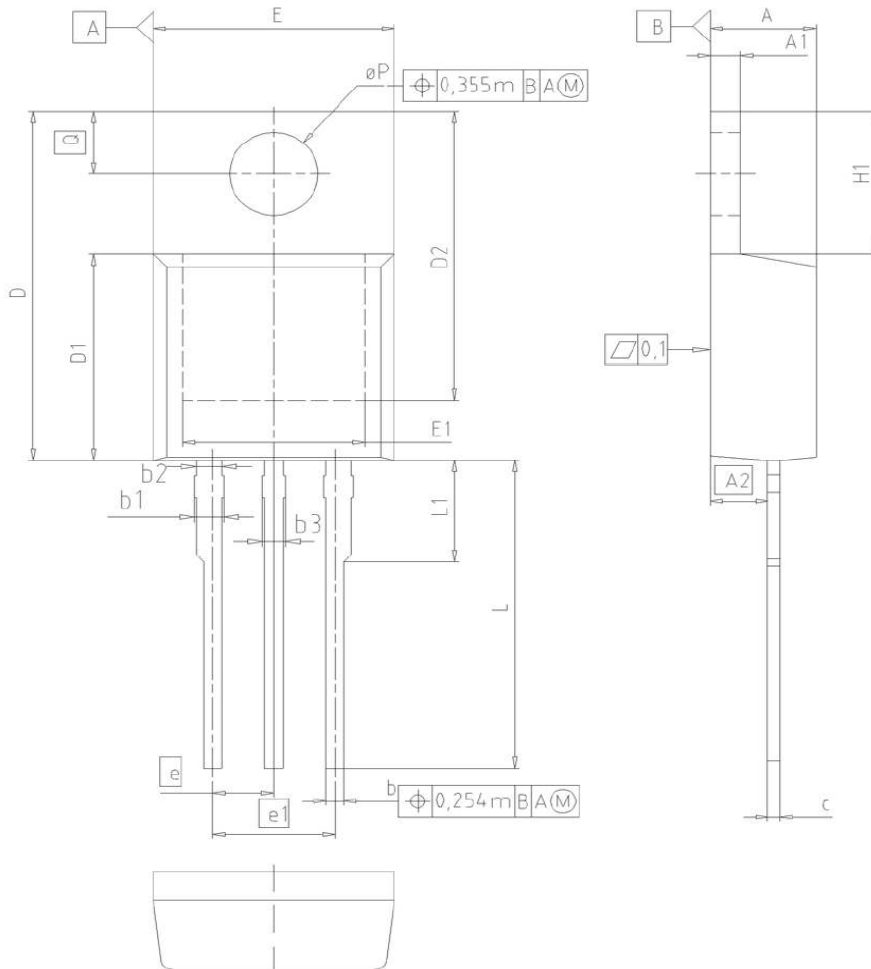
18 Typ. reverse recovery charge

$Q_{rr}=f(di/dt)$; parameter: $I_D=21.7\text{ A}$



Definition of diode switching characteristics





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
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

Dimension in mm/ inches

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