

CoolMOS™ Power Transistor

Features

- Lowest figure-of-merit $R_{ON} \times Q_g$
- Ultra low gate charge
- High peak current capability
- Qualified according to JEDEC¹⁾ for target applications
- Pb-free lead plating; RoHS compliant

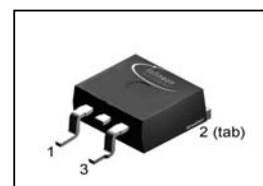
CoolMOS CP is specially designed for:

- Hard switching SMPS topologies

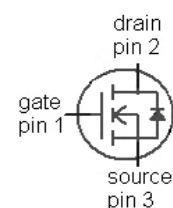
Product Summary

$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.385	Ω
$Q_{g,typ}$	17	nC

PG-TO263



Type	Package	Ordering Code	Marking
IPB60R385CP	PG-TO263	SP000228365	6R385P



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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current	I_D	$T_C=25\text{ °C}$	9.0	A
		$T_C=100\text{ °C}$	5.7	
Pulsed drain current ²⁾	$I_{D,pulse}$	$T_C=25\text{ °C}$	27	
Avalanche energy, single pulse	E_{AS}	$I_D=3.4\text{ A}$, $V_{DD}=50\text{ V}$	227	mJ
Avalanche energy, repetitive $t_{AR}^{2),3)}$	E_{AR}	$I_D=3.4\text{ A}$, $V_{DD}=50\text{ V}$	0.3	
Avalanche current, repetitive $t_{AR}^{2),3)}$	I_{AR}		3	A
MOSFET dv/dt ruggedness	dv/dt	$V_{DS}=0\ldots480\text{ V}$	50	V/ns
Gate source voltage	V_{GS}	static	± 20	V
		AC ($f>1\text{ Hz}$)	± 30	
Power dissipation	P_{tot}	$T_C=25\text{ °C}$	83	W
Operating and storage temperature	T_j, T_{stg}		-55 ... 150	°C

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

Parameter	Symbol	Conditions	Value	Unit
Continuous diode forward current	I_S	$T_C=25\text{ °C}$	5.2	A
Diode pulse current ²⁾	$I_{S,pulse}$		27	
Reverse diode dv/dt ⁴⁾	dv/dt		15	V/ns

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Thermal characteristics

Thermal resistance, junction - case	R_{thJC}		-	-	1.5	K/W
Thermal resistance, junction - ambient	R_{thJA}	SMD version, device on PCB, minimal footprint	-	-	62	
		SMD version, device on PCB, 6 cm ² cooling area ⁵⁾	-	35	-	
Soldering temperature, wave- & reflowsolderin allowed	T_{solder}	reflow MSL 1	-	-	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
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}$, $I_D=0.34\text{ mA}$	2.5	3	3.5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$	-	-	1	μA
		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$	-	10	-	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}$, $I_D=5.2\text{ A}$, $T_j=25\text{ °C}$	-	0.35	0.385	Ω
		$V_{GS}=10\text{ V}$, $I_D=5.2\text{ A}$, $T_j=150\text{ °C}$	-	0.94	-	
Gate resistance	R_G	$f=1\text{ MHz}$, open drain	-	1.8	-	Ω

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Dynamic characteristics

Input capacitance	C_{iss}	$V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$	-	790	-	pF
Output capacitance	C_{oss}		-	38	-	
Effective output capacitance, energy related ⁶⁾	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	36	-	
Effective output capacitance, time related ⁷⁾	$C_{o(tr)}$		-	96	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=5.2\text{ A},$ $R_G=3.3\ \Omega$	-	10	-	ns
Rise time	t_r		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	40	-	
Fall time	t_f		-	5	-	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD}=400\text{ V}, I_D=5.2\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	4	-	nC
Gate to drain charge	Q_{gd}		-	6	-	
Gate charge total	Q_g		-	17	22	
Gate plateau voltage	$V_{plateau}$		-	5.0	-	V

Reverse Diode

Diode forward voltage	V_{SD}	$V_{GS}=0\text{ V}, I_F=5.2\text{ A},$ $T_j=25\text{ }^\circ\text{C}$	-	0.9	1.2	V
Reverse recovery time	t_{rr}	$V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$	-	260	-	ns
Reverse recovery charge	Q_{rr}		-	3.1	-	μC
Peak reverse recovery current	I_{rrm}		-	24	-	A

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⁾ $I_{SD} \leq I_D$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DClk}=400\text{ V}$, $V_{peak} < V_{(BR)DSS}$, $T_j < T_{j,max}$, identical low side and high side switch

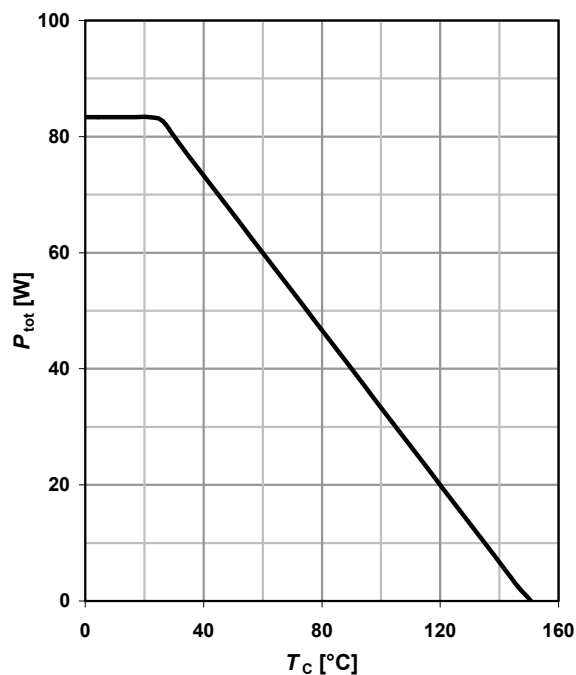
⁵⁾ Device on 40mm*40mm*1.5 epoxy PCB FR4 with 6cm² (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air

⁶⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁷⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

1 Power dissipation

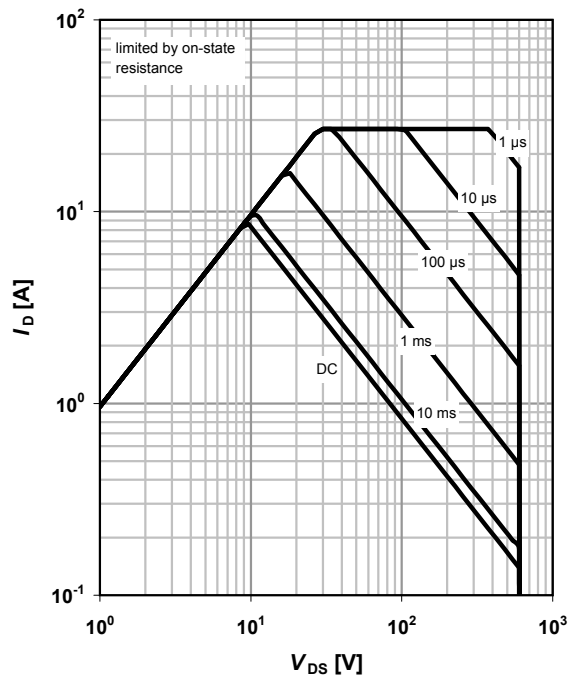
$$P_{\text{tot}} = f(T_c)$$



2 Safe operating area

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

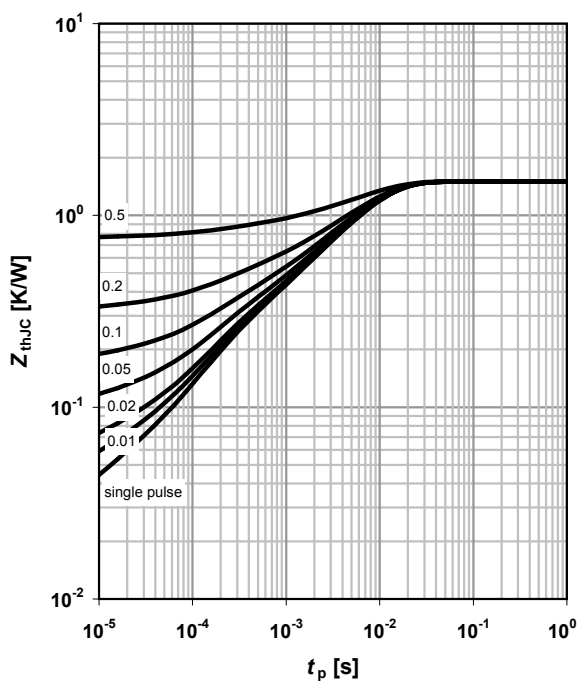
parameter: t_p



3 Max. transient thermal impedance

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

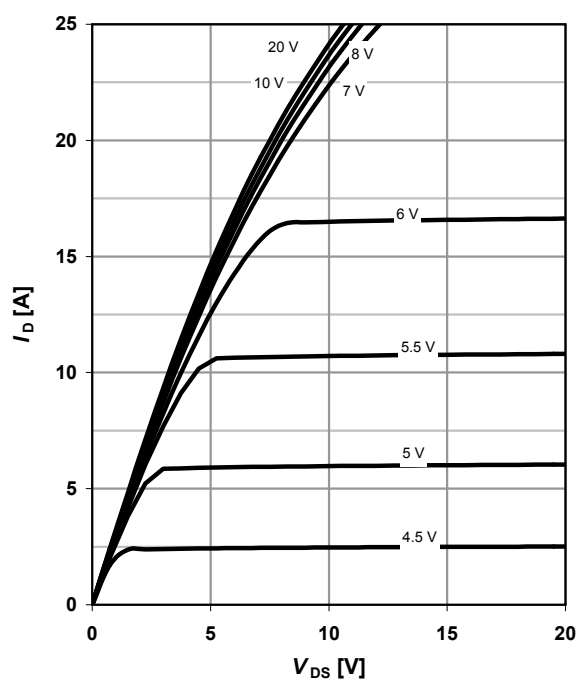
parameter: $D = t_p/T$



4 Typ. output characteristics

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

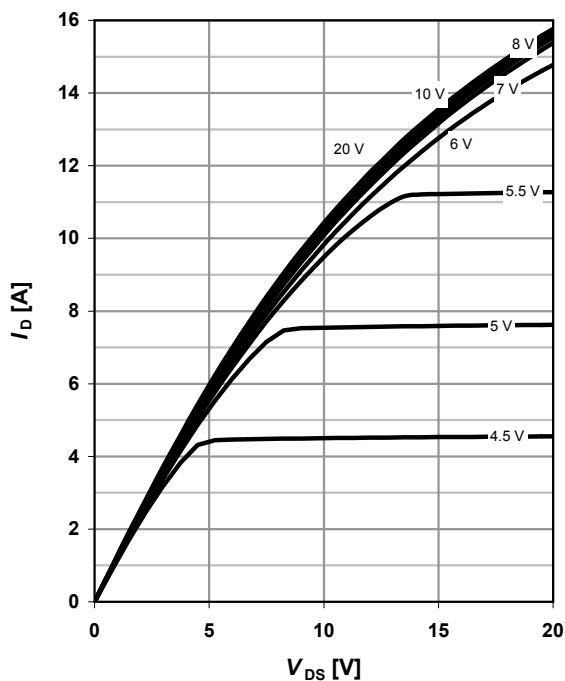
parameter: V_{GS}



5 Typ. output characteristics

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

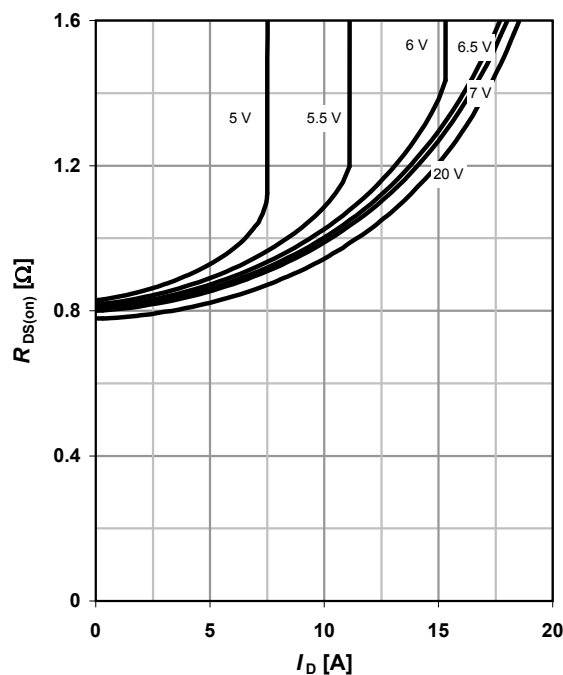
parameter: V_{GS}



6 Typ. drain-source on-state resistance

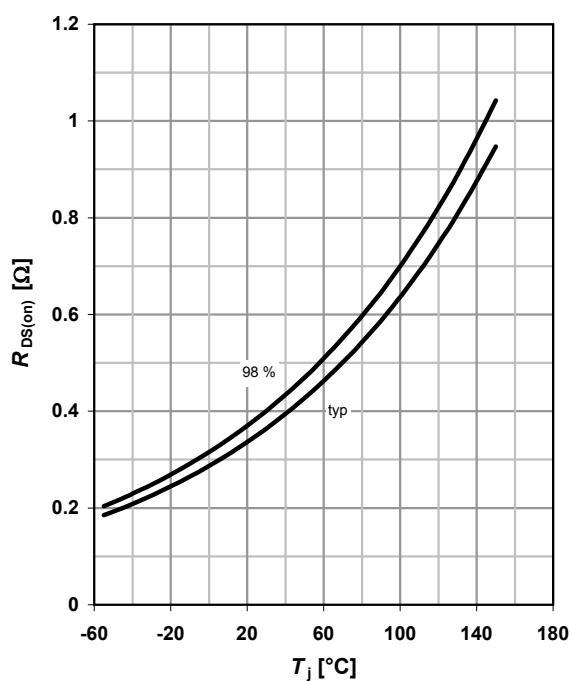
$$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$$

parameter: V_{GS}



7 Drain-source on-state resistance

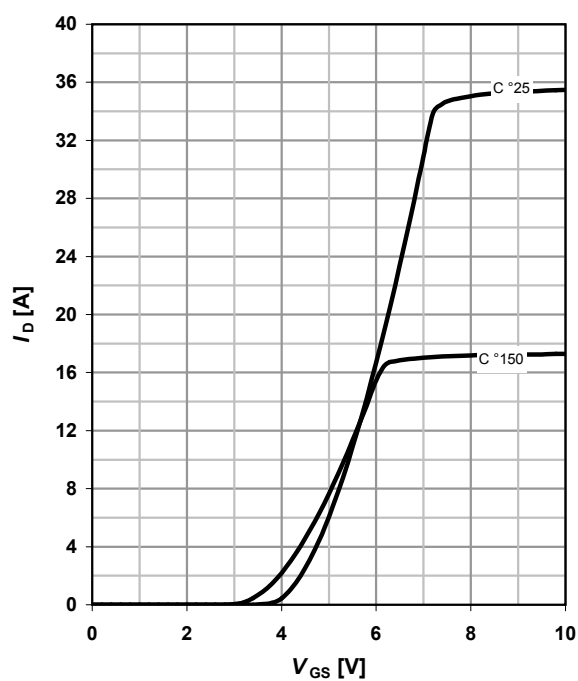
$$R_{DS(on)} = f(T_j); I_D = 5.2\text{ A}; V_{GS} = 10\text{ V}$$



8 Typ. transfer characteristics

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

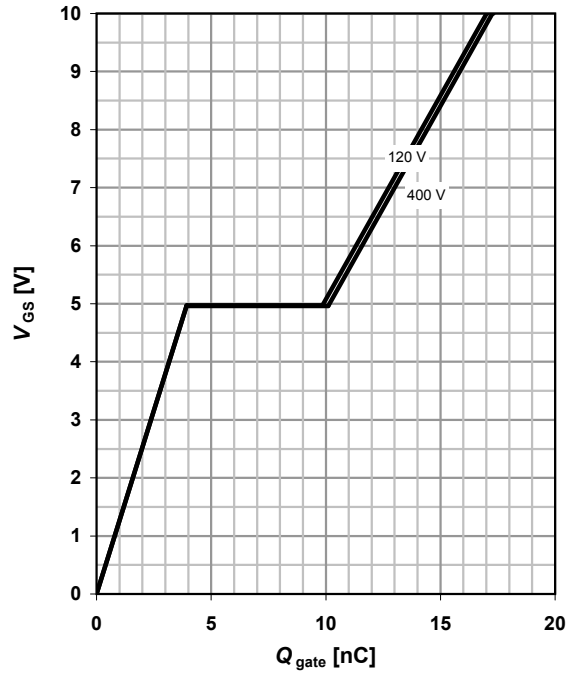
parameter: T_j



9 Typ. gate charge

$$V_{GS}=f(Q_{gate}); I_D=5.2 \text{ A pulsed}$$

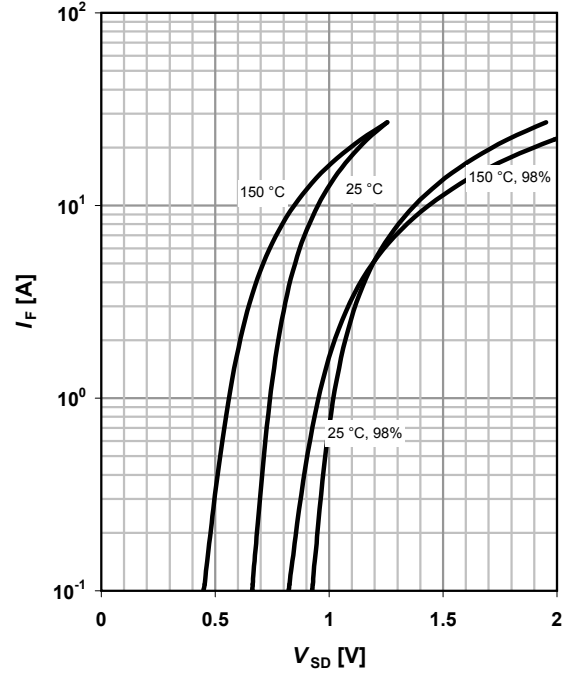
parameter: V_{DD}



10 Forward characteristics of reverse diode

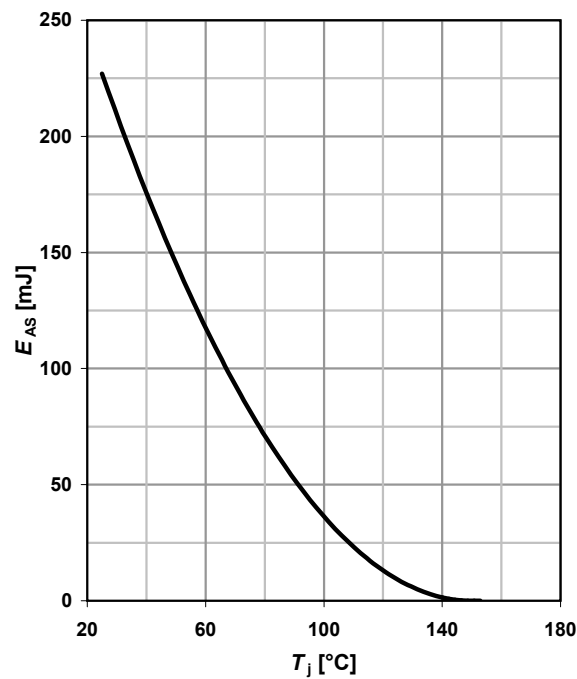
$$I_F=f(V_{SD})$$

parameter: T_j



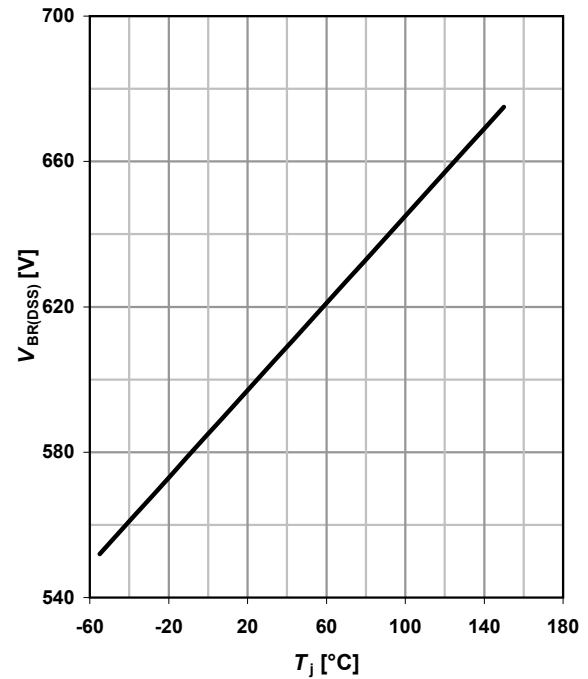
11 Avalanche energy

$$E_{AS}=f(T_j); I_D=3.4 \text{ A}; V_{DD}=50 \text{ V}$$

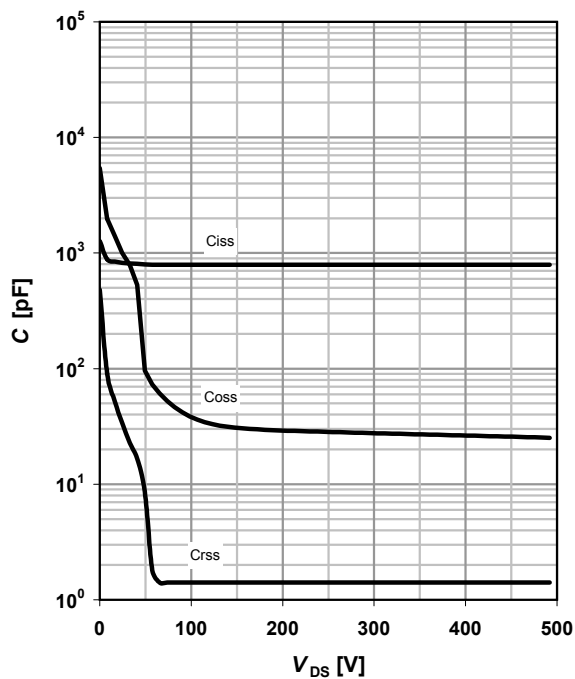


12 Drain-source breakdown voltage

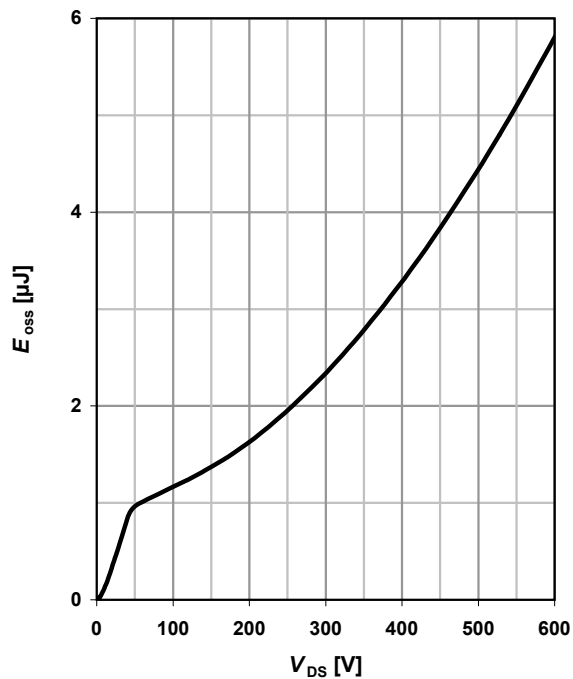
$$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$$



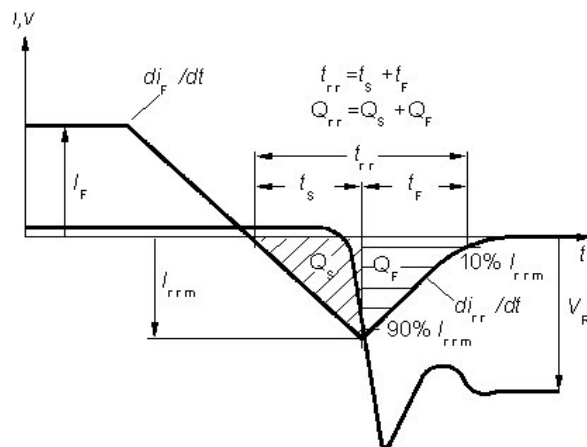
13 Typ. capacitances

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


14 Typ. Coss stored energy

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


Definition of diode switching characteristics



Technical drawing of a mechanical part, showing front and side views with dimensions and tolerances.

Front View (Left):

- Overall width: E
- Overall height: D
- Inner width: $E1$
- Inner height: $L1$
- Bottom flange width: $b2$
- Bottom flange thickness: e
- Bottom flange inner width: $e1$
- Bottom flange outer width: b
- Bottom flange height: $L2$
- Feature A: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature B: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).

Side View (Right):

- Overall width: A
- Overall height: $C2$
- Feature A1: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature B: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature C: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature D: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature E: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature F: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature G: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature H: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature I: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature J: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature K: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature L: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature M: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature N: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature O: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature P: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature Q: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature R: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature S: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature T: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature U: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature V: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature W: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature X: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature Y: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).
- Feature Z: A hole with diameter $\phi 0,254(M)$ and position tolerance $0,1$ (indicated by a square symbol with a diagonal line).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	0.000	0.254	0.000	0.010
b	0.650	0.850	0.026	0.033
b2	0.950	1.321	0.037	0.052
c	0.330	0.650	0.013	0.026
c2	0.170	1.400	0.046	0.055
D	8.509	9.450	0.335	0.372
D1	7.100	-	0.280	-
E	9.800	10.312	0.386	0.406
E1	6.500		0.256	
e	2.540		0.100	
e1	5.080		0.200	
N	2		2	
H	14.605	15.875	0.575	0.625
L	2.200	3.000	0.087	0.118
L1	-	1.600	-	0.063
L2	1.000	1.778	0.039	0.070
F1	16.050	16.250	0.632	0.640
F2	9.300	9.500	0.366	0.374
F3	4.500	4.700	0.177	0.185
F4	10.700	10.900	0.421	0.429
F5	3.630	3.830	0.143	0.151
F6	1.100	1.300	0.043	0.051

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