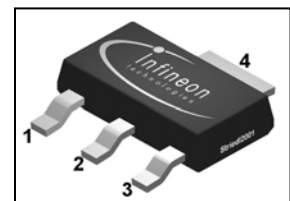


**CoolMOS™ Power Transistor**
**Features**

- New revolutionary high voltage technology
- Ultra low gate charge
- Ultra low effective capacitances
- Extreme dv/dt rated
- Qualified according to JEDEC<sup>0)</sup> for target applications

**Product Summary**

$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	2.5	$\Omega$
$I_D$	0.4	A

**SOT223**


Type	Package	Ordering Code	Marking
SPN02N60C3	SOT223	Q67040-S4553	02N60C3

drain pins 2, 4



source pin3

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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current	$I_D$	$T_A=25\text{ °C}$	0.4	A
		$T_A=70\text{ °C}$	0.3	
Pulsed drain current <sup>1)</sup>	$I_{D,pulse}$	$T_A=25\text{ °C}$	5.4	
Avalanche energy, single pulse	$E_{AS}$	$I_D=0.9\text{ A}$ , $V_{DD}=50\text{ V}$	50	mJ
Avalanche energy, repetitive $t_{AR}$ <sup>1),2)</sup>	$E_{AR}$	$I_D=1.8\text{ A}$ , $V_{DD}=50\text{ V}$	0.07	
Avalanche current, repetitive $t_{AR}$ <sup>1)</sup>	$I_{AR}$		1.8	A
Drain source voltage slope	dv/dt	$I_D=1.8\text{ A}$ , $V_{DS}=480\text{ V}$ , $T_j=125\text{ °C}$	50	V/ns
Gate source voltage	$V_{GS}$	static	$\pm 20$	V
	$V_{GS}$	AC ( $f > 1\text{ Hz}$ )	$\pm 30$	
Power dissipation	$P_{tot}$	$T_A=25\text{ °C}$	1.8	W
Operating and storage temperature	$T_j$ , $T_{stg}$		-55 ... 150	$^{\circ}\text{C}$

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
<b>Thermal characteristics</b>						
Thermal resistance, junction - soldering point	$R_{thJS}$		-	30	-	K/W
Thermal resistance, junction - ambient	$R_{thJA}$	SMD version, device on PCB, minimal footprint	-	110	-	K/W
		SMD version, device on PCB, 6 cm <sup>2</sup> cooling area <sup>2)</sup>	-	70	-	
Soldering temperature	$T_{sold}$	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	$V_{(BR)DS}$	$V_{GS}=0\text{ V}$ , $I_D=0.25\text{ A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}$ , $I_D=0.08\text{ mA}$	2.1	3	3.9	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$	-	0.5	1	$\mu\text{A}$
		$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ °C}$	-	-	50	
Gate-source leakage current	$I_{GSS}$	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}$ , $I_D=1.1\text{ A}$ , $T_j=25\text{ °C}$	-	2.0	2.5	$\Omega$
		$V_{GS}=10\text{ V}$ , $I_D=1.1\text{ A}$ , $T_j=150\text{ °C}$	-	5.2	-	
Gate resistance	$R_G$	$f=1\text{ MHz}$ , open drain	-	9	-	
Transconductance	$g_{fs}$	$ V_{DS} >2 I_D R_{DS(on)max}$ , $I_D=1.1\text{ A}$	-	1.75	-	S

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

**Dynamic characteristics**

Input capacitance	$C_{iss}$	$V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$ $f=1\text{ MHz}$	-	200	-	pF
Output capacitance	$C_{oss}$		-	90	-	
Reverse transfer capacitance	$C_{rss}$		-	4	-	
Effective output capacitance, energy related <sup>3)</sup>	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	8	-	
Effective output capacitance, time related <sup>4)</sup>	$C_{o(tr)}$		-	16	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=350\text{ V},$ $V_{GS}=10\text{ V}, I_D=1.8\text{ A},$ $R_G=25\ \Omega$	-	6	-	ns
Rise time	$t_r$		-	3	-	
Turn-off delay time	$t_{d(off)}$		-	68	-	
Fall time	$t_f$		-	12	30	

**Gate Charge Characteristics**

Gate to source charge	$Q_{gs}$	$V_{DD}=420\text{ V}, I_D=1.8\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	1.6	-	nC
Gate to drain charge	$Q_{gd}$		-	4	-	
Gate charge total	$Q_g$		-	10	13	
Gate plateau voltage	$V_{plateau}$		-	5.5	-	V

<sup>1)</sup> Pulse width limited by maximum temperature  $T_{j,max}$  only

<sup>2)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 μm thick) copper area for drain connection. PCB is vertical in still air.

<sup>3)</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>4)</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%  $V_{DSS}$ .

<sup>0)</sup> J-STD20 and JESD22

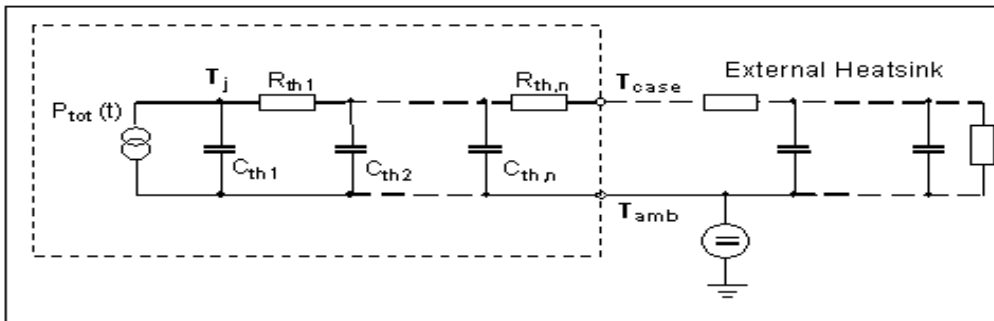
Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

**Reverse Diode**

Diode continuous forward current	$I_S$	$T_C=25\text{ }^\circ\text{C}$	-	-	0.4	A
Diode pulse current	$I_{S,pulse}$		-	-	5.4	
Diode forward voltage	$V_{SD}$	$V_{GS}=0\text{ V}, I_F=0.4\text{ A}, T_J=25\text{ }^\circ\text{C}$	-	0.82	1.05	V
Reverse recovery time	$t_{rr}$	$V_R=420\text{ V}, I_F=I_S, di_F/dt=100\text{ A}/\mu\text{s}$	-	200	350	ns
Reverse recovery charge	$Q_{rr}$		-	1.3	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	9	-	A
Peak rate of fall of reverse recovery current	$di_{rr}/dt$	$T_J=25\text{ }^\circ\text{C}$	-	200	-	$\text{A}/\mu\text{s}$

**Typical Transient Thermal Characteristics**

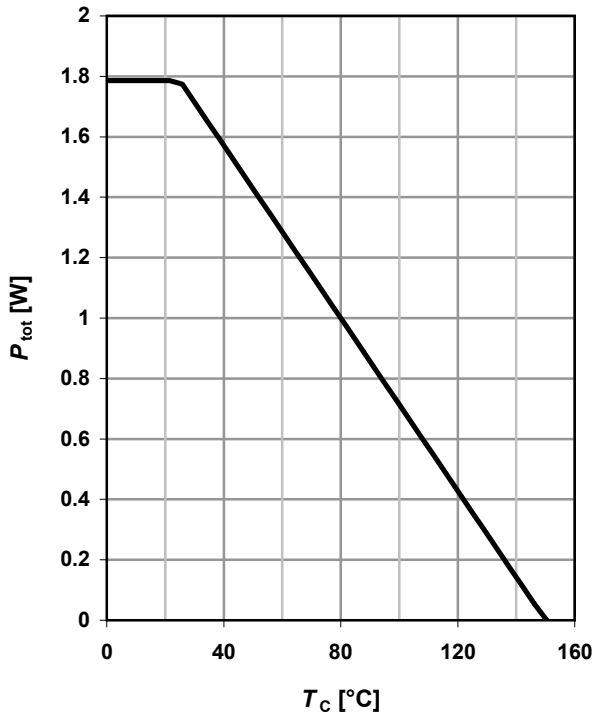
Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
$R_{th1}$	0.113	K/W	$C_{th1}$	0.0000144	Ws/K
$R_{th2}$	0.156		$C_{th2}$	0.000087	
$R_{th3}$	0.875		$C_{th3}$	0.000123	
$R_{th4}$	3.63		$C_{th4}$	0.0005	
$R_{th5}$	8.29		$C_{th5}$	0.012	
			$C_{th6}$	$0.05^{5)}$	



<sup>5)</sup>  $C_{th6}$  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**

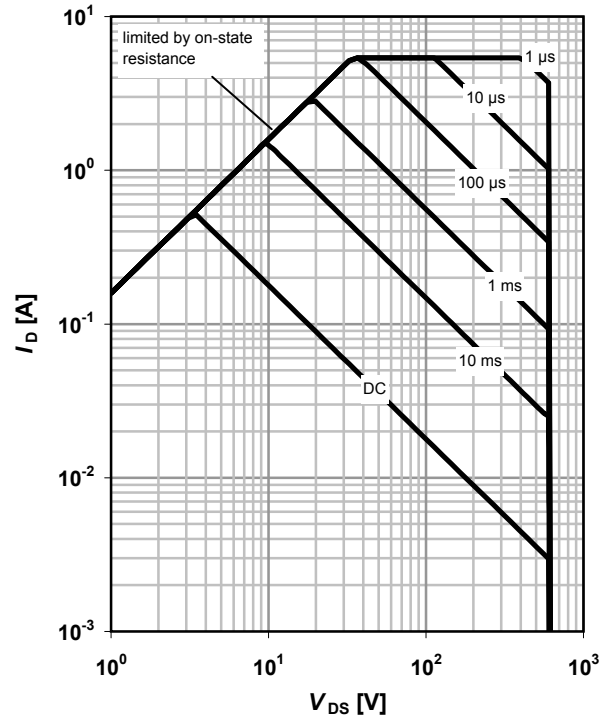
$P_{tot}=f(T_C)$



**2 Safe operating area**

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

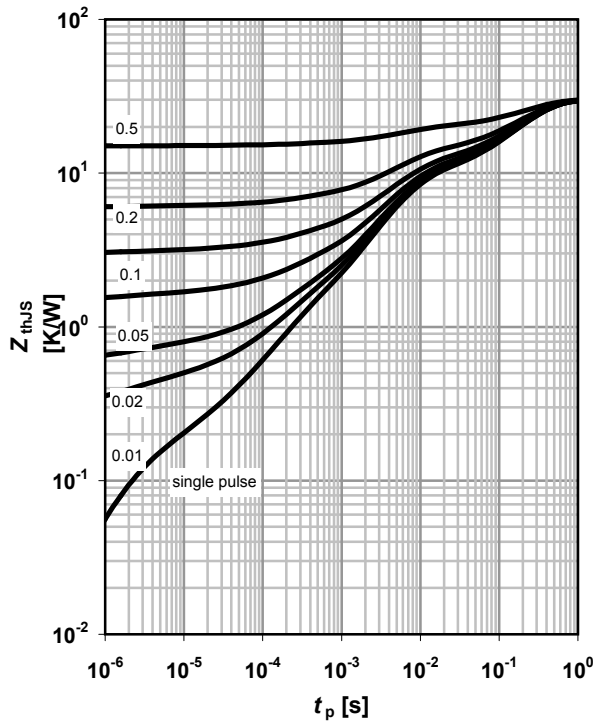
parameter:  $t_p$



**3 Max. transient thermal impedance**

$I_D=f(V_{DS}); T_j=25\text{ °C}$

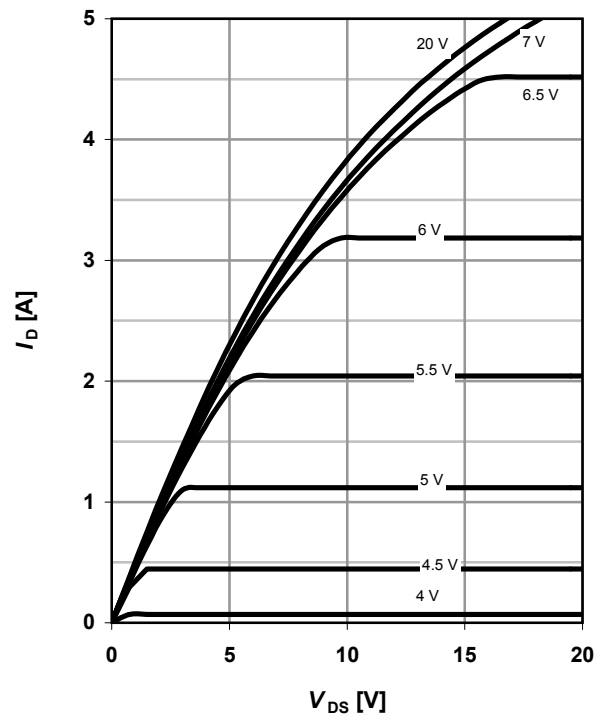
parameter:  $D=t_p/T$



**4 Typ. output characteristics**

$I_D=f(V_{DS}); T_j=25\text{ °C}$

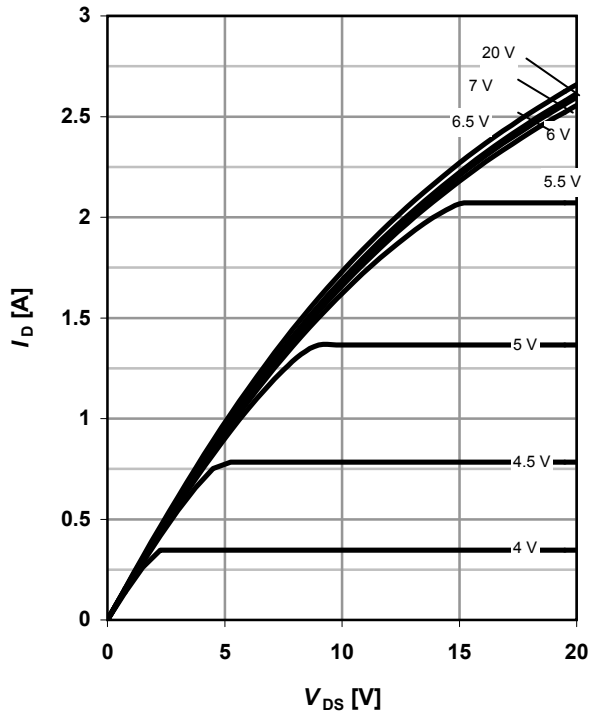
parameter:  $V_{GS}$



**5 Typ. output characteristics**

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

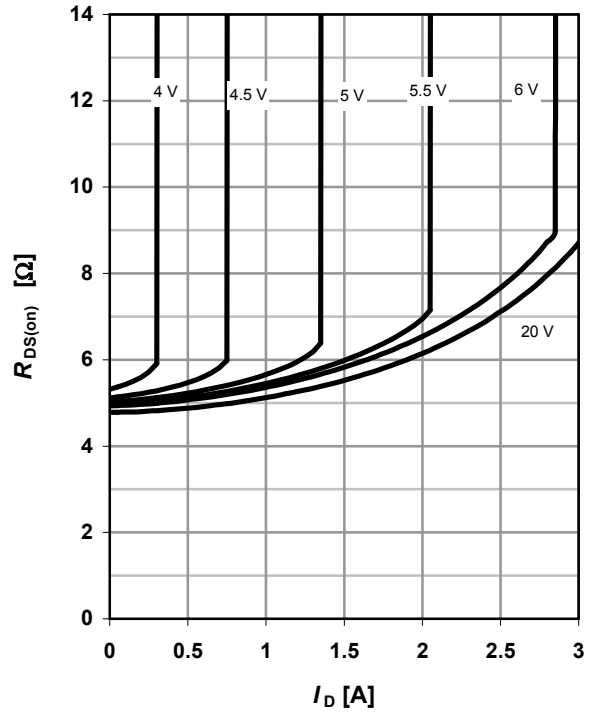
parameter:  $V_{GS}$



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

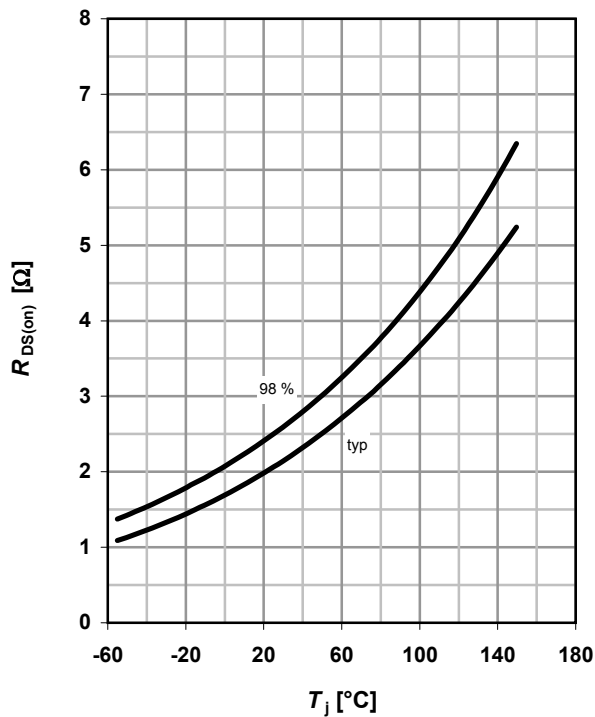
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter:  $V_{GS}$



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

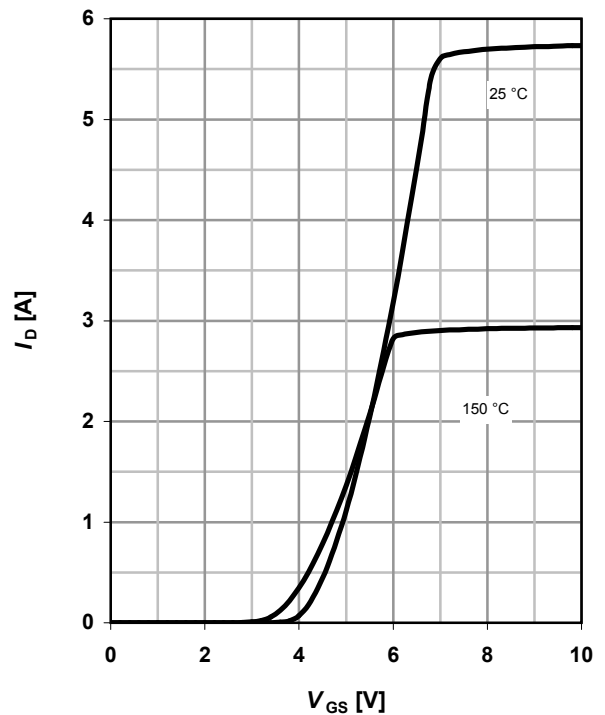
$R_{DS(on)} = f(T_j); I_D = 1.1\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

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

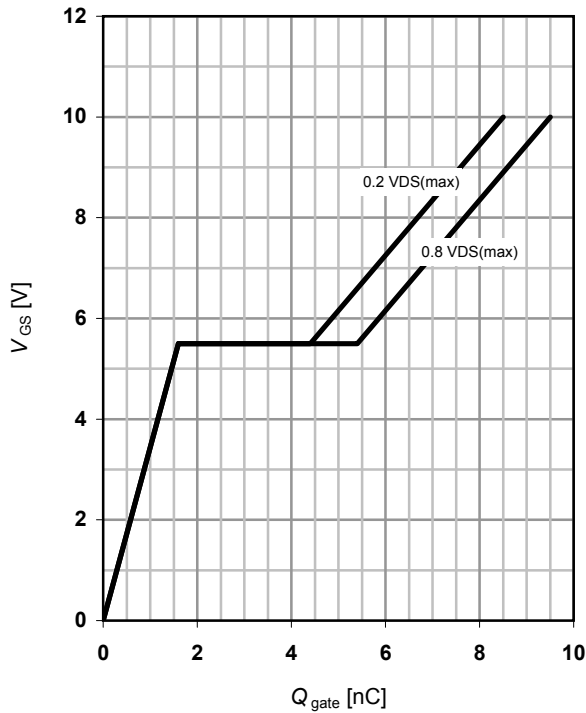
parameter:  $T_j$



**9 Typ. gate charge**

$V_{GS}=f(Q_{gate}); I_D=1.8\text{ A pulsed}$

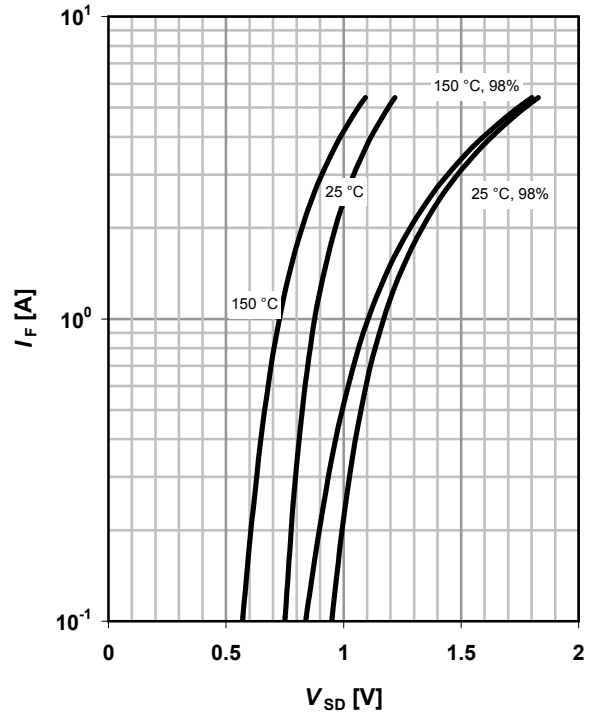
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

$I_F=f(V_{SD})$

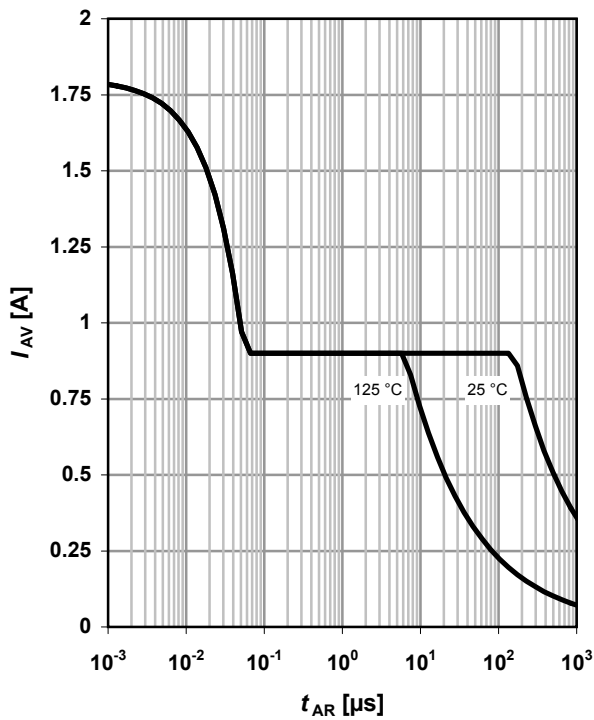
parameter:  $T_j$



**11 Avalanche SOA**

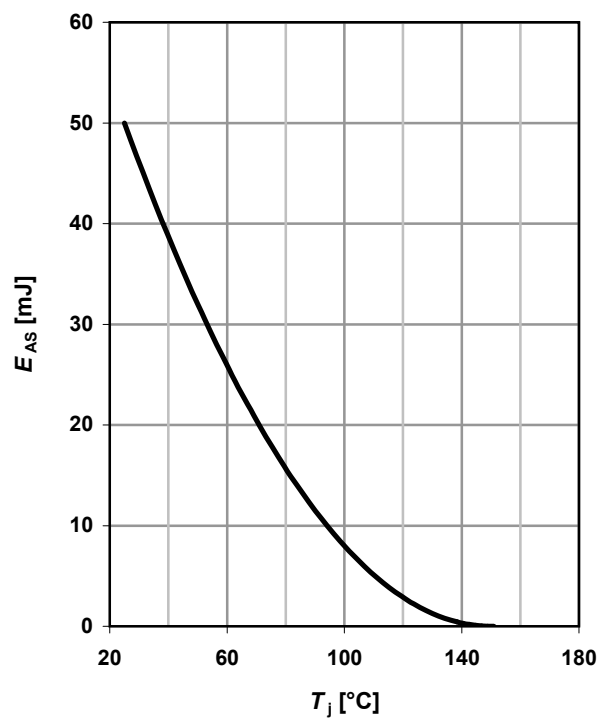
$I_{AR}=f(t_{AR})$

parameter:  $T_{j(start)}$



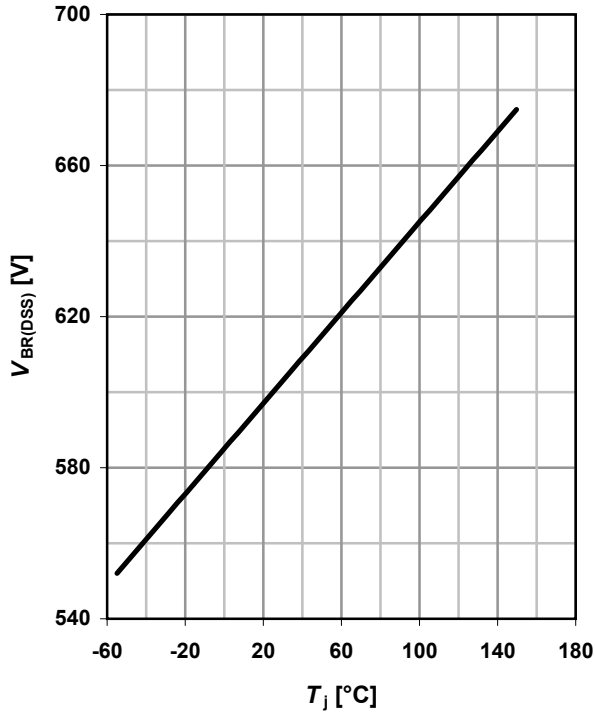
**12 Avalanche energy**

$E_{AS}=f(T_j); I_D=0.9\text{ A}; V_{DD}=50\text{ V}$



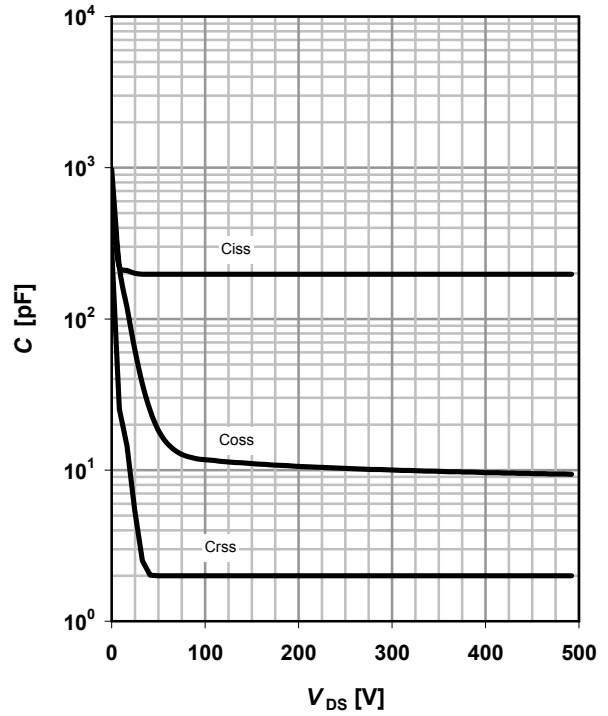
**13 Drain-source breakdown voltage**

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



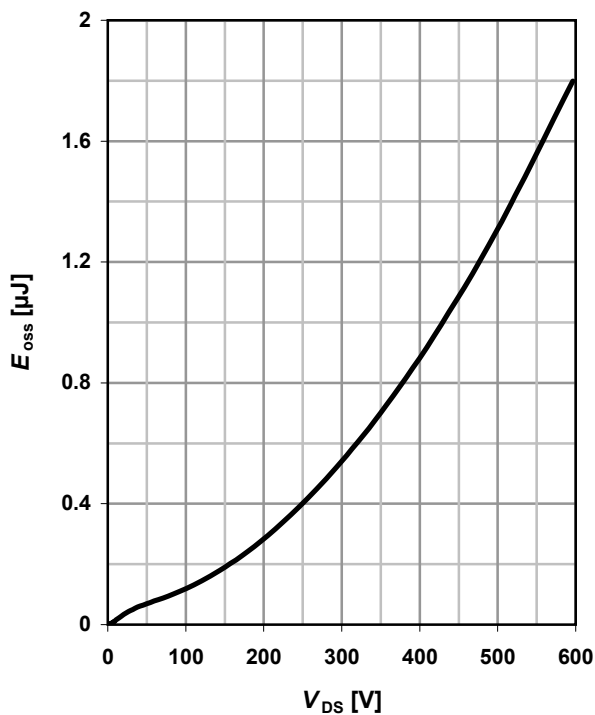
**14 Typ. capacitances**

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



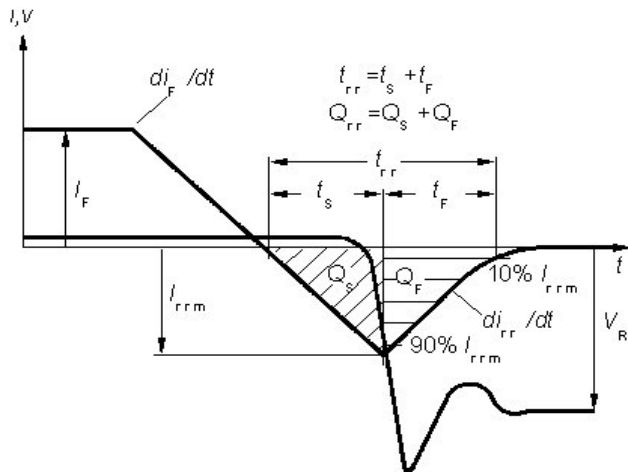
**15 Typ.  $C_{oss}$  stored energy**

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

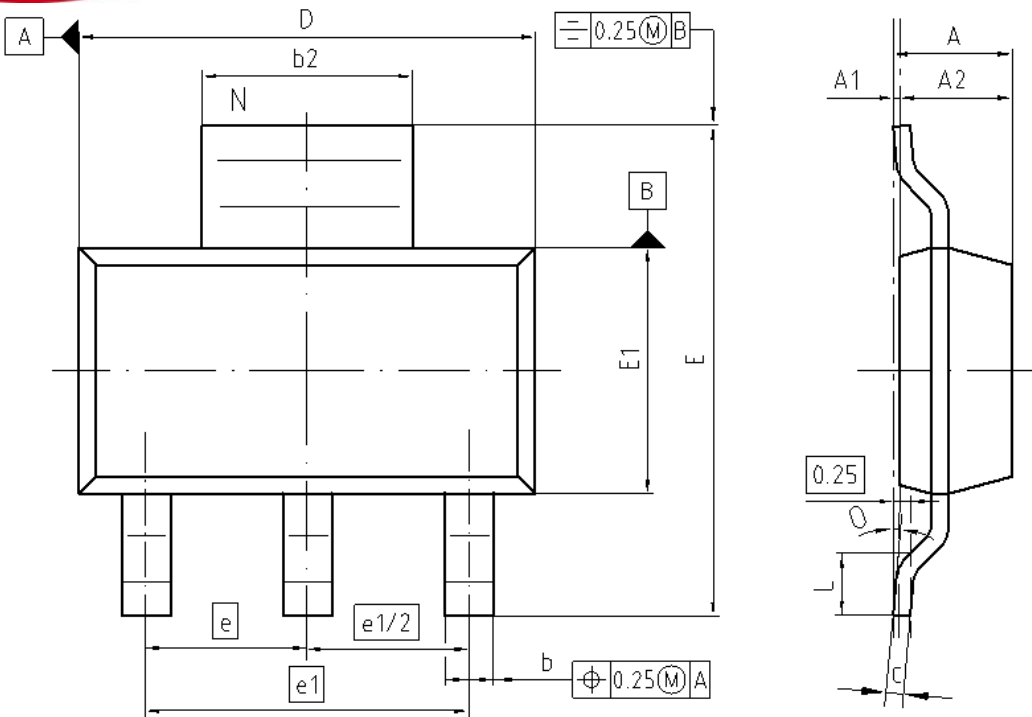




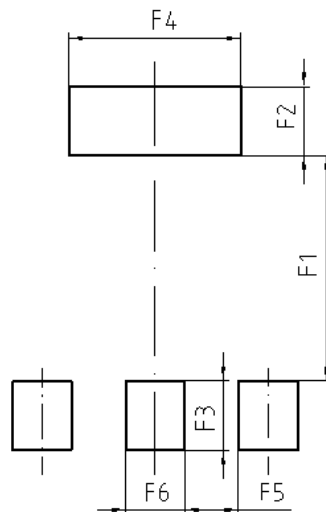
Definition of diode switching characteristics



SOT-223



**FOOTPRINT (REFLOW SOLDERING)**



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.6	1.8	0.063	0.071
A1	-	0.1	-	0.004
A2	1.5	1.7	0.059	0.067
b	0.6	0.8	0.024	0.031
b2	2.9	3.1	0.114	0.122
c	0.24	0.32	0.009	0.013
D	6.3	6.7	0.248	0.264
E	6.7	7.3	0.264	0.287
E1	3.3	3.7	0.123	0.146
e	2.3 BASIC		0.091 BASIC	
e1	4.6 BASIC		0.181 BASIC	
L	0.75	-	0.023	-
N	4		4	
O	0°	10°	0°	10°
F1	1.8 BASIC		0.189 BASIC	
F2	1.4 BASIC		0.055 BASIC	
F3	1.4 BASIC		0.055 BASIC	
F4	3.5 BASIC		0.138 BASIC	
F5	1.1 BASIC		0.043 BASIC	
F6	1.2 BASIC		0.047 BASIC	

**REFERENCE**  
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**SCALE**

**EUROPEAN PROJECTION**

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