

## Cool MOS™ Power Transistor

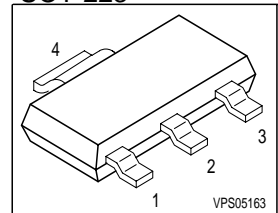
### Feature

- New revolutionary high voltage technology
- Worldwide best  $R_{DS(on)}$  in SOT 223
- Ultra low gate charge
- Extreme  $dv/dt$  rated
- Ultra low effective capacitances
- Improved noise immunity

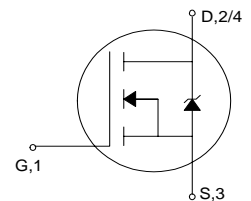
### Product Summary

$V_{DS}$	600	V
$R_{DS(on)}$	0.95	$\Omega$
$I_D$	0.8	A

SOT-223



Type	Package	Ordering Code	Marking
SPN04N60C2	SOT-223	Q67040-S4308	04N60C2



### Maximum Ratings, at $T_A = 25^\circ\text{C}$ , unless otherwise specified

Parameter	Symbol	Value	Unit
Continuous drain current $T_A = 25^\circ\text{C}$ $T_A = 70^\circ\text{C}$	$I_D$	0.8 0.65	A
Pulsed drain current, $t_p$ limited by $T_{jmax}$	$I_{D\ puls}$	3	
Reverse diode $dv/dt$ $I_S=0.8A, V_{DS} < V_{DD}, di/dt=100A/\mu s, T_{jmax}=150^\circ\text{C}$	$dv/dt$	6	V/ns
Gate source voltage	$V_{GS}$	$\pm 20$	V
Power dissipation, $T_A = 25^\circ\text{C}$	$P_{tot}$	1.8	W
Operating and storage temperature	$T_j, T_{stg}$	-55... +150	$^\circ\text{C}$

**Thermal Characteristics**

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>Characteristics</b>					
Thermal resistance, junction - soldering point	$R_{thJS}$	-	20	-	K/W
SMD version, device on PCB:	$R_{thJA}$	-	110	-	
@ min. footprint @ 6 cm <sup>2</sup> cooling area <sup>1)</sup>		-	-	70	
Linear derating factor		-	0.05	-	W/K
Soldering temperature, 1.6 mm (0.063 in.) from case for 10s	$T_{sold}$	-	-	260	°C

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

**Static Characteristics**

Drain-source breakdown voltage $V_{GS}=0V, I_D=0.25mA$	$V_{(BR)DSS}$	600	-	-	V
Gate threshold voltage, $V_{GS} = V_{DS}$ $I_D=200\mu A$	$V_{GS(th)}$	3.5	4.5	5.5	
Zero gate voltage drain current $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}, T_j = 25\text{ °C}$ $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}, T_j = 150\text{ °C}$	$I_{DSS}$	-	0.1	1	$\mu A$
		-	-	50	
Gate-source leakage current $V_{GS}=20V, V_{DS}=0V$	$I_{GSS}$	-	-	100	nA
Drain-source on-state resistance $V_{GS}=10V, I_D=0.65A, T_j=25\text{ °C}$	$R_{DS(on)}$	-	0.8	0.95	$\Omega$
Gate input resistance $f = 1\text{ MHz}, \text{open drain}$	$R_G$	-	0.95	-	

<sup>1)</sup>Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70  $\mu m$  thick) copper area for drain connection. PCB is vertical without blown air.

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
<b>Characteristics</b>						
Transconductance	$g_{fs}$	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ $I_D = 0.65\text{A}$	-	1	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$ ,	-	600	-	pF
Output capacitance	$C_{oss}$	$f = 1\text{MHz}$	-	325	-	
Reverse transfer capacitance	$C_{rss}$		-	15	-	
Effective output capacitance, 1) energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V}$ to $480\text{V}$	-	20	-	pF
Effective output capacitance, 2) time related	$C_{o(tr)}$		-	35	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380\text{V}$ , $V_{GS} = 0/13\text{V}$ ,	-	10	-	ns
Rise time	$t_r$	$I_D = 0.8\text{A}$ , $R_G = 18\Omega$ ,	-	30	-	
Turn-off delay time	$t_{d(off)}$	$T_j = 125^\circ\text{C}$	-	60	-	
Fall time	$t_f$		-	30	-	

**Gate Charge Characteristics**

Gate to source charge	$Q_{gs}$	$V_{DD} = 350\text{V}$ , $I_D = 0.8\text{A}$	-	4.1	-	nC
Gate to drain charge	$Q_{gd}$		-	9.2	-	
Gate charge total	$Q_g$	$V_{DD} = 350\text{V}$ , $I_D = 0.8\text{A}$ , $V_{GS} = 0$ to $10\text{V}$	-	17	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$ , $I_D = 0.8\text{A}$	-	7.5	-	V

<sup>1</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%  $V_{DSS}$ .

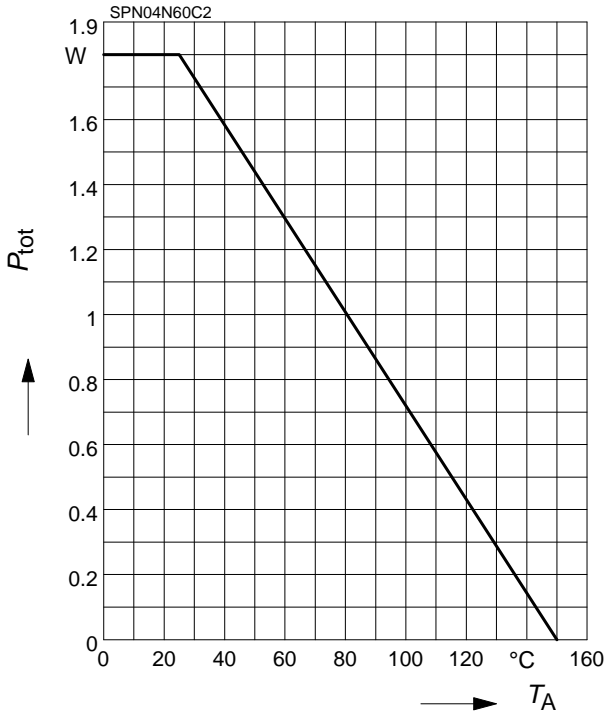
<sup>2</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

Electrical Characteristics, at  $T_j = 25\text{ °C}$ , unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
<b>Characteristics</b>						
Inverse diode continuous forward current	$I_S$	$T_A=25\text{ °C}$	-	-	0.8	A
Inverse diode direct current, pulsed	$I_{SM}$		-	-	3	
Inverse diode forward voltage	$V_{SD}$	$V_{GS}=0V, I_F=I_S$	-	0.85	1.05	V
Reverse recovery time	$t_{rr}$	$V_R=350V, I_F=I_S,$	-	200	-	ns
Reverse recovery charge	$Q_{rr}$	$di_F/dt=100A/\mu s$	-	1.2	-	$\mu C$

### 1 Power dissipation

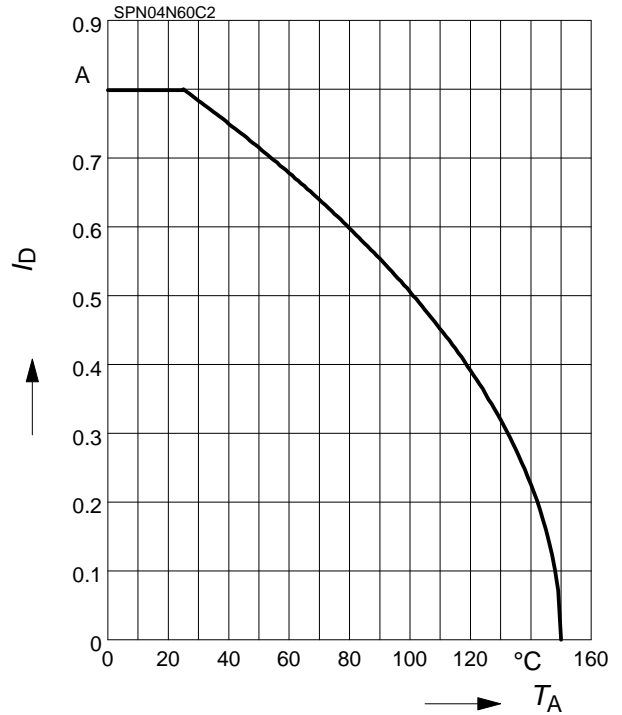
$$P_{tot} = f(T_A)$$



### 2 Drain current

$$I_D = f(T_A)$$

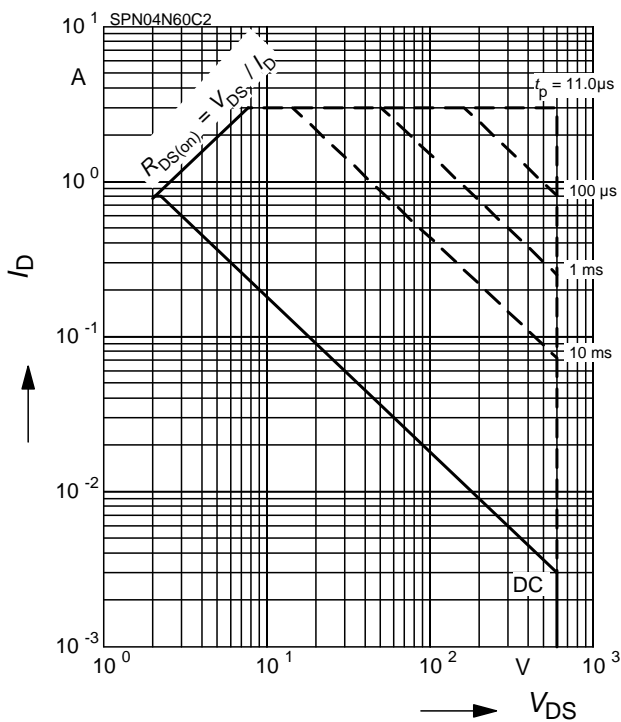
parameter:  $V_{GS} \geq 10 \text{ V}$



### 3 Safe operating area

$$I_D = f(V_{DS})$$

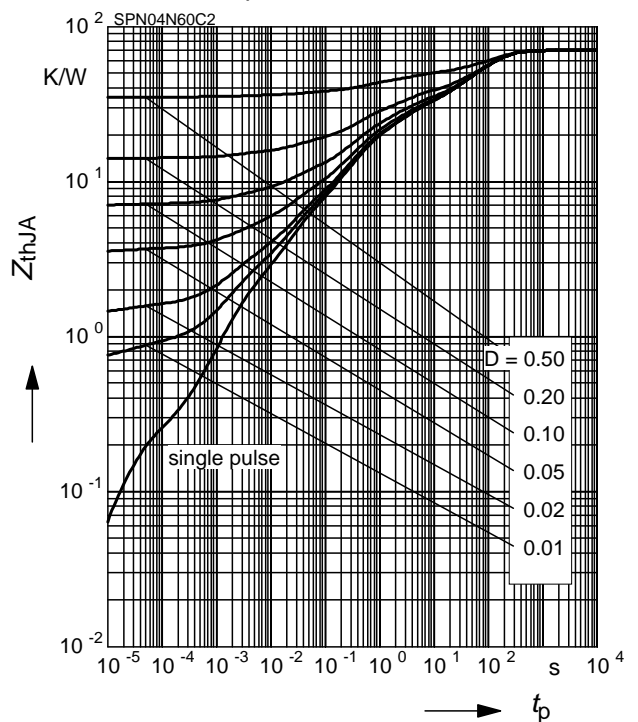
parameter:  $D = 0, T_A = 25^\circ\text{C}$



### 4 Transient thermal impedance

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

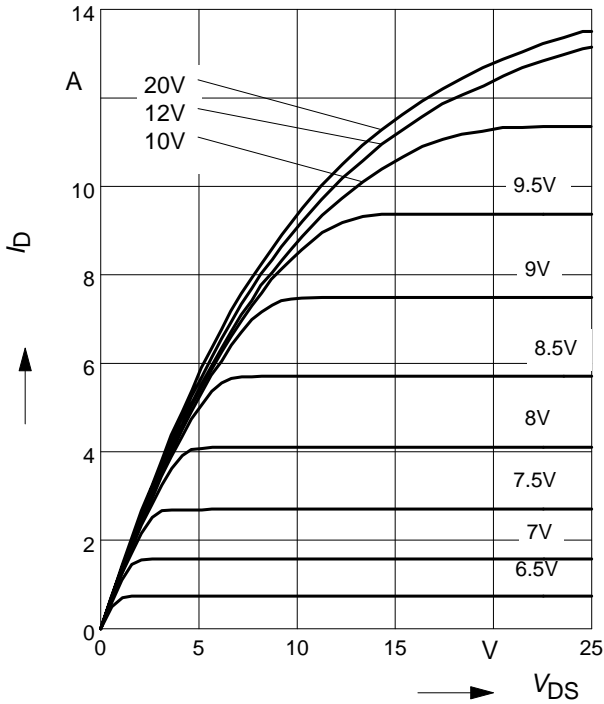
parameter:  $D = t_p/T$



**5 Typ. output characteristic**

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

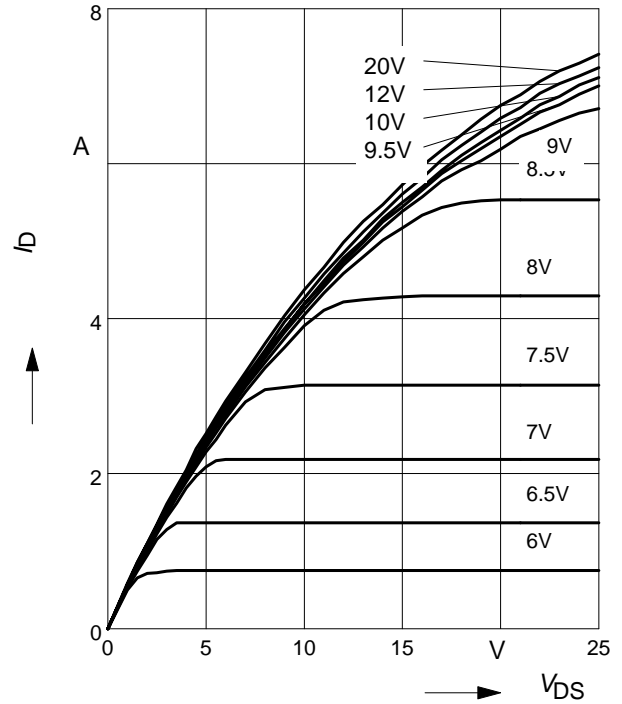
parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



**6 Typ. output characteristic**

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

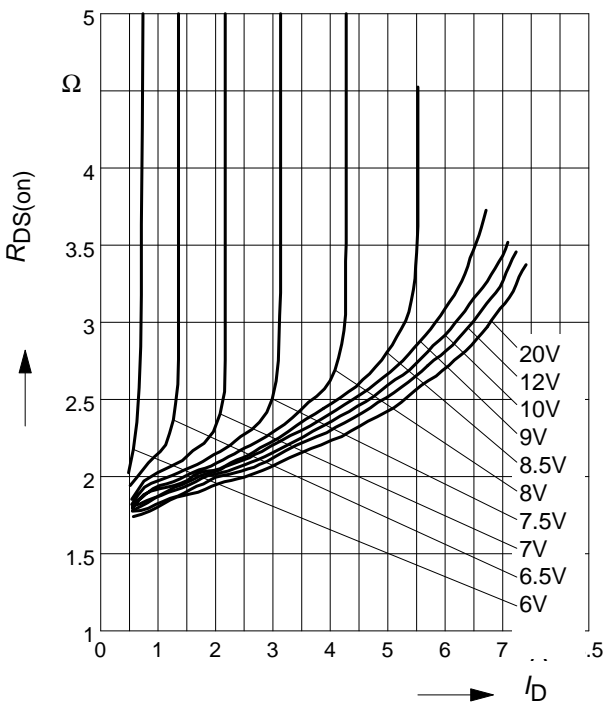
parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



**7 Typ. drain-source on resistance**

$R_{DS(on)} = f(I_D)$

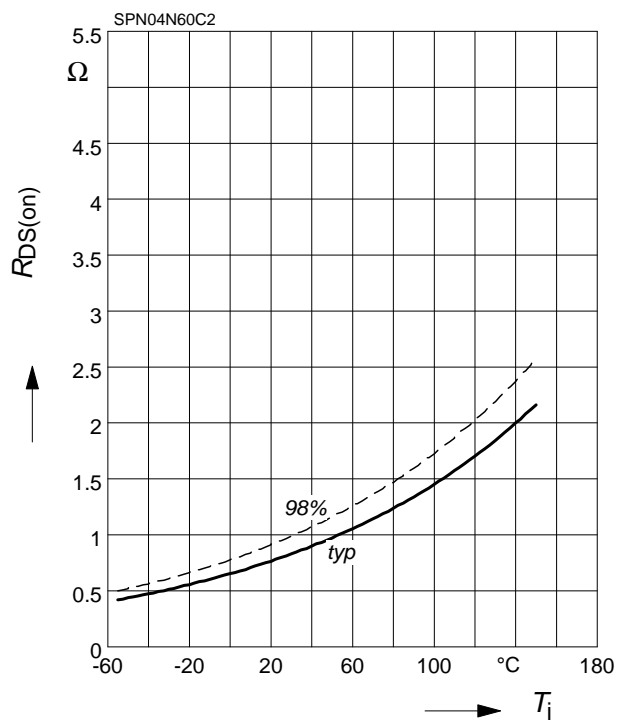
parameter:  $T_j = 150^\circ\text{C}, V_{GS}$



**8 Drain-source on-state resistance**

$R_{DS(on)} = f(T_j)$

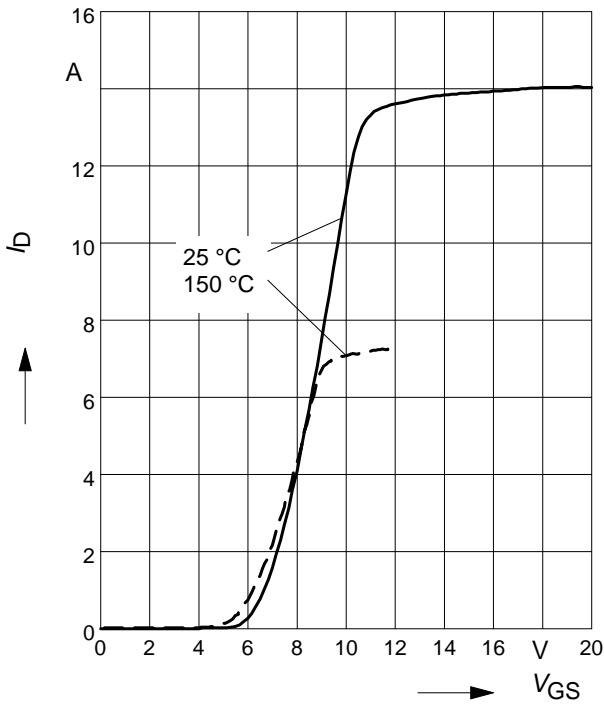
parameter:  $I_D = 0.65 \text{ A}, V_{GS} = 10 \text{ V}$



**9 Typ. transfer characteristics**

$I_D = f(V_{GS})$ ;  $V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$

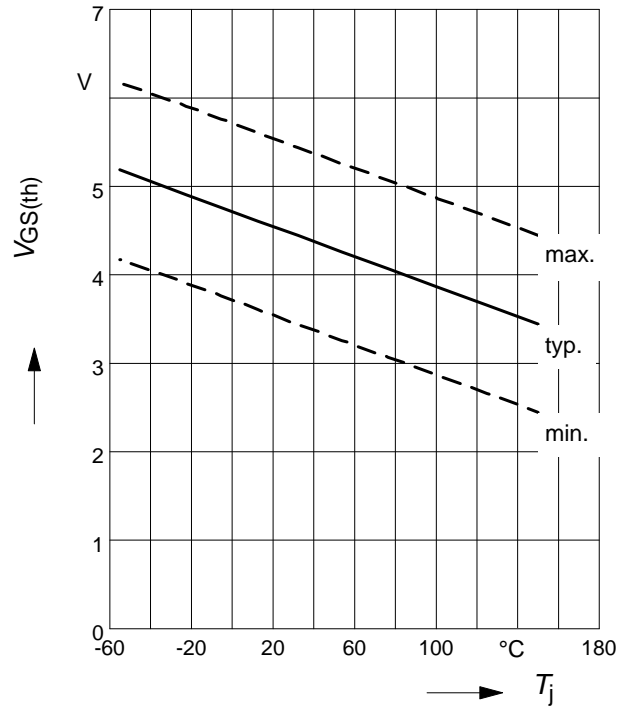
parameter:  $t_p = 10 \mu s$



**10 Gate threshold voltage**

$V_{GS(th)} = f(T_j)$

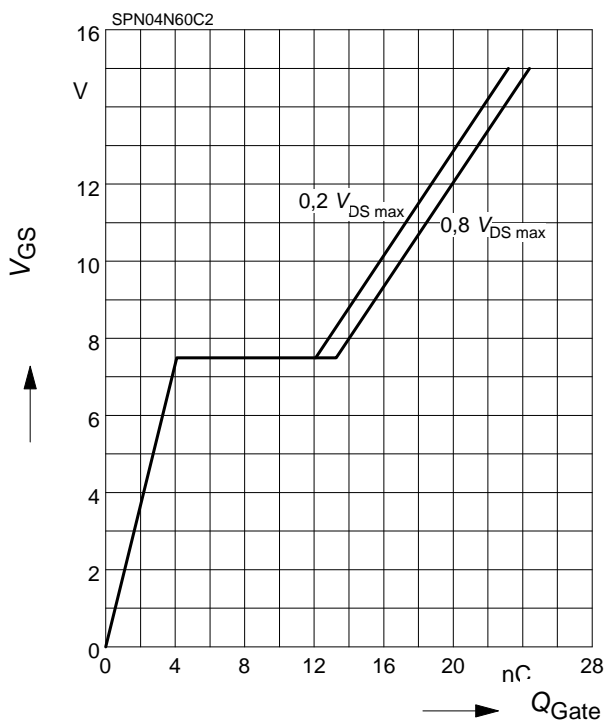
parameter:  $V_{GS} = V_{DS}$ ,  $I_D = 200 \mu A$



**11 Typ. gate charge**

$V_{GS} = f(Q_{Gate})$

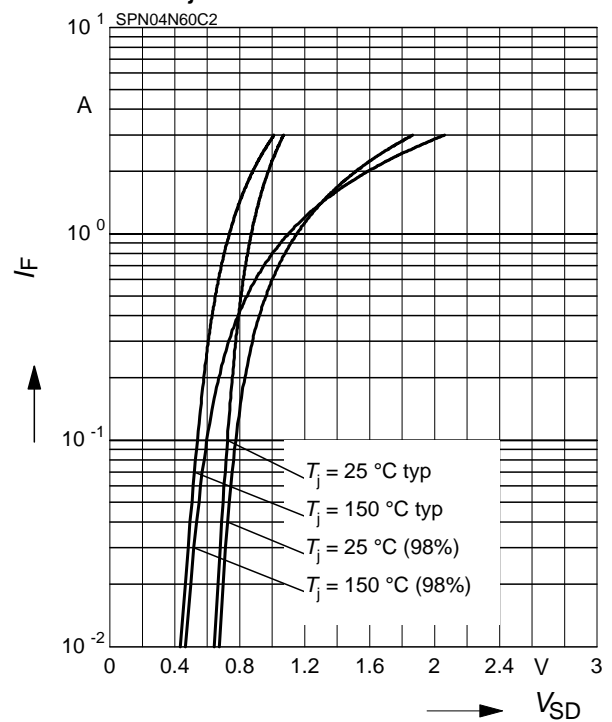
parameter:  $I_D = 0.8 A$  pulsed



**12 Forward characteristics of body diode**

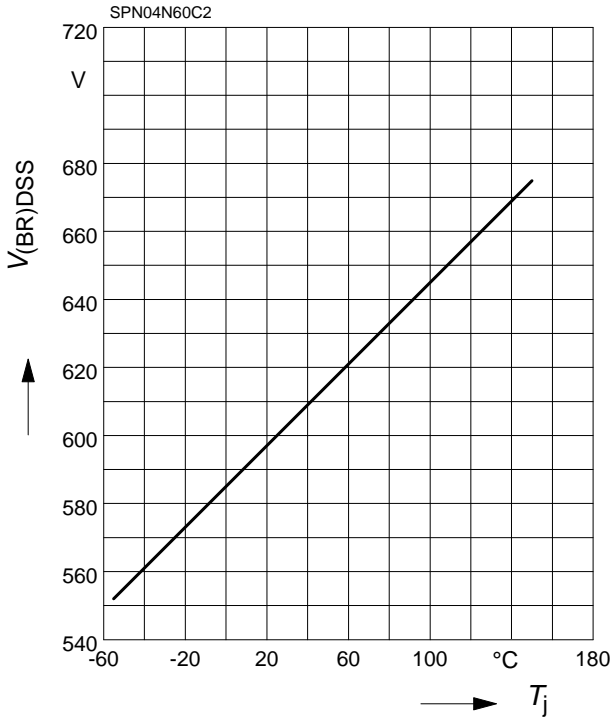
$I_F = f(V_{SD})$

parameter:  $T_j$ ,  $t_p = 10 \mu s$



**13 Drain-source breakdown voltage**

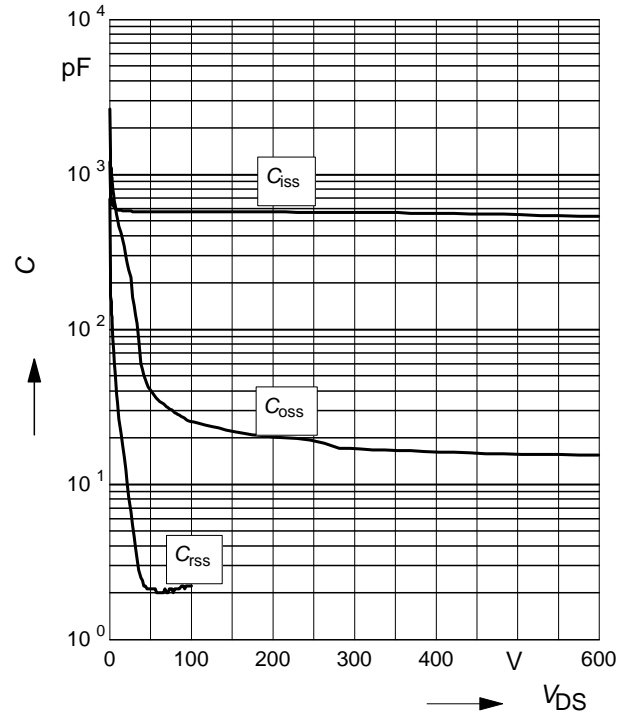
$$V_{(BR)DSS} = f(T_j)$$



**14 Typ. capacitances**

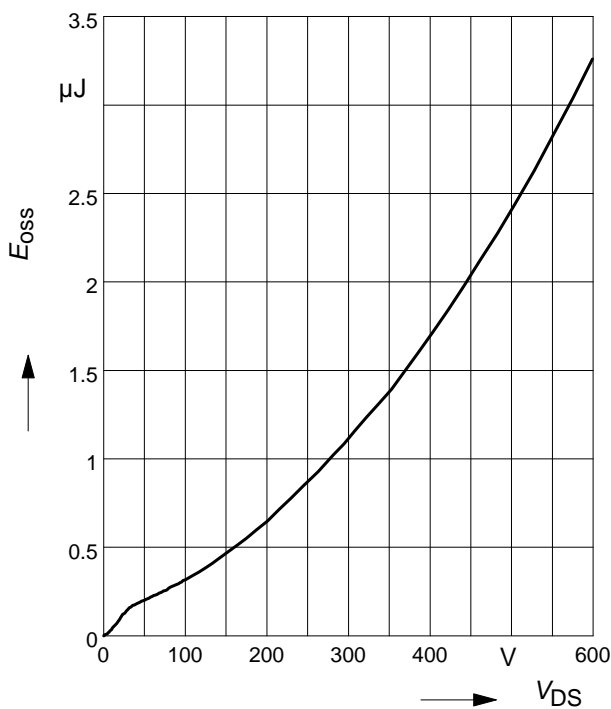
$$C = f(V_{DS})$$

parameter: V<sub>GS</sub>=0V, f=1 MHz



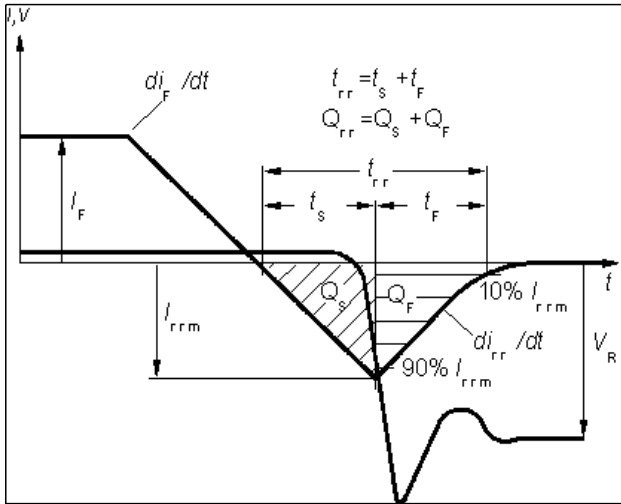
**15 Typ. C<sub>oss</sub> stored energy**

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

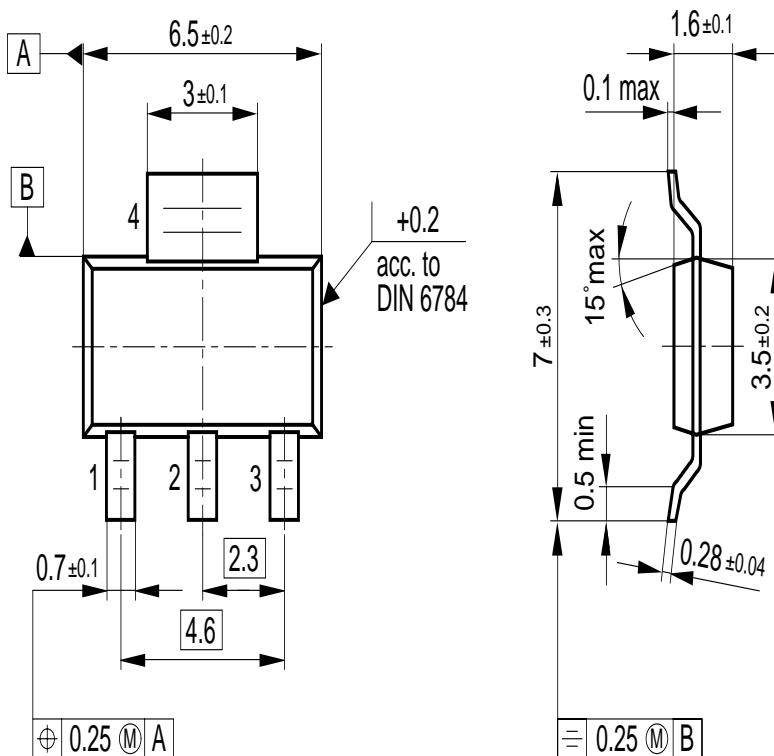




Definition of diodes switching characteristics



SOT223



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