

Cool MOS™ Power Transistor

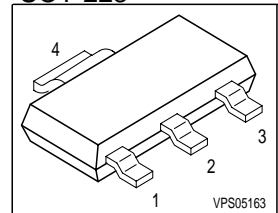
Feature

- 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

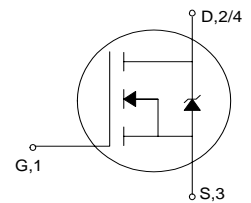
Product Summary

V_{DS}	600	V
$R_{DS(on)}$	0.95	Ω
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}	± 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.	
Characteristics					
Thermal resistance, junction - soldering point	R_{thJS}	-	20	-	K/W
SMD version, device on PCB: @ min. footprint	R_{thJA}	-	110	-	
@ 6 cm ² cooling area ¹⁾		-	-	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	μA
		-	-	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	Ω
Gate input resistance $f = 1\text{ MHz}, \text{open drain}$	R_G	-	0.95	-	

¹Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm² (one layer, 70 μm 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.	
Characteristics						
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 480V	-	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	$t_{d(off)}$	$T_j = 125\text{ }^\circ\text{C}$	-	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 10V	-	17	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$, $I_D = 0.8\text{A}$	-	7.5	-	V

¹ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

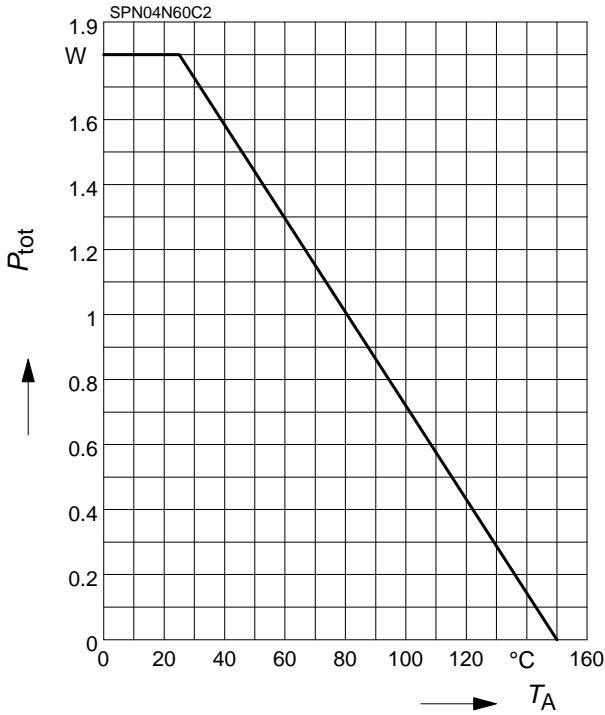
² $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
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	-	μC

1 Power dissipation

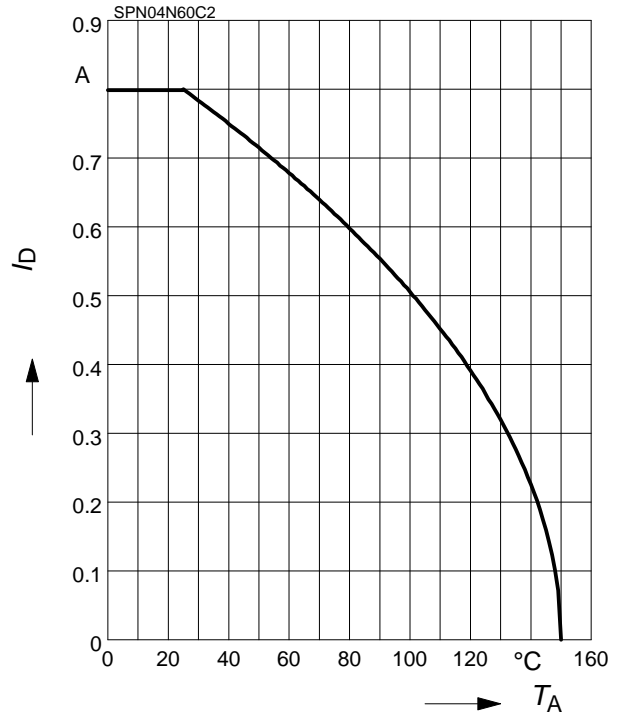
$$P_{tot} = f(T_A)$$



2 Drain current

$$I_D = f(T_A)$$

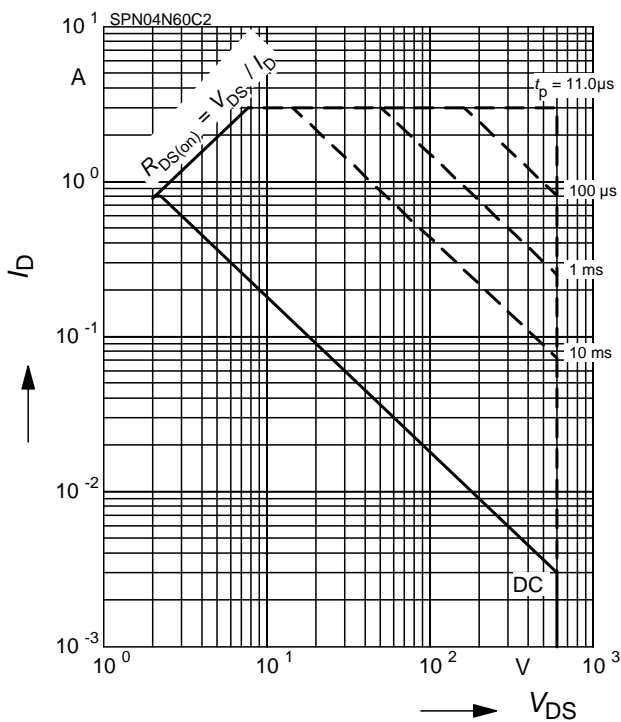
parameter: $V_{GS} \geq 10 \text{ V}$



3 Safe operating area

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

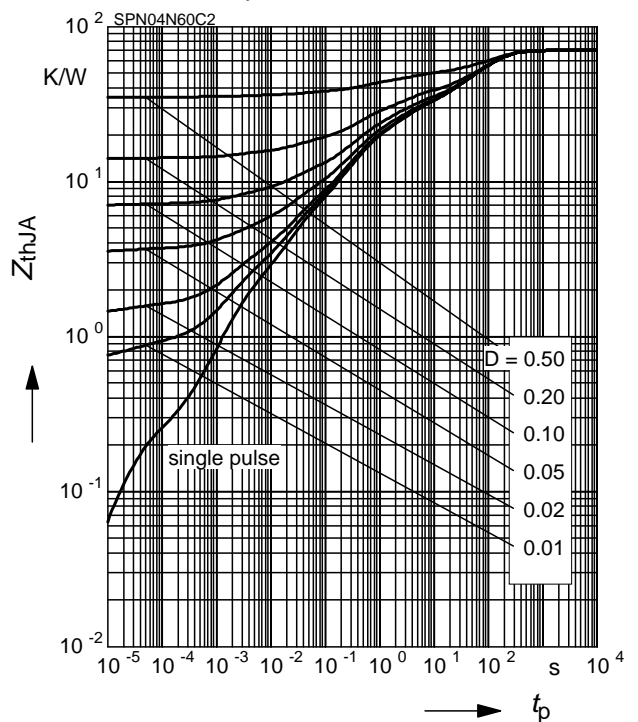
parameter: $D = 0, T_A = 25^\circ\text{C}$



4 Transient thermal impedance

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

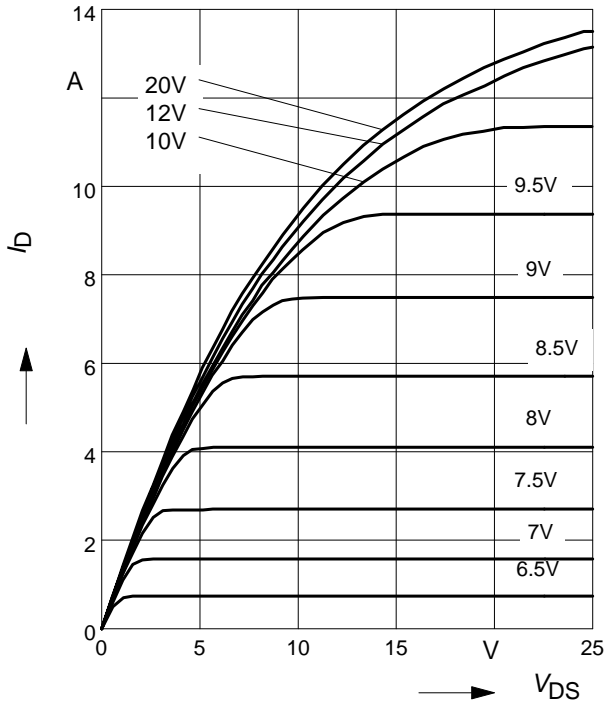
parameter: $D = t_p/T$



5 Typ. output characteristic

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

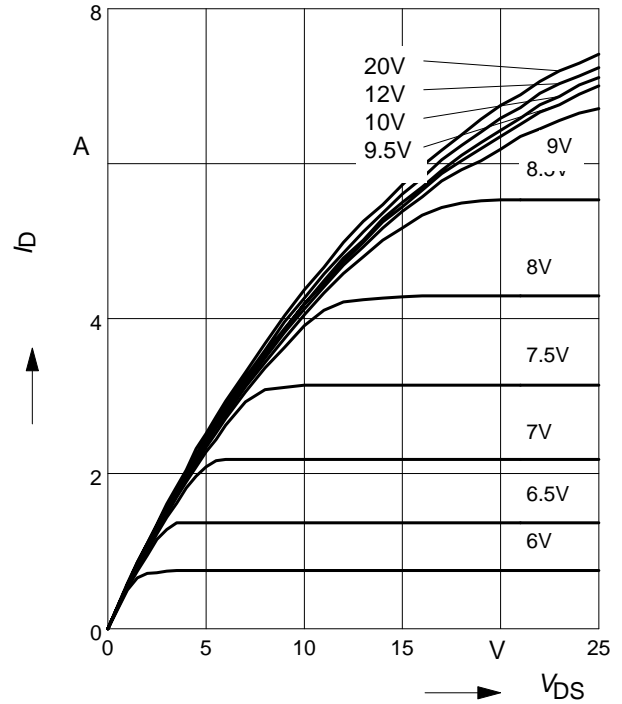
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



6 Typ. output characteristic

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

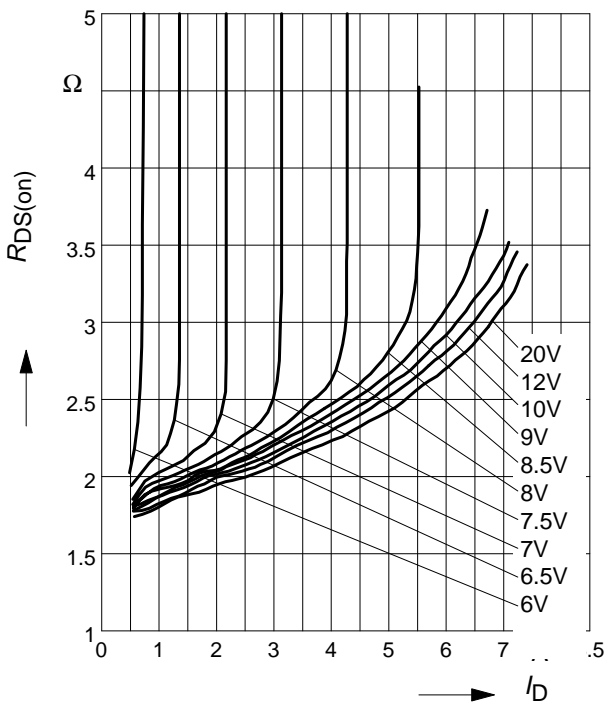
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



7 Typ. drain-source on resistance

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

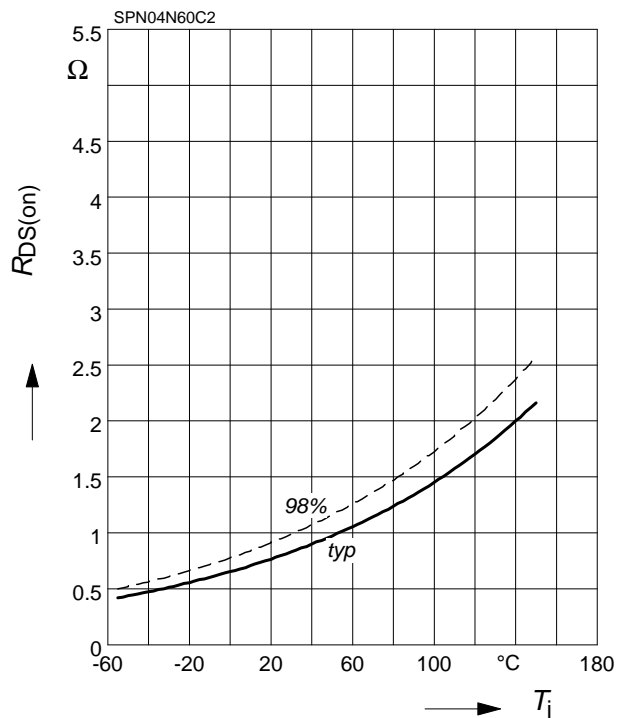
parameter: $T_j = 150^\circ\text{C}, V_{GS}$



8 Drain-source on-state resistance

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

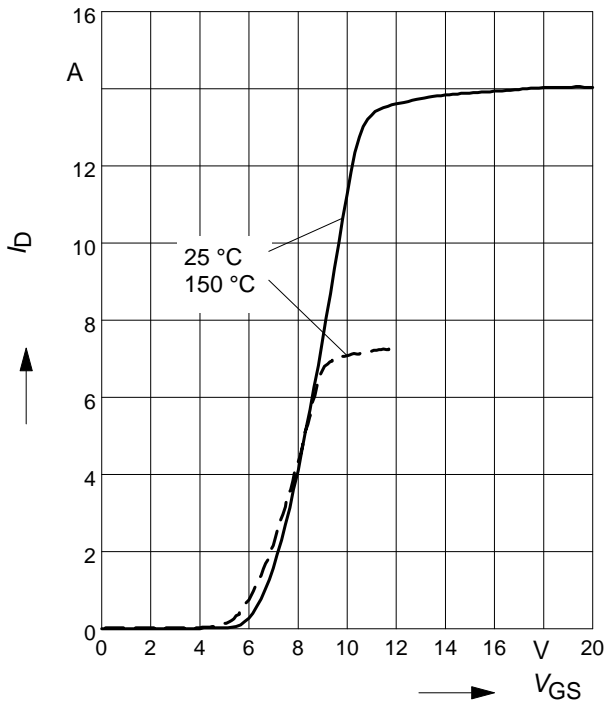
parameter: $I_D = 0.65 \text{ A}, V_{GS} = 10 \text{ V}$



9 Typ. transfer characteristics

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

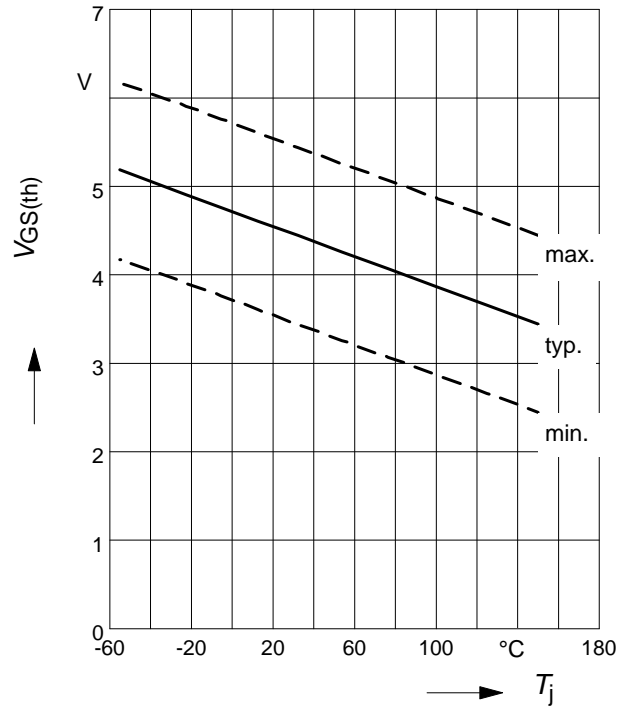
parameter: $t_p = 10 \mu s$



10 Gate threshold voltage

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

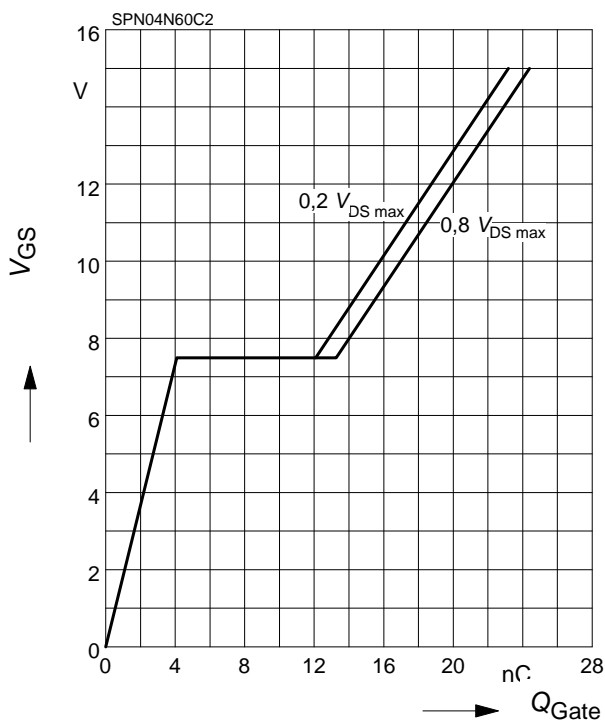
parameter: $V_{GS} = V_{DS}$, $I_D = 200 \mu A$



11 Typ. gate charge

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

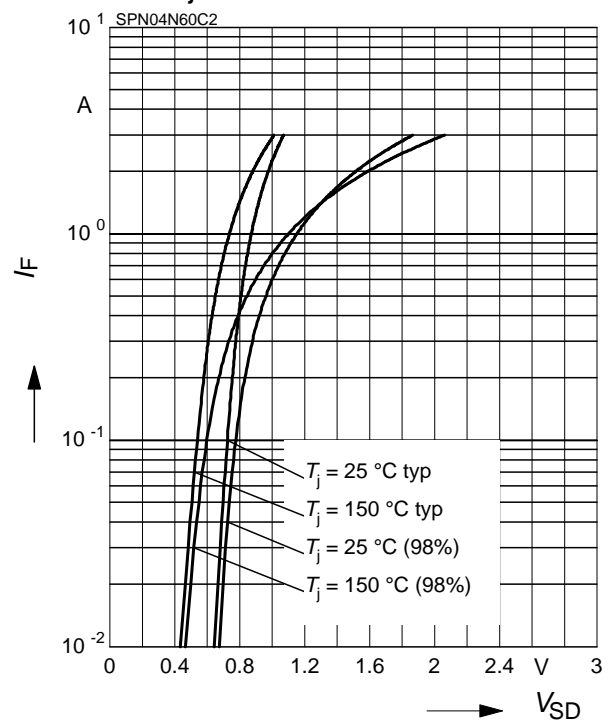
parameter: $I_D = 0.8 A$ pulsed



12 Forward characteristics of body diode

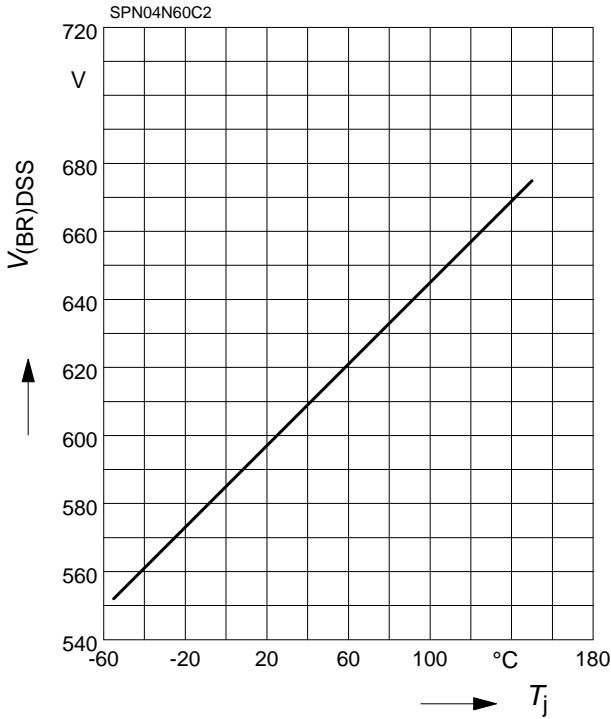
$I_F = f(V_{SD})$

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



13 Drain-source breakdown voltage

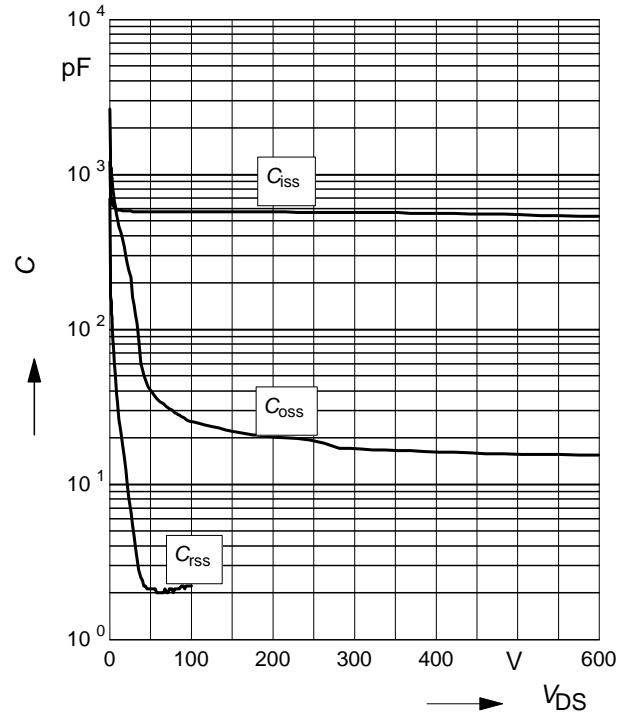
$$V_{(BR)DSS} = f(T_j)$$



14 Typ. capacitances

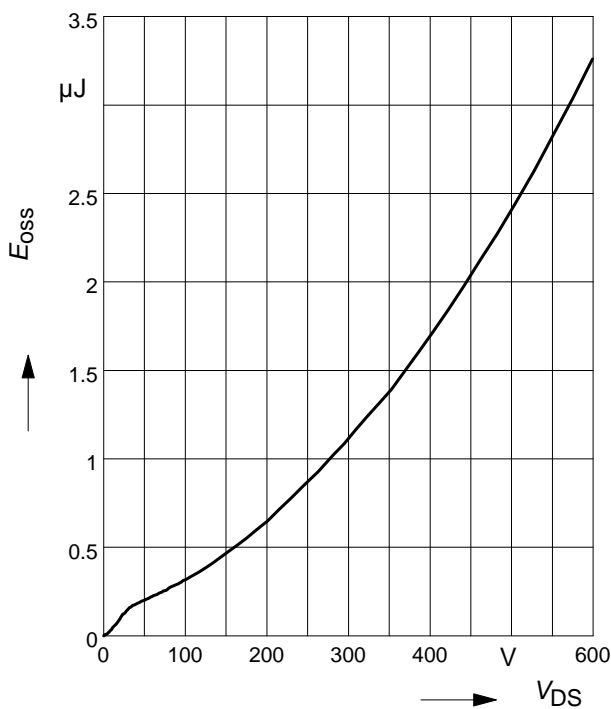
$$C = f(V_{DS})$$

parameter: $V_{GS}=0V, f=1\text{ MHz}$

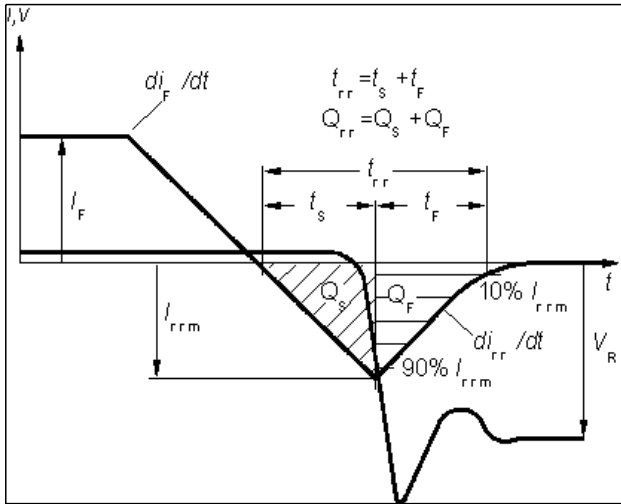


15 Typ. C_{oss} stored energy

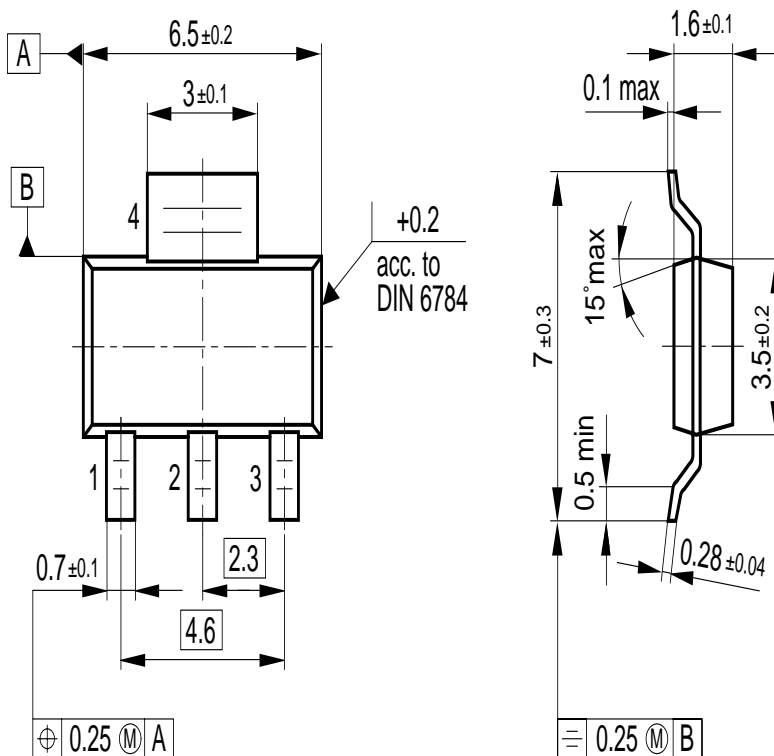
$$E_{oss} = f(V_{DS})$$



Definition of diodes switching characteristics



SOT223



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