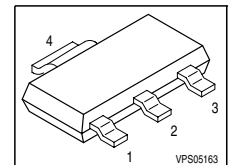


Cool MOS™ Power Transistor
Feature

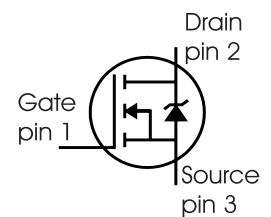
- New revolutionary high voltage technology
- Worldwide best $R_{DS(on)}$ in SOT 223
- Ultra low gate charge
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance

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

SOT-223



Type	Package	Ordering Code	Marking
SPN04N60S5	SOT-223	Q67040-S4211	04N60S5


Maximum Ratings

Parameter	Symbol	Value	Unit
Continuous drain current $T_A = 25\text{ °C}$ $T_A = 70\text{ °C}$	I_D	0.8 0.65	A
Pulsed drain current, t_p limited by T_{jmax} $T_A = 25\text{ °C}$	I_D puls	3	
Gate source voltage	V_{GS}	± 20	V
Gate source voltage AC ($f > 1\text{ Hz}$)	V_{GS}	± 30	
Power dissipation, $T_A = 25\text{ °C}$	P_{tot}	1.8	W
Operating and storage temperature	T_j, T_{stg}	-55... +150	$^{\circ}\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480 \text{ V}$, $I_D = 4.5 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$	dv/dt	20	V/ns

Thermal Characteristics

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

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{V}$, $I_D=0.25\text{mA}$	600	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}$, $I_D=4.5\text{A}$	-	700	-	μA
Gate threshold voltage	$V_{GS(th)}$	$I_D=200\mu\text{A}$, $V_{GS}=V_{DS}$	3.5	4.5	5.5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$, $T_j=150^\circ\text{C}$	-	0.5	1	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=2.8\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.8	0.95	Ω
			-	2.3	-	
Gate input resistance	R_G	$f=1\text{MHz}$, open Drain	-	20	-	

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}	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$	-	600	-	pF
Output capacitance	C_{oss}		-	325	-	
Reverse transfer capacitance	C_{rss}		-	15	-	
Effective output capacitance, ²⁾ energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 480\text{V}$	-	20	-	pF
Effective output capacitance, ³⁾ time related	$C_{o(tr)}$		-	35	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 350\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 0.8\text{A}$, $R_G = 18\Omega$	-	40	-	ns
Rise time	t_r		-	20	-	
Turn-off delay time	$t_{d(off)}$		-	130	-	
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	$V_{DD} = 350\text{V}$, $I_D = 0.8\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$	-	17	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$, $I_D = 0.8\text{A}$	-	8	-	V

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.

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

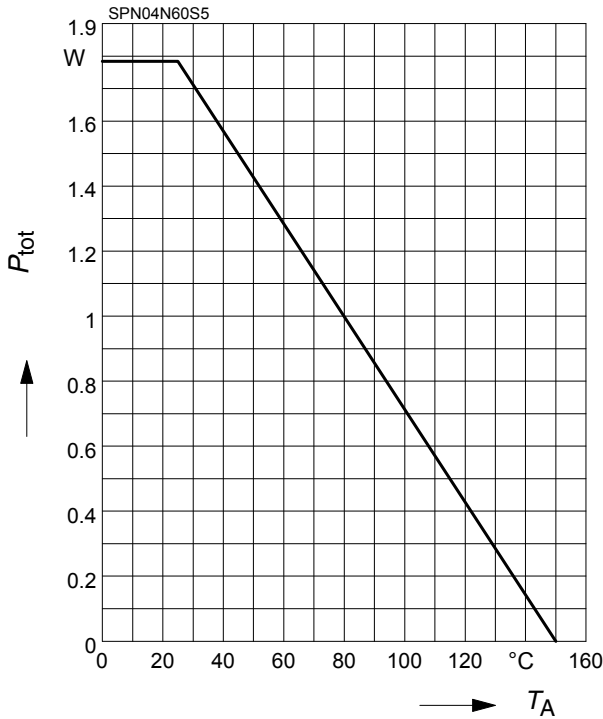
³ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

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

1 Power dissipation

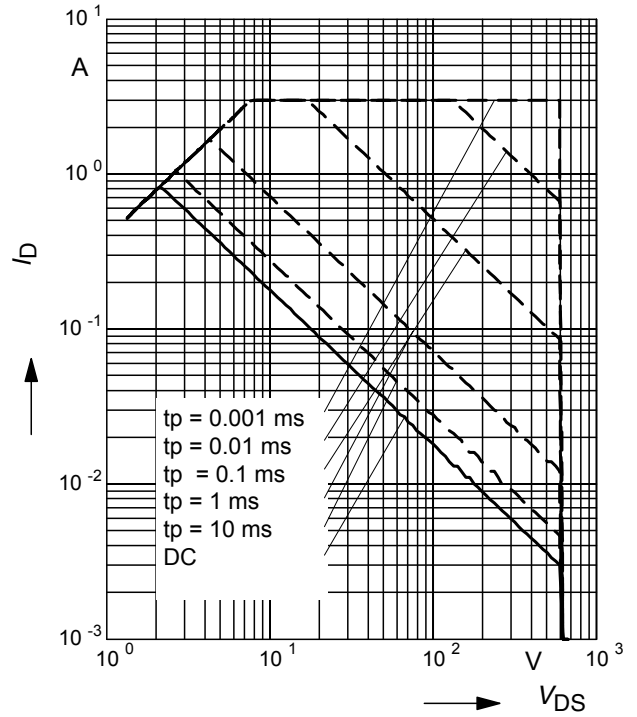
$P_{tot} = f(T_A)$



2 Safe operating area

$I_D = f(V_{DS})$

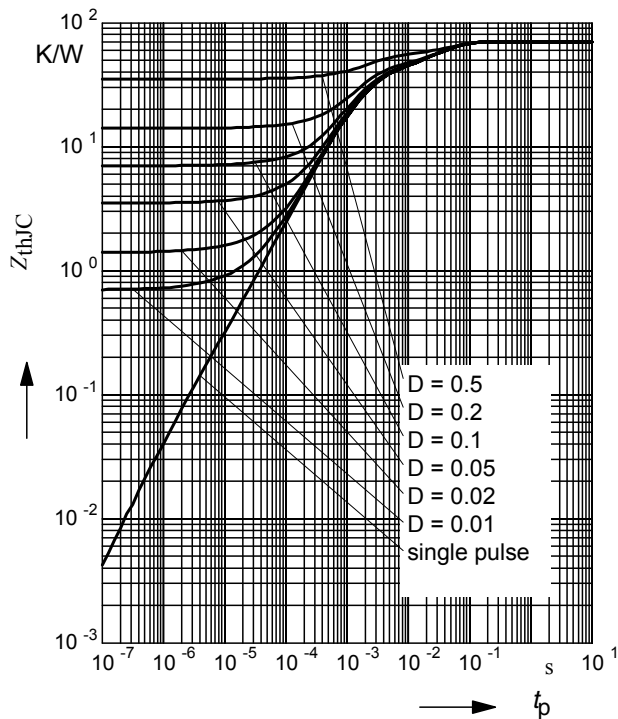
parameter : $D = 0$, $T_A = 25^\circ\text{C}$



3 Transient thermal impedance

$Z_{thJC} = f(t_p)$

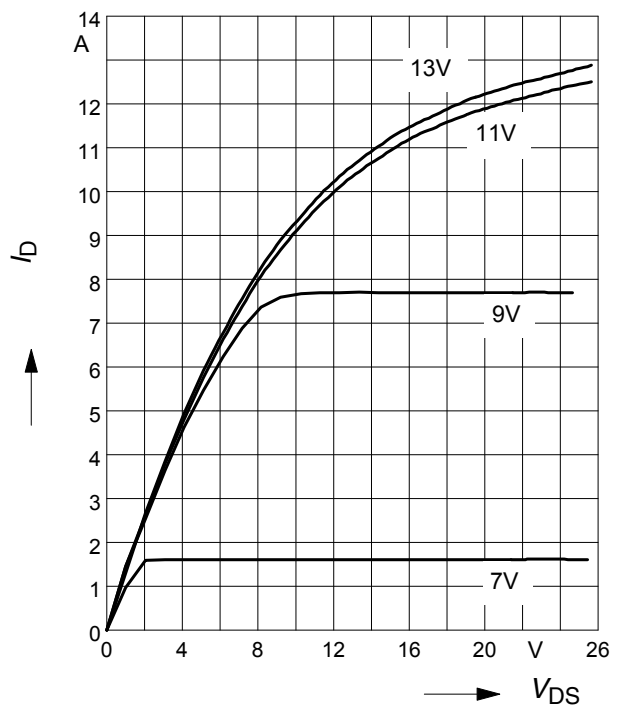
parameter: $D = t_p/T$



4 Typ. output characteristic

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

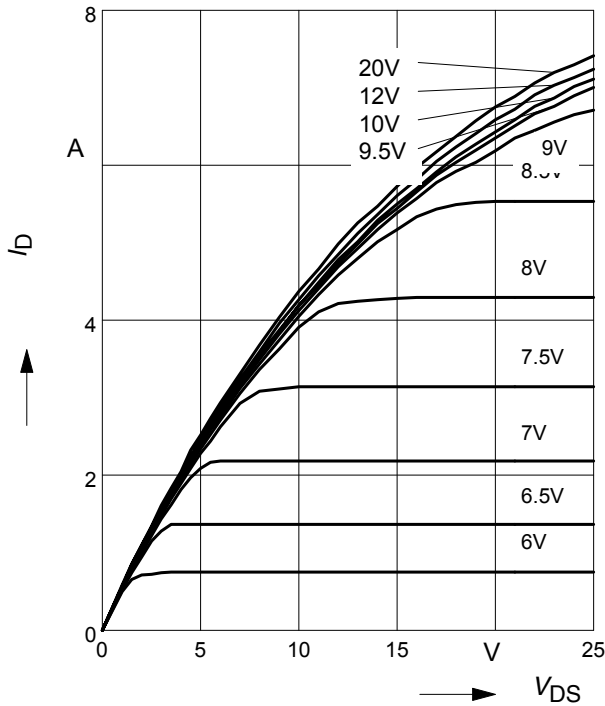
parameter: $t_p = 10 \mu\text{s}$, V_{GS}



5 Typ. output characteristic

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

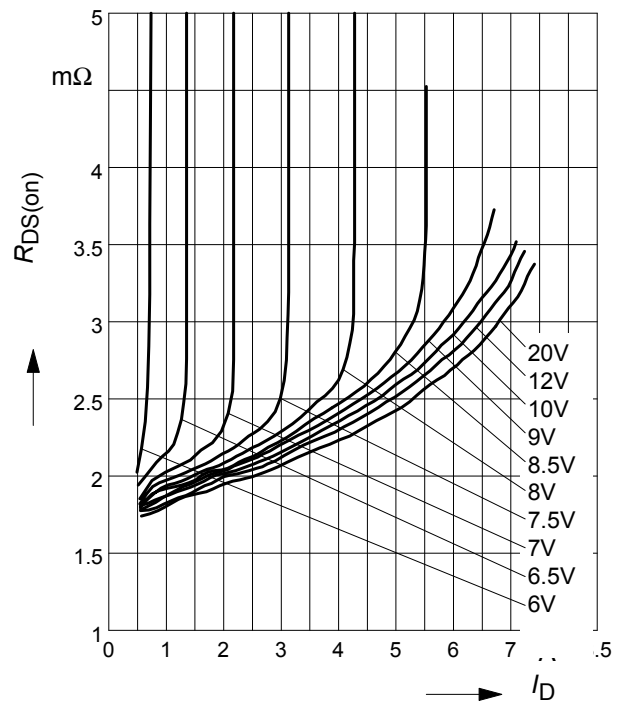
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



6 Typ. drain-source on resistance

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

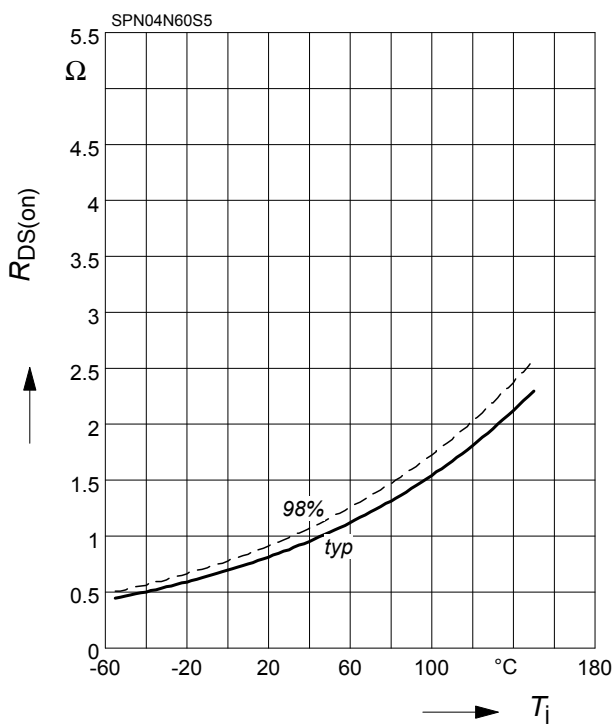
parameter: $T_j = 150^\circ\text{C}, V_{GS}$



7 Drain-source on-state resistance

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

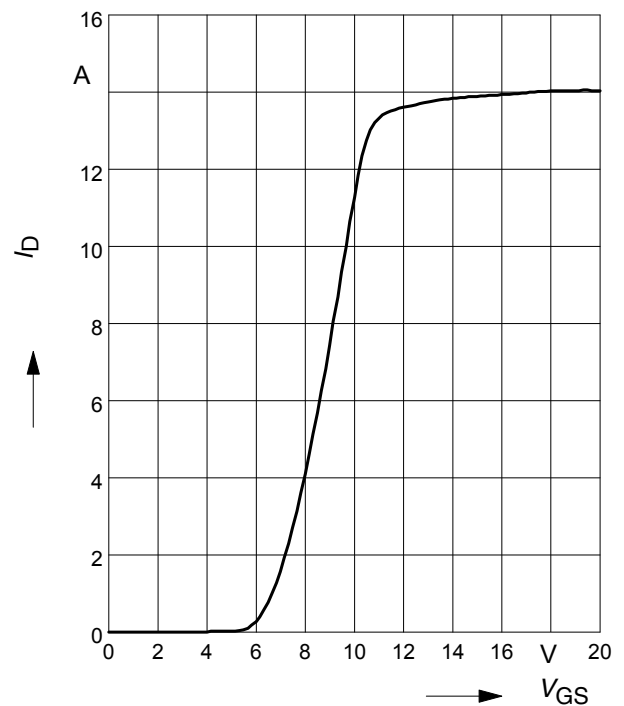
parameter: $I_D = 0.65 \text{ A}, V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

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

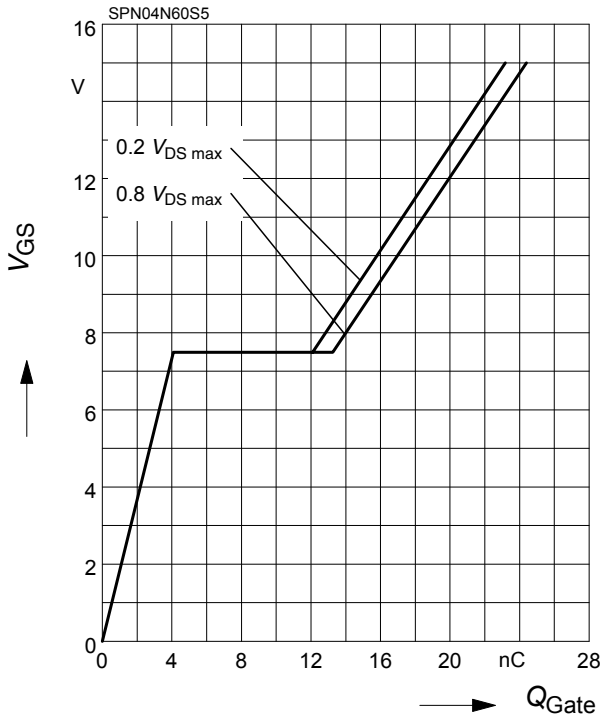
parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

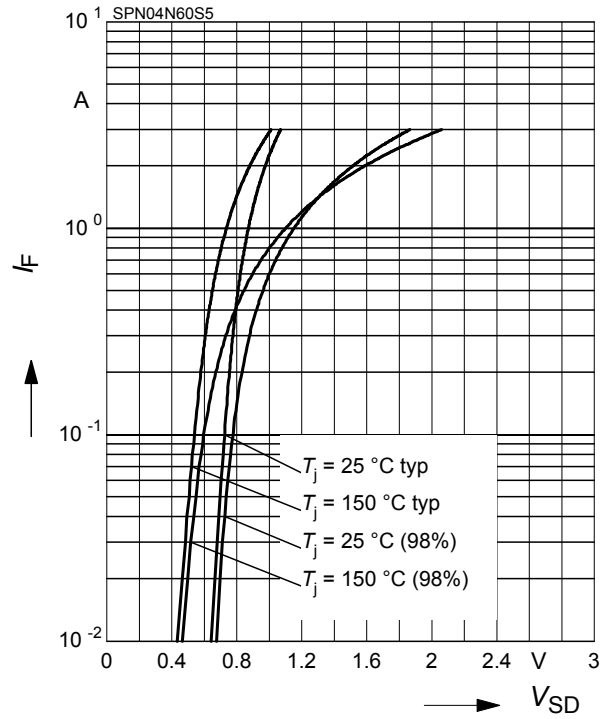
parameter: $I_D = 0.8 \text{ A pulsed}$



10 Forward characteristics of body diode

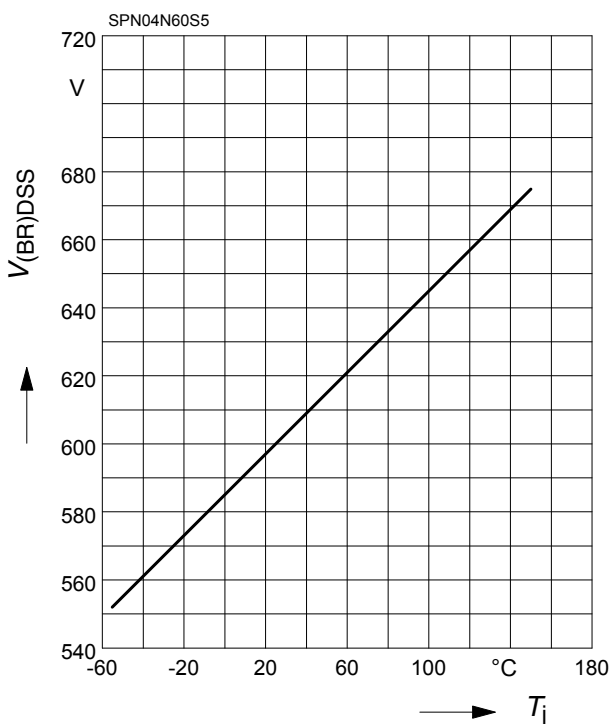
$I_F = f(V_{SD})$

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



11 Drain-source breakdown voltage

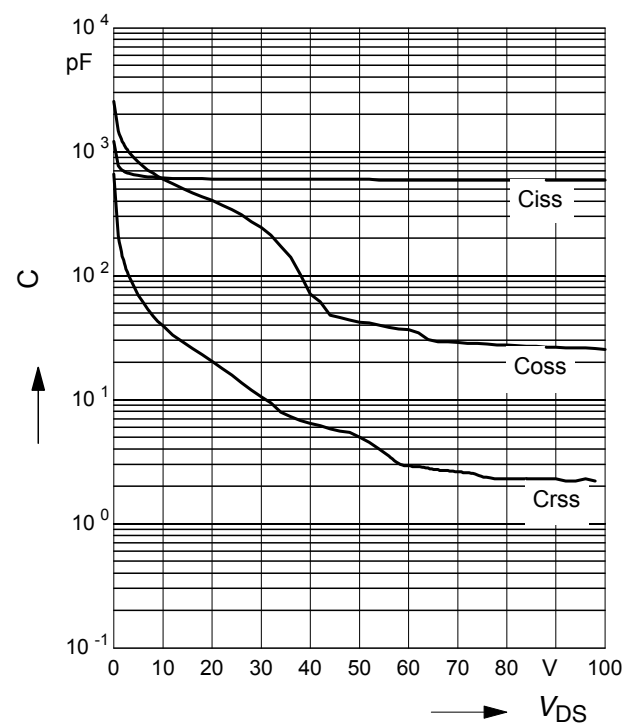
$V_{(BR)DSS} = f(T_j)$



12 Typ. capacitances

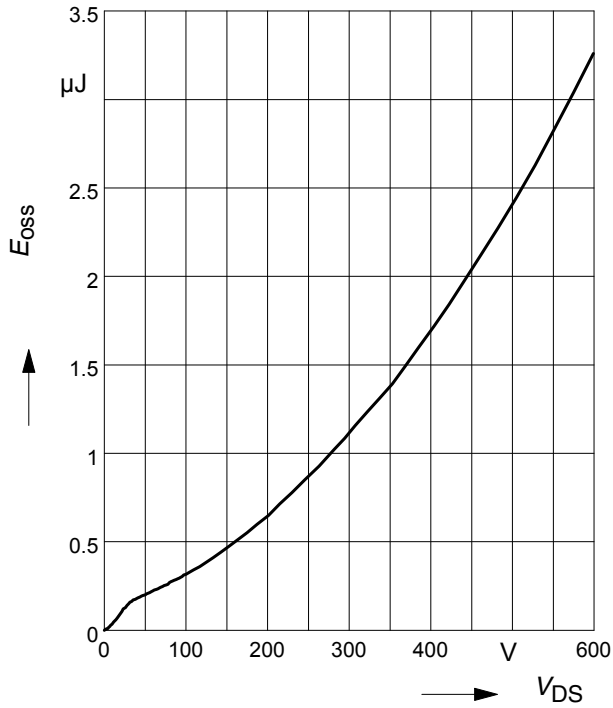
$C = f(V_{DS})$

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

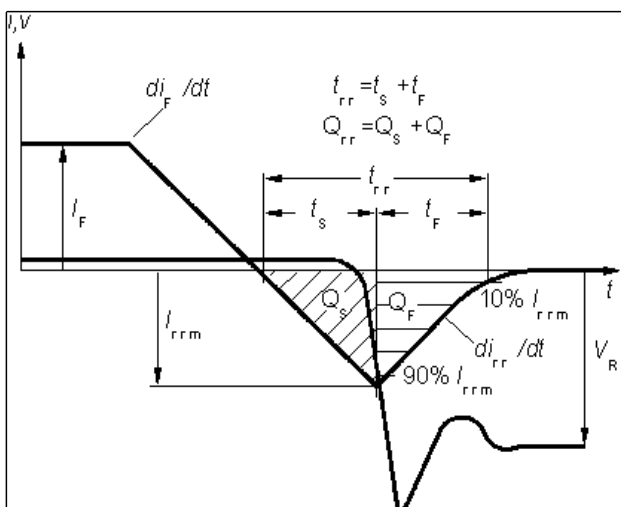


13 Typ. C_{OSS} stored energy

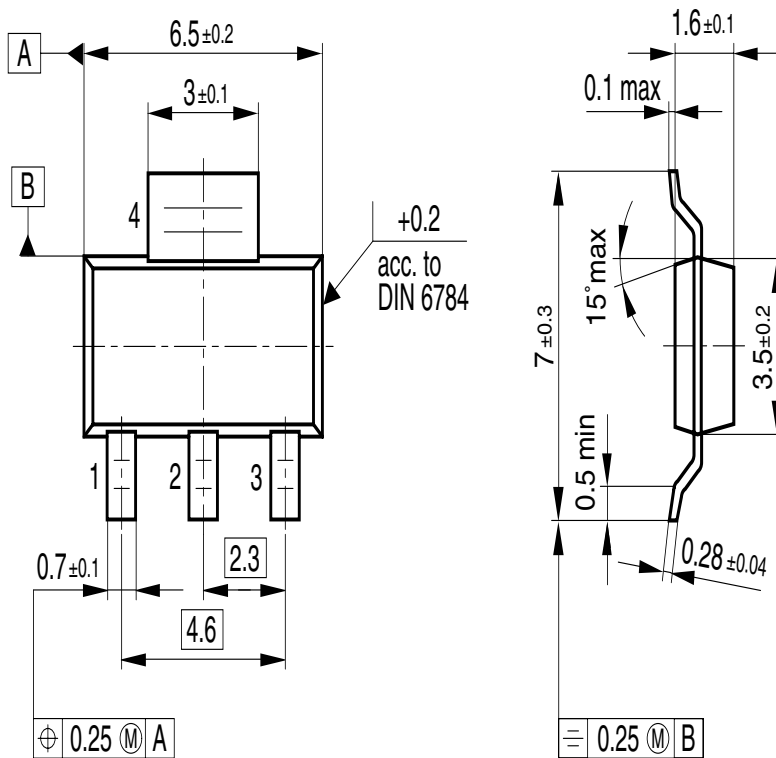
$$E_{OSS} = f(V_{DS})$$



Definition of diodes switching characteristics



SOT223



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