

Cool MOS™ Power Transistor

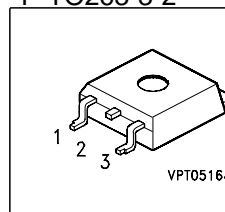


- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Optimized capacitances
- Improved noise immunity
- Former development designation:
SPPx6N60S5/SPBx6N60S5

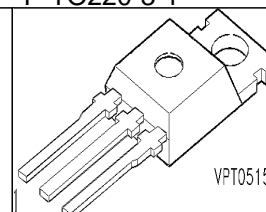
Product Summary

$V_{DS} @ T_{jmax}$	650	V
$R_{DS(on)}$	0.95	Ω
I_D	4.5	A

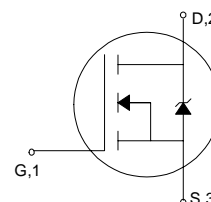
P-TO263-3-2



P-TO220-3-1



Type	Package	Ordering Code	Marking
SPP04N60S5	P-TO220-3-1	Q67040-S4200	04N60S5
SPB04N60S5	P-TO263-3-2	Q67040-S4201	04N60S5



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

Parameter	Symbol	Value	Unit
Continuous drain current	I_D	4.5	A
$T_C = 25^\circ\text{C}$			
$T_C = 100^\circ\text{C}$		2.8	
Pulsed drain current ¹⁾	$I_{D \text{ puls}}$	7.7	
$T_C = 25^\circ\text{C}$			
Avalanche energy, single pulse	E_{AS}	130	mJ
$I_D = 3.6 \text{ A}$, $V_{DD} = 50 \text{ V}$			
Avalanche energy (repetitive, limited by T_{jmax})	E_{AR}	0.4	
$I_D = 4.5 \text{ A}$, $V_{DD} = 50 \text{ V}$			
Avalanche current (repetitive, limited by T_{jmax})	I_{AR}	4.5	A
Reverse diode dv/dt	dv/dt	6	kV/ μs
$I_S = 4.5 \text{ A}$, $V_{DS} < V_{DSS}$, $di/dt = 100 \text{ A}/\mu\text{s}$, $T_{jmax} = 150^\circ\text{C}$			
Gate source voltage	V_{GS}	± 20	V
Power dissipation	P_{tot}	50	W
$T_C = 25^\circ\text{C}$			
Operating and storage temperature	T_j, T_{stg}	-55... +150	$^\circ\text{C}$

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

Parameter	Symbol	Values			Unit
		min.	typ.	max.	

Thermal Characteristics

Thermal resistance, junction - case	R_{thJC}	-	-	2.5	K/W
Thermal resistance, junction - ambient (Leaded and through-hole packages)	R_{thJA}	-	-	62	
SMD version, device on PCB: @ min. footprint @ 6 cm ² cooling area ²⁾	R_{thJA}	- -	- 35	62 -	

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

Drain-source breakdown voltage $V_{GS} = 0\text{ V}$, $I_D = 0.25\text{ mA}$	$V_{(BR)DSS}$	600	-	-	V
Gate threshold voltage, $V_{GS} = V_{DS}$ $I_D = 200\text{ }\mu\text{A}$, $T_j = 25\text{ °C}$	$V_{GS(th)}$	3.5	4.5	5.5	
Zero gate voltage drain current, $V_{DS} = V_{DSS}$ $V_{GS} = 0\text{ V}$, $T_j = 25\text{ °C}$ $V_{GS} = 0\text{ V}$, $T_j = 150\text{ °C}$	I_{DSS}	- -	0.5 -	1 50	μA
Gate-source leakage current $V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$	I_{GSS}	-	-	100	nA
Drain-source on-state resistance $V_{GS} = 10\text{ V}$, $I_D = 2.8\text{ A}$	$R_{DS(on)}$	-	0.85	0.95	Ω

¹ current limited by T_{jmax}
² Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6 cm² (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.	

Dynamic Characteristics

Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 2.8\text{A}$	-	2.5	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$	-	580	-	pF
Output capacitance	C_{oss}		-	220	-	
Reverse transfer capacitance	C_{rss}		-	7	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 350\text{V}$, $V_{GS} = 10\text{V}$, $I_D = 4.5\text{A}$, $R_G = 18\Omega$	-	55	-	ns
Rise time	t_r	$V_{DD} = 350\text{V}$, $V_{GS} = 10\text{V}$, $I_D = 4.5\text{A}$, $R_G = 18\Omega$	-	30	-	
Turn-off delay time	$t_{d(off)}$	$I_D = 4.5\text{A}$, $R_G = 18\Omega$	-	60	90	
Fall time	t_f	$I_D = 4.5\text{A}$, $R_G = 18\Omega$	-	15	22.5	

Gate Charge Characteristics

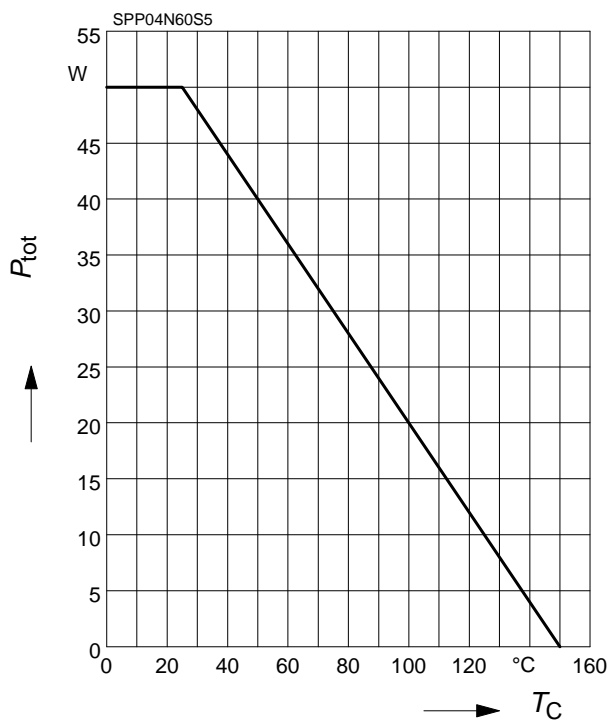
Gate to source charge	Q_{gs}	$V_{DD} = 350\text{V}$, $I_D = 4.5\text{A}$	-	4.5	-	nC
Gate to drain charge	Q_{gd}		-	11	-	
Total gate charge	Q_g	$V_{DD} = 350\text{V}$, $I_D = 4.5\text{A}$, $V_{GS} = 0\text{ to }10\text{V}$	-	17.6	22.9	

Reverse Diode

Inverse diode continuous forward current	I_S	$T_C = 25^{\circ}\text{C}$	-	-	4.5	A
Inverse diode direct current, pulsed	I_{SM}		-	-	7.7	
Inverse diode forward voltage	V_{SD}	$V_{GS} = 0\text{V}$, $I_F = 4.5\text{A}$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R = 350\text{V}$, $I_F = I_S$	-	900	1530	ns
Reverse recovery charge	Q_{rr}	$di_F/dt = 100\text{A}/\mu\text{s}$	-	3.2	-	

Power dissipation

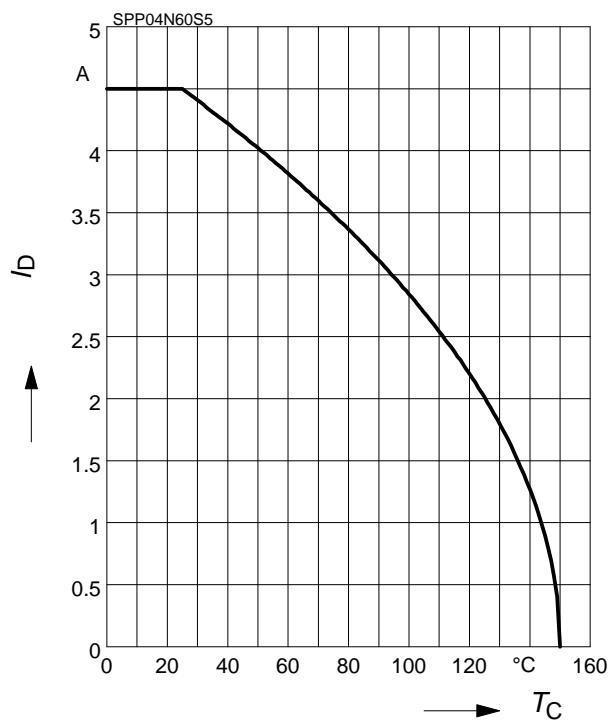
$$P_{\text{tot}} = f(T_C)$$



Drain current

$$I_D = f(T_C)$$

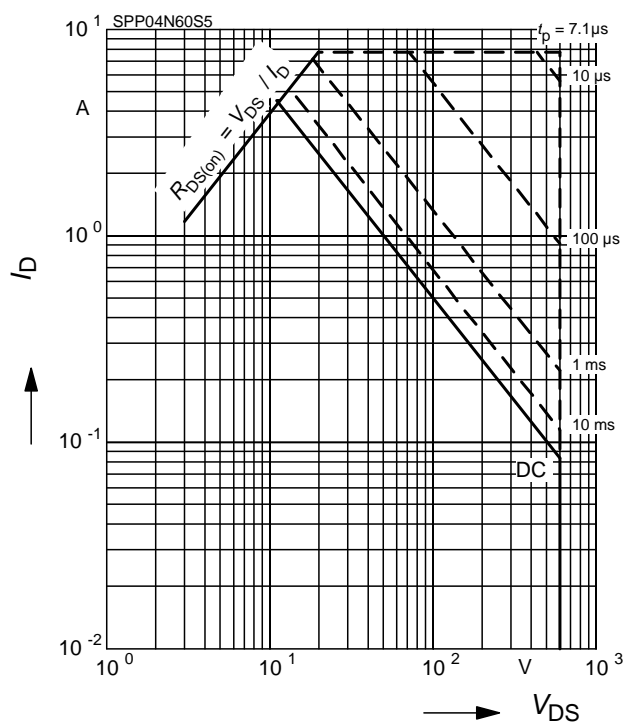
parameter: $V_{GS} \geq 10 \text{ V}$



Safe operating area

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

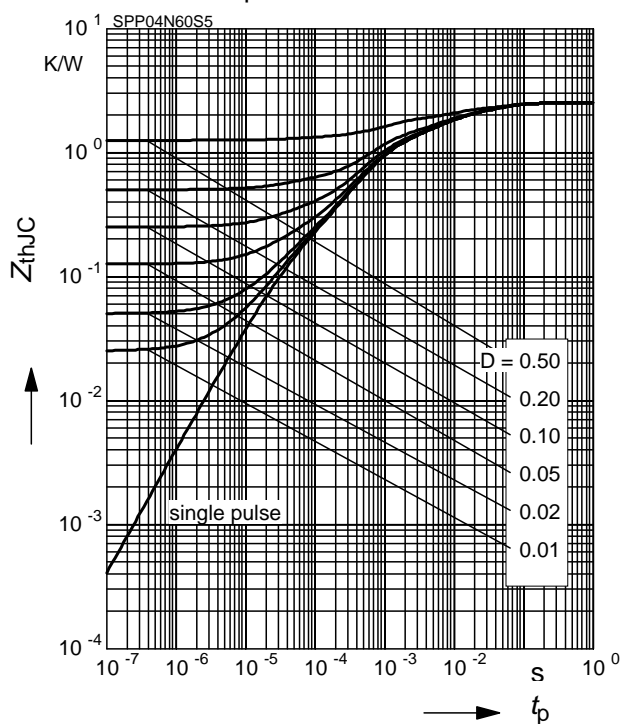
parameter: $D=0.01$, $T_C=25^\circ\text{C}$



Transient thermal impedance

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

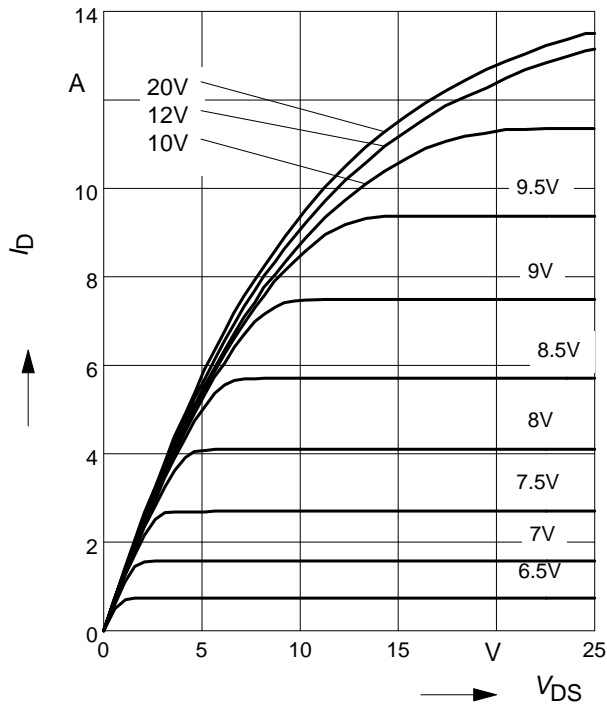
parameter: $D = t_p / T$



Typ. output characteristic

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

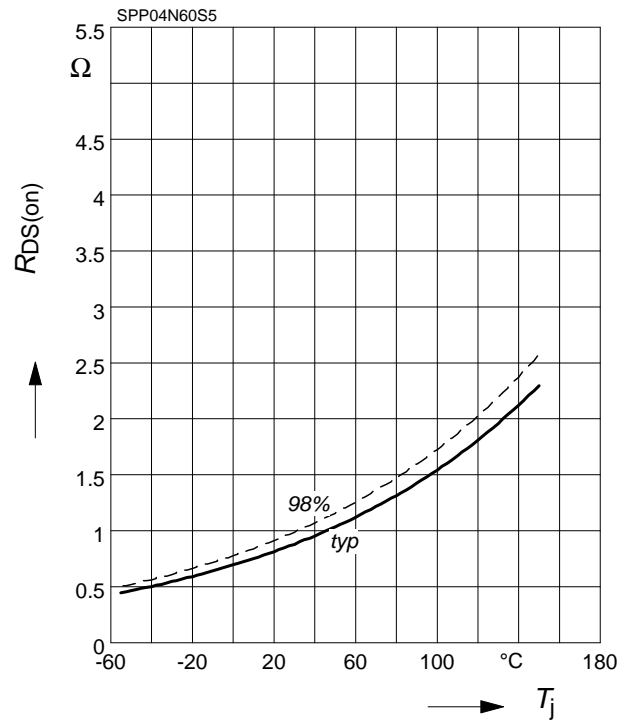
Parameter: V_{GS} , $T_j = 25^\circ\text{C}$



Drain-source on-resistance

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

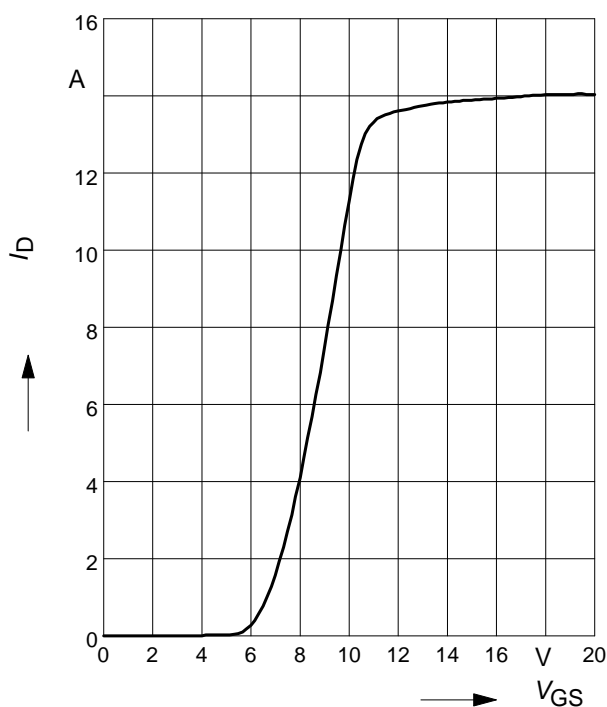
parameter: $I_D = 2.8\text{ A}$, $V_{GS} = 10\text{ V}$



Typ. transfer characteristics

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

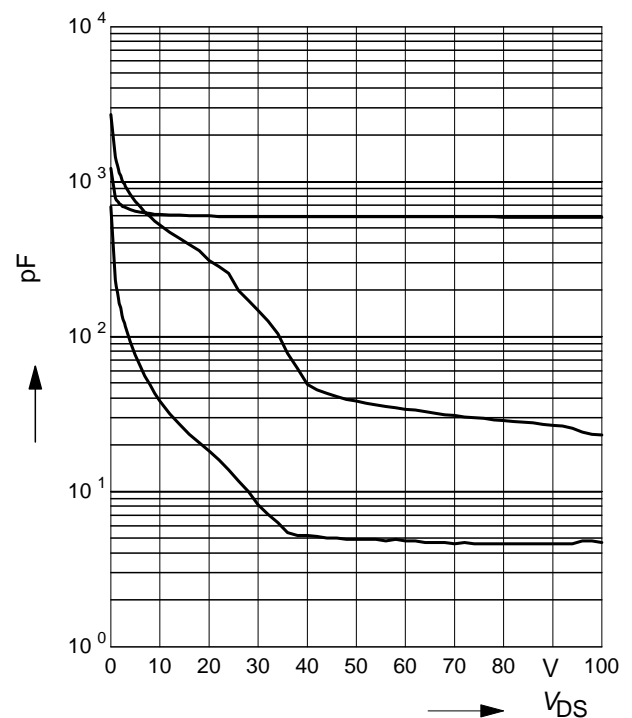
$V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$



Typ. capacitances

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

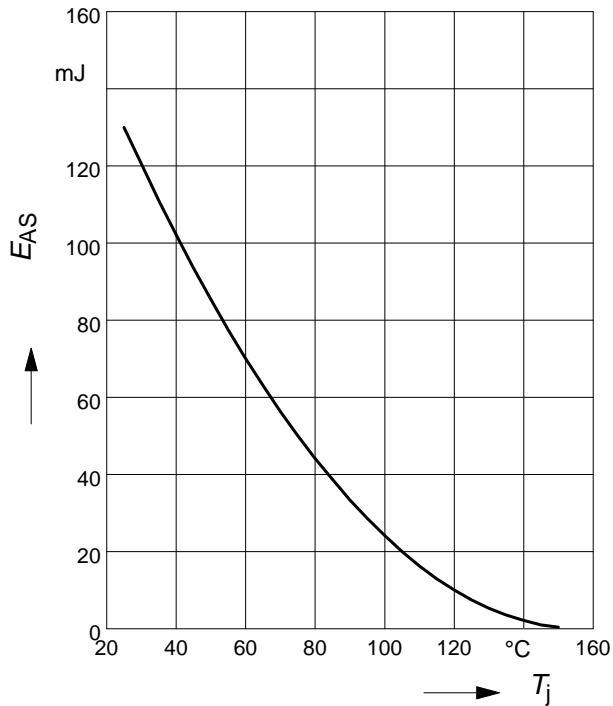
parameter: $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$



Avalanche energy

$$E_{AS} = f(T_j)$$

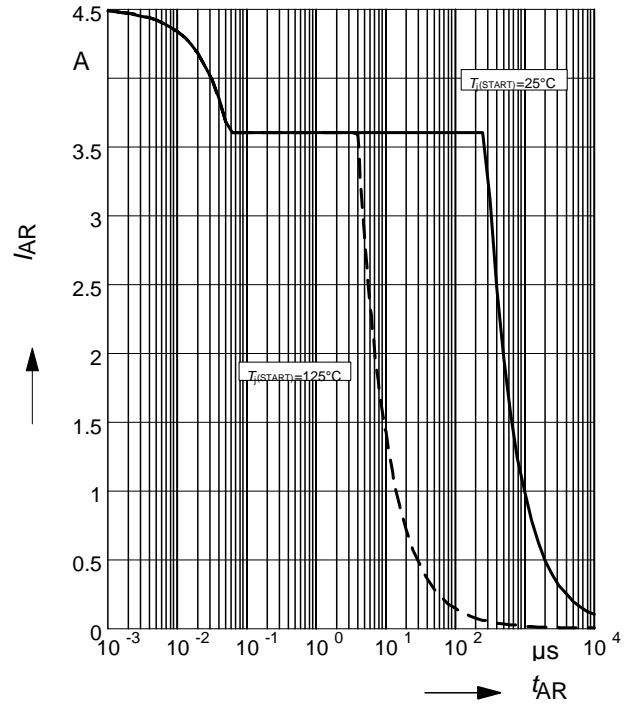
par.: $I_D = 3.6A$, $V_{DD} = 50V$



Avalanche SOA

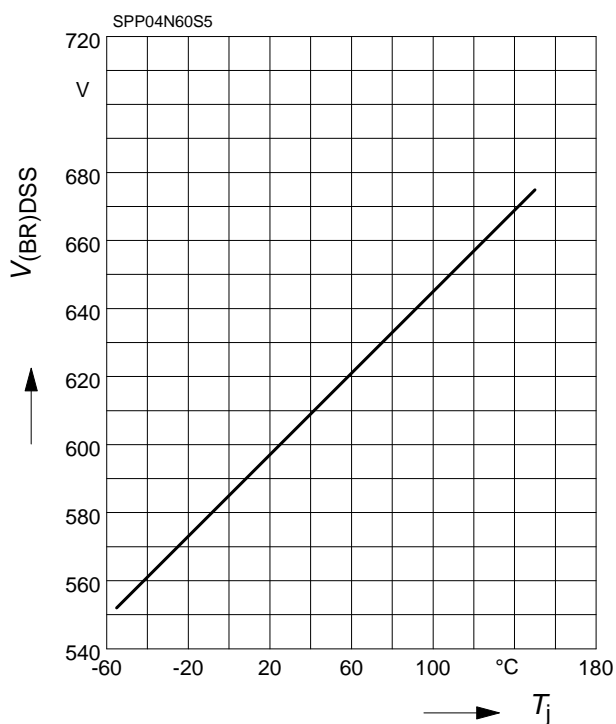
$$I_{AR} = f(t_{AR})$$

par.: $T_j \leq 150^\circ C$



Drain-source breakdown voltage

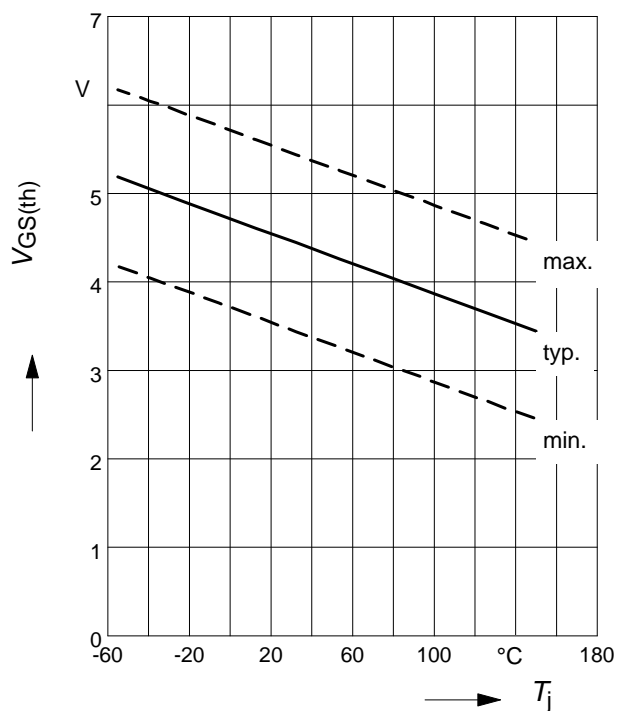
$$V_{(BR)DSS} = f(T_j)$$



Gate threshold voltage

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

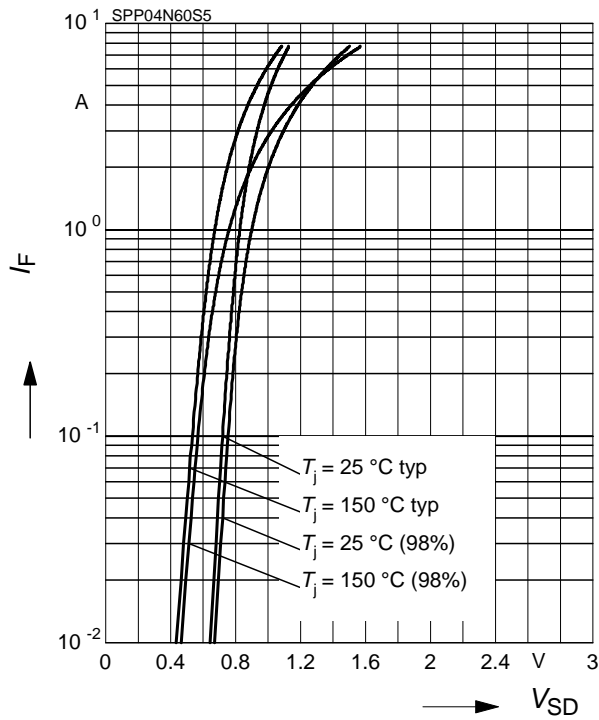
parameter: $V_{GS} = V_{DS}$, $I_D = 200 \mu A$



Forward characteristics of reverse diode

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

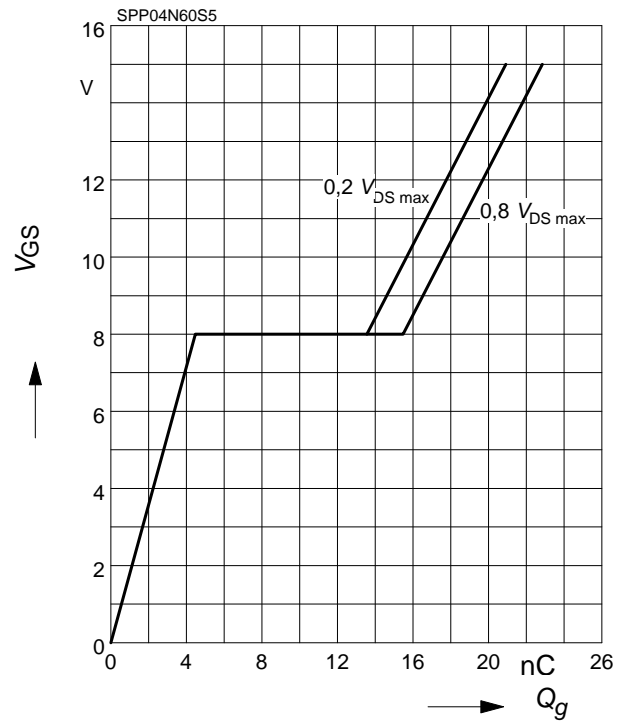
parameter: T_j , $t_p = 10 \mu s$



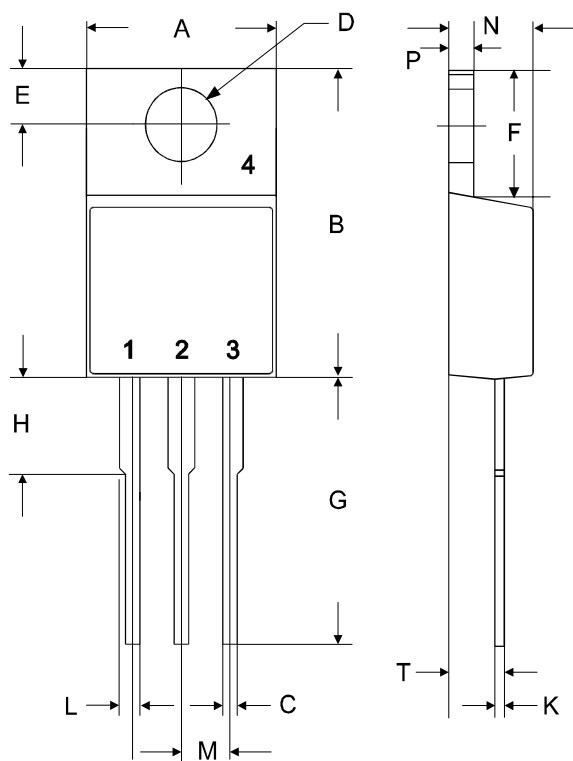
Typ. gate charge

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

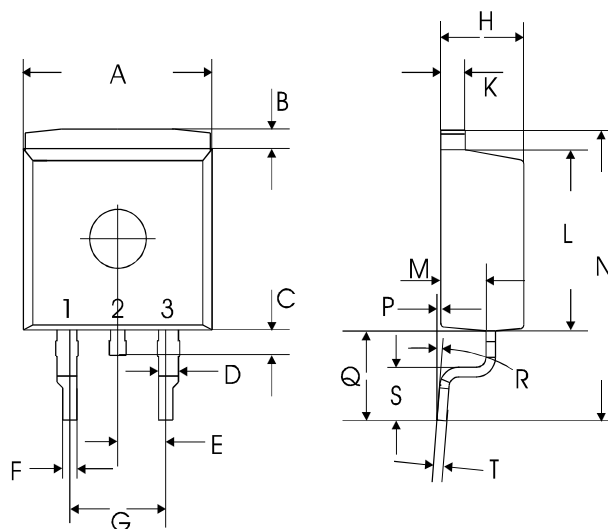
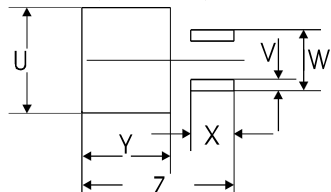
parameter: $I_{Dpuls} = 4.5 \text{ A}$



P-TO220-3-1



symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.70	10.30	0.3819	0.4055
B	14.88	15.95	0.5858	0.6280
C	0.65	0.86	0.0256	0.0339
D	3.55	3.89	0.1398	0.1531
E	2.60	3.00	0.1024	0.1181
F	6.00	6.80	0.2362	0.2677
G	13.00	14.00	0.5118	0.5512
H	4.35	4.75	0.1713	0.1870
K	0.38	0.65	0.0150	0.0256
L	0.95	1.32	0.0374	0.0520
M	2.54 typ.		0.1 typ.	
N	4.30	4.50	0.1693	0.1772
P	1.17	1.40	0.0461	0.0551
T	2.30	2.72	0.0906	0.1071

TO-263 (D²Pak/P-TO220SMD)

Footprint
(dif. scale)


symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.80	10.20	0.3858	0.4016
B	0.70	1.30	0.0276	0.0512
C	1.00	1.60	0.0394	0.0630
D	1.03	1.07	0.0406	0.0421
E	2.54 typ.		0.1 typ.	
F	0.65	0.85	0.0256	0.0335
G	5.08 typ.		0.2 typ.	
H	4.30	4.50	0.1693	0.1772
K	1.17	1.37	0.0461	0.0539
L	9.05	9.45	0.3563	0.3720
M	2.30	2.50	0.0906	0.0984
N	15 typ.		0.5906 typ.	
P	0.00	0.20	0.0000	0.0079
Q	4.20	5.20	0.1654	0.2047
R	8° max		8° max	
S	2.40	3.00	0.0945	0.1181
T	0.40	0.60	0.0157	0.0236
U	10.80		0.4252	
V	1.15		0.0453	
W	6.23		0.2453	
X	4.60		0.1811	
Y	9.40		0.3701	
Z	16.15		0.6358	

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