

Cool MOS™ Power Transistor

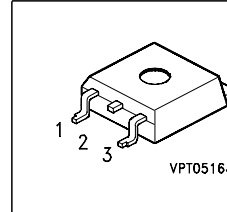


- New revolutionary high voltage technology
- Worldwide best $R_{DS(on)}$ in TO 220
- Ultra low gate charge
- Improved periodic avalanche rating
- Extreme dv/dt rated
- Optimized capacitances
- Improved noise immunity
- Former development designation:
SPPx1N60S5/SPBx1N60S5

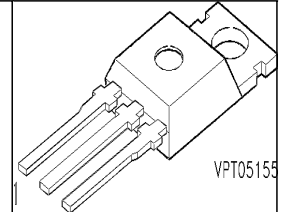
Product Summary

$V_{DS} @ T_{jmax}$	650	V
$R_{DS(on)}$	0.19	Ω
I_D	20	A

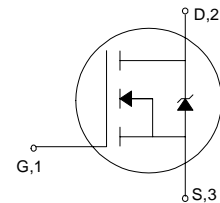
P-TO263-3-2



P-TO220-3-1



Type	Package	Ordering Code	Marking
SPP20N60S5	P-TO220-3-1	Q67040-S4751	20N60S5
SPB20N60S5	P-TO263-3-2	Q67040-S4171	20N60S5



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

Parameter	Symbol	Value	Unit
Continuous drain current	I_D	20	A
$T_C=25\text{ }^\circ\text{C}$		20	
$T_C=100\text{ }^\circ\text{C}$		13	
Pulsed drain current ¹⁾	$I_{D\text{ puls}}$	40	A
$T_C=25\text{ }^\circ\text{C}$			
Avalanche energy, single pulse	E_{AS}	690	mJ
$I_D = 10\text{ A}, V_{DD} = 50\text{ V}$			
Avalanche energy (repetitive, limited by T_{jmax})	E_{AR}	1	mJ
$I_D = 20\text{ A}, V_{DD} = 50\text{ V}$			
Avalanche current (repetitive, limited by T_{jmax})	I_{AR}	20	A
Reverse diode dv/dt	dv/dt	6	kV/ μs
$I_S=20\text{ A}, V_{DS}<V_{DSS}, di/dt=100\text{ A}/\mu\text{s}, T_{jmax}=150\text{ }^\circ\text{C}$			
Gate source voltage	V_{GS}	± 20	V
Power dissipation	P_{tot}	208	W
$T_C=25\text{ }^\circ\text{C}$			
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}	-	-	0.6	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}	-	-	62	
		-	35	-	

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, $V_{GS} = V_{DS}$ $I_D = 1\text{ mA}$, $T_j = 25\text{ °C}$	$V_{GS(th)}$	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	25	μA
		-	-	250	
Gate-source leakage current $V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$	I_{GSS}	-	-	100	nA
Drain-source on-state resistance $V_{GS} = 10\text{ V}$, $I_D = 13\text{ A}$	$R_{DS(on)}$	-	0.16	0.19	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}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 13\text{A}$	-	12	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$	-	3000	-	pF
Output capacitance	C_{oss}		-	1170	-	
Reverse transfer capacitance	C_{rss}		-	28	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 350\text{V}$, $V_{GS} = 10\text{V}$, $I_D = 20\text{A}$, $R_G = 5.7\Omega$	-	120	-	ns
Rise time	t_r		-	25	-	
Turn-off delay time	$t_{d(off)}$		-	140	210	
Fall time	t_f		-	30	45	

Gate Charge Characteristics

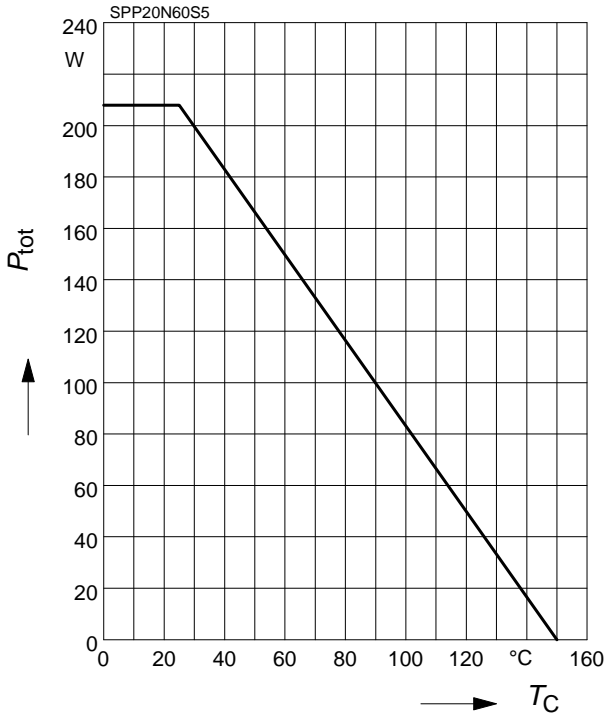
Gate to source charge	Q_{gs}	$V_{DD} = 350\text{V}$, $I_D = 20\text{A}$	-	21	-	nC
Gate to drain charge	Q_{gd}		-	47	-	
Total gate charge	Q_g	$V_{DD} = 350\text{V}$, $I_D = 20\text{A}$, $V_{GS} = 0$ to 10V	-	79	103	

Reverse Diode

Inverse diode continuous forward current	I_S	$T_C = 25\text{ }^\circ\text{C}$	-	-	20	A
Inverse diode direct current, pulsed	I_{SM}		-	-	40	
Inverse diode forward voltage	V_{SD}	$V_{GS} = 0\text{V}$, $I_F = 20\text{A}$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R = 100\text{V}$, $I_F = I_S$, $di_F/dt = 100\text{A}/\mu\text{s}$	-	610	-	ns
Reverse recovery charge	Q_{rr}		-	12	-	μC

Power dissipation

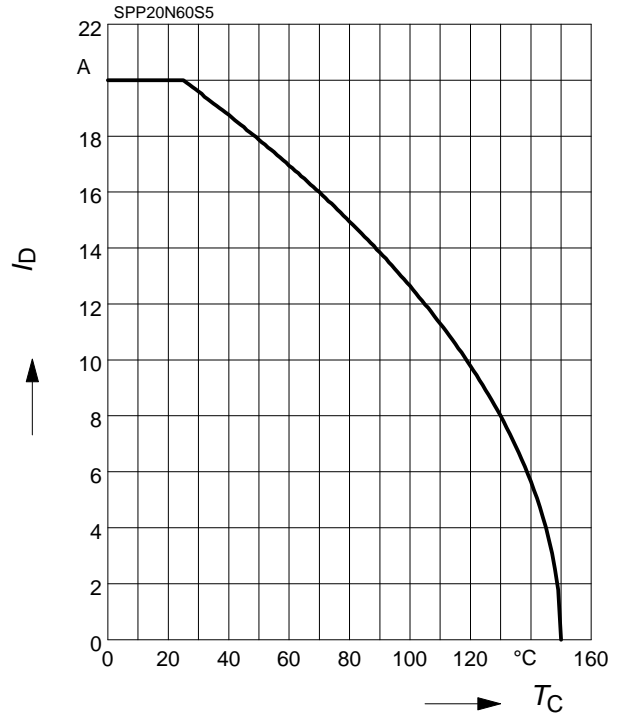
$$P_{tot} = f(T_C)$$



Drain current

$$I_D = f(T_C)$$

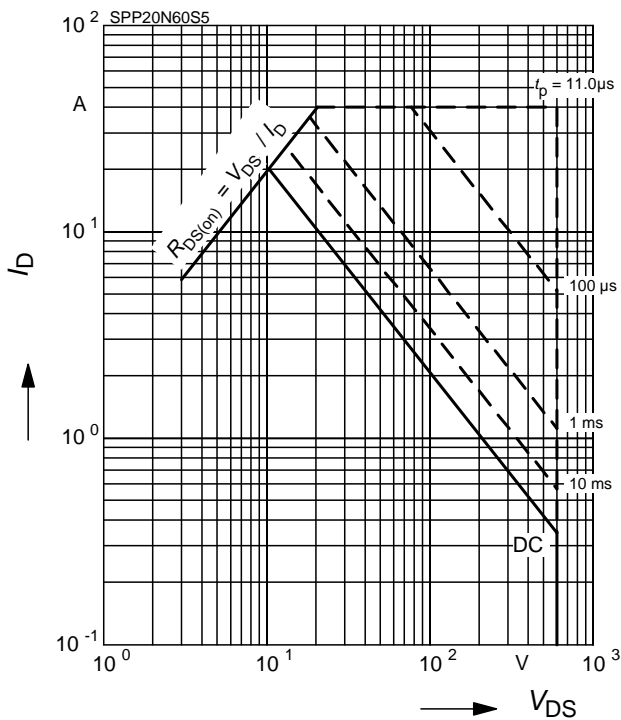
parameter: $V_{GS} \geq 10\text{ V}$



Safe operating area

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

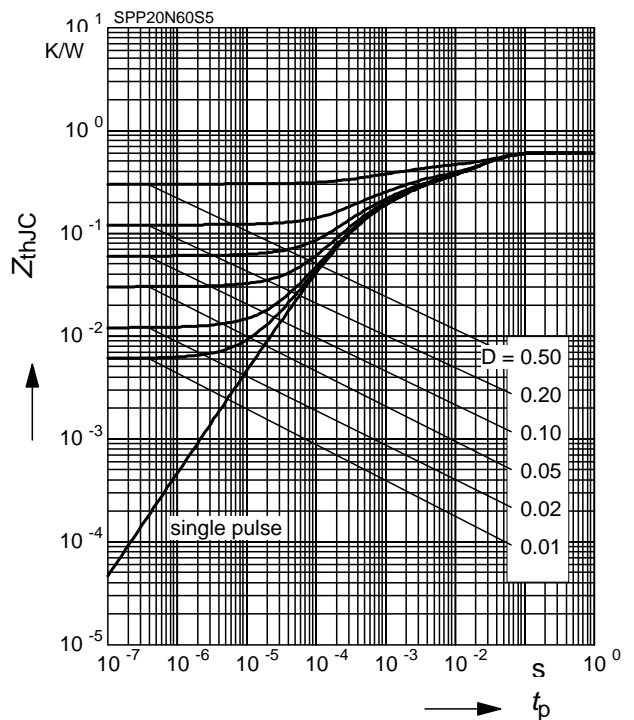
parameter: $D=0.01, T_C=25^\circ\text{C}$



Transient thermal impedance

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

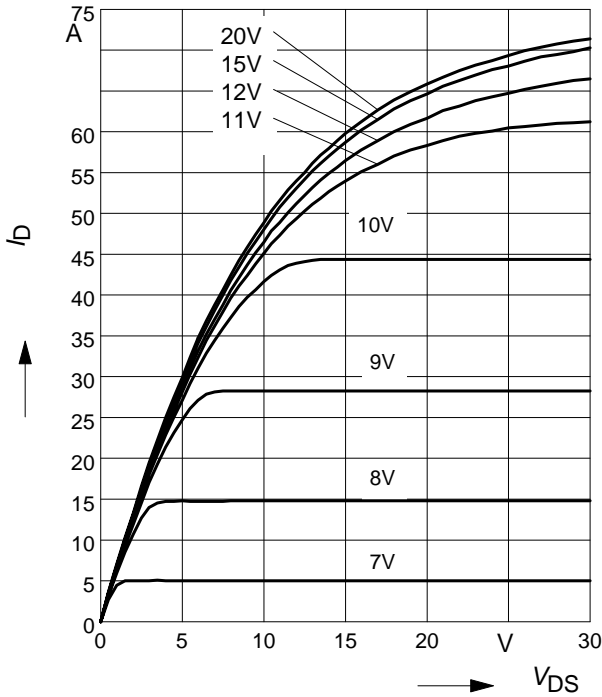
parameter: $D = t_p/T$



Typ. output characteristic

$I_D = f(V_{DS})$

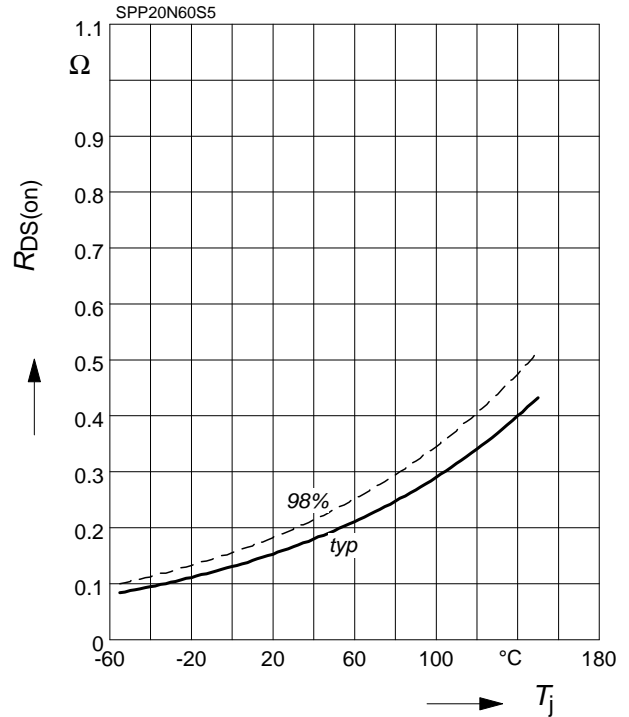
Parameter: $V_{GS}, T_j = 25\text{ }^\circ\text{C}$



Drain-source on-resistance

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

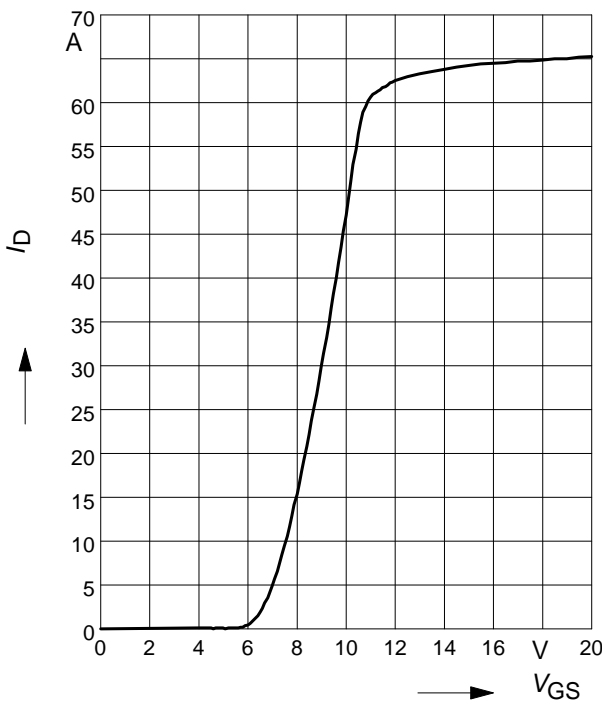
parameter: $I_D = 13\text{ A}, V_{GS} = 10\text{ V}$



Typ. transfer characteristics

$I_D = f(V_{GS})$

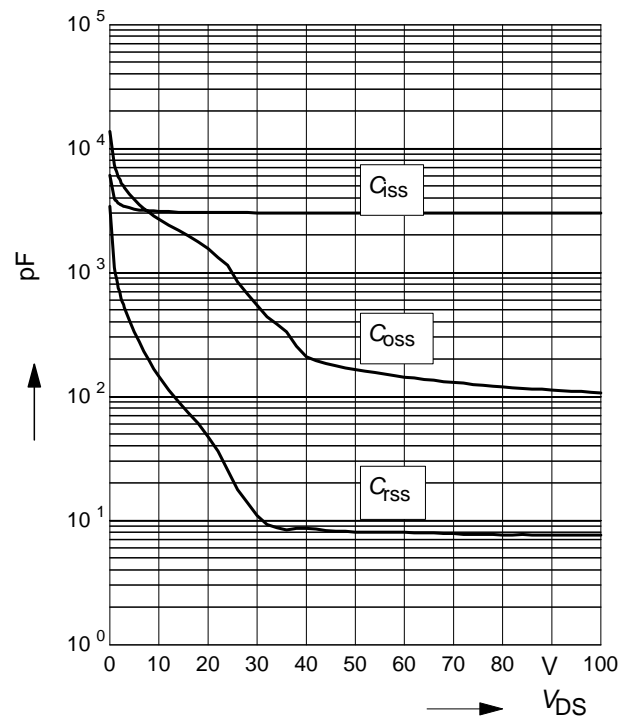
$V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$



Typ. capacitances

$C = f(V_{DS})$

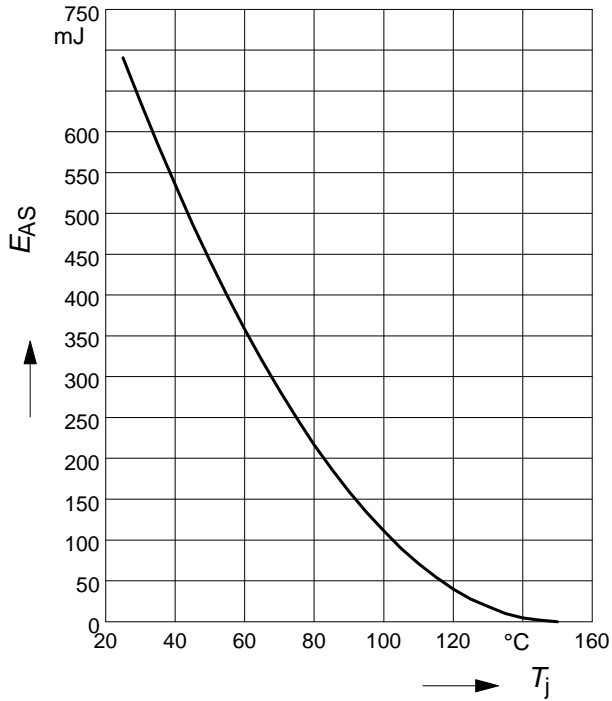
parameter: $V_{GS} = 0\text{ V}, f = 1\text{ MHz}$



Avalanche Energy

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

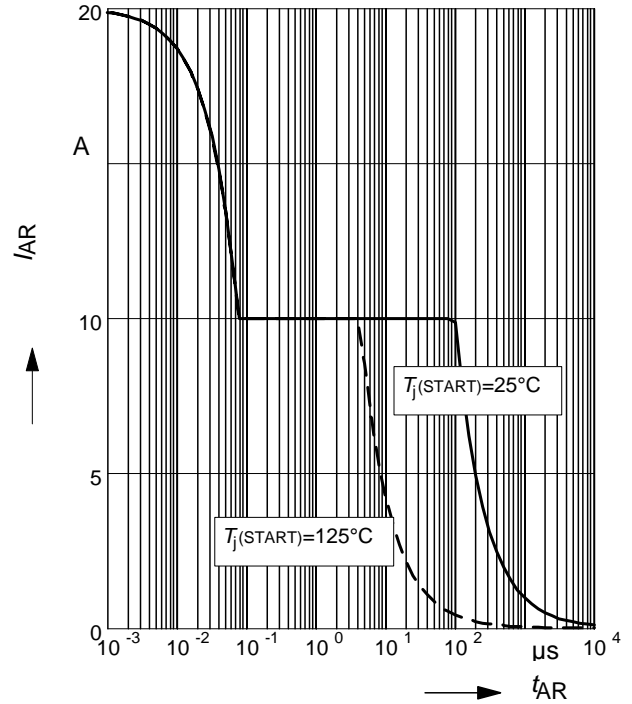
par.: $I_D = 10 \text{ A}$, $V_{DD} = 50 \text{ V}$



Avalanche SOA

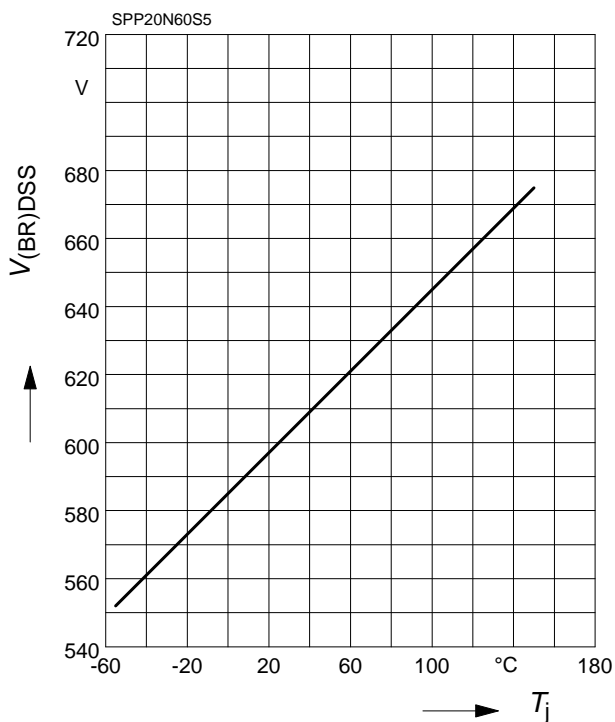
$$I_{AR} = f(t_{AR})$$

par.: $T_j \leq 150 \text{ °C}$



Drain-source breakdown voltage

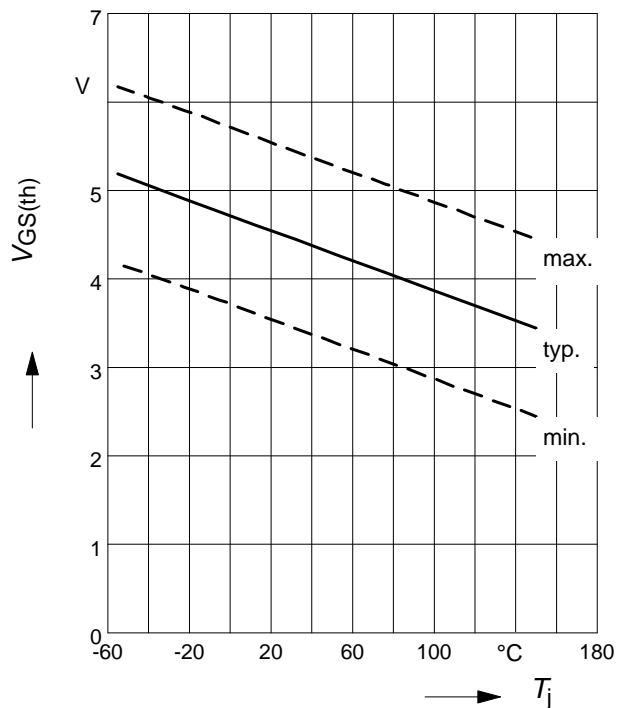
$$V_{(BR)DSS} = f(T_j)$$



Gate threshold voltage

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

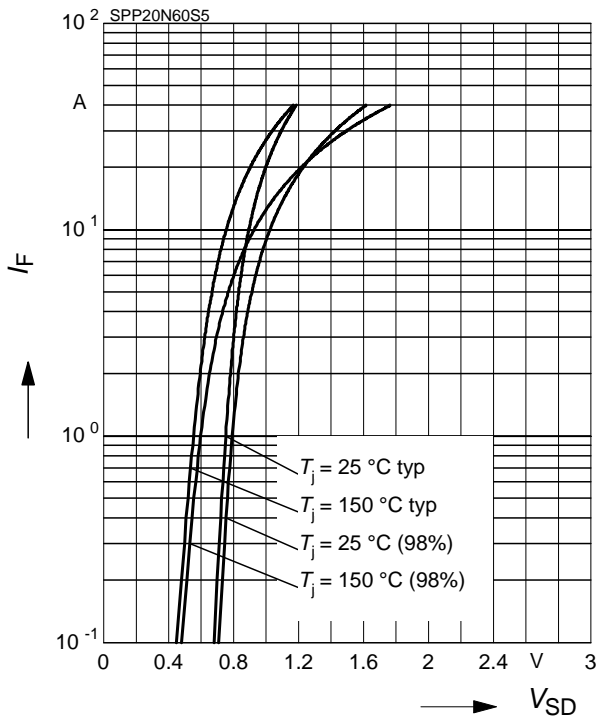
parameter: $V_{GS} = V_{DS}$, $I_D = 1 \text{ mA}$



Forward characteristics of reverse diode

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

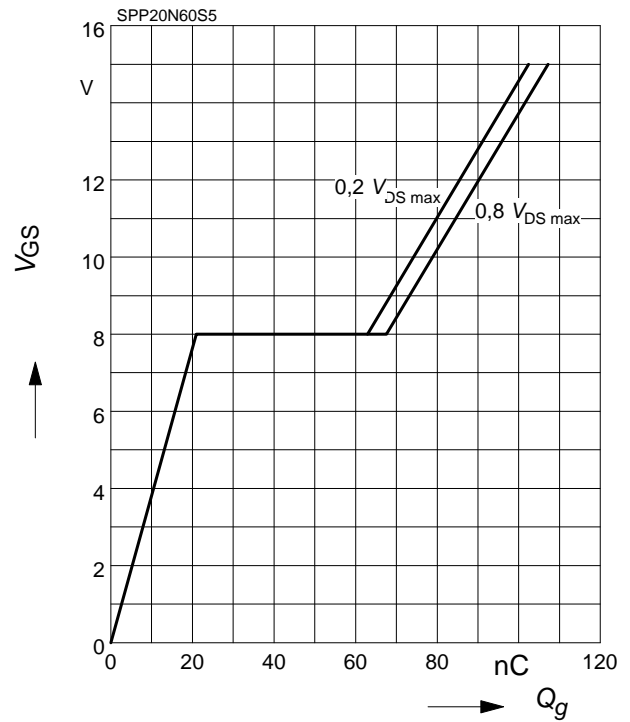
parameter: T_j , $t_p = 10 \mu s$

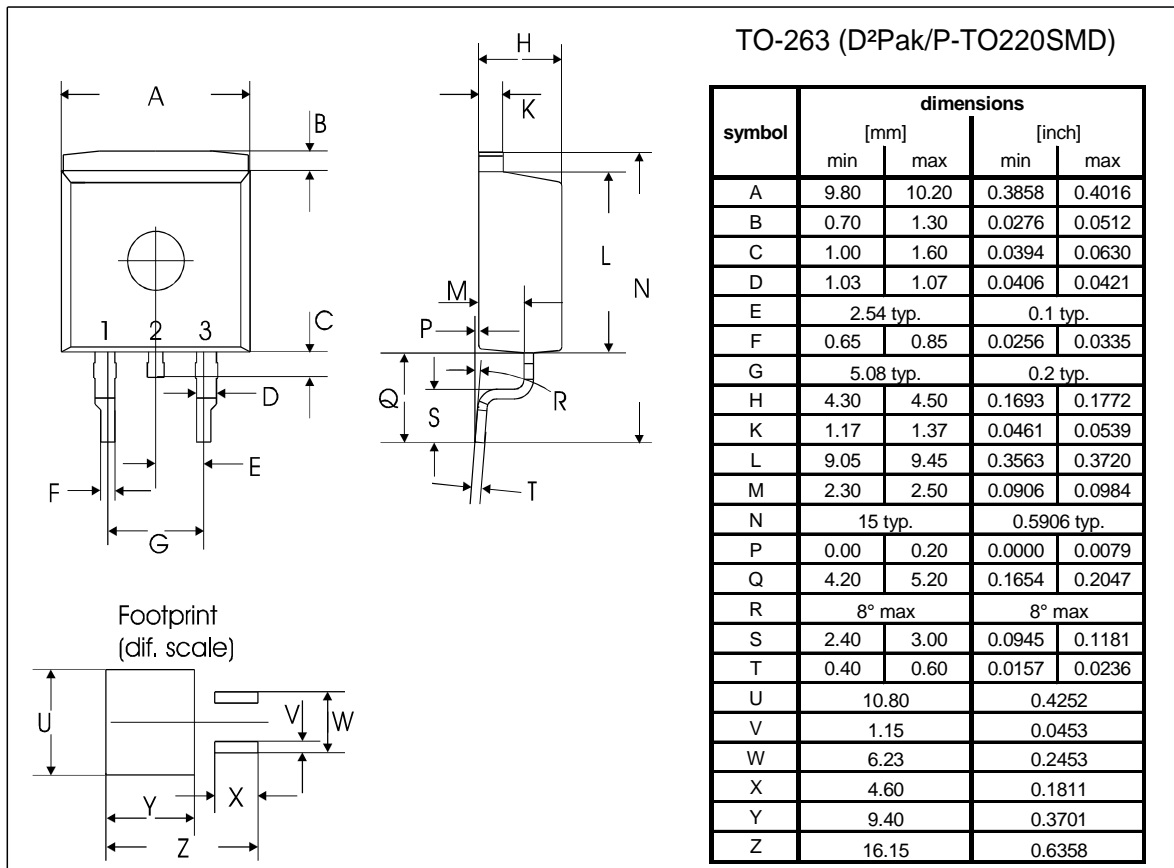
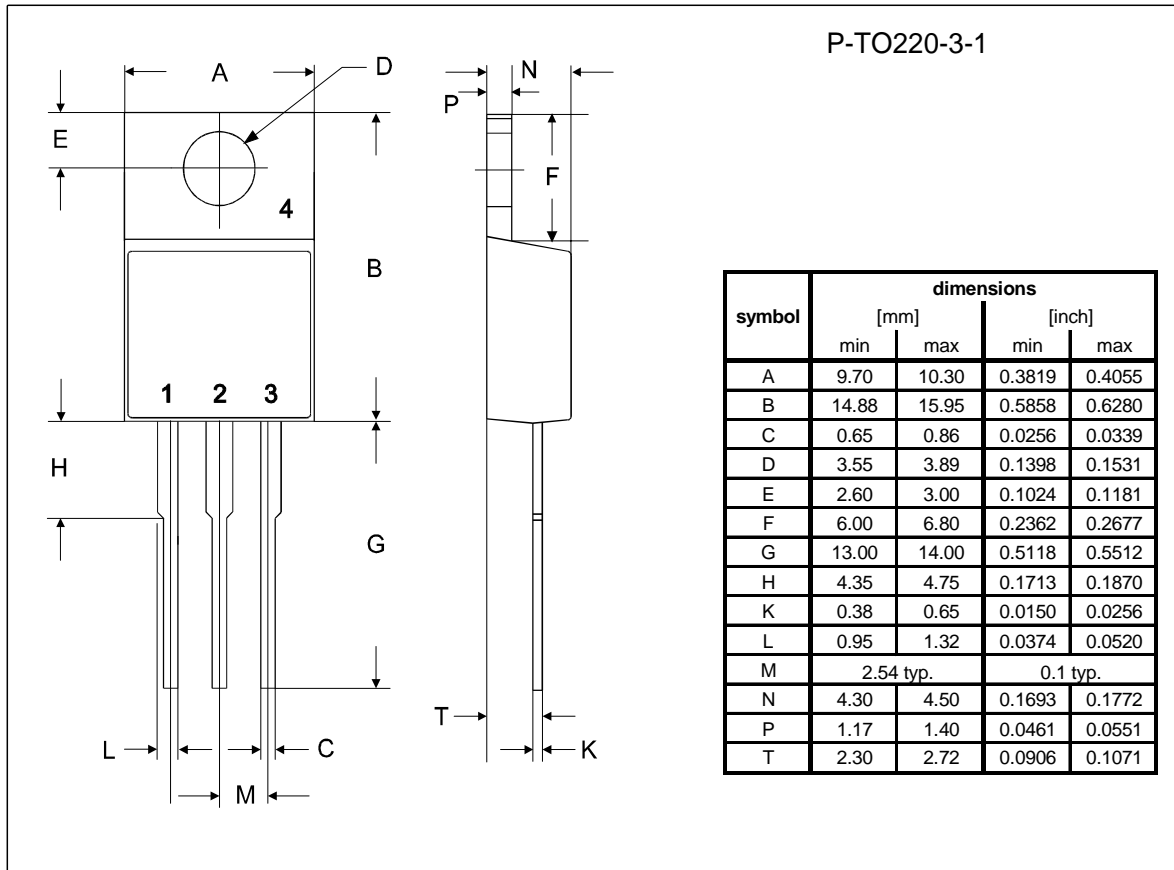


Typ. gate charge

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

parameter: $I_{Dpuls} = 20 \text{ A}$





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