

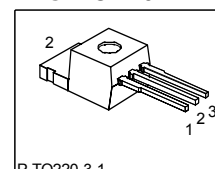
Cool MOS™ Power Transistor

Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC⁰⁾ for target applications

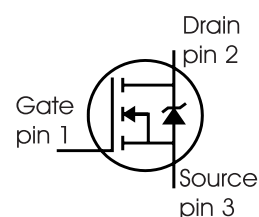
V_{DS}	600	V
$R_{DS(on)}$	1.4	Ω
I_D	3.2	A

PG-TO220



P-TO220-3-1

Type	Package	Ordering Code	Marking
SPP03N60S5	PG-TO220	Q67040-S4184	03N60S5



Maximum Ratings

Parameter	Symbol	Value	Unit
Continuous drain current $T_C = 25\text{ }^\circ\text{C}$ $T_C = 100\text{ }^\circ\text{C}$	I_D	3.2 2	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\text{ puls}}$	5.7	
Avalanche energy, single pulse $I_D = 2.4\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AS}	100	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ¹⁾ $I_D = 3.2\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AR}	0.2	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	3.2	A
Gate source voltage	V_{GS}	± 20	V
Gate source voltage AC ($f > 1\text{ Hz}$)	V_{GS}	± 30	
Power dissipation, $T_C = 25\text{ }^\circ\text{C}$	P_{tot}	38	W
Operating and storage temperature	T_j, T_{stg}	-55... +150	$^\circ\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480 \text{ V}$, $I_D = 3.2 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$	dv/dt	20	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	3.3	K/W
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
SMD version, device on PCB: @ min. footprint @ 6 cm ² cooling area ²⁾	R_{thJA}	- -	- 35	62 -	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s ³⁾	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	$V_{(BR)DS}$	$V_{GS}=0\text{V}$, $I_D=3.2\text{A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=135\mu\text{A}$, $V_{GS}=V_{DS}$	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 70	μA
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$	-	-	100	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=2\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	- -	1.26 3.4	1.4 -	Ω

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}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 2A$	-	1.8	-	S
Input capacitance	C_{iss}	$V_{GS} = 0V$, $V_{DS} = 25V$, $f = 1MHz$	-	420	-	pF
Output capacitance	C_{oss}		-	150	-	
Reverse transfer capacitance	C_{rss}		-	3.6	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 350V$, $V_{GS} = 0/10V$, $I_D = 3.2A$, $R_G = 20\Omega$	-	35		ns
Rise time	t_r		-	25	-	
Turn-off delay time	$t_{d(off)}$		-	40		
Fall time	t_f		-	15	22.5	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD} = 350\text{V}$, $I_D = 3.2\text{A}$	-	3.5	-	nC
Gate to drain charge	Q_{gd}		-	7	-	
Gate charge total	Q_g	$V_{DD} = 350\text{V}$, $I_D = 3.2\text{A}$, $V_{GS} = 0 \text{ to } 10\text{V}$	-	12.4	16	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$, $I_D = 3.2\text{A}$	-	8	-	V

⁰J-STD20 and JESD22

¹Repetitive avalanche causes additional power losses that can be calculated as $P_{AV} = E_{AR} \cdot f$.

²Device 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.

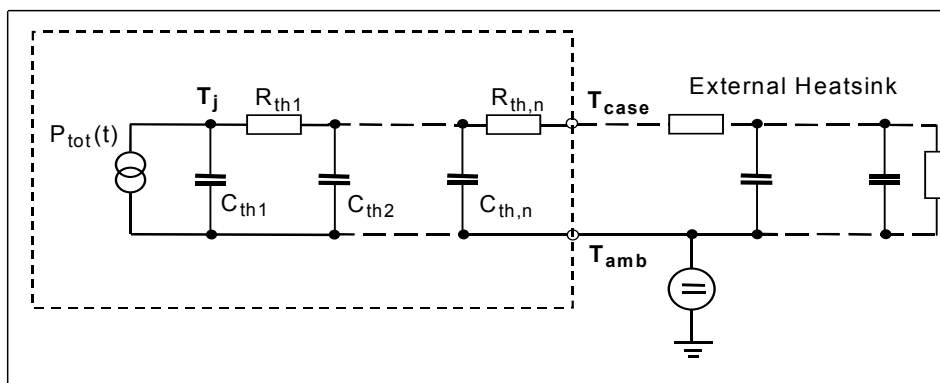
³Soldering temperature for TO-263: 220°C, reflow

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	$T_C=25^{\circ}\text{C}$	-	-	3.2	A
Inverse diode direct current, pulsed	I_{SM}		-	-	5.7	
Inverse diode forward voltage	V_{SD}	$V_{GS}=0\text{V}$, $I_F=I_S$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R=350\text{V}$, $I_F=I_S$, $di_F/dt=100\text{A}/\mu\text{s}$	-	1000	1700	ns
Reverse recovery charge	Q_{rr}		-	2.3	-	

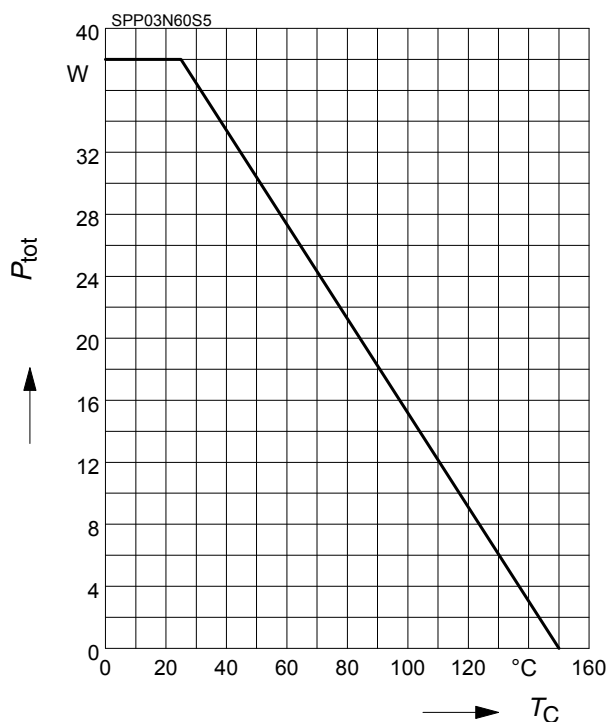
Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
R_{th1}	0.054	K/W	C_{th1}	0.00005232	Ws/K
R_{th2}	0.103		C_{th2}	0.0002034	
R_{th3}	0.178		C_{th3}	0.0002963	
R_{th4}	0.757		C_{th4}	0.0009103	
R_{th5}	0.682		C_{th5}	0.002084	
R_{th6}	0.202		C_{th6}	0.024	



1 Power dissipation

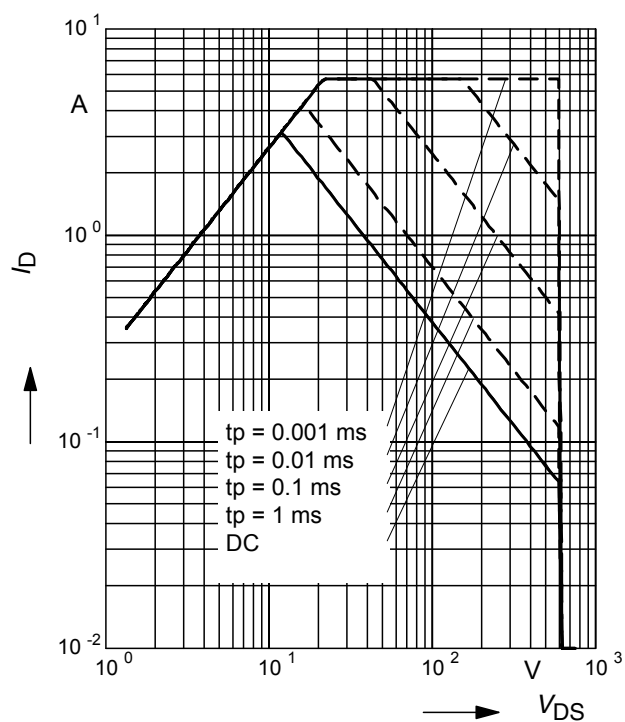
$$P_{\text{tot}} = f(T_C)$$



2 Safe operating area

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

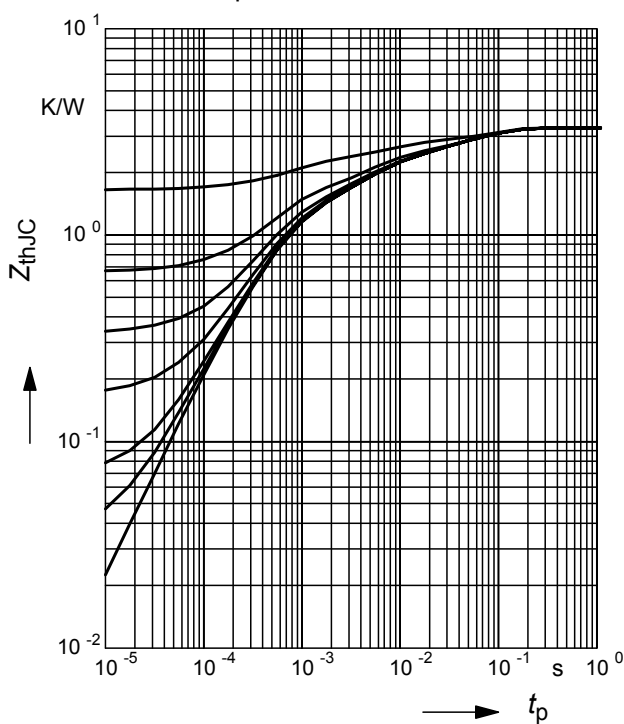
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



3 Transient thermal impedance

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

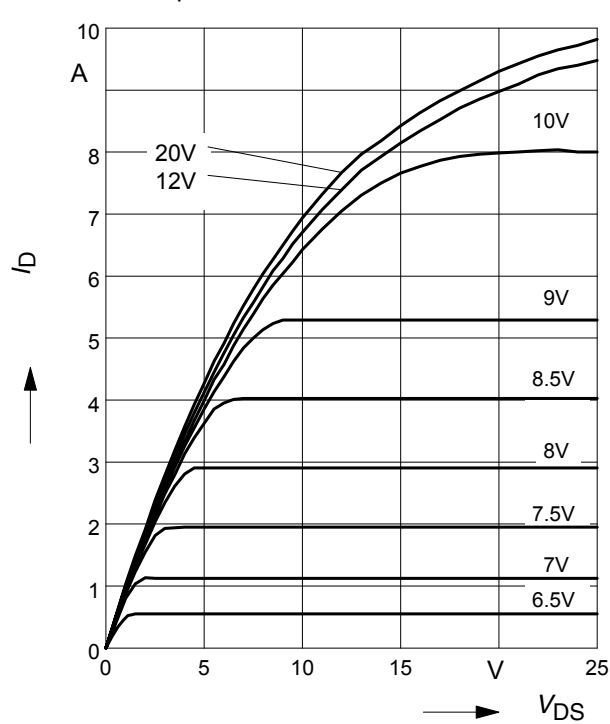
parameter: $D = t_p/T$



4 Typ. output characteristic

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

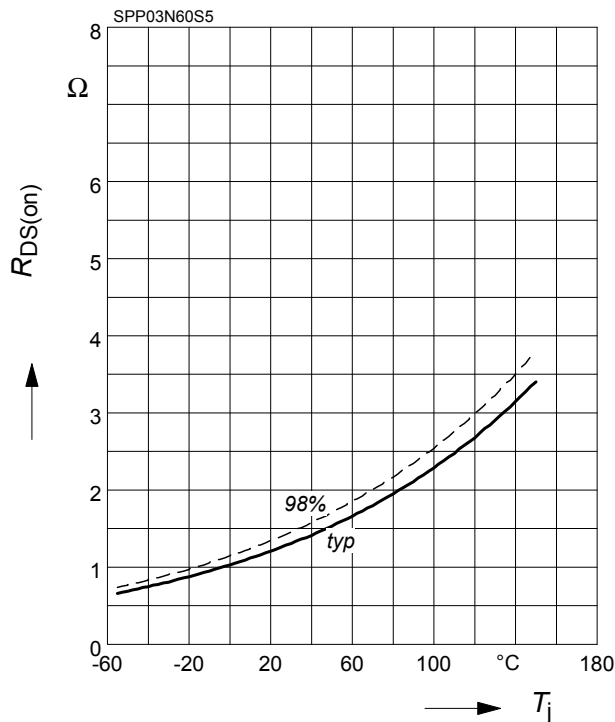
parameter: $t_p = 10 \mu\text{s}$, V_{GS}



5 Drain-source on-state resistance

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

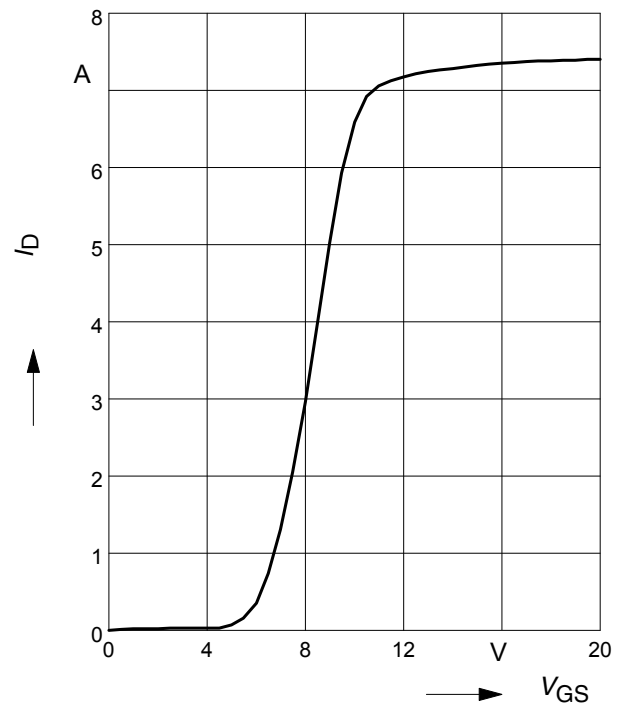
parameter: $I_D = 2 \text{ A}$, $V_{GS} = 10 \text{ V}$



6 Typ. transfer characteristics

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

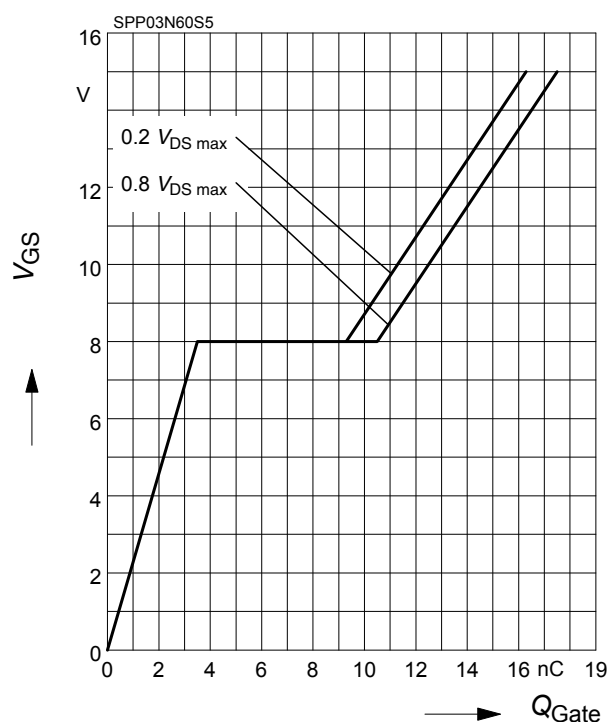
parameter: $t_p = 10 \mu\text{s}$



7 Typ. gate charge

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

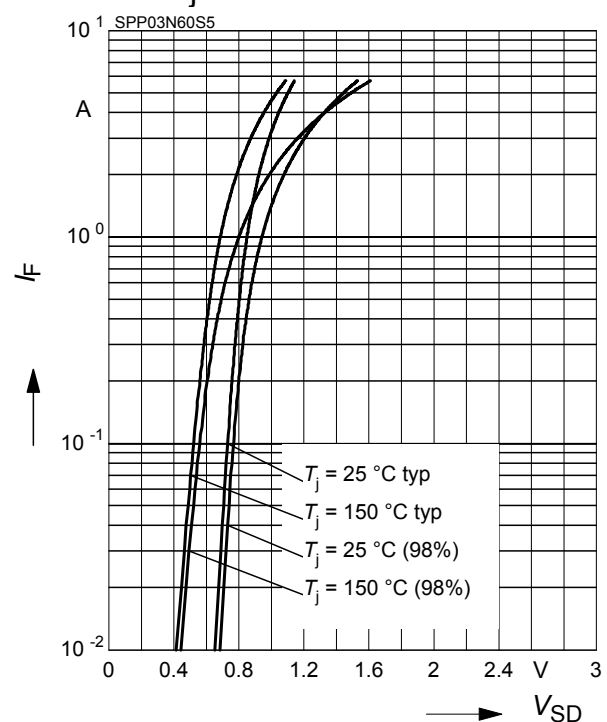
parameter: $I_D = 3.2 \text{ A}$ pulsed



8 Forward characteristics of body diode

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

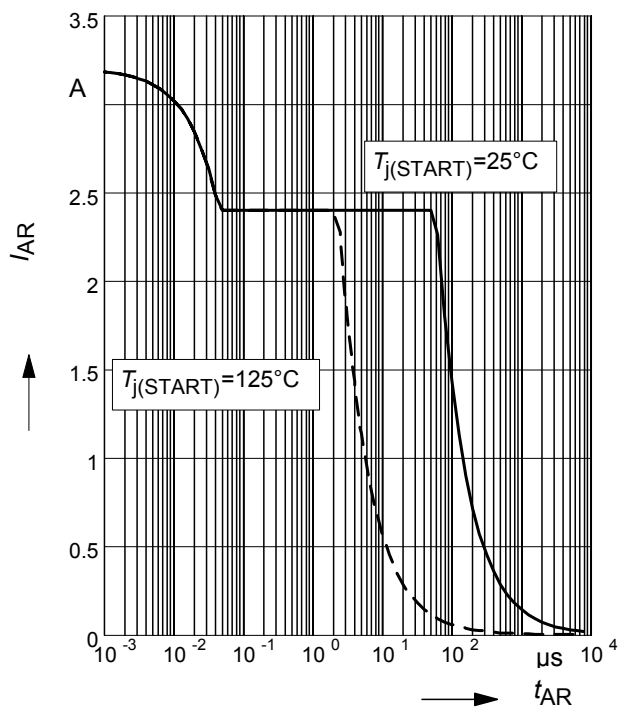
parameter: T_j , $t_p = 10 \mu\text{s}$



9 Avalanche SOA

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

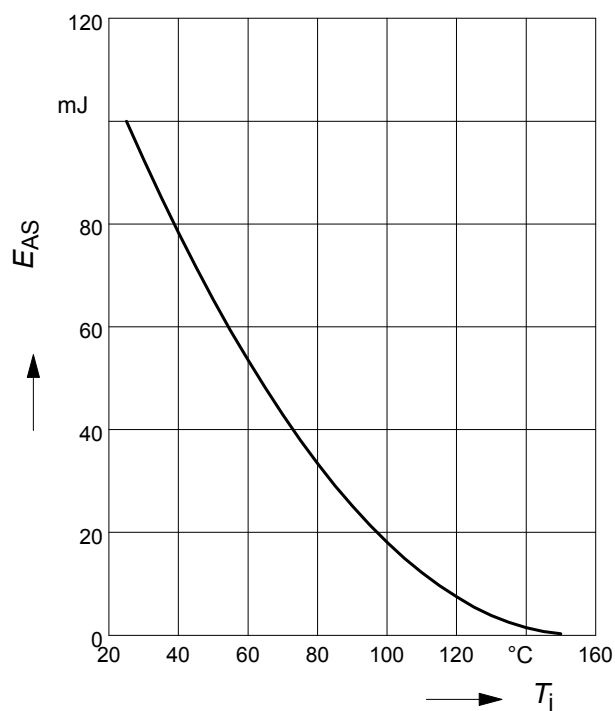
par.: $T_j \leq 150^\circ\text{C}$



10 Avalanche energy

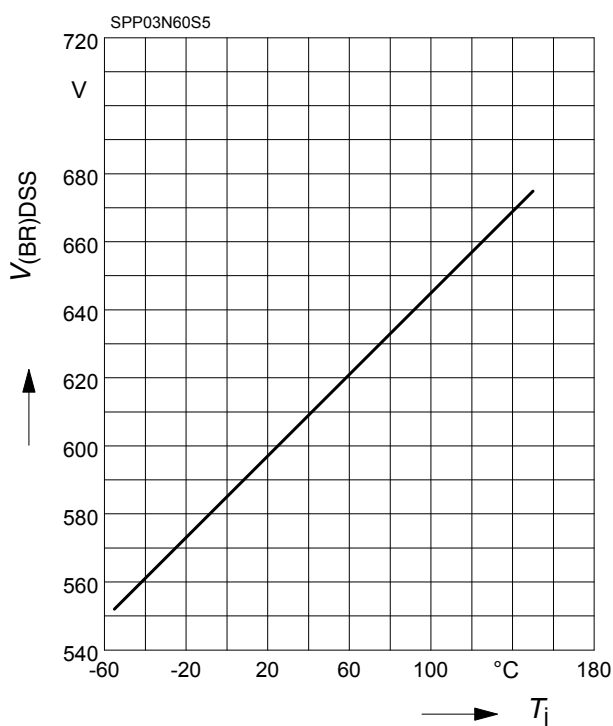
$$E_{AS} = f(T_j)$$

par.: $I_D = 2.4\text{ A}$, $V_{DD} = 50\text{ V}$



11 Drain-source breakdown voltage

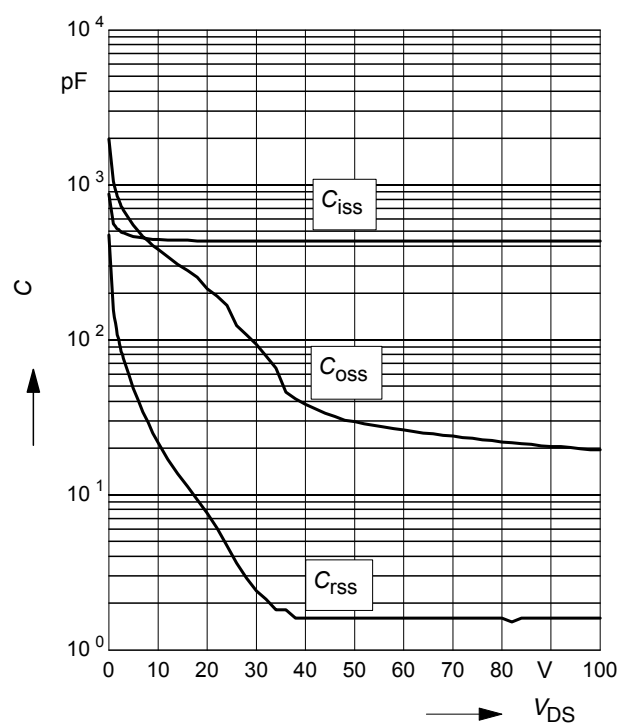
$$V_{(BR)DSS} = f(T_j)$$



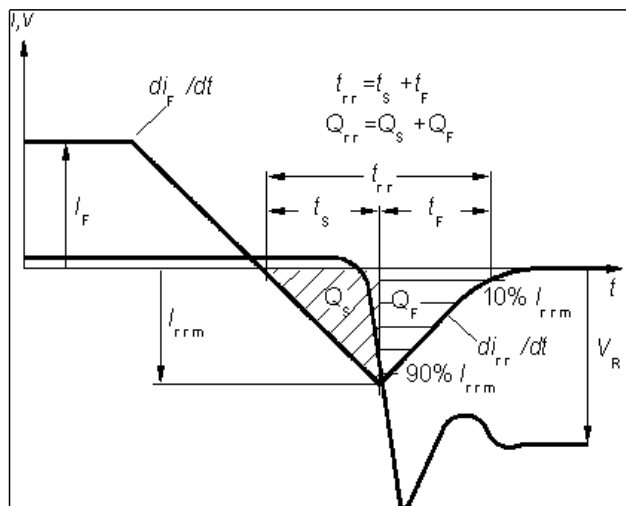
12 Typ. capacitances

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

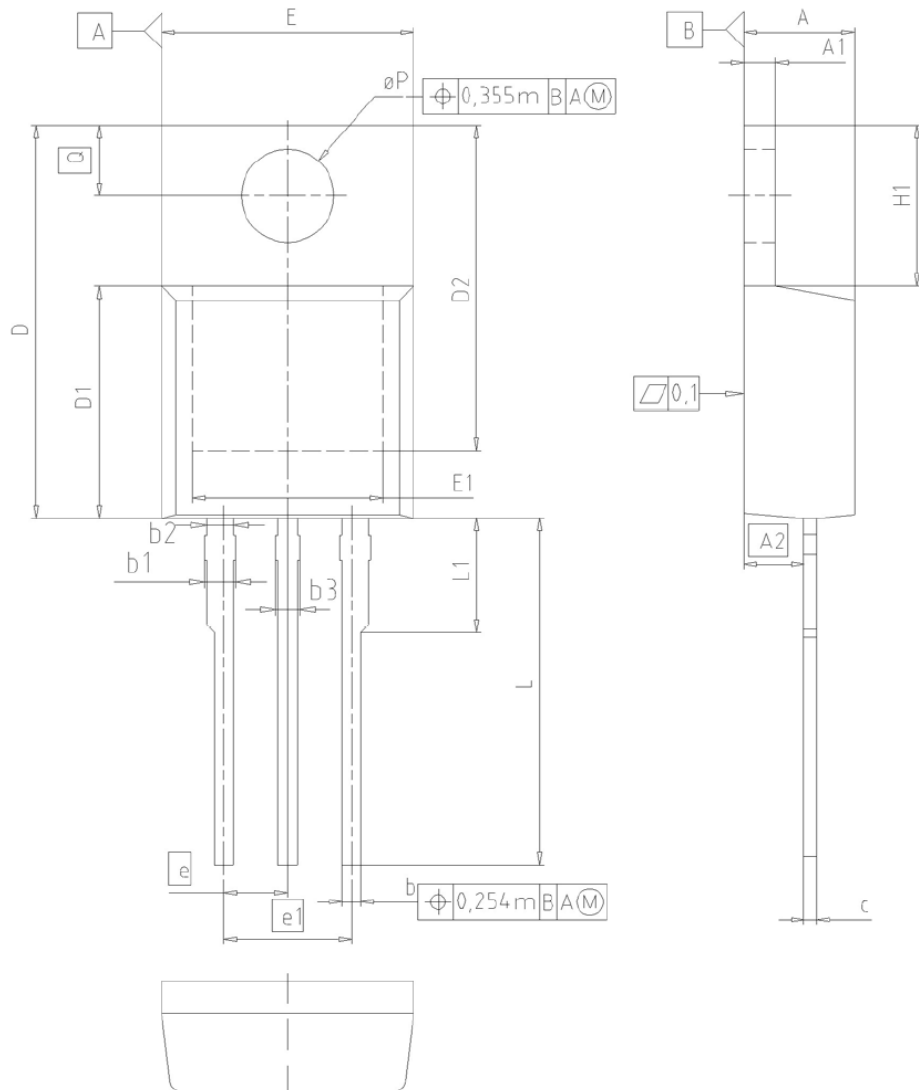
parameter: $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$



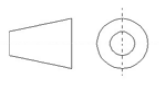
Definition of diodes switching characteristics



PG-TO220-3-1, PG-TO220-3-21



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.30	4.57	0.169	0.180
A1	1.17	1.40	0.046	0.055
A2	2.15	2.72	0.085	0.107
b	0.65	0.86	0.026	0.034
b1	0.95	1.40	0.037	0.055
b2	0.95	1.15	0.037	0.045
b3	0.65	1.15	0.026	0.045
c	0.33	0.60	0.013	0.024
D	14.81	15.95	0.583	0.628
D1	8.51	9.45	0.335	0.372
D2	12.19	13.10	0.480	0.516
E	9.70	10.36	0.382	0.408
E1	6.50	8.60	0.256	0.339
e	2.54		0.100	
e1	5.08		0.200	
N	3		3	
H1	5.90	6.90	0.232	0.272
L	13.00	14.00	0.512	0.551
L1	-	4.80	-	0.189
øP	3.60	3.89	0.142	0.153
Q	2.60	3.00	0.102	0.118

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