Cool MOS™ Power Transistor

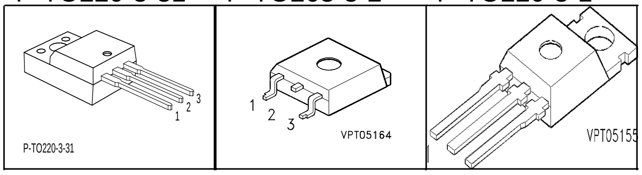
Feature

- New revolutionary high voltage technology
- Worldwide best $R_{DS(on)}$ in TO 220
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- High peak current capability
- Improved transconductance
- 150 °C operating temperature

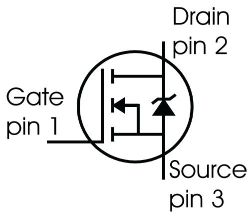
Product Summary

V_{DS} @ T_{jmax}	650	V
$R_{DS(on)}$	0.19	Ω
I_D	20.7	A

P-TO220-3-31 P-TO263-3-2 P-TO220-3-1



Type	Package	Ordering Code	Marking
SPP20N60C3	P-TO220-3-1	Q67040-S4398	20N60C3
SPB20N60C3	P-TO263-3-2	Q67040-S4397	20N60C3
SPA20N60C3	P-TO220-3-31	Q67040-S4410	20N60C3



Maximum Ratings

Parameter	Symbol	Value		Unit
		SPP_B	SPA	
Continuous drain current	I_D			A
T_C = 25 °C		20.7	20.7 1)	
T_C = 100 °C		13.1	13.1 1)	
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\ puls}$	62.1	62.1	A
Avalanche energy, single pulse I_D=10A, V_{DD}=50V	E_{AS}	690	690	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} 2) I_D=20A, V_{DD}=50V	E_{AR}	1	1	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	20	20	A
Reverse diode dv/dt I_S = 20.7 A, V_{DS} < V_{DD}, di/dt=100A/µs, T_{jmax}=150°C	dv/dt	6	6	V/ns
Gate source voltage static	V_{GS}	±20	±20	V
Gate source voltage AC (f >1Hz)	V_{GS}	±30	±30	
Power dissipation, T_C = 25°C	P_{tot}	208	34.5	W
Operating and storage temperature	T_j , T_{stg}	-55...+150		°C

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Characteristics					
Thermal resistance, junction - case	R_{thJC}	-	-	0.6	K/W
Thremal resistance, junction - case, FullPAK	R_{thJC_FP}	-	-	3.6	
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
Thermal resistance, junction - ambient, FullPAK	R_{thJA_FP}	-	-	80	
SMD version, device on PCB: @ min. footprint @ 6 cm^2 cooling area 3)	R_{thJA}	 - -	 - 35	 62 -	
Linear derating factor		-	-	1.67	W/K
Linear derating factor, FullPAK		-	-	0.28	
Soldering temperature, 1.6 mm (0.063 in.) from case for 10s	T_{sold}	-	-	260	°C

Electrical Characteristics, at T_j = 25 °C, unless otherwise specified

Parameter	Symbol	min.	typ.	max.	Unit
Static Characteristics					
Drain-source breakdown voltage V_{GS}=0V, I_D=0.25mA	$V_{(BR)DSS}$	600	-	-	V
Drain-source avalanche breakdown voltage V_{GS}=0V, I_D=20A	$V_{(BR)DS}$	-	700	-	
Gate threshold voltage, V_{GS} = V_{DS} I_D = 1 mA	$V_{GS(th)}$	2.1	3	3.9	
Zero gate voltage drain current V_{DS} = 600 V, V_{GS} = 0 V, T_j = 25 °C V_{DS} = 600 V, V_{GS} = 0 V, T_j = 150 °C	I_{DSS}	 - -	 0.1 -	 1 100	µA
Gate-source leakage current V_{GS}=30V, V_{DS}=0V	I_{GSS}	-	-	100	nA
Drain-source on-state resistance V_{GS}=10V, I_D=13.1A, T_j=25°C V_{GS}=10V, I_D=13.1A, T_j=150°C	$R_{DS(on)}$	 - -	 0.16 0.54	 0.19 0.64	Ω
Gate input resistance f = 1 MHz, open drain	R_G	-	0.54	-	

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Transconductance	g_{fs}	V_{DS}≥2*I_D*$R_{DS(on)max}$, I_D=13.1A	-	17.5	-	S
Input capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	-	2400	-	pF
Output capacitance	C_{oss}		-	780	-	
Reverse transfer capacitance	C_{rss}		-	50	-	
Effective output capacitance,[4] energy related	$C_{o(er)}$	V_{GS}=0V, V_{DS}=0V to 480V	-	83	-	
Effective output capacitance,[5] time related	$C_{o(tr)}$		-	160	-	
Turn-on delay time	$t_{d(on)}$	V_{DD}=380V, V_{GS}=0/13V, I_D=20.7A, R_G=3.6Ω, T_j=125	-	10	-	ns
Rise time	t_r	V_{DD}=380V, V_{GS}=0/13V, I_D=20.7A, R_G=3.6Ω	-	5	-	
Turn-off delay time	$t_{d(off)}$		-	67	100	
Fall time	t_f		-	4.5	12	
Gate Charge Characteristics						
Gate to source charge	Q_{gs}	V_{DD}=480V, I_D=20.7A	-	11	-	nC
Gate to drain charge	Q_{gd}		-	33	-	
Gate charge total	Q_g	V_{DD}=480V, I_D=20.7A, V_{GS}=0 to 10V	-	87	114	
Gate plateau voltage	$V_{(plateau)}$	V_{DD}=480V, I_D=20.7A	-	5.5	-	V

[1] Limited only by maximum temperature

[2] Repetitve avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR}*f$.

[3] Device 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.

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

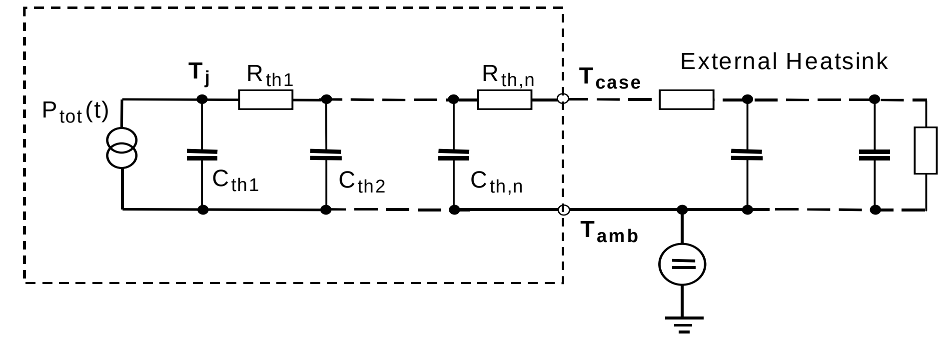
[5] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Inverse diode continuous forward current	I_S	T_C=25°C	-	-	20.7	A
Inverse diode direct current, pulsed	I_{SM}		-	-	62.1	
Inverse diode forward voltage	V_{SD}	V_{GS}=0V, I_F=I_S	-	1	1.2	V
Reverse recovery time	t_{rr}	V_R=480V, I_F=I_S , di_F/dt=100A/µs	-	500	800	ns
Reverse recovery charge	Q_{rr}		-	11	-	µC
Peak reverse recovery current	I_{rrm}		-	70	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt	T_j=25°C	-	1400	-	A/µs

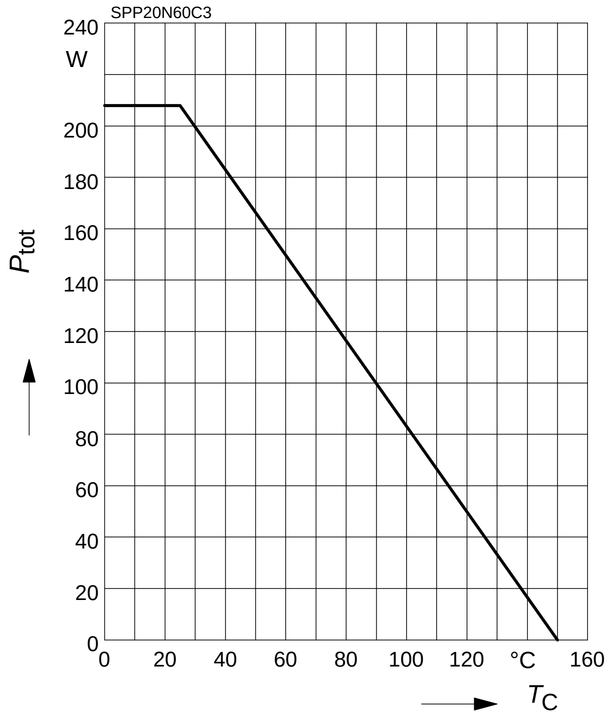
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_B	SPA			SPP_B	SPA	
R_{th1}	0.00746	0.0077	K/W	C_{th1}	0.000439	0.000376	Ws/K
R_{th2}	0.017	0.015		C_{th2}	0.00145	0.00141	
R_{th3}	0.028	0.022		C_{th3}	0.00239	0.00192	
R_{th4}	0.065	0.063		C_{th4}	0.00499	0.00323	
R_{th5}	0.081	0.214		C_{th5}	0.021	0.019	
R_{th6}	0.037	2.479		C_{th6}	0.146	0.412	



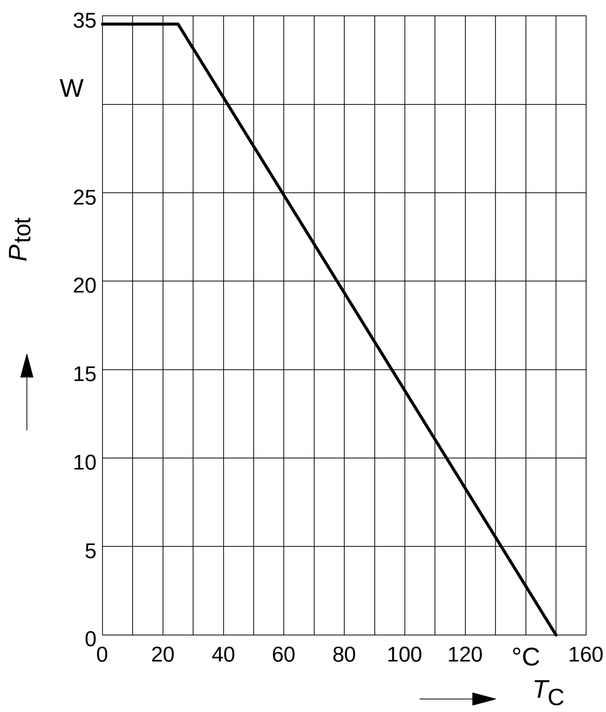
1 Power dissipation

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



2 Power dissiaption FullPAK

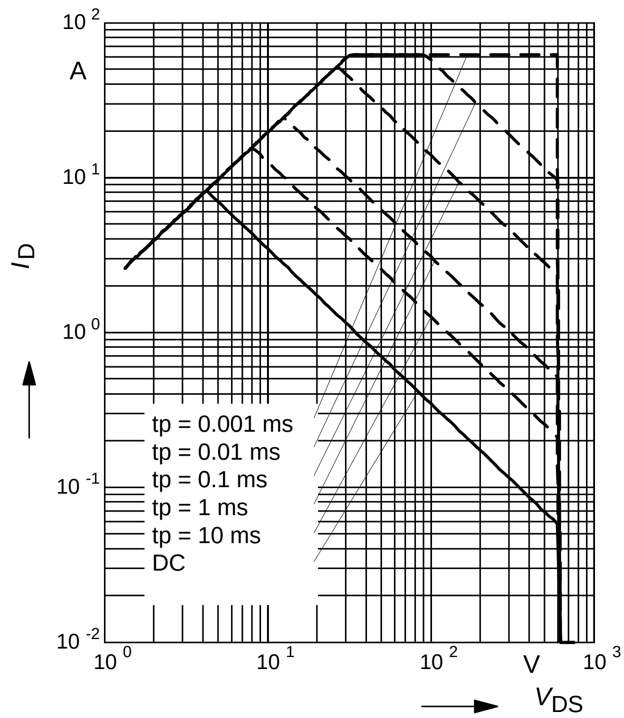
$P_{tot} = f\,(T_C)$



3 Safe operating area FullPAK

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

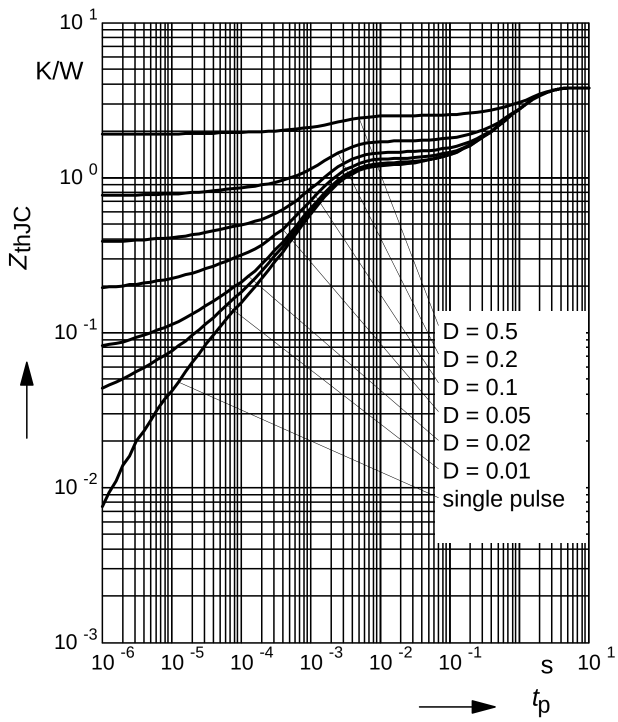
parameter: $D = 0$, $T_C = 25°C$



4 Transient thermal impedance FullPAK

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

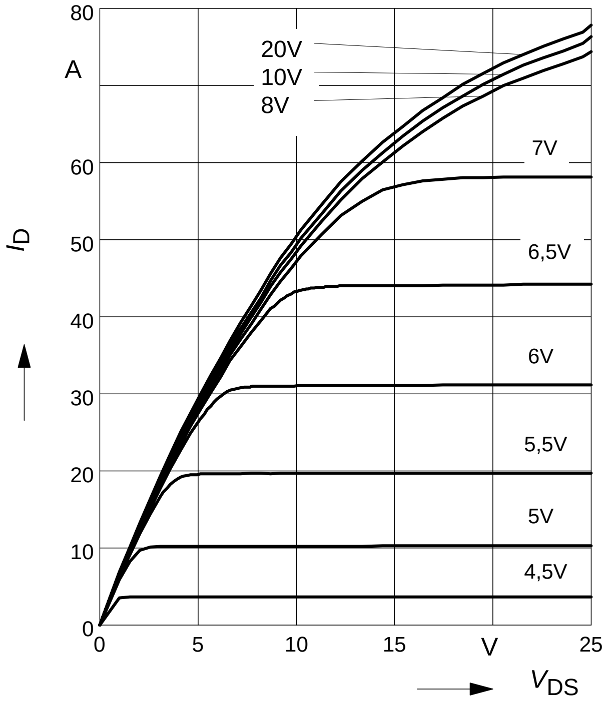
parameter: $D = t_p/t$



5 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=25°C

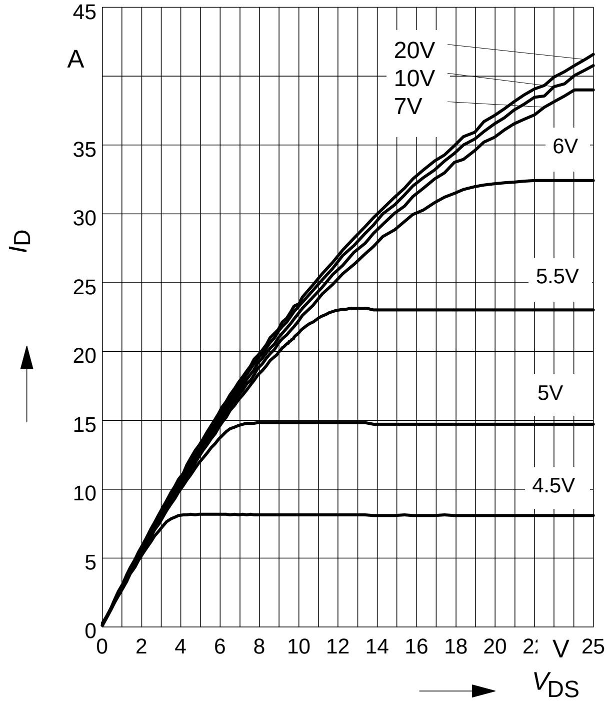
parameter: t_p = 10 µs, V_{GS}



6 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=150°C

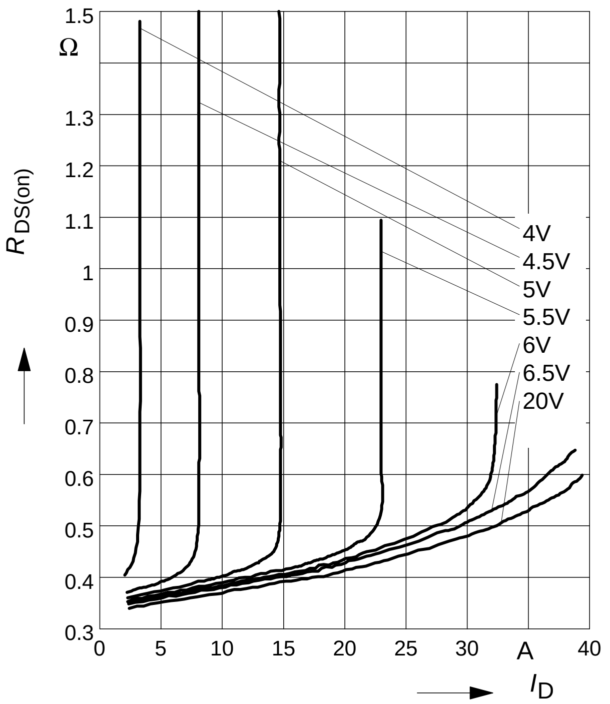
parameter: t_p = 10 µs, V_{GS}



7 Typ. drain-source on resistance

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

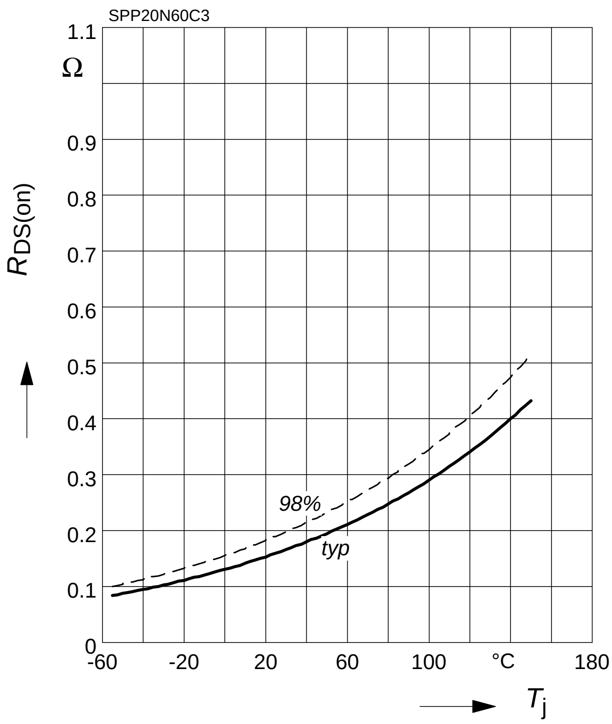
parameter: T_j=150°C, V_{GS}



8 Drain-source on-state resistance

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

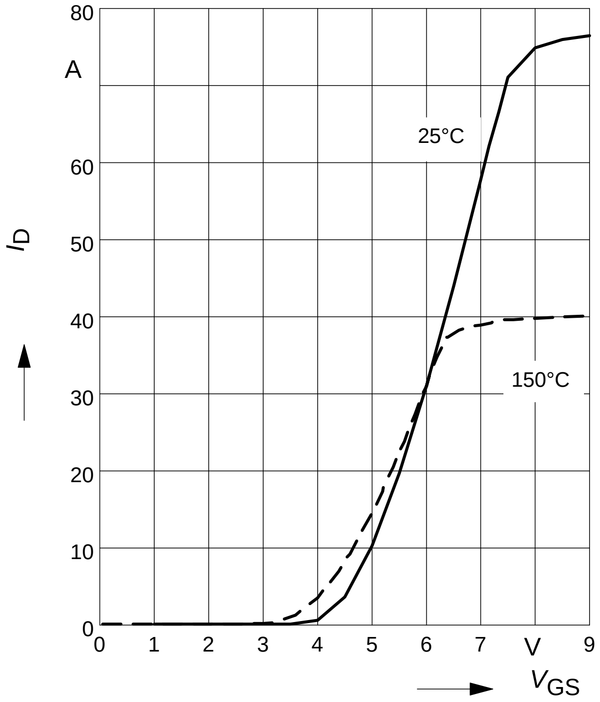
parameter : I_D = 13.1 A, V_{GS} = 10 V



9 Typ. transfer characteristics

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

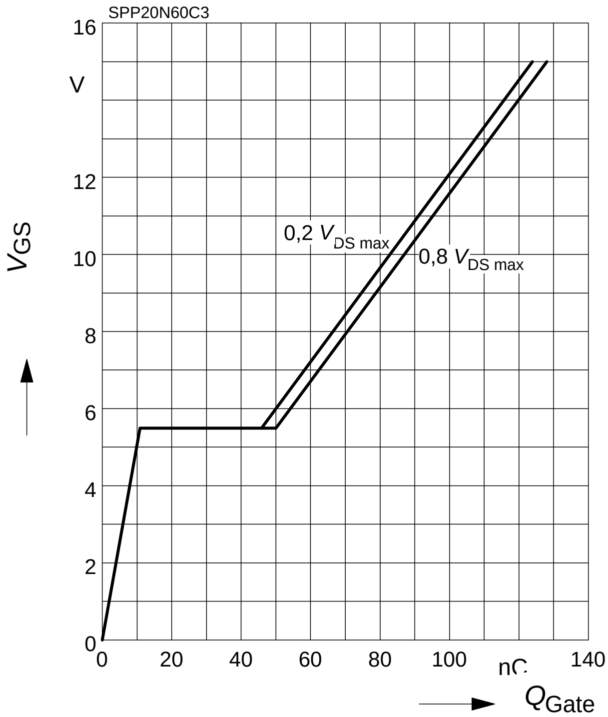
parameter: t_p = 10 µs



10 Typ. gate charge

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

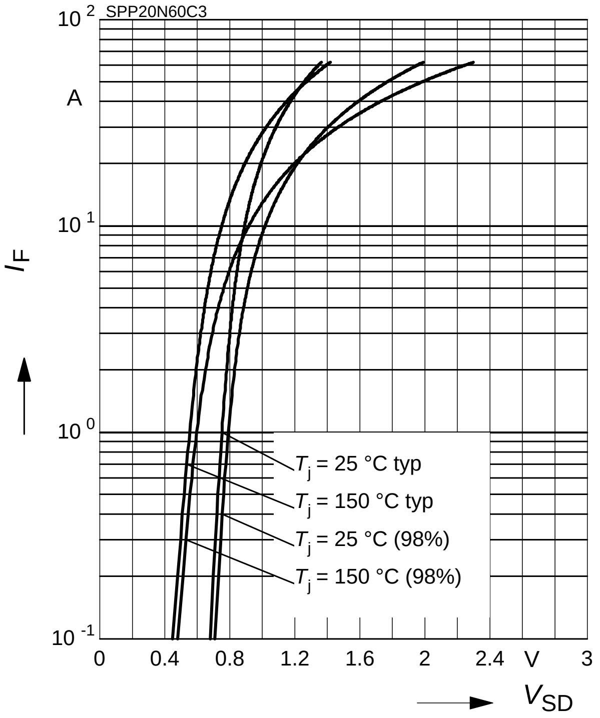
parameter: I_D = 20.7 A pulsed



11 Forward characteristics of body diode

$I_F = f(V_{SD})$

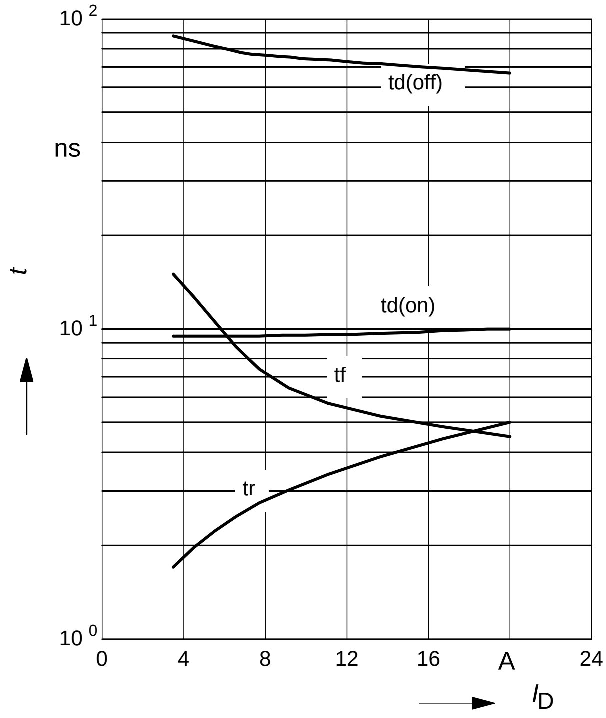
parameter: T_j , tp = 10 µs



12 Typ. switching time

$t = f(I_D)$, inductive load, T_j=125°C

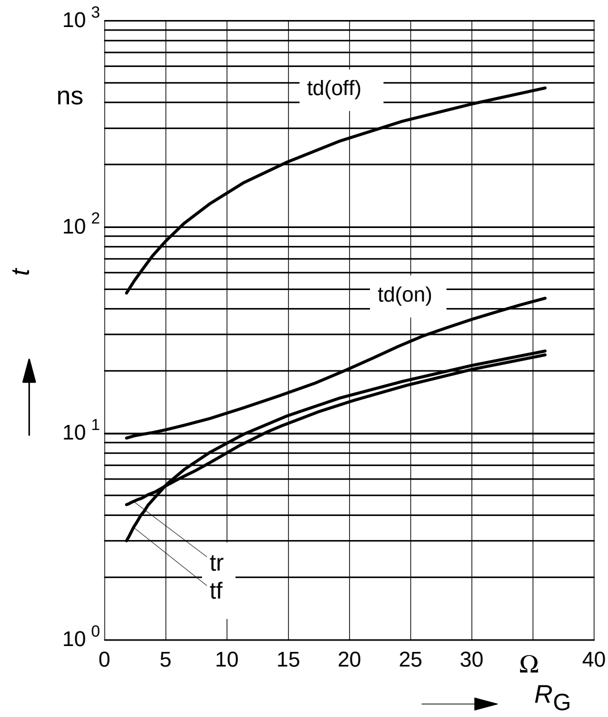
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=3.6Ω



13 Typ. switching time

$t = f(R_G)$, inductive load, T_j=125°C

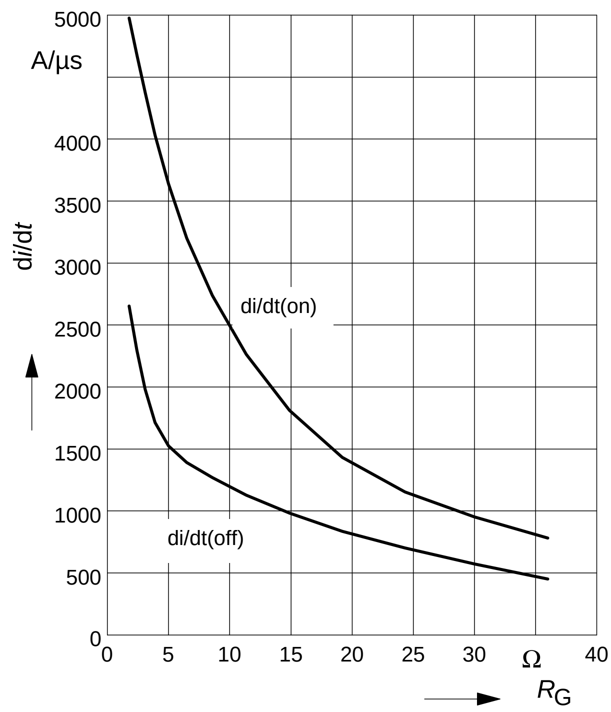
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=20.7 A



14 Typ. drain current slope

$di/dt = f(R_G)$, inductive load, T_j = 125°C

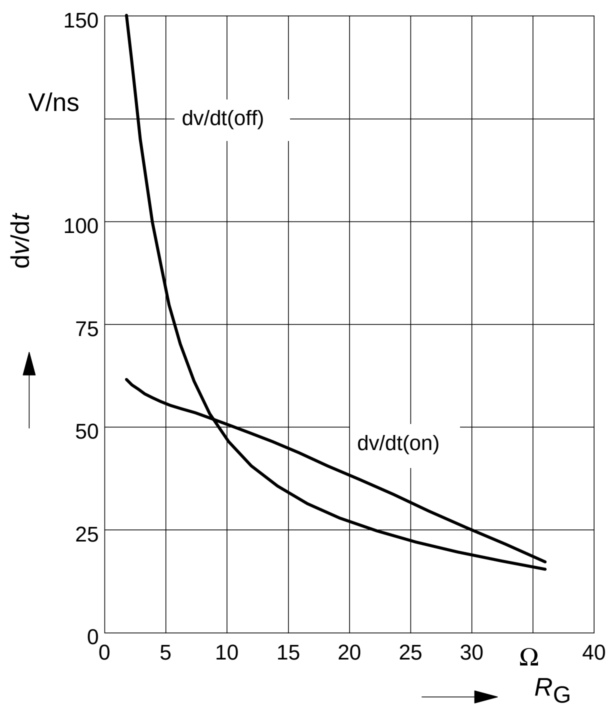
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=20.7A



15 Typ. drain source voltage slope

$dv/dt = f(R_G)$, inductive load, T_j = 125°C

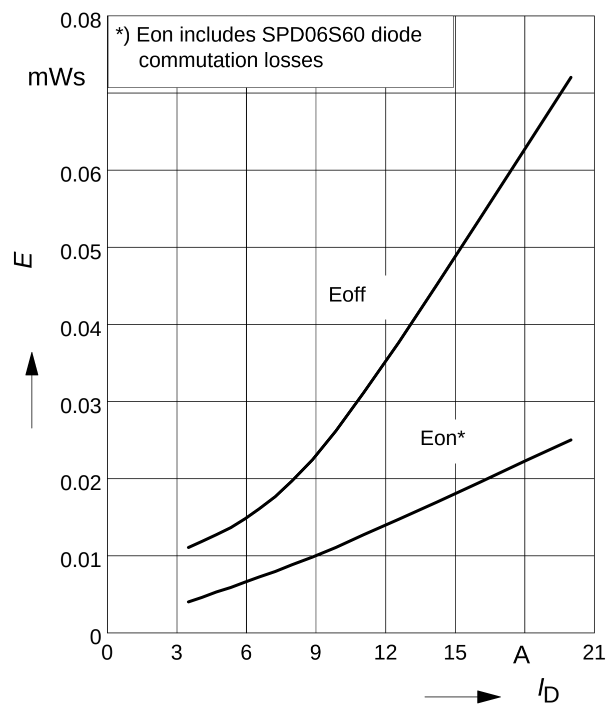
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=20.7A



16 Typ. switching losses

$E = f(I_D)$, inductive load, T_j=125°C

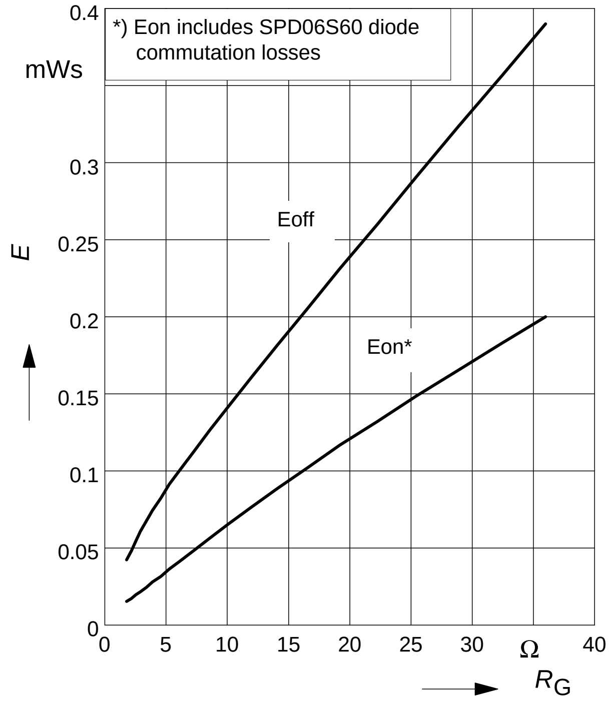
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=3.6Ω



17 Typ. switching losses

$E = f(R_G)$, inductive load, T_j=125°C

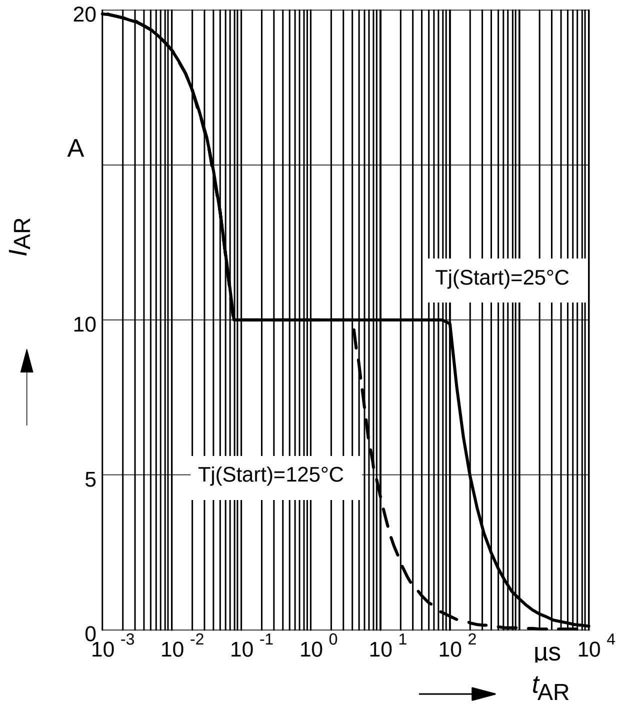
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=20.7A



18 Avalanche SOA

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

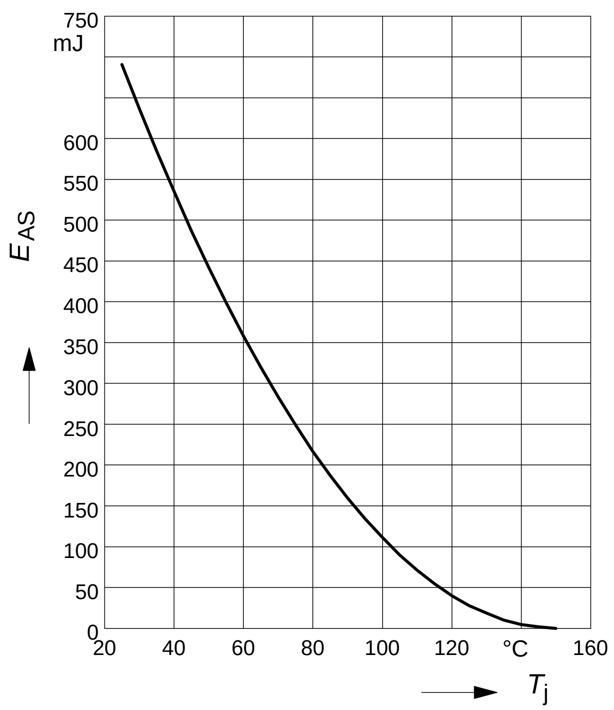
par.: $T_j \le 150$ °C



19 Avalanche energy

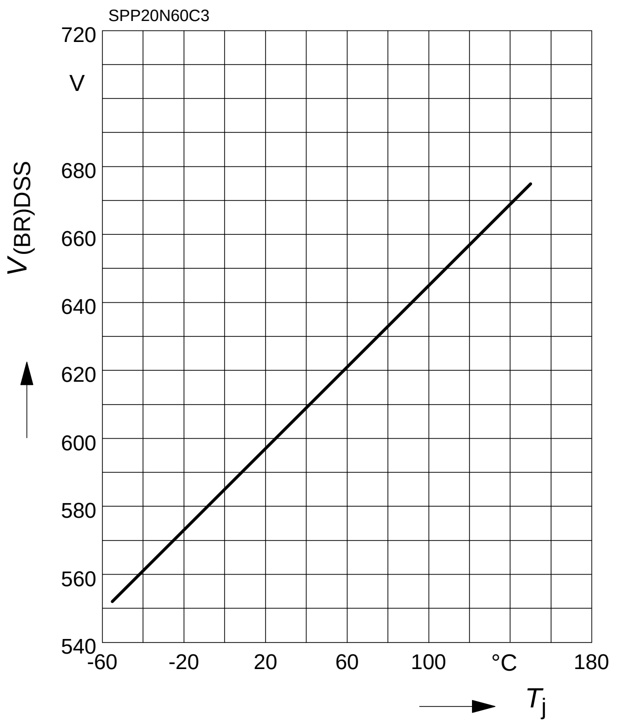
$E_{AS} = f(T_j)$

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



20 Drain-source breakdown voltage

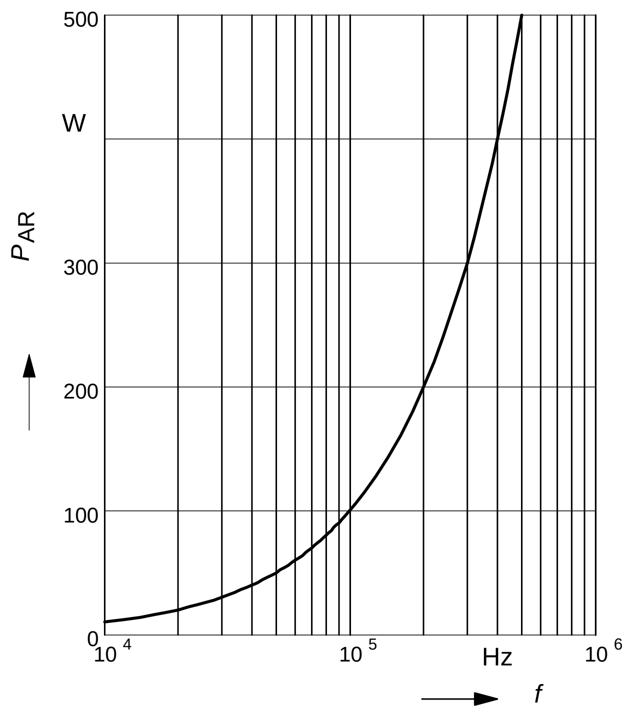
$V_{(BR)DSS} = f(T_j)$



21 Avalanche power losses

$P_{AR} = f(f)$

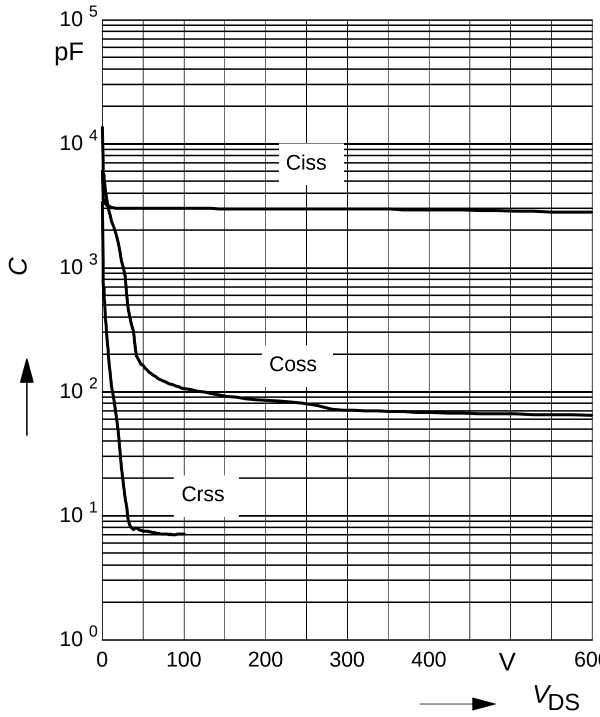
parameter: E_{AR}=1mJ



22 Typ. capacitances

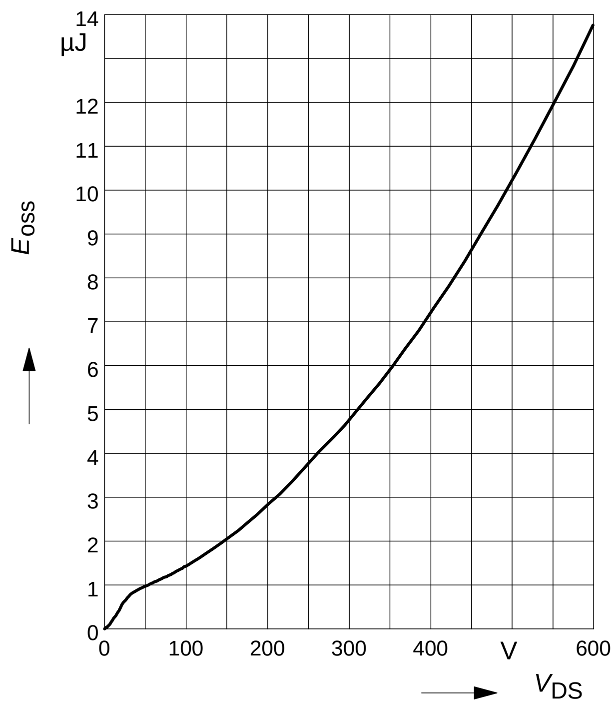
$C = f(V_{DS})$

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

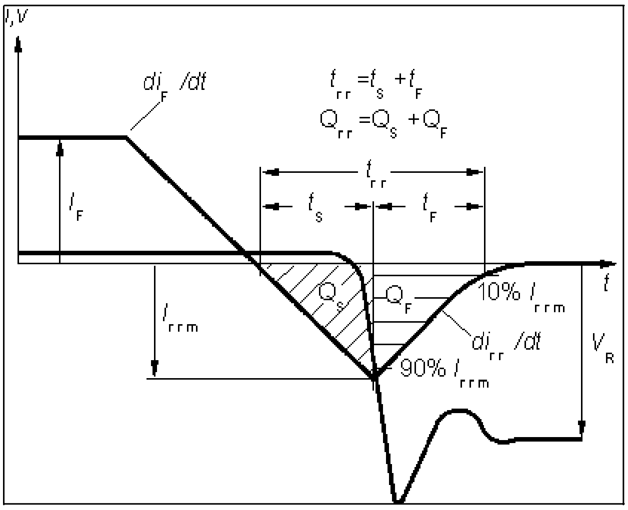


23 Typ. C_{oss} stored energy

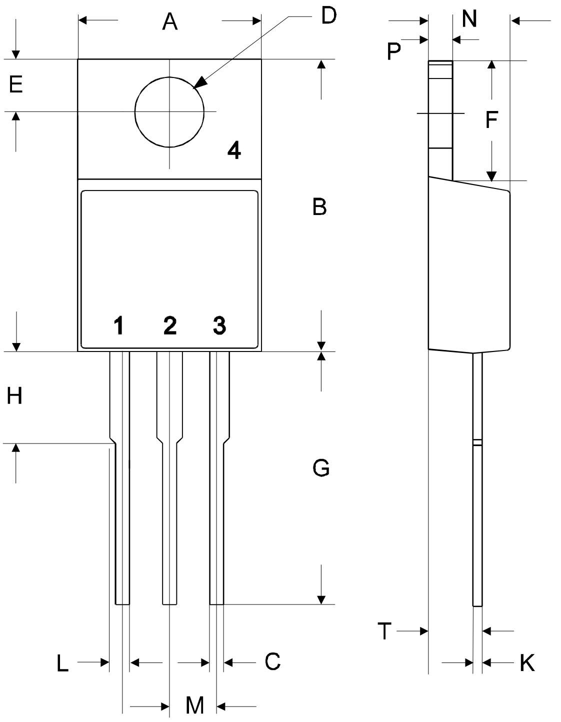
$E_{oss}=f(V_{DS})$



Definition of diodes switching characteristics

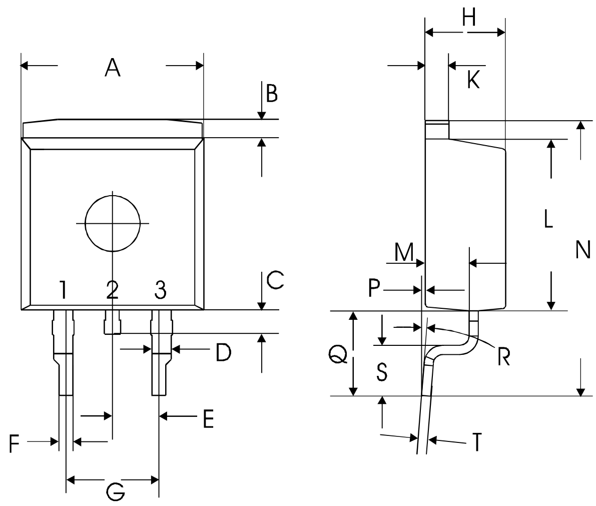


P-TO220-3-1

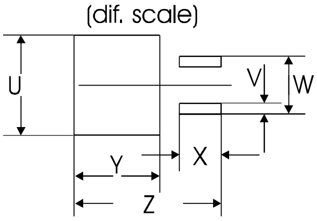


symbol	dimensions			
	[mm]		[inch]	
	min	max	min	max
A	9.70	10.30	0.3819	0.4055
B	14.88	15.95	0.5858	0.6280
C	0.65	0.86	0.0256	0.0339
D	3.55	3.89	0.1398	0.1531
E	2.60	3.00	0.1024	0.1181
F	6.00	6.80	0.2362	0.2677
G	13.00	14.00	0.5118	0.5512
H	4.35	4.75	0.1713	0.1870
K	0.38	0.65	0.0150	0.0256
L	0.95	1.32	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

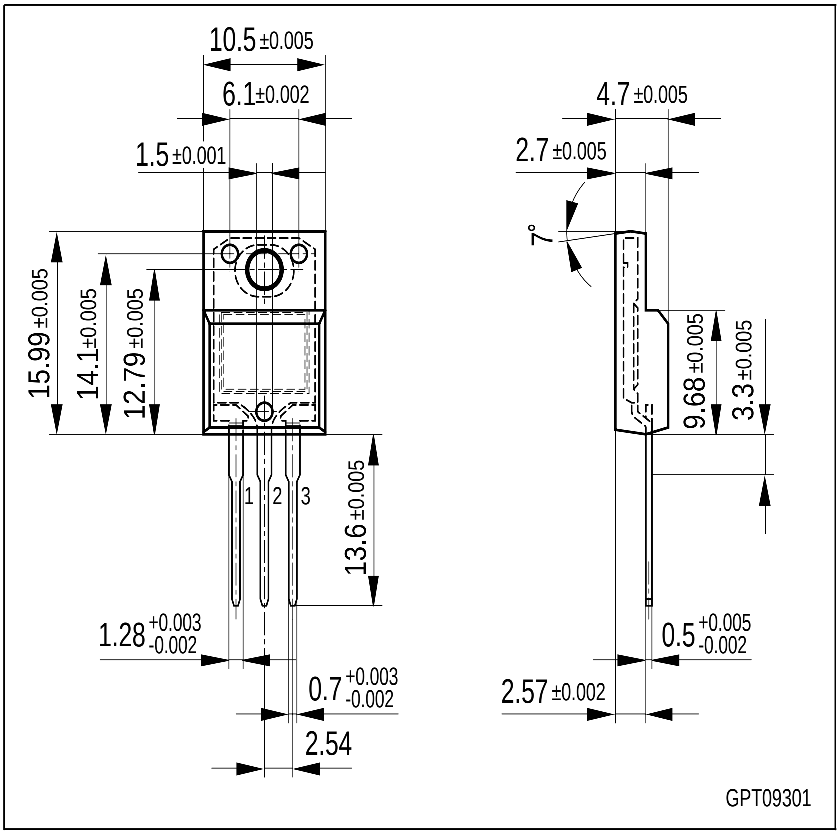
TO-263 (D²Pak/P-TO220SMD)



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	



Please refer to mounting instructions (application note AN-TO220-3-31-01)

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