Cool MOS™ Power Transistor

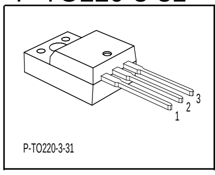
Feature

- New revolutionary high voltage technology
- Worldwide best $R_{DS(on)}$ in TO 220
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances

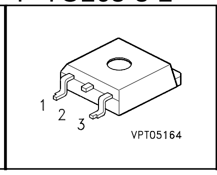
Product Summary

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

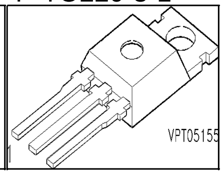
P-TO220-3-31



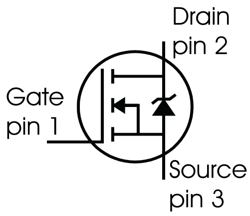
P-TO263-3-2



P-TO220-3-1



Type	Package	Ordering Code	Marking
SPP20N60C2	P-TO220-3-1	Q67040-S4320	20N60C2
SPB20N60C2	P-TO263-3-2	Q67040-S4322	20N60C2
SPA20N60C2	P-TO220-3-31	Q67040-S4333	20N60C2



Maximum Ratings

Parameter	Symbol	Value		Unit
		SPP_B	SPA	
Continuous drain current T_C = 25 °C T_C = 100 °C	I_D	 20 13	 20[1)] 13[1)]	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\ puls}$	40	40	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 A, V_{DS} < V_{DD}, di/dt=100A/µs, T_{jmax}=150°C	dv/dt	6	6	V/ns
Gate source voltage	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=1mA	$V_{GS(th)}$	3.5	4.5	5.5	
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}=20V, V_{DS}=0V	I_{GSS}	-	-	100	nA
Drain-source on-state resistance V_{GS}=10V, I_D=13A, T_j=25°C	$R_{DS(on)}$	-	0.16	0.19	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}	$V_{DS}\geq 2*I_D*R_{DS(on)max}$, I_D=13A	-	12	-	S
Input capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	-	3000	-	pF
Output capacitance	C_{oss}		-	1170	-	
Reverse transfer capacitance	C_{rss}		-	28	-	
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=20A, R_G=3.6Ω, T_j=125°C	-	21	-	ns
Rise time	t_r		-	51	-	
Turn-off delay time	$t_{d(off)}$		-	56	84	
Fall time	t_f		-	6	9	
Gate Charge Characteristics						
Gate to source charge	Q_{gs}	V_{DD}=350V, I_D=20A	-	21	-	nC
Gate to drain charge	Q_{gd}		-	46	-	
Gate charge total	Q_g	V_{DD}=350V, I_D=20A, V_{GS}=0 to 10V	-	79	103	
Gate plateau voltage	$V_{(plateau)}$	V_{DD}=350V, I_D=20A	-	8	-	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}.

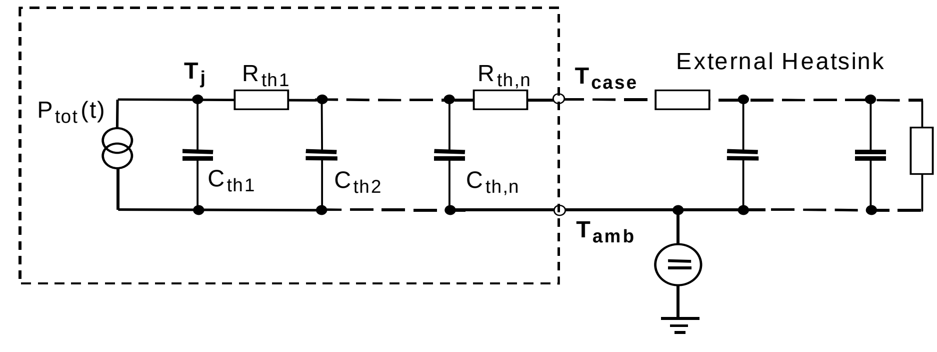
[5]$C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Inverse diode continuous forward current	I_S	T_C=25°C	-	-	20	A
Inverse diode direct current, pulsed	I_{SM}		-	-	40	
Inverse diode forward voltage	V_{SD}	V_{GS}=0V, I_F=I_S	-	1	1.2	V
Reverse recovery time	t_{rr}	V_R=350V, I_F=I_S ,	-	610	1040	ns
Reverse recovery charge	Q_{rr}	di_F/dt=100A/µs	-	12	-	µC
Peak reverse recovery current	I_{rrm}		-	48	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt	T_j=25°C	-	1500	-	A/µs

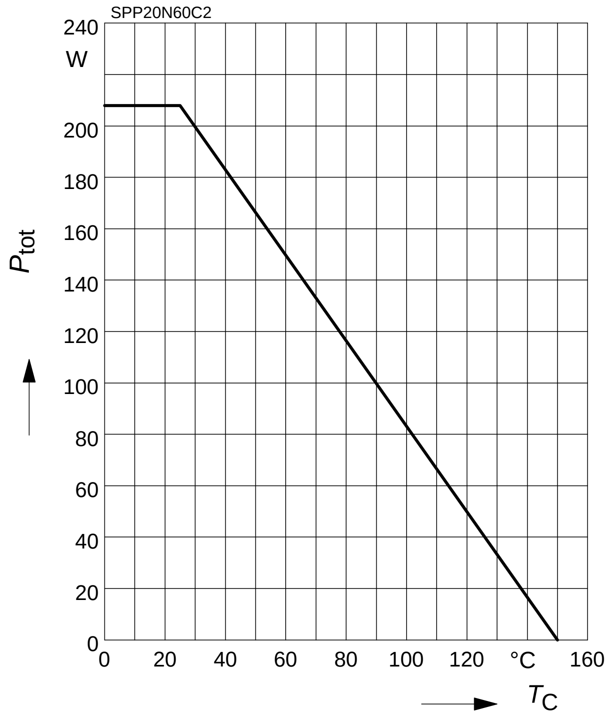
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_B	SPA			SPP_B	SPA	
R_{th1}	0.007416	0.077	K/W	C_{th1}	0.0004409	0.000376	Ws/K
R_{th2}	0.016	0.015		C_{th2}	0.001462	0.00141	
R_{th3}	0.021	0.022		C_{th3}	0.0024	0.00192	
R_{th4}	0.06	0.063		C_{th4}	0.003031	0.00332	
R_{th5}	0.083	0.214		C_{th5}	0.02	0.019	
R_{th6}	0.038	2.479		C_{th6}	0.146	0.412	



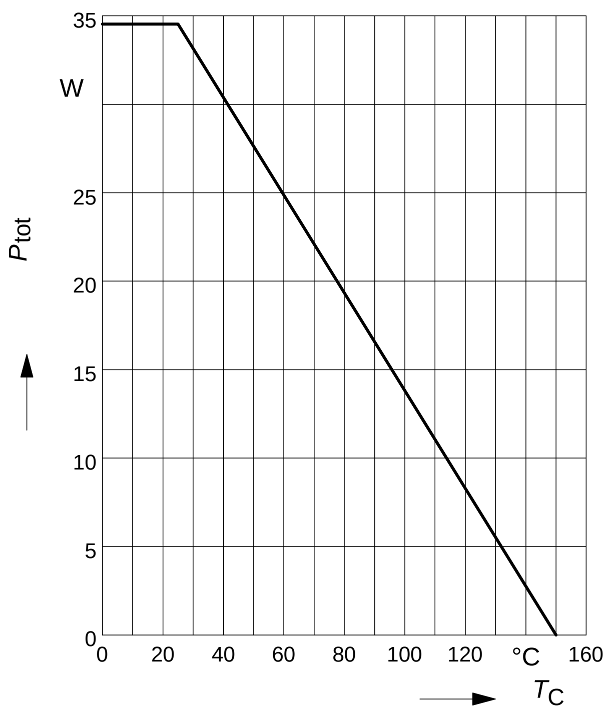
1 Power dissipation

$P_{tot} = f(T_C)$



2 Power dissiaption FullPAK

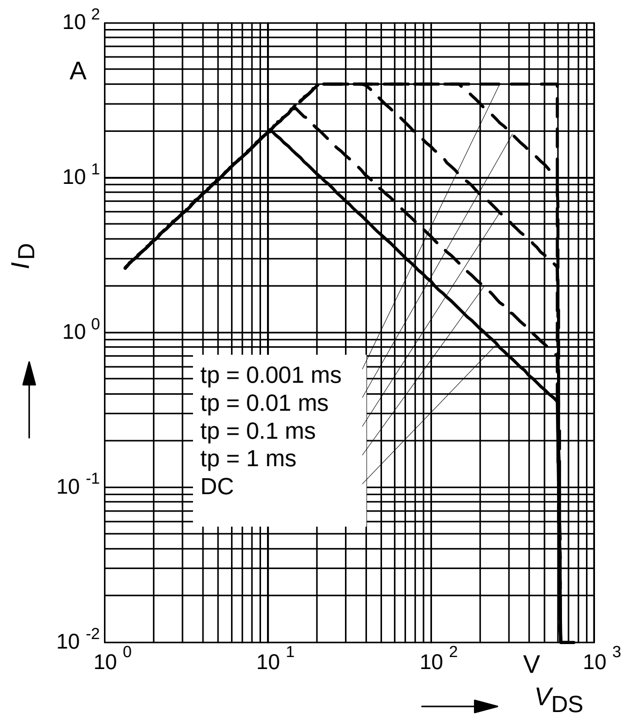
$P_{tot} = f(T_C)$



3 Safe operating area

$I_D = f(V_{DS})$

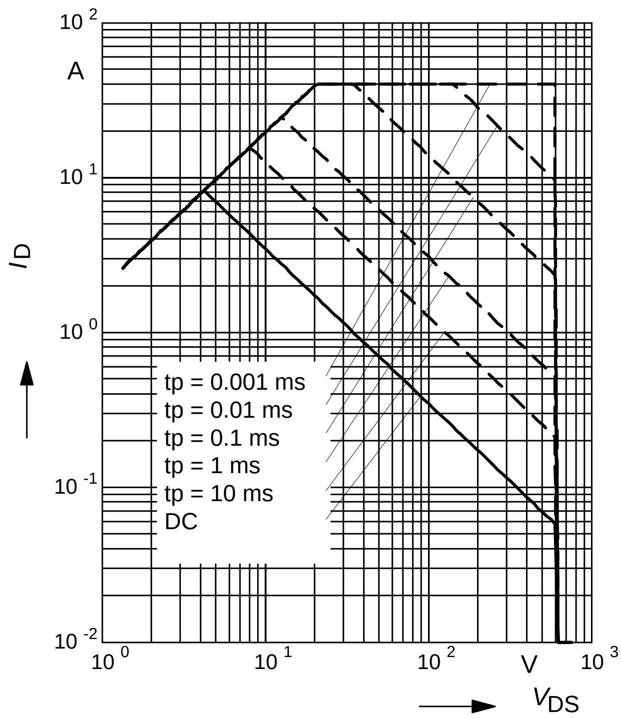
parameter : $D = 0$, T_C=25°C



4 Safe operating area FullPAK

$I_D = f(V_{DS})$

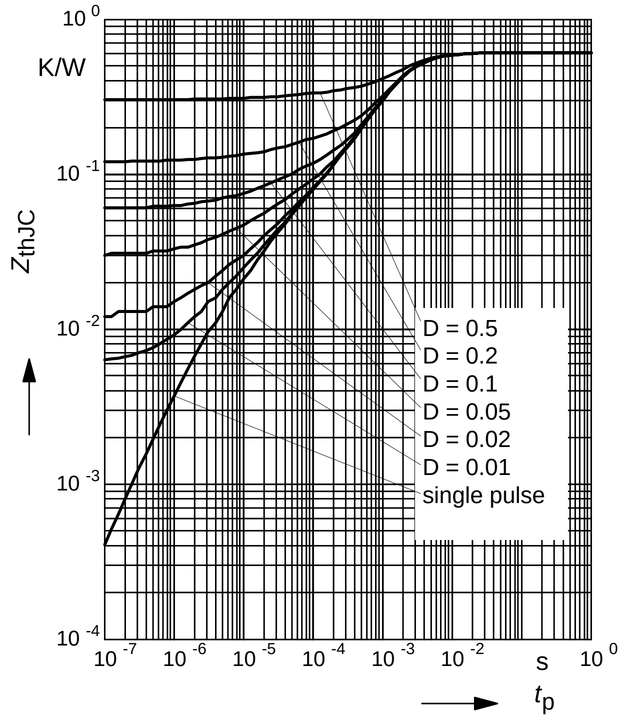
parameter: $D = 0$, T_C = 25°C



5 Transient thermal impedance

$Z_{thJC} = f(t_p)$

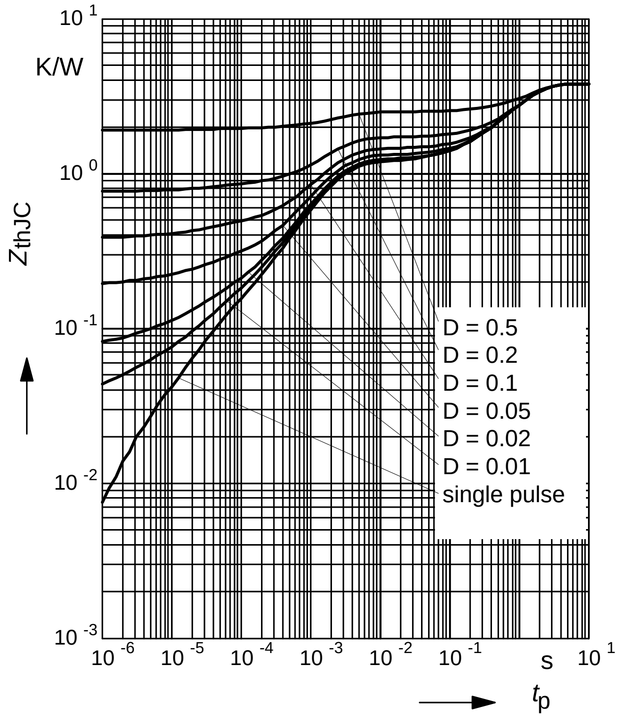
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

$Z_{thJC} = f(t_p)$

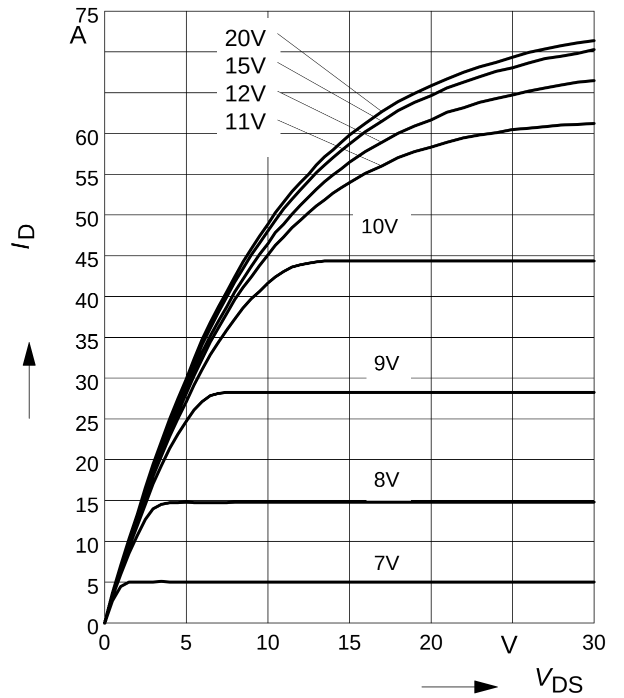
parameter: $D = t_p/t$



7 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=25°C

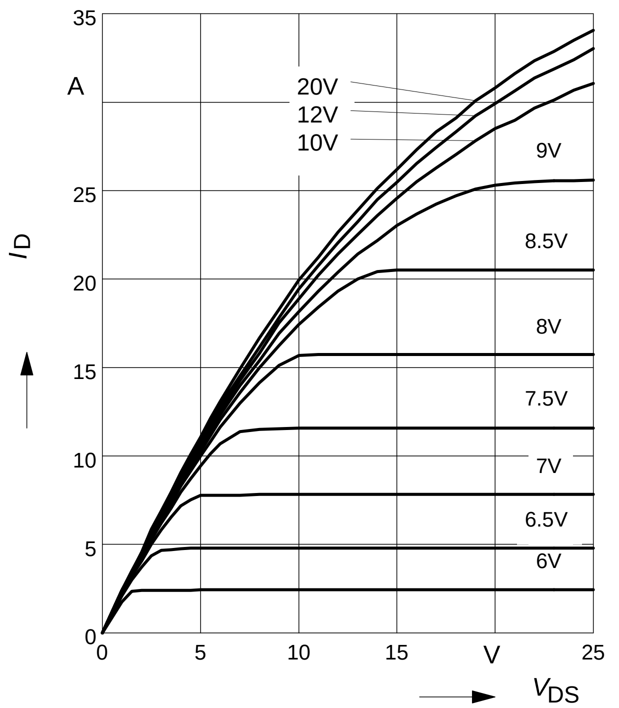
parameter: t_p = 10 µs, V_{GS}



8 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=150°C

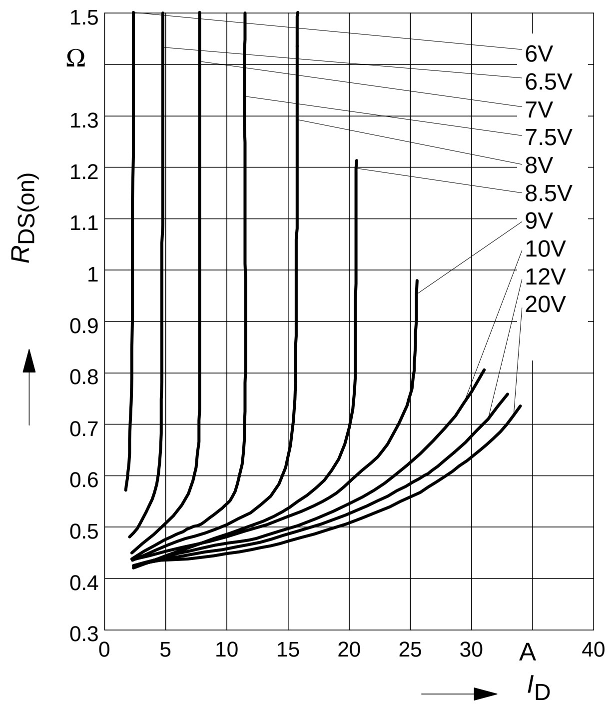
parameter: t_p = 10 µs, V_{GS}



9 Typ. drain-source on resistance

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

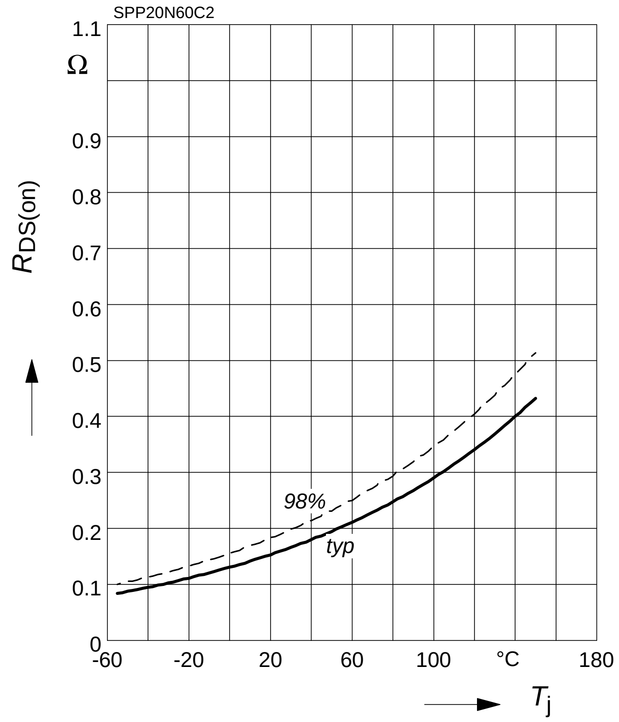
parameter: T_j=150°C, V_{GS}



10 Drain-source on-state resistance

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

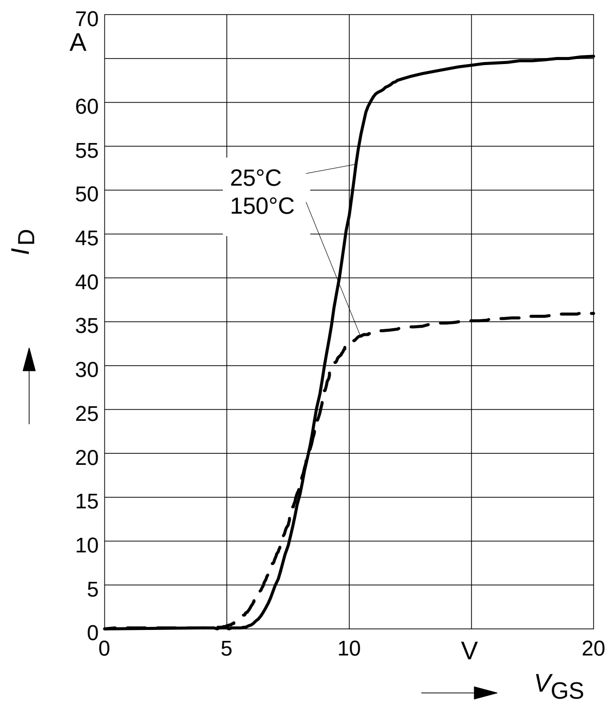
parameter : I_D = 13 A, V_{GS} = 10 V



11 Typ. transfer characteristics

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

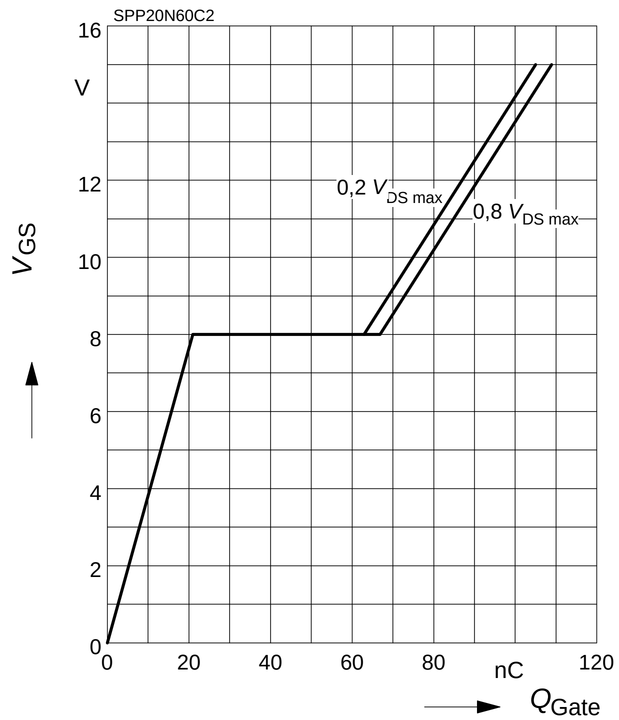
parameter: t_p = 10 µs



12 Typ. gate charge

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

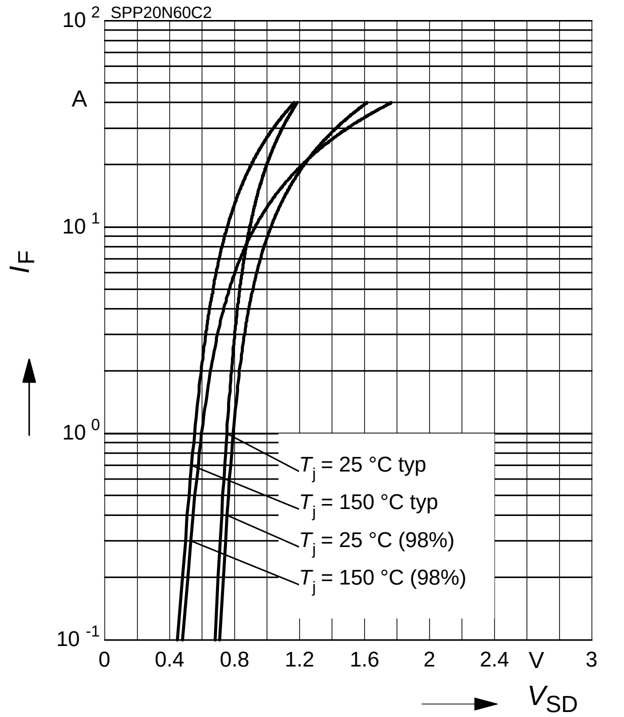
parameter: I_D = 20 A pulsed



13 Forward characteristics of body diode

$I_F = f(V_{SD})$

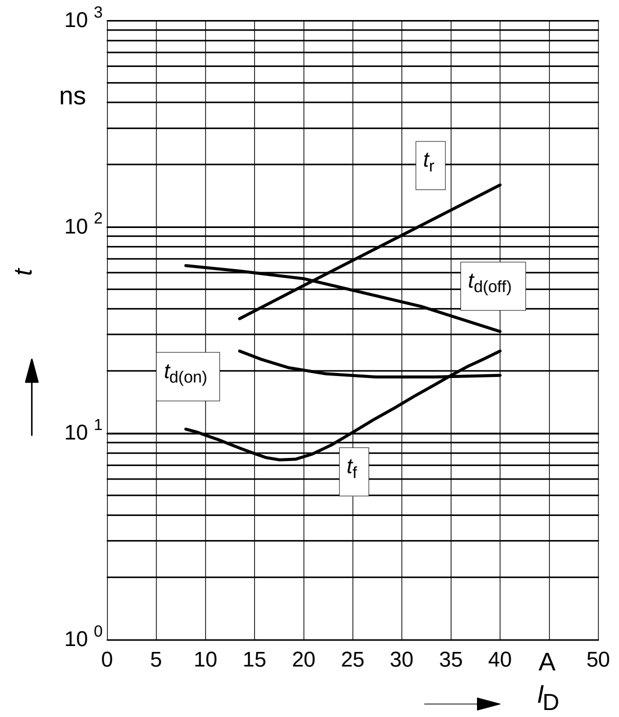
parameter: T_j , t_p = 10 µs



14 Typ. switching time

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

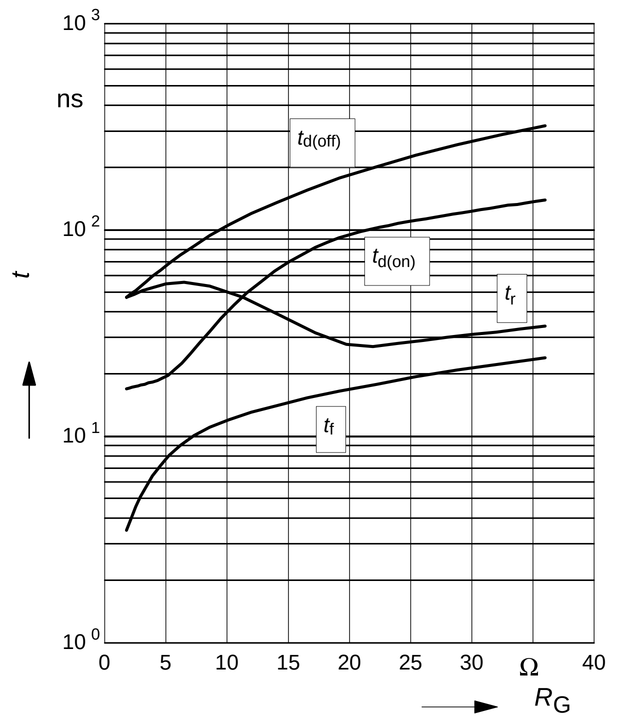
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=3.6Ω



15 Typ. switching time

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

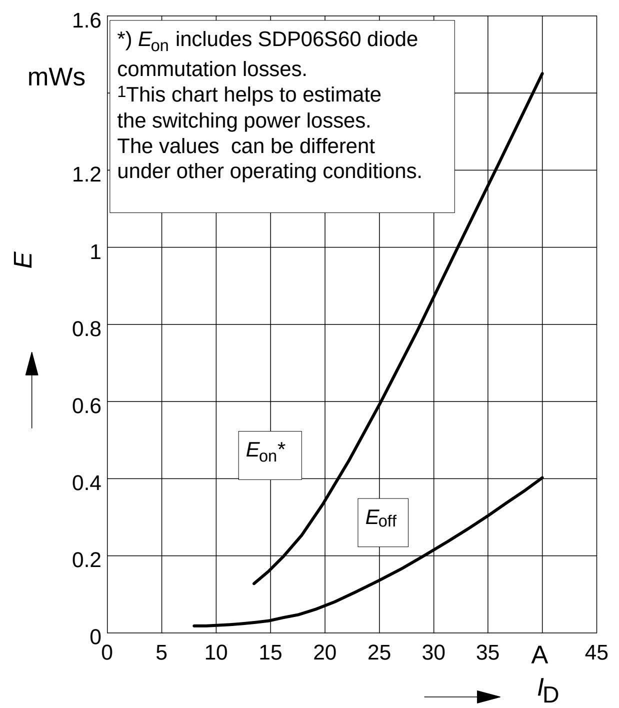
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=20A



16 Typ. switching losses1)

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

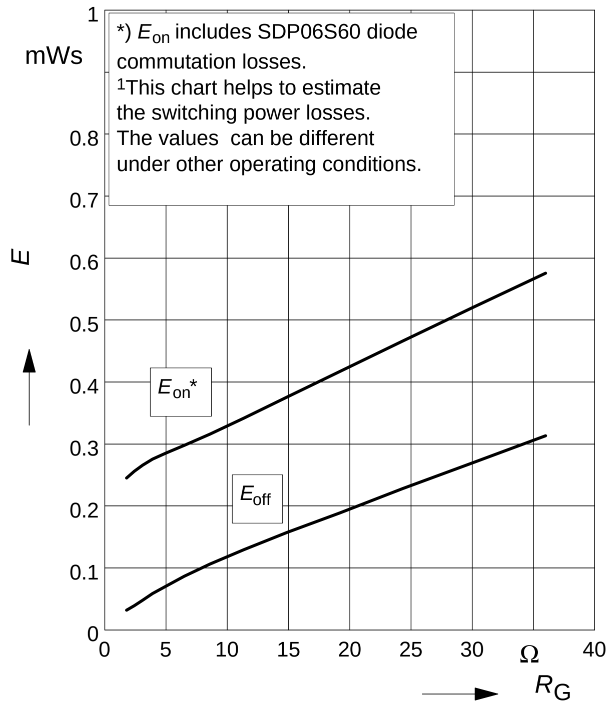
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=3.6Ω



17 Typ. switching losses[1)]

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

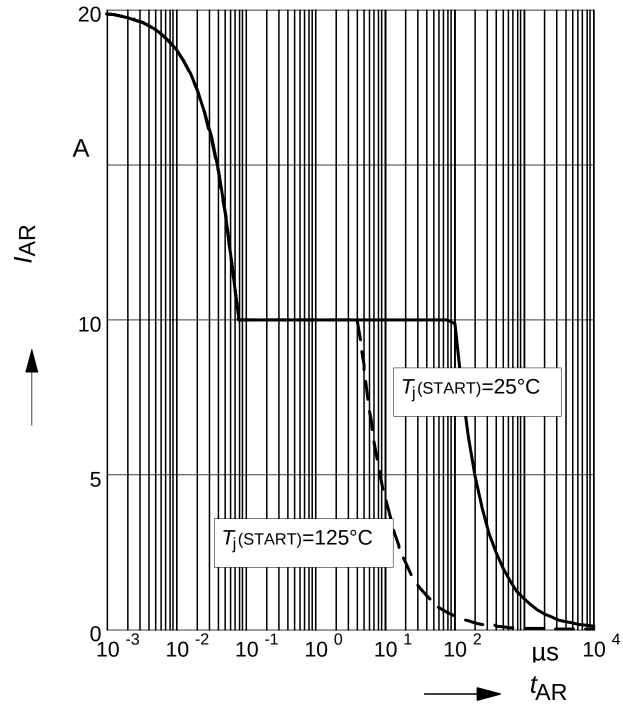
par.: V_{DS}=380V, V_{GS}=0/+13V,I_D=20A



18 Avalanche SOA

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

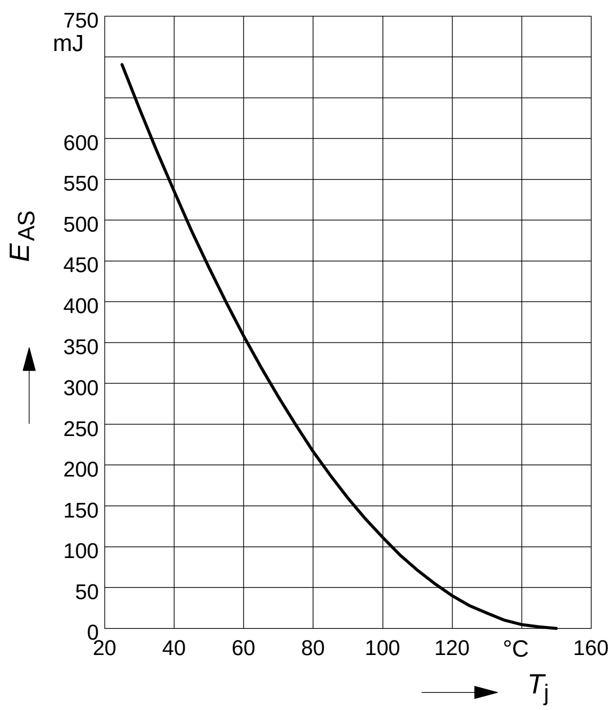
par.: $T_j \leq 150$ °C



19 Avalanche energy

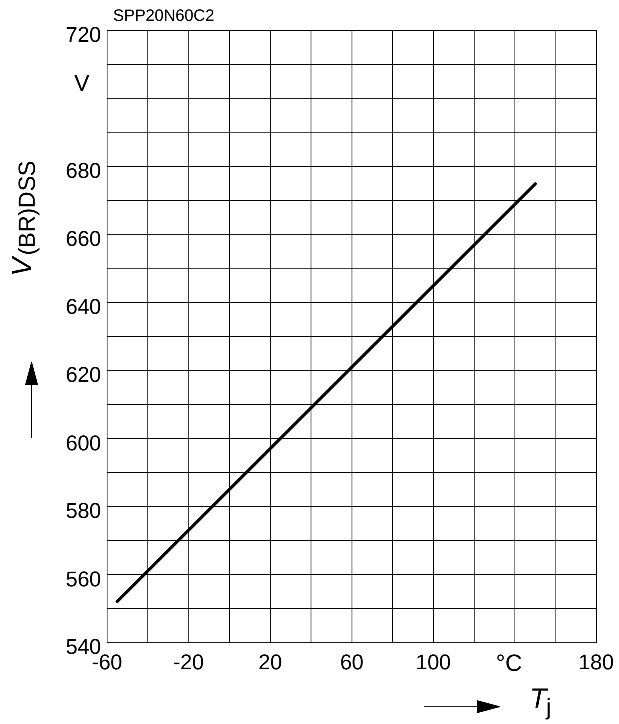
$E_{AS} = f(T_j)$

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



20 Drain-source breakdown voltage

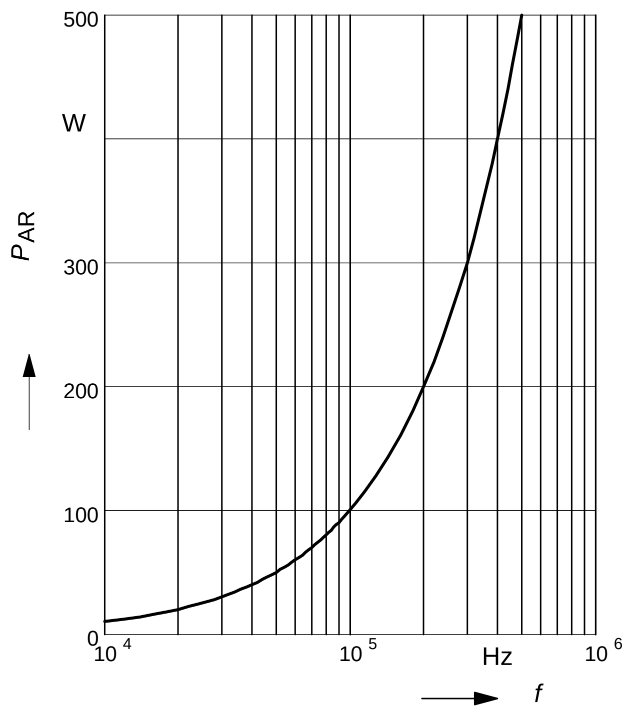
$V_{(BR)DSS} = f(T_j)$



21 Avalanche power losses

$P_{AR} = f(f)$

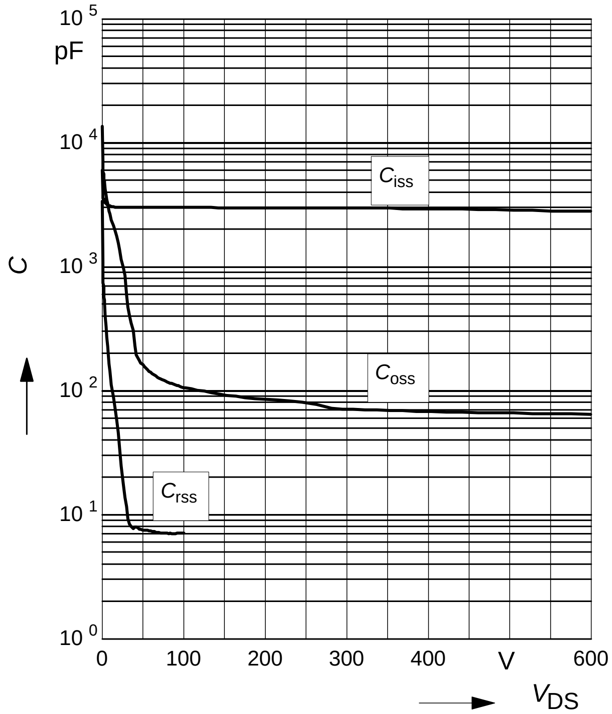
parameter: E_{AR}=1mJ



22 Typ. capacitances

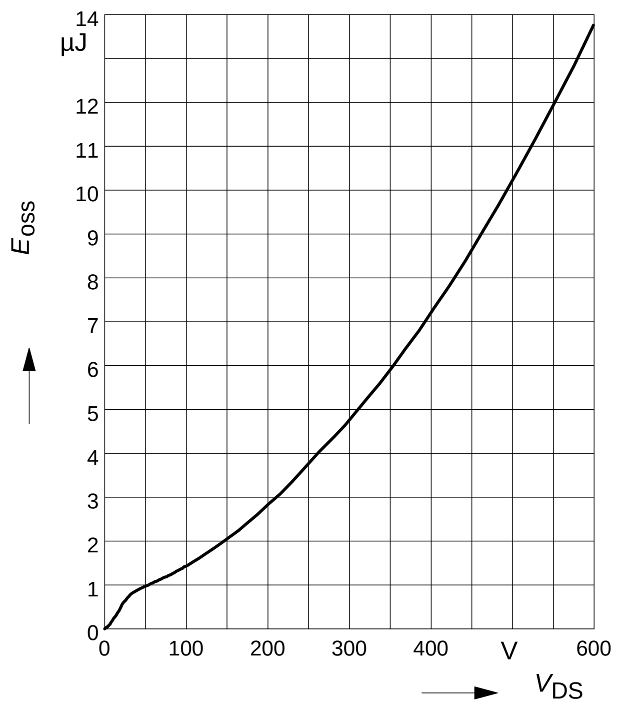
$C = f(V_{DS})$

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

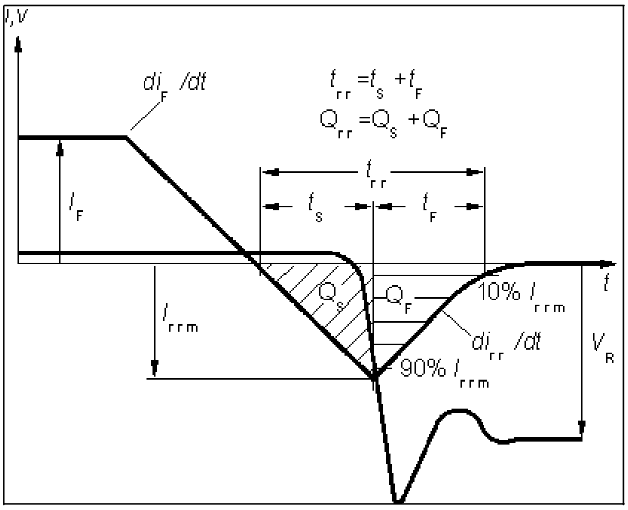


23 Typ. C_{oss} stored energy

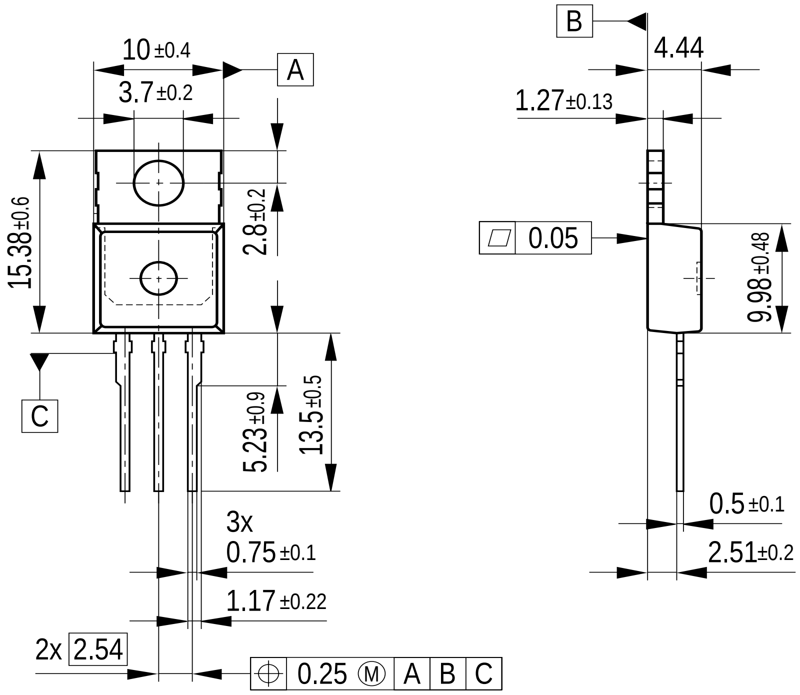
$E_{oss}=f(V_{DS})$



Definition of diodes switching characteristics

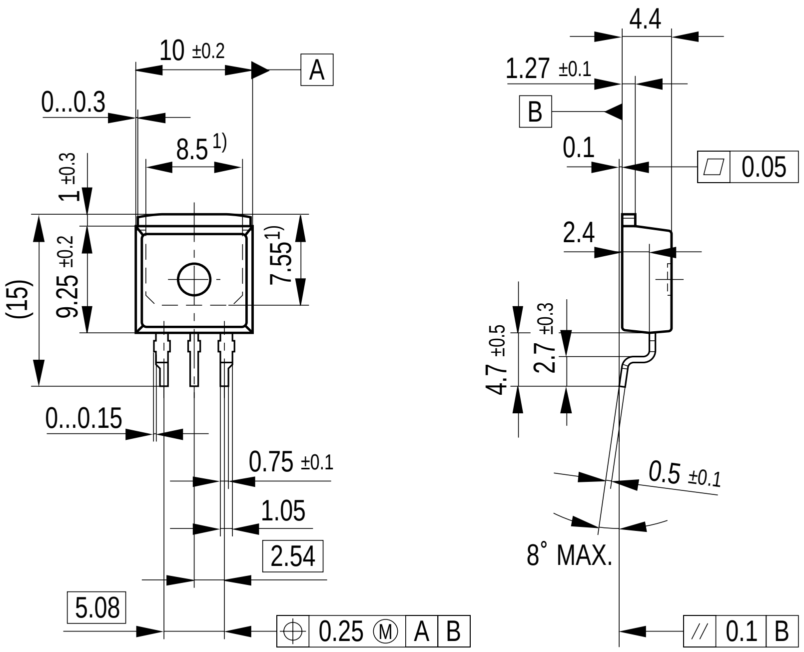


P-TO-220-3-1



All metal surfaces tin plated, except area of cut.
Metal surface min. x=7.25, y=12.3

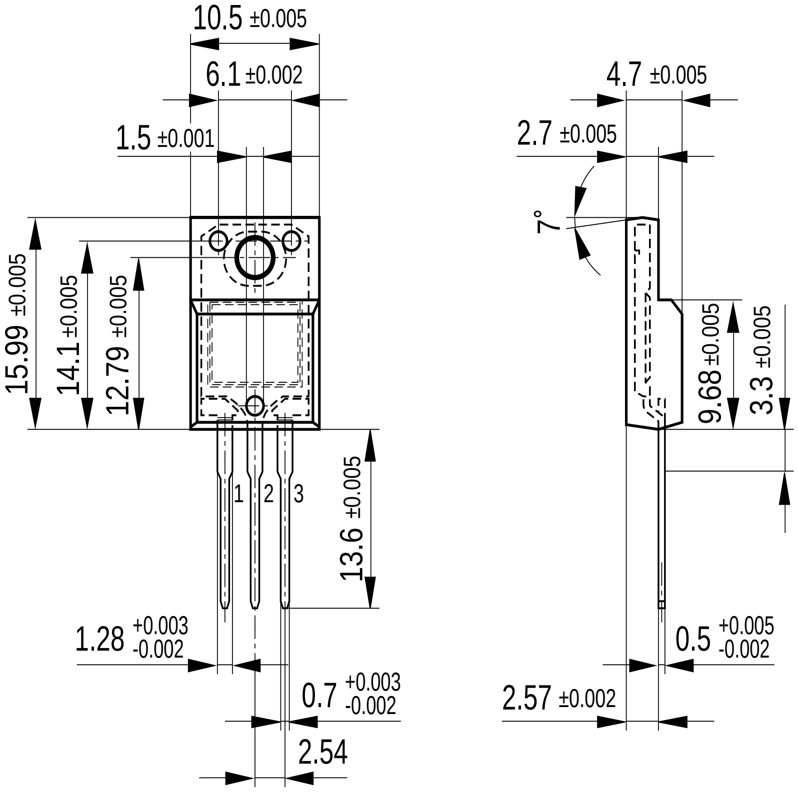
P-TO-263-3-1 (D^2-PAK)



1) Typical

All metal surfaces: tin plated, except area of cut.
Metal surface min. x=7.25, y=6.9

P-TO-220-3-31 (FullPAK)



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

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