Cool MOS™ Power Transistor

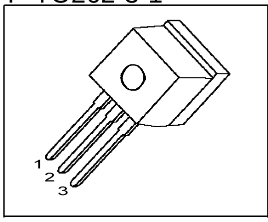
Feature

- 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

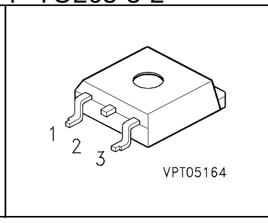
Product Summary

V_{DS} @ T_{jmax}	650	V
$R_{DS(on)}$	0.38	Ω
I_D	11	A

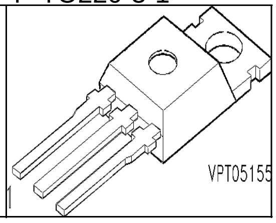
P-TO262-3-1



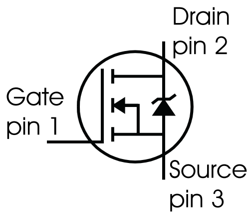
P-TO263-3-2



P-TO220-3-1



Type	Package	Ordering Code	Marking
SPP11N60C3	P-TO220-3-1	Q67040-S4395	11N60C3
SPB11N60C3	P-TO263-3-2	Q67040-S4396	11N60C3
SPI11N60C3	P-TO262-3-1	Q67042-S4403	11N60C3



Maximum Ratings, at T_j = 25 °C, unless otherwise specified

Parameter	Symbol	Value	Unit
Continuous drain current	I_D		A
T_C = 25 °C		11	
T_C = 100 °C		7	
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\ puls}$	33	
Avalanche energy, single pulse I_D=5.5A, V_{DD}=50V	E_{AS}	340	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} 1) I_D=11A, V_{DD}=50V	E_{AR}	0.6	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	11	A
Reverse diode dv/dt I_S=11A, V_{DS} < V_{DD}, di/dt=100A/µs, T_{jmax}=150°C	dv/dt	6	V/ns
Gate source voltage static	V_{GS}	±20	V
Gate source voltage dynamic	V_{GS}	±30	
Power dissipation, T_C = 25°C	P_{tot}	125	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}	-	-	1	K/W
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
SMD version, device on PCB:	R_{thJA}				
@ min. footprint		-	-	62	
@ 6 cm² cooling area [2)]		-	35	-	
Linear derating factor		-	-	1	W/K
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=11A	$V_{(BR)DS}$	-	700	-	
Gate threshold voltage, V_{GS} = V_{DS} I_D = 0.5 mA	$V_{GS(th)}$	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}				µA
V_{DS} = 600 V, V_{GS} = 0 V, T_j = 25 °C		-	-	25	
V_{DS} = 600 V, V_{GS} = 0 V, T_j = 150 °C		-	-	250	
Gate-source leakage current V_{GS}=20V, V_{DS}=0V	I_{GSS}	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$				Ω
V_{GS}=10V, I_D=7A, T_j=25°C		-	0.34	0.38	
V_{GS}=10V, I_D=7A, T_j=150°C		-	1.1	1.22	
Gate input resistance f = 1 MHz, open drain	R_G	-	0.86	-	

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

[2]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.

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Transconductance	g_{fs}	$V_{DS} \geq 2 * I_D * R_{DS(on)max}$, I_D=7A	-	8.3	-	S
Input capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	-	1460	-	pF
Output capacitance	C_{oss}		-	610	-	
Reverse transfer capacitance	C_{rss}		-	21	-	
Effective output capacitance,[1] energy related	$C_{o(er)}$	V_{GS}=0V, V_{DS}=0V to 480V	-	45	-	pF
Effective output capacitance,[2] time related	$C_{o(tr)}$		-	85	-	
Turn-on delay time	$t_{d(on)}$	V_{DD}=380V, V_{GS}=0/10V, I_D=11A, R_G=6.8Ω	-	10	-	ns
Rise time	t_r		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	44	70	
Fall time	t_f		-	5	9	

Gate Charge Characteristics

Parameter	Symbol	Conditions	min.	typ.	max.	Unit
Gate to source charge	Q_{gs}	V_{DD}=480V, I_D=11A	-	5.5	-	nC
Gate to drain charge	Q_{gd}		-	22	-	
Gate charge total	Q_g	V_{DD}=480V, I_D=11A, V_{GS}=0 to 10V	-	45	60	
Gate plateau voltage	$V_{(plateau)}$	V_{DD}=480V, I_D=11A	-	5.5	-	V

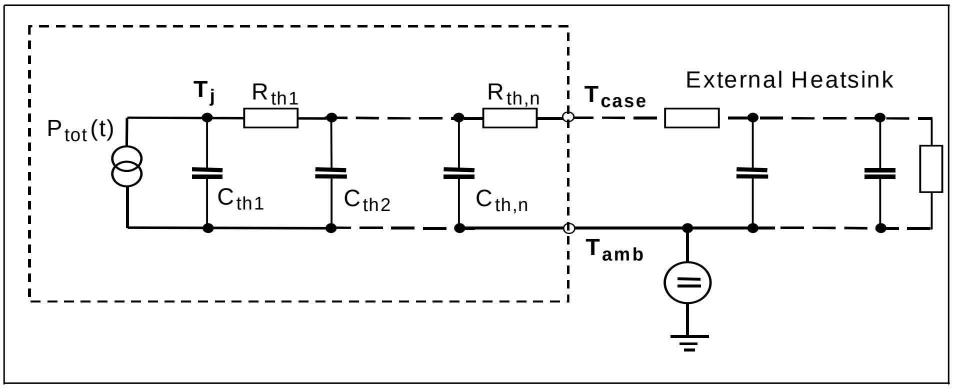
[1] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Inverse diode continuous forward current	I_S	T_C=25°C	-	-	11	A
Inverse diode direct current, pulsed	I_{SM}		-	-	33	
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 ,	-	400	600	ns
Reverse recovery charge	Q_{rr}	di_F/dt=100A/µs	-	6	-	µC
Peak reverse recovery current	I_{rrm}		-	41	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	1200	-	A/µs

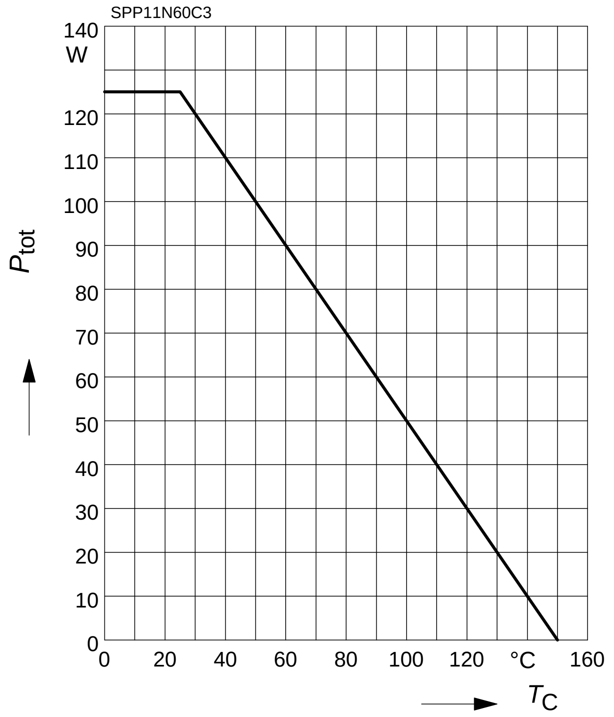
Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
R_{th1}	0.015	K/W	C_{th1}	0.0002121	Ws/K
R_{th2}	0.034		C_{th2}	0.0007091	
R_{th3}	0.056		C_{th3}	0.001184	
R_{th4}	0.124		C_{th4}	0.00254	
R_{th5}	0.143		C_{th5}	0.011	
R_{th6}	0.057		C_{th6}	0.092	



1 Power dissipation

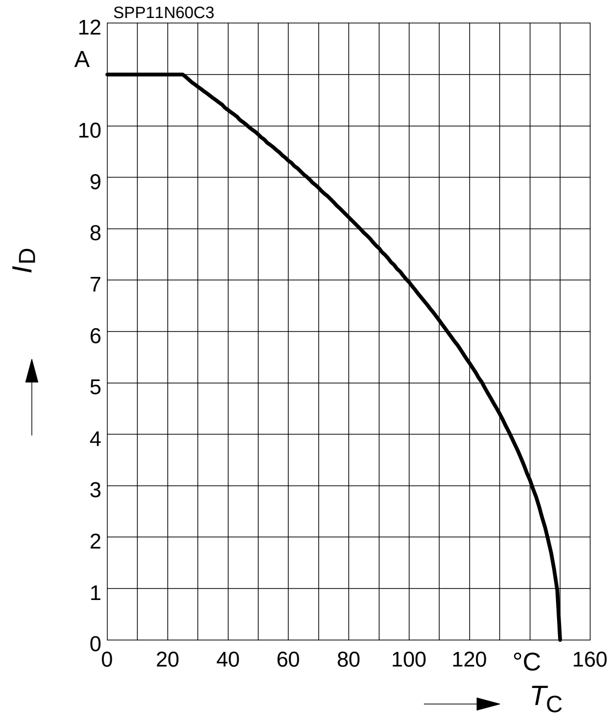
$P_{tot} = f(T_C)$



2 Drain current

$I_D = f(T_C)$

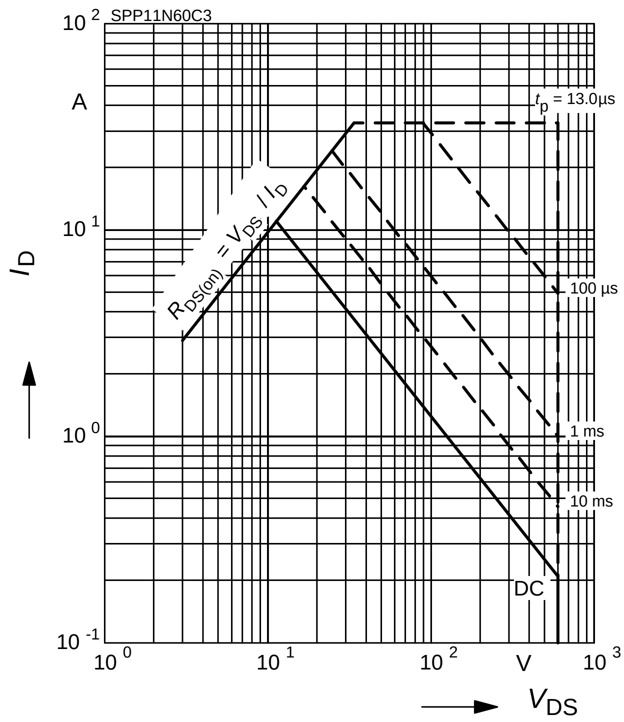
parameter: $V_{GS} \geq 10$ V



3 Safe operating area

$I_D = f(V_{DS})$

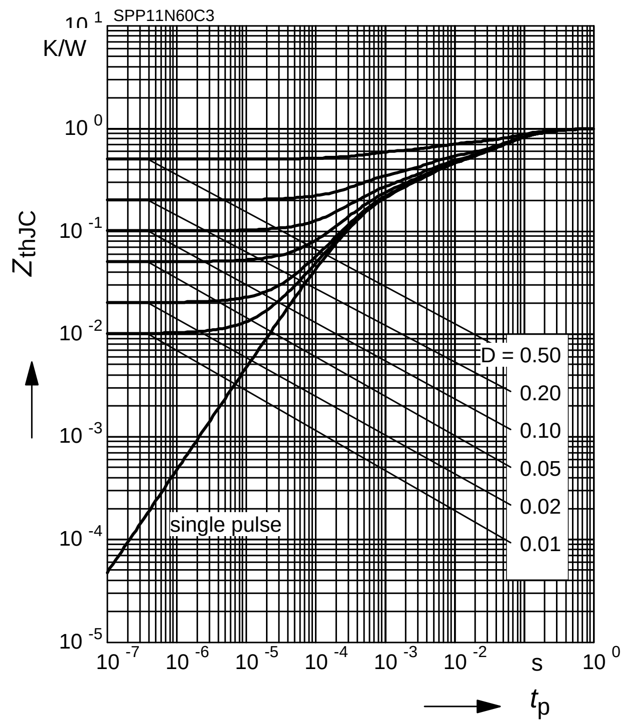
parameter : $D = 0$, T_C=25°C



4 Transient thermal impedance

$Z_{thJC} = f(t_p)$

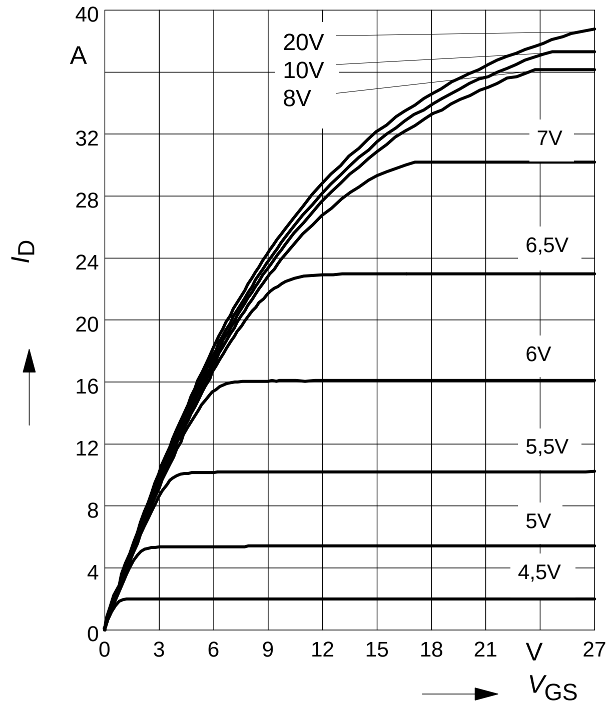
parameter : $D = t_p/T$



5 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=25°C

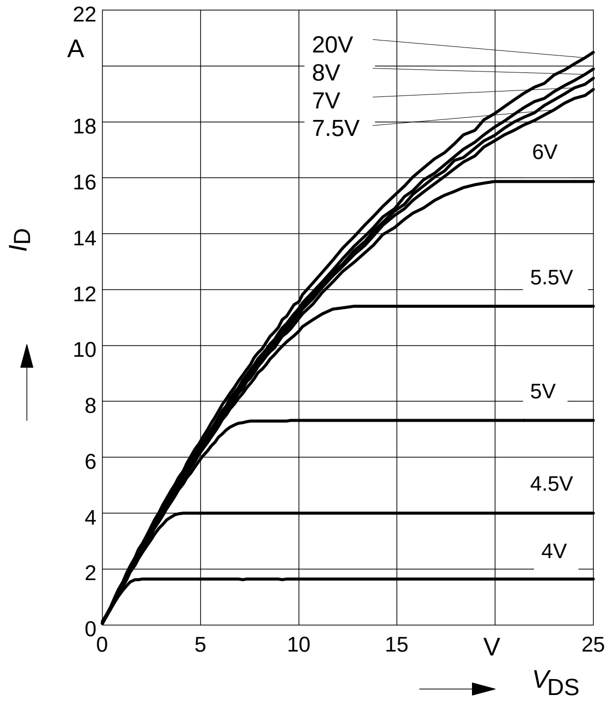
parameter: t_p = 10 µs, V_{GS}



6 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=150°C

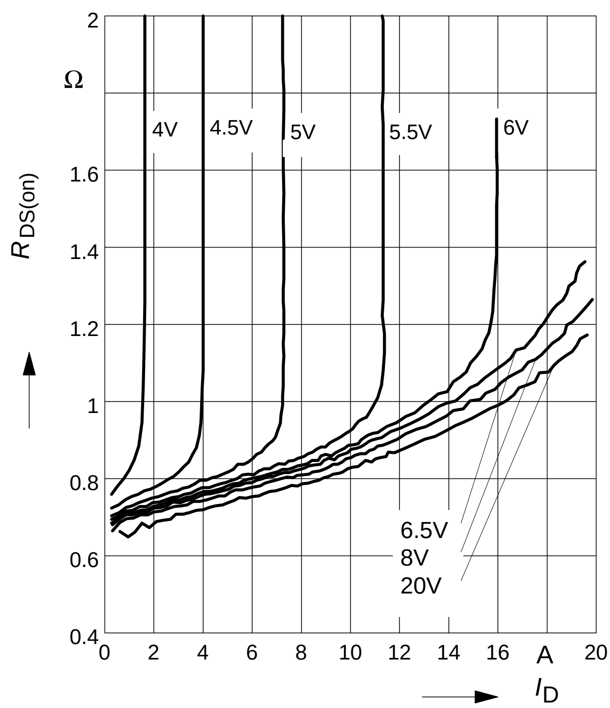
parameter: t_p = 10 µs, V_{GS}



7 Typ. drain-source on resistance

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

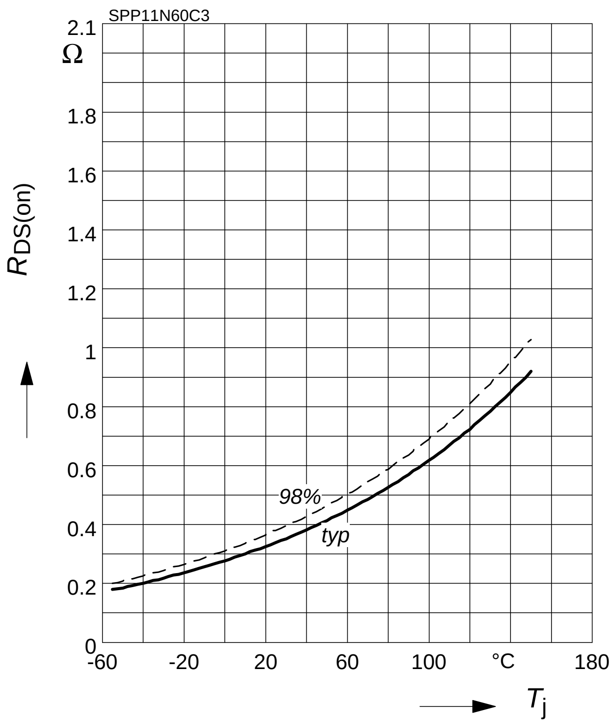
parameter: T_j=150°C, V_{GS}



8 Drain-source on-state resistance

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

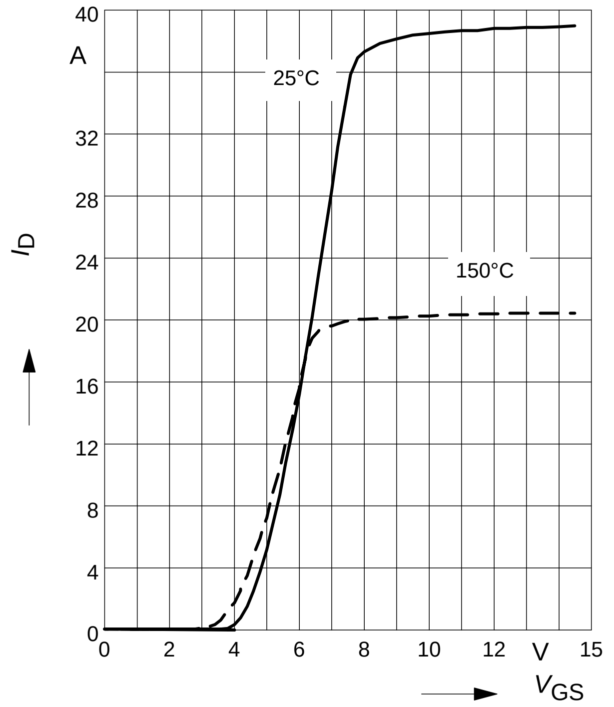
parameter : I_D = 7 A, V_{GS} = 10 V



9 Typ. transfer characteristics

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

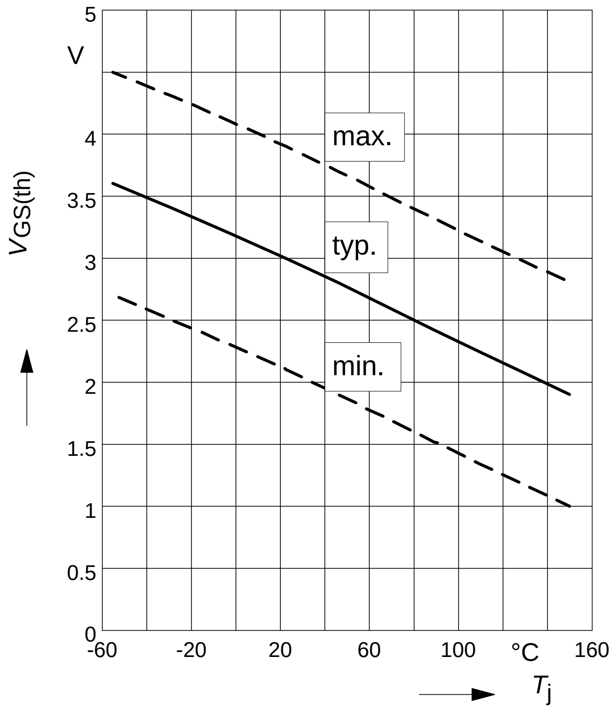
parameter: $t_p = 10\ \mu s$



10 Gate threshold voltage

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

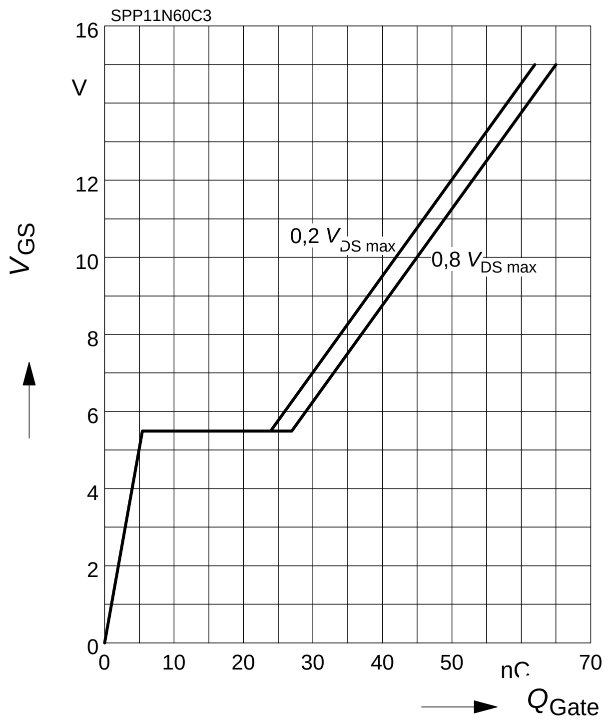
parameter: $V_{GS} = V_{DS}$, $I_D = 0.5$ mA



11 Typ. gate charge

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

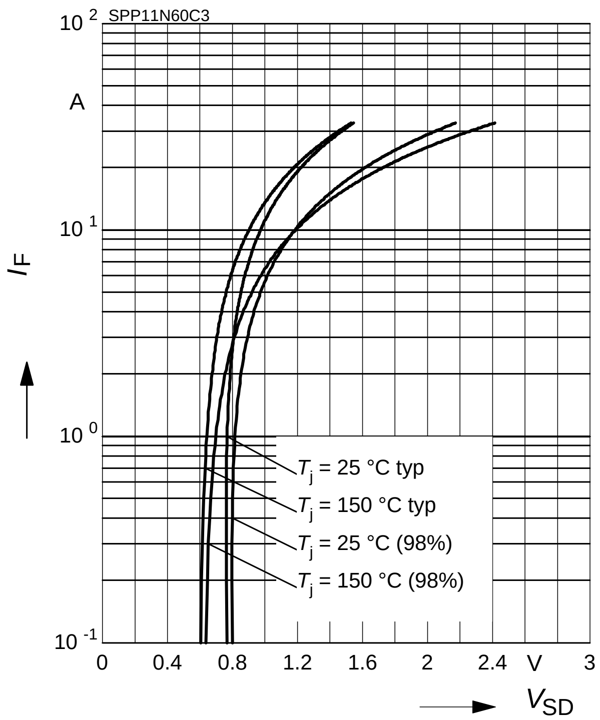
parameter: $I_D = 11$ A pulsed



12 Forward characteristics of body diode

$I_F = f(V_{SD})$

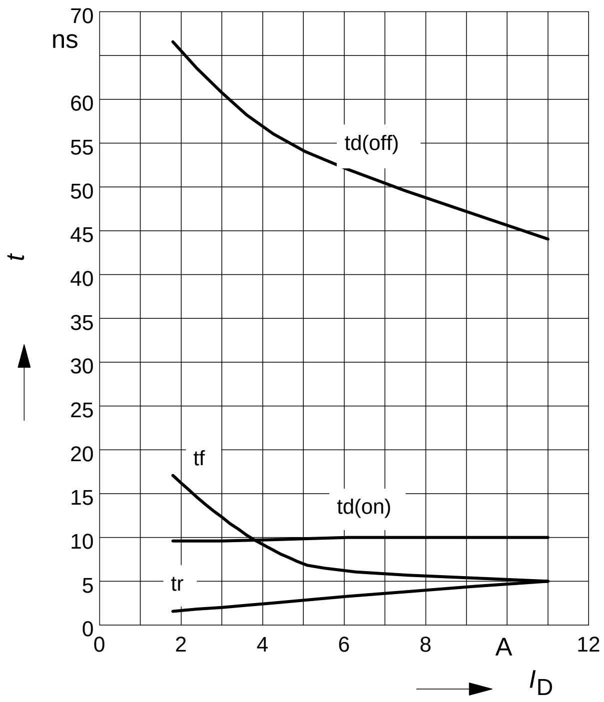
parameter: T_j, $t_p = 10\ \mu s$



6.8 Typ. switching time

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

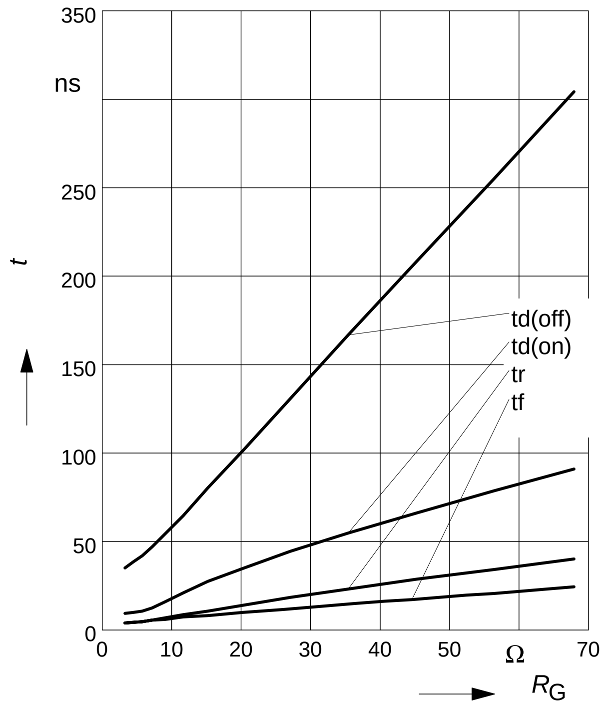
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=6.8Ω



13 Typ. switching time

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

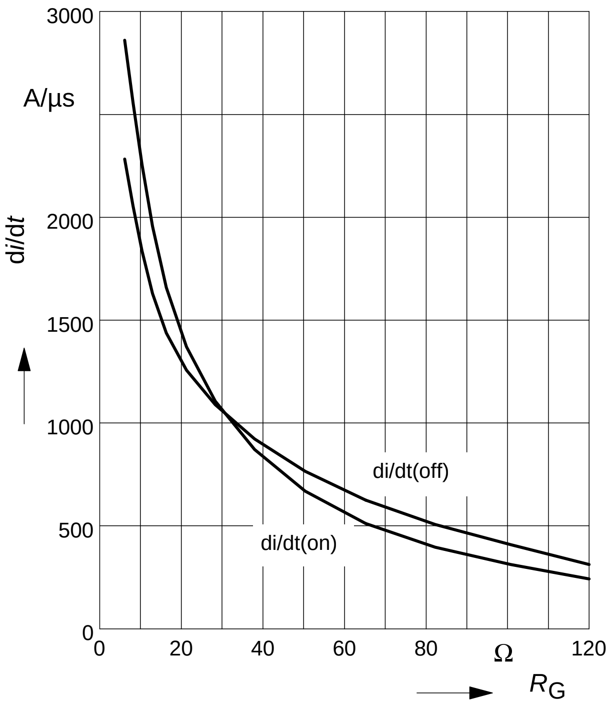
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11 A



14 Typ. drain current slope

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

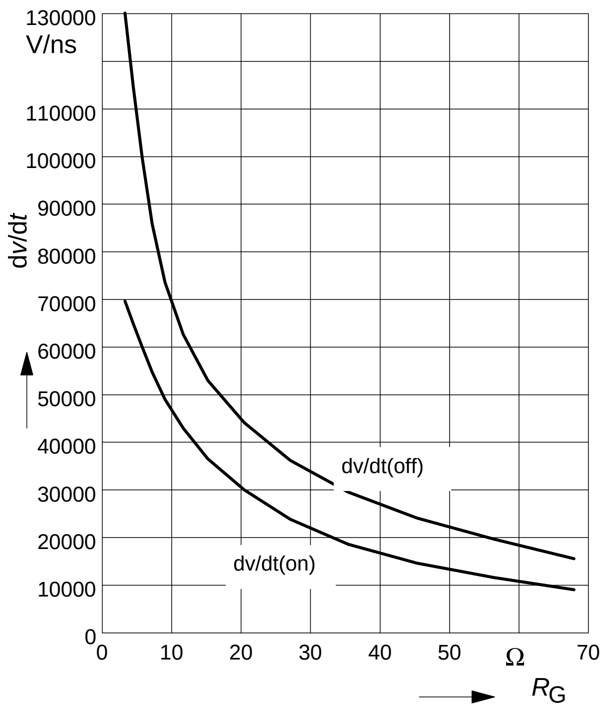
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11A



15 Typ. drain source voltage slope

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

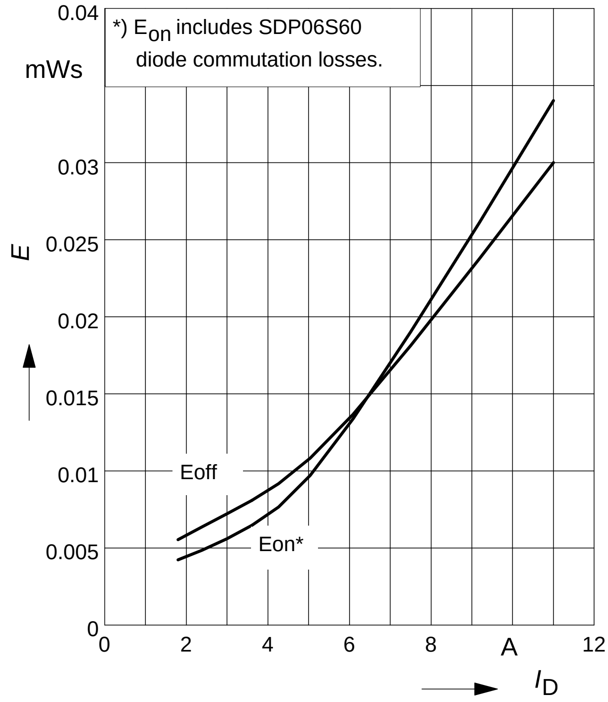
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11A



16 Typ. switching losses

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

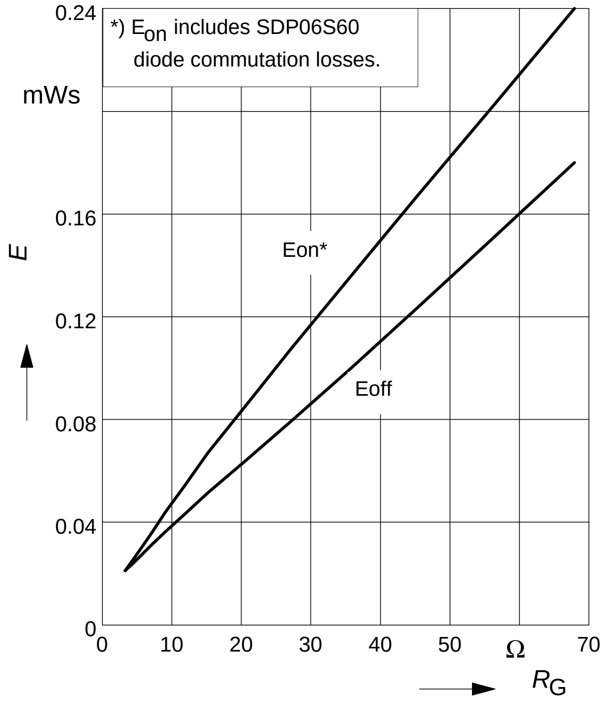
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=6.8Ω



17 Typ. switching losses

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

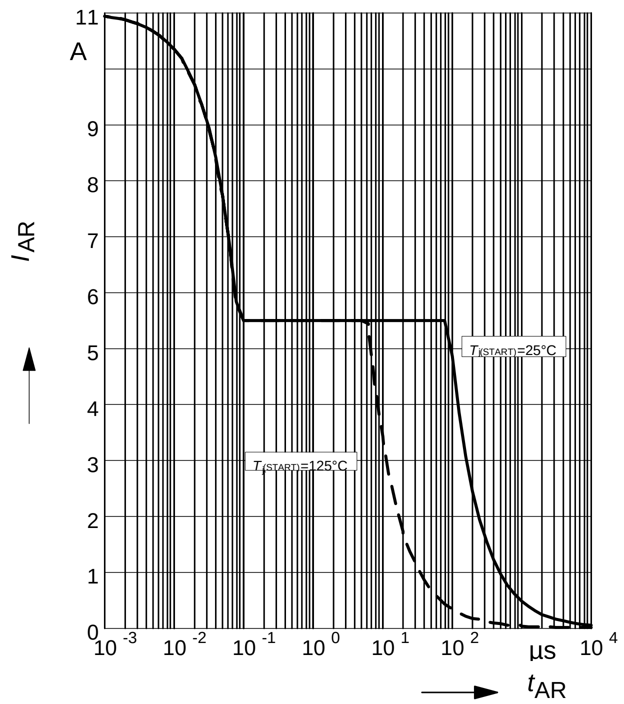
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11A



18 Avalanche SOA

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

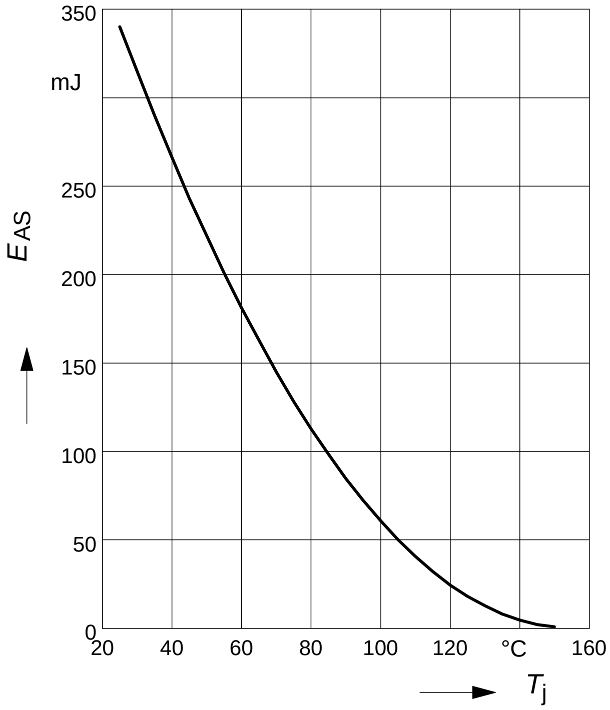
par.: $T_j \leq 150$ °C



19 Avalanche energy

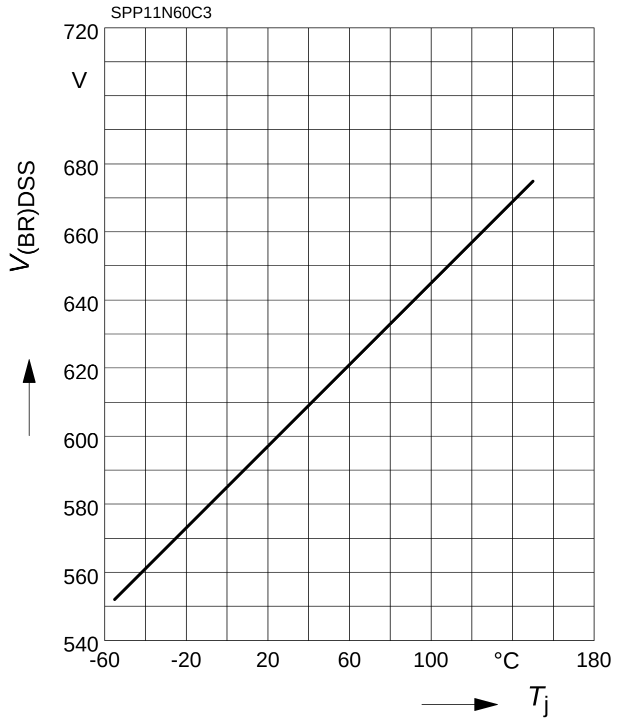
$E_{AS} = f\ (T_j)$

par.: I_D = 5.5 A, V_{DD} = 50 V



20 Drain-source breakdown voltage

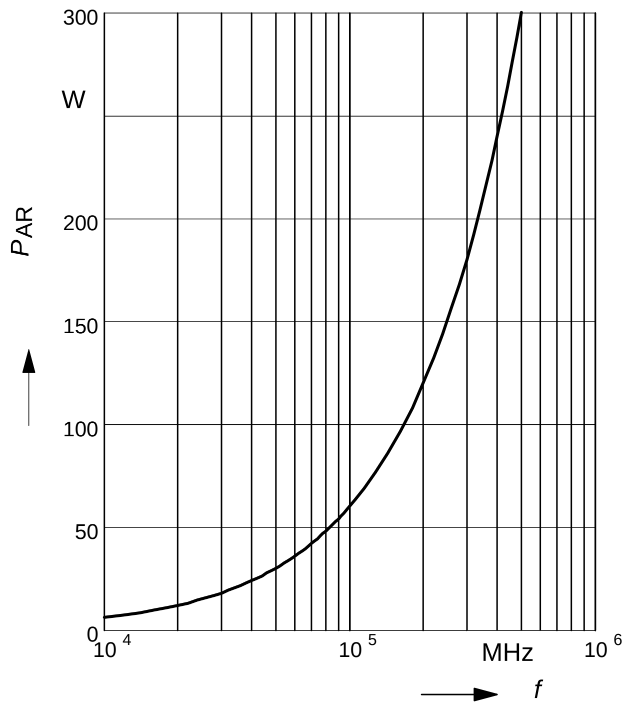
$V_{(BR)DSS} = f\ (T_j)$



21 Avalanche power losses

$P_{AR} = f\ (f\ )$

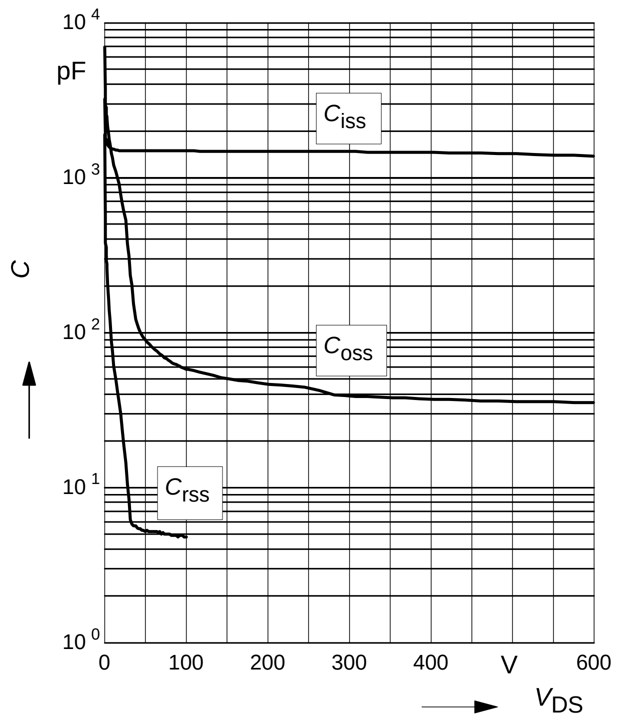
parameter: E_{AR}=0.6mJ



22 Typ. capacitances

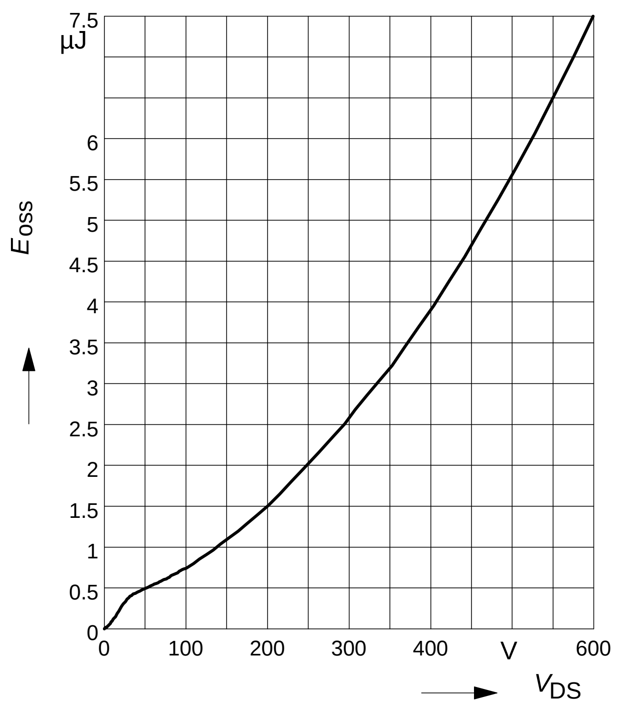
$C = f\ (V_{DS})$

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

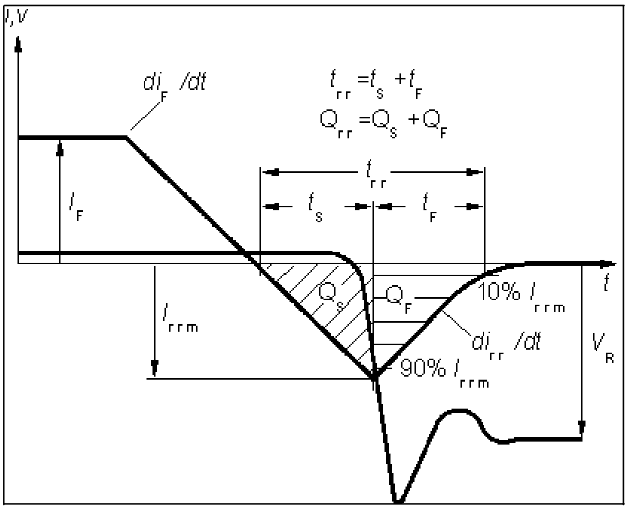


23 Typ. C_{oss} stored energy

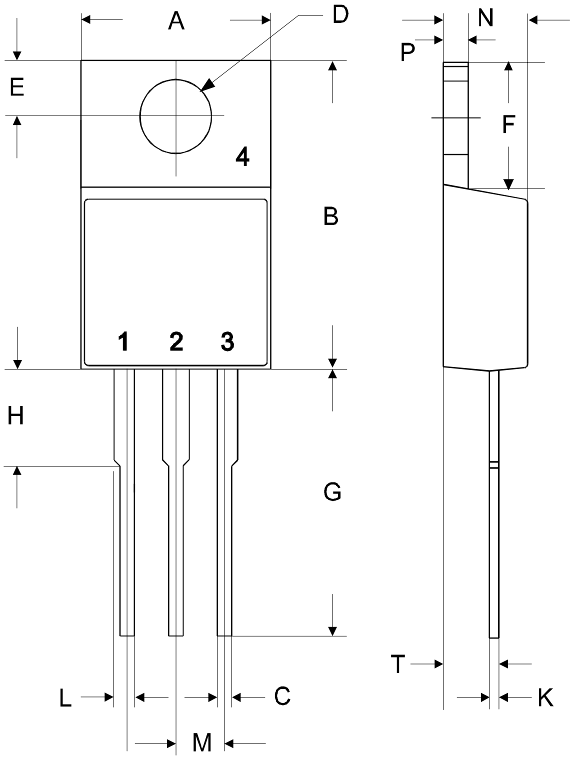
E_{oss}=f(V_{DS})



Definition of diodes switching characteristics

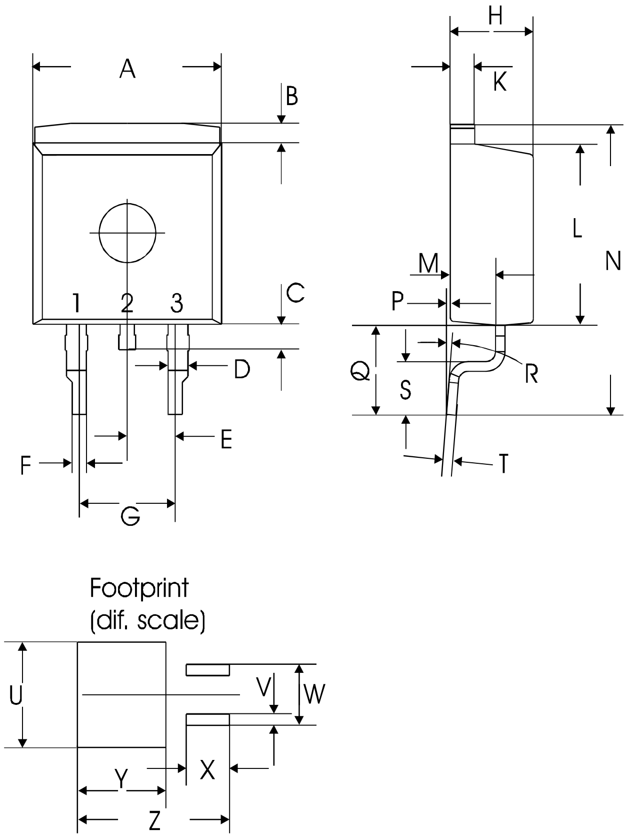


P-TO220-3-1



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)



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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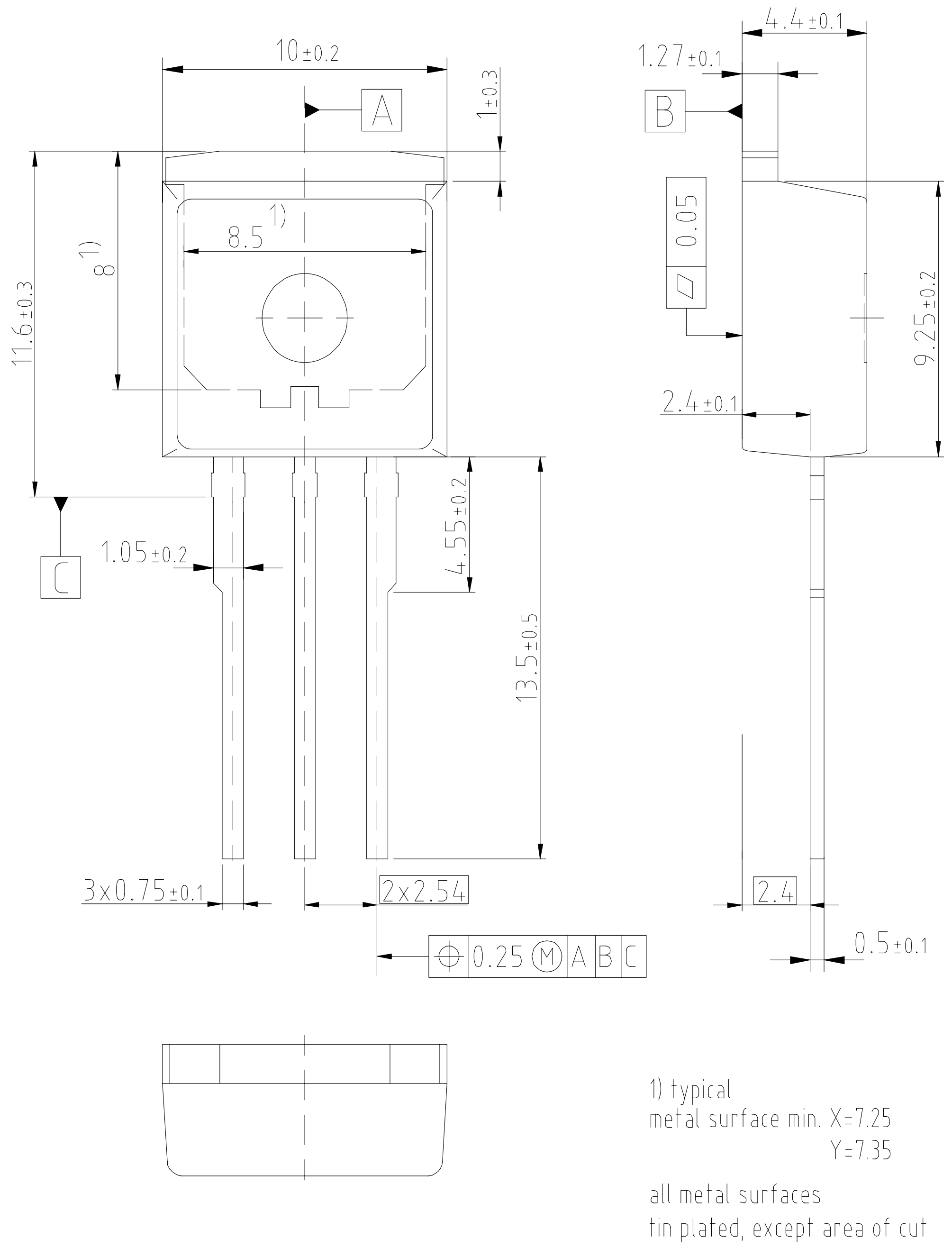
10±0.2
1±0.3
A
B
1.27±0.1
4.4±0.1
8.5 1)
8 1)
11.6±0.3
0.05
9.25±0.2
2.4±0.1
C
1.05±0.2
4.55±0.2
13.5±0.5
3x0.75±0.1
2x2.54
2.4
0.25 M A B C
0.5±0.1
1) typical
metal surface min. X=7.25
Y=7.35
all metal surfaces
tin plated, except area of cut

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