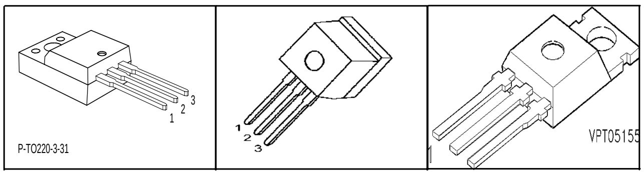
Cool MOS™ Power Transistor

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

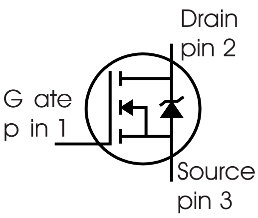
Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme d*v*/d*t* rated
- High peak current capability
- Improved transconductance
- PG-TO-220-3-31;-3-111: Fully isolated package (2500 VAC; 1 minute)
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC[0)] for target applications

PG-TO220FP PG-TO262 PG-TO220



Type	Package	Ordering Code	Marking
SPP11N60C3	PG-TO220	Q67040-S4395	11N60C3
SPI11N60C3	PG-TO262	Q67042-S4403	11N60C3
SPA11N60C3	PG-TO220FP	Q67040-S4408	11N60C3
SPA11N60C3E8185	PG-TO220		11N60C3



Maximum Ratings

Parameter	Symbol	Value		Unit
		SPP_I	SPA	
Continuous drain current T_C = 25 °C T_C = 100 °C	I_D	 11 7	 11 1) 7 1)	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\ puls}$	33	33	A
Avalanche energy, single pulse I_D=5.5A, V_{DD}=50V	E_{AS}	340	340	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} 2) I_D=11A, V_{DD}=50V	E_{AR}	0.6	0.6	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	11	11	A
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}	125	33	W
Operating and storage temperature	T_j , T_{stg}	-55...+150		°C
Reverse diode dv/dt 7)	dv/dt	15		V/ns

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope V_{DS} = 480 V, I_D = 11 A, T_j = 125 °C	dv/dt	50	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	1	K/W
Thermal resistance, junction - case, FullPAK	R_{thJC_FP}	-	-	3.8	
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
Thermal resistance, junction - ambient, FullPAK	R_{thJA_FP}	-	-	80	
SMD version, device on PCB:	R_{thJA}				
@ min. footprint		-	-	62	
@ 6 cm^2 cooling area [3)]		-	35	-	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s [4)]	T_{sold}	-	-	260	°C

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	V_{GS}=0V, I_D=0.25mA	600	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	V_{GS}=0V, I_D=11A	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	I_D=500µA, V_{GS}=V_{DS}	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	V_{DS}=600V, V_{GS}=0V,				µA
		T_j=25°C	-	0.1	1	
		T_j=150°C	-	-	100	
Gate-source leakage current	I_{GSS}	V_{GS}=30V, V_{DS}=0V	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS}=10V, I_D=7A				Ω
		T_j=25°C	-	0.34	0.38	
		T_j=150°C	-	0.92	-	
Gate input resistance	R_G	f=1MHz, open drain	-	0.86	-	

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS}\geq2*I_D*R_{DS(on)max}$, I_D=7A	-	8.3	-	S
Input capacitance	C_{iss}	V_{GS}=0V, V_{DS}=25V, f=1MHz	-	1200	-	pF
Output capacitance	C_{oss}		-	390	-	
Reverse transfer capacitance	C_{rss}		-	30	-	
Effective output capacitance,[5] energy related	$C_{o(er)}$	V_{GS}=0V, V_{DS}=0V to 480V	-	45	-	
Effective output capacitance,[6] 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

[0]J-STD20 and JESD22

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

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

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

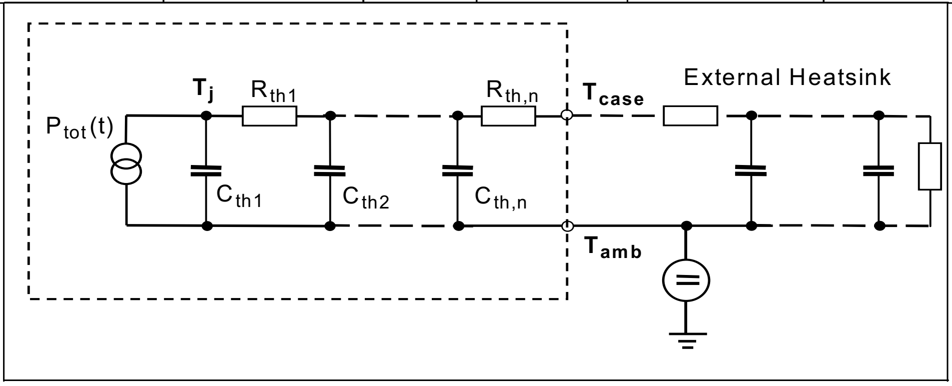
[7]ISD<=ID, di/dt<=400A/us, VDClink=400V, Vpeak<VBR, DSS, Tj<Tj,max.
Identical low-side and high-side switch.

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
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 , di_F/dt=100A/µs	-	400	600	ns
Reverse recovery charge	Q_{rr}		-	6	-	µC
Peak reverse recovery current	I_{rrm}		-	41	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt	T_j=25°C	-	1200	-	A/µs

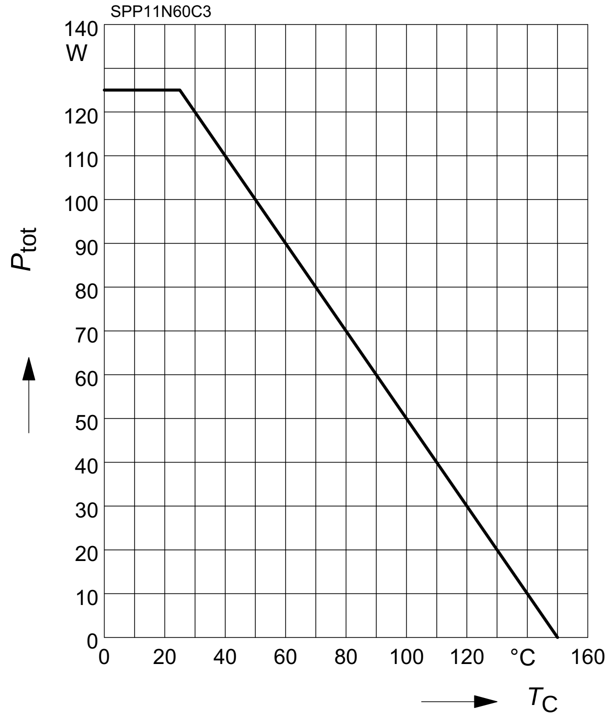
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_I	SPA			SPP_I	SPA	
R_{th1}	0.015	0.15	K/W	C_{th1}	0.0001878	0.0001878	Ws/K
R_{th2}	0.03	0.03		C_{th2}	0.0007106	0.0007106	
R_{th3}	0.056	0.056		C_{th3}	0.000988	0.000988	
R_{th4}	0.197	0.194		C_{th4}	0.002791	0.002791	
R_{th5}	0.216	0.413		C_{th5}	0.007285	0.007401	
R_{th6}	0.083	2.522		C_{th6}	0.063	0.412	



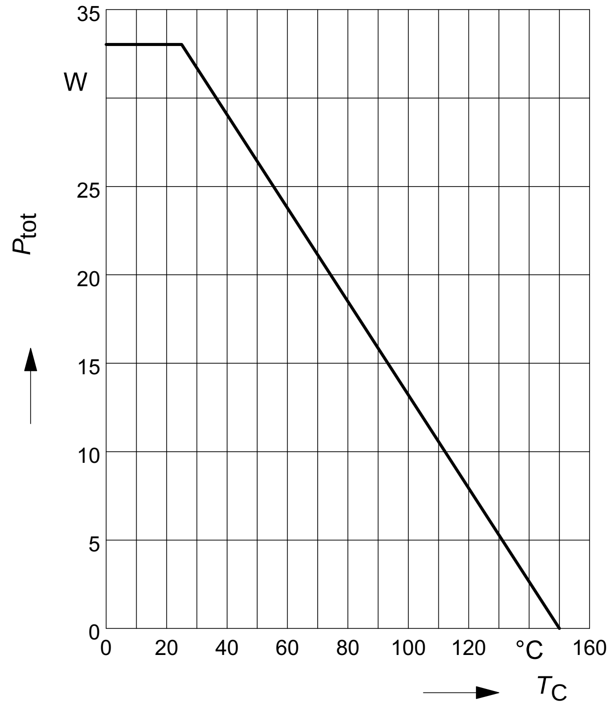
1 Power dissipation

$P_{tot} = f(T_C)$



2 Power dissipation FullPAK

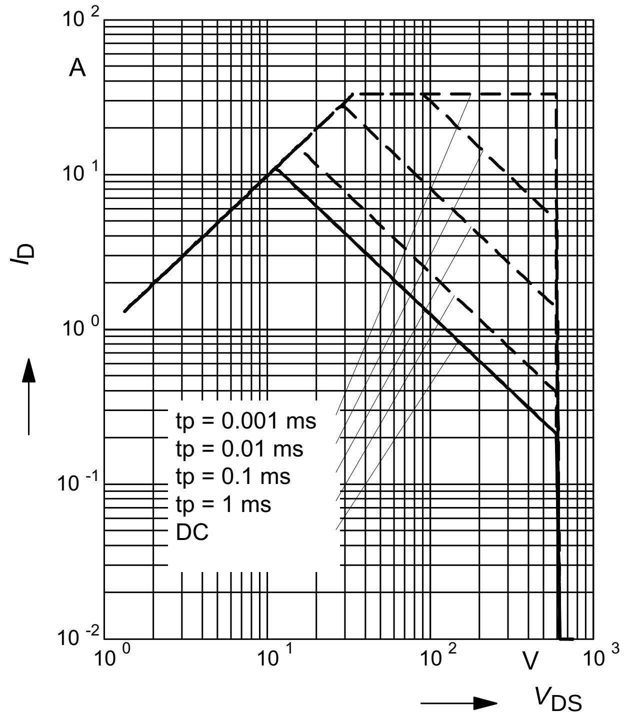
$P_{tot} = f(T_C)$



3 Safe operating area

$I_D = f(V_{DS})$

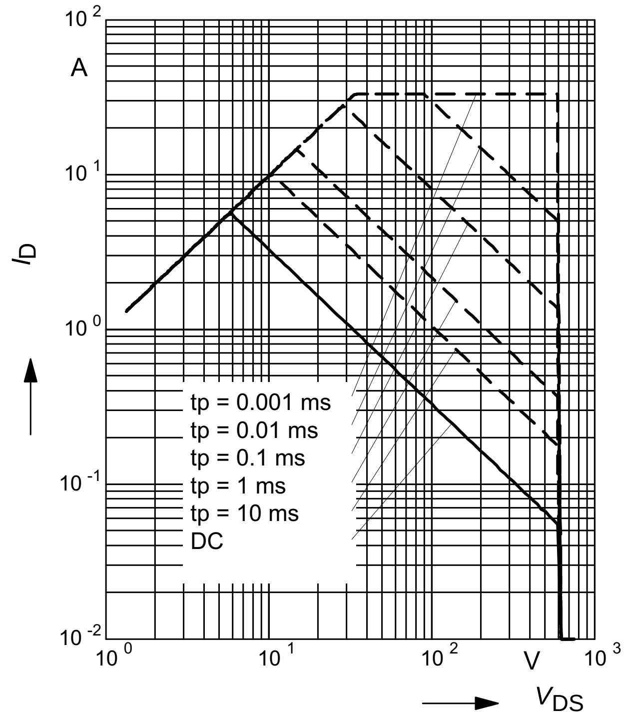
parameter : $D = 0$, T_C=25°C



4 Safe operating area FullPAK

$I_D = f(V_{DS})$

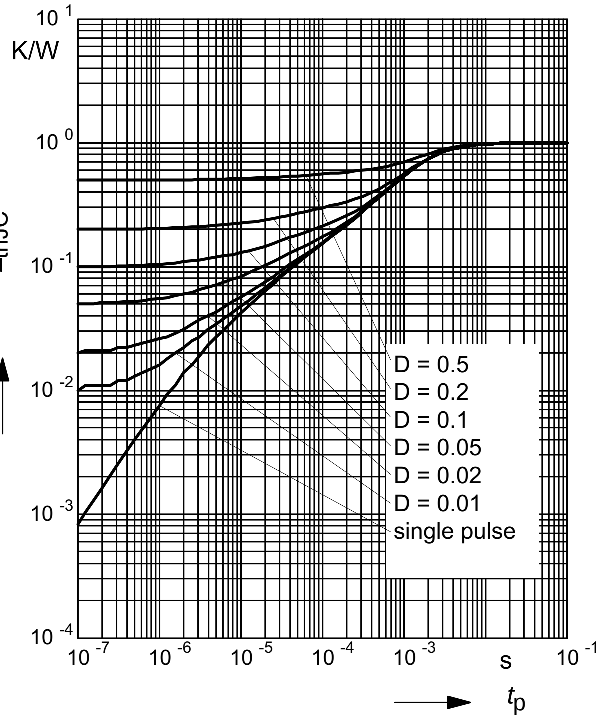
parameter: $D = 0$, T_C = 25°C



5 Transient thermal impedance

$Z_{thJC} = f(t_p)$

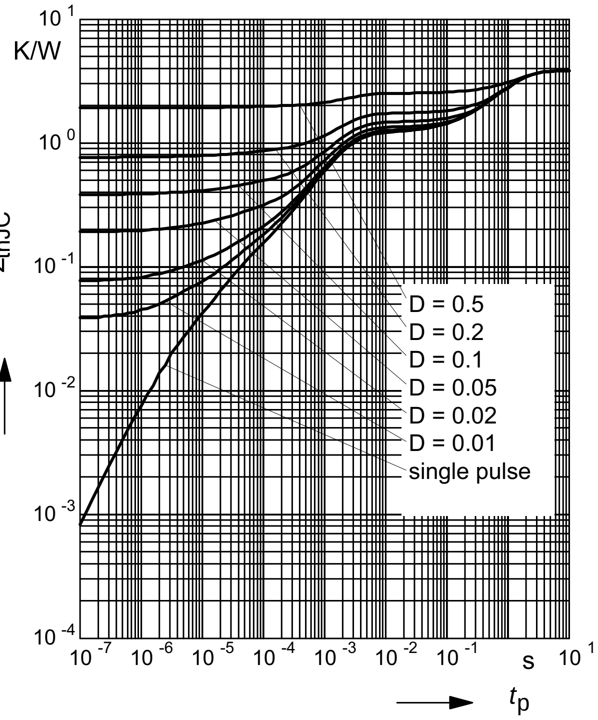
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

$Z_{thJC} = f(t_p)$

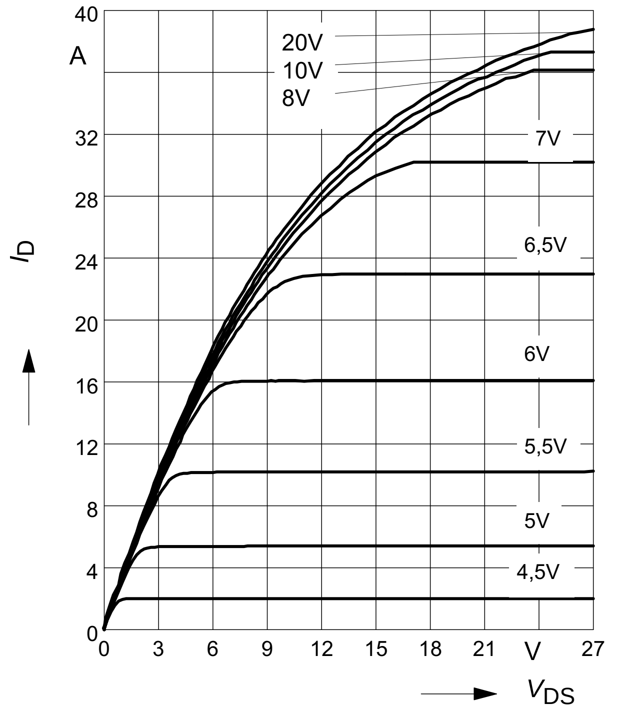
parameter: $D = t_p/t$



7 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=25°C

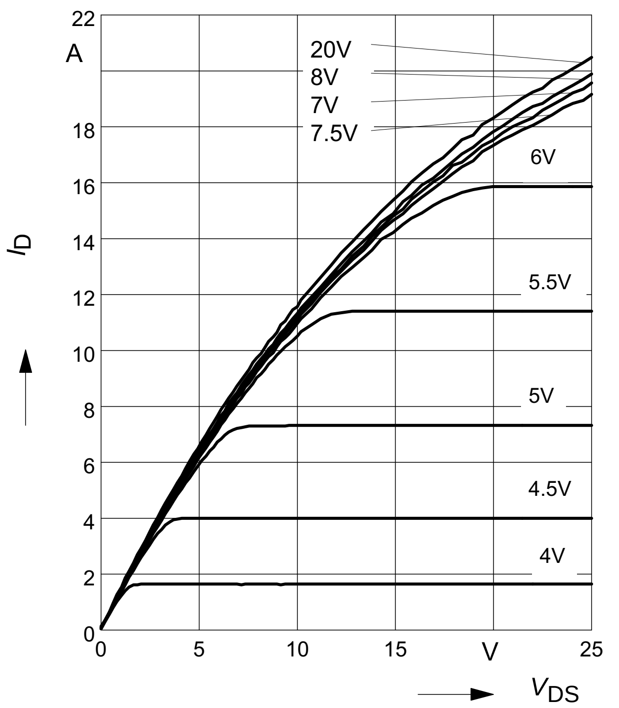
parameter: t_p = 10 µs, V_{GS}



8 Typ. output characteristic

$I_D = f(V_{DS})$; T_j=150°C

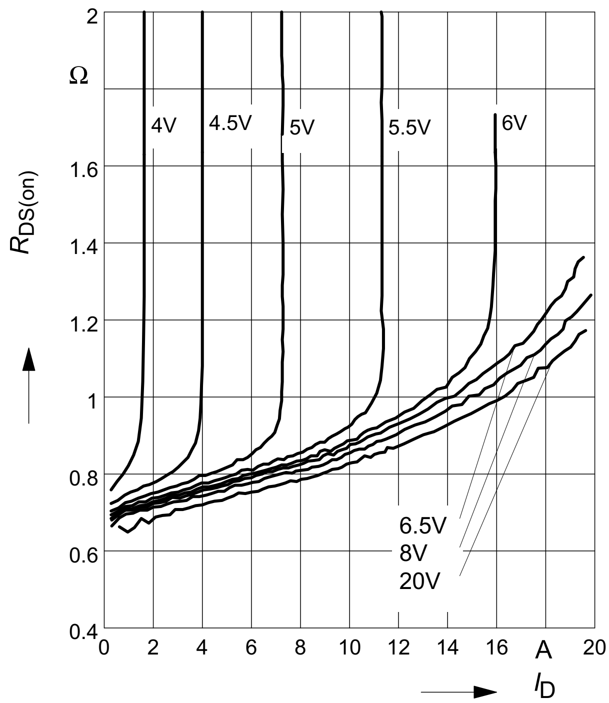
parameter: t_p = 10 µs, V_{GS}



9 Typ. drain-source on resistance

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

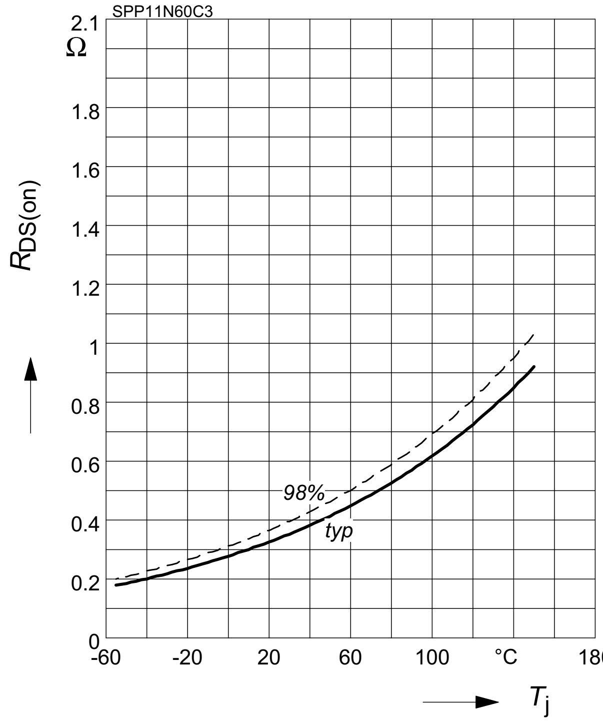
parameter: T_j=150°C, V_{GS}



10 Drain-source on-state resistance

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

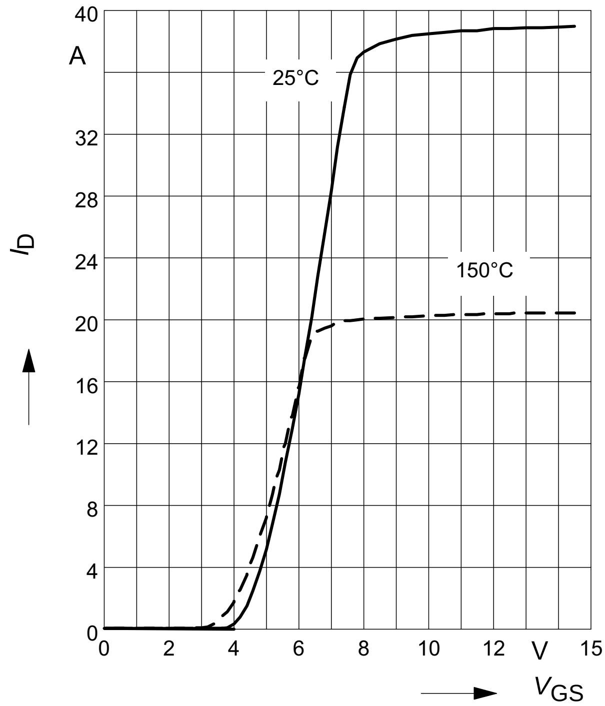
parameter : I_D = 7 A, V_{GS} = 10 V



11 Typ. transfer characteristics

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

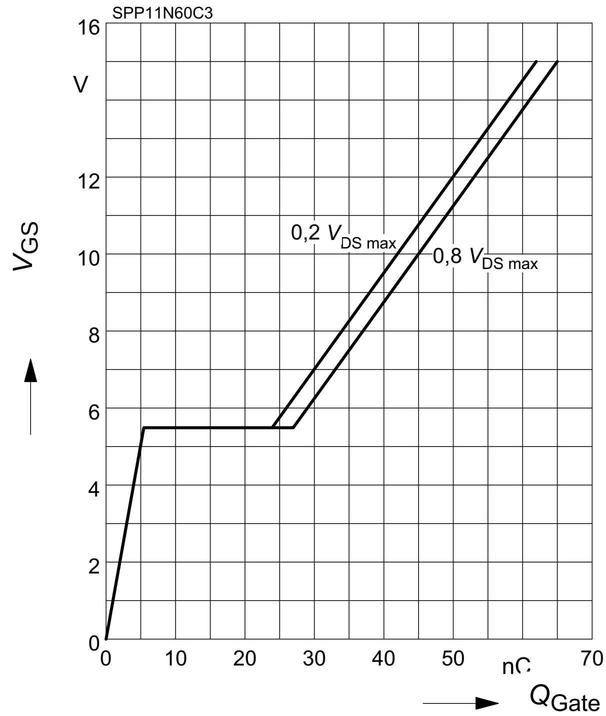
parameter: t_p = 10 µs



12 Typ. gate charge

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

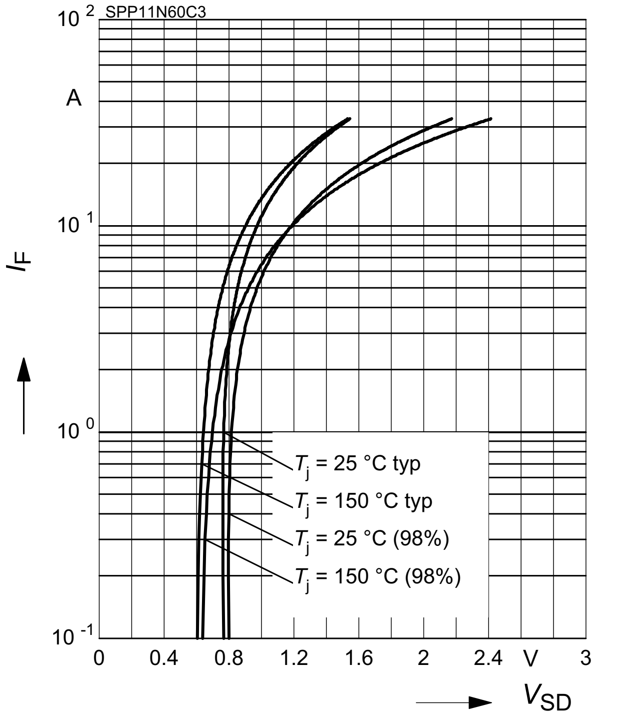
parameter: I_D = 11 A pulsed



13 Forward characteristics of body diode

$I_F = f(V_{SD})$

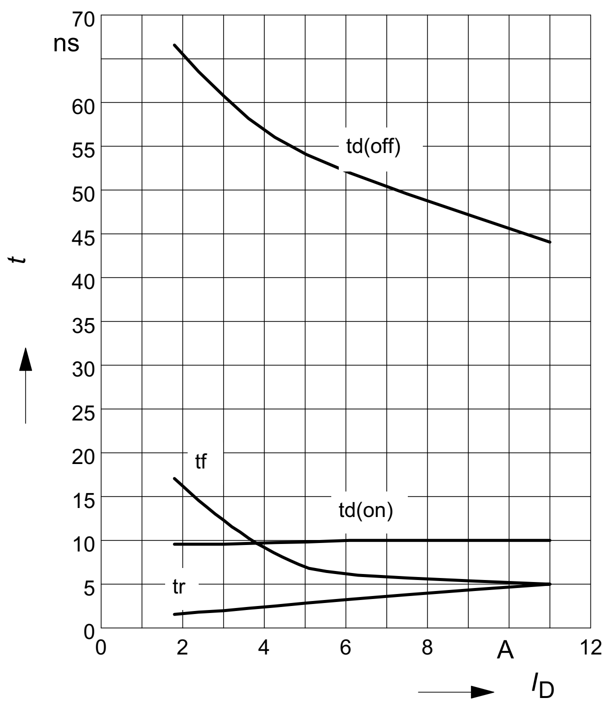
parameter: T_j , t_p = 10 µs



14 Typ. switching time

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

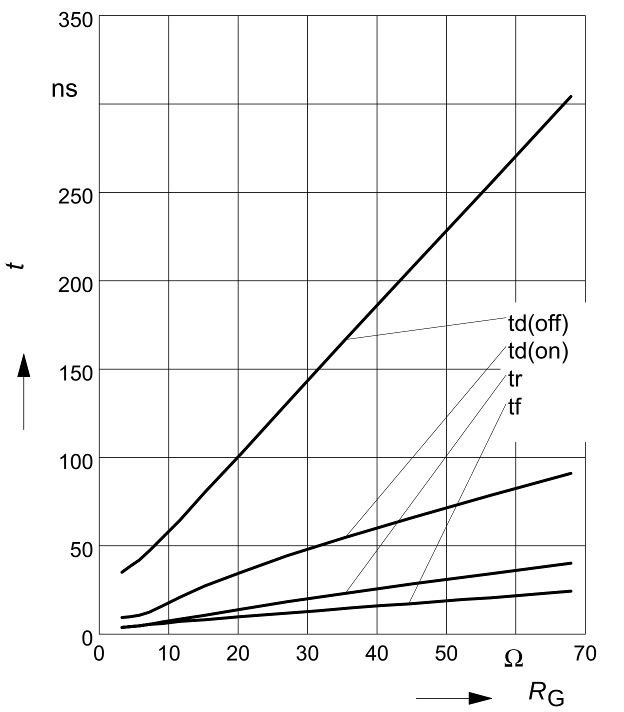
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=6.8Ω



15 Typ. switching time

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

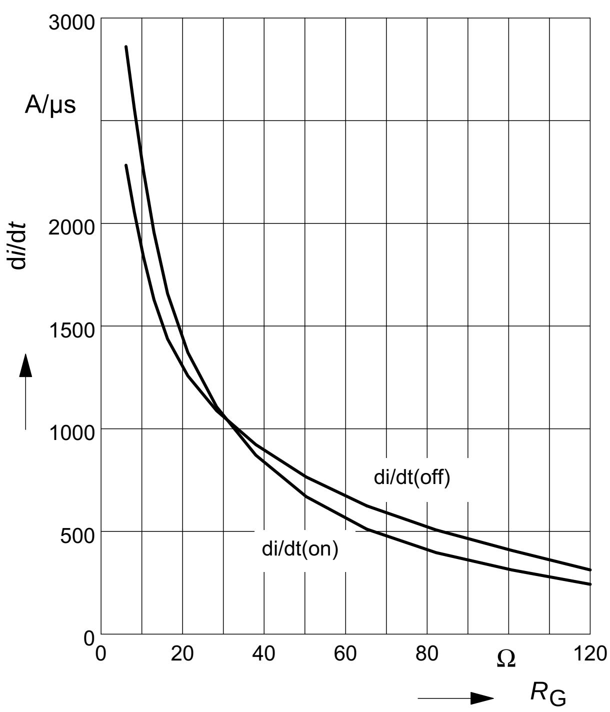
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11 A



16 Typ. drain current slope

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

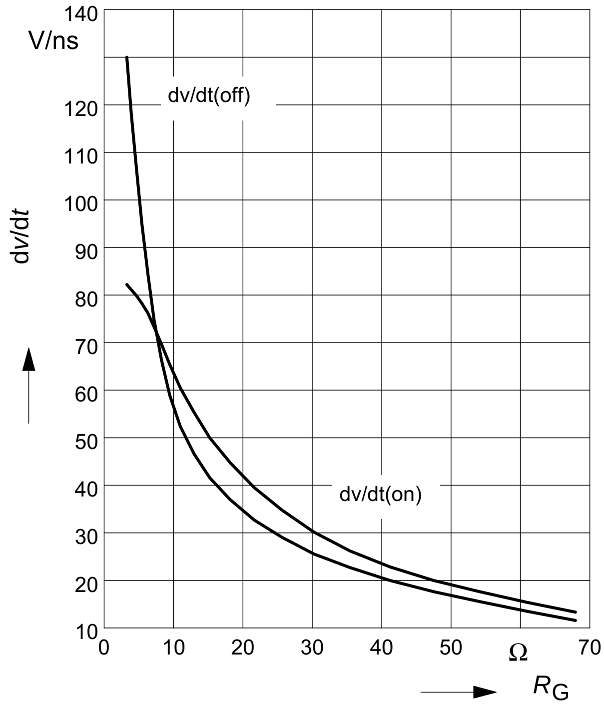
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11A



17 Typ. drain source voltage slope

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

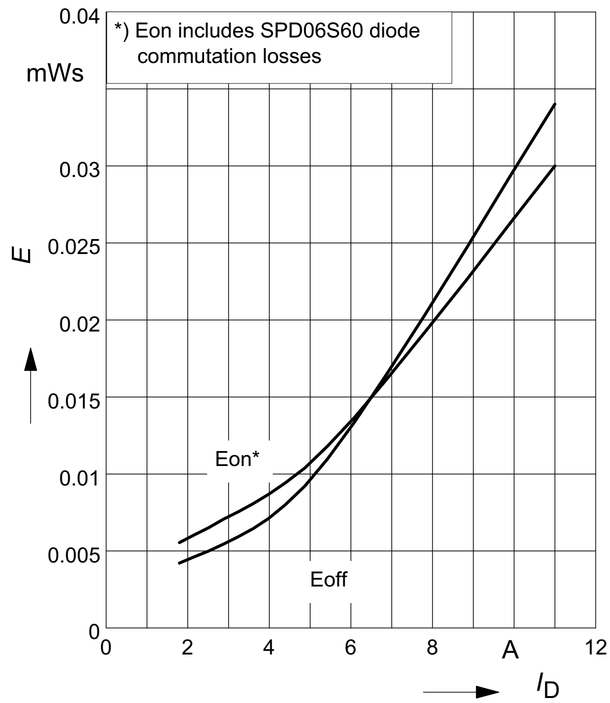
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11A



18 Typ. switching losses

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

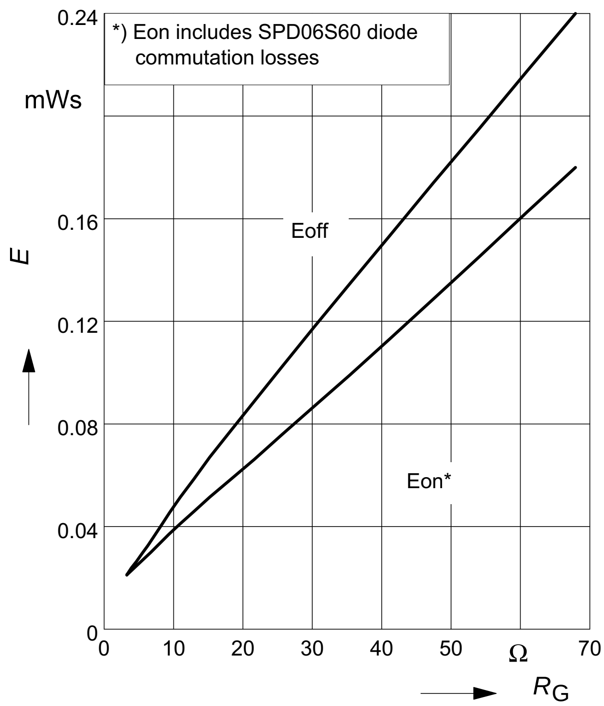
par.: V_{DS}=380V, V_{GS}=0/+13V, R_G=6.8Ω



19 Typ. switching losses

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

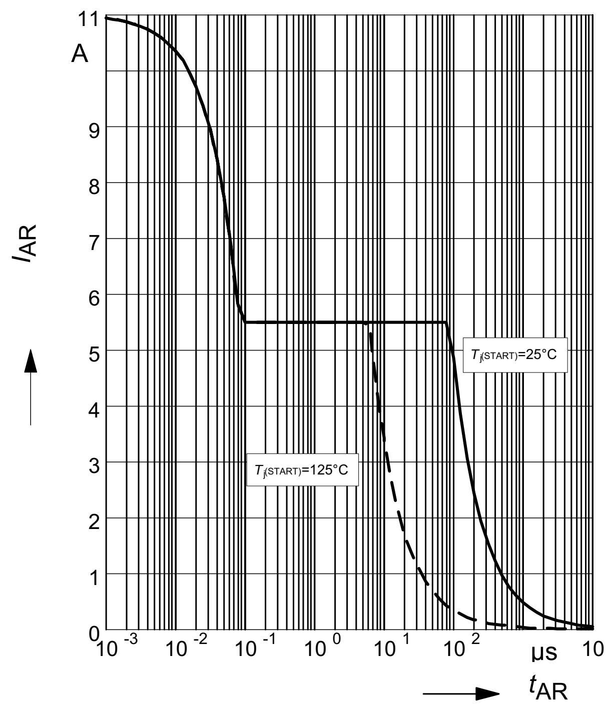
par.: V_{DS}=380V, V_{GS}=0/+13V, I_D=11A



20 Avalanche SOA

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

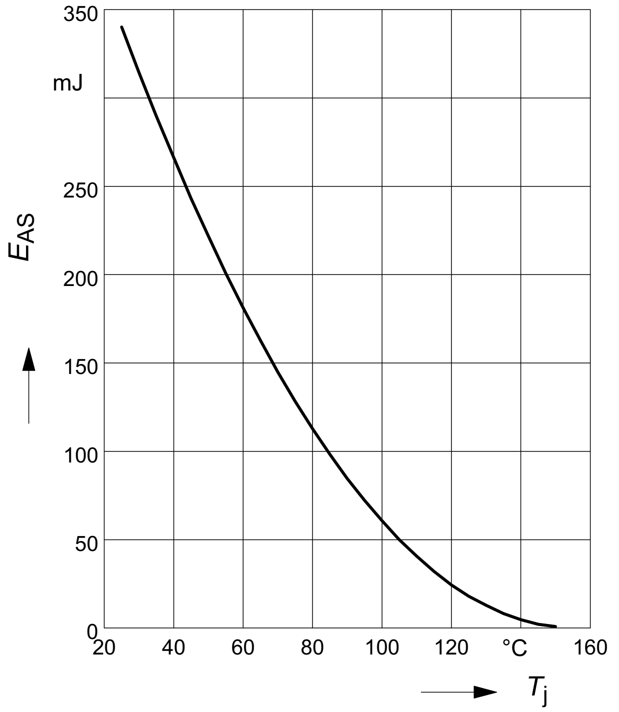
par.: $T_j \leq$ 150 °C



21 Avalanche energy

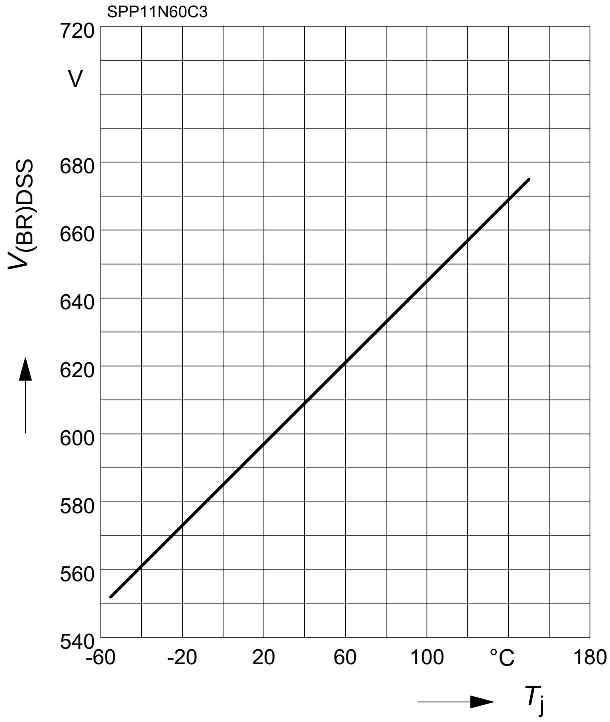
$E_{AS} = f(T_j)$

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



22 Drain-source breakdown voltage

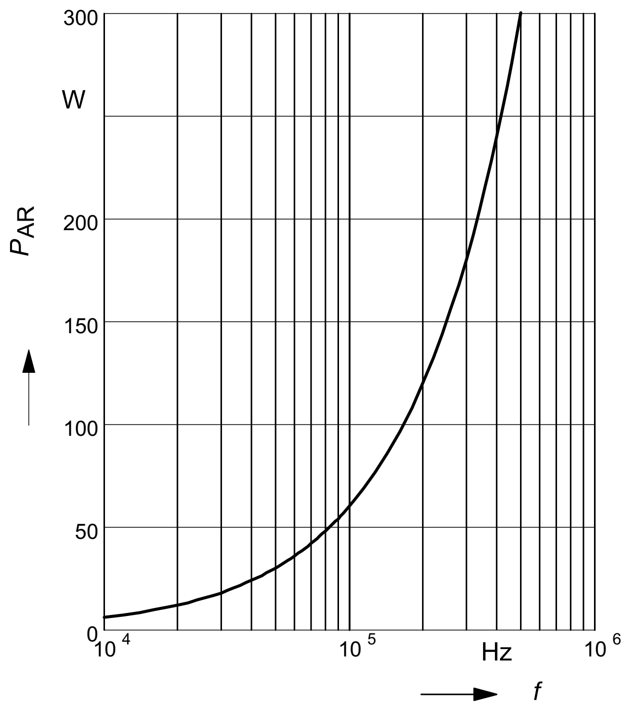
$V_{(BR)DSS} = f(T_j)$



23 Avalanche power losses

$P_{AR} = f(f)$

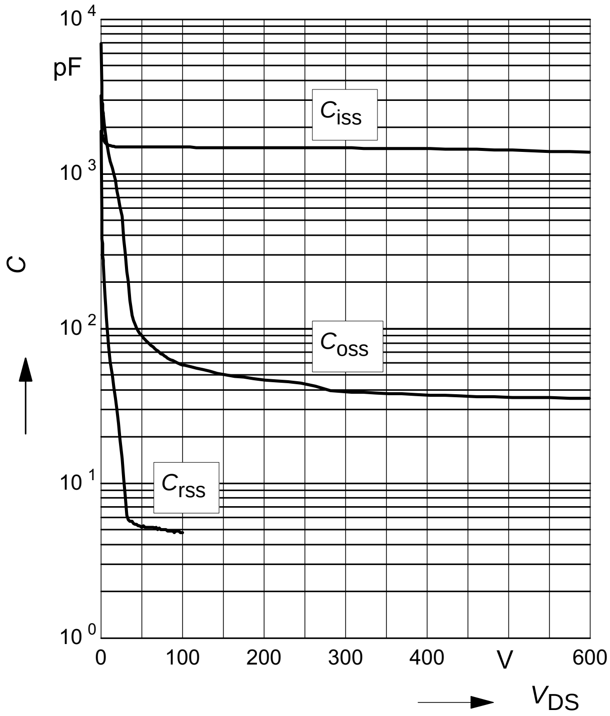
parameter: E_{AR}=0.6mJ



24 Typ. capacitances

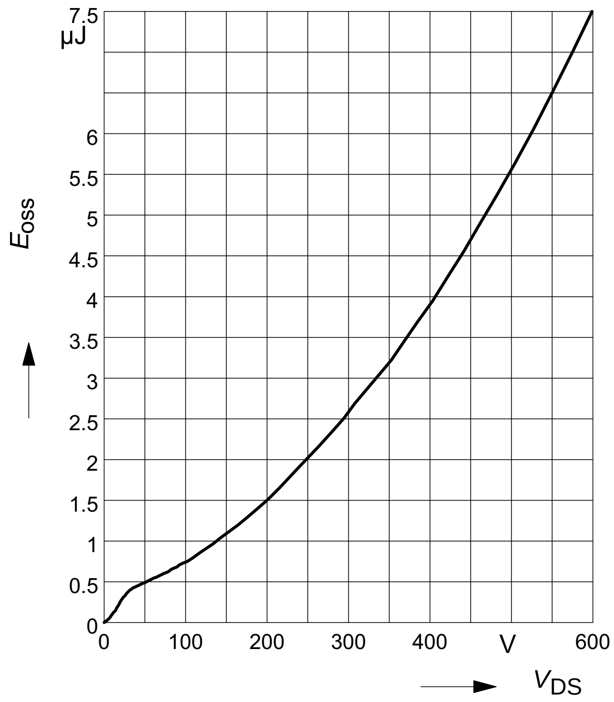
$C = f(V_{DS})$

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

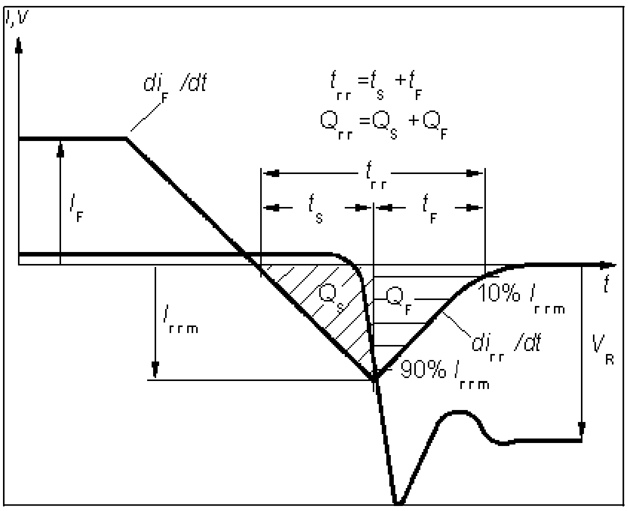


25 Typ. C_{oss} stored energy

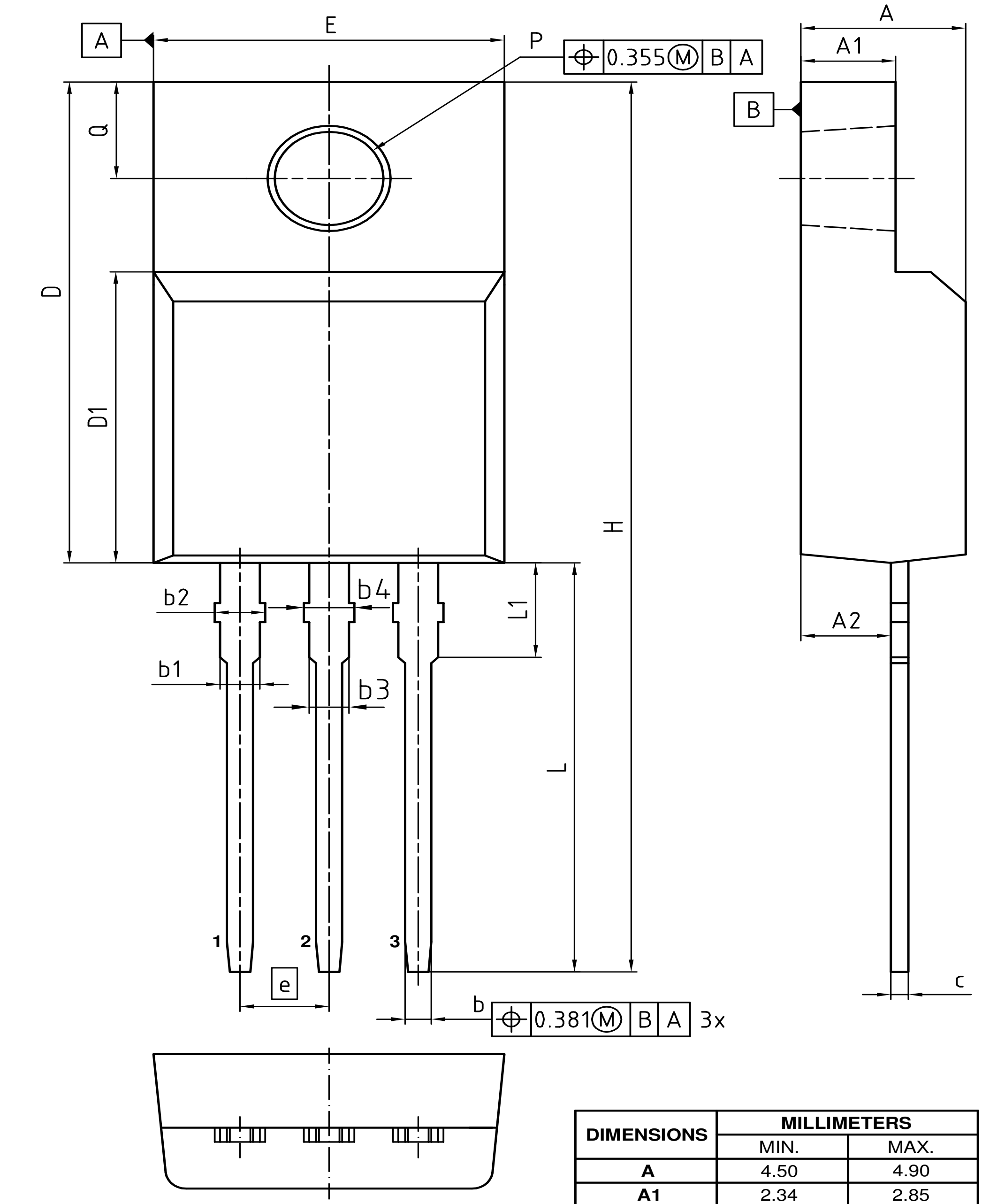
$E_{oss}=f(V_{DS})$



Definition of diodes switching characteristics



Outline PG-TO220 FullPAK



NOTES:
ALL DIMENSIONS REFER TO JEDEC STANDARD TO-281
AND DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS
OR GATE BURRS
GATE BURRS ARE LESS THAN 0.5 mm

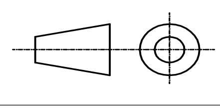
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.50	4.90
A1	2.34	2.85
A2	2.42	2.86
b	0.65	0.90
b1	0.95	1.38
b2	0.95	1.51
b3	0.65	1.38
b4	0.65	1.51
c	0.40	0.63
D	15.67	16.15
D1	8.97	9.83
E	10.00	10.65
e	2.54	
H	28.70	29.75
L	12.78	13.75
L1	2.83	3.45
øP	3.00	3.30
Q	3.15	3.50

DOCUMENT NO.
Z8B00003319

REVISION
07

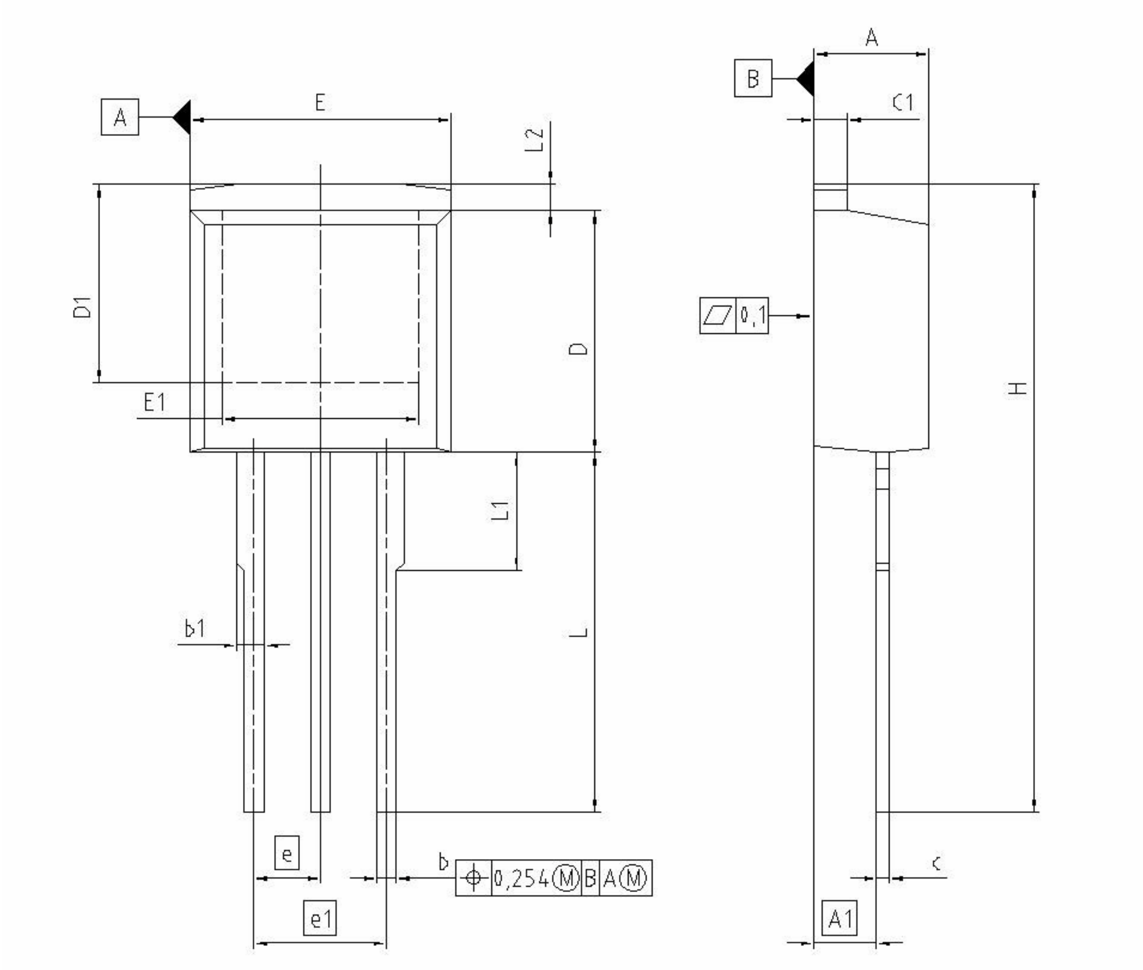
SCALE 5:1
0 1 2 3 4 5mm

EUROPEAN PROJECTION



ISSUE DATE
27.01.2017

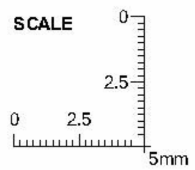
PG-TO-262-3-1 (I²-PAK)



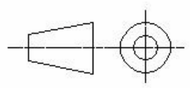
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.500	0.169	0.177
A1	2.150	2.650	0.085	0.104
b	0.650	0.850	0.026	0.033
b1	0.635	1.400	0.025	0.055
c	0.400	0.600	0.016	0.024
c1	1.170	1.370	0.046	0.054
D	9.050	9.450	0.356	0.372
D1	6.900	7.650	0.272	0.301
E	9.800	10.200	0.386	0.402
E1	7.250	8.600	0.285	0.339
e	2.540		0.100	
e1	5.080		0.200	
N	3		3	
L	13.000	14.000	0.512	0.551
L1	4.350	4.750	0.171	0.187
L2	0.700	1.300	0.028	0.051

REFERENCE
JEDEC TO262

SCALE



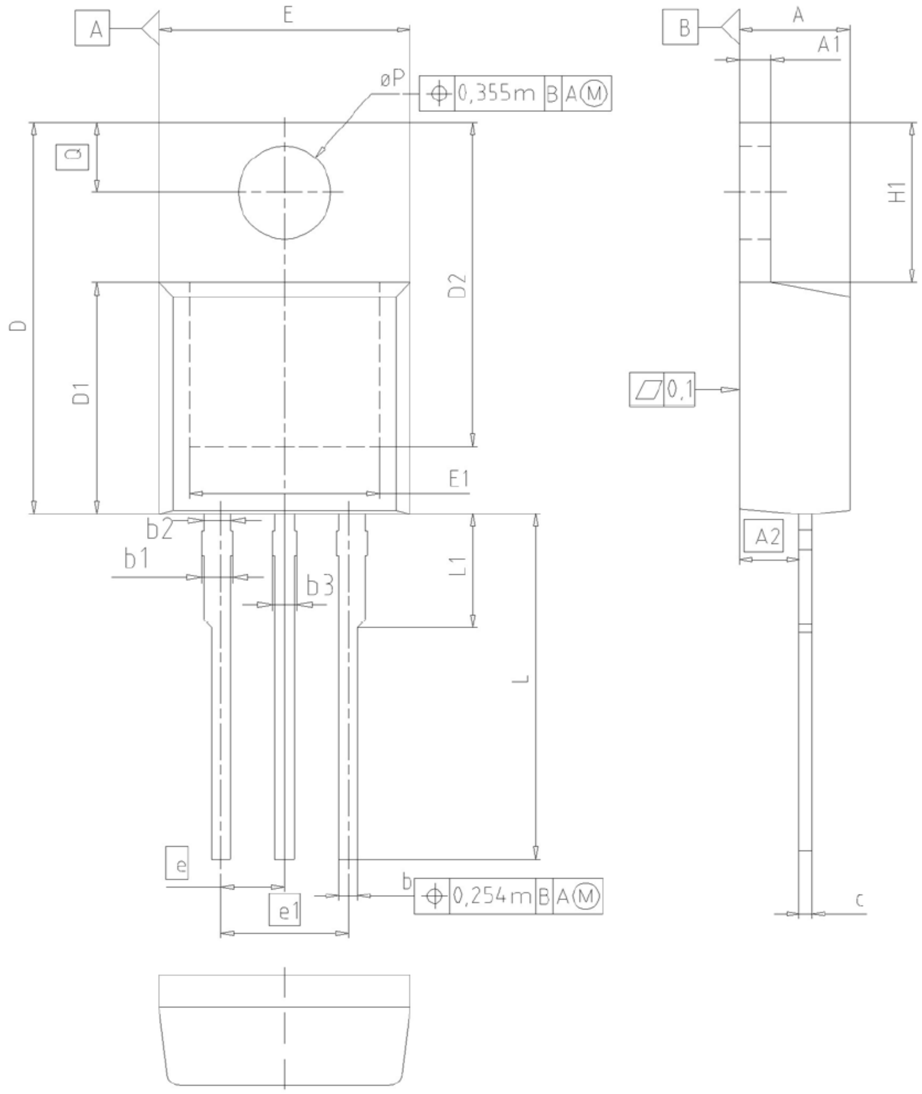
EUROPEAN PROJECTION



ISSUE DATE
01-06-2005

FILE
TO262_1

PG-TO-220-3-1, PG-TO-220-3-21



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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Revision History

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Revision: 2018-02-09, Rev. 2.3

Previous Revision

Revision	Date	Subjects (major changes since last revision)
3.3	2018-02-09	Outline FullPAK update

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