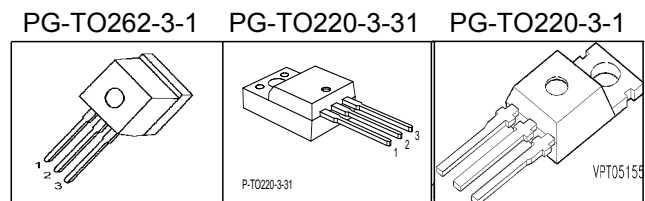


Cool MOS™ Power Transistor

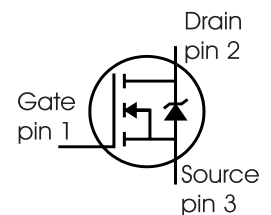
Feature

- 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
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC⁰⁾ for target applications

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



Type	Package	Ordering Code	Marking
SPP20N65C3	PG-TO220-3-1	Q67040-S4556	20N65C3
SPA20N65C3	PG-TO220-3-31	Q67040-S4555	20N65C3
SPI20N65C3	PG-TO262-3-1	Q67040-S4560	20N65C3



Maximum Ratings

Parameter	Symbol	Value		Unit
		SPP_I	SPA	
Continuous drain current $T_C = 25\text{ }^\circ\text{C}$ $T_C = 100\text{ }^\circ\text{C}$	I_D	20.7 13.1	20.7 ¹⁾ 13.1 ¹⁾	A
Pulsed drain current, t_p limited by T_{jmax}	I_D puls	62.1	62.1	A
Avalanche energy, single pulse $I_D=3.5\text{A}$, $V_{DD}=50\text{V}$	E_{AS}	690	690	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ²⁾ $I_D=7\text{A}$, $V_{DD}=50\text{V}$	E_{AR}	1	1	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	7	7	A
Gate source voltage	V_{GS}	± 20	± 20	V
Gate source voltage AC ($f > 1\text{Hz}$)	V_{GS}	± 30	± 30	
Power dissipation, $T_C = 25\text{ }^\circ\text{C}$	P_{tot}	208	34.5	W
Operating and storage temperature	T_j , T_{stg}	-55...+150		$^\circ\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480\text{ V}, I_D = 20.7\text{ A}, T_j = 125\text{ }^\circ\text{C}$	dv/dt	50	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	0.6	K/W
Thermal resistance, junction - case, FullPAK	$R_{thJC\text{ FP}}$	-	-	3.6	
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	
Thermal resistance, junction - ambient, FullPAK	$R_{thJA\text{ FP}}$	-	-	80	
SMD version, device on PCB: @ min. footprint @ 6 cm ² cooling area ³⁾	R_{thJA}	-	-	62	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s	T_{sold}	-	-	260	°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	$V_{(BR)DSS}$	$V_{GS}=0\text{V}, I_D=0.25\text{mA}$	650	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}, I_D=7\text{A}$	-	730	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=1000\mu\text{A}, V_{GS}=V_D$	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{V}, V_{GS}=0\text{V},$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.1	1	μA
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{V}, V_{DS}=0\text{V}$	-	-	100	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}, I_D=13.1\text{A}$ $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	-	0.16	0.19	Ω
Gate input resistance	R_G	$f=1\text{MHz}, \text{open drain}$	-	0.54	-	

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$ $I_D = 13.1A$	-	17.5	-	S
Input capacitance	C_{iss}	$V_{GS} = 0V, V_{DS} = 25V,$	-	2400	-	pF
Output capacitance	C_{oss}	$f = 1MHz$	-	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	$t_{d(on)}$	$V_{DD} = 380V, V_{GS} = 0/13V,$ $I_D = 20.7A,$ $R_G = 3.6\Omega, T_j = 125$	-	10	-	ns
Rise time	t_r	$V_{DD} = 380V, V_{GS} = 0/13V,$	-	5	-	
Turn-off delay time	$t_{d(off)}$	$I_D = 20.7A,$	-	67	100	
Fall time	t_f	$R_G = 3.6\Omega$	-	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

⁰J-STD20 and JESD22

¹Limited only by maximum temperature

²Repetitive avalanche causes additional power losses that can be calculated as $P_{AV} = E_{AR} \cdot f$.

³Device 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} .

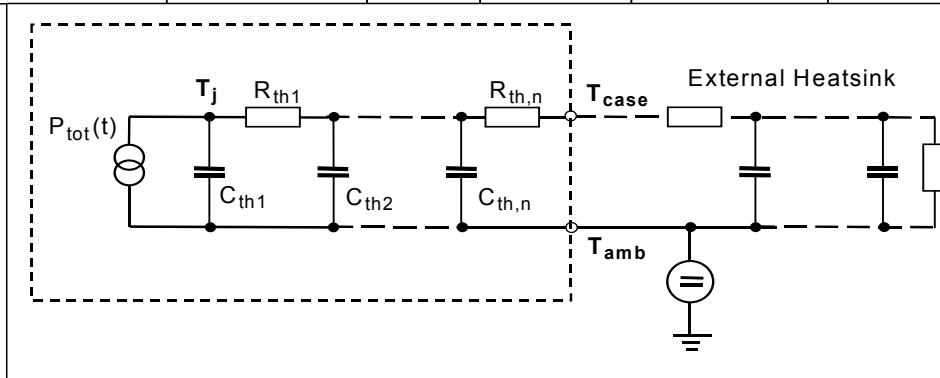
⁵ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

Electrical Characteristics

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

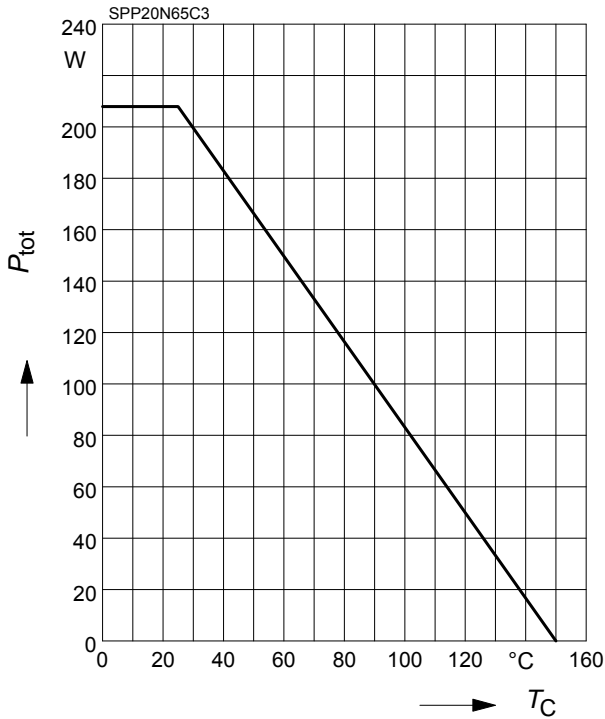
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_I	SPA			SPP_I	SPA	
R_{th1}	0.00769	0.00769	K/W	C_{th1}	0.0003763	0.0003763	Ws/K
R_{th2}	0.015	0.015		C_{th2}	0.001411	0.001411	
R_{th3}	0.029	0.029		C_{th3}	0.001931	0.001931	
R_{th4}	0.114	0.163		C_{th4}	0.005297	0.005297	
R_{th5}	0.136	0.323		C_{th5}	0.012	0.008453	
R_{th6}	0.059	2.526		C_{th6}	0.091	0.412	



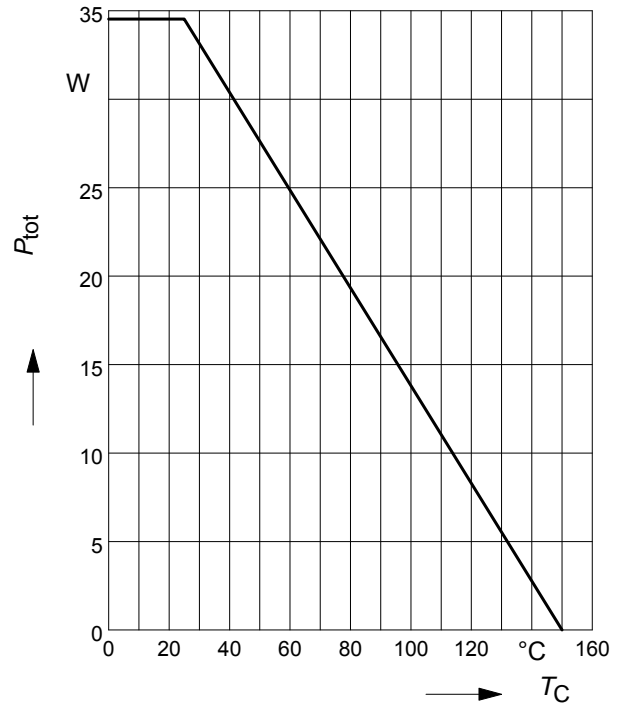
1 Power dissipation

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



2 Power dissipation FullPAK

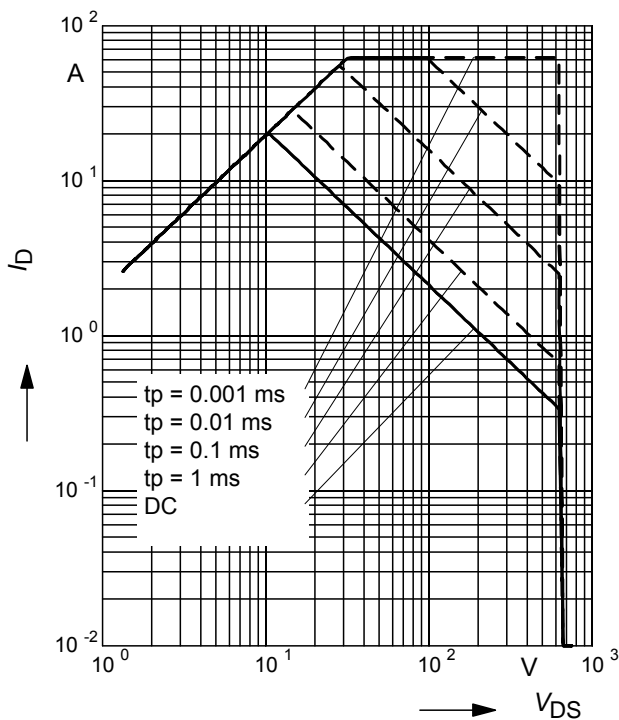
$$P_{tot} = f(T_C)$$



3 Safe operating area

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

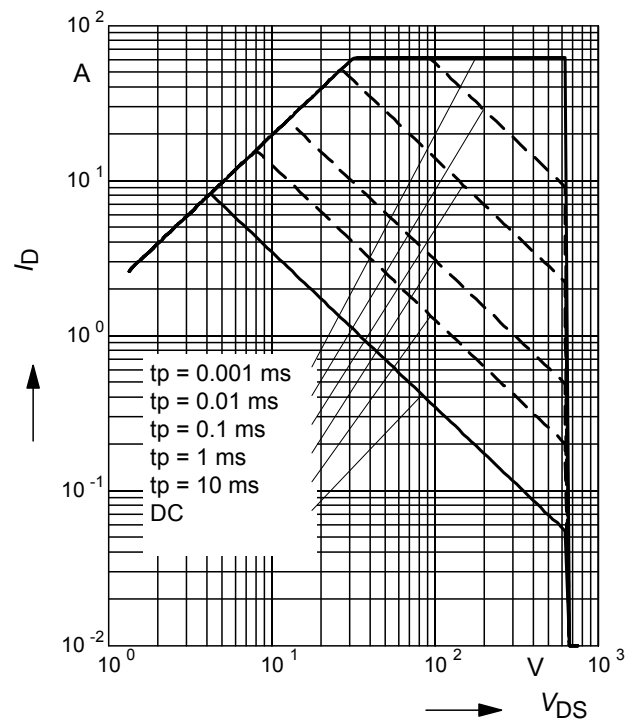
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



4 Safe operating area FullPAK

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

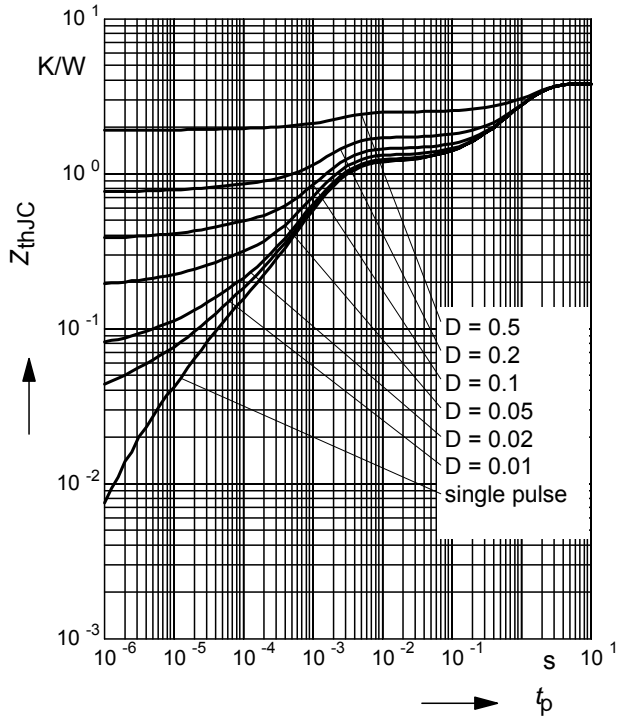
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



5 Transient thermal impedance FullPAK

$Z_{thJC} = f(t_p)$

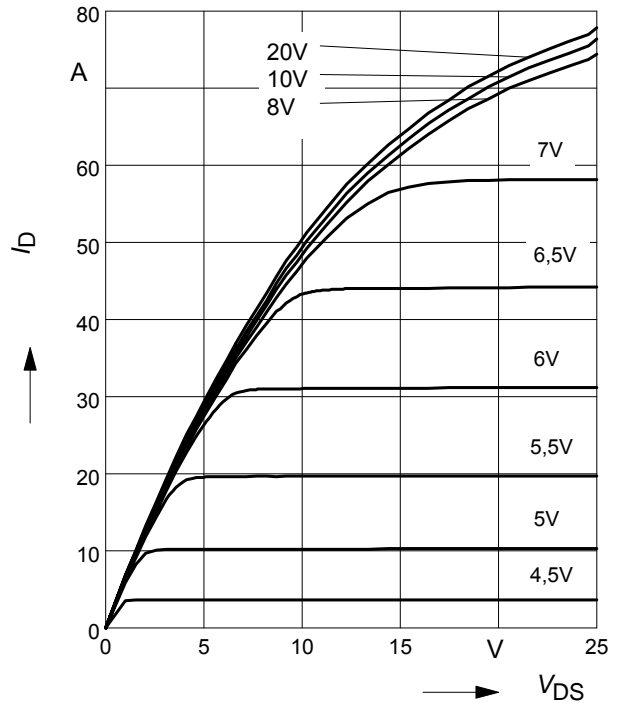
parameter: $D = t_p/t$



6 Typ. output characteristic

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

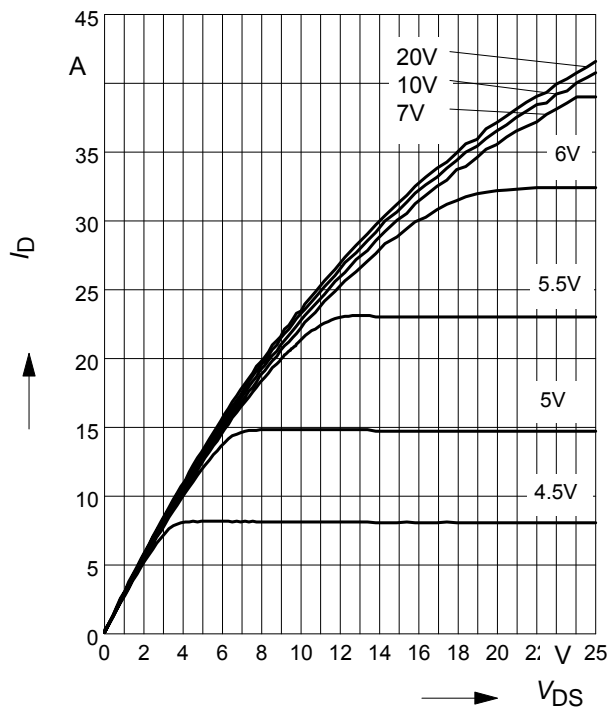
parameter: $t_p = 10 \mu s, V_{GS}$



7 Typ. output characteristic

$I_D = f(V_{DS}); T_j=150^\circ C$

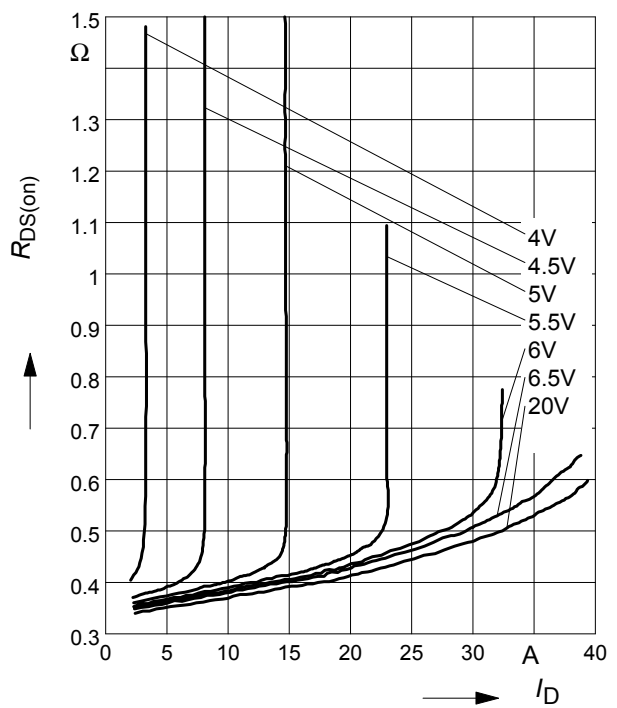
parameter: $t_p = 10 \mu s, V_{GS}$



8 Typ. drain-source on resistance

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

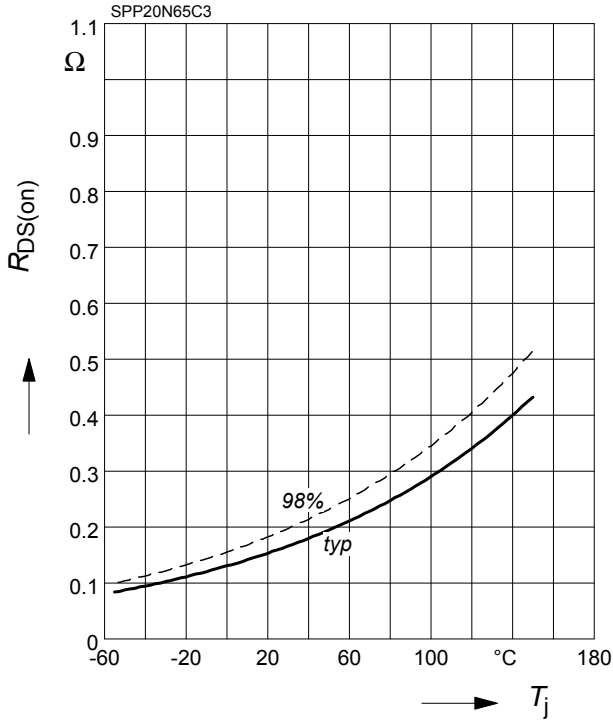
parameter: $T_j=150^\circ C, V_{GS}$



9 Drain-source on-state resistance

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

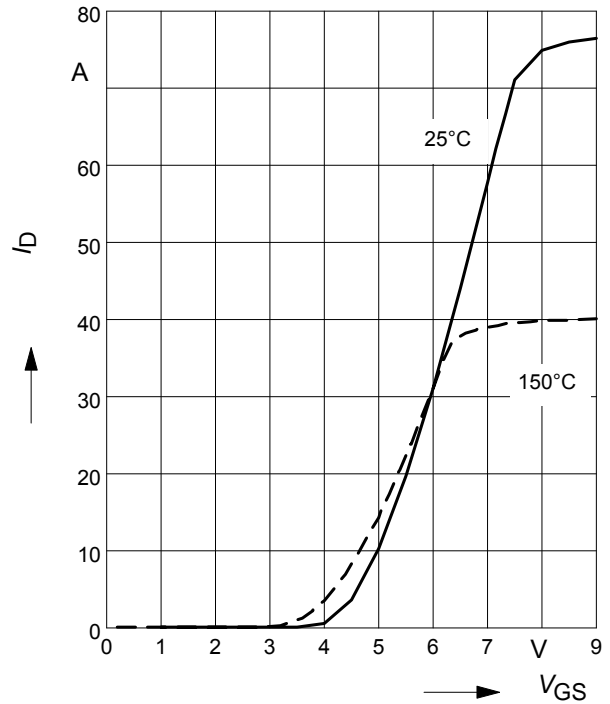
parameter: $I_D = 13.1 \text{ A}$, $V_{GS} = 10 \text{ V}$



10 Typ. transfer characteristics

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

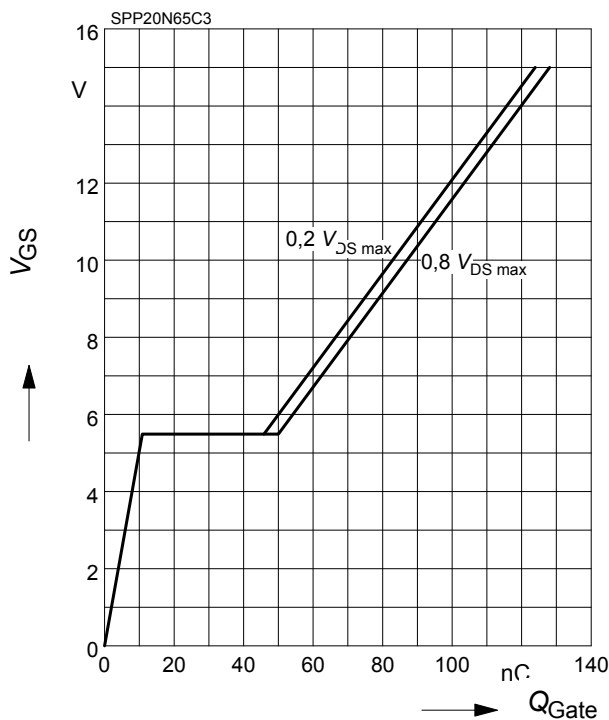
parameter: $t_p = 10 \mu\text{s}$



11 Typ. gate charge

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

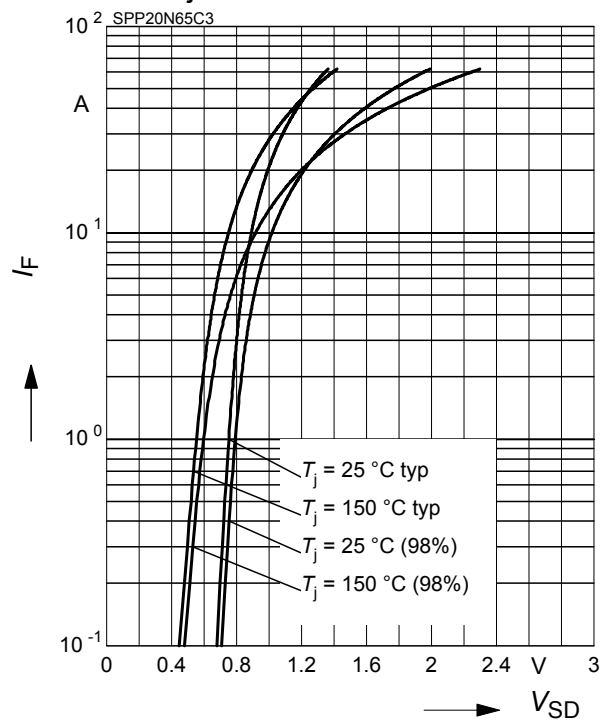
parameter: $I_D = 20.7 \text{ A}$ pulsed



12 Forward characteristics of body diode

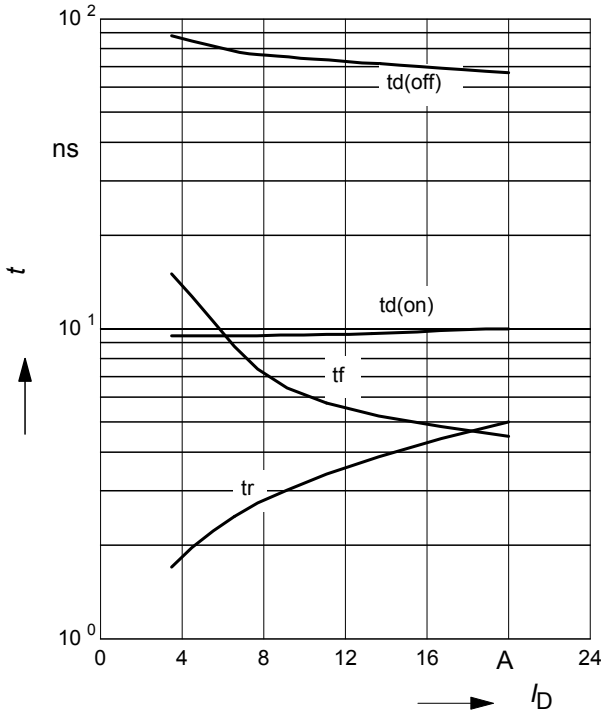
$$I_F = f(V_{SD})$$

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



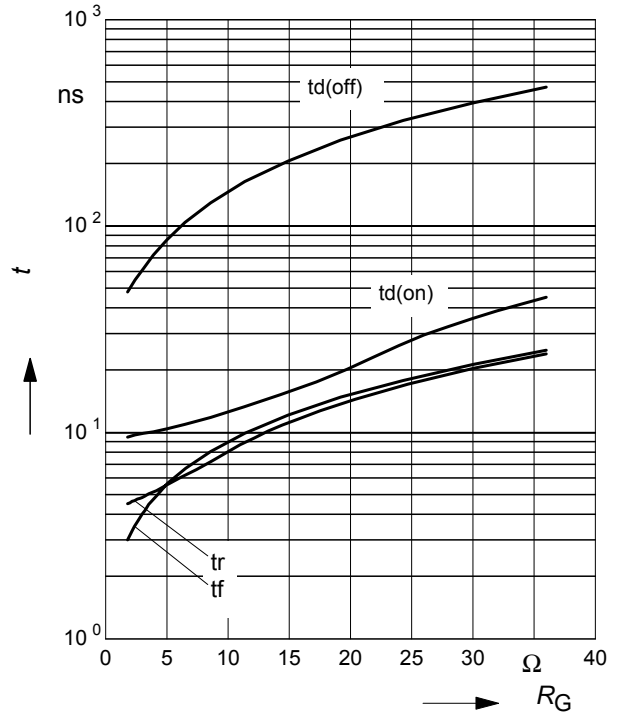
13 Typ. switching time

$t = f(I_D)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $R_G = 3.6\Omega$



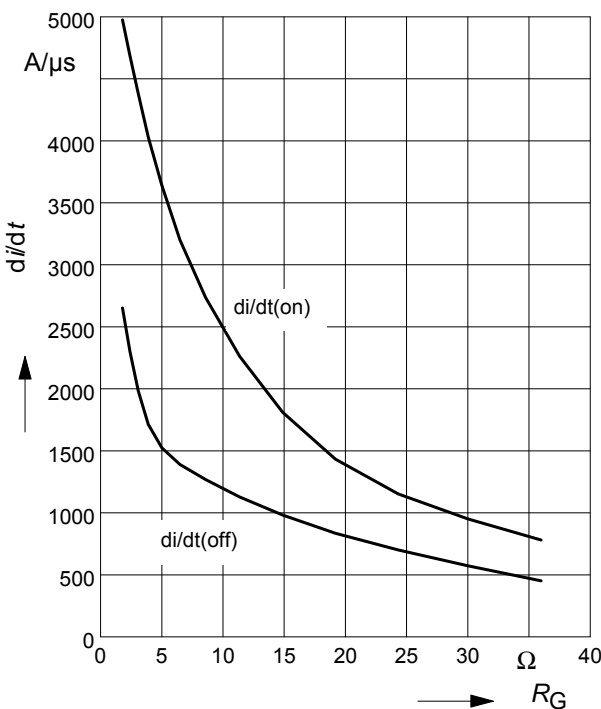
14 Typ. switching time

$t = f(R_G)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 20.7\text{ A}$



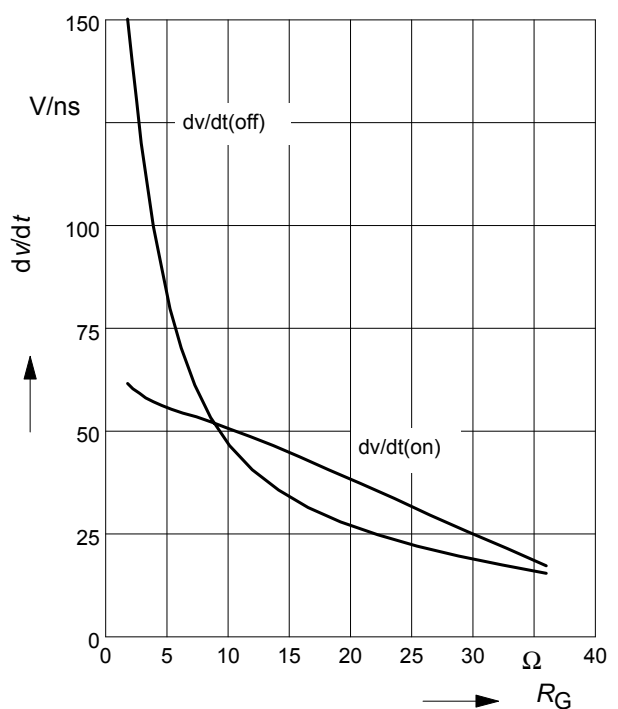
15 Typ. drain current slope

$di/dt = f(R_G)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 20.7\text{A}$



16 Typ. drain source voltage slope

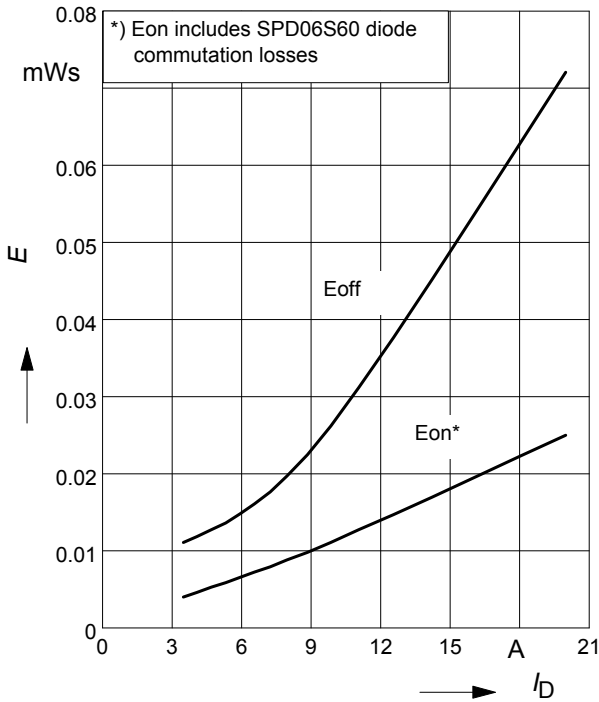
$dv/dt = f(R_G)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 20.7\text{A}$



17 Typ. switching losses

$E = f(I_D)$, inductive load, $T_j=125^\circ\text{C}$

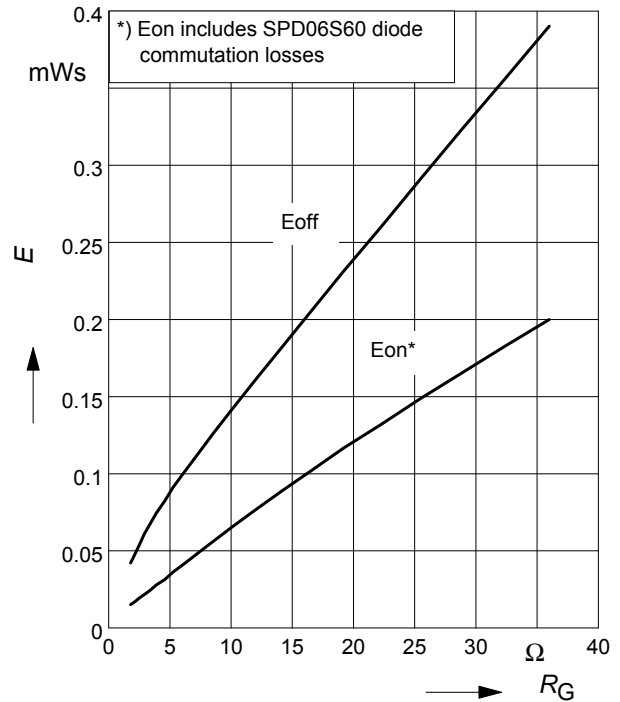
par.: $V_{DS}=380\text{V}$, $V_{GS}=0/+13\text{V}$, $R_G=3.6\Omega$



18 Typ. switching losses

$E = f(R_G)$, inductive load, $T_j=125^\circ\text{C}$

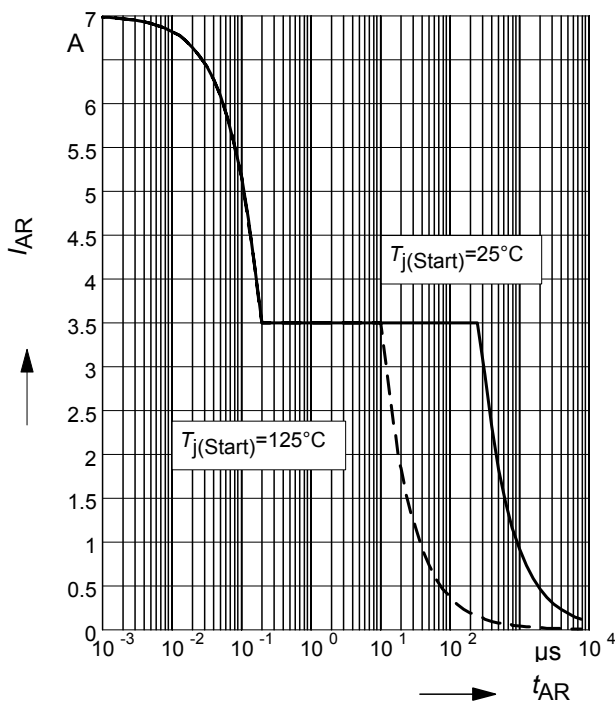
par.: $V_{DS}=380\text{V}$, $V_{GS}=0/+13\text{V}$, $I_D=11\text{A}$



19 Avalanche SOA

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

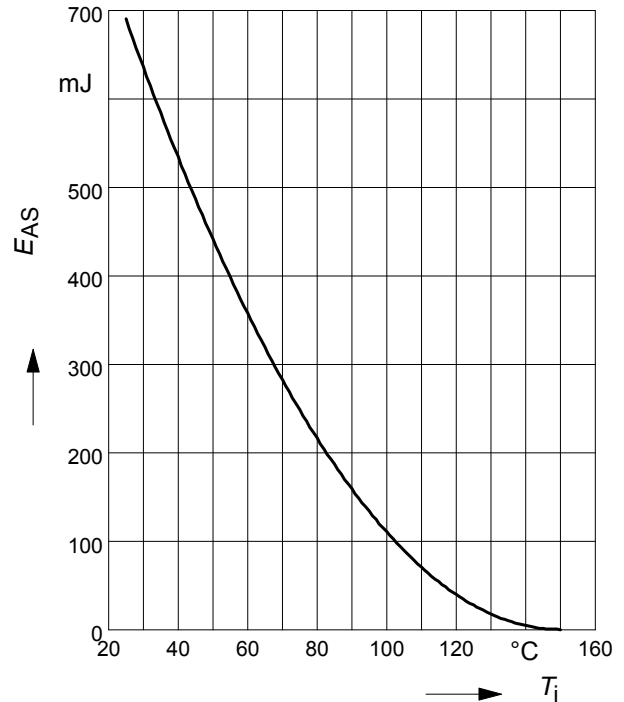
par.: $T_j \leq 150^\circ\text{C}$



20 Avalanche energy

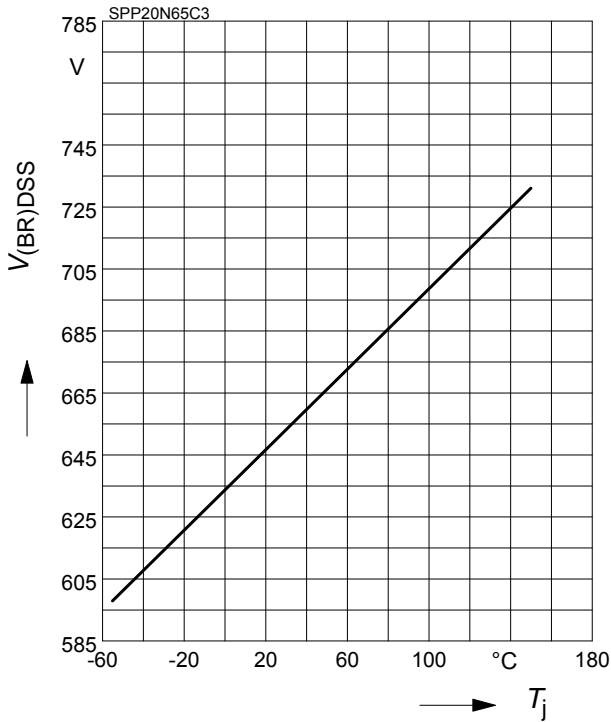
$E_{AS} = f(T_j)$

par.: $I_D = 3.5\text{A}$, $V_{DD} = 50\text{V}$



21 Drain-source breakdown voltage

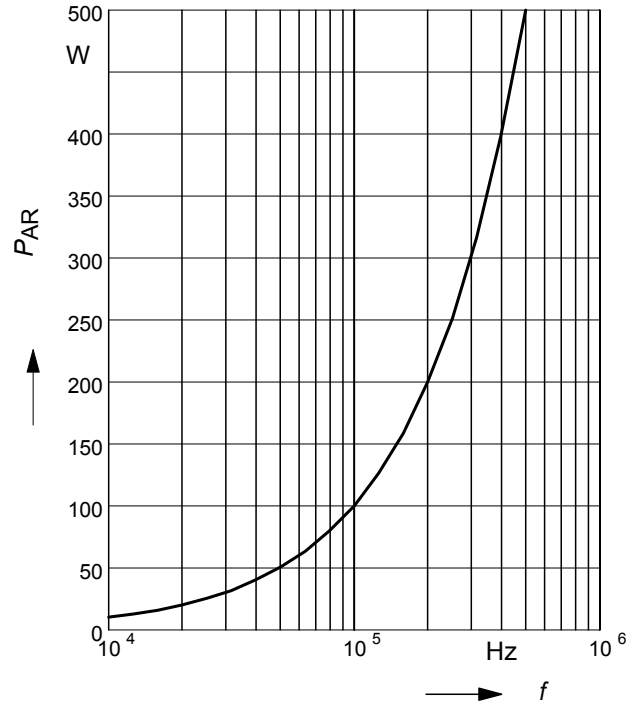
$$V_{(BR)DSS} = f(T_j)$$



22 Avalanche power losses

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

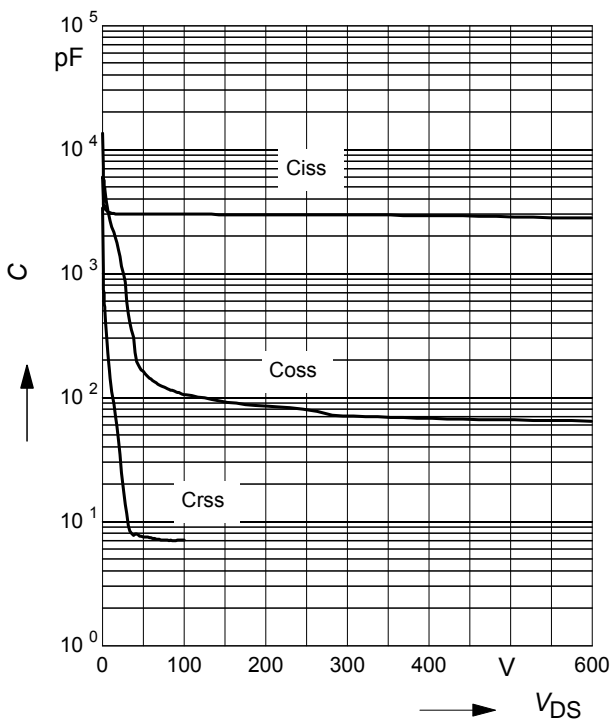
parameter: $E_{AR}=1mJ$



23 Typ. capacitances

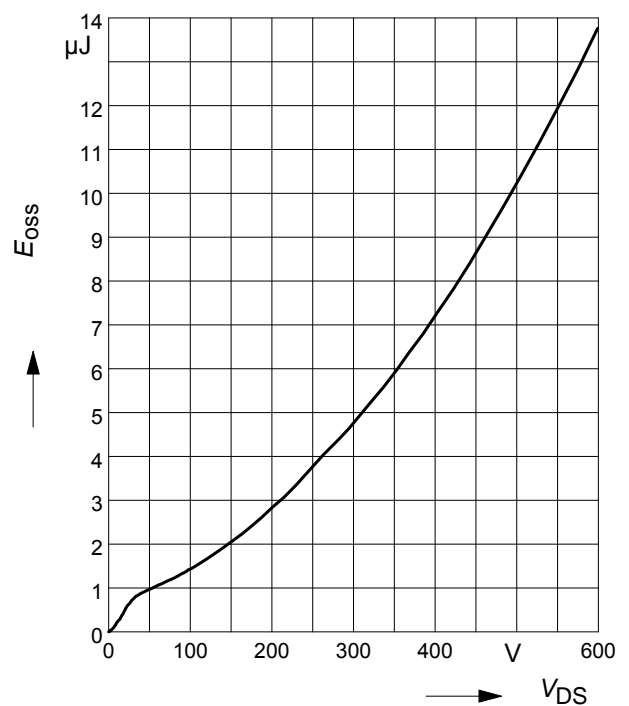
$$C = f(V_{DS})$$

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

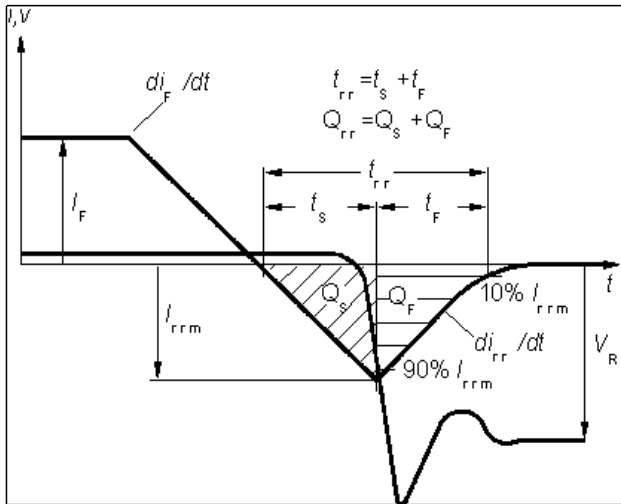


24 Typ. C_{OSS} stored energy

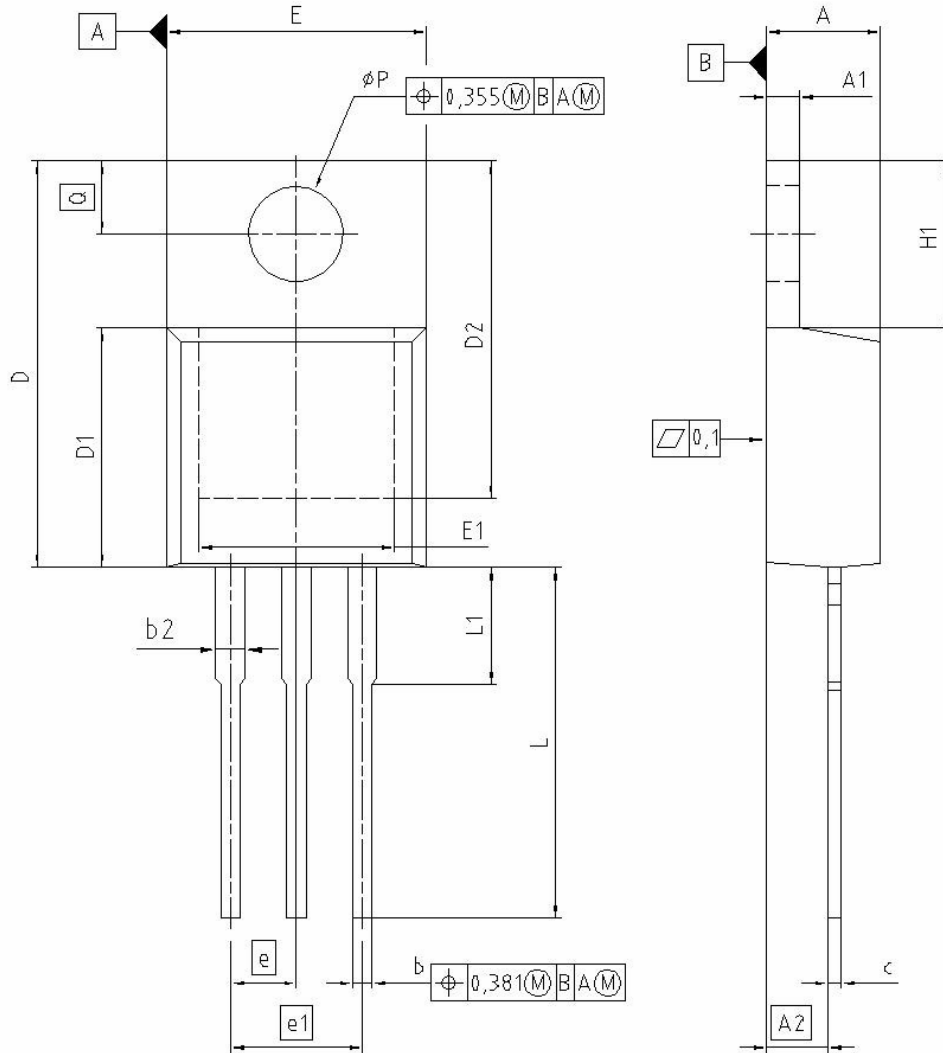
$$E_{OSS} = f(V_{DS})$$



Definition of diodes switching characteristics



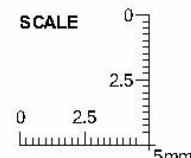
PG-TO-220-3-1



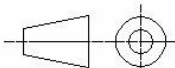
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.572	0.169	0.180
A1	1.170	1.400	0.046	0.055
A2	2.215	2.718	0.087	0.107
b	0.650	0.864	0.026	0.034
b2	0.635	1.778	0.025	0.070
c	0.330	0.600	0.013	0.024
D	14.808	15.950	0.583	0.628
D1	8.509	9.450	0.335	0.372
D2	12.850	13.100	0.506	0.516
E	9.700	10.363	0.382	0.408
E1	6.500	8.600	0.256	0.339
e	2.540		0.100	
e1	5.080		0.200	
N	3		3	
H1	5.900	6.900	0.232	0.272
L	13.000	14.000	0.512	0.551
L1	-	4.800	-	0.189
øP	3.700	3.886	0.146	0.153
Q	2.600	3.000	0.102	0.118

REFERENCE
JEDEC TO220

SCALE



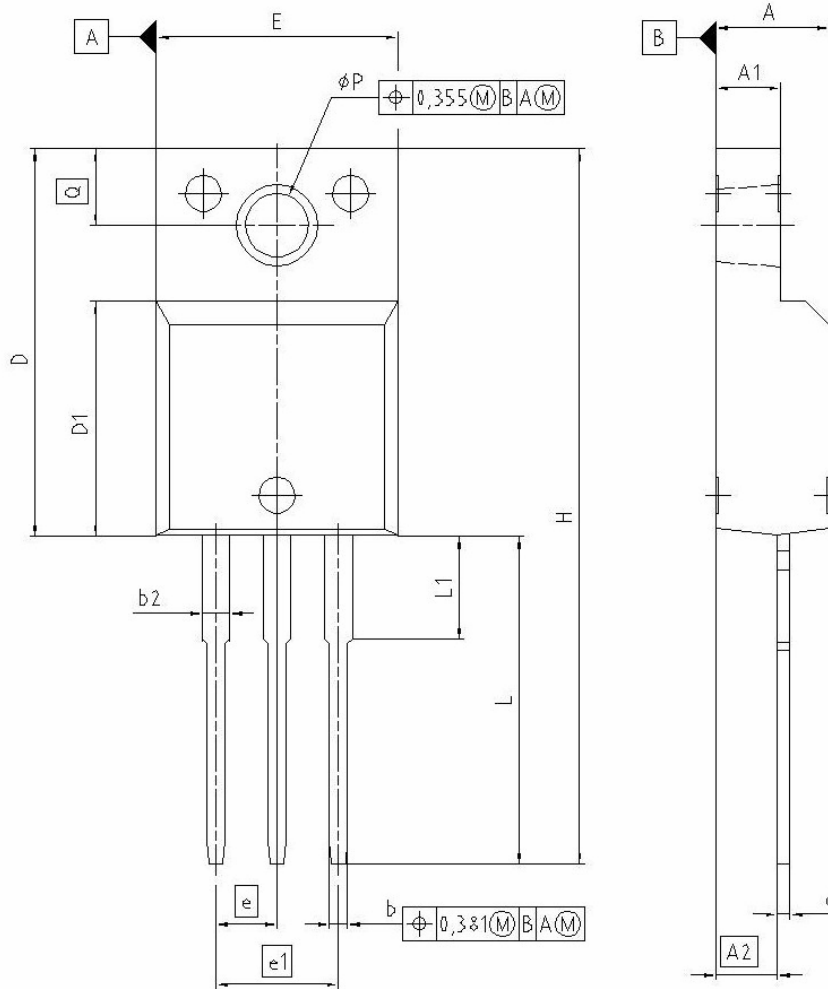
EUROPEAN PROJECTION



ISSUE DATE
01-06-2005

FILE
TO220_1

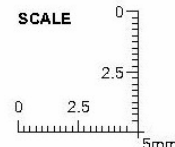
PG-TO-220-3-31 (FullPAK)



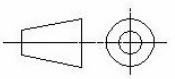
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.572	4.826	0.180	0.190
A1	2.573	2.827	0.101	0.111
A2	2.514	2.616	0.099	0.103
b	0.649	0.776	0.025	0.030
b2	1.143	1.509	0.045	0.059
c	0.449	0.627	0.017	0.027
D	15.863	16.117	0.624	0.634
D1	9.554	9.808	0.376	0.386
E	10.373	10.627	0.408	0.418
e	2.540		0.100	
e1	5.080		0.200	
N	3		3	
H	29.463	29.717	1.160	1.170
L	13.473	13.727	0.530	0.540
L1	3.175	3.429	0.125	0.135
øP	2.949	3.025	0.119	0.116
Q	3.149	3.251	0.124	0.128

REFERENCE
J...

SCALE



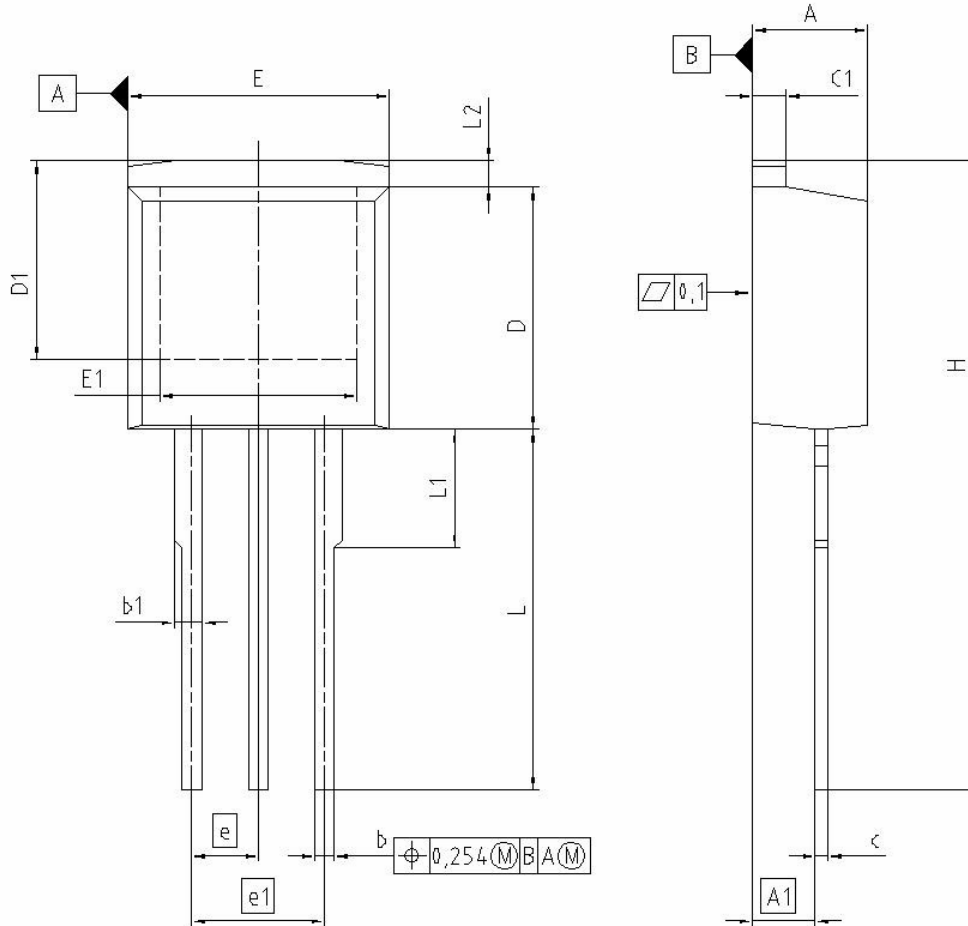
EUROPEAN PROJECTION



ISSUE DATE
17-08-2005

FILE
TO220_2

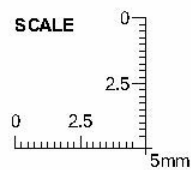
PG-TO-262-3-1 (I²-PAK)



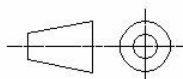
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.300	4.500	0.169	0.177
A1	2.150	2.650	0.085	0.104
b	0.650	0.850	0.026	0.033
b1	0.635	1.400	0.025	0.055
c	0.400	0.600	0.016	0.024
c1	1.170	1.370	0.046	0.054
D	9.050	9.450	0.356	0.372
D1	6.900	7.650	0.272	0.301
E	9.800	10.200	0.386	0.402
E1	7.250	8.600	0.285	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



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