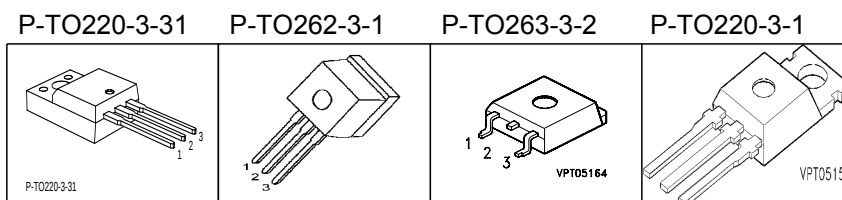


Cool MOS™ Power Transistor

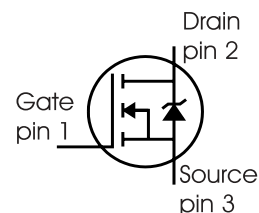
Feature

- 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
- P-TO-220-3-31: Fully isolated package (2500 VAC; 1 minute)



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

Type	Package	Ordering Code	Marking
SPP20N60C3	P-TO220-3-1	Q67040-S4398	20N60C3
SPB20N60C3	P-TO263-3-2	Q67040-S4397	20N60C3
SPI20N60C3	P-TO262-3-1	Q67040-S4550	20N60C3
SPA20N60C3	P-TO220-3-31	Q67040-S4410	20N60C3



Maximum Ratings

Parameter	Symbol	Value		Unit
		SPP20N60C3	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}	$I_{D\text{ puls}}$	62.1	62.1	A
Avalanche energy, single pulse $I_D=10\text{A}$, $V_{DD}=50\text{V}$	E_{AS}	690	690	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ²⁾ $I_D=20\text{A}$, $V_{DD}=50\text{V}$	E_{AR}	1	1	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	20	20	A
Gate source voltage static	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 $V_{DS} = 480 \text{ V}$, $I_D = 20.7 \text{ A}$, $T_j = 125^\circ\text{C}$	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	
		-	35	-	
Soldering temperature, 1.6 mm (0.063 in.) from case for 10s ⁴⁾	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	$V_{(BR)DSS}$	$V_{GS}=0\text{V}$, $I_D=0.25\text{mA}$	600	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}$, $I_D=20\text{A}$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=1000\mu\text{A}$, $V_{GS}=V_{DS}$	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$	-	0.1	1	μA
		$T_j=150^\circ\text{C}$	-	-	100	
Gate-source leakage current	I_{GSS}	$V_{GS}=30\text{V}$, $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=13.1\text{A}$	-	-	-	Ω
		$T_j=25^\circ\text{C}$	-	0.16	0.19	
		$T_j=150^\circ\text{C}$	-	0.43	-	
Gate input resistance	R_G	$f=1\text{MHz}$, 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}	$V_{GS} = 0V$, $V_{DS} = 25V$, $f = 1MHz$	-	2400	-	pF
Output capacitance	C_{oss}		-	780	-	
Reverse transfer capacitance	C_{rss}		-	50	-	
Effective output capacitance, ⁵⁾ energy related	$C_{o(er)}$	$V_{GS} = 0V$, $V_{DS} = 0V$ to $480V$	-	83	-	
Effective output capacitance, ⁶⁾ 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		-	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

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.

⁴Soldering 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} .

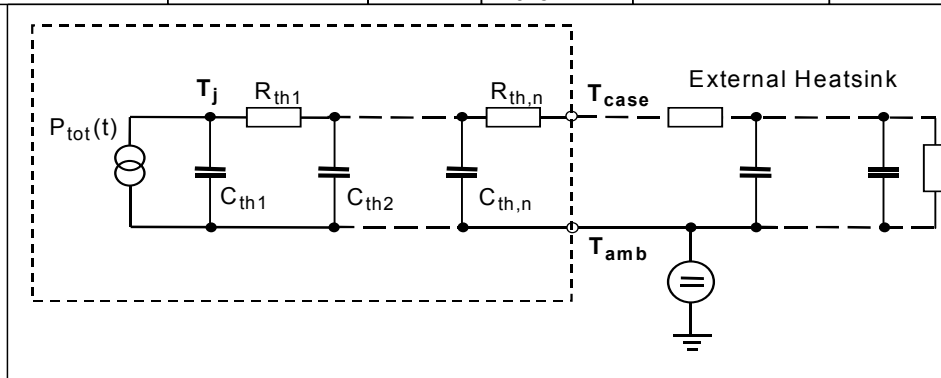
⁶ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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	-	$\text{A}/\mu\text{s}$

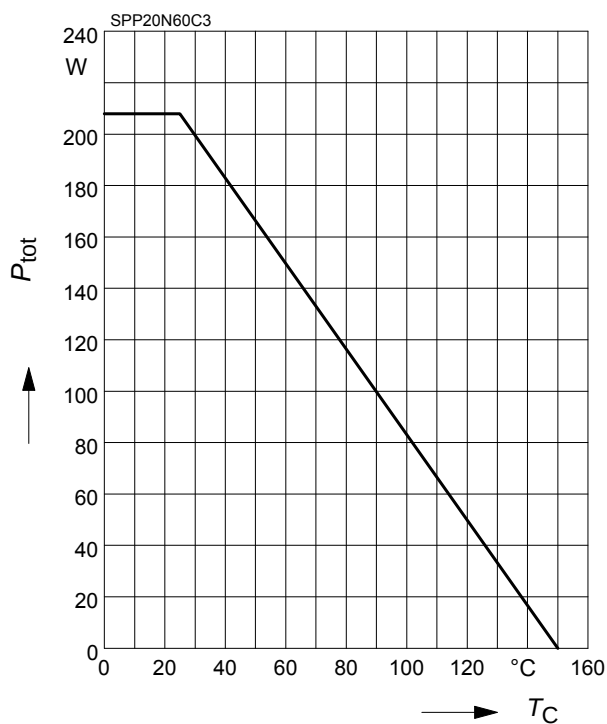
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_B_I	SPA			SPP_B_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	



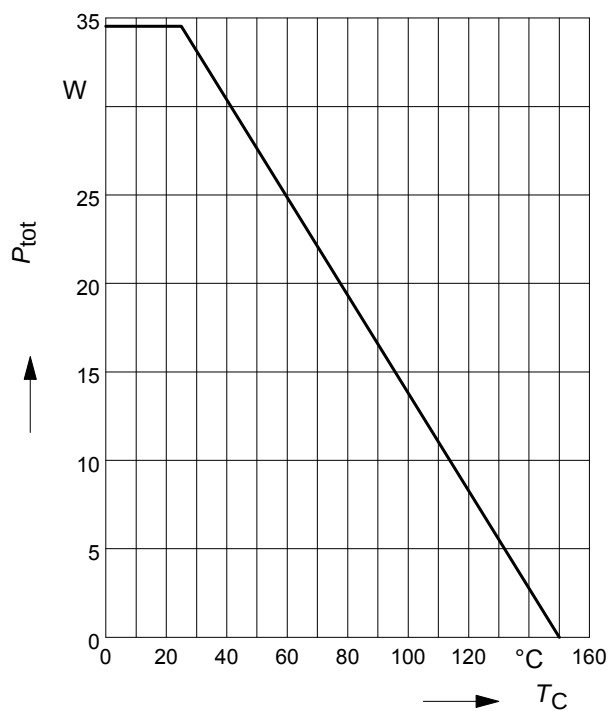
1 Power dissipation

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



2 Power dissipation FullPAK

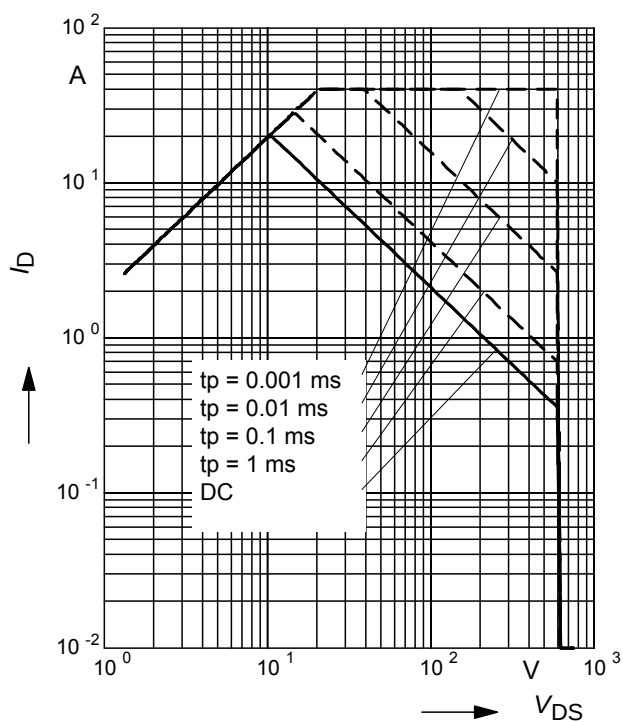
$$P_{\text{tot}} = f(T_C)$$



3 Safe operating area

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

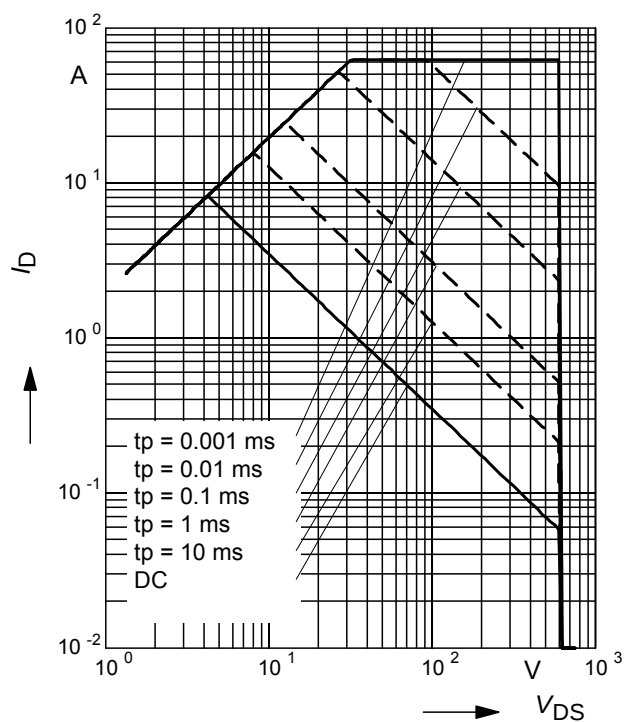
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



4 Safe operating area FullPAK

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

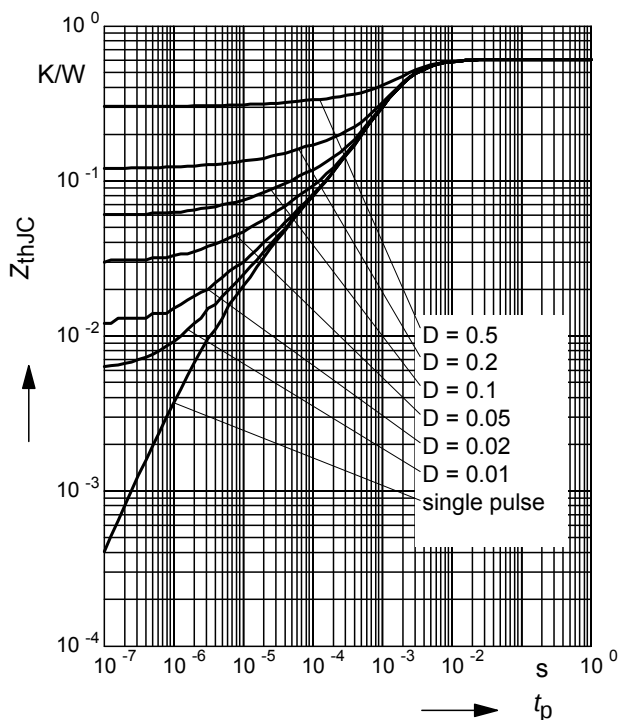
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



5 Transient thermal impedance

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

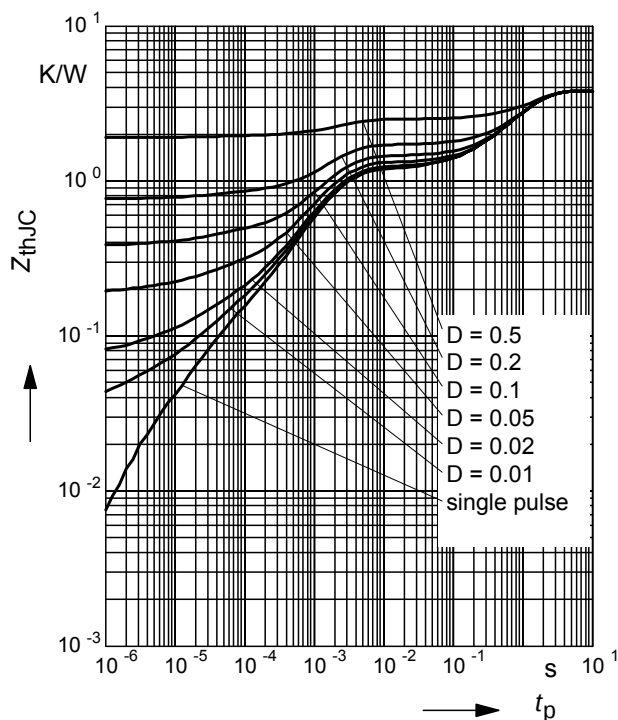
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

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

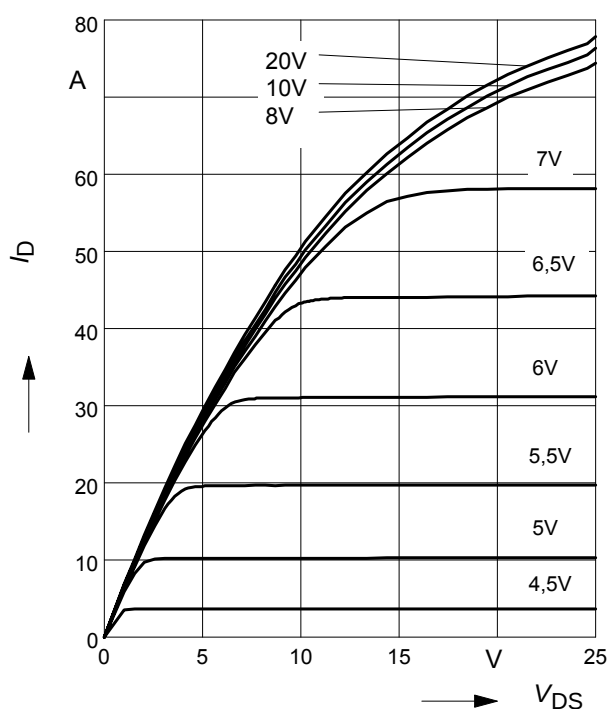
parameter: $D = t_p/t$



7 Typ. output characteristic

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

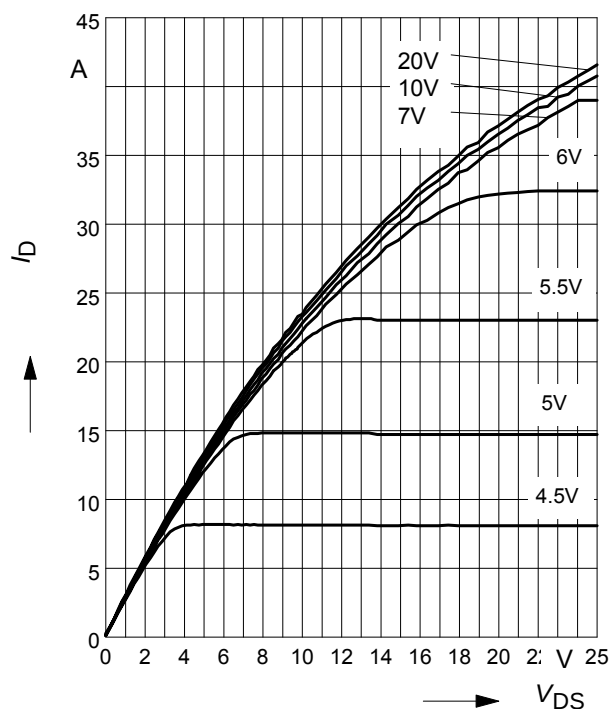
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



8 Typ. output characteristic

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

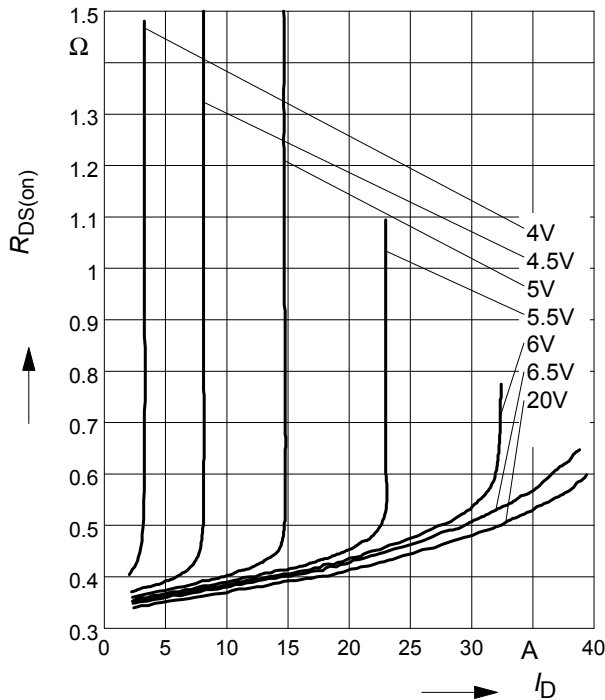
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



9 Typ. drain-source on resistance

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

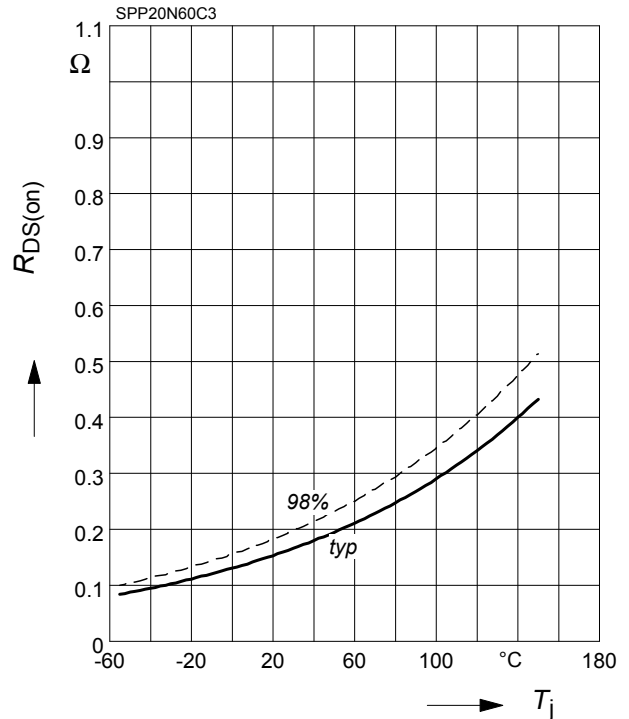
parameter: $T_j = 150^\circ\text{C}$, V_{GS}



10 Drain-source on-state resistance

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

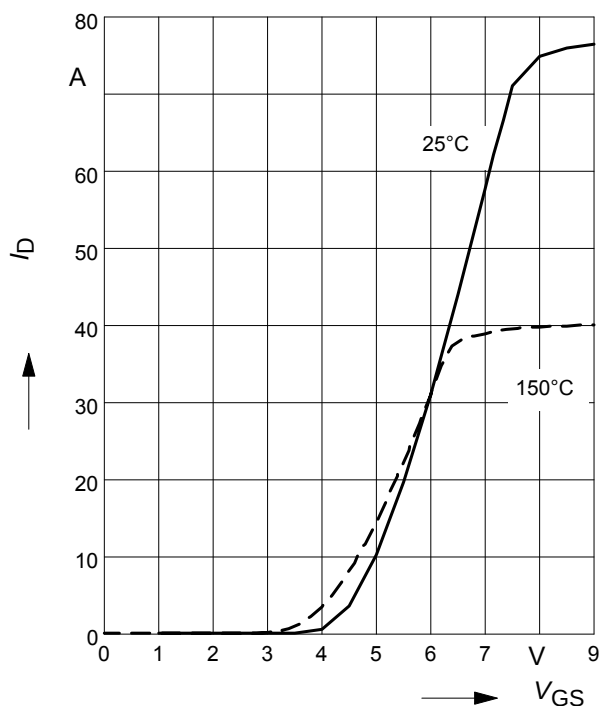
parameter: $I_D = 13.1$ A, $V_{GS} = 10$ V



11 Typ. transfer characteristics

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

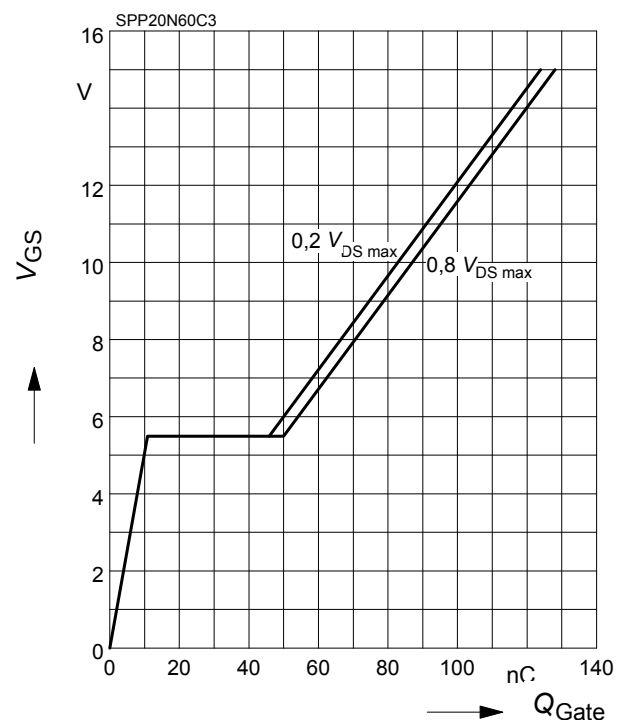
parameter: $t_p = 10$ μs



12 Typ. gate charge

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

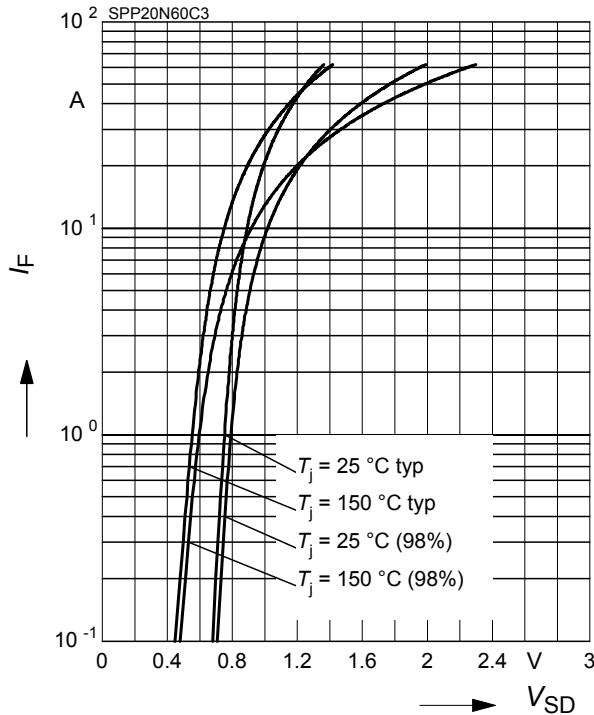
parameter: $I_D = 20.7$ A pulsed



13 Forward characteristics of body diode

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

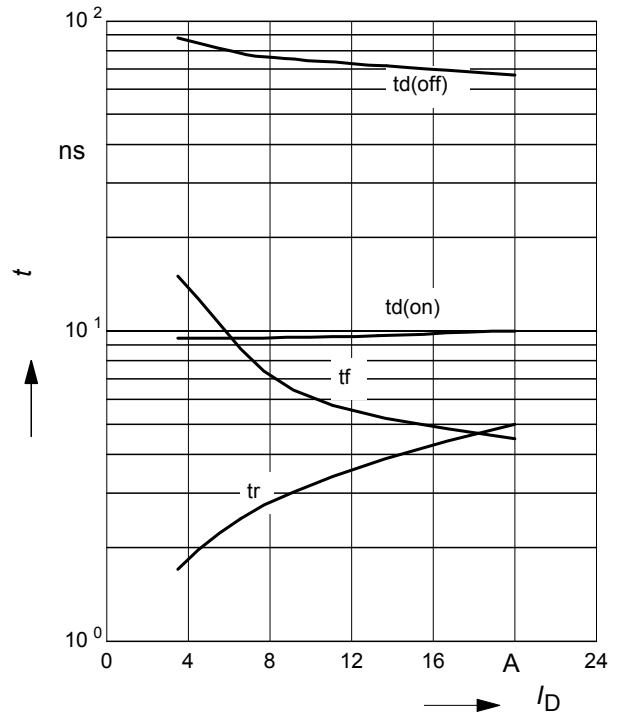
parameter: T_j , $t_p = 10 \mu s$



14 Typ. switching time

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

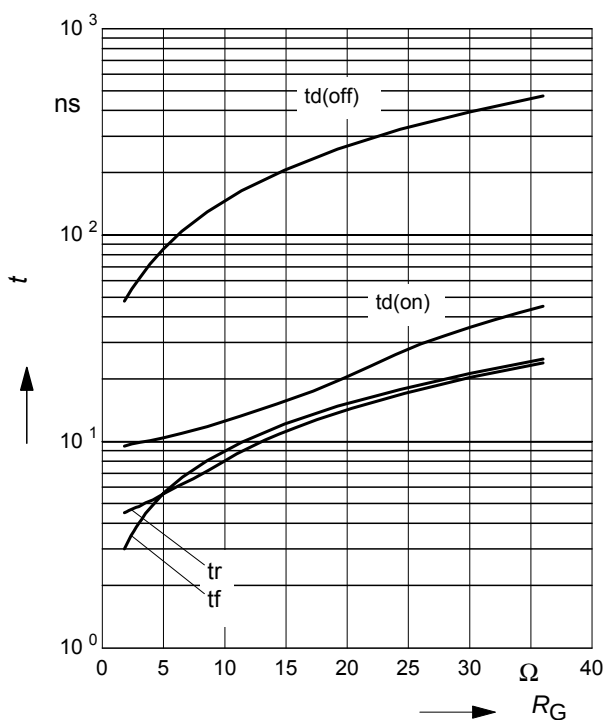
par.: $V_{DS} = 380V$, $V_{GS} = 0/+13V$, $R_G = 3.6\Omega$



15 Typ. switching time

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

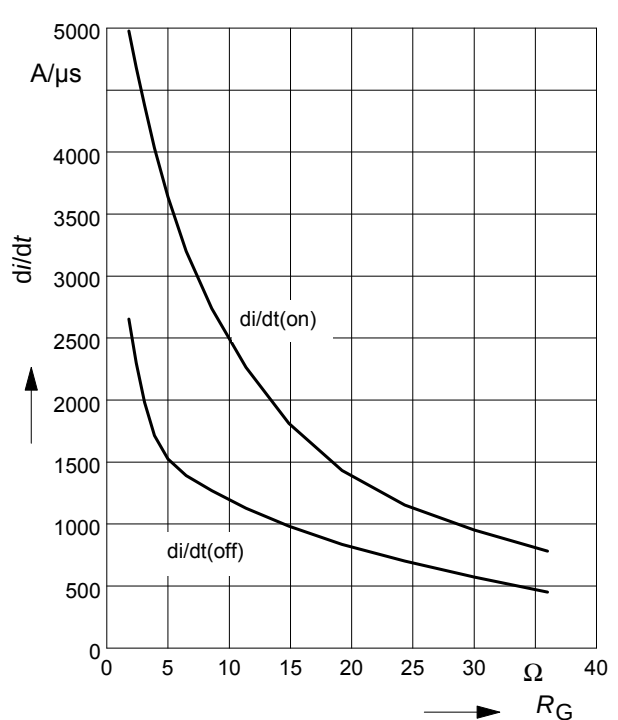
par.: $V_{DS} = 380V$, $V_{GS} = 0/+13V$, $I_D = 20.7 A$



16 Typ. drain current slope

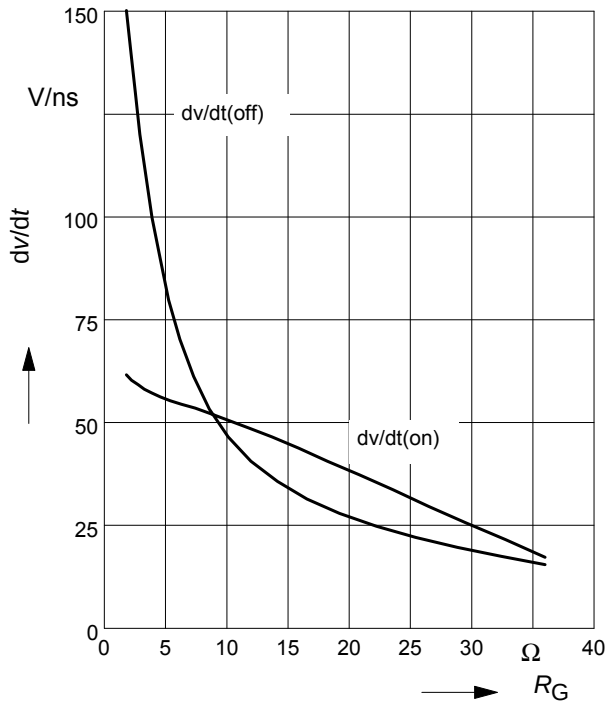
$$di/dt = f(R_G), \text{ inductive load, } T_j = 125^\circ C$$

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



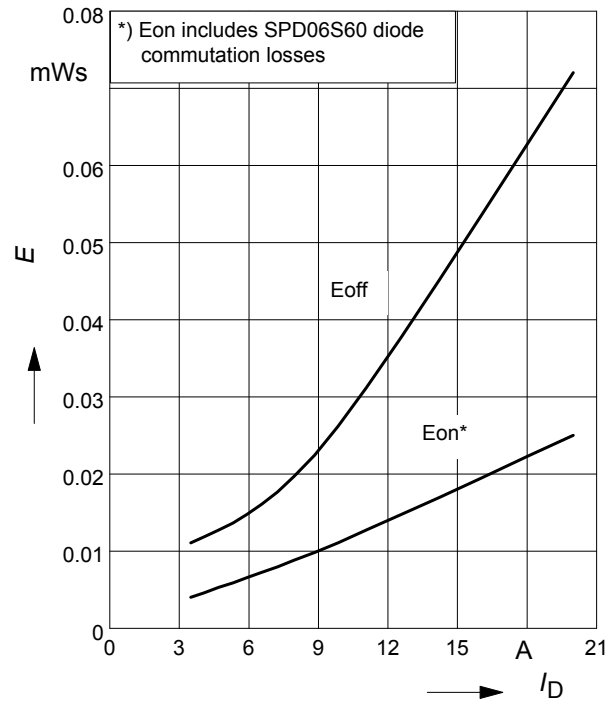
17 Typ. drain source voltage slope

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



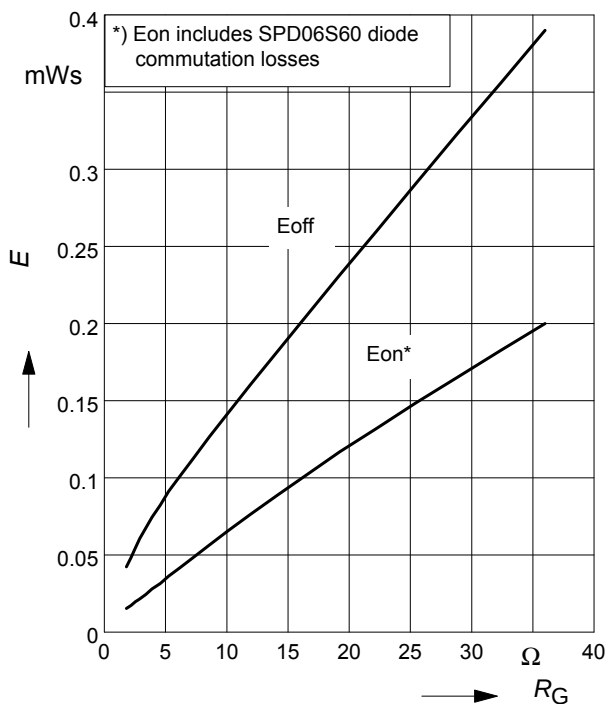
18 Typ. switching losses

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



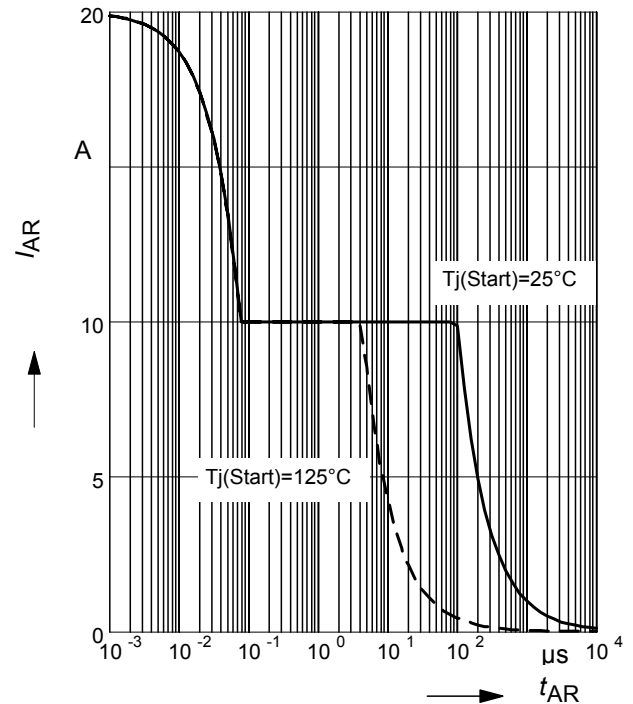
19 Typ. switching losses

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



20 Avalanche SOA

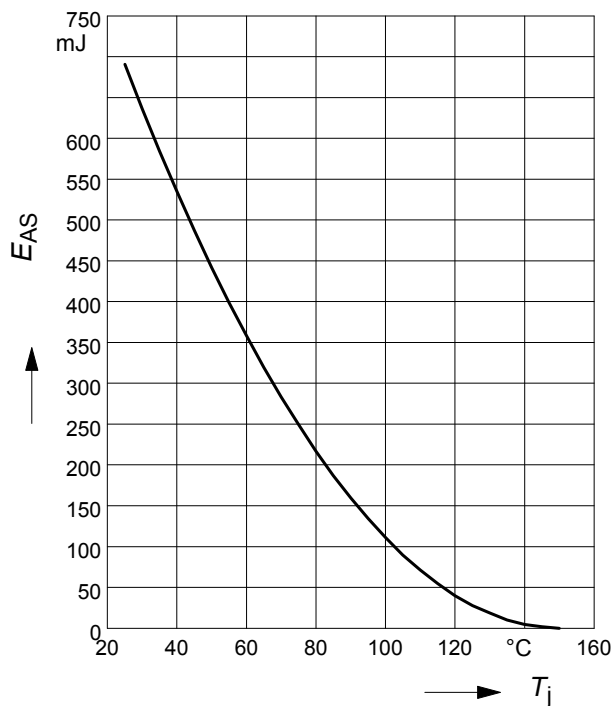
$I_{AR} = f(t_{AR})$
par.: $T_j \leq 150^\circ\text{C}$



21 Avalanche energy

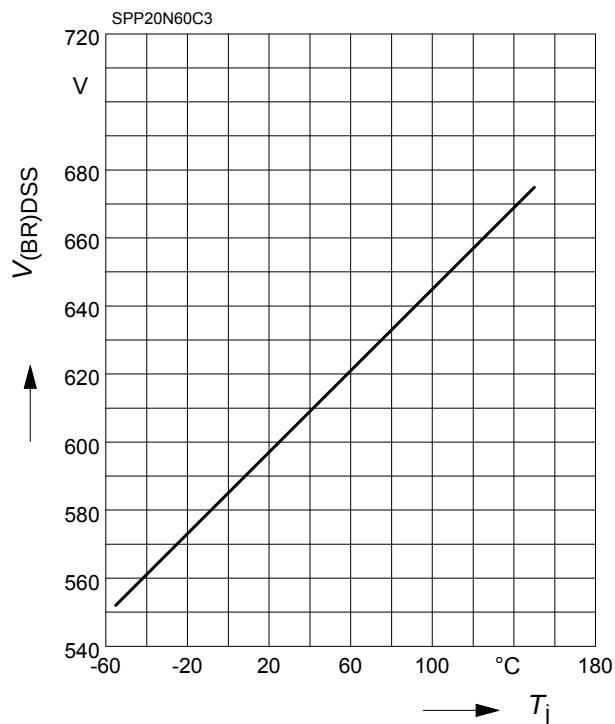
$$E_{AS} = f(T_j)$$

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



22 Drain-source breakdown voltage

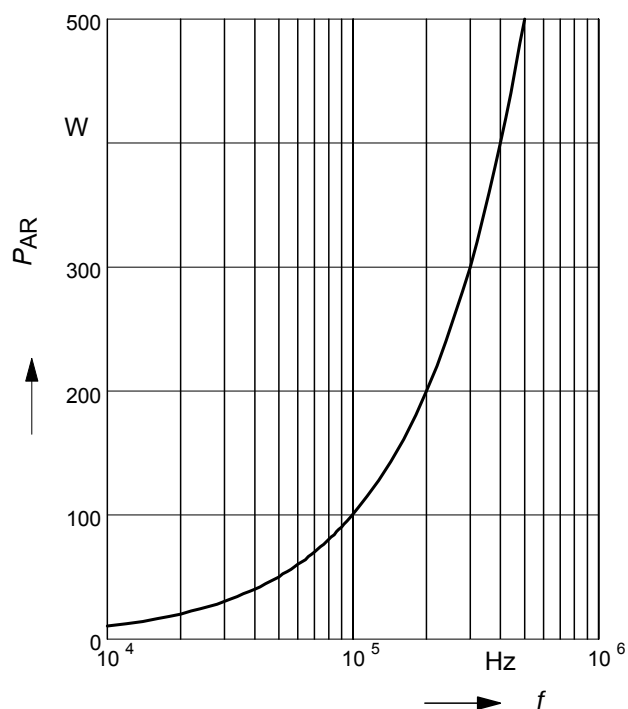
$$V_{(BR)DSS} = f(T_j)$$



23 Avalanche power losses

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

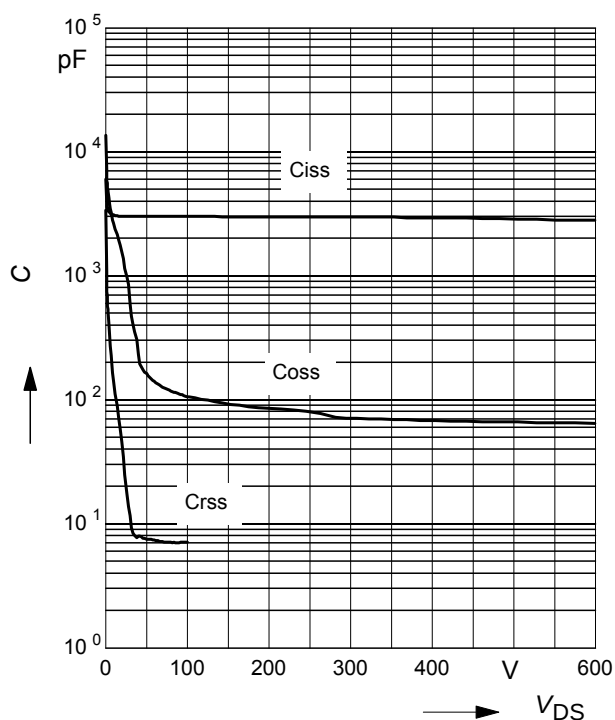
parameter: $E_{AR} = 1\text{ mJ}$



24 Typ. capacitances

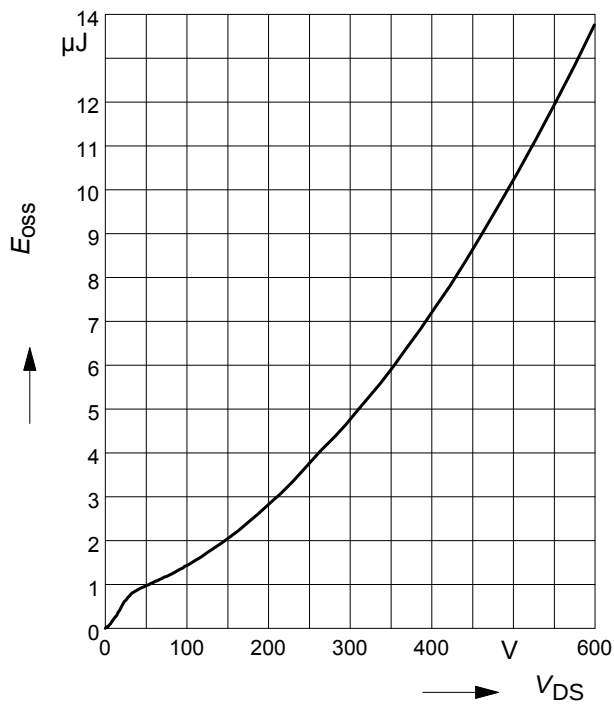
$$C = f(V_{DS})$$

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

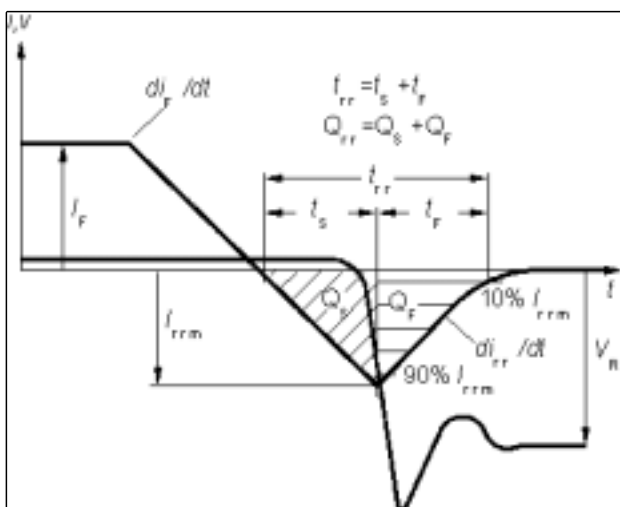


25 Typ. C_{oss} stored energy

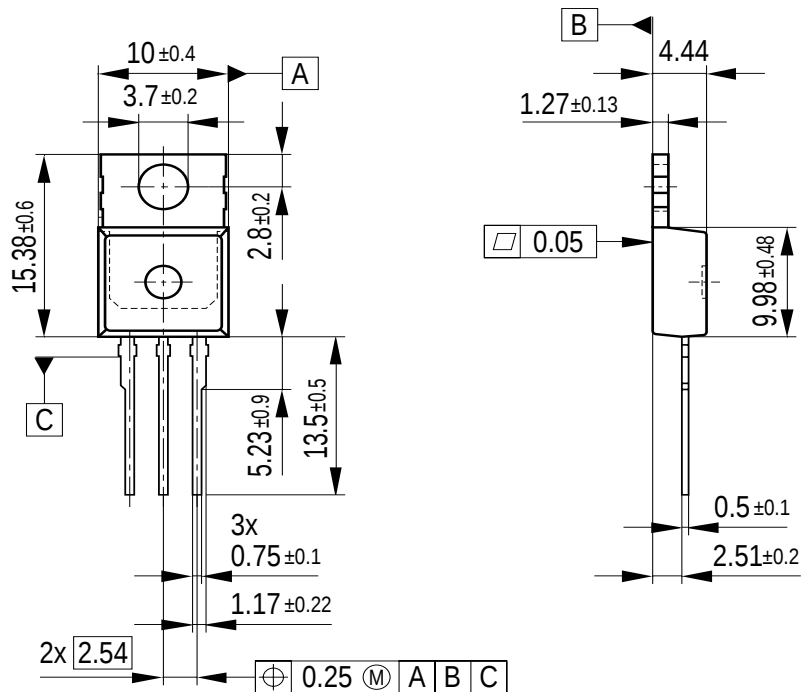
$$E_{oss} = f(V_{DS})$$



Definition of diodes switching characteristics

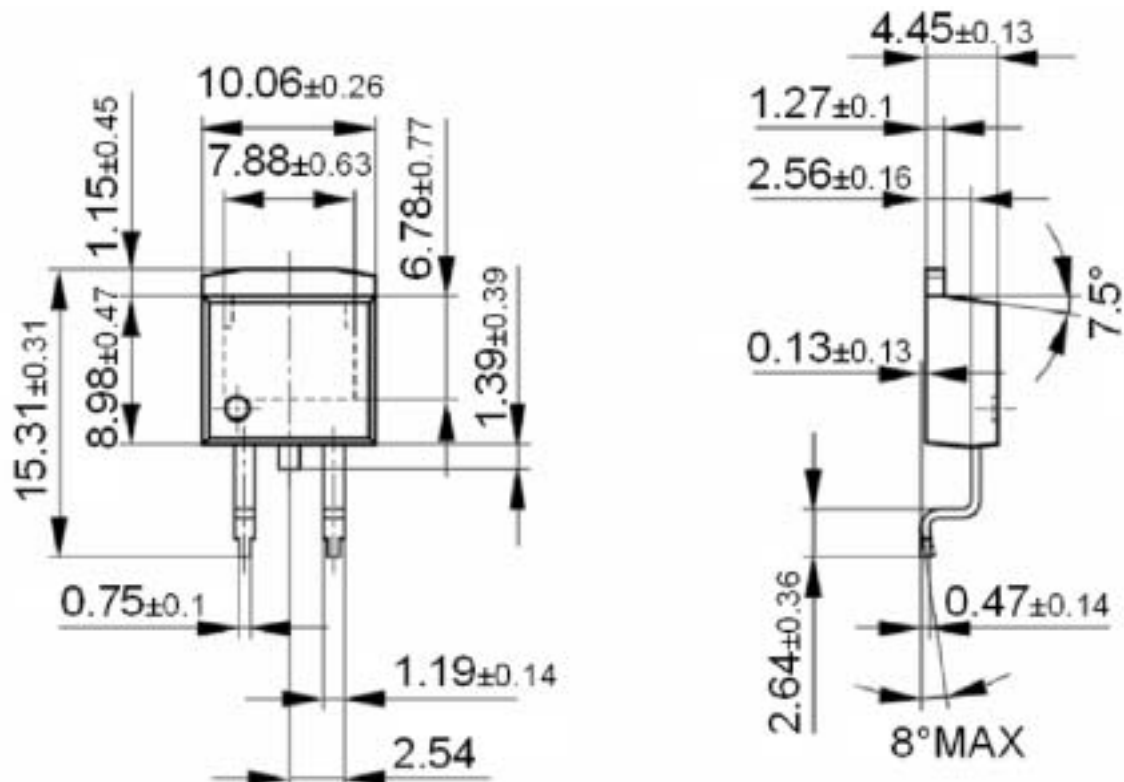


P-TO-220-3-1

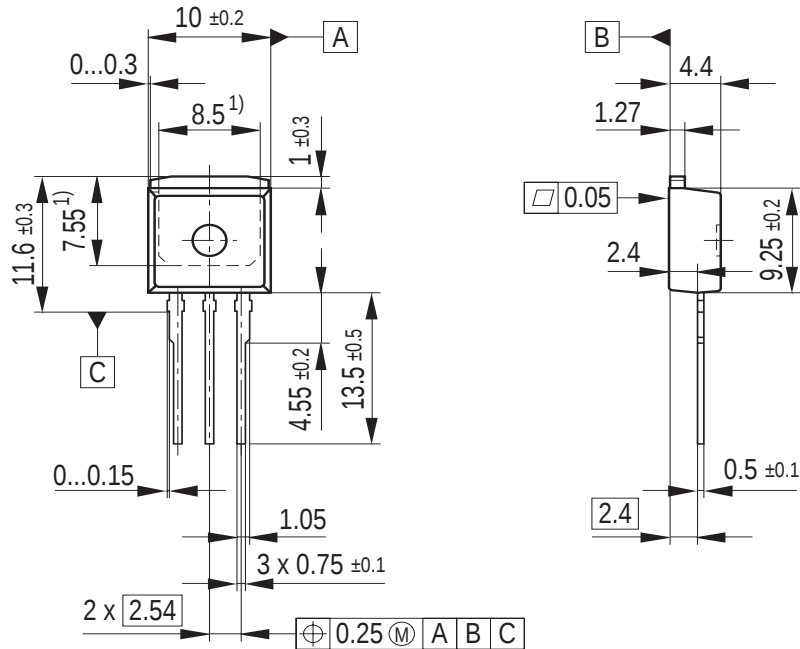


All metal surfaces tin plated, except area of cut.
Metal surface min. x=7.25, y=12.3

P-TO-263-3-2 (D²PAK)



P-TO-262-3-1 (I²-PAK)

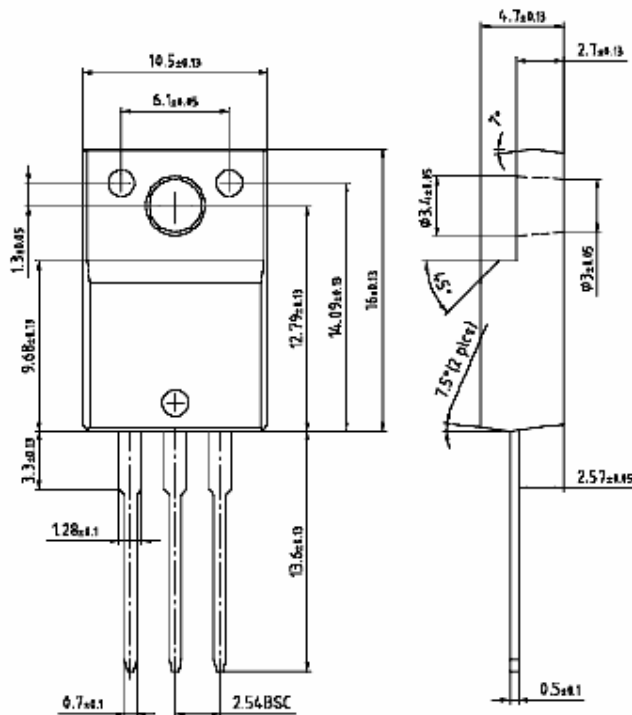


1) Typical

Metal surface min. X = 7.25, Y = 6.9

All metal surfaces tin plated, except area of cut.

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



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

Published by
Infineon Technologies AG,
Bereichs Kommunikation
St.-Martin-Strasse 53,
D-81541 München
© Infineon Technologies AG 1999
All Rights Reserved.

Attention please!

The information herein is given to describe certain components and shall not be considered as warranted characteristics.

Terms of delivery and rights to technical change reserved.

We hereby disclaim any and all warranties, including but not limited to warranties of non-infringement, regarding circuits, descriptions and charts stated herein.

Infineon Technologies is an approved CECC manufacturer.

Information

For further information on technology, delivery terms and conditions and prices please contact your nearest Infineon Technologies Office in Germany or our Infineon Technologies Representatives worldwide (see address list).

Warnings

Due to technical requirements components may contain dangerous substances.

For information on the types in question please contact your nearest Infineon Technologies Office.

Infineon Technologies Components may only be used in life-support devices or systems with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body, or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.