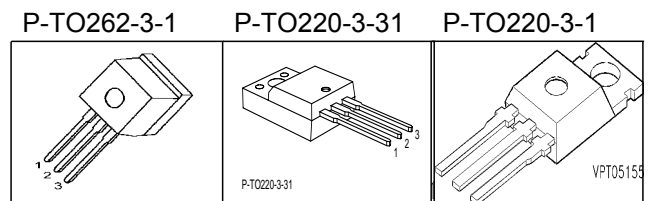


Cool MOS™ Power Transistor

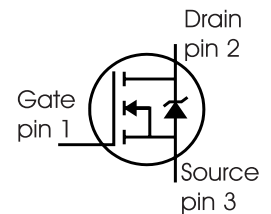
Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- High peak current capability
- Improved transconductance

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



Type	Package	Ordering Code	Marking
SPP11N65C3	P-TO220-3-1	Q67040-S4557	11N65C3
SPA11N65C3	P-TO220-3-31	Q67040-S4554	11N65C3
SPI11N65C3	P-TO262-3-1	Q67040-S4561	11N65C3



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	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 $I_D=2.5\text{A}$, $V_{DD}=50\text{V}$	E_{AS}	340	340	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ²⁾ $I_D=4\text{A}$, $V_{DD}=50\text{V}$	E_{AR}	0.6	0.6	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	4	4	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}	125	33	W
Operating and storage temperature	T_j , T_{stg}	-55...+150		$^\circ\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480\text{ V}$, $I_D = 11\text{ A}$, $T_j = 125\text{ °C}$	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	$R_{thJC\text{ FP}}$	-	-	3.8	
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 $T_j=25\text{ °C}$ 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 ⁵⁾	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}$, $I_D=4\text{A}$	-	730	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=500\mu\text{A}$, $V_{GS}=V_{DS}$	2.1	3	3.9	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25\text{ °C}$ $T_j=150\text{ °C}$	-	0.1	1	μA
			-	-	100	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=7\text{A}$ $T_j=25\text{ °C}$ $T_j=150\text{ °C}$	-	0.34	0.38	Ω
			-	0.92	-	
Gate input resistance	R_G	$f=1\text{MHz}$, open drain	-	0.86	-	

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 7A$	-	8.3	-	S
Input capacitance	C_{iss}	$V_{GS} = 0V$, $V_{DS} = 25V$,	-	1200	-	pF
Output capacitance	C_{oss}	$f = 1MHz$	-	390	-	
Reverse transfer capacitance	C_{rss}		-	30	-	
Effective output capacitance, ⁶⁾ energy related	$C_{o(er)}$	$V_{GS} = 0V$, $V_{DS} = 0V$ to 480V	-	45	-	
Effective output capacitance, ⁷⁾ time related	$C_{o(tr)}$		-	85	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380V$, $V_{GS} = 0/10V$,	-	10	-	ns
Rise time	t_r	$I_D = 11A$,	-	5	-	
Turn-off delay time	$t_{d(off)}$	$R_G = 6.8\Omega$	-	44	70	
Fall time	t_f		-	5	9	

Gate Charge Characteristics

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

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

⁵HTRB @ 1000h, 600V, T_{jmax} resp. accelerated HTRB @ 168h, 600V, $T_j = 175^\circ C$
according to JEDEC A108, MIL-STD 750/1038-1040, 1042

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

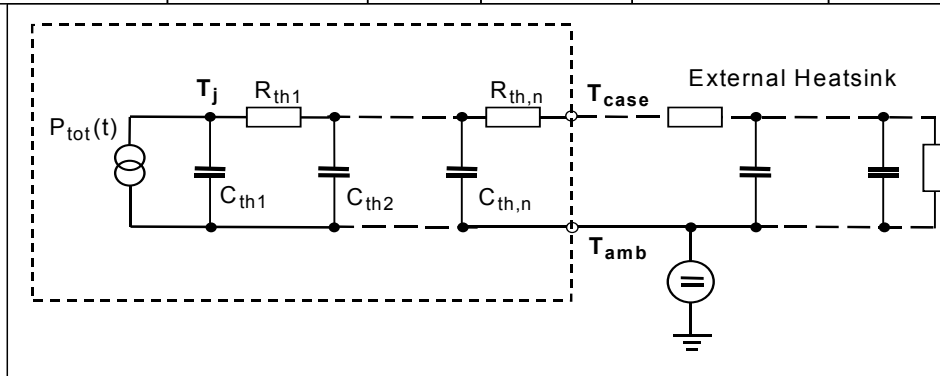
⁷ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	I_S	$T_C=25^\circ\text{C}$	-	-	11	A
Inverse diode direct current, pulsed	I_{SM}		-	-	33	
Inverse diode forward voltage	V_{SD}	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R=480\text{V}, I_F=I_S,$	-	400	600	ns
Reverse recovery charge	Q_{rr}	$di_F/dt=100\text{A}/\mu\text{s}$	-	6	-	μC
Peak reverse recovery current	I_{rrm}		-	41	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt	$T_j=25^\circ\text{C}$	-	1200	-	$\text{A}/\mu\text{s}$

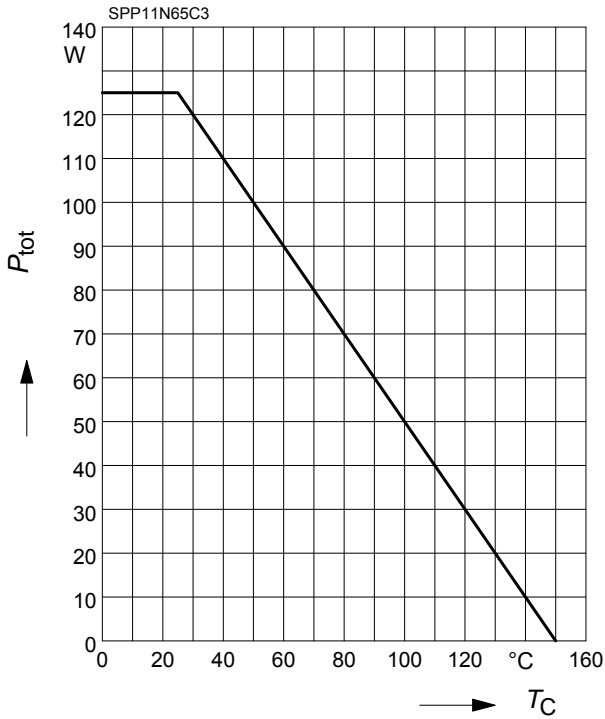
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPP_B	SPA			SPP_B	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	



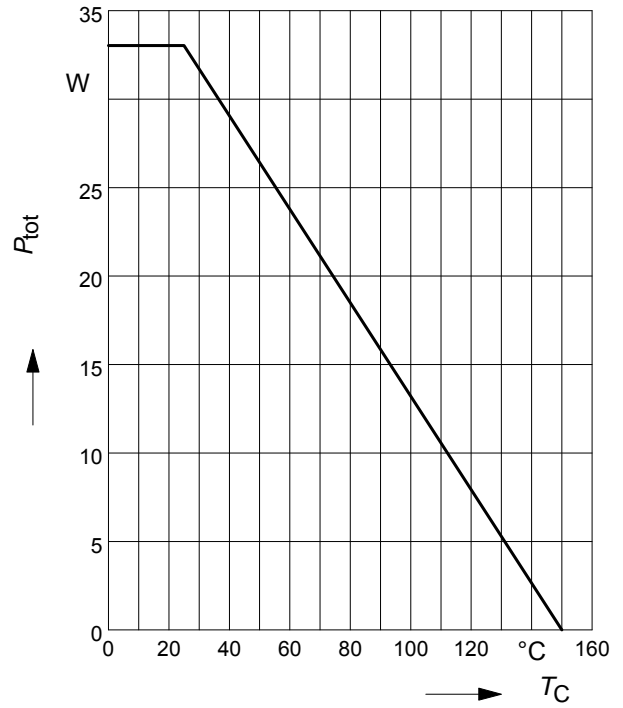
1 Power dissipation

$P_{tot} = f(T_C)$



2 Power dissipation FullPAK

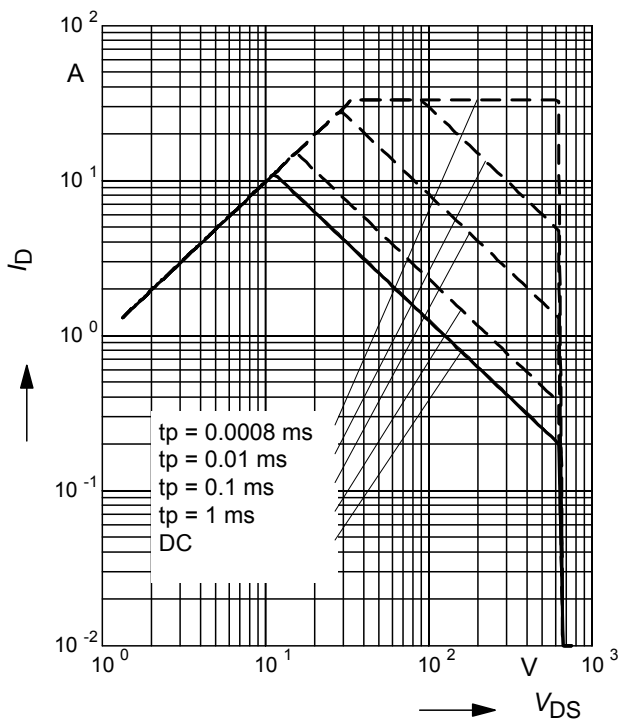
$P_{tot} = f(T_C)$



3 Safe operating area

$I_D = f(V_{DS})$

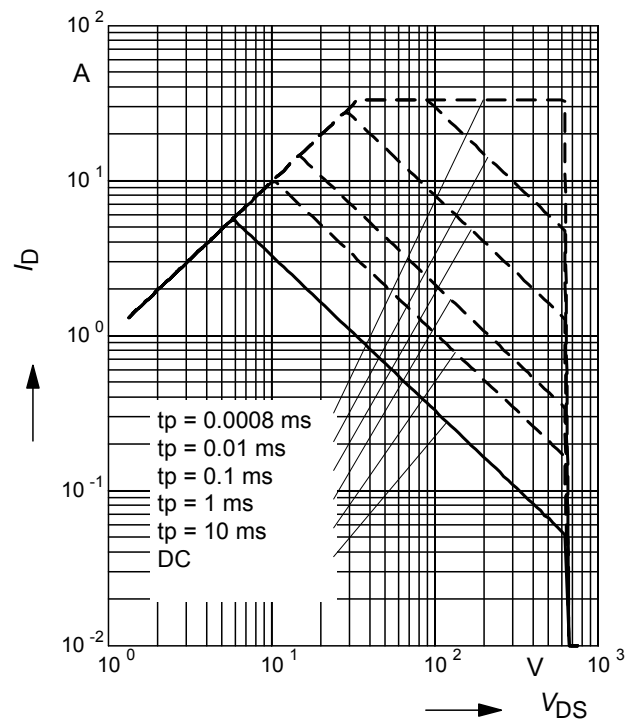
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



4 Safe operating area FullPAK

$I_D = f(V_{DS})$

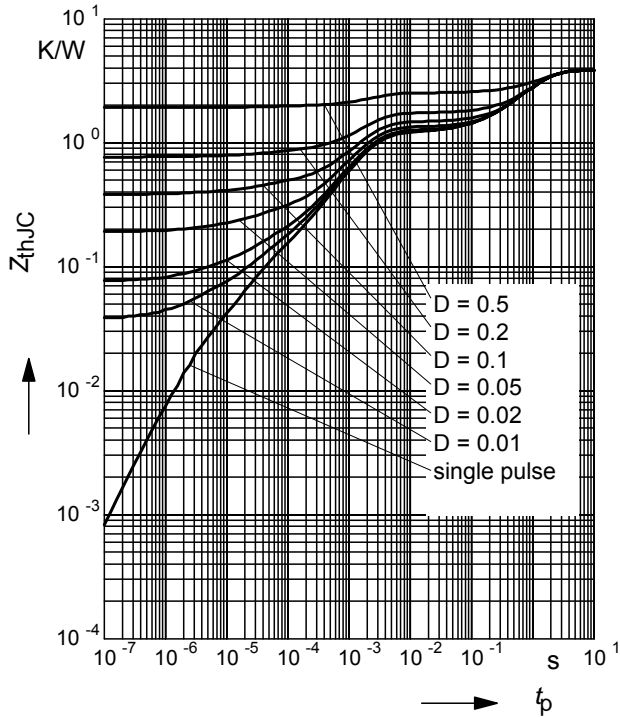
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



5 Transient thermal impedance FullPAK

$Z_{thJC} = f(t_p)$

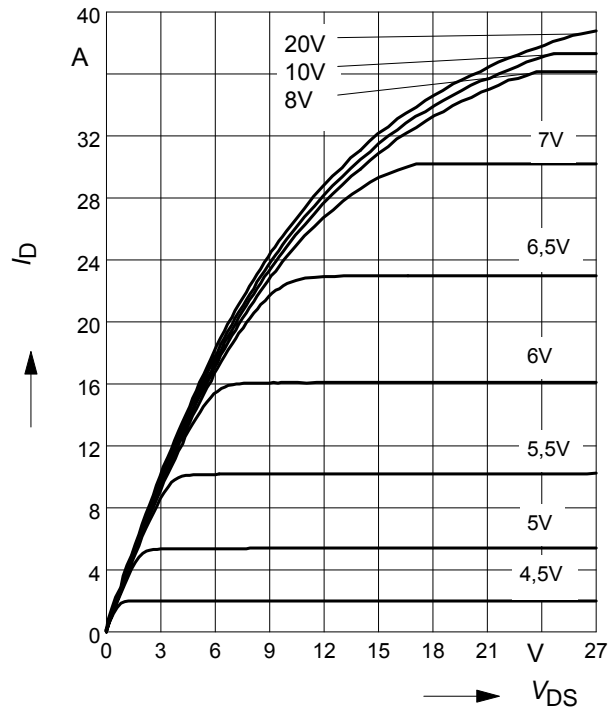
parameter: $D = t_p/t$



6 Typ. output characteristic

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

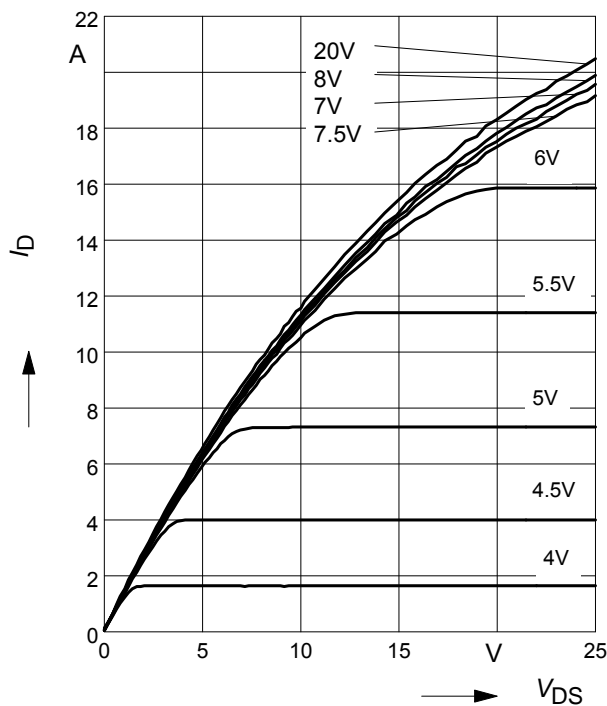
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



7 Typ. output characteristic

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

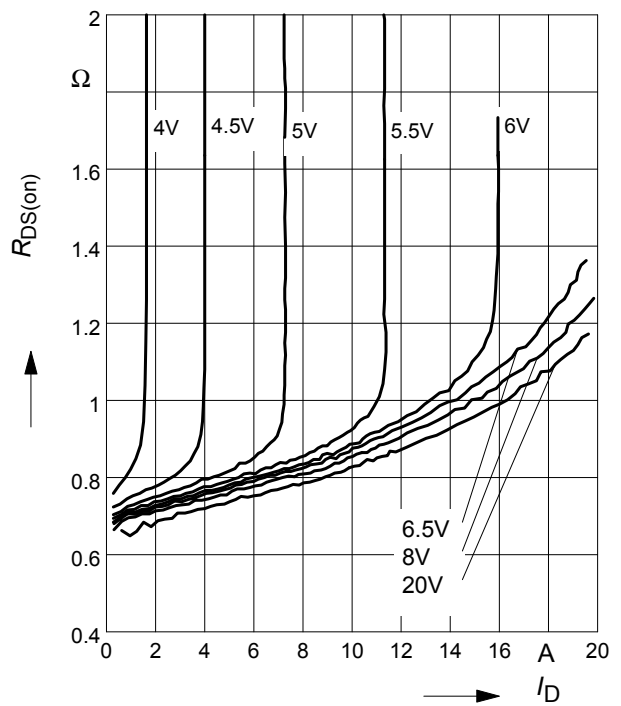
parameter: $t_p = 10 \mu\text{s}, V_{GS}$



8 Typ. drain-source on resistance

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

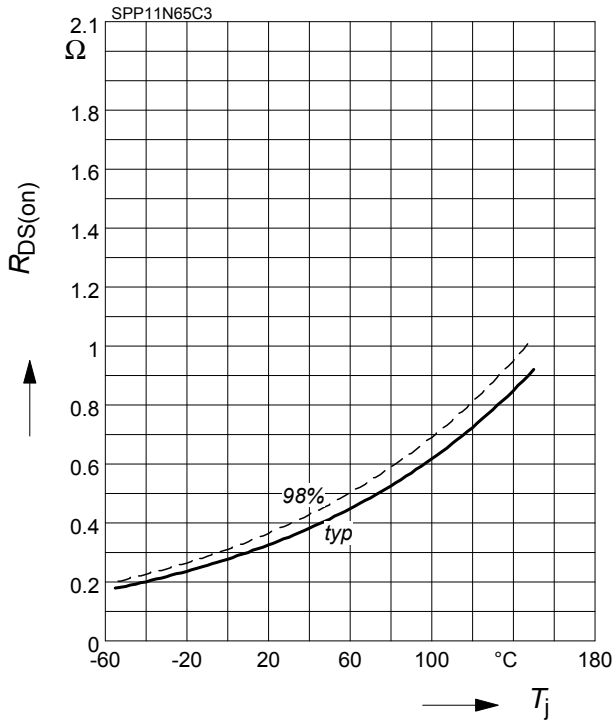
parameter: $T_j=150^\circ\text{C}, V_{GS}$



9 Drain-source on-state resistance

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

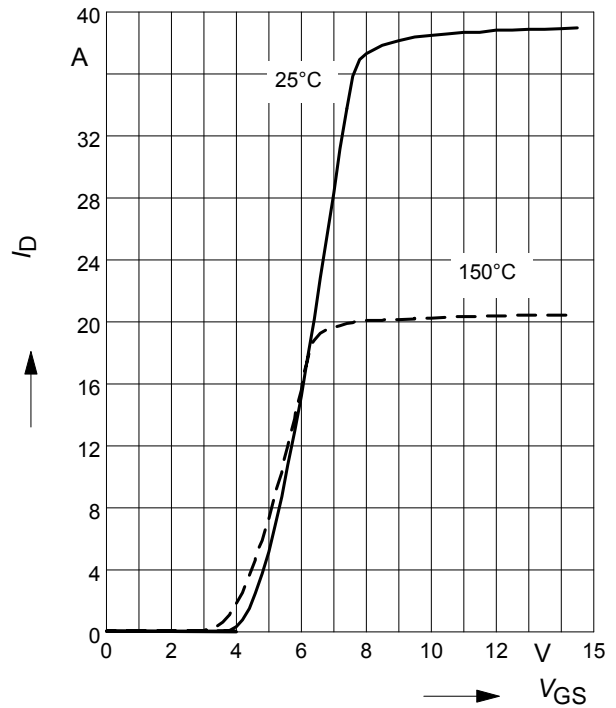
parameter: $I_D = 7 \text{ A}$, $V_{GS} = 10 \text{ V}$



10 Typ. transfer characteristics

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

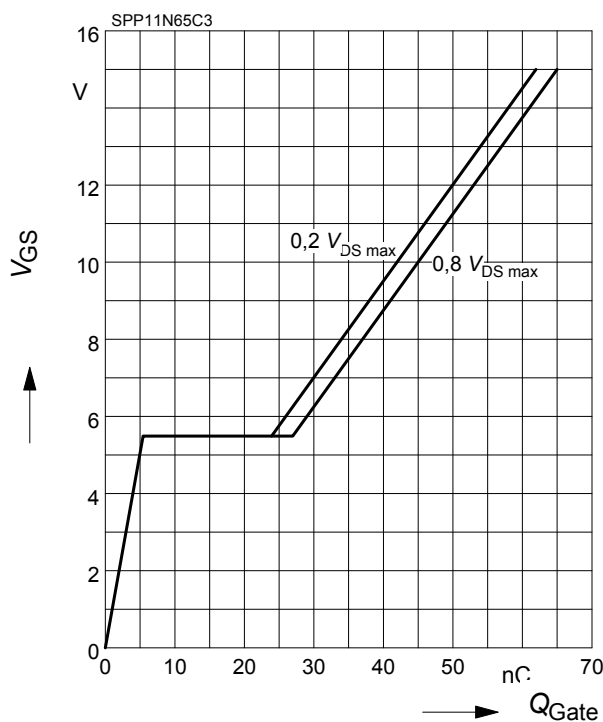
parameter: $t_p = 10 \mu\text{s}$



11 Typ. gate charge

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

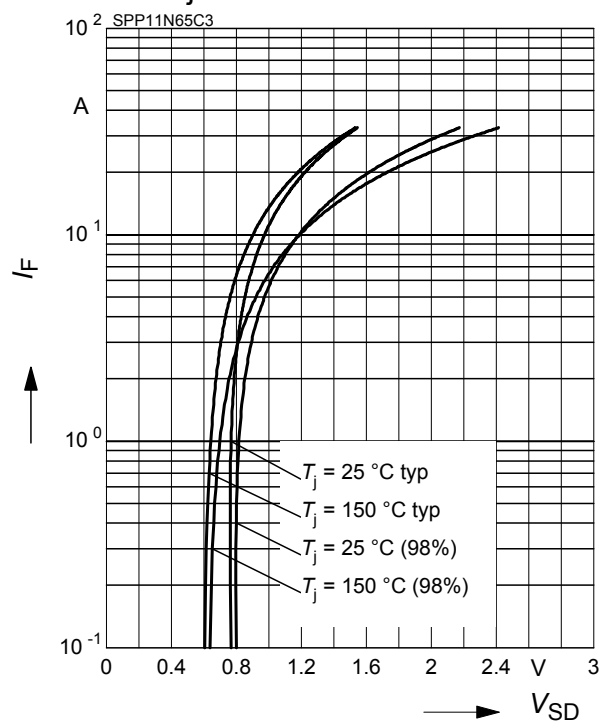
parameter: $I_D = 11 \text{ A pulsed}$



12 Forward characteristics of body diode

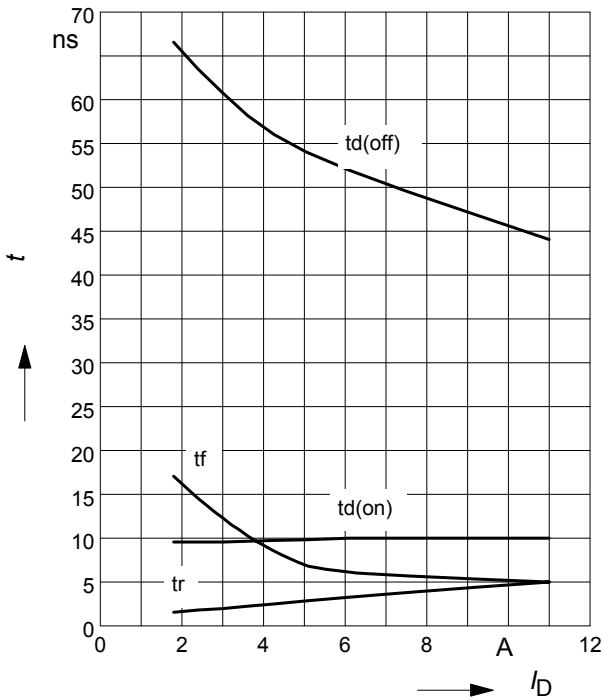
$$I_F = f(V_{SD})$$

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



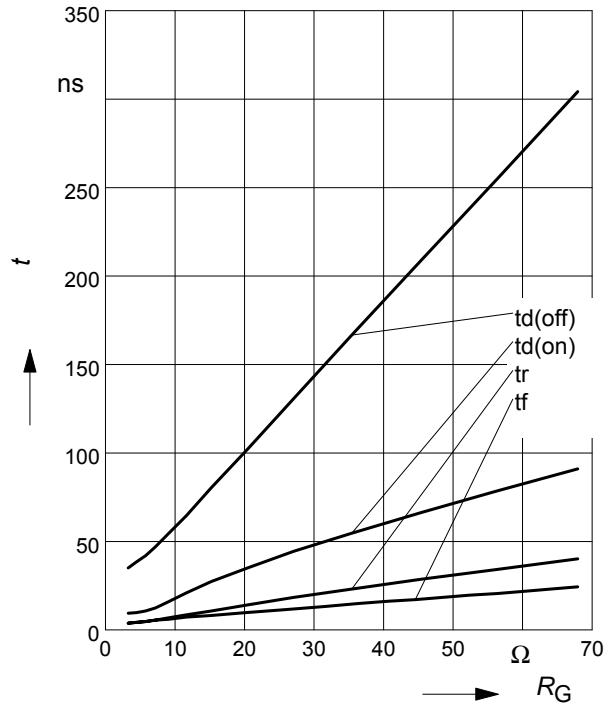
13 Typ. switching time

$t = f(I_D)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $R_G = 6.8\Omega$



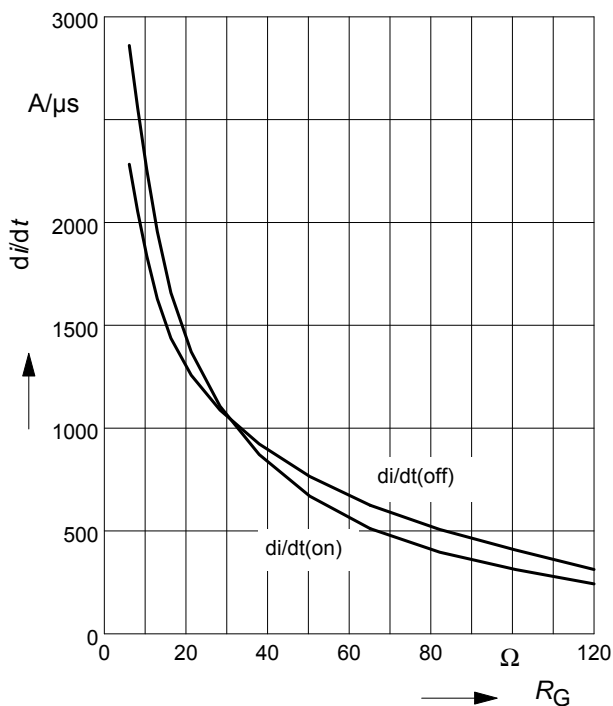
14 Typ. switching time

$t = f(R_G)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 11\text{ A}$



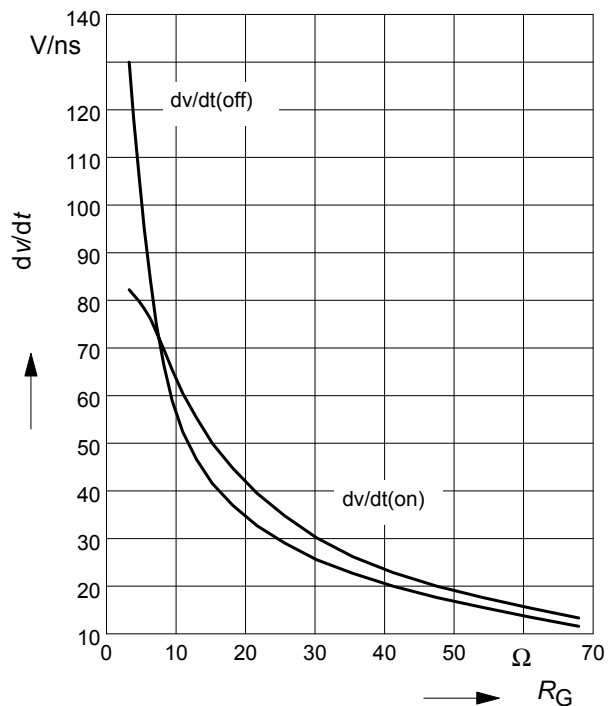
15 Typ. drain current slope

$di/dt = f(R_G)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 11\text{A}$



16 Typ. drain source voltage slope

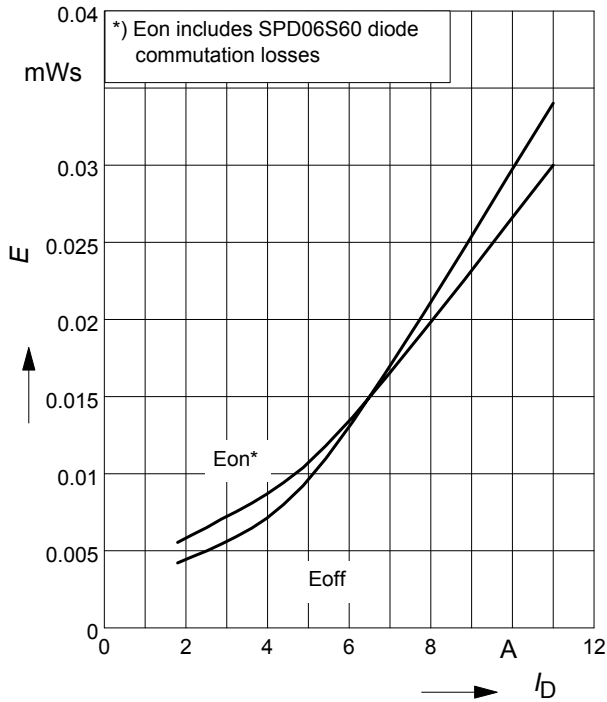
$dv/dt = f(R_G)$, inductive load, $T_j = 125^\circ\text{C}$
par.: $V_{DS} = 380\text{V}$, $V_{GS} = 0/+13\text{V}$, $I_D = 11\text{A}$



17 Typ. switching losses

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

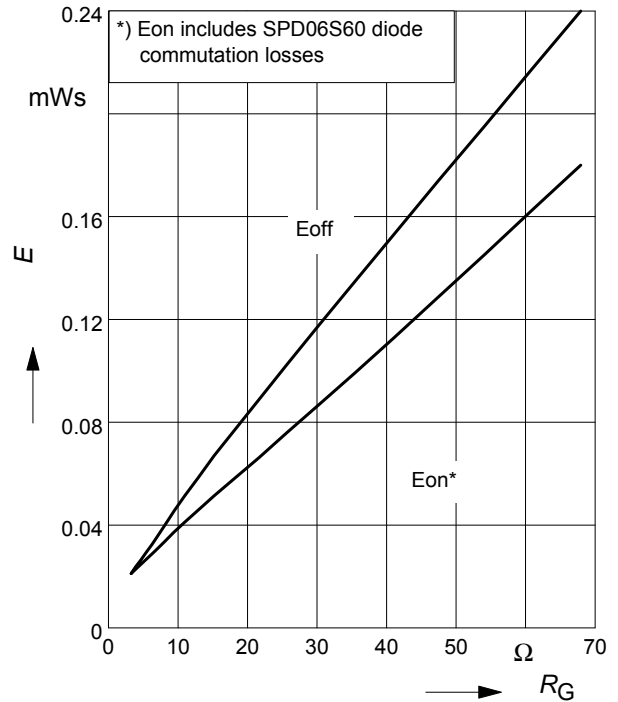
par.: $V_{DS}=380\text{V}$, $V_{GS}=0/+13\text{V}$, $R_G=6.8\Omega$



18 Typ. switching losses

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

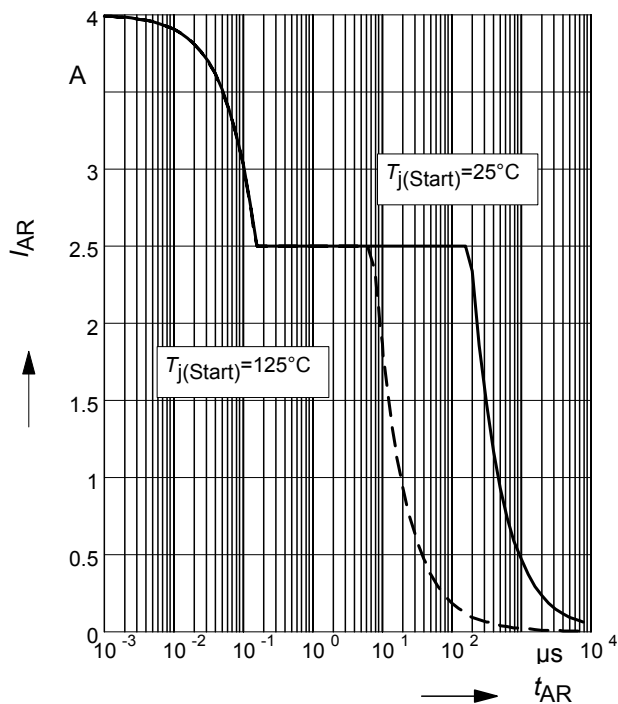
par.: $V_{DS}=380\text{V}$, $V_{GS}=0/+13\text{V}$, $I_D=11\text{A}$



19 Avalanche SOA

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

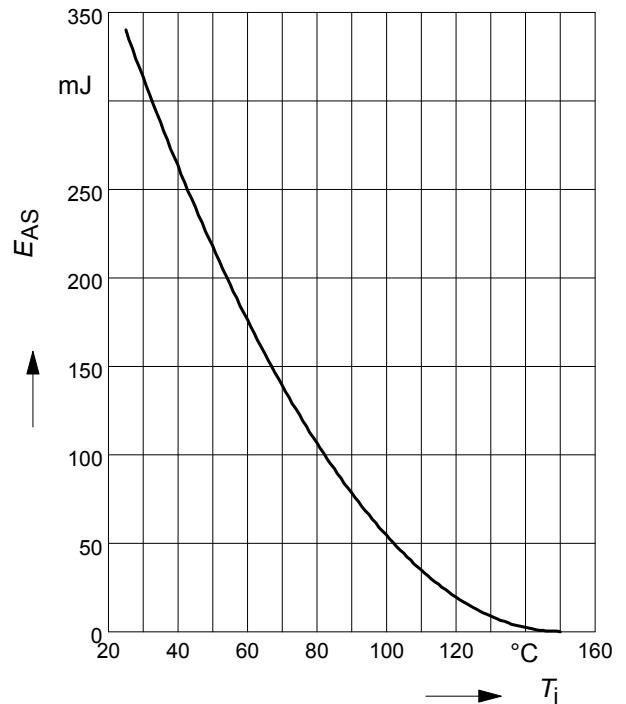
par.: $T_j \leq 150^\circ\text{C}$



20 Avalanche energy

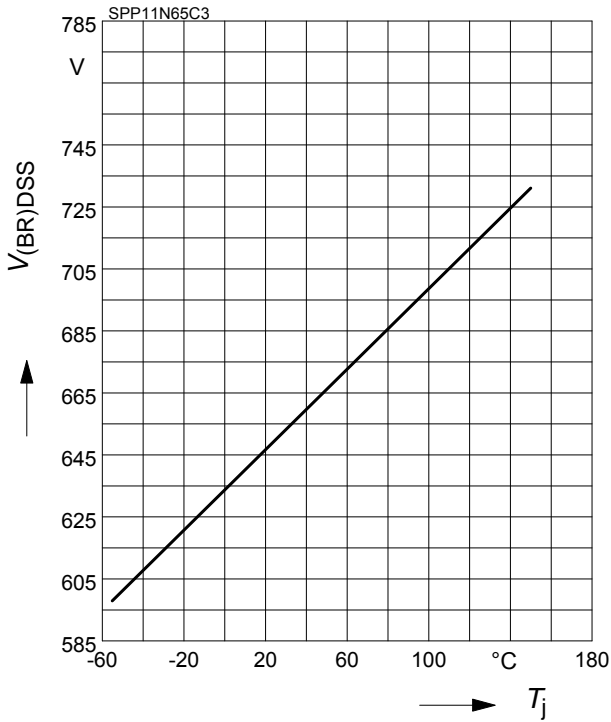
$E_{AS} = f(T_j)$

par.: $I_D = 2.5\text{A}$, $V_{DD} = 50\text{V}$



21 Drain-source breakdown voltage

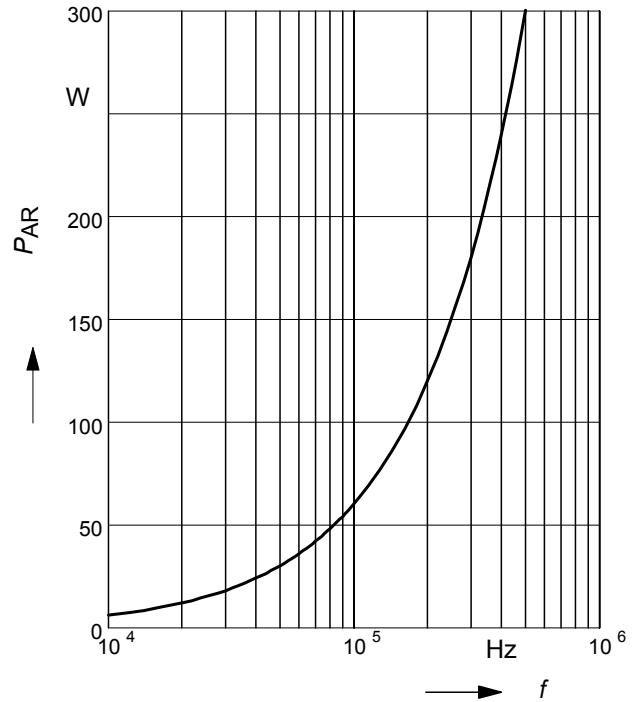
$$V_{(BR)DSS} = f(T_j)$$



22 Avalanche power losses

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

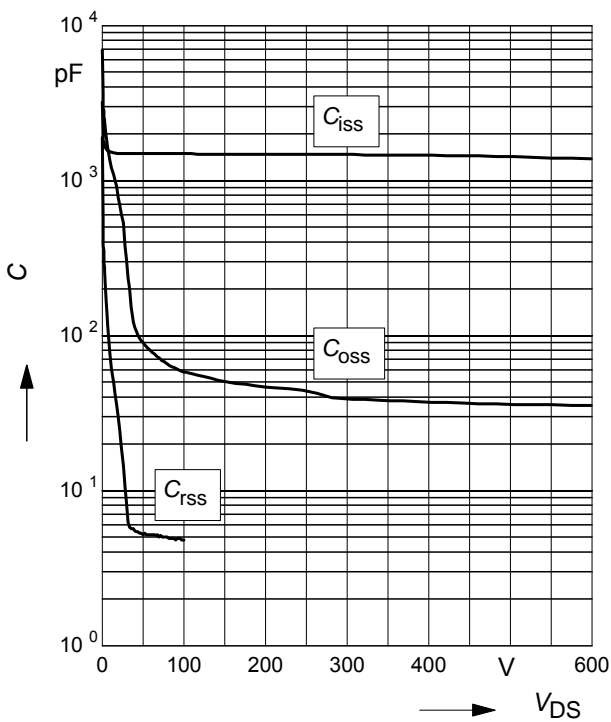
parameter: $E_{AR}=0.6mJ$



23 Typ. capacitances

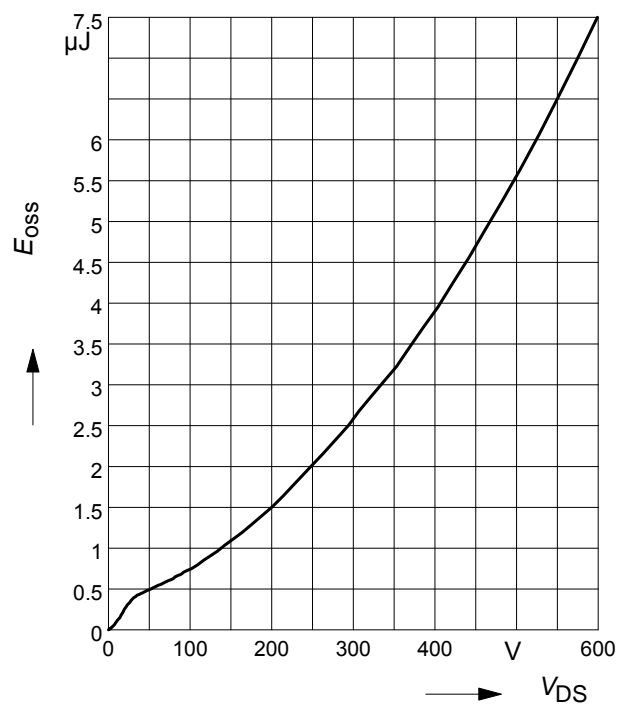
$$C = f(V_{DS})$$

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

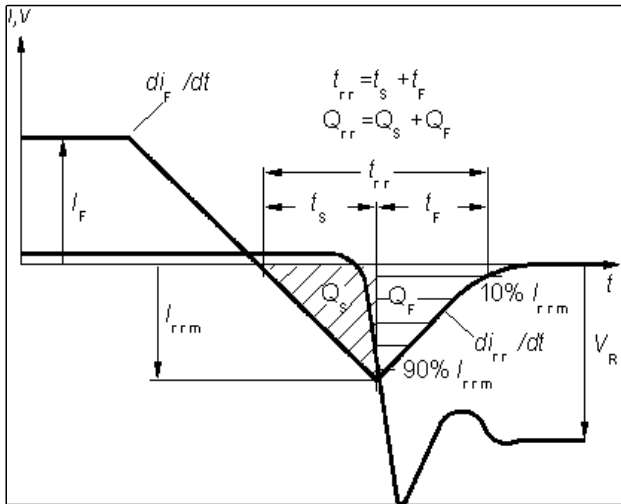


24 Typ. C_{oss} stored energy

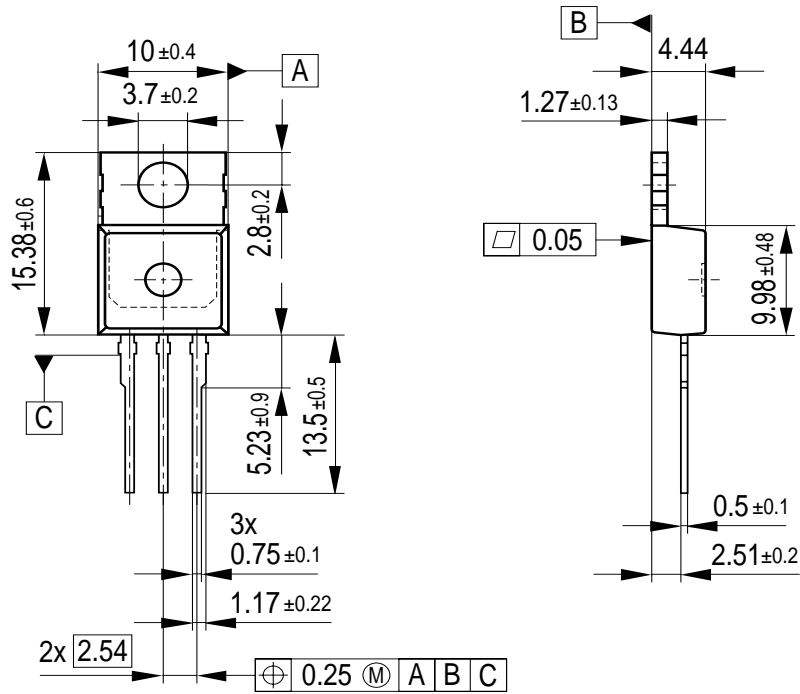
$$E_{oss} = f(V_{DS})$$



Definition of diodes switching characteristics



P-TO-220-3-1



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

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