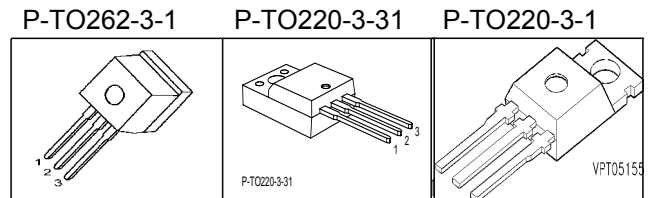


## Cool MOS™ Power Transistor

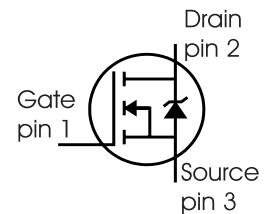
### Feature

- 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	$\Omega$
$I_D$	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 <sup>1)</sup> 7 <sup>1)</sup>	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 $T_{jmax}$ <sup>2)</sup> $I_D=4\text{A}$ , $V_{DD}=50\text{V}$	$E_{AR}$	0.6	0.6	
Avalanche current, repetitive $t_{AR}$ limited by $T_{jmax}$	$I_{AR}$	4	4	A
Gate source voltage	$V_{GS}$	$\pm 20$	$\pm 20$	V
Gate source voltage AC ( $f > 1\text{Hz}$ )	$V_{GS}$	$\pm 30$	$\pm 30$	
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 <sup>2</sup> cooling area <sup>3)</sup>	$R_{thJA}$	-	-	62	
		-	35	-	
Soldering temperature, 1.6 mm (0.063 in.) from case for 10s <sup>4)</sup>	$T_{sold}$	-	-	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 <sup>5)</sup>	-	-	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	$\mu\text{A}$
			-	-	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	$\Omega$
			-	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	$C_{iss}$	$V_{GS} = 0V$ , $V_{DS} = 25V$ , $f = 1MHz$	-	1200	-	pF
Output capacitance	$C_{oss}$		-	390	-	
Reverse transfer capacitance	$C_{rss}$		-	30	-	
Effective output capacitance, <sup>6)</sup> energy related	$C_{o(er)}$	$V_{GS} = 0V$ , $V_{DS} = 0V$ to 480V	-	45	-	
Effective output capacitance, <sup>7)</sup> time related	$C_{o(tr)}$		-	85	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380V$ , $V_{GS} = 0/10V$ , $I_D = 11A$ , $R_G = 6.8\Omega$	-	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**

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

<sup>1</sup>Limited only by maximum temperature

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

<sup>3</sup>Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70 μm thick) copper area for drain connection. PCB is vertical without blown air.

<sup>4</sup>Soldering temperature for TO-263: 220°C, reflow

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

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

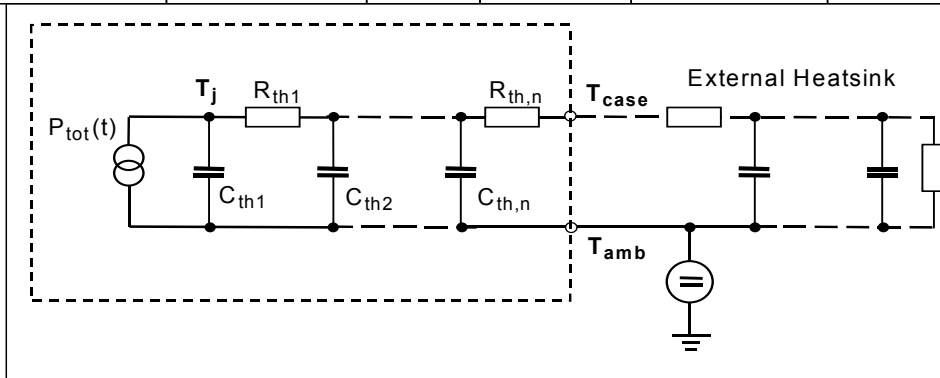
<sup>7</sup> $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

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

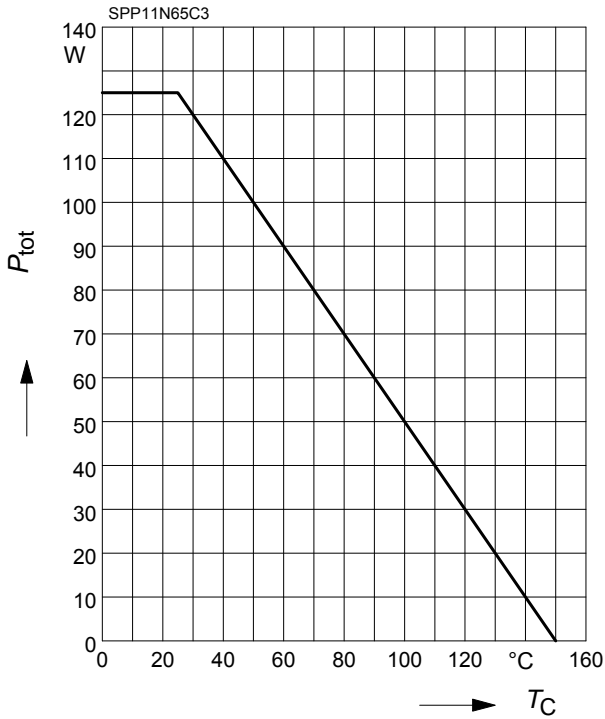
**Typical Transient Thermal Characteristics**

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	



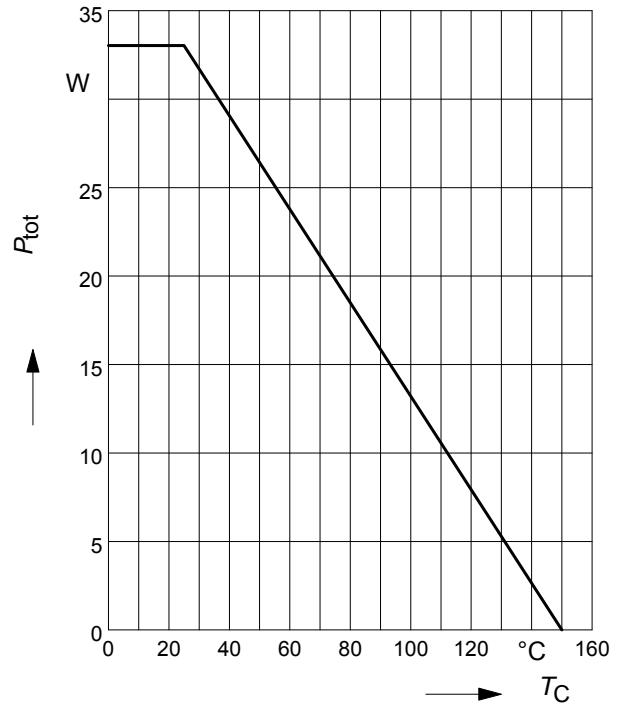
**1 Power dissipation**

$P_{tot} = f(T_C)$



**2 Power dissipation FullPAK**

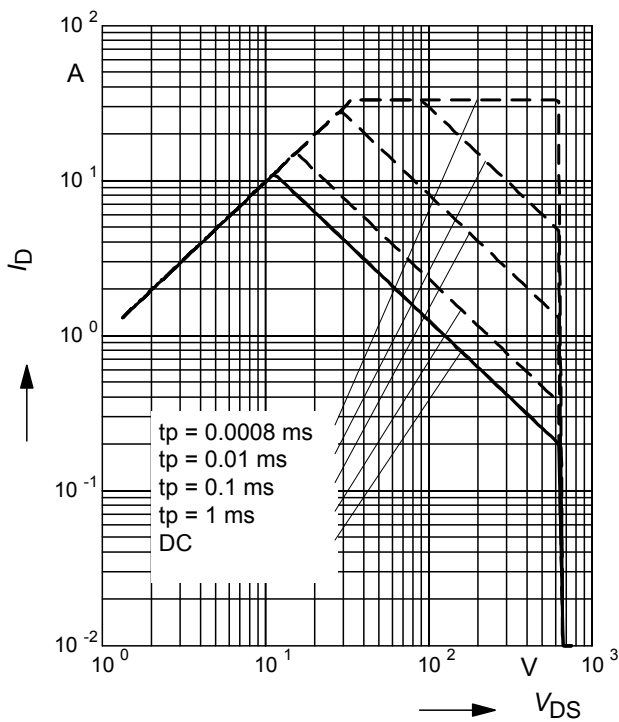
$P_{tot} = f(T_C)$



**3 Safe operating area**

$I_D = f(V_{DS})$

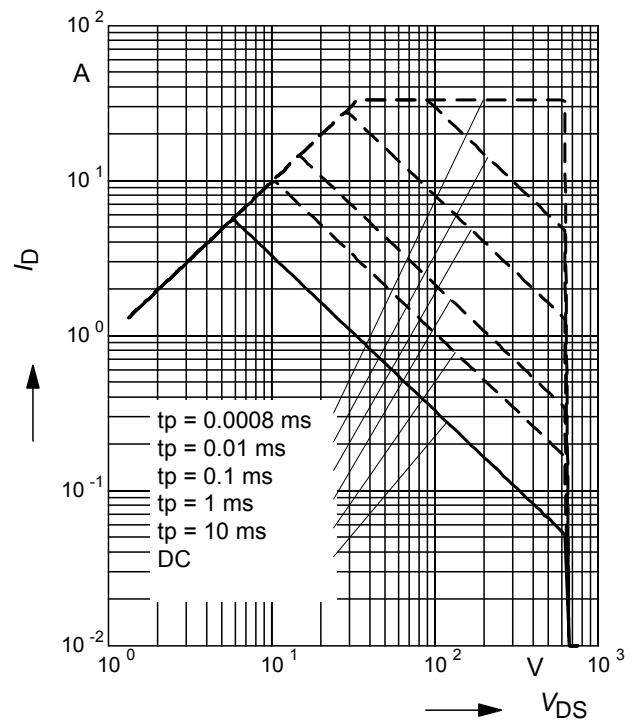
parameter :  $D = 0$  ,  $T_C = 25^\circ\text{C}$



**4 Safe operating area FullPAK**

$I_D = f(V_{DS})$

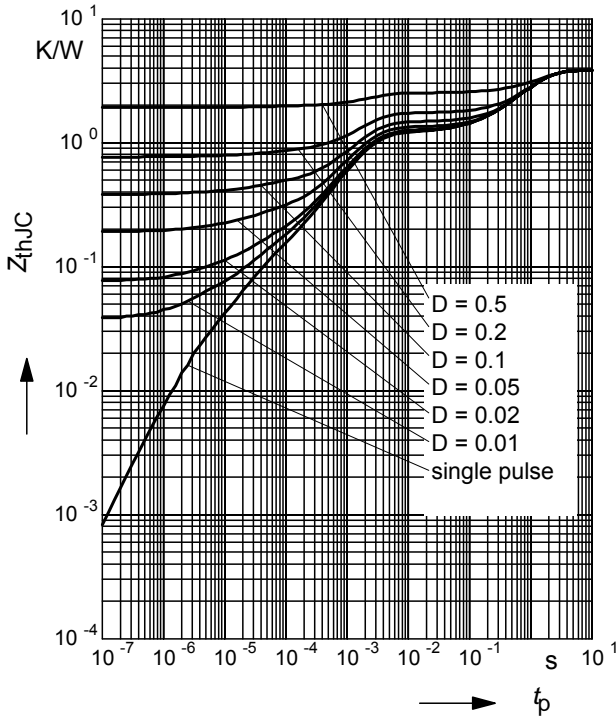
parameter:  $D = 0$  ,  $T_C = 25^\circ\text{C}$



**5 Transient thermal impedance FullPAK**

$Z_{thJC} = f(t_p)$

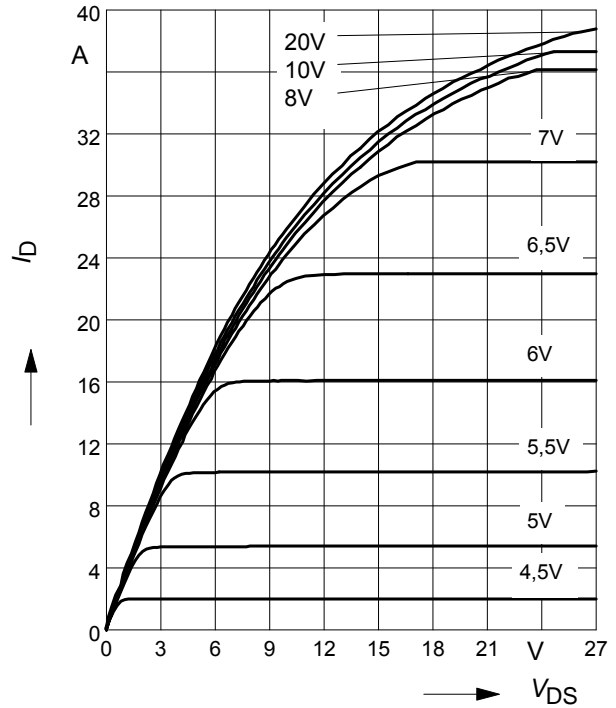
parameter:  $D = t_p/t$



**6 Typ. output characteristic**

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

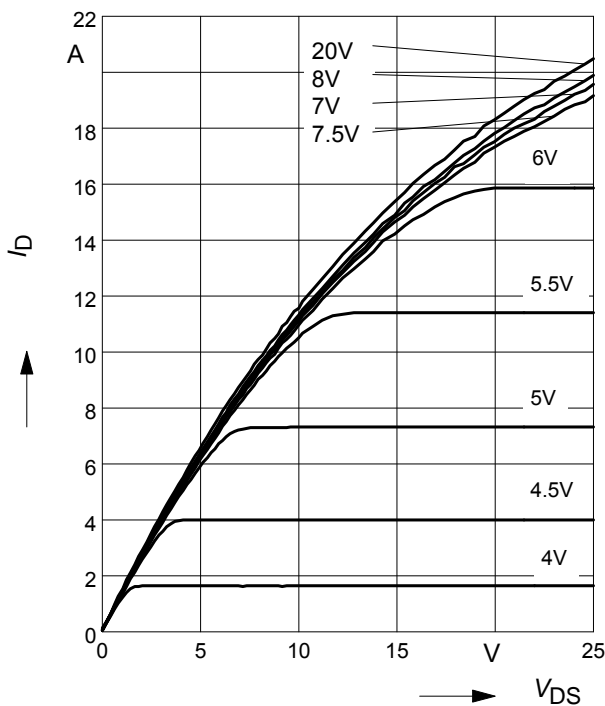
parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



**7 Typ. output characteristic**

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

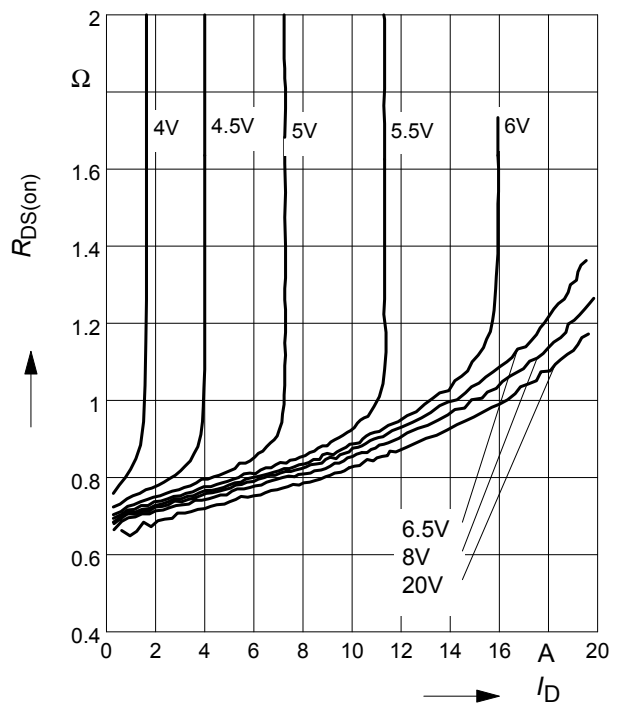
parameter:  $t_p = 10 \mu\text{s}, V_{GS}$



**8 Typ. drain-source on resistance**

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

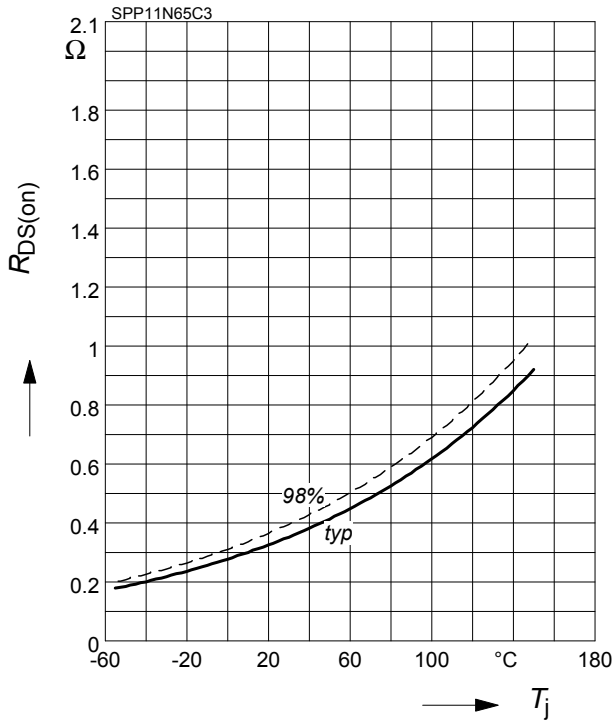
parameter:  $T_j=150^\circ\text{C}, V_{GS}$



**9 Drain-source on-state resistance**

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

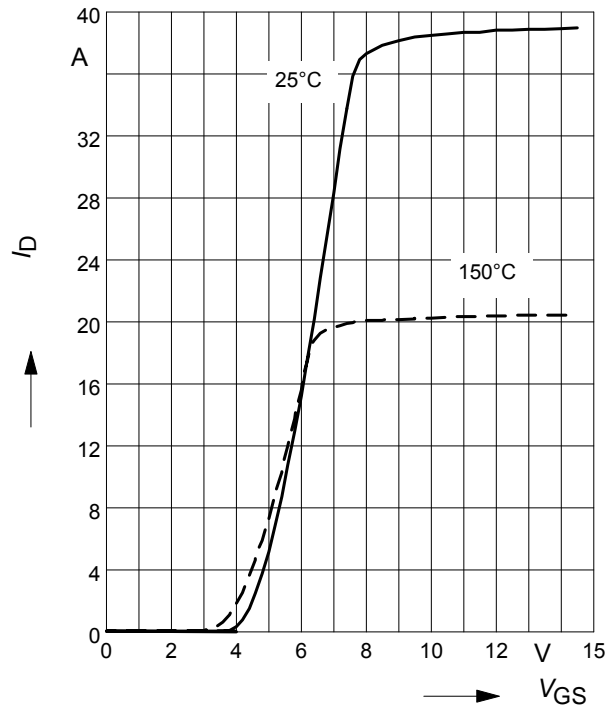
parameter:  $I_D = 7\text{ A}$ ,  $V_{GS} = 10\text{ V}$



**10 Typ. transfer characteristics**

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

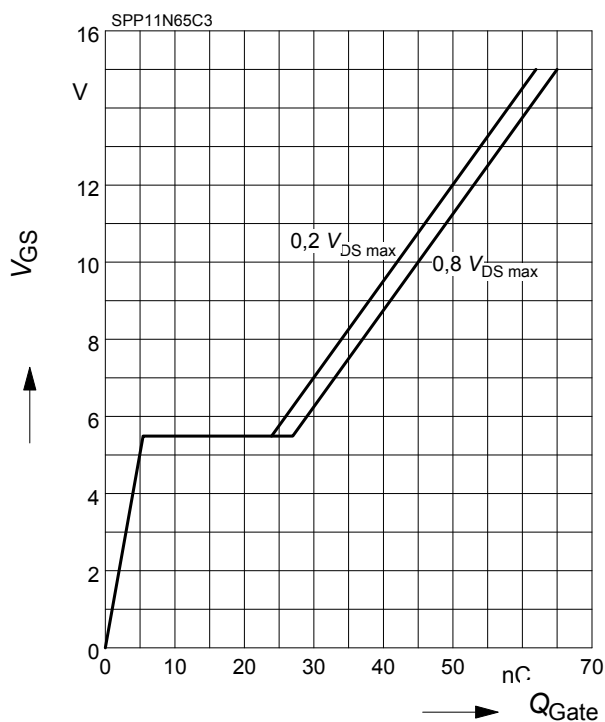
parameter:  $t_p = 10\text{ }\mu\text{s}$



**11 Typ. gate charge**

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

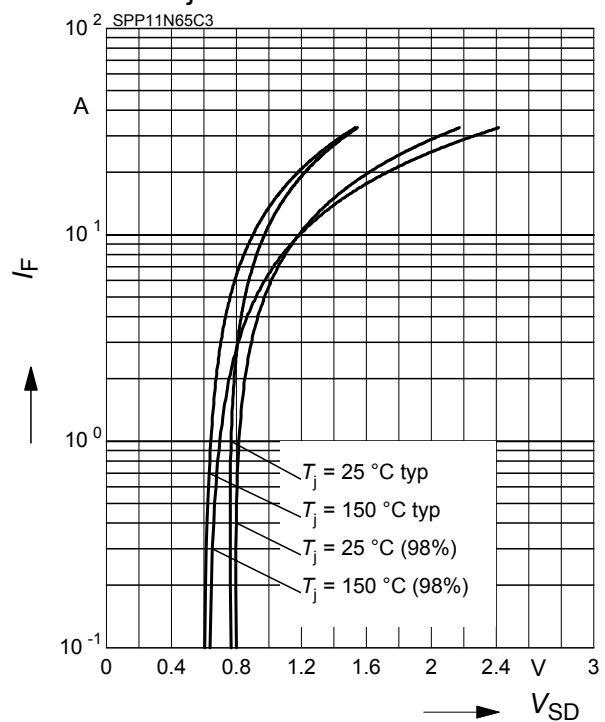
parameter:  $I_D = 11\text{ A}$  pulsed



**12 Forward characteristics of body diode**

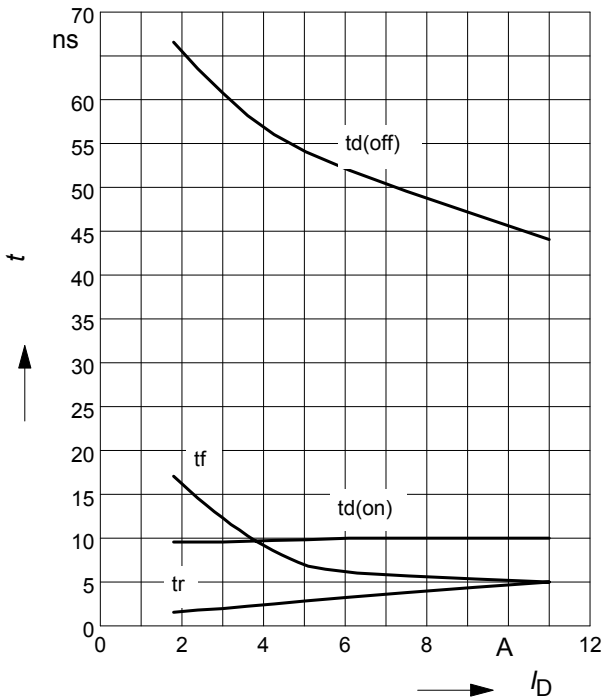
$$I_F = f(V_{SD})$$

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



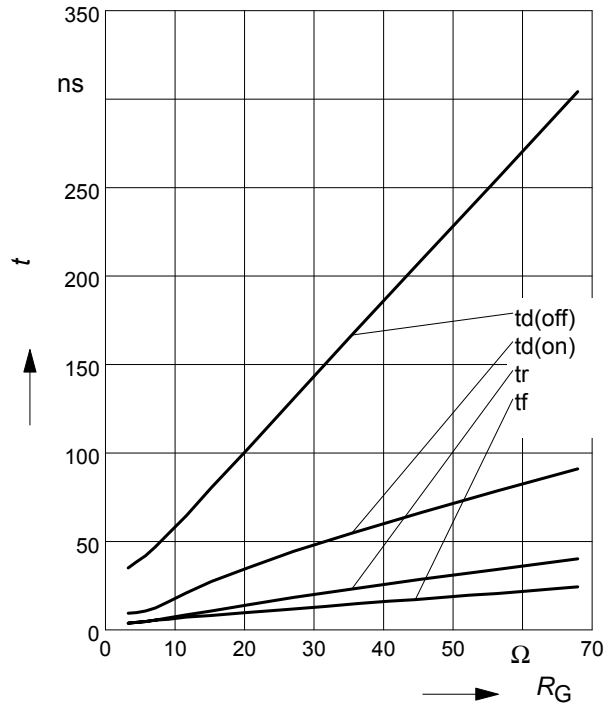
**13 Typ. switching time**

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



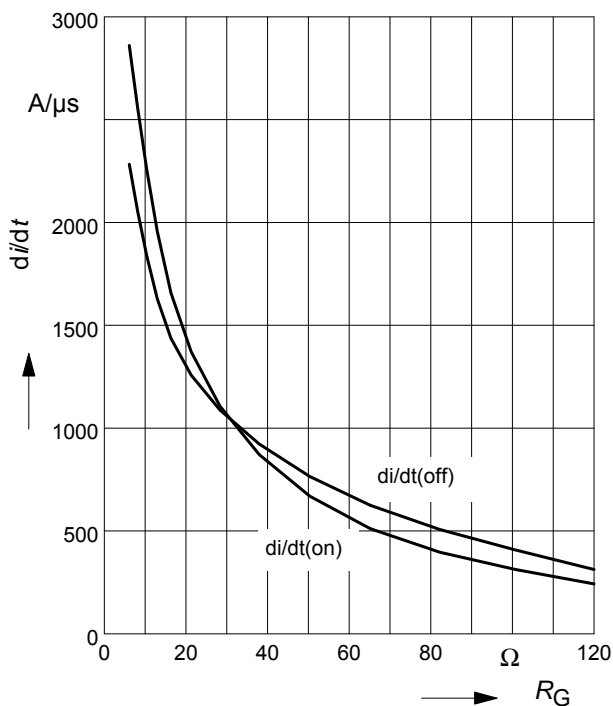
**14 Typ. switching time**

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



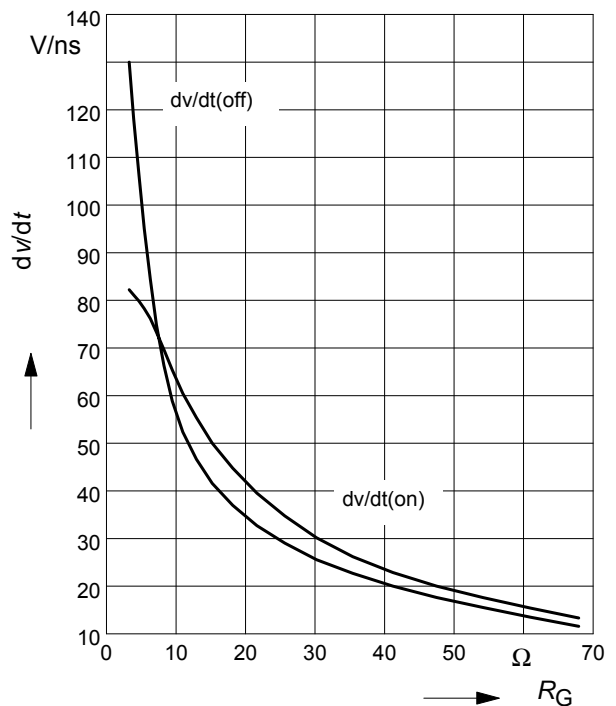
**15 Typ. drain current slope**

$di/dt = f(R_G)$ , 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.:  $V_{DS} = 380\text{V}$ ,  $V_{GS} = 0/+13\text{V}$ ,  $I_D = 11\text{A}$

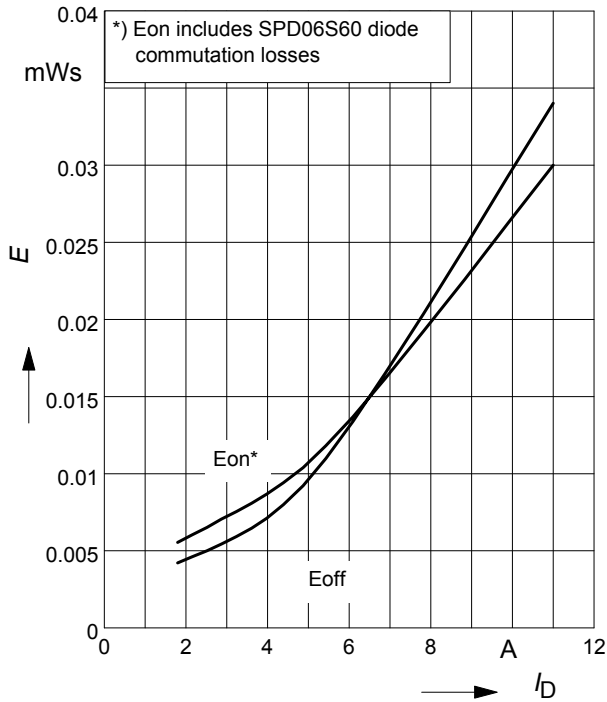




**17 Typ. switching losses**

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

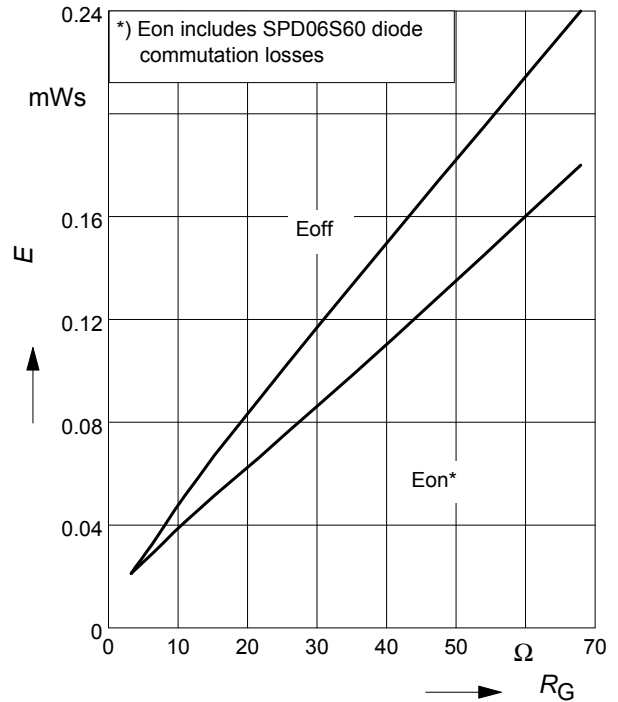
par.:  $V_{DS}=380\text{V}$ ,  $V_{GS}=0/+13\text{V}$ ,  $R_G=6.8\Omega$



**18 Typ. switching losses**

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

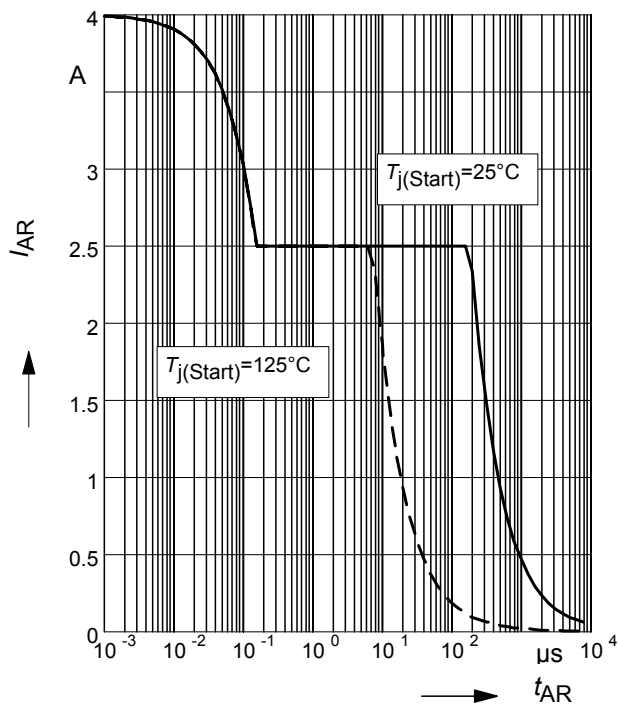
par.:  $V_{DS}=380\text{V}$ ,  $V_{GS}=0/+13\text{V}$ ,  $I_D=11\text{A}$



**19 Avalanche SOA**

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

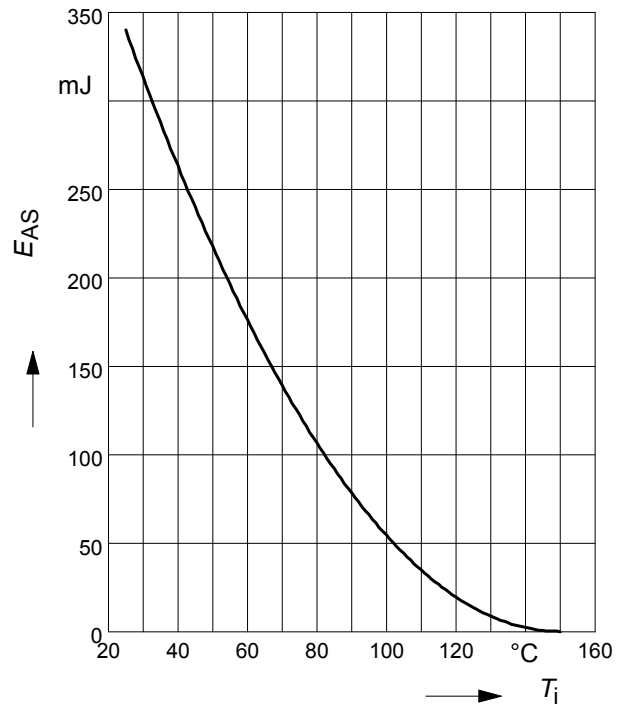
par.:  $T_j \leq 150^\circ\text{C}$



**20 Avalanche energy**

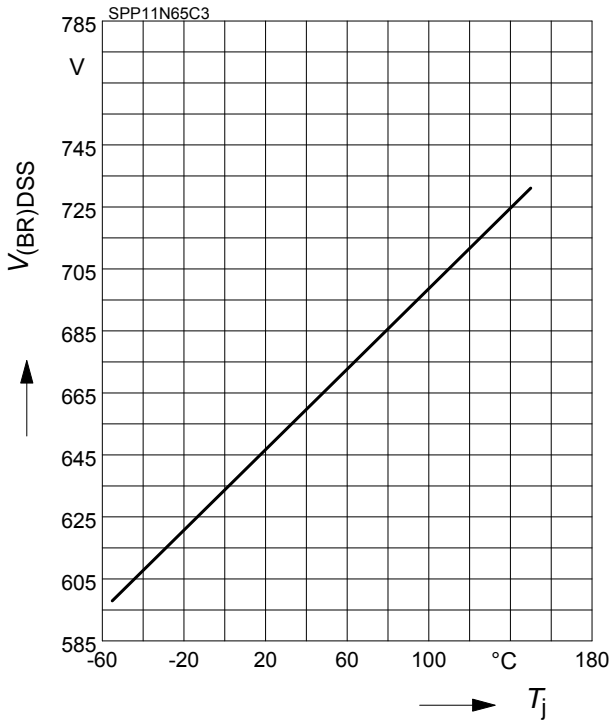
$E_{AS} = f(T_j)$

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



**21 Drain-source breakdown voltage**

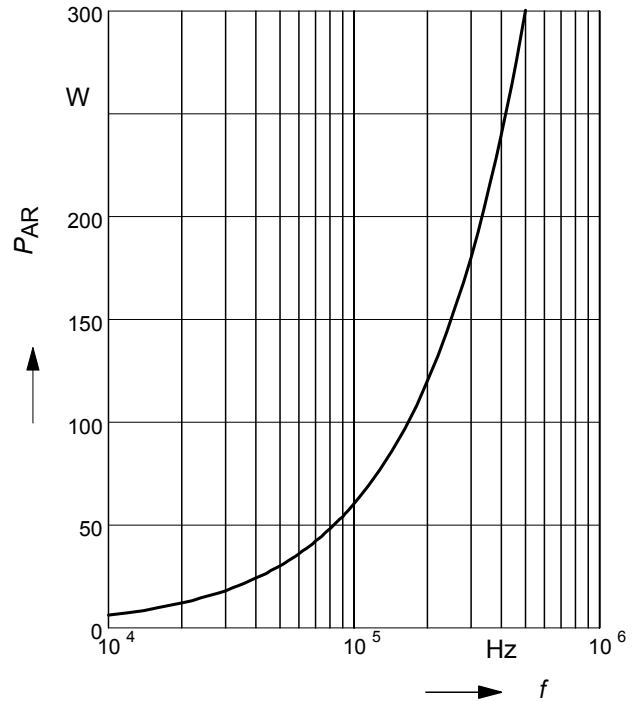
$$V_{(BR)DSS} = f(T_j)$$



**22 Avalanche power losses**

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

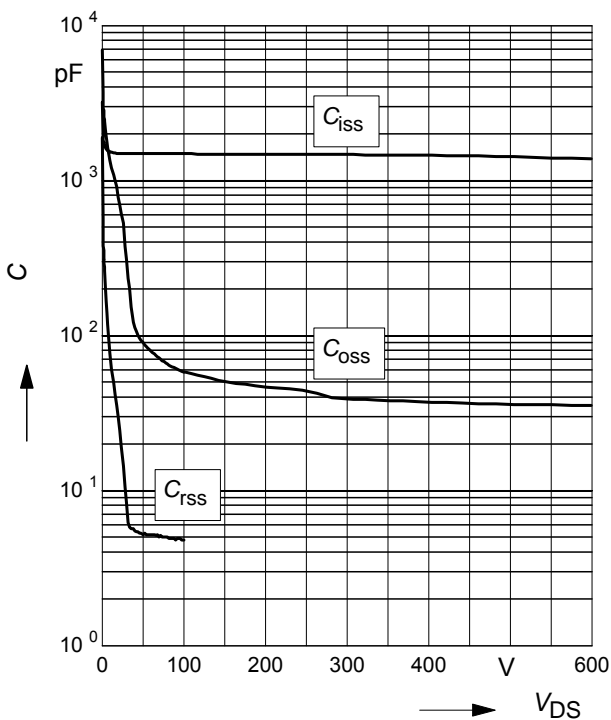
parameter:  $E_{AR}=0.6mJ$



**23 Typ. capacitances**

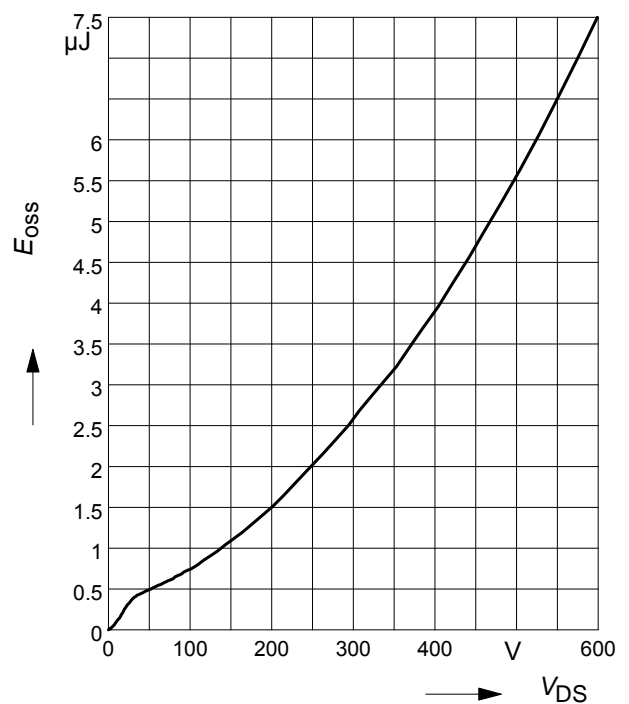
$$C = f(V_{DS})$$

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

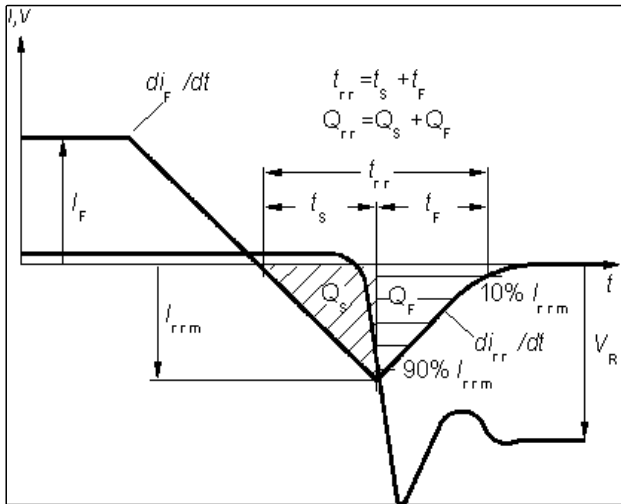


**24 Typ.  $C_{oss}$  stored energy**

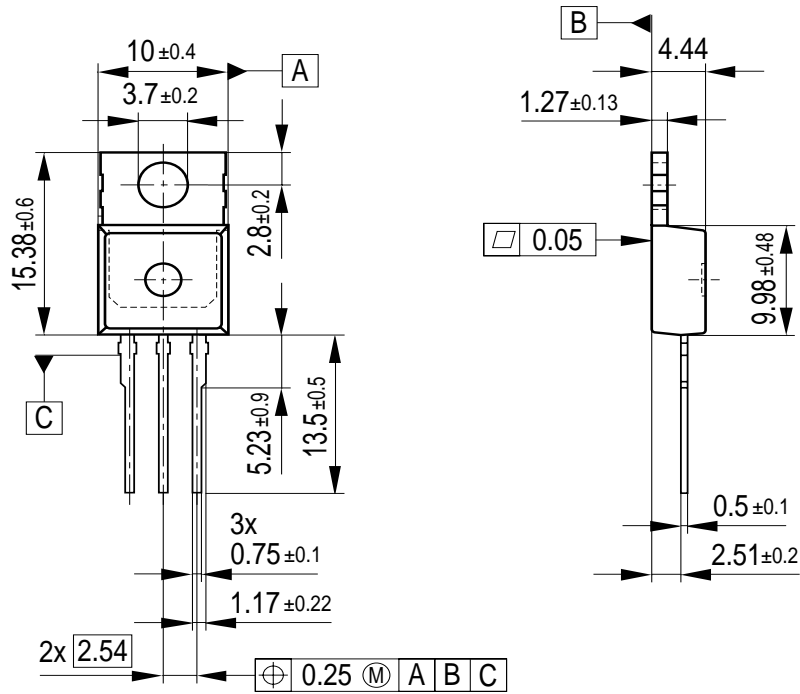
$$E_{oss} = f(V_{DS})$$



Definition of diodes switching characteristics

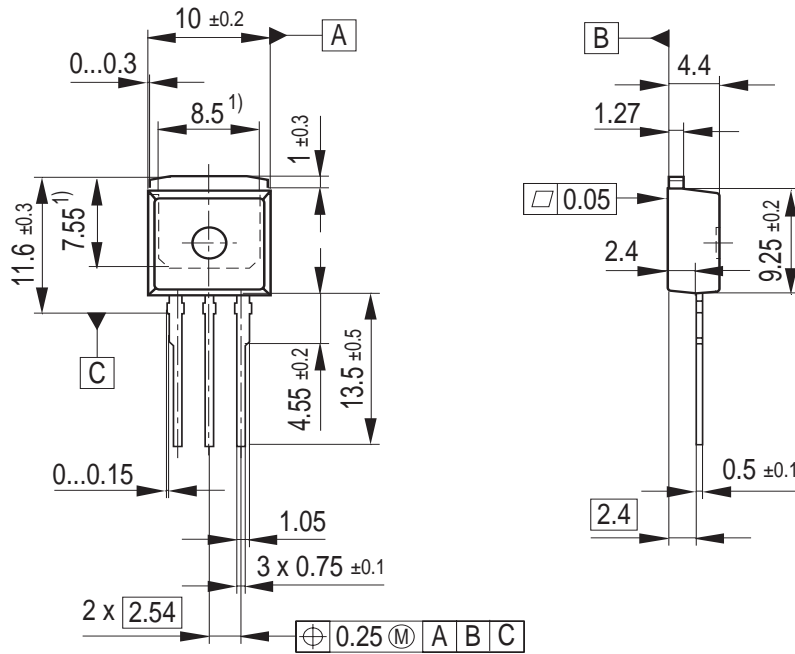


P-TO-220-3-1



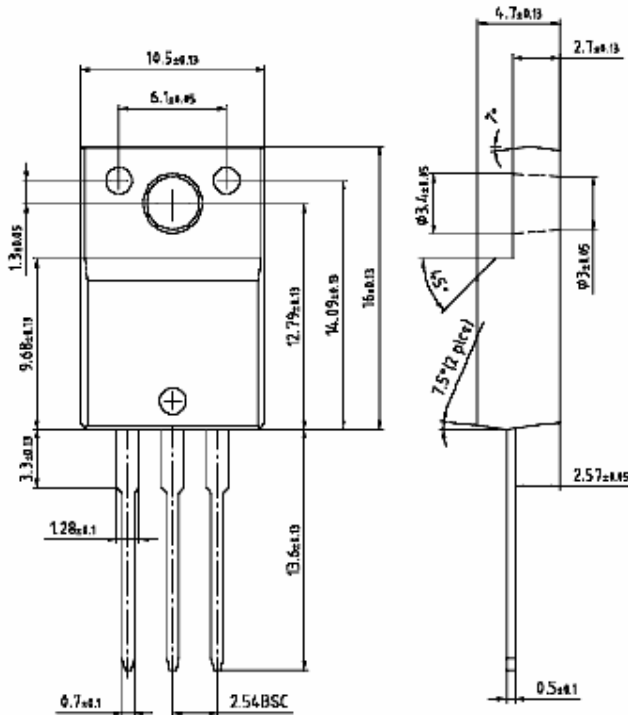
All metal surfaces tin plated, except area of cut.  
Metal surface min.  $x=7.25$ ,  $y=12.3$

P-TO-262-3-1 (I<sup>2</sup>-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)

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