

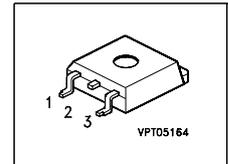
Cool MOS™ Power Transistor

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

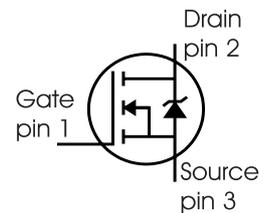
Feature

- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- High peak current capability
- Improved transconductance
- Qualified according to JEDEC⁰⁾ for target applications

PG-TO263



Type	Package	Ordering Code	Marking
SPB20N60C3	PG-TO263	Q67040-S4397	20N60C3


Maximum Ratings

Parameter	Symbol	Value		Unit
		SPB		
Continuous drain current $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$	I_D	20.7 13.1		A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\text{ puls}}$	62.1		A
Avalanche energy, single pulse $I_D=10A, V_{DD}=50V$	E_{AS}	690		mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ²⁾ $I_D=20A, V_{DD}=50V$	E_{AR}	1		
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	20		A
Gate source voltage static	V_{GS}	± 20		V
Gate source voltage AC ($f > 1\text{Hz}$)	V_{GS}	± 30		
Power dissipation, $T_C = 25\text{ °C}$	P_{tot}	208		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 $V_{DS} = 480\text{ V}$, $I_D = 20.7\text{ A}$, $T_j = 125\text{ °C}$	dv/dt	50	V/ns

Thermal Characteristics

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Thermal resistance, junction - case	R_{thJC}	-	-	0.6	K/W
		-	-		
Thermal resistance, junction - ambient, leaded	R_{thJA}	-	-	62	°C
		-	-		
SMD version, device on PCB: @ min. footprint @ 6 cm ² cooling area ³⁾	R_{thJA}	-	-	62	
		-	35	-	
Soldering temperature, reflow soldering, MSL1	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	$V_{(BR)DSS}$	$V_{GS}=0\text{V}$, $I_D=0.25\text{mA}$	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}	$V_{DS}=600\text{V}$, $V_{GS}=0\text{V}$, $T_j=25\text{ °C}$ $T_j=150\text{ °C}$	-	0.1	1	μA
			-	-	100	
Gate-source leakage current	I_{GSS}	$V_{GS}=30\text{V}$, $V_{DS}=0\text{V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=13.1\text{A}$, $T_j=25\text{ °C}$ $T_j=150\text{ °C}$	-	0.16	0.19	Ω
			-	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}	$V_{GS} = 0V$, $V_{DS} = 25V$,	-	2400	-	pF
Output capacitance	C_{oss}	$f = 1MHz$	-	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	$V_{DD} = 380V$, $V_{GS} = 0/13V$,	-	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.

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 $I_{SD} \leq I_D$, $di/dt \leq 400A/us$, $V_{DClink} = 400V$, $V_{peak} < V_{BR, DSS}$, $T_j < T_{j,max}$.

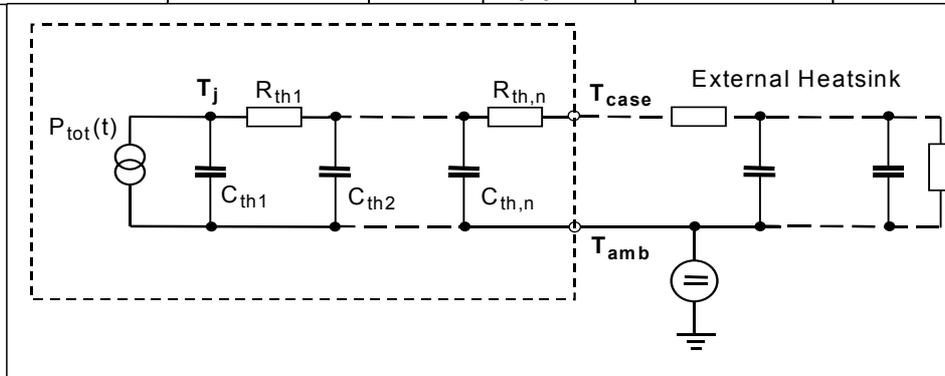
Identical low-side and high-side switch.

Electrical Characteristics

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	I_S	$T_C=25^\circ\text{C}$	-	-	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	-	$\text{A}/\mu\text{s}$

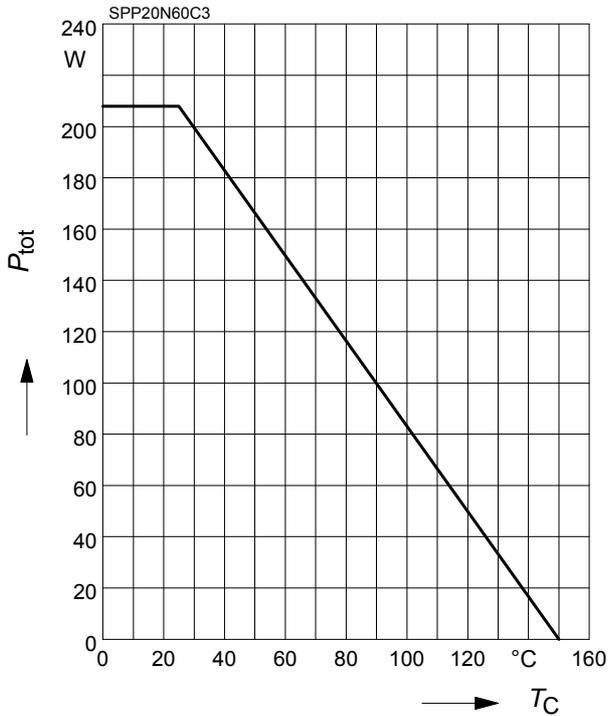
Typical Transient Thermal Characteristics

Symbol	Value		Unit	Symbol	Value		Unit
	SPB				SPB		
R_{th1}	0.00769		K/W	C_{th1}	0.0003763		Ws/K
R_{th2}	0.015			C_{th2}	0.001411		
R_{th3}	0.029			C_{th3}	0.001931		
R_{th4}	0.114			C_{th4}	0.005297		
R_{th5}	0.136			C_{th5}	0.012		
R_{th6}	0.059			C_{th6}	0.091		



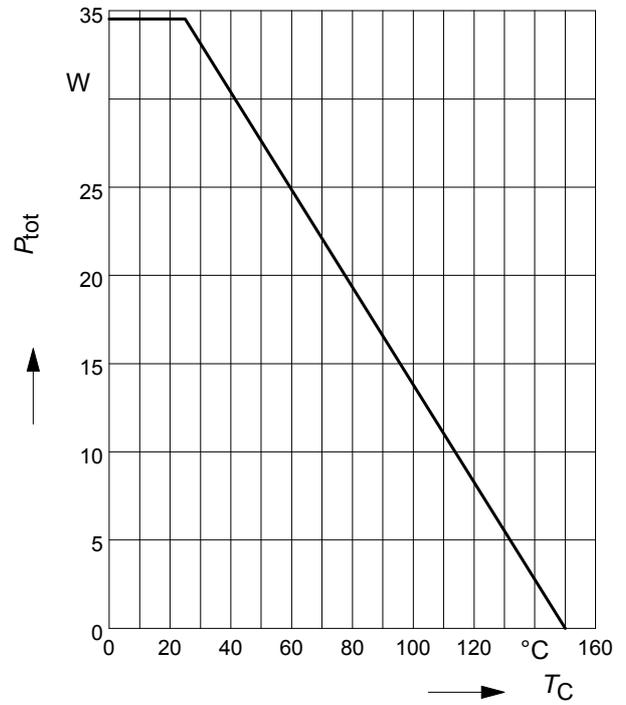
1 Power dissipation

$P_{tot} = f(T_C)$



2 Power dissipation FullPAK

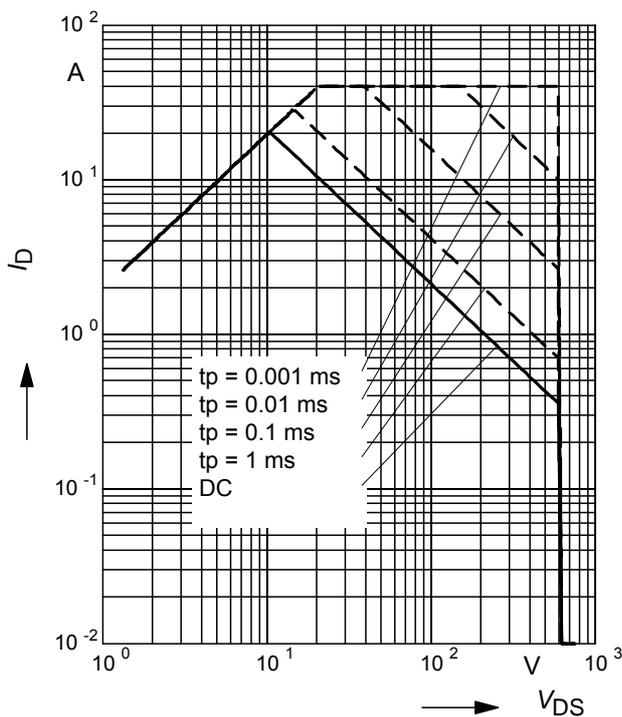
$P_{tot} = f(T_C)$



3 Safe operating area

$I_D = f(V_{DS})$

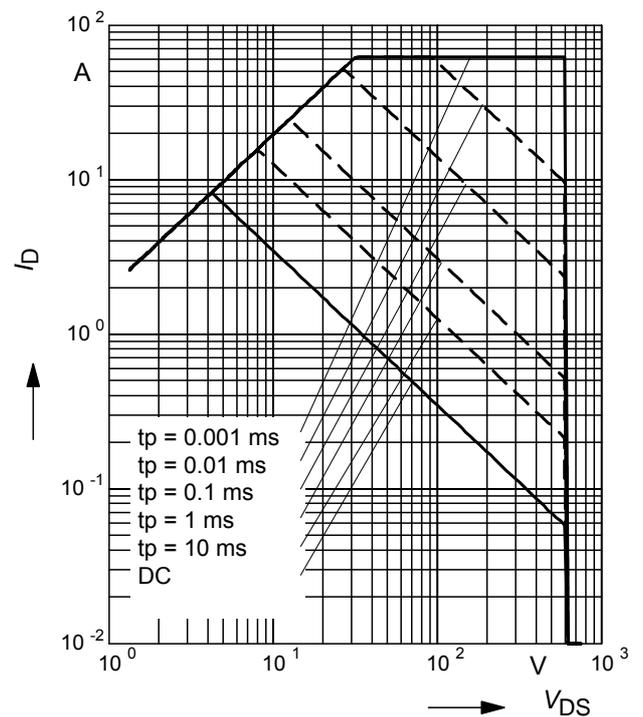
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



4 Safe operating area FullPAK

$I_D = f(V_{DS})$

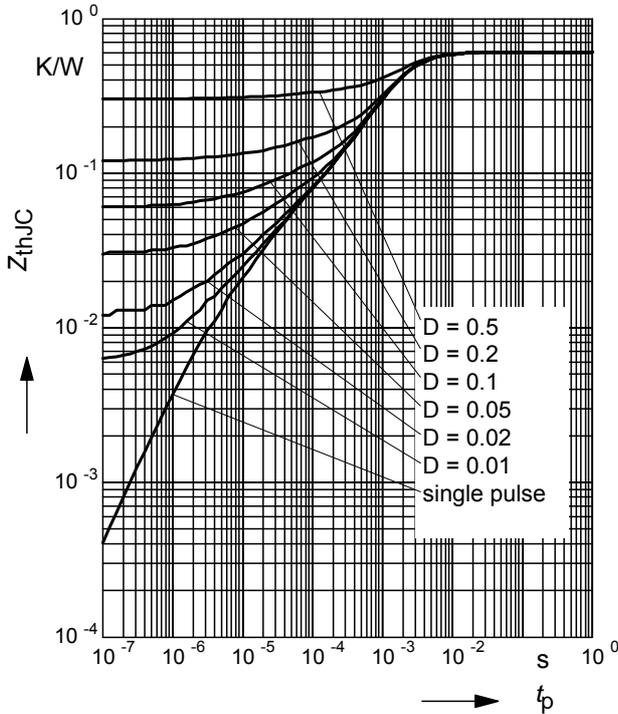
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



5 Transient thermal impedance

$Z_{thJC} = f(t_p)$

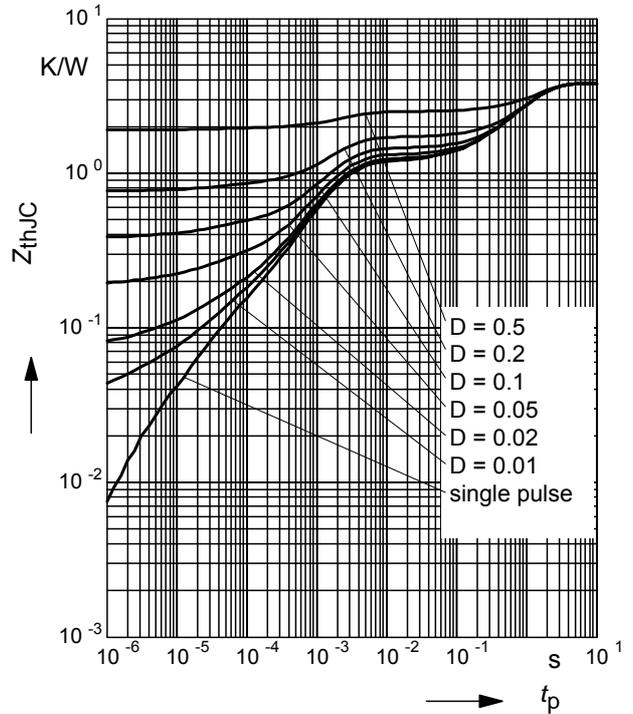
parameter: $D = t_p/T$



6 Transient thermal impedance FullPAK

$Z_{thJC} = f(t_p)$

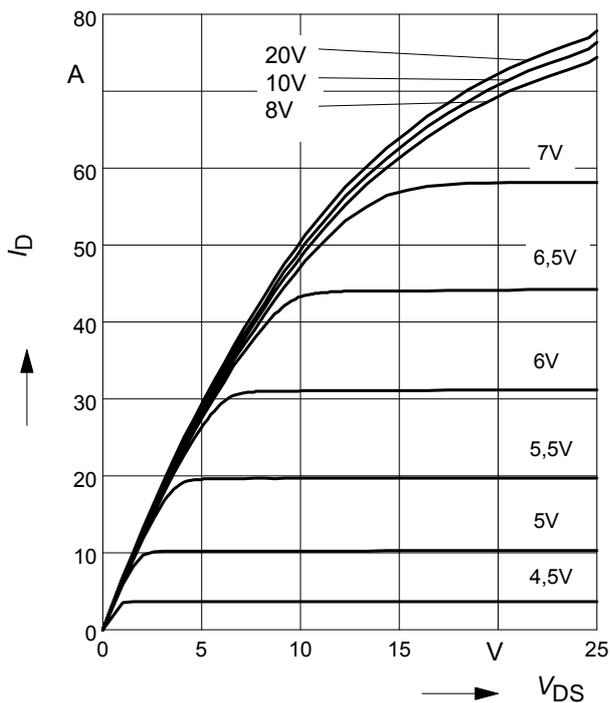
parameter: $D = t_p/t$



7 Typ. output characteristic

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

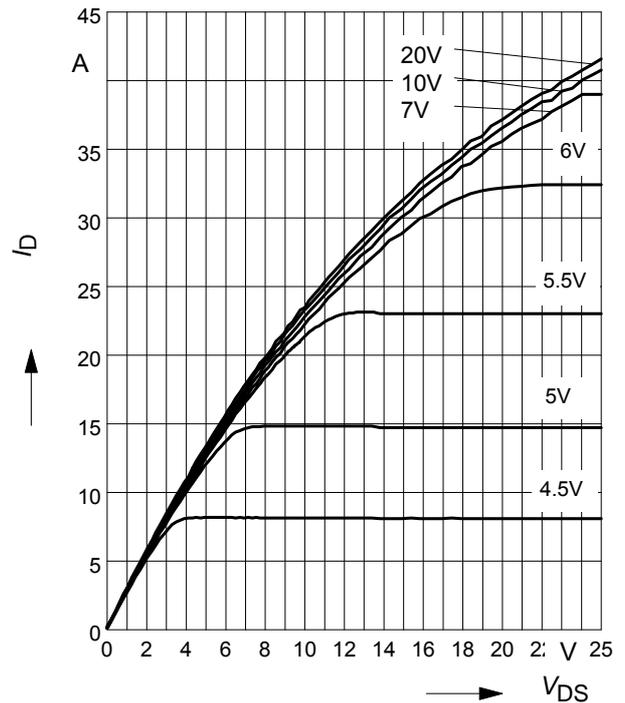
parameter: $t_p = 10 \mu s, V_{GS}$



8 Typ. output characteristic

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

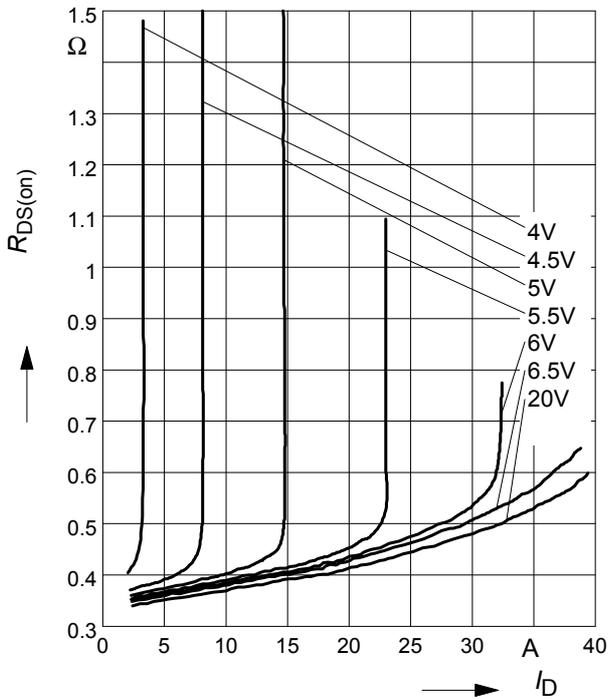
parameter: $t_p = 10 \mu s, V_{GS}$



9 Typ. drain-source on resistance

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

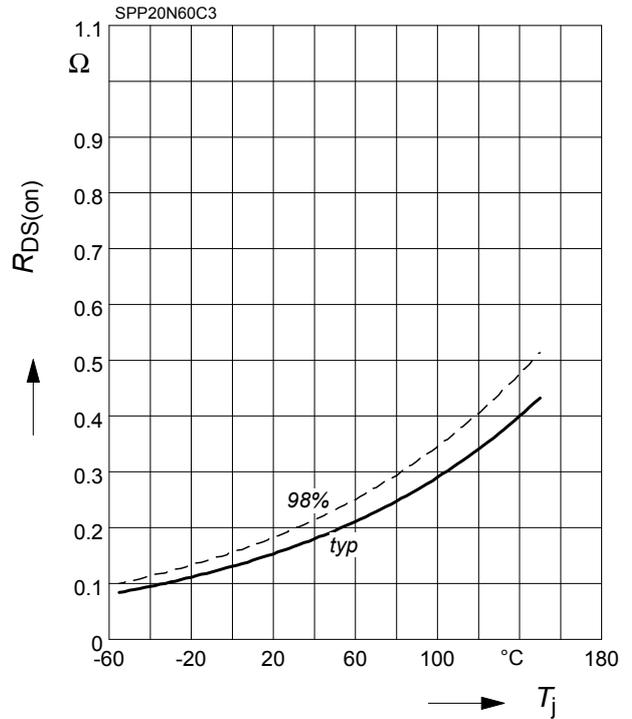
parameter: $T_j = 150^\circ\text{C}$, V_{GS}



10 Drain-source on-state resistance

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

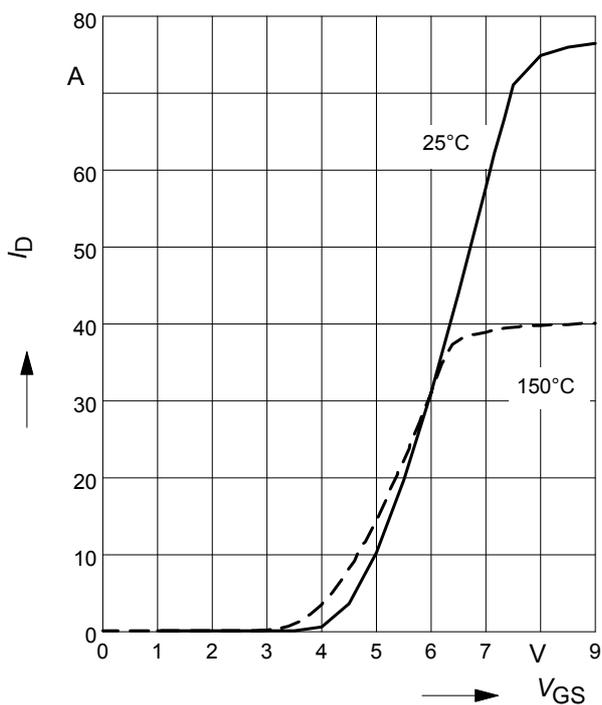
parameter: $I_D = 13.1\text{ A}$, $V_{GS} = 10\text{ V}$



11 Typ. transfer characteristics

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

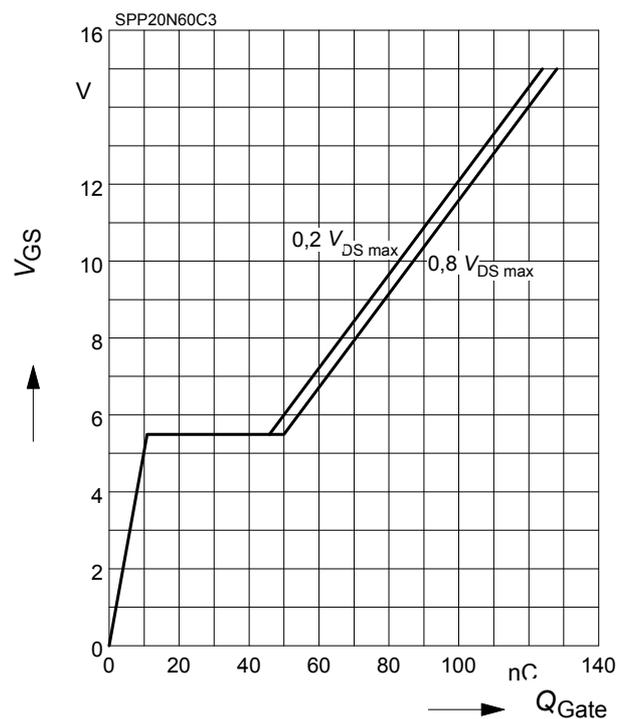
parameter: $t_p = 10\ \mu\text{s}$



12 Typ. gate charge

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

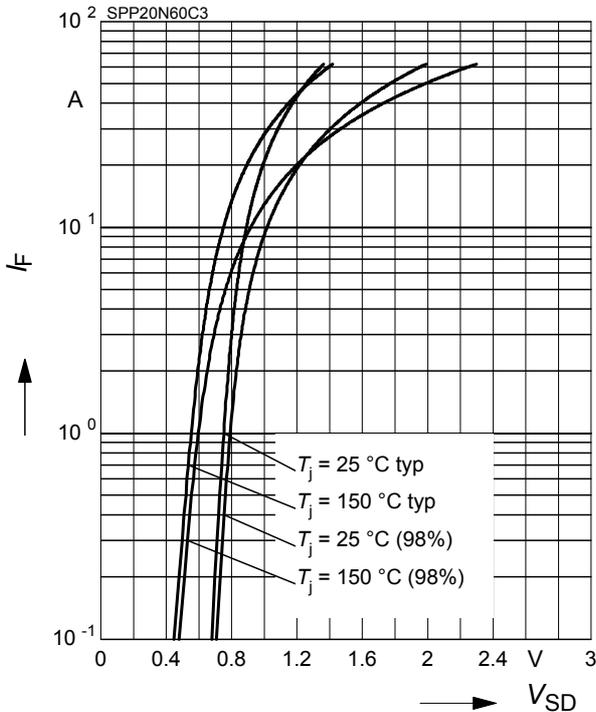
parameter: $I_D = 20.7\text{ A pulsed}$



13 Forward characteristics of body diode

$I_F = f(V_{SD})$

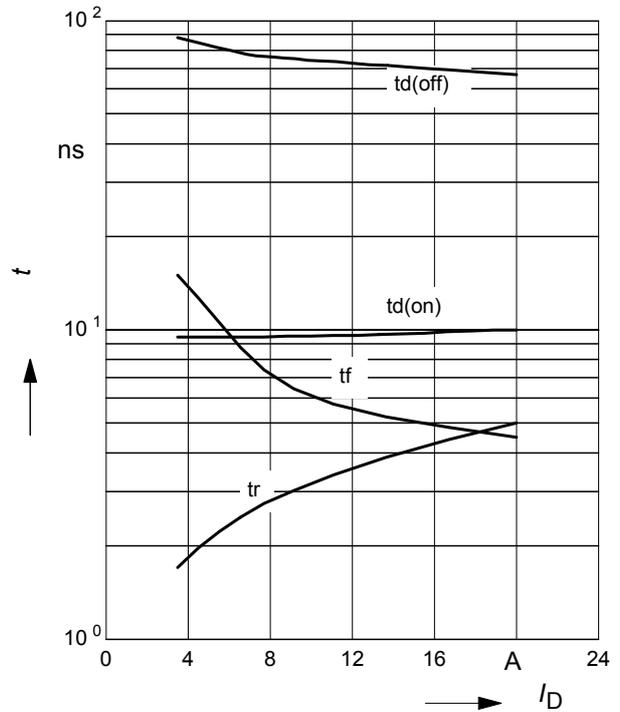
parameter: T_j , $t_p = 10 \mu s$



14 Typ. switching time

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

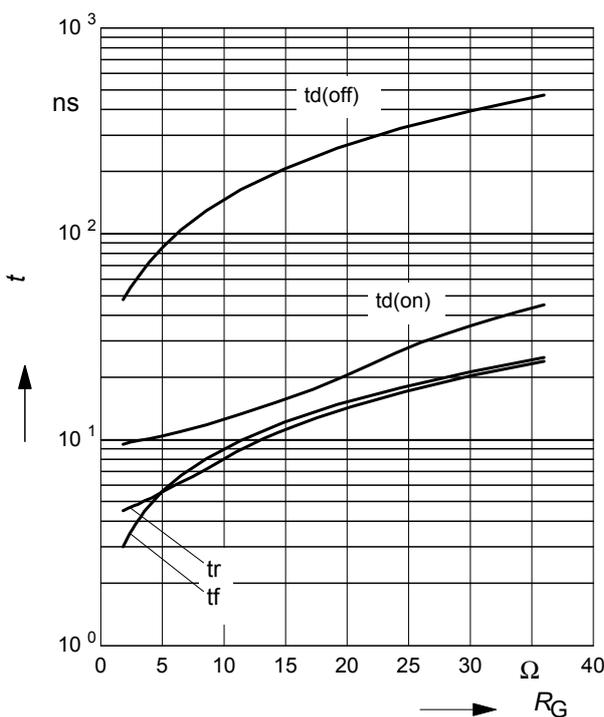
par.: $V_{DS} = 380V$, $V_{GS} = 0/+13V$, $R_G = 3.6\Omega$



15 Typ. switching time

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

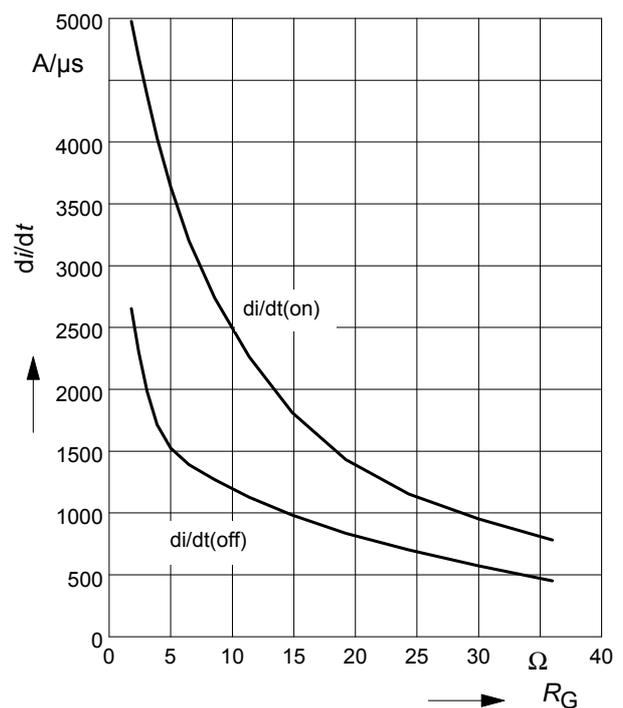
par.: $V_{DS} = 380V$, $V_{GS} = 0/+13V$, $I_D = 20.7 A$



16 Typ. drain current slope

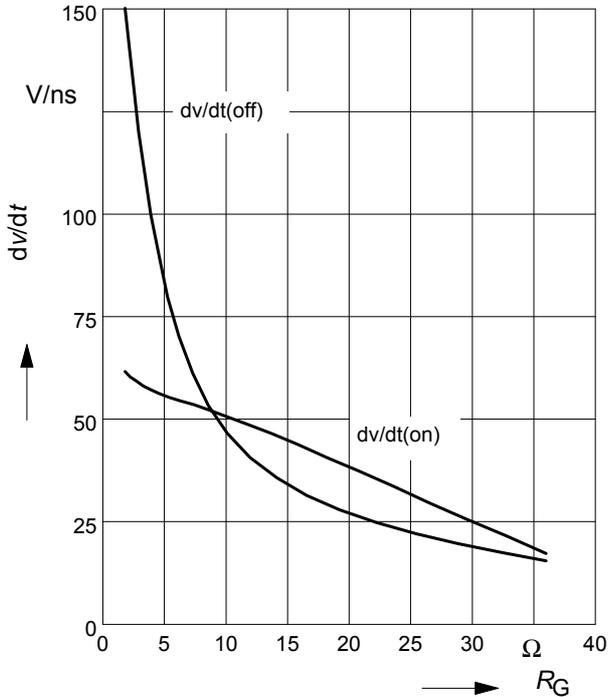
$di/dt = f(R_G)$, inductive load, $T_j = 125^\circ C$

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



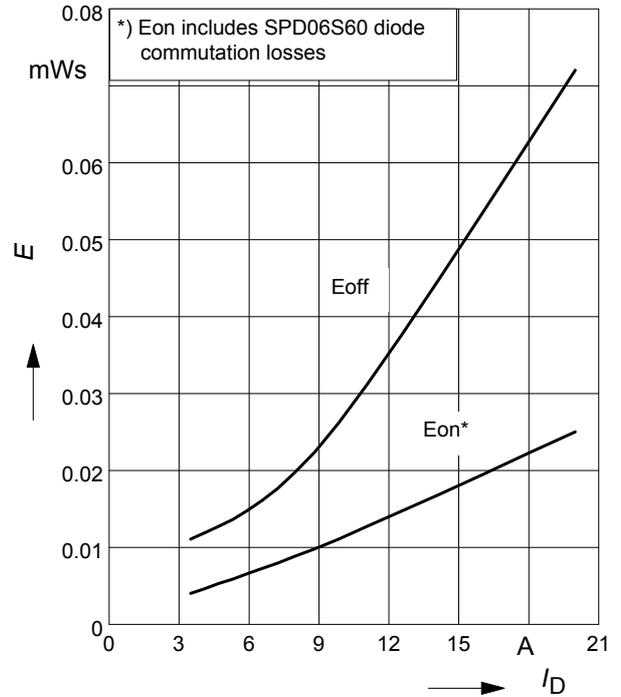
17 Typ. drain source voltage slope

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



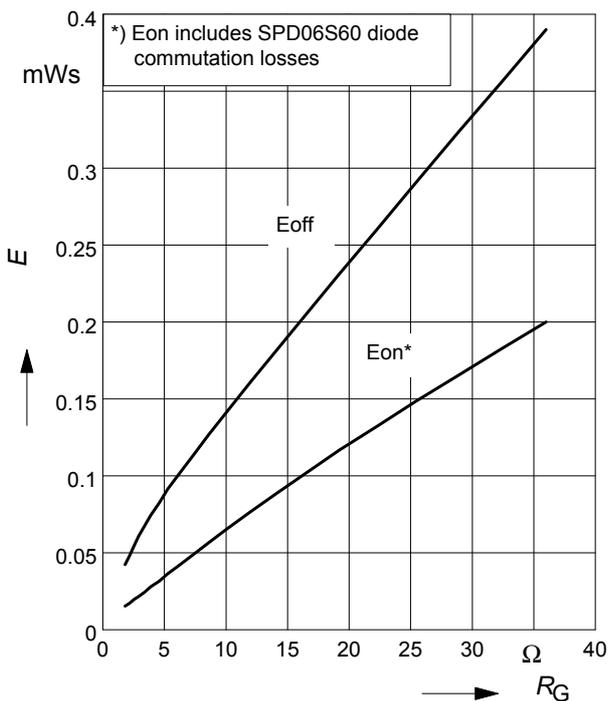
18 Typ. switching losses

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



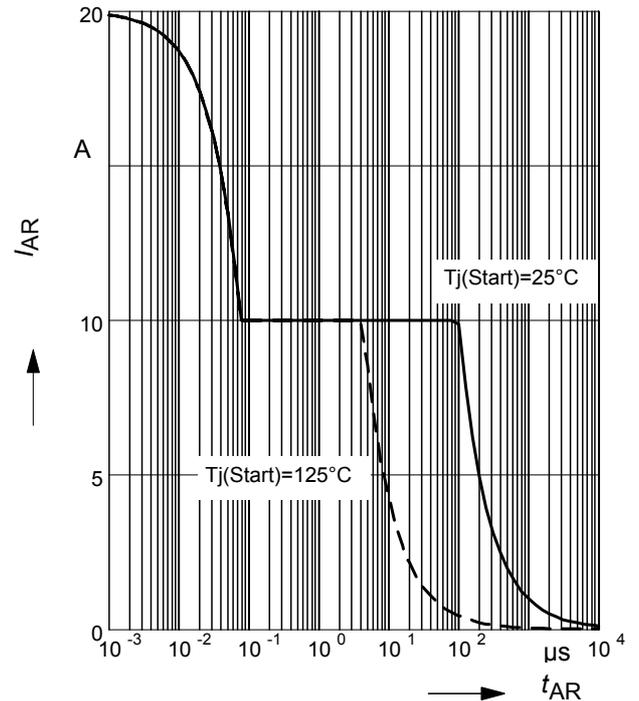
19 Typ. switching losses

$E = f(R_G)$, 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

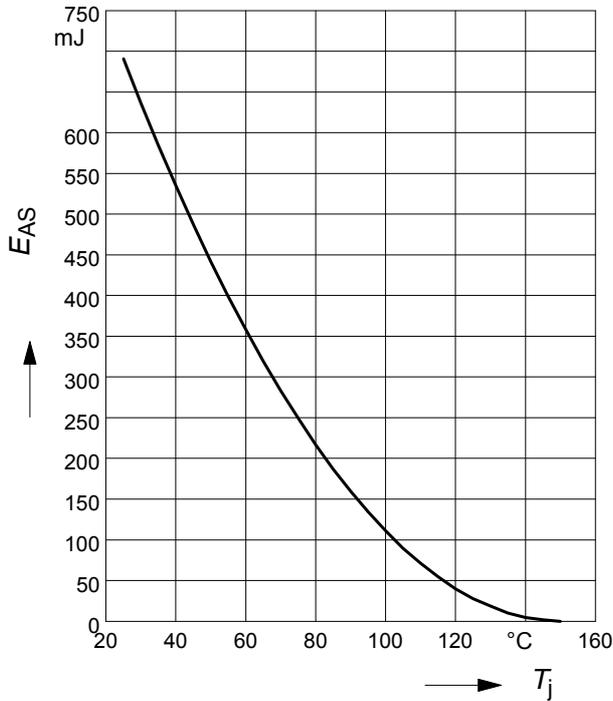
$I_{AR} = f(t_{AR})$
 par.: $T_j \leq 150^\circ\text{C}$



21 Avalanche energy

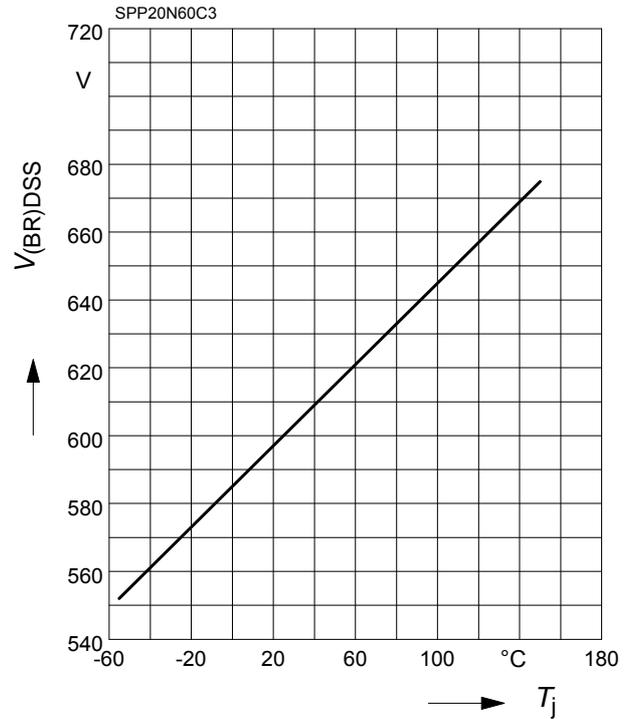
$$E_{AS} = f(T_j)$$

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



22 Drain-source breakdown voltage

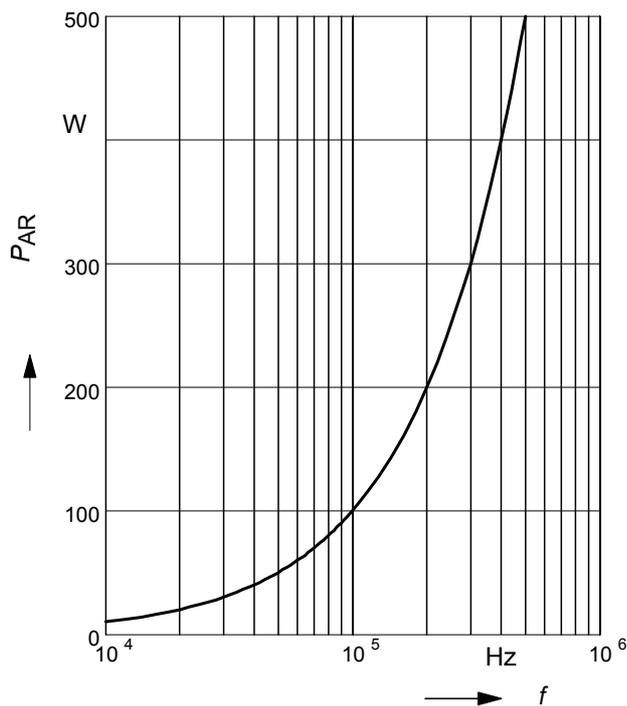
$$V_{(BR)DSS} = f(T_j)$$



23 Avalanche power losses

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

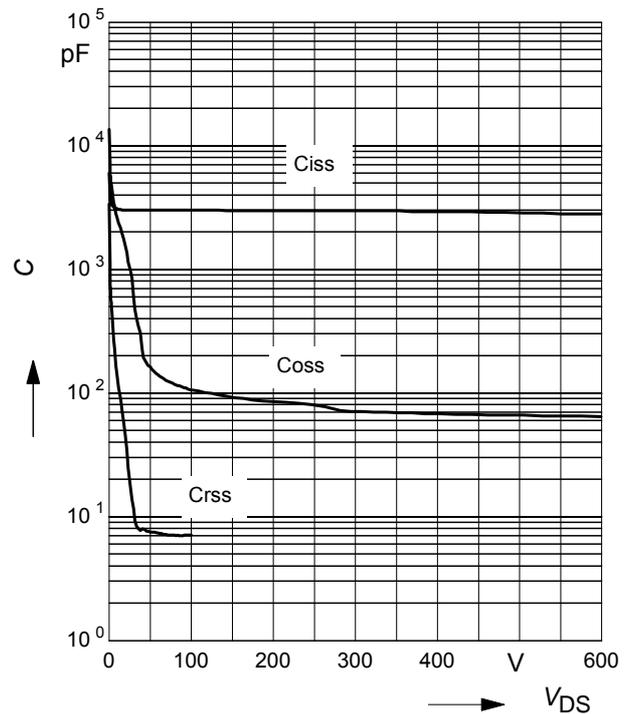
parameter: $E_{AR} = 1\text{ mJ}$



24 Typ. capacitances

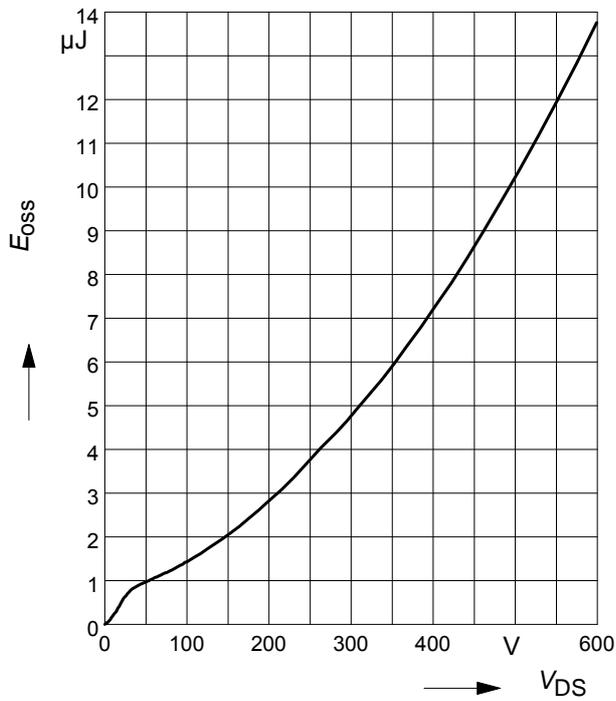
$$C = f(V_{DS})$$

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

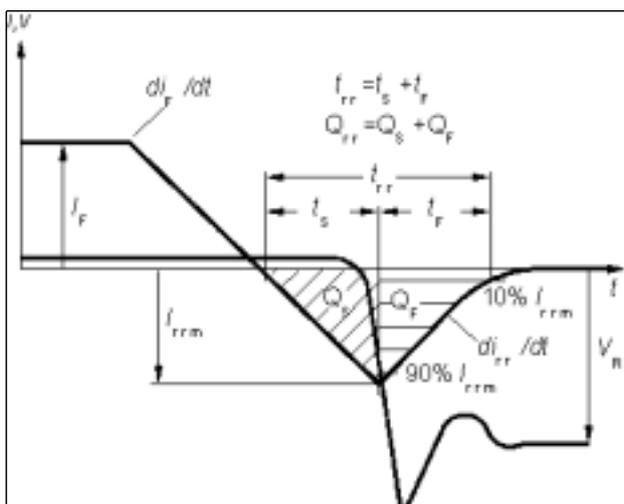


25 Typ. C_{oss} stored energy

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



Definition of diodes switching characteristics



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Infineon Technologies AG
81726 Munich, Germany
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