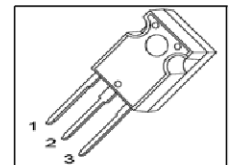


Cool MOS™ Power Transistor
Feature

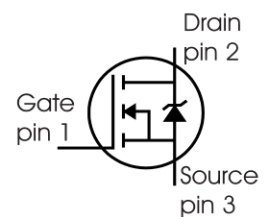
- New revolutionary high voltage technology
- Ultra low gate charge
- Periodic avalanche rated
- Extreme dv/dt rated
- Ultra low effective capacitances
- Improved transconductance
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC⁰⁾ for target applications

V_{DS}	600	V
$R_{DS(on)}$	0.19	Ω
I_D	20	A

PG-TO247



Type	Package	Ordering Code	Marking
SPW20N60S5	PG-TO247	Q67040-S4238	20N60S5


Maximum Ratings

Parameter	Symbol	Value	Unit
Continuous drain current $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$	I_D	20 13	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\text{ puls}}$	40	
Avalanche energy, single pulse $I_D = 10\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AS}	690	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ¹ $I_D = 20\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AR}	1	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	20	A
Gate source voltage	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	$^{\circ}\text{C}$



Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 480\text{ V}, I_D = 20\text{ A}, T_j = 125\text{ °C}$	dv/dt	20	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}	-	-	50	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s	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	$V_{(BR)DSS}$	$V_{GS}=0V, I_D=0.25mA$	600	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0V, I_D=20A$	-	700	-	
Gate threshold voltage	$V_{GS(th)}$	$I_D=1000\mu A, V_{GS}=V_{DS}$	3.5	4.5	5.5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600V, V_{GS}=0V,$ $T_j=25\text{ °C},$ $T_j=150\text{ °C}$	-	0.5	5	μA
			-	-	250	
Gate-source leakage current	I_{GSS}	$V_{GS}=20V, V_{DS}=0V$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10V, I_D=13A,$ $T_j=25\text{ °C}$ $T_j=150\text{ °C}$	-	0.16	0.19	Ω
			-	0.43	-	
Gate input resistance	R_G	$f=1MHz, \text{ open Drain}$	-	12	-	

Electrical Characteristics , at $T_j = 25\text{ }^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Characteristics						
Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 13\text{A}$	-	12	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$	-	3000	-	pF
Output capacitance	C_{oss}		-	1170	-	
Reverse transfer capacitance	C_{rss}		-	28	-	
Effective output capacitance, ²⁾ energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 480\text{V}$	-	83	-	pF
Effective output capacitance, ³⁾ time related	$C_{o(tr)}$		-	160	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 350\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 20\text{A}$, $R_G = 3.6\Omega$	-	120	-	ns
Rise time	t_r		-	25	-	
Turn-off delay time	$t_{d(off)}$		-	130	195	
Fall time	t_f		-	30	45	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD} = 350\text{V}$, $I_D = 20\text{A}$	-	21	-	nC
Gate to drain charge	Q_{gd}		-	47	-	
Gate charge total	Q_g	$V_{DD} = 350\text{V}$, $I_D = 20\text{A}$, $V_{GS} = 0\text{ to } 10\text{V}$	-	79	103	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 350\text{V}$, $I_D = 20\text{A}$	-	8	-	V

⁰J-STD20 and JESD22

¹Repetitive avalanche causes additional power losses that can be calculated as $P_{AV} = E_{AR} \cdot f$.

² $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

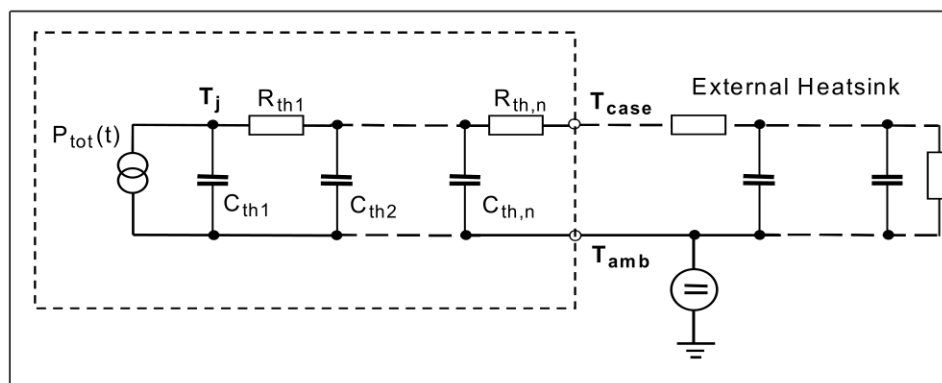
³ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

Electrical Characteristics, at $T_j = 25\text{ }^\circ\text{C}$, unless otherwise specified

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Inverse diode continuous forward current	I_S	$T_C=25^\circ\text{C}$	-	-	20	A
Inverse diode direct current, pulsed	I_{SM}		-	-	40	
Inverse diode forward voltage	V_{SD}	$V_{GS}=0\text{V}, I_F=I_S$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R=350\text{V}, I_F=I_S,$	-	610	-	ns
Reverse recovery charge	Q_{rr}	$di_F/dt=100\text{A}/\mu\text{s}$	-	12	-	μC

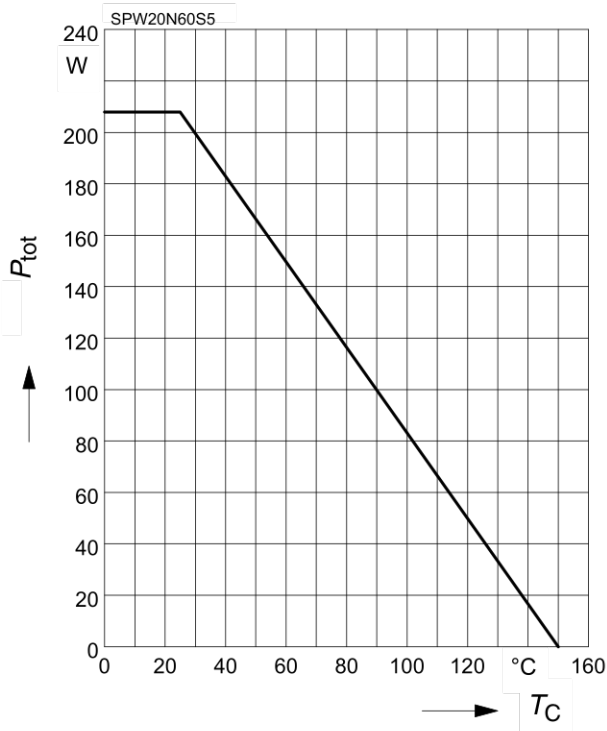
Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
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

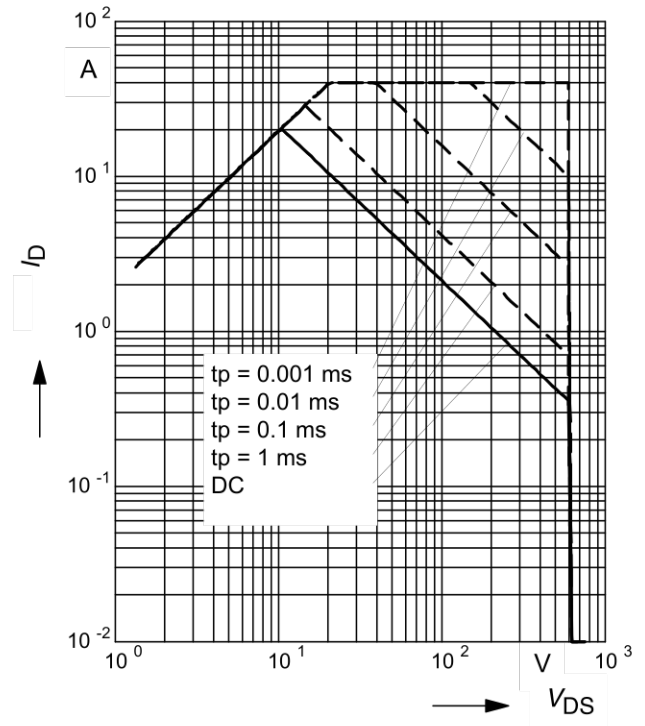
$$P_{tot} = f(T_C)$$



2 Safe operating area

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

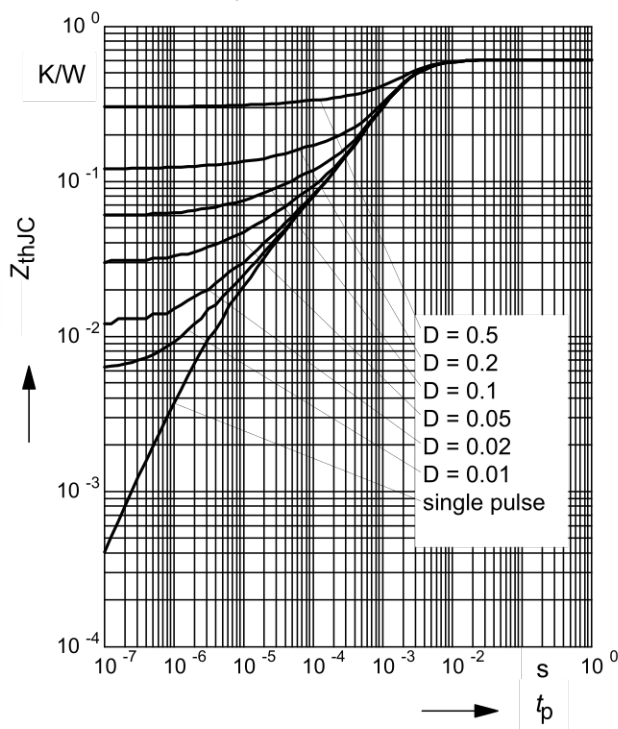
parameter : $D = 0$, $T_C = 25^\circ\text{C}$



3 Transient thermal impedance

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

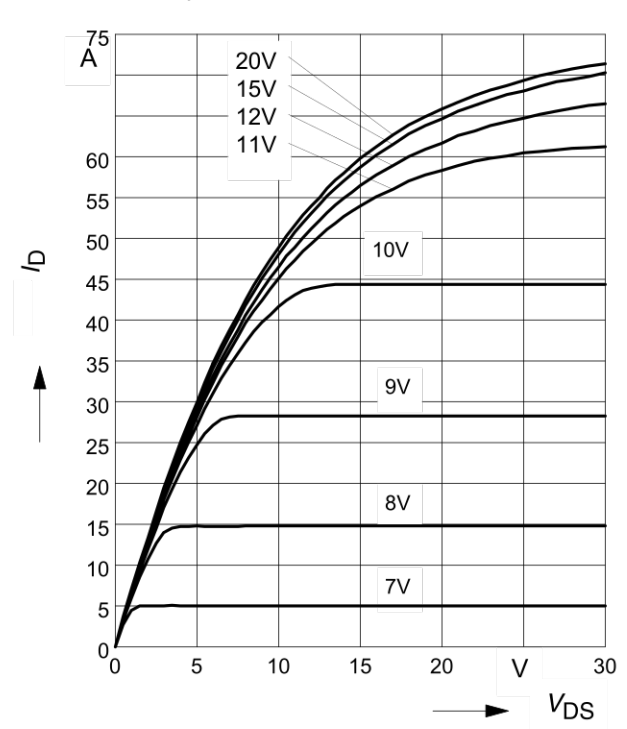
parameter: $D = t_p/T$



4 Typ. output characteristic

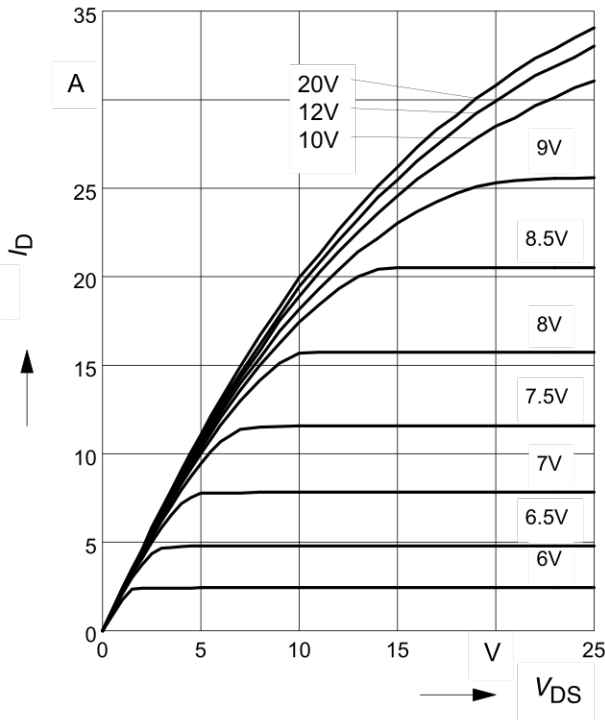
$$I_D = f(V_{DS}); T_j = 25^\circ\text{C}$$

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



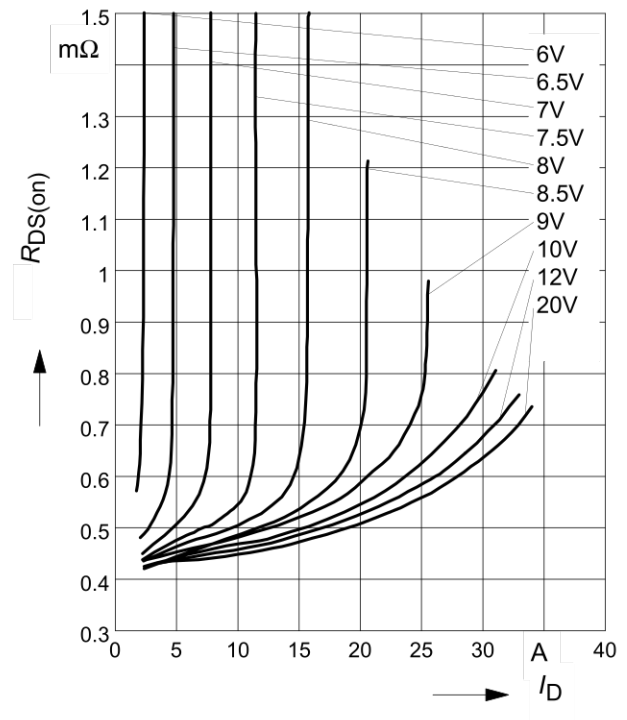
5 Typ. output characteristic

$I_D = f(V_{DS}); T_j = 150^\circ\text{C}$
 parameter: $t_p = 10 \mu\text{s}, V_{GS}$



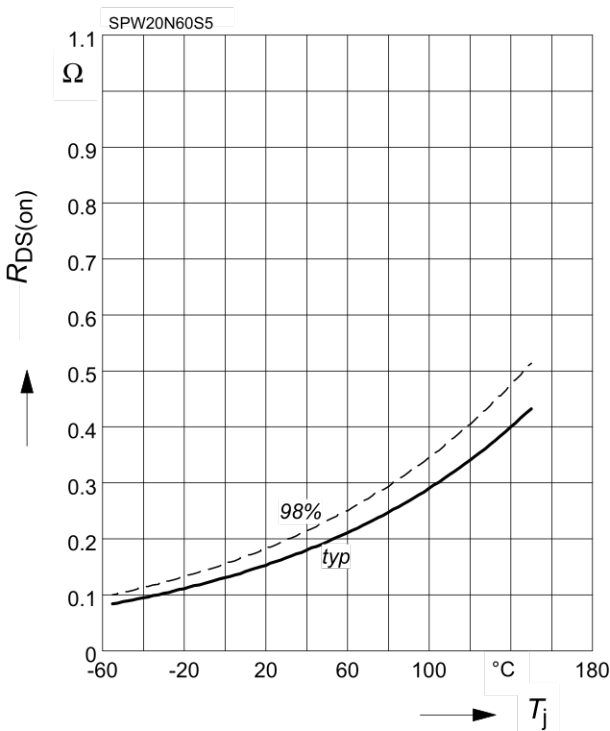
6 Typ. drain-source on resistance

$R_{DS(on)} = f(I_D)$
 parameter: $T_j = 150^\circ\text{C}, V_{GS}$



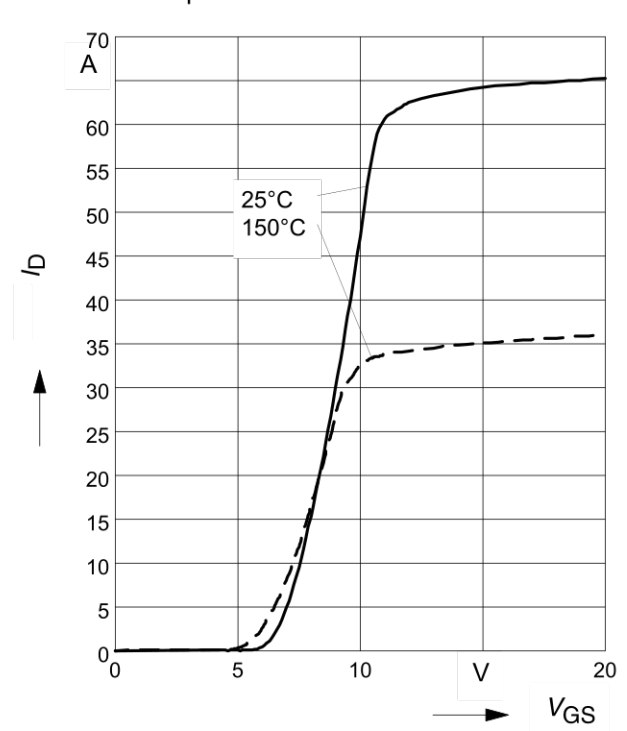
7 Drain-source on-state resistance

$R_{DS(on)} = f(T_j)$
 parameter: $I_D = 13 \text{ A}, V_{GS} = 10 \text{ V}$



8 Typ. transfer characteristics

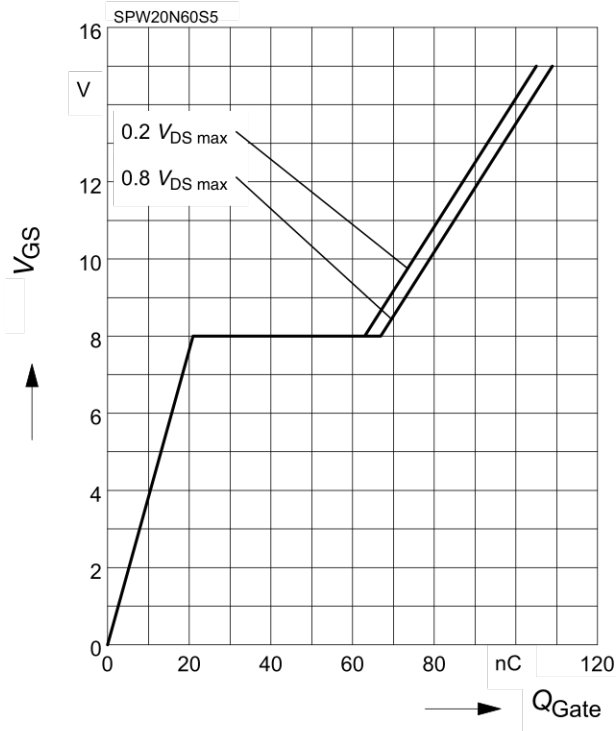
$I_D = f(V_{GS}); V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$
 parameter: $t_p = 10 \mu\text{s}$



9 Typ. gate charge

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

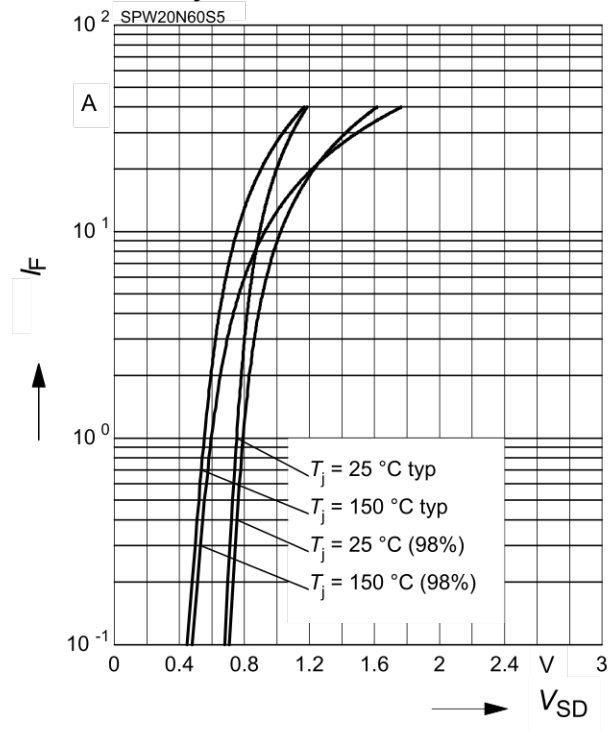
parameter: $I_D = 20$ A pulsed



10 Forward characteristics of body diode

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

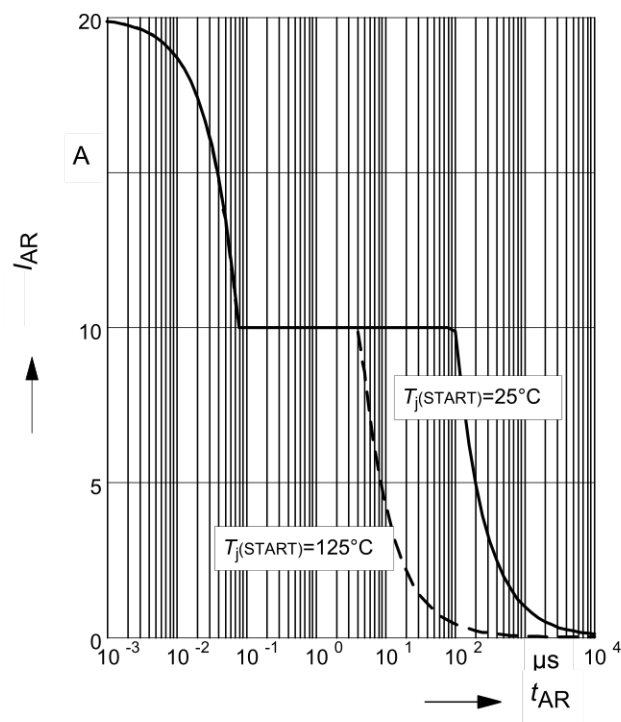
parameter: $T_j, t_p = 10 \mu s$



11 Avalanche SOA

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

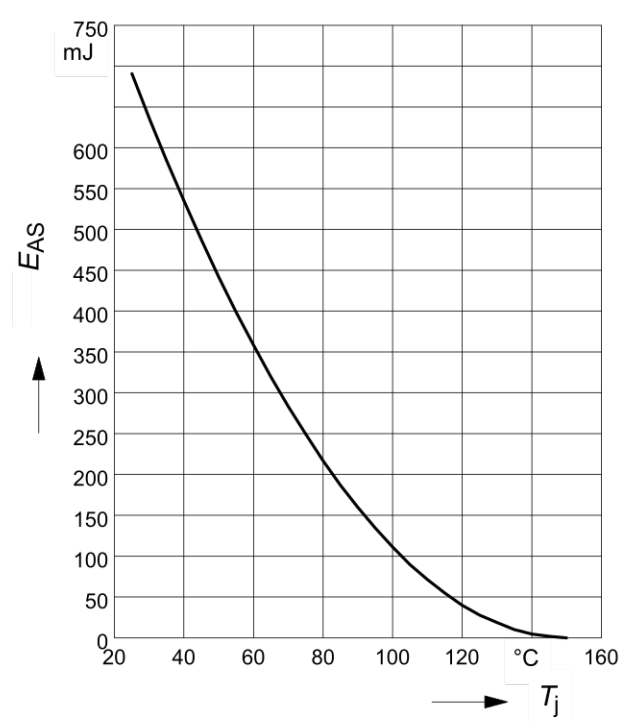
par.: $T_j \leq 150 \text{ °C}$



12 Avalanche energy

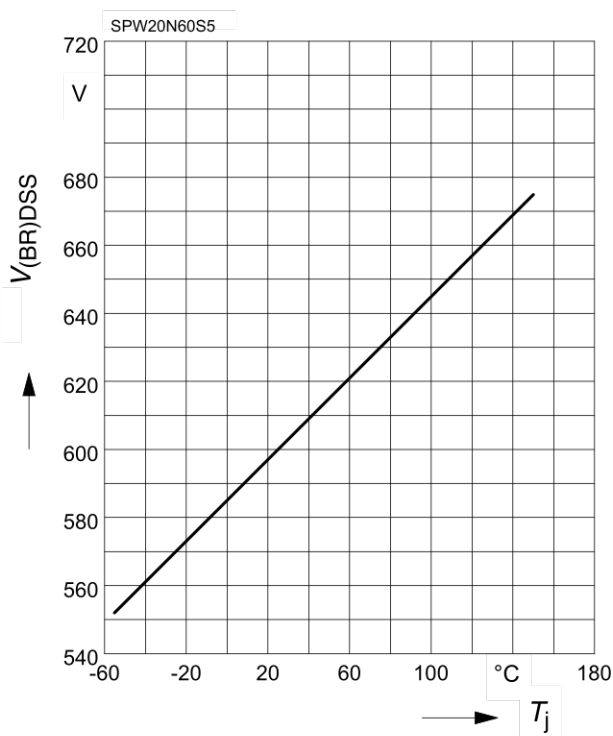
$$E_{AS} = f(T_j)$$

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



13 Drain-source breakdown voltage

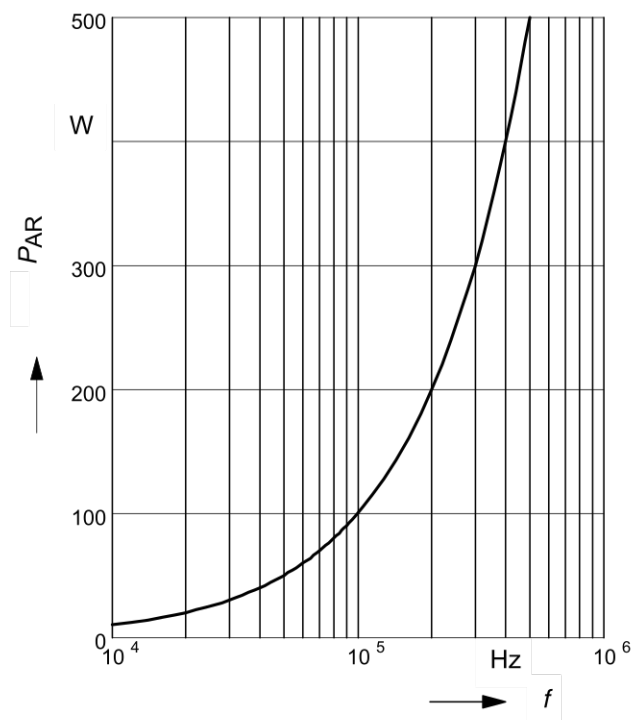
$$V_{(BR)DSS} = f(T_j)$$



14 Avalanche power losses

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

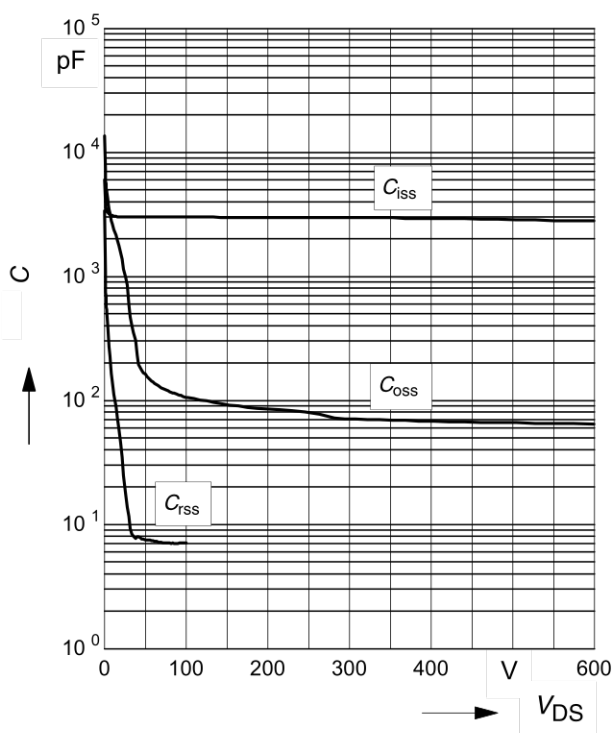
parameter: $E_{AR}=1mJ$



15 Typ. capacitances

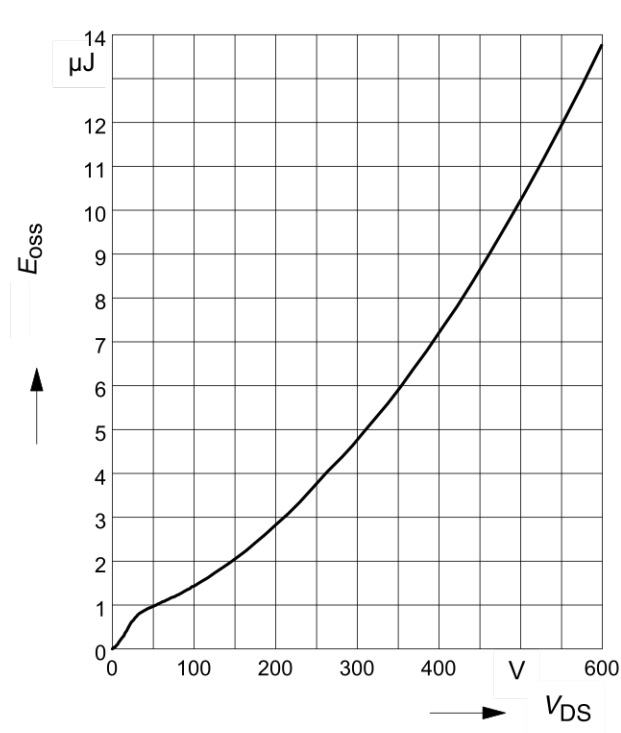
$$C = f(V_{DS})$$

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

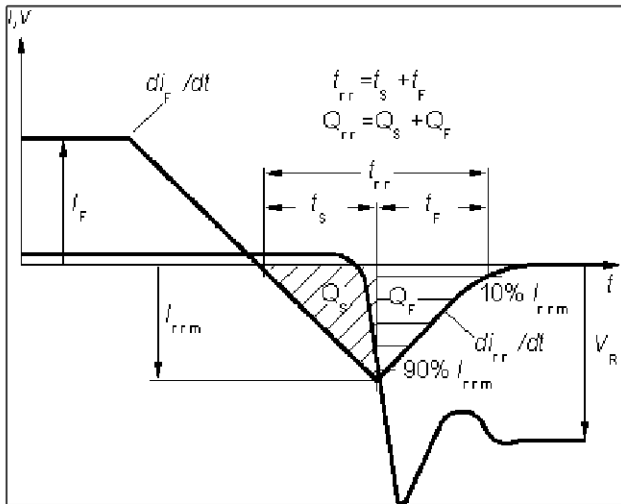


16 Typ. C_{OSS} stored energy

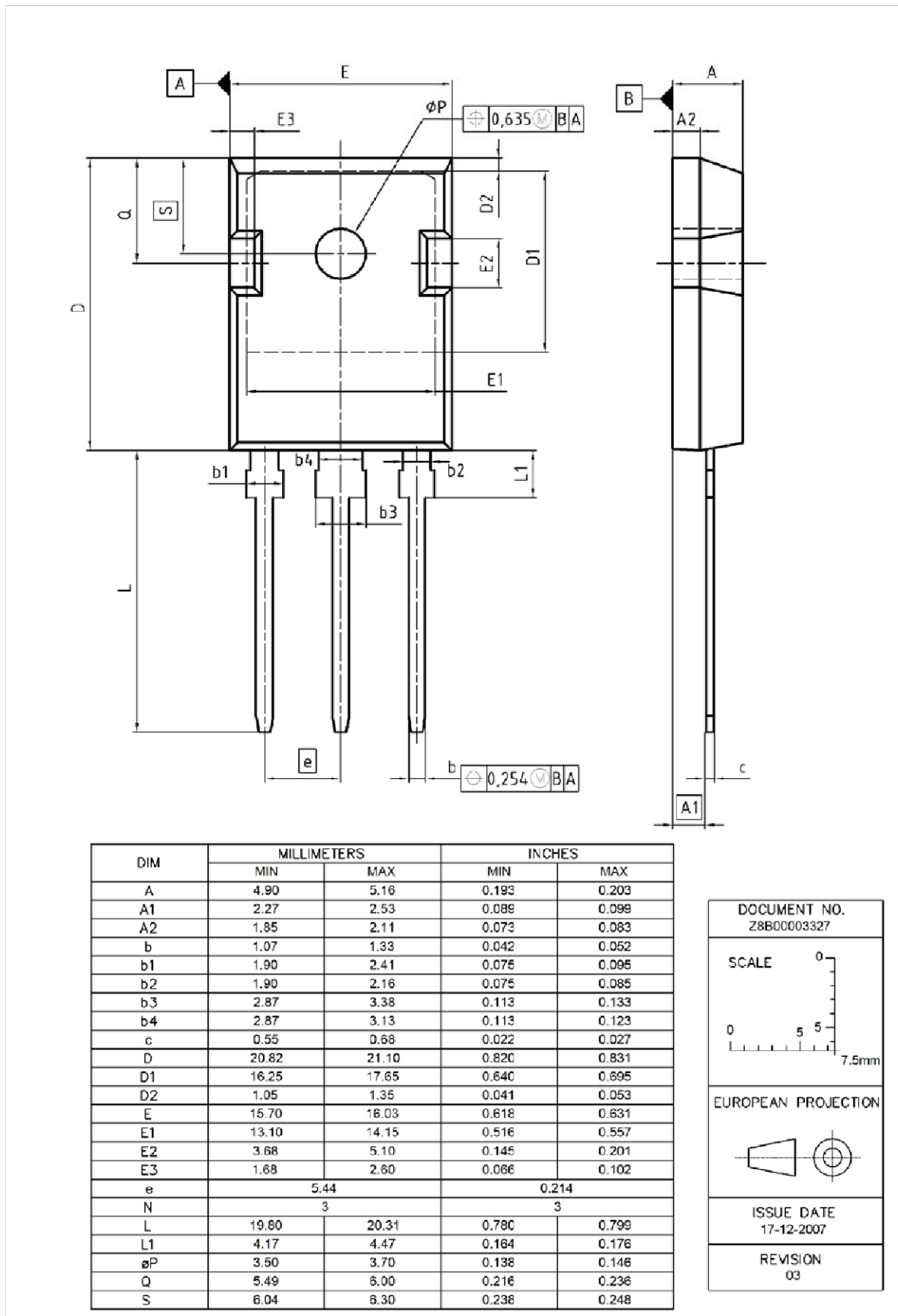
$$E_{OSS} = f(V_{DS})$$



Definition of diodes switching characteristics



PG-TO-247-3-1





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Infineon Technologies AG
81726 Munich, Germany
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1 New package outlines TO-247

Assembly capacity extension for CoolMOSTM technology products assembled in lead-free package PG-TO247-3 at subcontractor ASE (Weihai) Inc., China (Changes are marked in blue.)

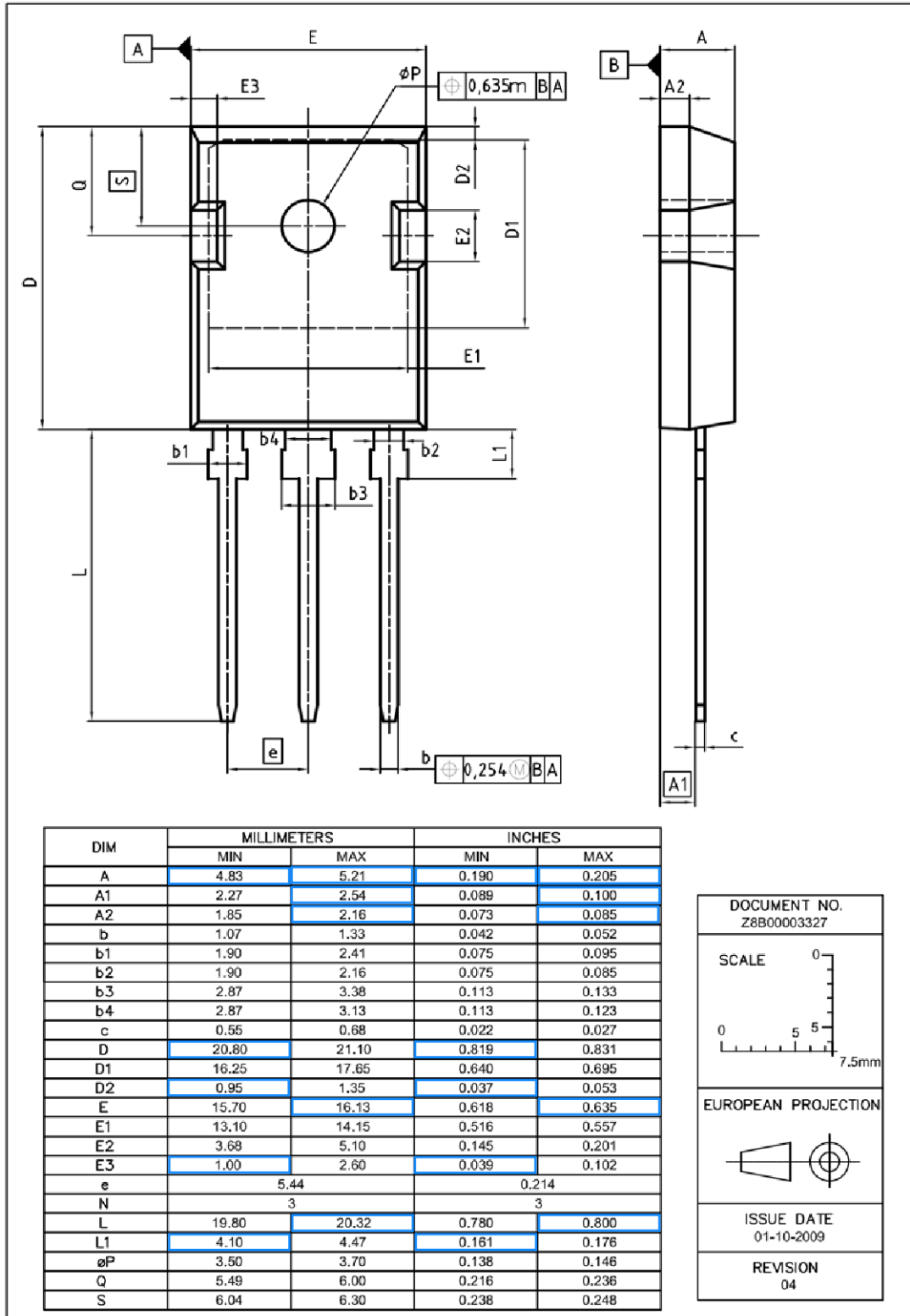


Figure 1 Outlines TO-247, dimensions in mm/inches