

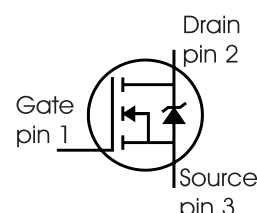
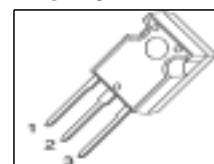
Cool MOS™ Power Transistor

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

$V_{DS} @ T_{jmax}$	560	V
$R_{DS(on)}$	0.38	Ω
I_D	11.6	A

PG-T0247



Type	Package	Ordering Code	Marking
SPW12N50C3	PG-T0247	Q67040-S4580	12N50C3

Maximum Ratings

Parameter	Symbol	Value	Unit
Continuous drain current $T_C = 25\text{ }^\circ\text{C}$ $T_C = 100\text{ }^\circ\text{C}$	I_D	11.6 7	A
Pulsed drain current, t_p limited by T_{jmax}	$I_{D\text{ puls}}$	34.8	
Avalanche energy, single pulse $I_D = 5.5\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AS}	340	mJ
Avalanche energy, repetitive t_{AR} limited by T_{jmax} ¹ $I_D = 11.6\text{ A}$, $V_{DD} = 50\text{ V}$	E_{AR}	0.6	
Avalanche current, repetitive t_{AR} limited by T_{jmax}	I_{AR}	11.6	A
Reverse diode dv/dt ⁵⁾	dv/dt	15	V/ns
Gate source voltage	V_{GS}	± 20	V
Gate source voltage AC ($f > 1\text{ Hz}$)	V_{GS}	± 30	
Power dissipation, $T_C = 25\text{ }^\circ\text{C}$	P_{tot}	125	W
Operating and storage temperature	T_j, T_{stg}	-55... +150	$^\circ\text{C}$

Maximum Ratings

Parameter	Symbol	Value	Unit
Drain Source voltage slope $V_{DS} = 400 \text{ V}$, $I_D = 11.6 \text{ A}$, $T_j = 125 \text{ }^\circ\text{C}$	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 - ambient, leaded	R_{thJA}	-	-	62	
SMD version, device on PCB: @ min. footprint @ 6 cm ² cooling area ²⁾	R_{thJA}	- -	- 35	62 -	
Soldering temperature, wavesoldering 1.6 mm (0.063 in.) from case for 10s	T_{sold}	-	-	260	$^\circ\text{C}$

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$V_{GS}=0\text{V}$, $I_D=0.25\text{mA}$	500	-	-	V
Drain-Source avalanche breakdown voltage	$V_{(BR)DS}$	$V_{GS}=0\text{V}$, $I_D=11.6\text{A}$	-	600	-	
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}	$V_{DS}=500\text{V}$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$, $T_j=150^\circ\text{C}$	- -	0.1 -	1 100	μA
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$	-	-	100	
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{V}$, $I_D=7\text{A}$, $T_j=25^\circ\text{C}$ $T_j=150^\circ\text{C}$	- -	0.34 0.92	0.38 -	Ω
Gate input resistance	R_G	$f=1\text{MHz}$, open Drain	-	1.4	-	

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

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	
Transconductance	g_{fs}	$V_{DS} \geq 2 \cdot I_D \cdot R_{DS(on)max}$, $I_D = 7\text{A}$	-	8	-	S
Input capacitance	C_{iss}	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1\text{MHz}$	-	1200	-	pF
Output capacitance	C_{oss}		-	400	-	
Reverse transfer capacitance	C_{rss}		-	30	-	
Effective output capacitance, ³⁾ energy related	$C_{o(er)}$	$V_{GS} = 0\text{V}$, $V_{DS} = 0\text{V to } 400\text{V}$	-	45	-	pF
Effective output capacitance, ⁴⁾ time related	$C_{o(tr)}$		-	92	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 380\text{V}$, $V_{GS} = 0/10\text{V}$, $I_D = 11.6\text{A}$, $R_G = 6.8\Omega$	-	10	-	ns
Rise time	t_r		-	8	-	
Turn-off delay time	$t_{d(off)}$		-	45	-	
Fall time	t_f		-	8	-	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD} = 400\text{V}$, $I_D = 11.6\text{A}$	-	5	-	nC
Gate to drain charge	Q_{gd}		-	26	-	
Gate charge total	Q_g	$V_{DD} = 400\text{V}$, $I_D = 11.6\text{A}$, $V_{GS} = 0 \text{ to } 10\text{V}$	-	49	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} = 400\text{V}$, $I_D = 11.6\text{A}$	-	5	-	V

⁰J-STD20 and JESD22

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

²Device 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.

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

⁴ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁵ $I_{SD} \leq I_D$, $di/dt \leq 400\text{A/us}$, $V_{DClamp} = 400\text{V}$, $V_{peak} < V_{BR, DSS}$, $T_j < T_{j,max}$.

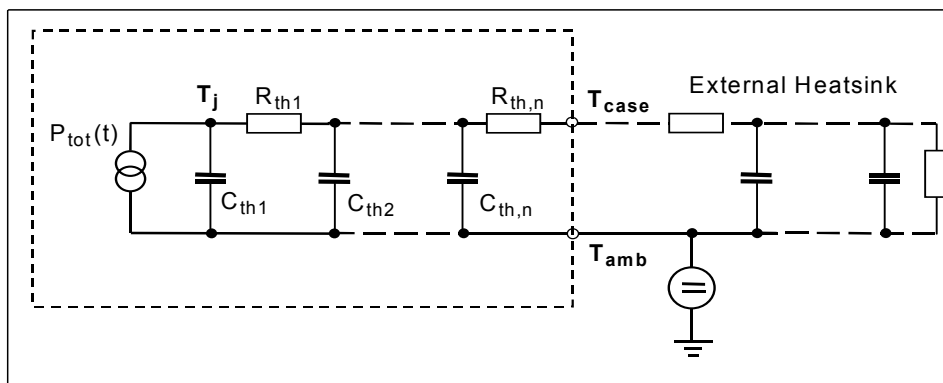
Identical low-side and high-side switch.

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	$T_C=25^{\circ}\text{C}$	-	-	11.6	A
Inverse diode direct current, pulsed	I_{SM}		-	-	34.8	
Inverse diode forward voltage	V_{SD}	$V_{GS}=0\text{V}$, $I_F=I_S$	-	1	1.2	V
Reverse recovery time	t_{rr}	$V_R=400\text{V}$, $I_F=I_S$, $di_F/dt=100\text{A}/\mu\text{s}$	-	380	-	ns
Reverse recovery charge	Q_{rr}		-	5.5	-	μC
Peak reverse recovery current	I_{rrm}		-	38	-	A
Peak rate of fall of reverse recovery current	di_{rr}/dt		-	1100	-	$\text{A}/\mu\text{s}$

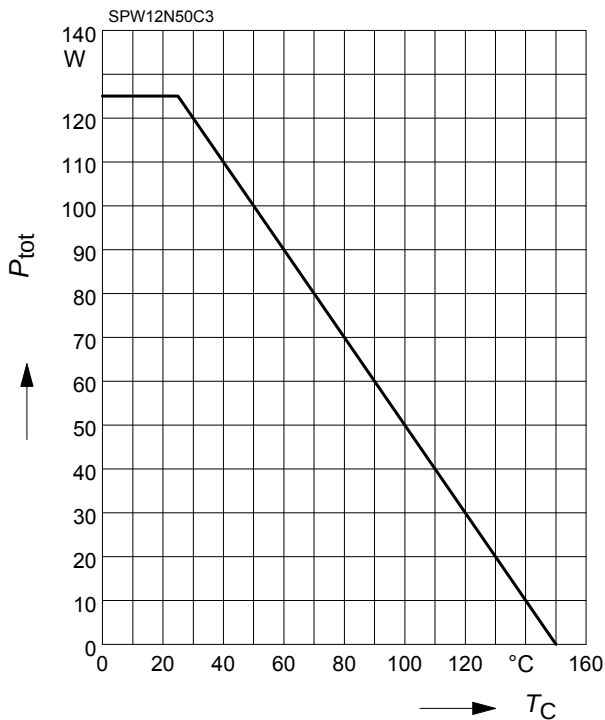
Typical Transient Thermal Characteristics

Symbol	Value	Unit	Symbol	Value	Unit
	typ.			typ.	
Thermal resistance			Thermal capacitance		
R_{th1}	0.015	K/W	C_{th1}	0.0001878	Ws/K
R_{th2}	0.03		C_{th2}	0.0007106	
R_{th3}	0.056		C_{th3}	0.000988	
R_{th4}	0.197		C_{th4}	0.002791	
R_{th5}	0.216		C_{th5}	0.007285	
R_{th6}	0.083		C_{th6}	0.063	



1 Power dissipation

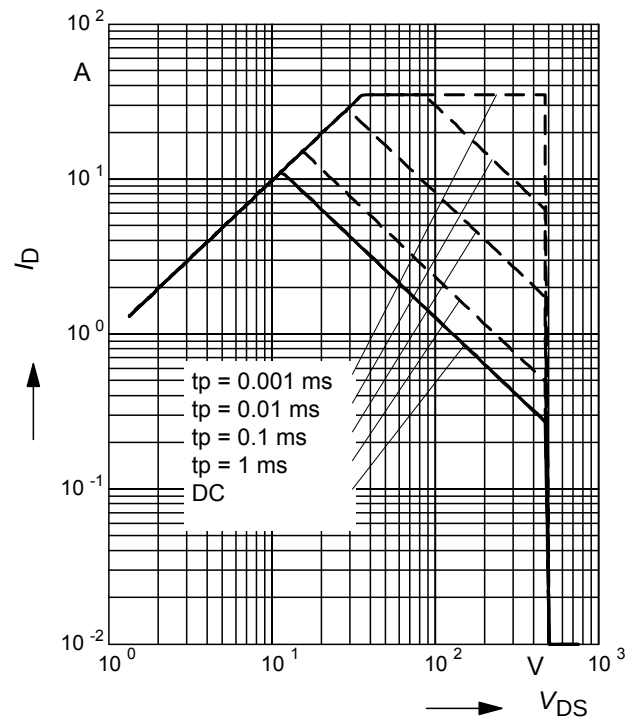
$$P_{\text{tot}} = f(T_C)$$



2 Safe operating area

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

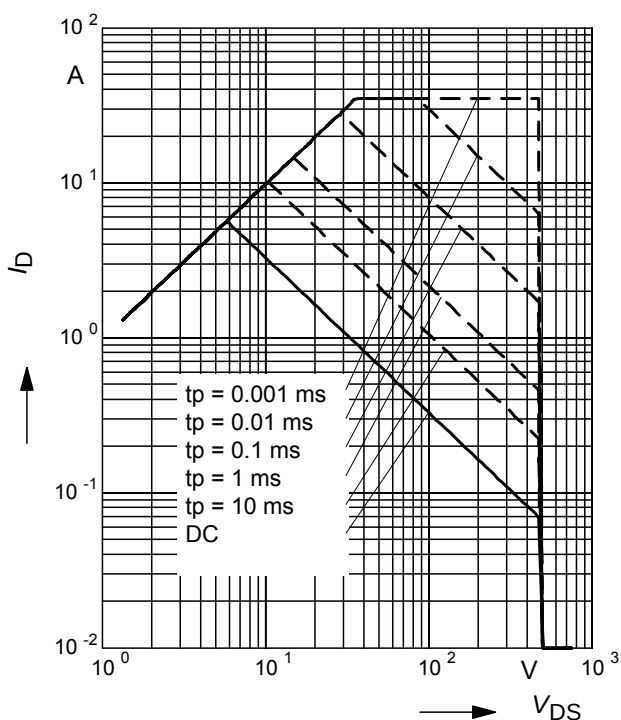
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



3 Safe operating area FullPAK

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

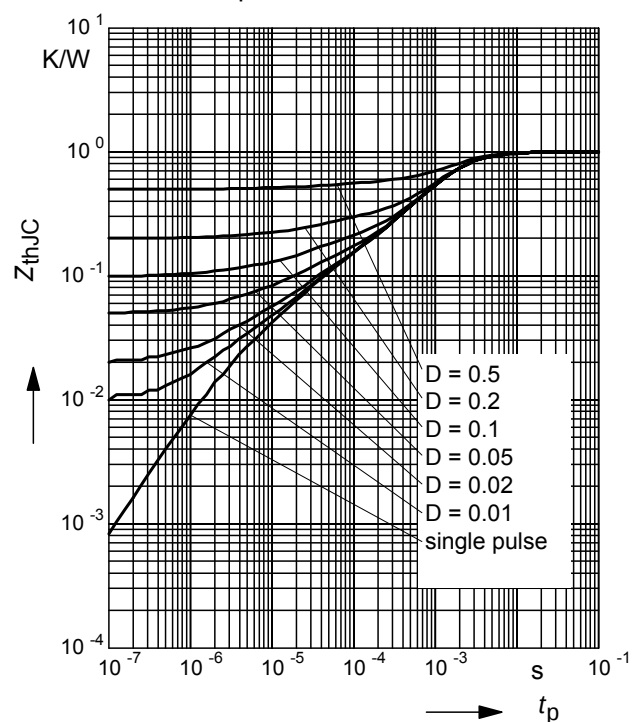
parameter: $D = 0$, $T_C = 25^\circ\text{C}$



4 Transient thermal impedance

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

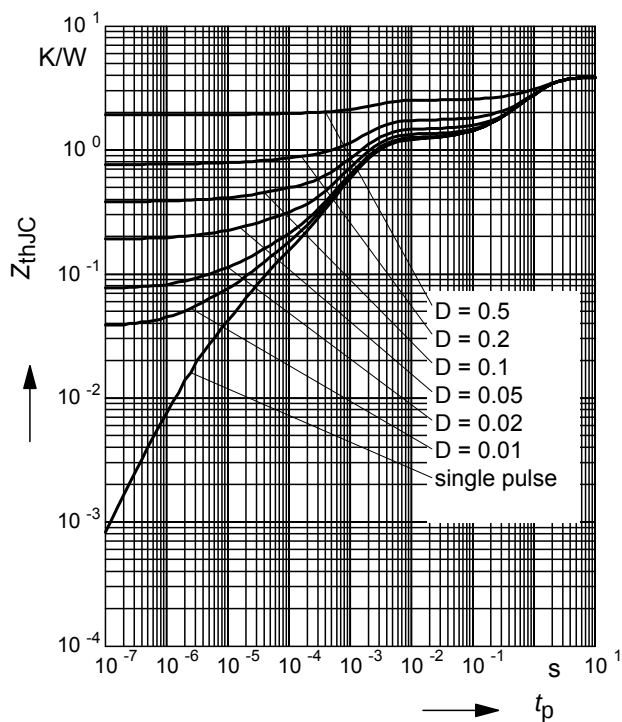
parameter: $D = t_p/T$



5 Transient thermal impedance FullPAK

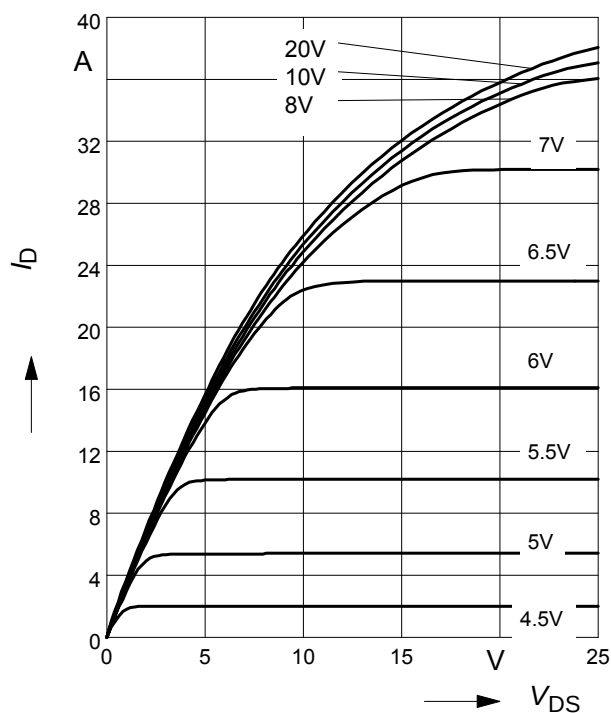
$$Z_{thJC} = f(t_p)$$

parameter: $D = t_p/t$


6 Typ. output characteristic

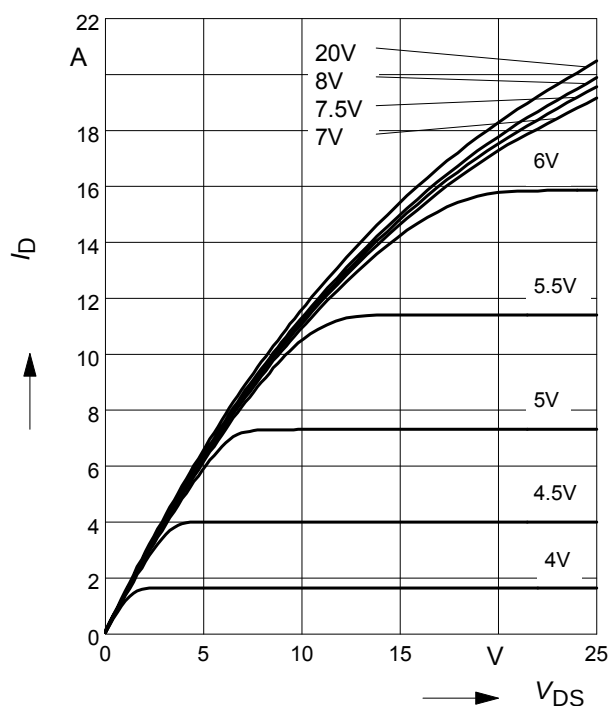
$$I_D = f(V_{DS}); T_j = 25^\circ\text{C}$$

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


7 Typ. output characteristic

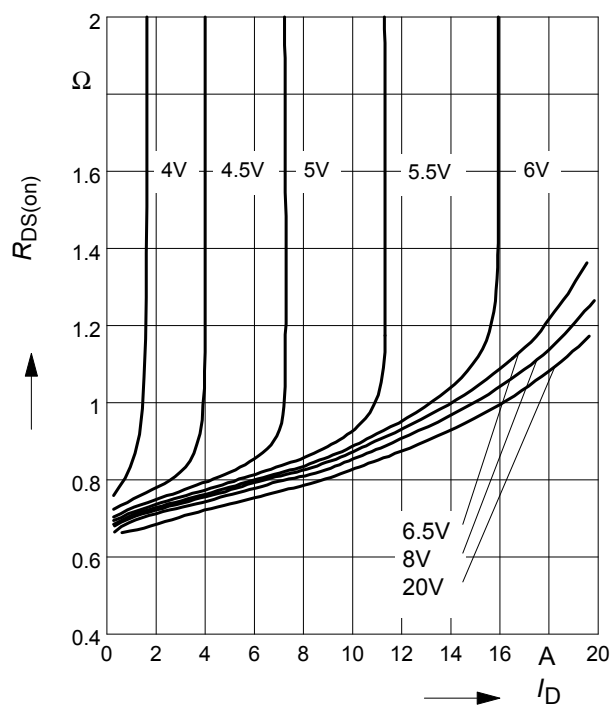
$$I_D = f(V_{DS}); T_j = 150^\circ\text{C}$$

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


8 Typ. drain-source on resistance

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

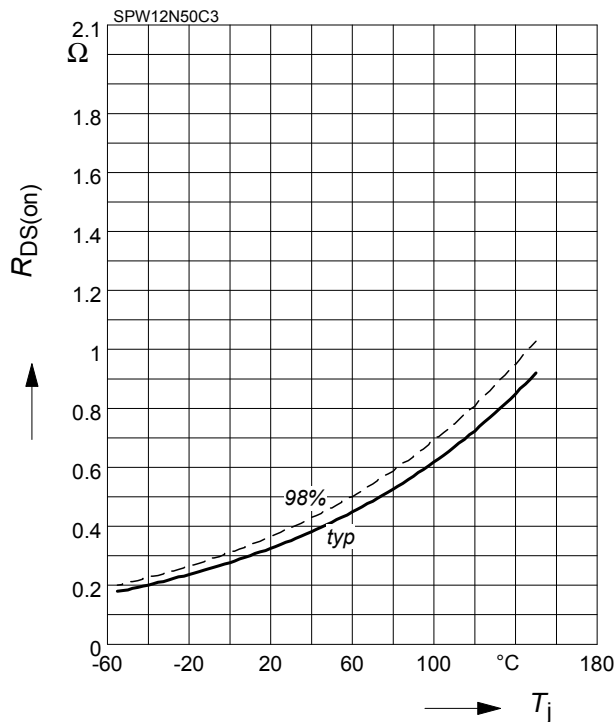
parameter: $T_j = 150^\circ\text{C}$, V_{GS}



9 Drain-source on-state resistance

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

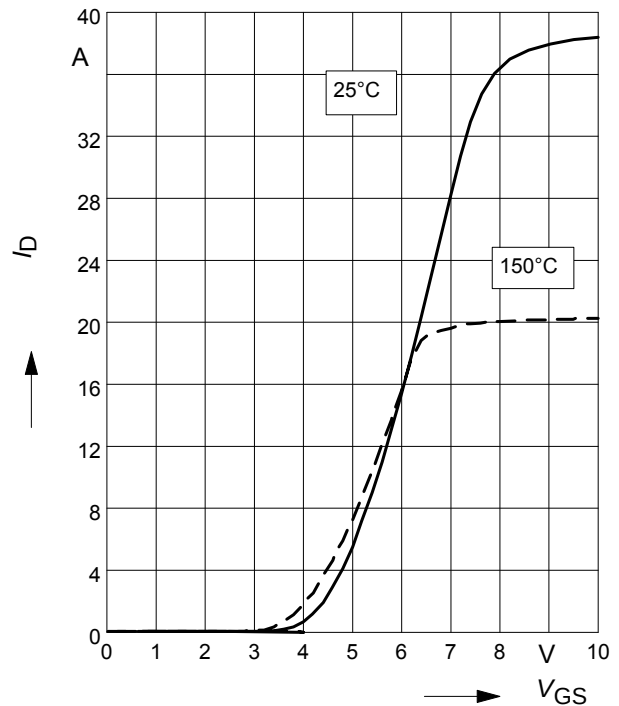
parameter: $I_D = 7 \text{ A}$, $V_{GS} = 10 \text{ V}$



10 Typ. transfer characteristics

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

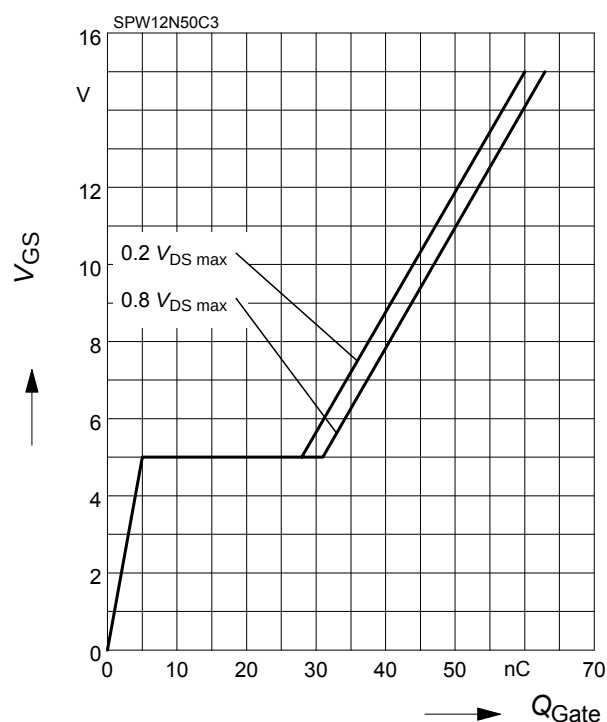
parameter: $t_p = 10 \mu\text{s}$



11 Typ. gate charge

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

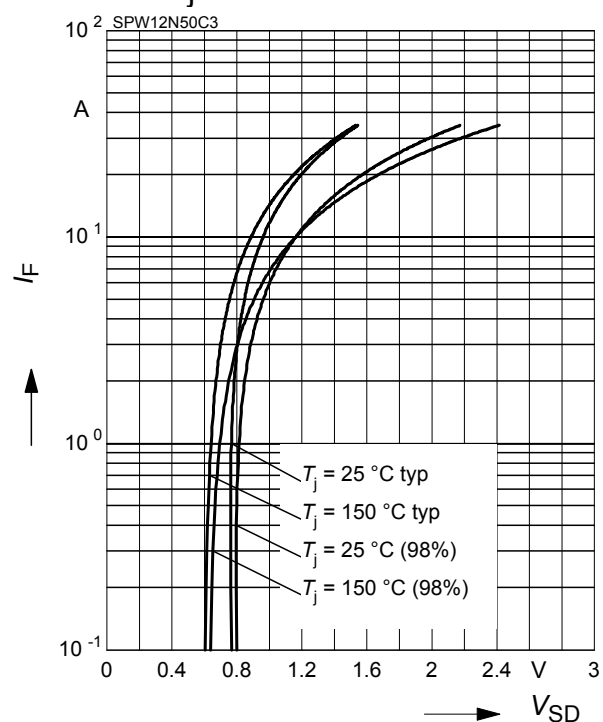
parameter: $I_D = 11.6 \text{ A}$ pulsed



12 Forward characteristics of body diode

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

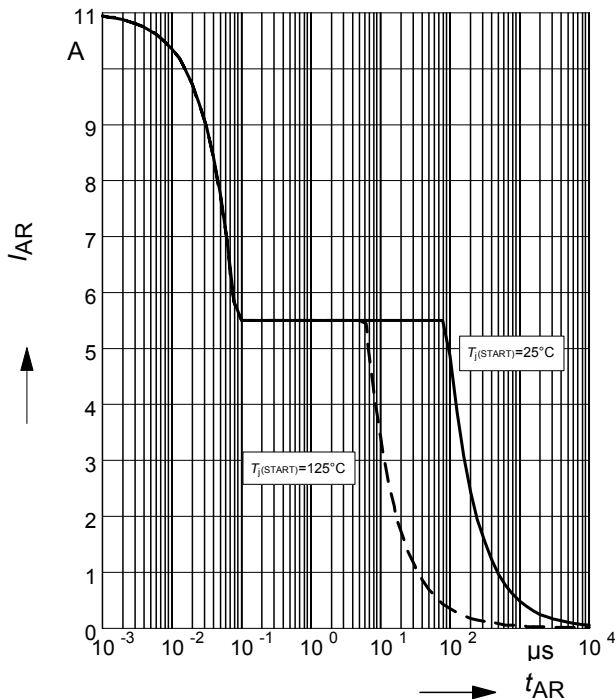
parameter: T_j , $t_p = 10 \mu\text{s}$



13 Avalanche SOA

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

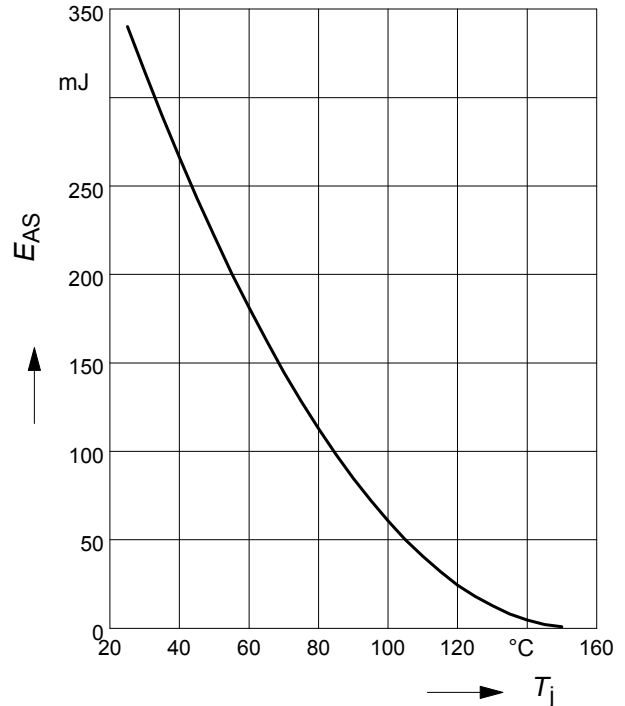
par.: $T_j \leq 150^\circ\text{C}$



14 Avalanche energy

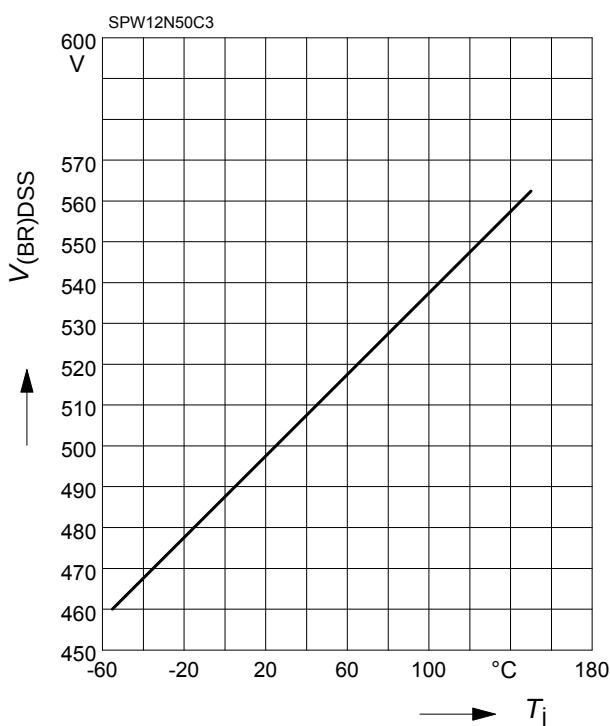
$$E_{AS} = f(T_j)$$

par.: $I_D = 5.5\text{ A}$, $V_{DD} = 50\text{ V}$



15 Drain-source breakdown voltage

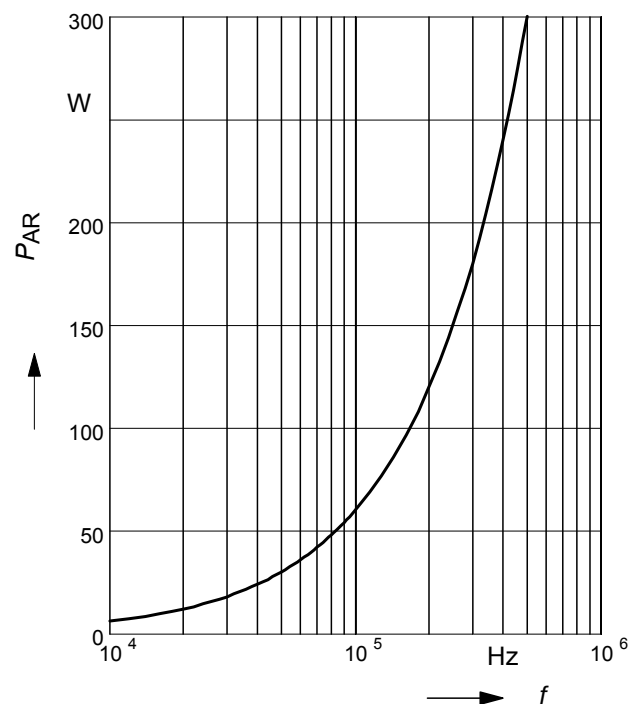
$$V_{(BR)DSS} = f(T_j)$$



16 Avalanche power losses

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

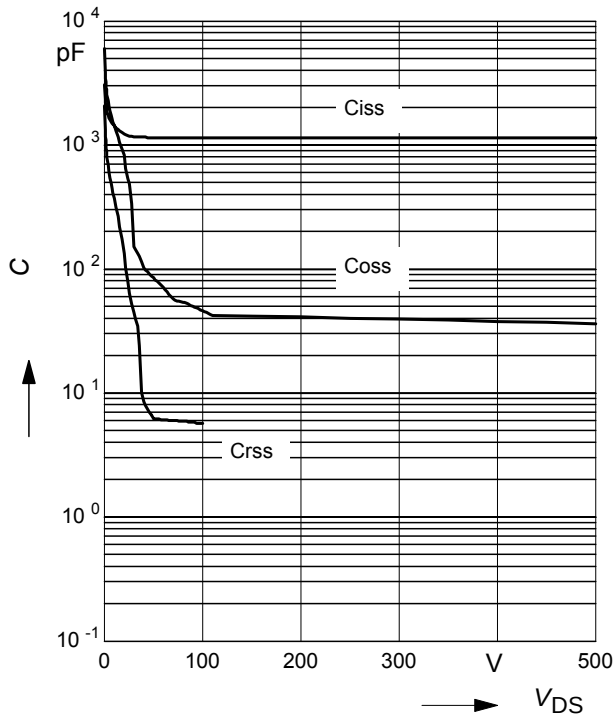
parameter: $E_{AR} = 0.6\text{ mJ}$



17 Typ. capacitances

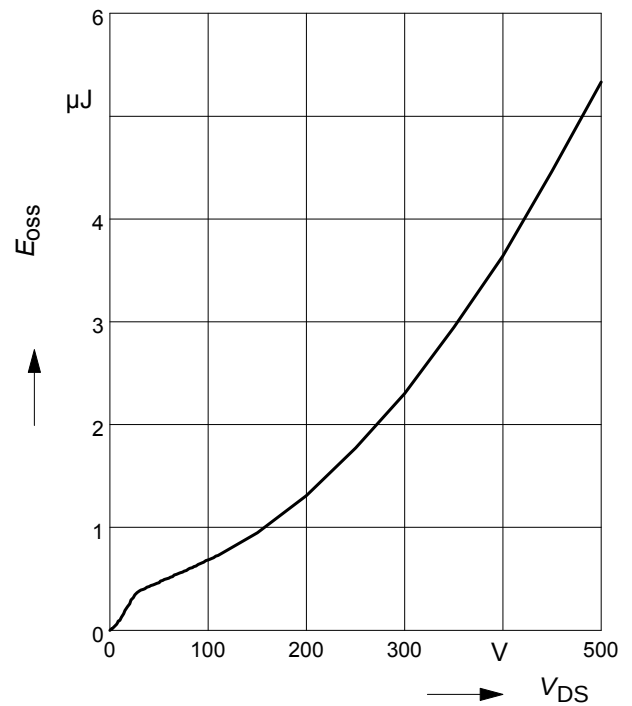
$$C = f(V_{DS})$$

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

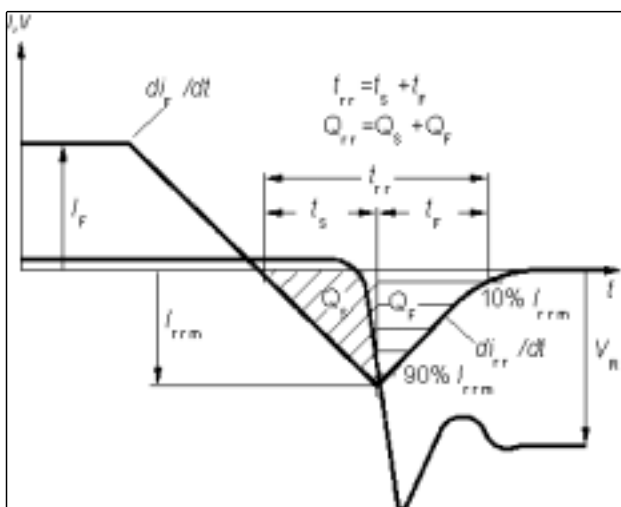


18 Typ. C_{OSS} stored energy

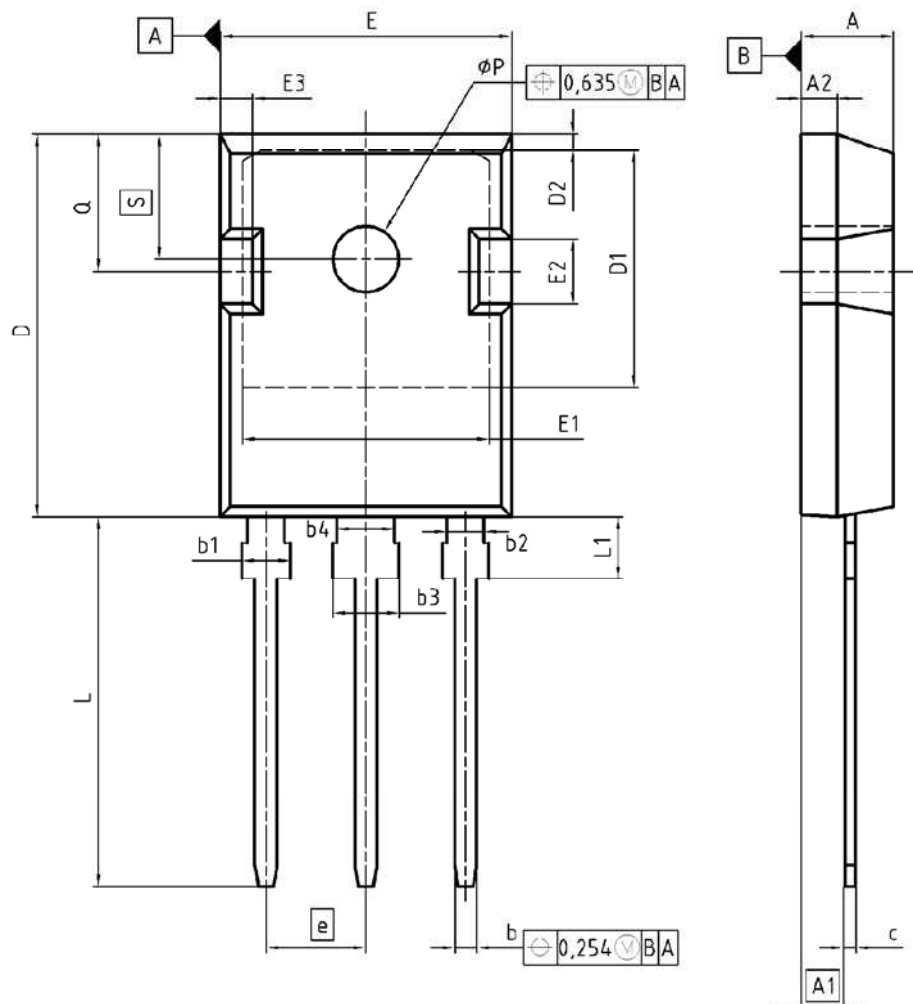
$$E_{oss}=f(V_{DS})$$



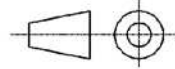
Definition of diodes switching characteristics



PG-TO-247-3-1



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.16	0.193	0.203
A1	2.27	2.53	0.089	0.099
A2	1.85	2.11	0.073	0.083
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.82	21.10	0.820	0.831
D1	16.25	17.65	0.640	0.695
D2	1.05	1.35	0.041	0.053
E	15.70	16.03	0.618	0.631
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.68	2.60	0.066	0.102
e	5.44		0.214	
N	3		3	
L	19.80	20.31	0.780	0.799
L1	4.17	4.47	0.164	0.176
ϕP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

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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.)

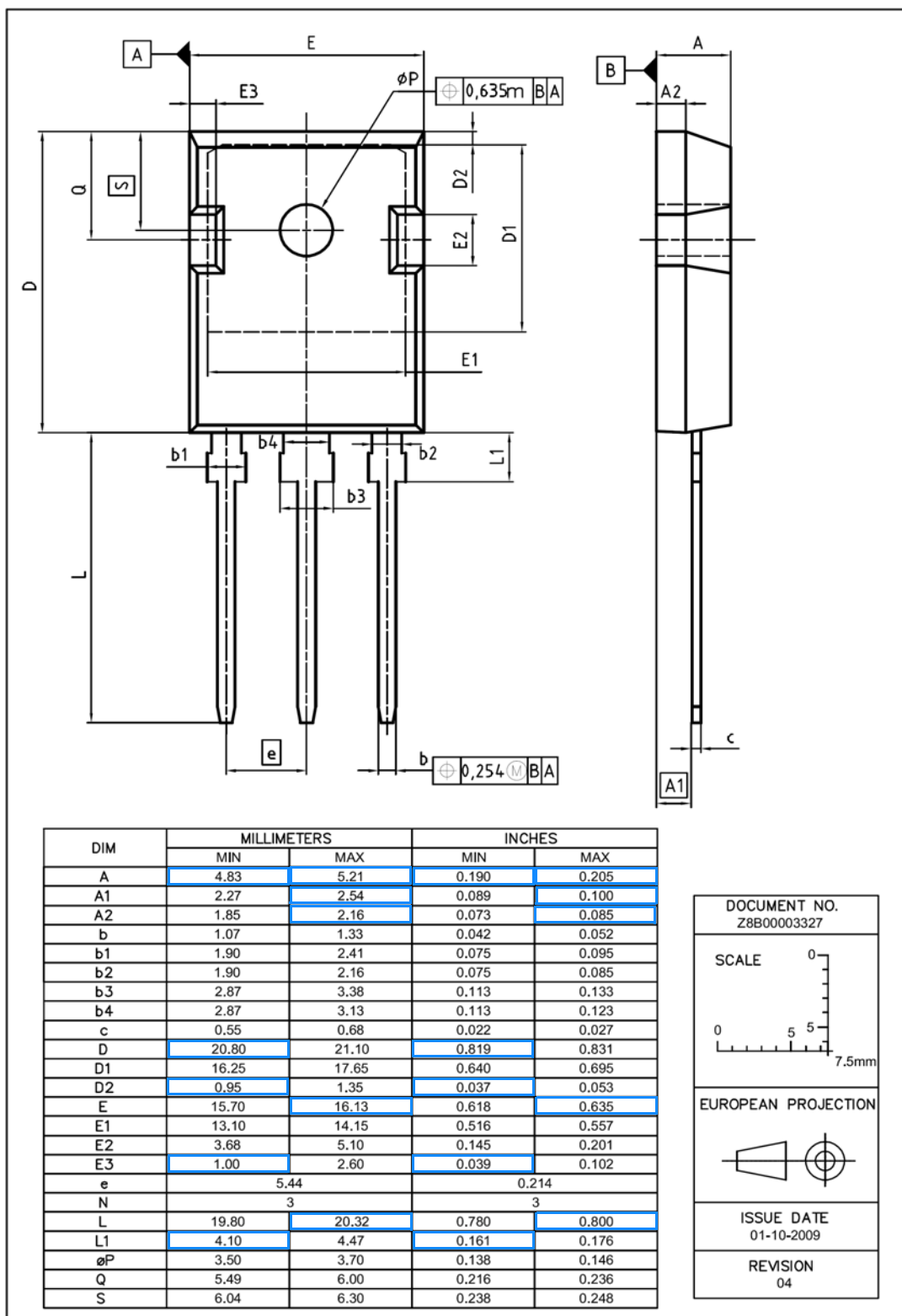


Figure 1 Outlines TO-247, dimensions in mm/inches