

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS C6

600V CoolMOS™ C6 Power Transistor
IPW60R041C6

Data Sheet

Rev. 2.1, 2010-07-12
Final

Industrial & Multimarket

1 Description

CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The offered devices provide all benefits of a fast switching SJ MOSFET while not sacrificing ease of use. Extremely low switching and conduction losses make switching applications even more efficient, more compact, lighter, and cooler.

Features

- Extremely low losses due to very low FOM $R_{DS(on)} \cdot Q_g$ and E_{oss}
- Very high commutation ruggedness
- Easy to use/drive
- JEDEC¹⁾ qualified, Pb-free plating, Halogen free

Applications

PFC stages, hard switching PWM stages and resonant switching PWM stages for e.g. PC Silverbox, Adapter, LCD & PDP TV, Lighting, Server, Telecom and UPS.

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.

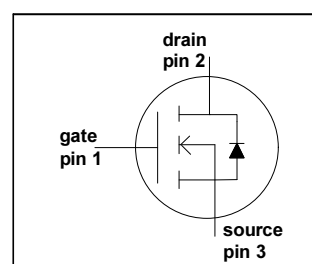


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.041	Ω
$Q_{g,typ}$	290	nC
$I_{D,pulse}$	272	A
$E_{oss} @ 400V$	22	μJ
Body diode di/dt	300	A/ μs

Related Links

- [IFX C6 Product Brief](#)
- [IFX C6 Portfolio](#)
- [IFX CoolMOS Webpage](#)
- [IFX Design tools](#)

Type	Package	Marking
IPW60R041C6	PG-TO247	6R041C6

1) J-STD20 and JESD22

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2 Maximum ratings

at $T_j = 25\text{ °C}$, unless otherwise specified.

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current ¹⁾	I_D	-	-	77.5	A	$T_C = 25\text{ °C}$
				49		$T_C = 100\text{ °C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	272	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	E_{AS}	-	-	1954	mJ	$I_D = 13.4\text{ A}$, $V_{DD} = 50\text{ V}$ (see table 17)
Avalanche energy, repetitive	E_{AR}	-	-	2.96		$I_D = 13.4\text{ A}$, $V_{DD} = 50\text{ V}$
Avalanche current, repetitive	I_{AR}	-	-	13.4	A	
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	$V_{DS} = 0 \dots 480\text{ V}$
Gate source voltage	V_{GS}	-20	-	20	V	static
		-30		30		AC ($f > 1\text{ Hz}$)
Power dissipation	P_{tot}	-	-	481	W	$T_C = 25\text{ °C}$
Operating and storage temperature	T_j, T_{stg}	-55	-	150	°C	
Mounting torque		-	-	60	Ncm	M3 and M3.5 screws
Continuous diode forward current	I_S	-	-	67.2	A	$T_C = 25\text{ °C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	272	A	$T_C = 25\text{ °C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 400\text{ V}$, $I_{SD} \leq I_D$, $T_j = 25\text{ °C}$
Maximum diode commutation speed ³⁾	di/dt	-	-	300	A/μs	(see table 18)

1) Limited by $T_{j,max}$. Maximum duty cycle $D = 0.75$

2) Pulse width t_p limited by $T_{j,max}$

3) Identical low side and high side switch with identical R_G

3 Thermal characteristics

Table 3 Thermal characteristics TO-247

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	0.26	°C/W	
Thermal resistance, junction - ambient	R_{thJA}	-	-	62		leaded
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6 mm (0.063 in.) from case for 10 s

4 Electrical characteristics

Electrical characteristics, at $T_j=25\text{ °C}$, unless otherwise specified.

Table 4 Static characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	600	-	-	V	$V_{GS}=0\text{ V}$, $I_D=0.25\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5		$V_{DS}=V_{GS}$, $I_D=2.96\text{ mA}$
Zero gate voltage drain current	I_{DSS}	-	-	5	μA	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ °C}$
		-	50	-		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.037	0.041	Ω	$V_{GS}=10\text{ V}$, $I_D=44.4\text{ A}$, $T_j=25\text{ °C}$
		-	0.096	-		$V_{GS}=10\text{ V}$, $I_D=44.4\text{ A}$, $T_j=150\text{ °C}$
Gate resistance	R_G	-	0.7	-	Ω	$f=1\text{ MHz}$, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	6530	-	pF	$V_{GS}=0\text{ V}$, $V_{DS}=100\text{ V}$, $f=1\text{ MHz}$
Output capacitance	C_{oss}	-	360	-		
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	235	-		$V_{GS}=0\text{ V}$, $V_{DS}=0\dots480\text{ V}$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	1210	-		$I_D=\text{constant}$, $V_{GS}=0\text{ V}$ $V_{DS}=0\dots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	23	-	ns	$V_{DD}=400\text{ V}$, $V_{GS}=13\text{ V}$, $I_D=44.4\text{ A}$, $R_G=1.7\Omega$ (see table 16)
Rise time	t_r	-	10	-		
Turn-off delay time	$t_{d(off)}$	-	130	-		
Fall time	t_f	-	7	-		

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

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

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	36	-	nC	$V_{DD}=480\text{ V}$, $I_D=44.4\text{ A}$, $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	Q_{gd}	-	150	-		
Gate charge total	Q_g	-	290	-		
Gate plateau voltage	$V_{plateau}$	-	5.4	-	V	

Table 7 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	$V_{GS}=0\text{ V}$, $I_F=44.4\text{ A}$, $T_j=25\text{ °C}$
Reverse recovery time	t_{rr}	-	950	-	ns	$V_R=400\text{ V}$, $I_F=44.4\text{ A}$, $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 18)
Reverse recovery charge	Q_{rr}	-	32	-	μC	
Peak reverse recovery current	I_{rrm}	-	62	-	A	

5 Electrical characteristics diagrams

Table 8

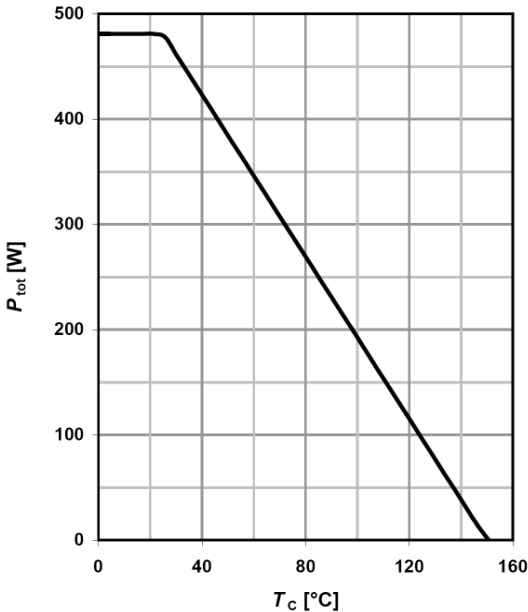
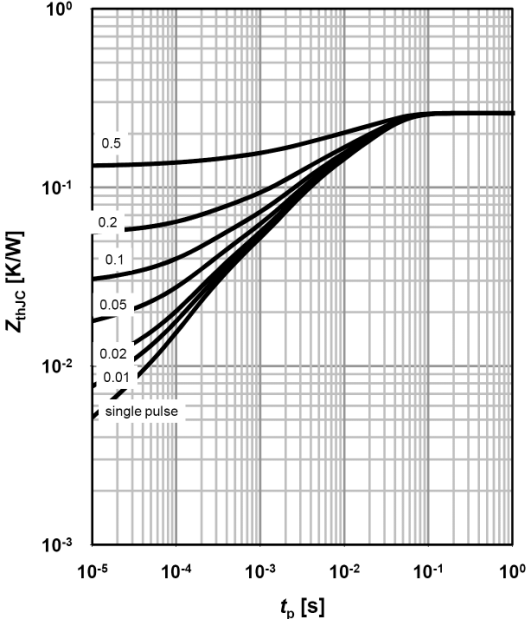
Power dissipation	Max. transient thermal impedance
 $P_{\text{tot}} = f(T_c)$	 $Z_{\text{thJC}} = f(t_p)$; parameter: $D = t_p / T$

Table 9

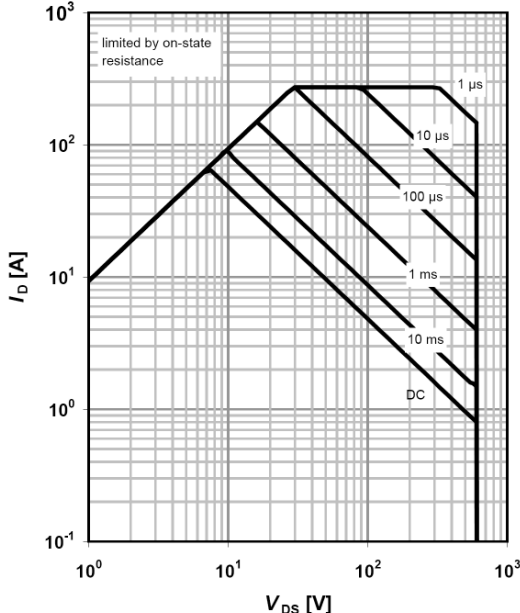
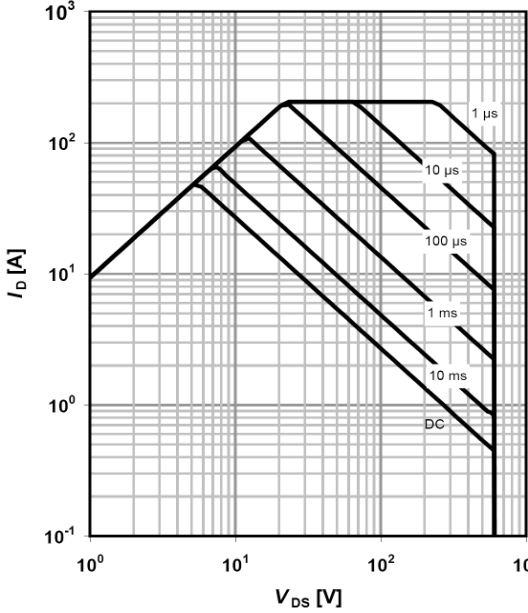
Safe operating area $T_c = 25^\circ\text{C}$	Safe operating area $T_c = 80^\circ\text{C}$
 $I_D = f(V_{DS}); T_c = 25^\circ\text{C}; D = 0$; parameter t_p	 $I_D = f(V_{DS}); T_c = 80^\circ\text{C}; D = 0$; parameter t_p

Table 10

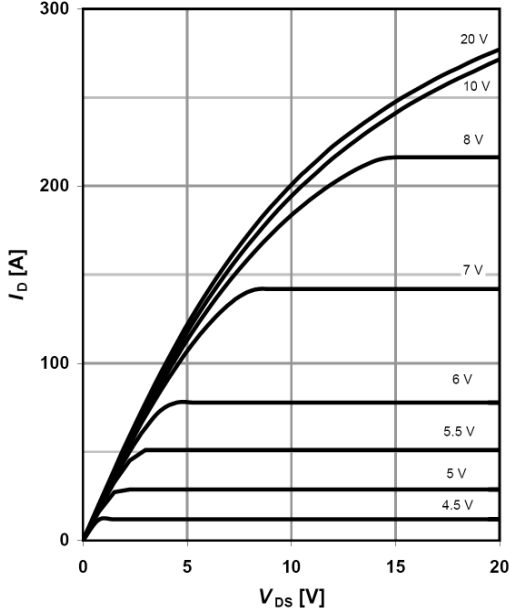
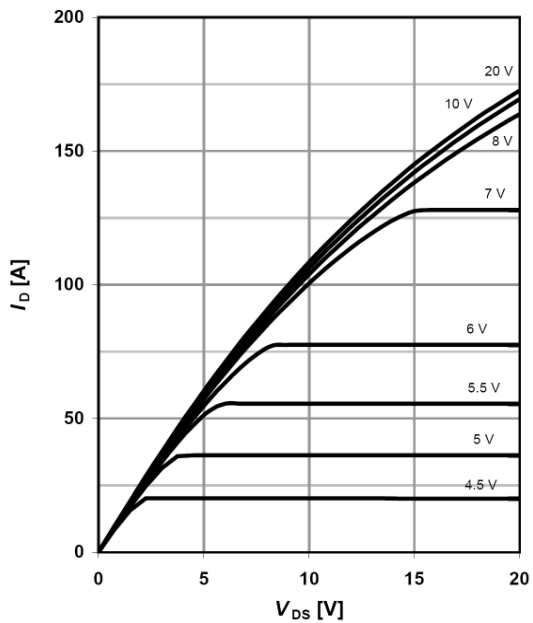
Typ. output characteristics $T_j=25\text{ °C}$	Typ. output characteristics $T_j=125\text{ °C}$
	
$I_D=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$	$I_D=f(V_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

Table 11

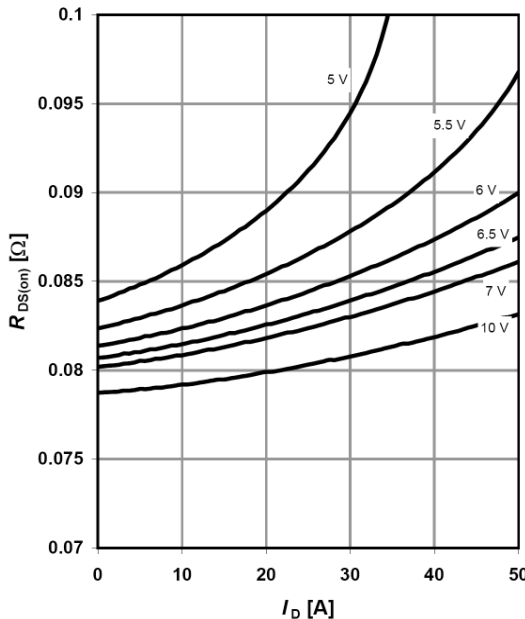
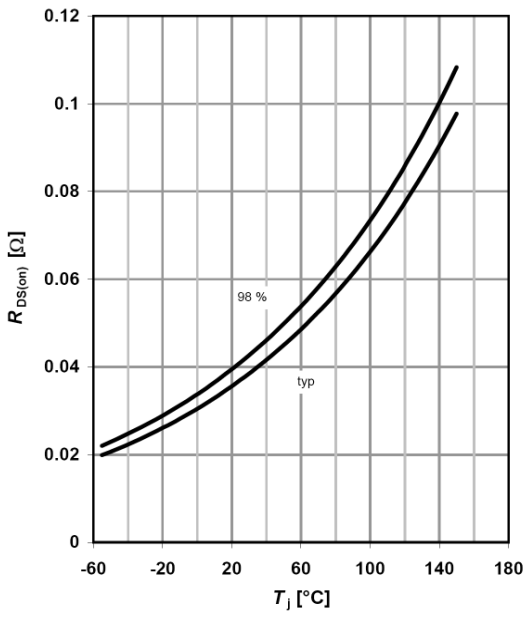
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}=f(I_D); T_j=125\text{ °C}; \text{parameter: } V_{GS}$	$R_{DS(on)}=f(T_j); I_D=44.4\text{ A}; V_{GS}=10\text{ V}$

Table 12

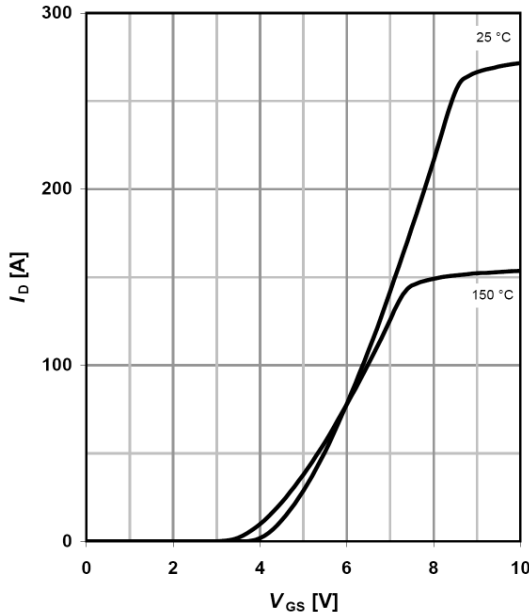
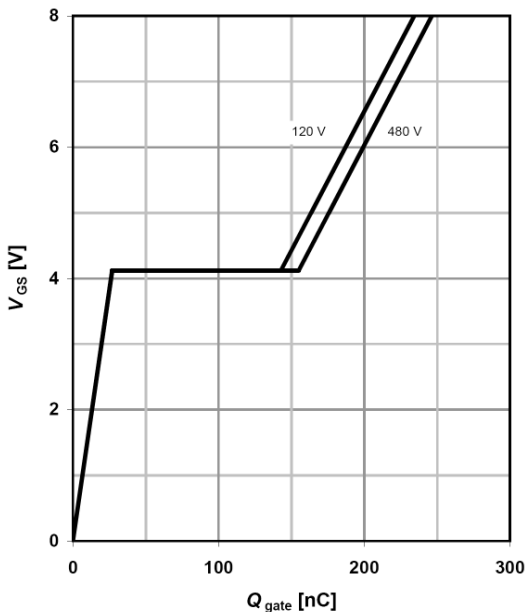
Typ. transfer characteristics	Typ. gate charge
 $I_D = f(V_{GS}); V_{DS} = 20V$	 $V_{GS} = f(Q_{gate}), I_D = 44.4 \text{ A pulsed}$

Table 13

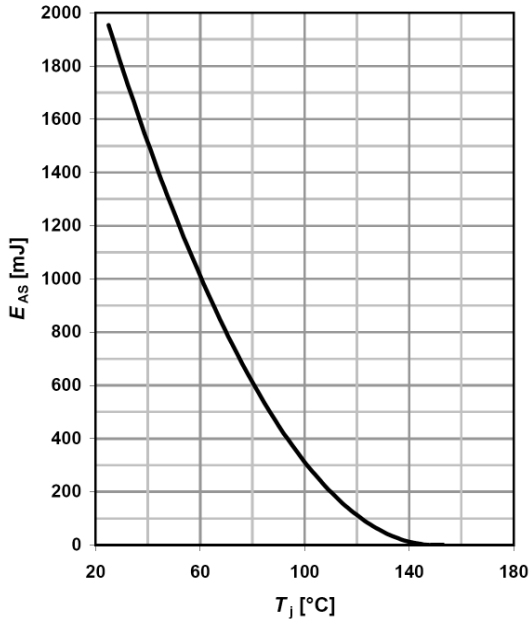
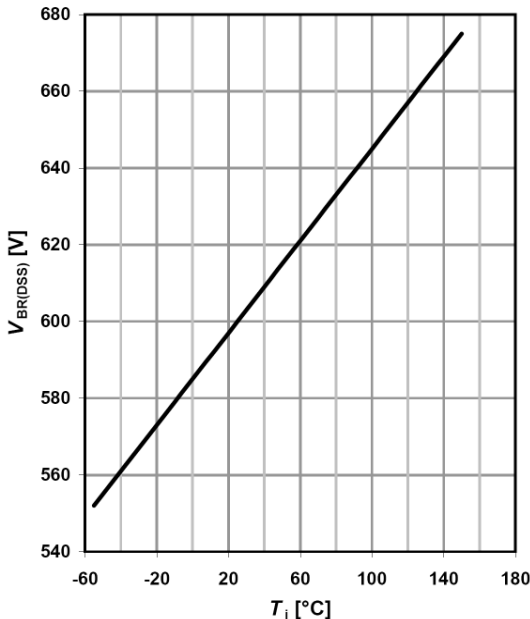
Avalanche energy	Drain-source breakdown voltage
 $E_{AS} = f(T_j); I_D = 13.4 \text{ A}; V_{DD} = 50 \text{ V}$	 $V_{BR(DSS)} = f(T_j); I_D = 0.25 \text{ mA}$

Table 14

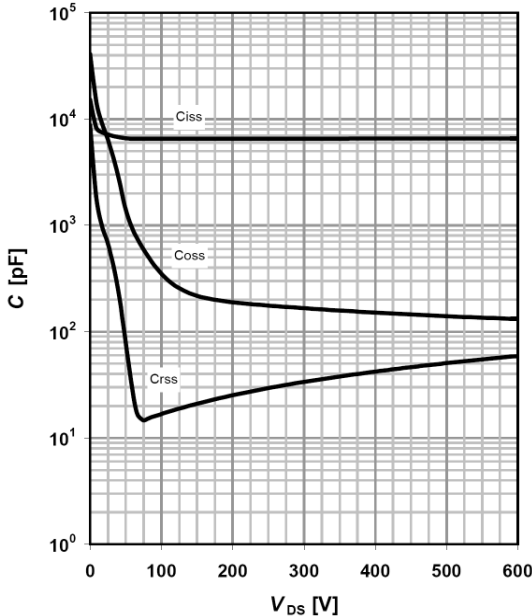
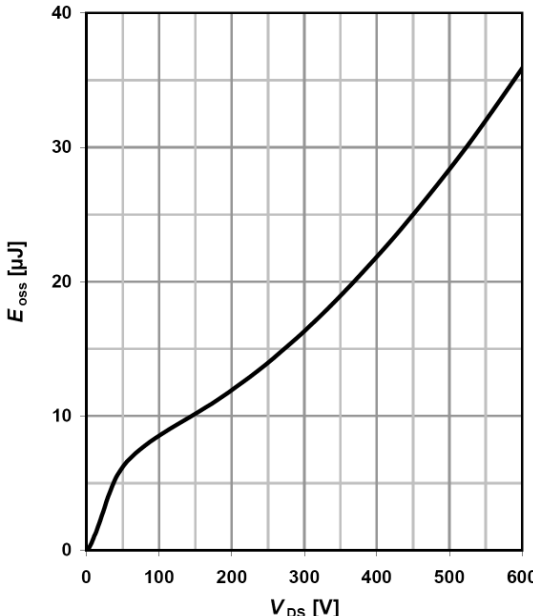
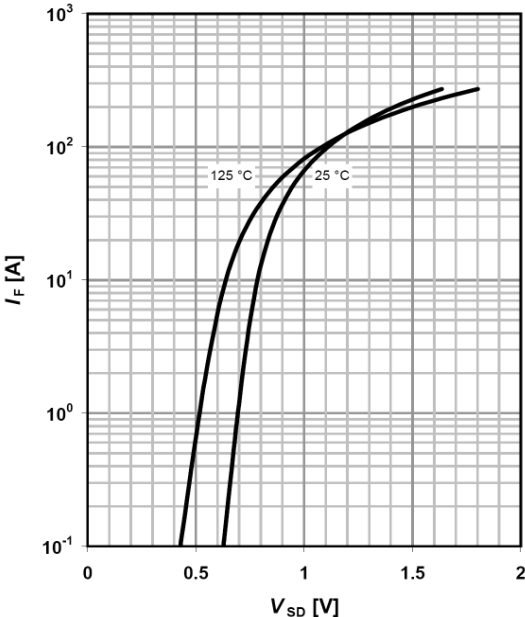
Typ. capacitances	Typ. C_{oss} stored energy
 $C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$	 $E_{oss} = f(V_{DS})$

Table 15

Forward characteristics of reverse diode
 $I_F = f(V_{SD}); \text{parameter: } T_j$

7 Package outlines

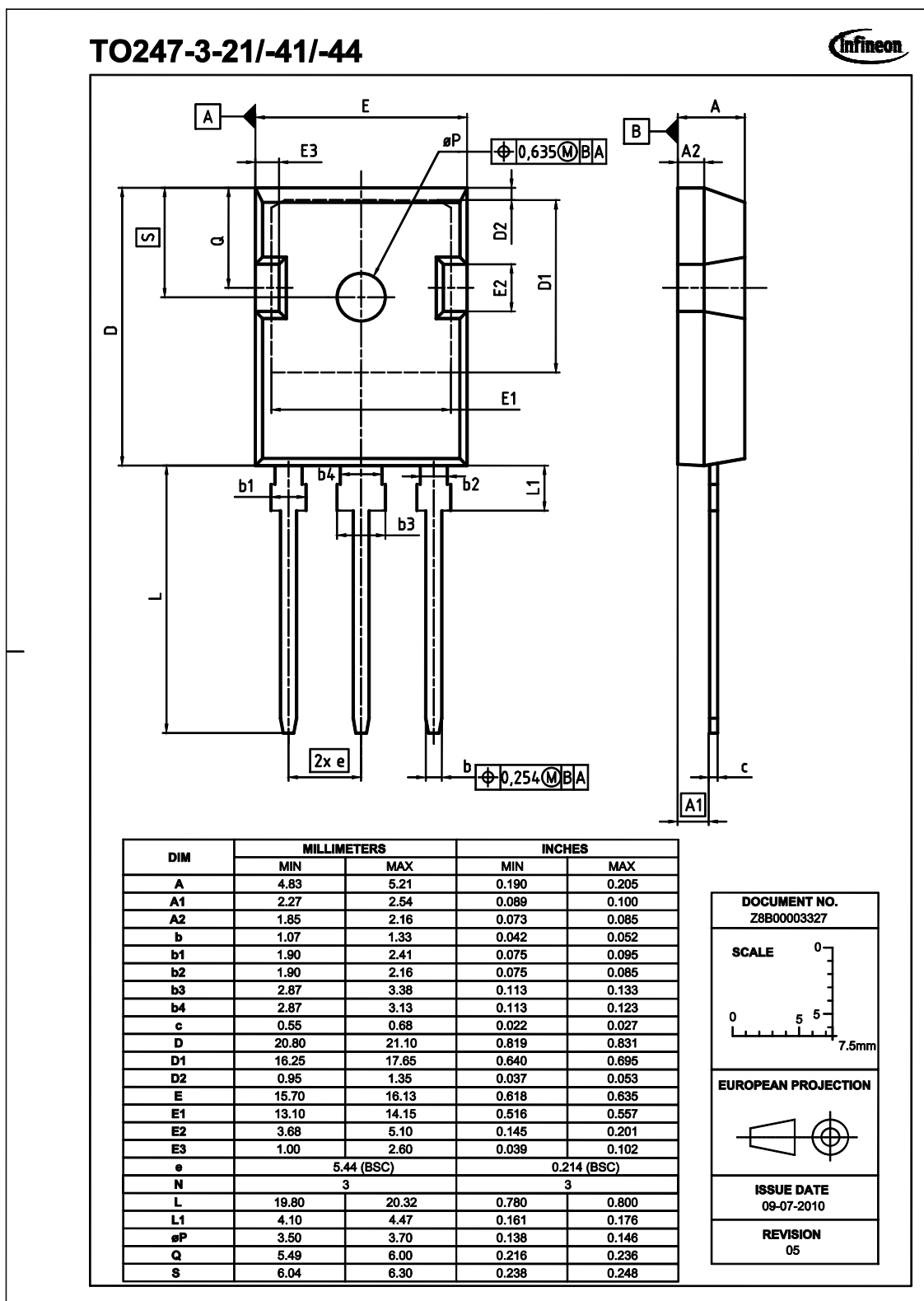


Figure 1 Outlines TO-247, dimensions in mm/inches

8 Revision History

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Edition 2010-07-12

Published by

Infineon Technologies AG

81726 Munich, Germany

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