

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.

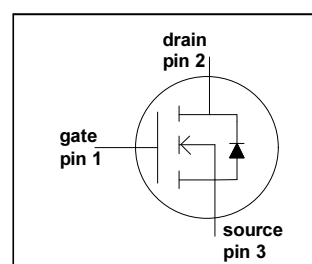


Table 1 Key Performance Parameters

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

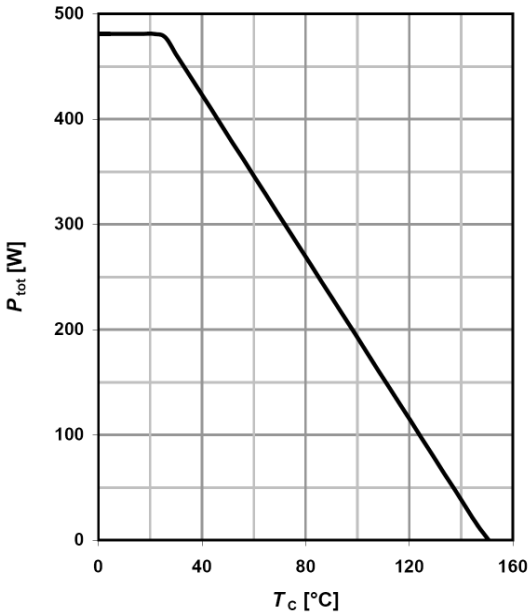
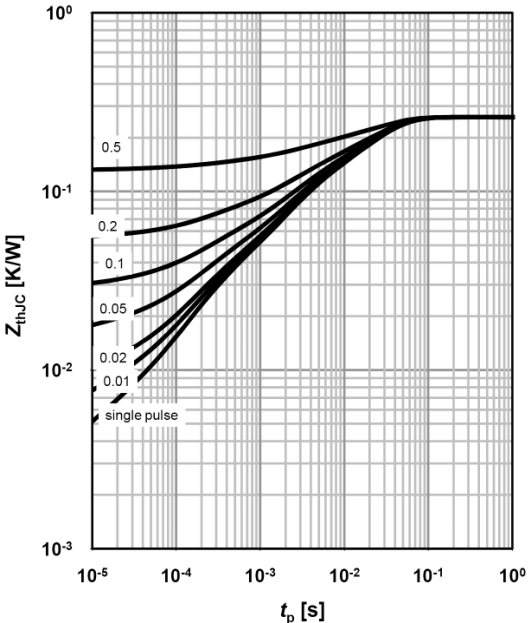
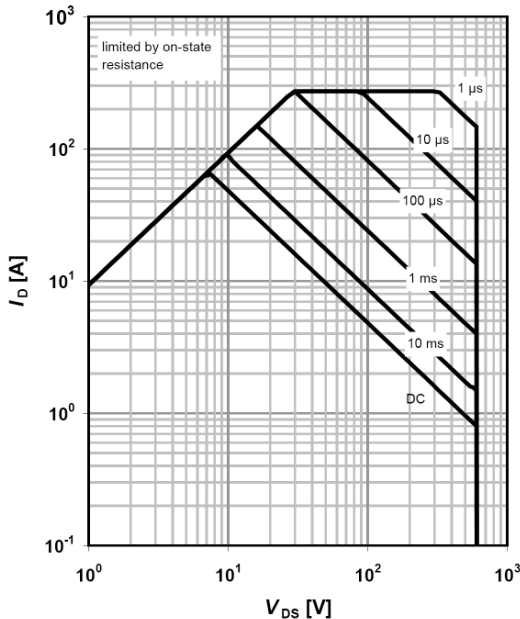
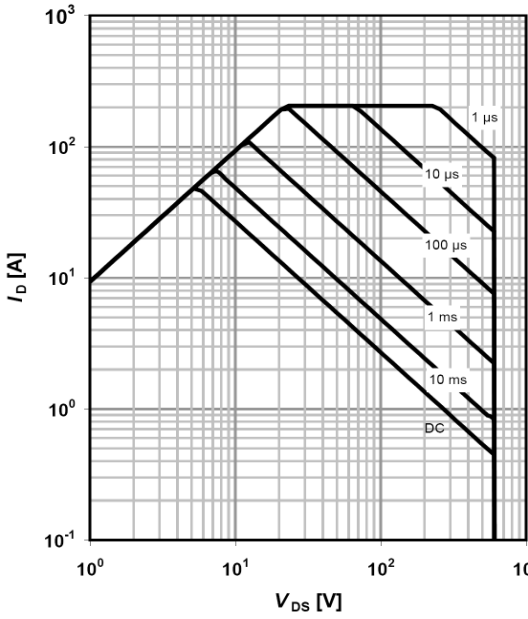
Power dissipation	Max. transient thermal impedance
 $P_{\text{tot}} = f(T_c)$	 $Z_{\text{thJC}} = f(t_p)$; parameter: $D = t_p / T$

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

Electrical characteristics diagrams

Table 10

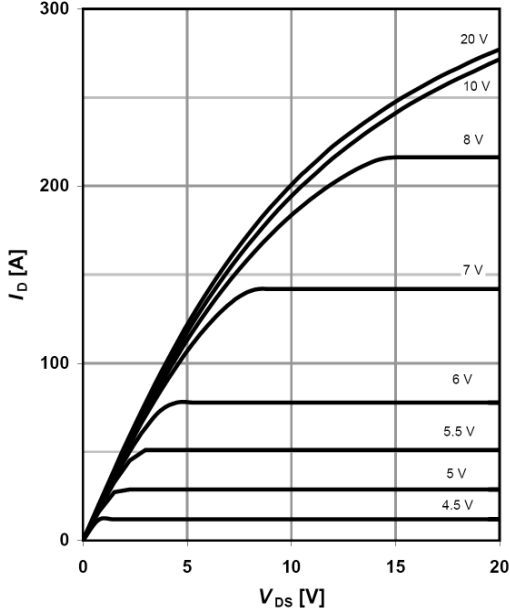
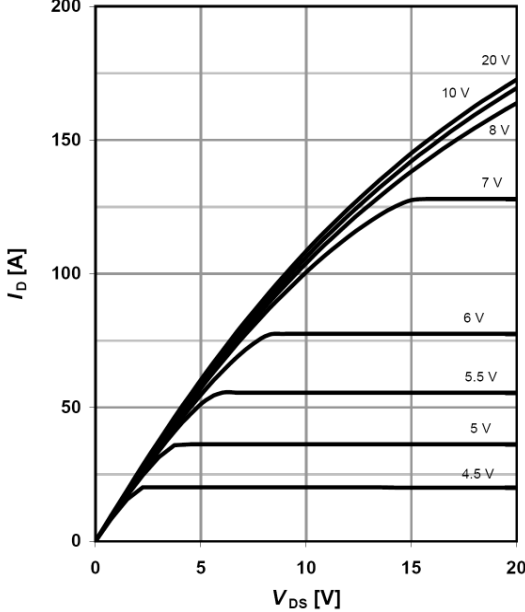
Typ. output characteristics $T_j=25\text{ °C}$	Typ. output characteristics $T_j=125\text{ °C}$
	
$I_D=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$	$I_D=f(V_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

Table 11

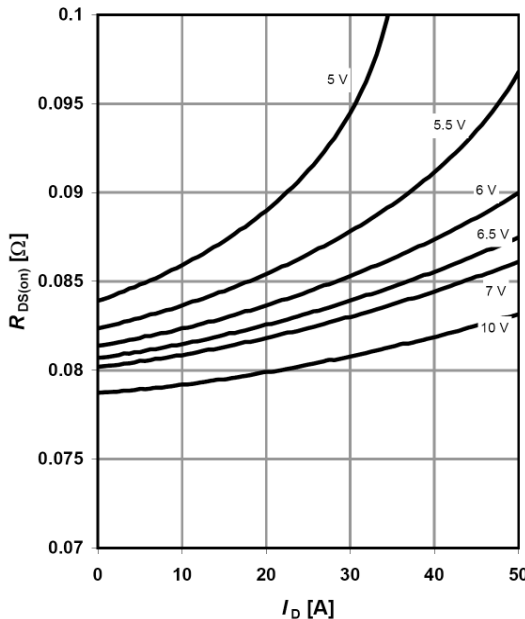
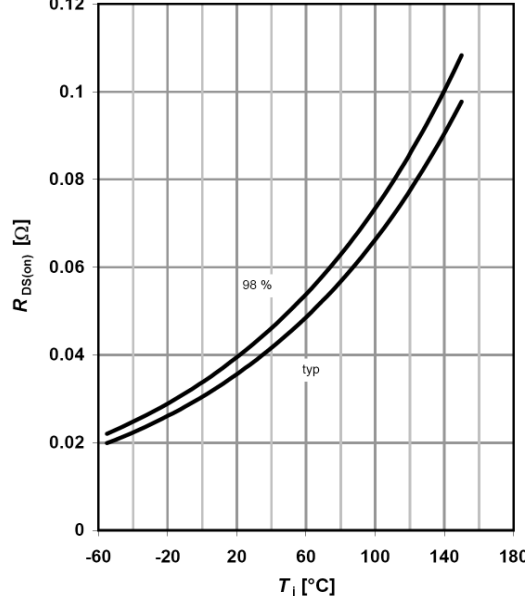
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}=f(I_D); T_j=125\text{ °C}; \text{parameter: } V_{GS}$	$R_{DS(on)}=f(T_j); I_D=44.4\text{ A}; V_{GS}=10\text{ V}$

Table 12

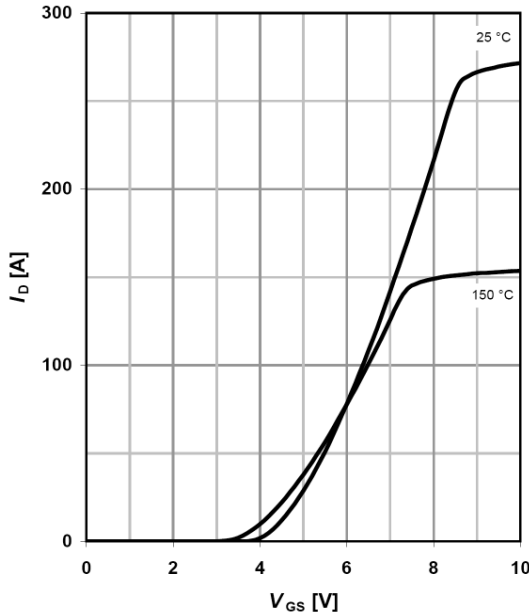
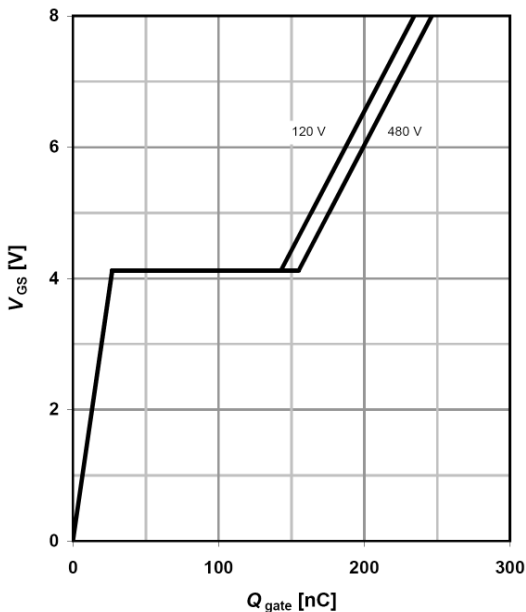
Typ. transfer characteristics	Typ. gate charge
 $I_D = f(V_{GS}); V_{DS} = 20V$	 $V_{GS} = f(Q_{gate}), I_D = 44.4 \text{ A pulsed}$

Table 13

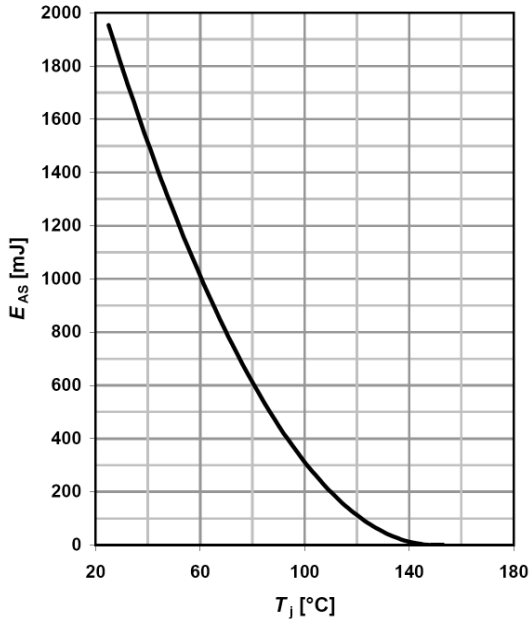
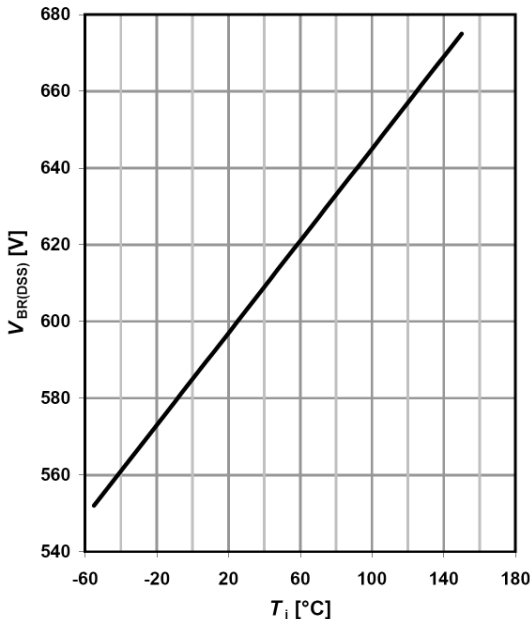
Avalanche energy	Drain-source breakdown voltage
 $E_{AS} = f(T_j); I_D = 13.4 \text{ A}; V_{DD} = 50 \text{ V}$	 $V_{BR(DSS)} = f(T_j); I_D = 0.25 \text{ mA}$

Table 14

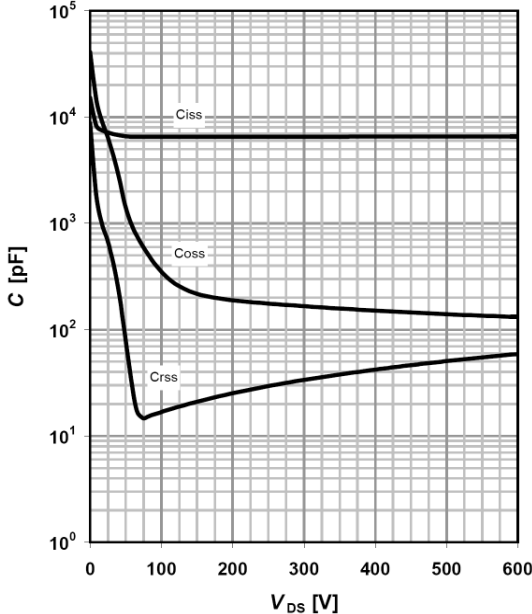
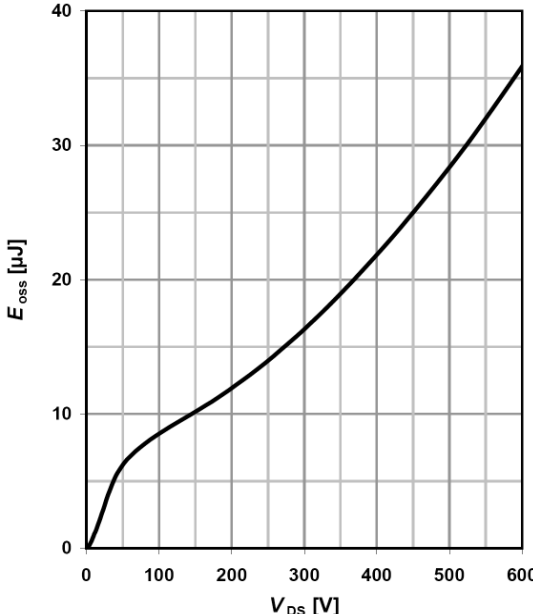
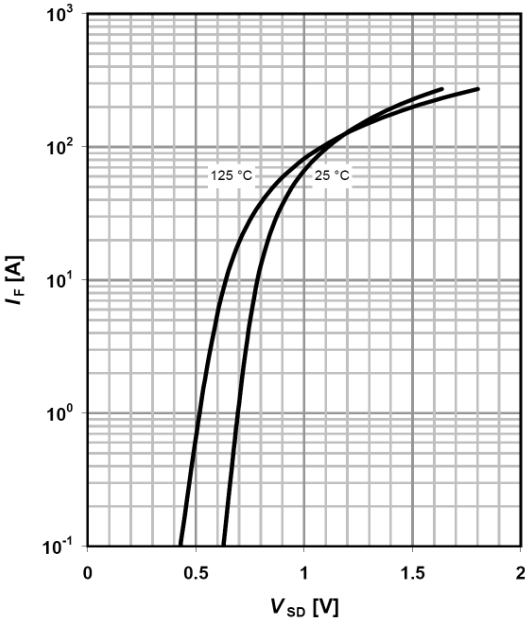
Typ. capacitances	Typ. C_{oss} stored energy
 $C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$	 $E_{oss} = f(V_{DS})$

Table 15

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

6 Test circuits

Table 16 Switching times test circuit and waveform for inductive load

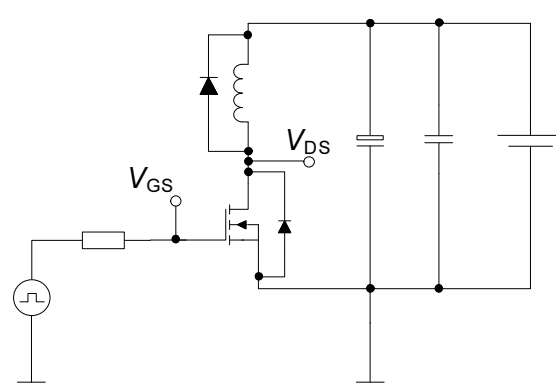
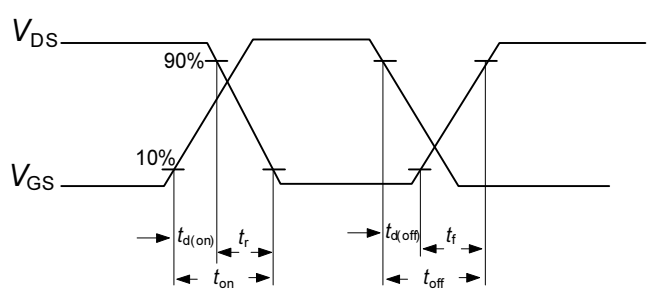
Switching times test circuit for inductive load	Switching time waveform
	

Table 17 Unclamped inductive load test circuit and waveform

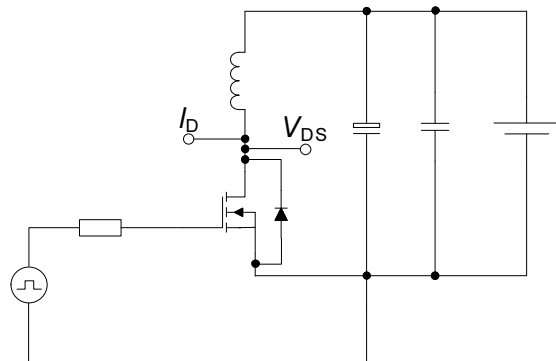
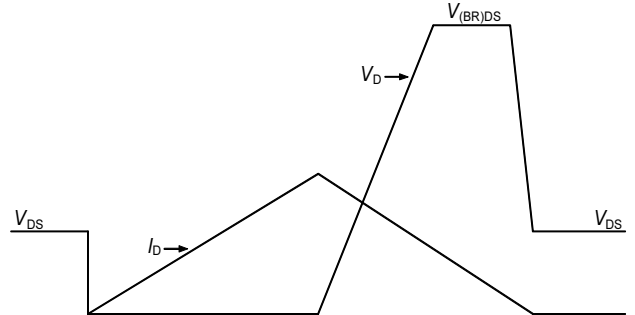
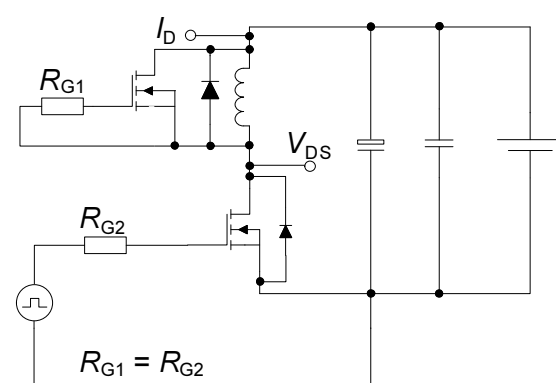
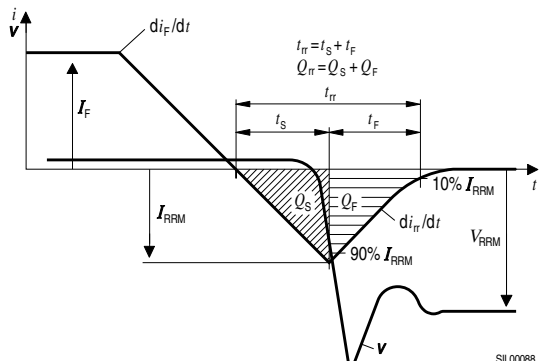
Unclamped inductive load test circuit	Unclamped inductive waveform
	

Table 18 Test circuit and waveform for diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
 $R_{G1} = R_{G2}$	 i v I_F I_{RRM} t_{rr} Q_{rr} $10\% I_{RRM}$ $90\% I_{RRM}$ V_{RRM} $d i_F / d t$ $d i_{rr} / d t$ $t_{rr} = t_s + t_f$ $Q_{rr} = Q_s + Q_f$ SIL00088

7 Package outlines

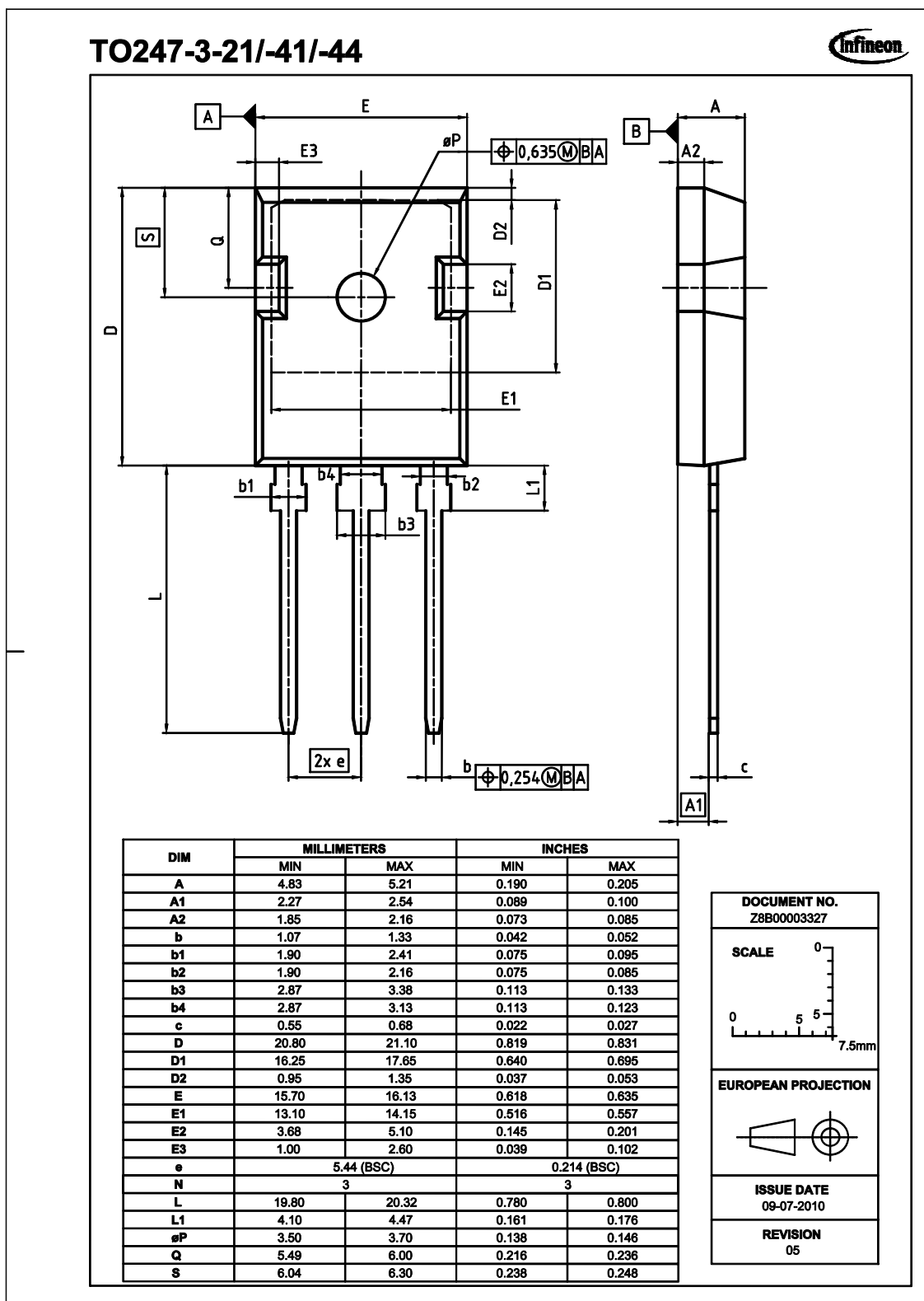


Figure 1 Outlines TO-247, dimensions in mm/inches

8 Revision History

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