MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS C6

600V CoolMOS™ C6 Power Transistor
IPW60R041C6

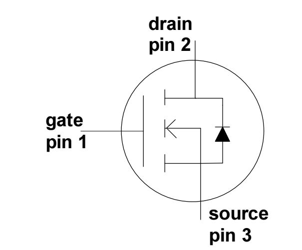
Data Sheet

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_{dson}*Q_g and E_{oss}
- Very high commutation ruggedness
- Easy to use/drive
- JEDEC[1] 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

Table of Contents

2 Maximum ratings

at T_j = 25 °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 °C
				49		T_C= 100°C
Pulsed drain current[2)]	$I_{D,pulse}$	-	-	272	A	T_C=25 °C
Avalanche energy, single pulse	E_{AS}	-	-	1954	mJ	I_D=13.4 A, V_{DD}=50 V (see table 17)
Avalanche energy, repetitive	E_{AR}	-	-	2.96		I_D=13.4 A, V_{DD}=50 V
Avalanche current, repetitive	I_{AR}	-	-	13.4	A	
MOSFET dv/dt ruggedness	dv/dt	-	-	50	V/ns	V_{DS}=0...480 V
Gate source voltage	V_{GS}	-20	-	20	V	static
		-30		30		AC (f>1 Hz)
Power dissipation	P_{tot}	-	-	481	W	T_C=25 °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 °C
Diode pulse current[2)]	$I_{S,pulse}$	-	-	272	A	T_C=25 °C
Reverse diode dv/dt[3)]	dv/dt	-	-	15	V/ns	V_{DS}=0...400 V, $I_{SD} \leq I_D$, T_j=25 °C
Maximum diode commutation speed[3)]	di_f/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 Tj=25 °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 V, I_D=0.25 mA
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5		V_{DS}=V_{GS}, I_D=2.96 mA
Zero gate voltage drain current	I_{DSS}	-	-	5	µA	V_{DS}=600 V, V_{GS}=0 V, T_j=25 °C
		-	50	-		V_{DS}=600 V, V_{GS}=0 V, T_j=150 °C
Gate-source leakage current	I_{GSS}	-	-	100	nA	V_{GS}=20 V, V_{DS}=0 V
Drain-source on-state resistance	$R_{DS(on)}$	-	0.037	0.041	Ω	V_{GS}=10 V, I_D=44.4 A, T_j=25 °C
		-	0.096	-		V_{GS}=10 V, I_D=44.4 A, T_j=150 °C
Gate resistance	R_G	-	0.7	-	Ω	f=1 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 V, V_{DS}=100 V, f=1 MHz
Output capacitance	C_{oss}	-	360	-		
Effective output capacitance, energy related[1)]	$C_{o(er)}$	-	235	-		V_{GS}=0 V, V_{DS}=0...480 V
Effective output capacitance, time related[2)]	$C_{o(tr)}$	-	1210	-		I_D=constant, V_{GS}=0 V V_{DS}=0...480V
Turn-on delay time	$t_{d(on)}$	-	23	-	ns	V_{DD}=400 V, V_{GS}=13 V, I_D=44.4A, R_G= 1.7Ω (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 V, I_D=44.4 A, V_{GS}=0 to 10 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 V, I_F=44.4 A, T_j=25 °C
Reverse recovery time	t_{rr}	-	950	-	ns	V_R=400 V, I_F=44.4 A, di_F/dt=100 A/µs (see table 18)
Reverse recovery charge	Q_{rr}	-	32	-	µC	
Peak reverse recovery current	I_{rrm}	-	62	-	A	

5 Electrical characteristics diagrams

Table 8

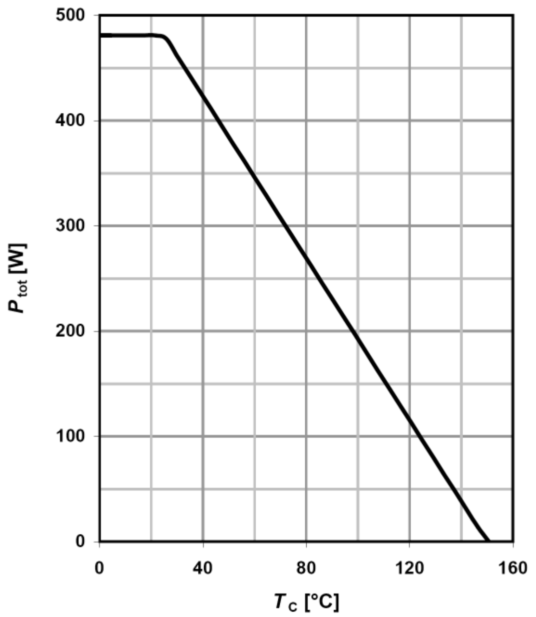
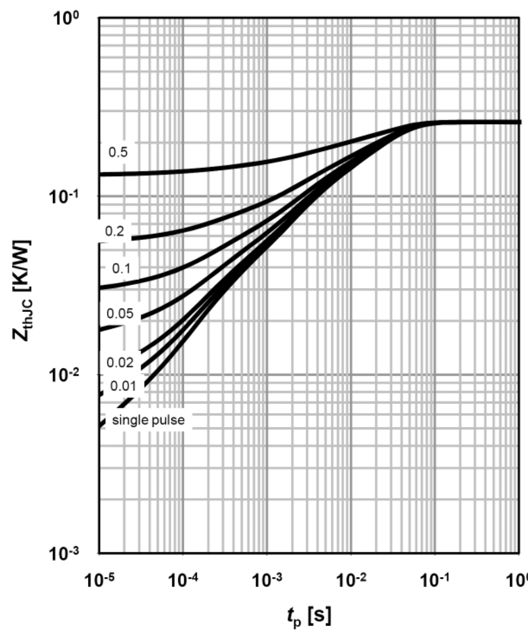
Power dissipation	**Max. transient thermal impedance**
	
P_{tot} = f(T_C)	$Z_{(thJC)}$=f(tp); parameter: D=t_p/T

Table 9

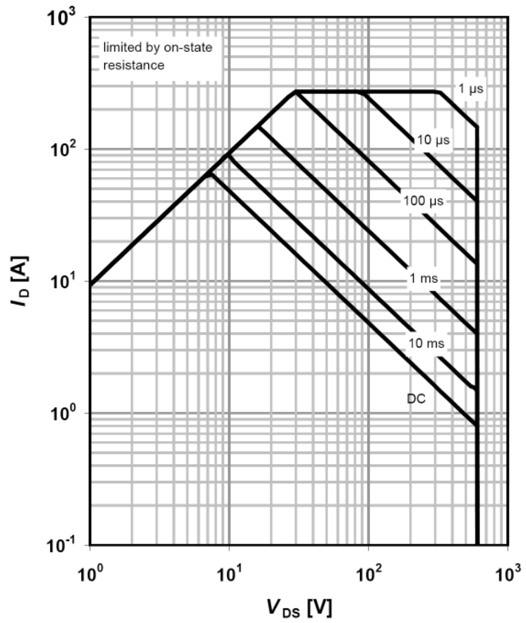
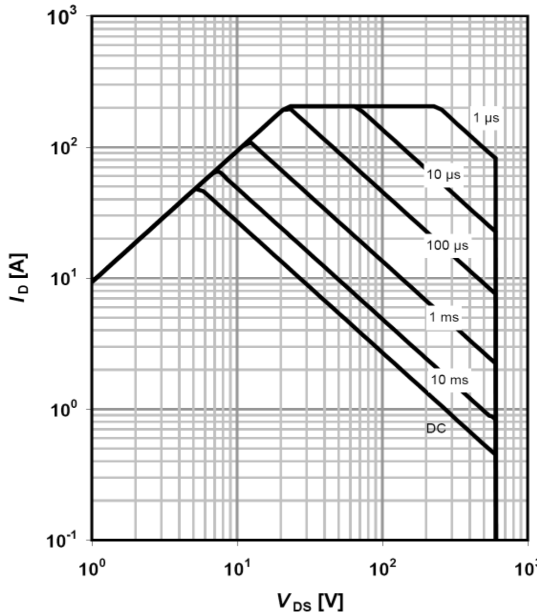
Safe operating area T_C=25 °C	**Safe operating area T_C=80 °C**
	
I_D=f(V_{DS}); T_C=25 °C; D=0; parameter t_p	I_D=f(V_{DS}); T_C=80 °C; D=0; parameter t_p

Table 10

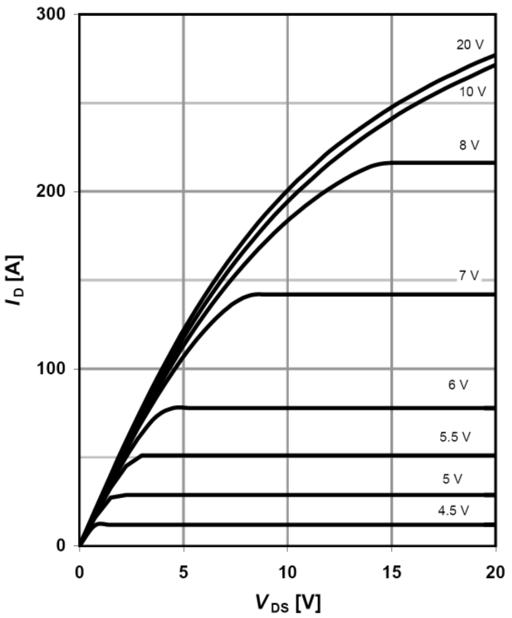
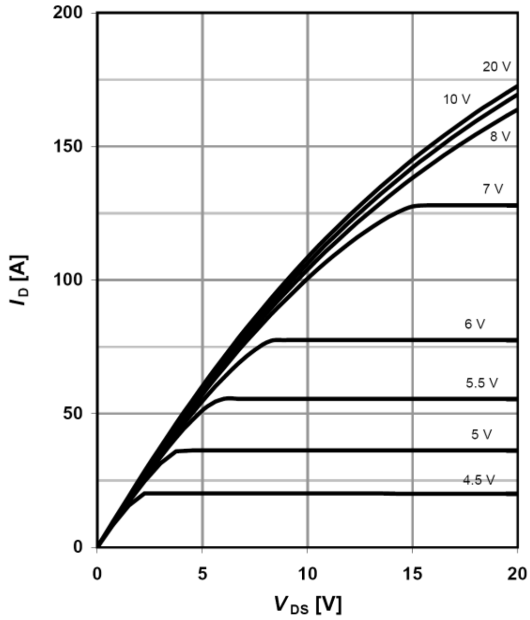
Typ. output characteristics T_j=25 °C	Typ. output characteristics T_j=125 °C
	
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}	I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

Table 11

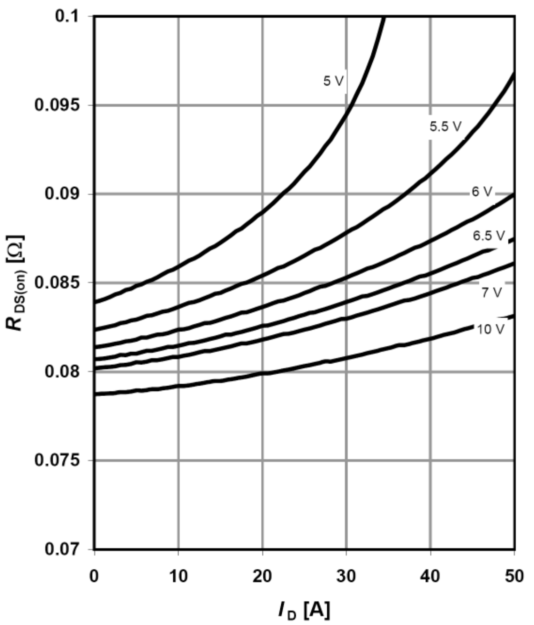
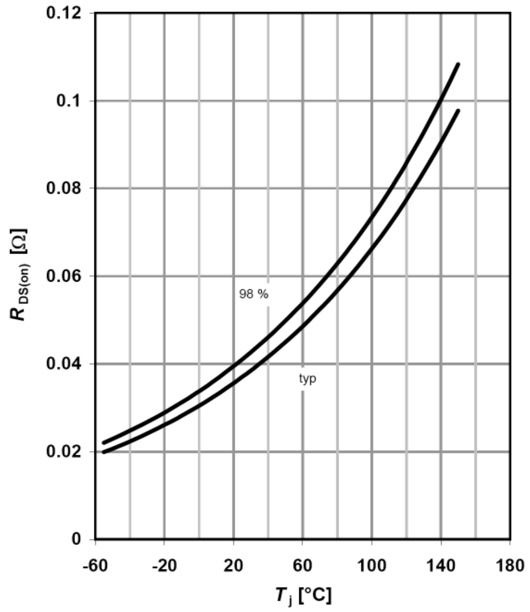
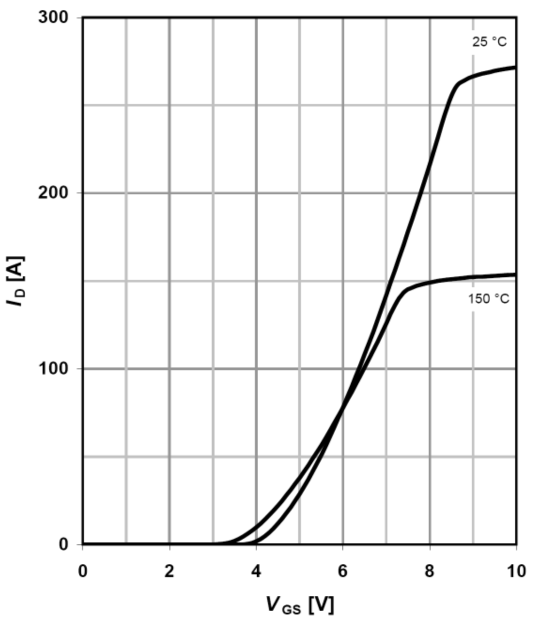
Typ. drain-source on-state resistance	Drain-source on-state resistance
	
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}	$R_{DS(on)}$=f(T_j); I_D=44.4 A; V_{GS}=10 V

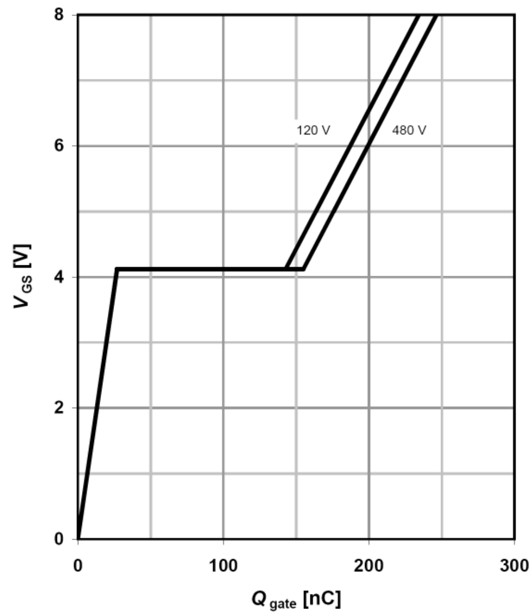
Table 12

Typ. transfer characteristics



I_D=f(V_{GS}); V_{DS}=20V

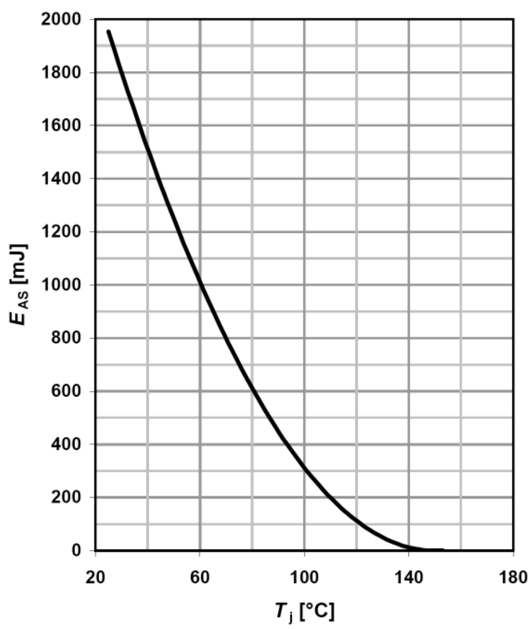
Typ. gate charge



V_{GS}=f(Q_{gate}), I_D=44.4 A pulsed

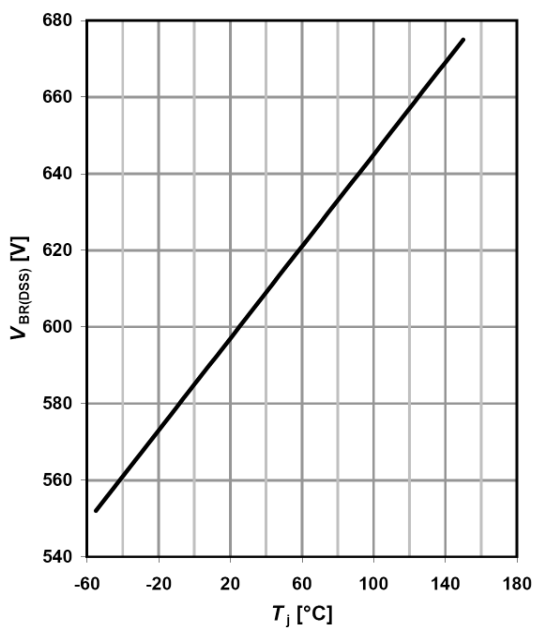
Table 13

Avalanche energy



E_{AS}=f(T_j); I_D=13.4 A; V_{DD}=50 V

Drain-source breakdown voltage



$V_{BR(DSS)}$=f(T_j); I_D=0.25 mA

Table 14

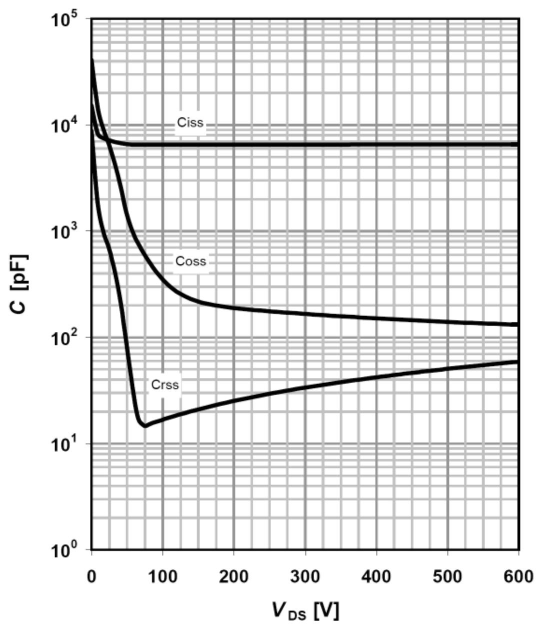
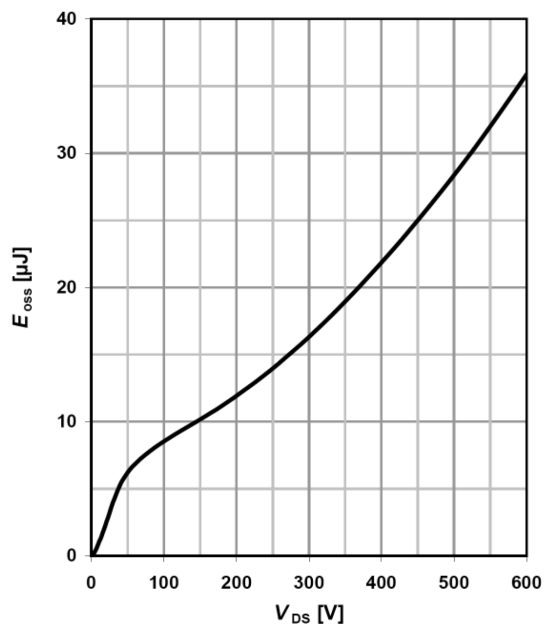
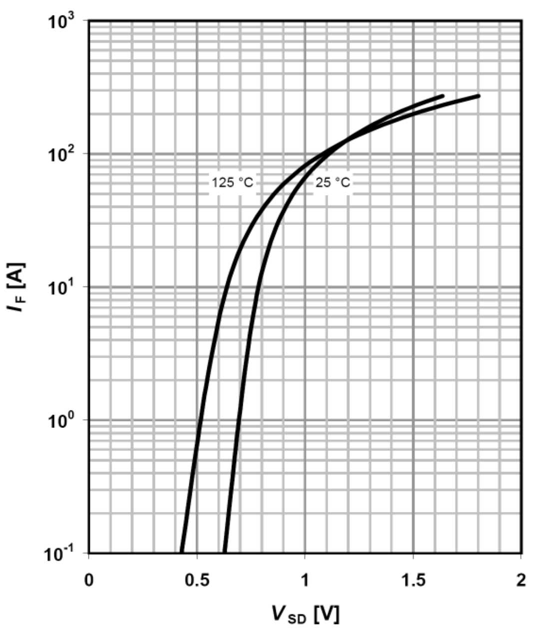
<table>
<tr><th>Typ. capacitances</th><th>Typ. C_{oss} stored energy</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>C=f(V_{DS}); V_{GS}=0 V; f=1 MHz</td><td>E_{oss}=f(V_{DS})</td></tr>
</table>

Table 15

<table>
<tr><th>Forward characteristics of reverse diode</th></tr>
<tr><td>
</td></tr>
<tr><td>I_F=f(V_{SD}); parameter: T_j</td></tr>
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6 Test circuits

Table 16 Switching times test circuit and waveform for inductive load

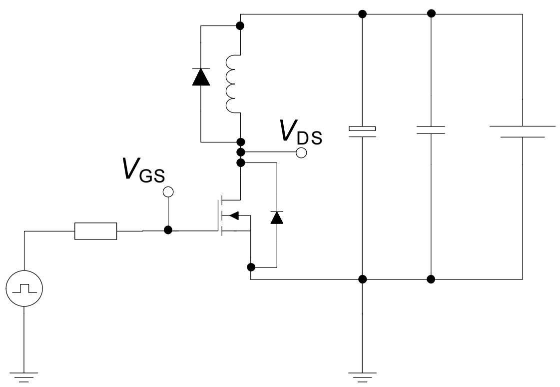
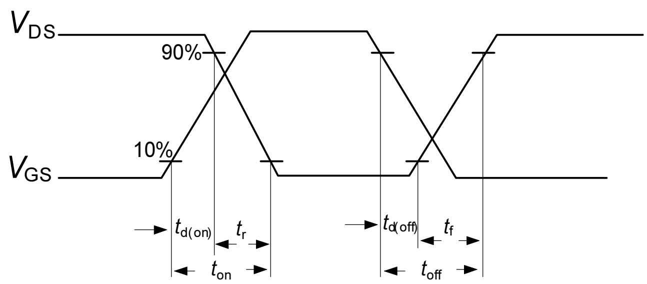
Switching times test circuit for inductive load	Switching time waveform
	

Table 17 Unclamped inductive load test circuit and waveform

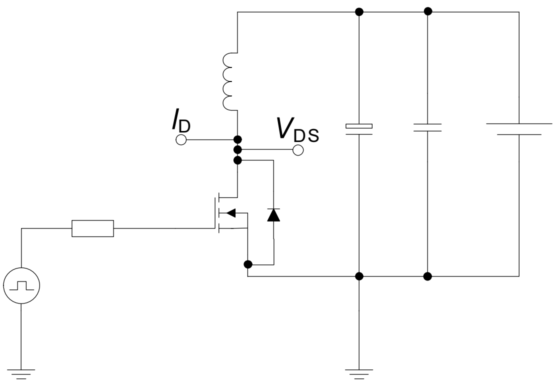
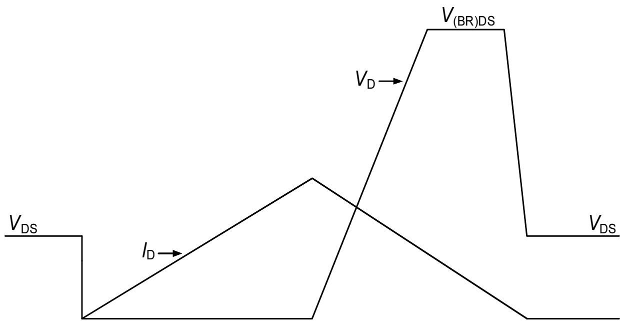
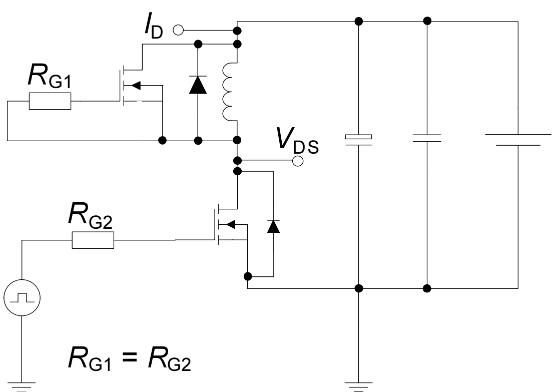
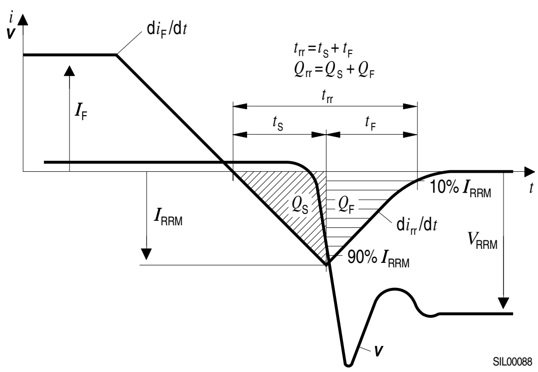
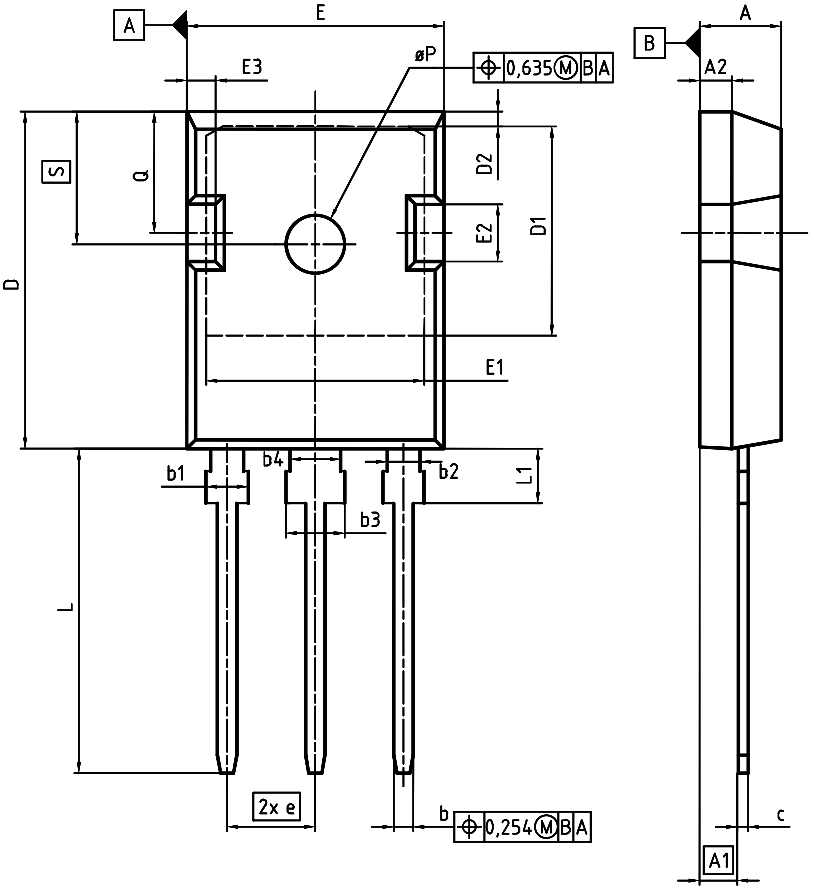
Unclamped inductive load test circuit	Unclamped inductive waveform
	

Table 18 Test circuit and waveform for diode characteristics

Test circuit for diode characteristics	Diode recovery waveform
	

7 Package outlines

TO247-3-21/-41/-44



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
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	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	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

DOCUMENT NO.
Z8B00003327

SCALE 0 5 7.5mm

EUROPEAN PROJECTION

ISSUE DATE
09-07-2010

REVISION
05

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

8 Revision History

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