

# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS C6

600V CoolMOS™ C6 Power Transistor  
IPD60R1K4C6

## Data Sheet

Rev. 2.0, 2010-07-19  
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 resulting 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
- JEDEC<sup>1)</sup> qualified, Pb-free plating

### 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.

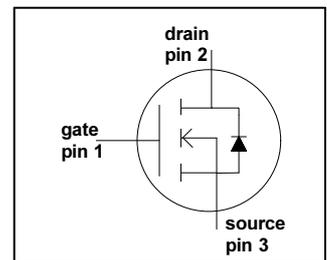
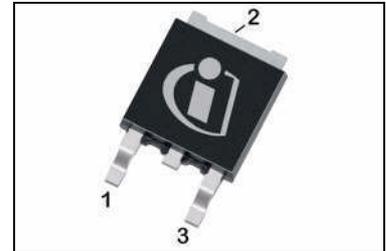


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	1.4	$\Omega$
$Q_{g,typ}$	9.4	nC
$I_{D,pulse}$	8	A
$E_{oss} @ 400V$	1	$\mu J$
Body diode $di/dt$	500	A/ $\mu s$

Type / Ordering Code	Package	Marking	Related Links
IPD60R1K4C6	PG-TO252	6R1K4C6	<a href="#">IFX C6 Product Brief</a> <a href="#">IFX C6 Portfolio</a> <a href="#">IFX CoolMOS Webpage</a> <a href="#">IFX Design tools</a>

1) J-STD20 and JESD22

## Table of Contents

1	Description .....	2
	Table of Contents .....	3
2	Maximum Ratings .....	4
3	Thermal characteristics .....	5
4	Electrical characteristics .....	6
5	Electrical characteristics diagrams .....	8
6	Test circuits .....	12
7	Package outlines .....	13
8	Revision History .....	14

## 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 <sup>1)</sup>	$I_D$	-	-	3.2	A	$T_C = 25\text{ °C}$
				2.0		$T_C = 100\text{ °C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	8	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	26	mJ	$I_D = 0.6\text{ A}, V_{DD} = 50\text{ V}$ (see table 17)
Avalanche energy, repetitive	$E_{AR}$	-	-	0.09		$I_D = 0.6\text{ A}, V_{DD} = 50\text{ V}$
Avalanche current, repetitive	$I_{AR}$	-	-	0.6	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	$P_{tot}$	-	-	28.4	W	$T_C = 25\text{ °C}$
Operating and storage temperature	$T_j, T_{stg}$	-55	-	150	°C	
Continuous diode forward current	$I_S$	-	-	2.8	A	$T_C = 25\text{ °C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	8	A	$T_C = 25\text{ °C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 480\text{ V}, I_{SD} \leq I_D,$ $T_j = 25\text{ °C}$
Maximum diode commutation speed <sup>3)</sup>	di/dt			500	A/ $\mu\text{s}$	(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**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	4.4	°C/W	
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	62		SMD version, device on PCB, minimal footprint
			35			SMD version, device on PCB, 6cm <sup>2</sup> cooling area <sup>1)</sup>
Soldering temperature, wave- & reflowsoldering allowed	$T_{sold}$	-	-	260	°C	reflow MSL1

1) Device on 40mm\*40mm\*1.5 epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70µm thick) copper area for drain connection. PCB is vertical without air stream cooling

## 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		$V_{DS}=V_{GS}$ , $I_D=0.09\text{ mA}$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_J=25\text{ °C}$
		-	10	-		$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_J=150\text{ °C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	1.26	1.4	$\Omega$	$V_{GS}=10\text{ V}$ , $I_D=1.1\text{ A}$ , $T_J=25\text{ °C}$
		-	3.28	-		$V_{GS}=10\text{ V}$ , $I_D=1.1\text{ A}$ , $T_J=150\text{ °C}$
Gate resistance	$R_G$	-	14	-	$\Omega$	$f=1\text{ MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition	
		Min.	Typ.	Max.			
Input capacitance	$C_{iss}$	-	200	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$	
Output capacitance	$C_{oss}$	-	16	-			
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	11	-			$V_{GS}=0\text{ V}$ , $V_{DS}=0\dots480\text{ V}$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	41.3	-			$I_D=\text{constant}$ , $V_{GS}=0\text{ V}$ $V_{DS}=0\dots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	8	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=10\text{ V}$ , $I_D=1.4\text{ A}$ , $R_G=12.2\text{ }\Omega$ (see table 16)	
Rise time	$t_r$	-	7	-			
Turn-off delay time	$t_{d(off)}$	-	40	-			
Fall time	$t_f$	-	20	-			

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	$Q_{gs}$	-	1.1	-	nC	$V_{DD}=480\text{ V}$ , $I_D=1.4\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	5	-		
Gate charge total	$Q_g$	-	9.4	-		
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	$V_{GS}=0\text{ V}$ , $I_F=1.4\text{ A}$ , $T_j=25\text{ °C}$
Reverse recovery time	$t_{rr}$	-	230	-	ns	$V_R=400\text{ V}$ , $I_F=1.4\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 18)
Reverse recovery charge	$Q_{rr}$	-	1.1	-	$\mu\text{C}$	
Peak reverse recovery current	$I_{rrm}$	-	9.8	-	A	

5 Electrical characteristics diagrams

Table 8

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

Table 9

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

Table 10

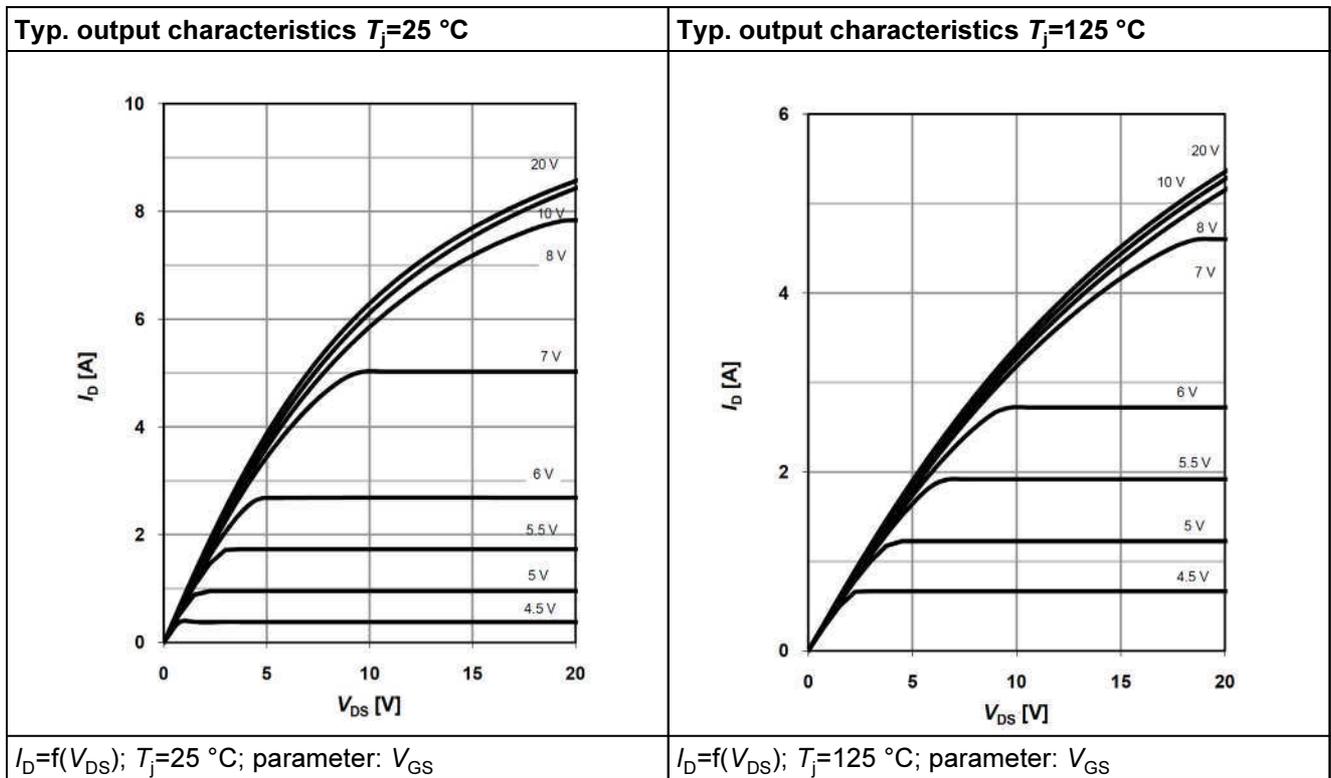


Table 11

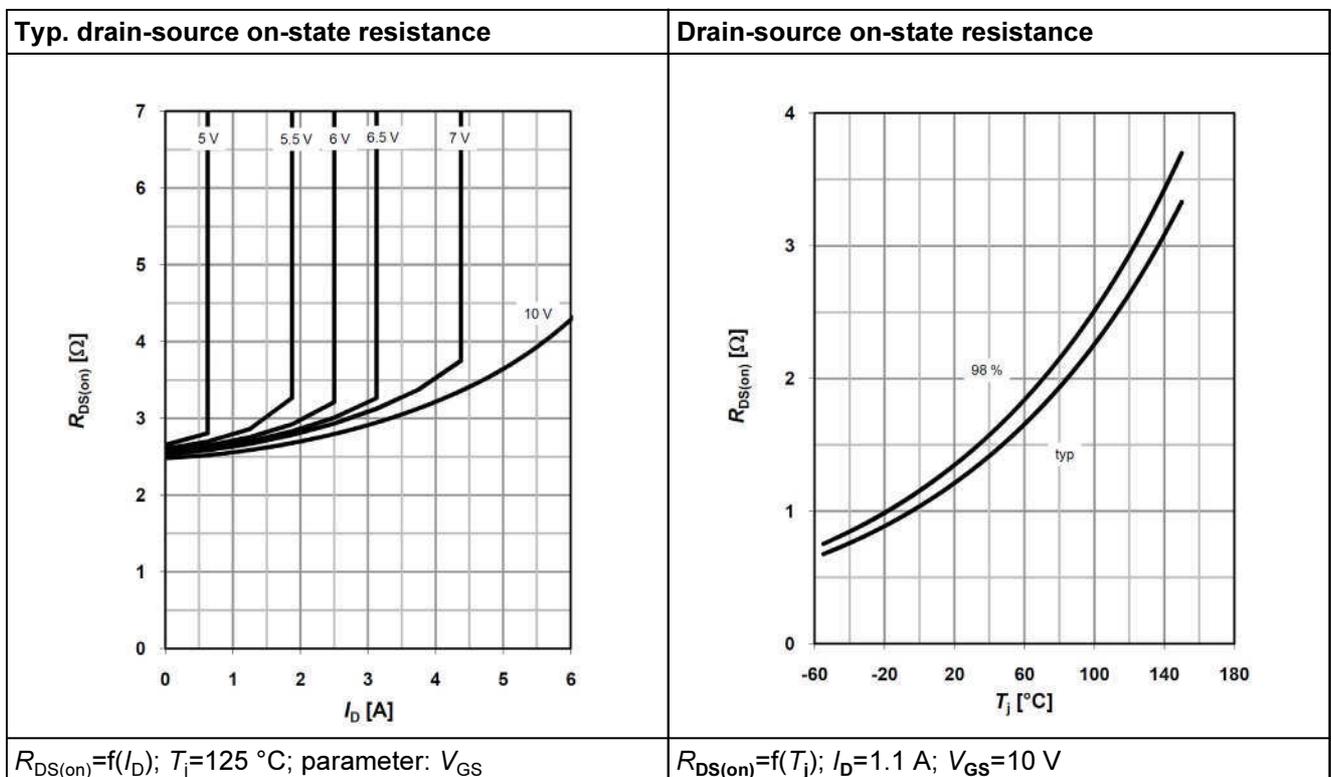


Table 12

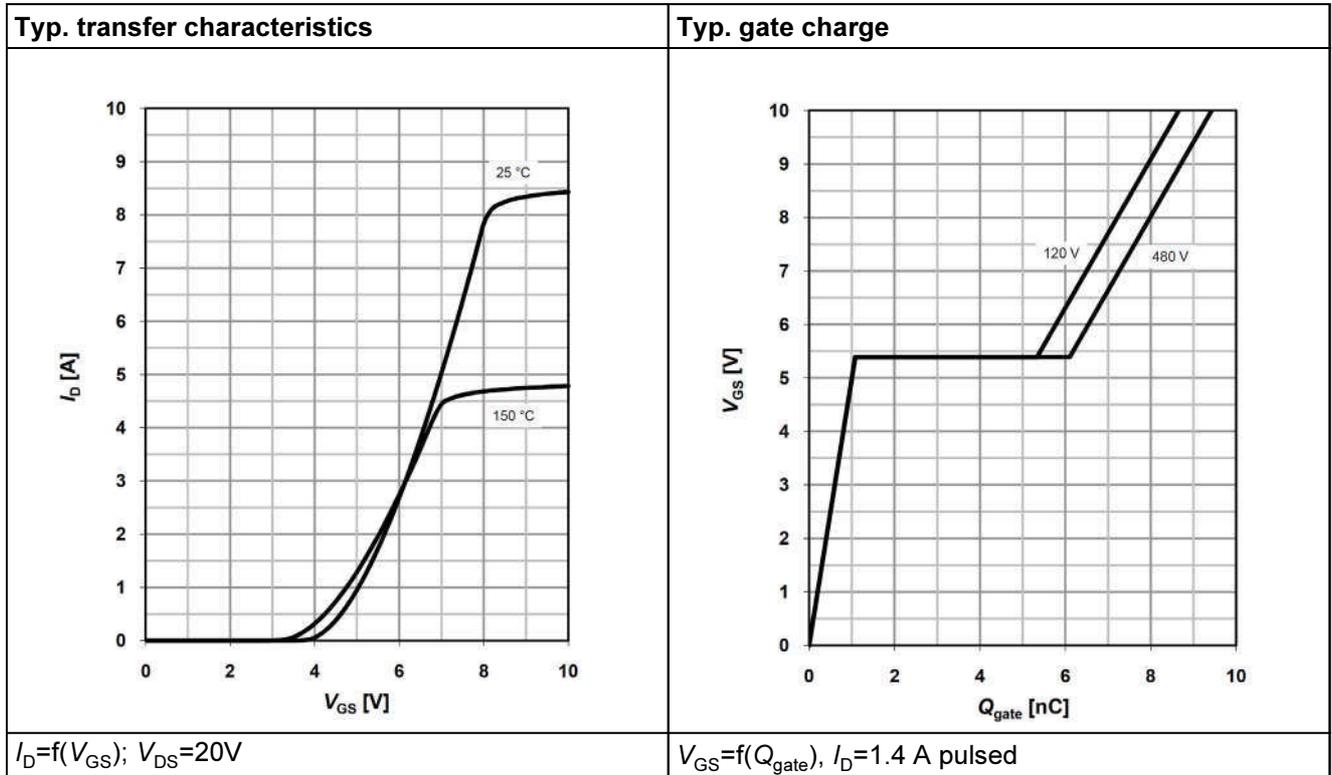


Table 13

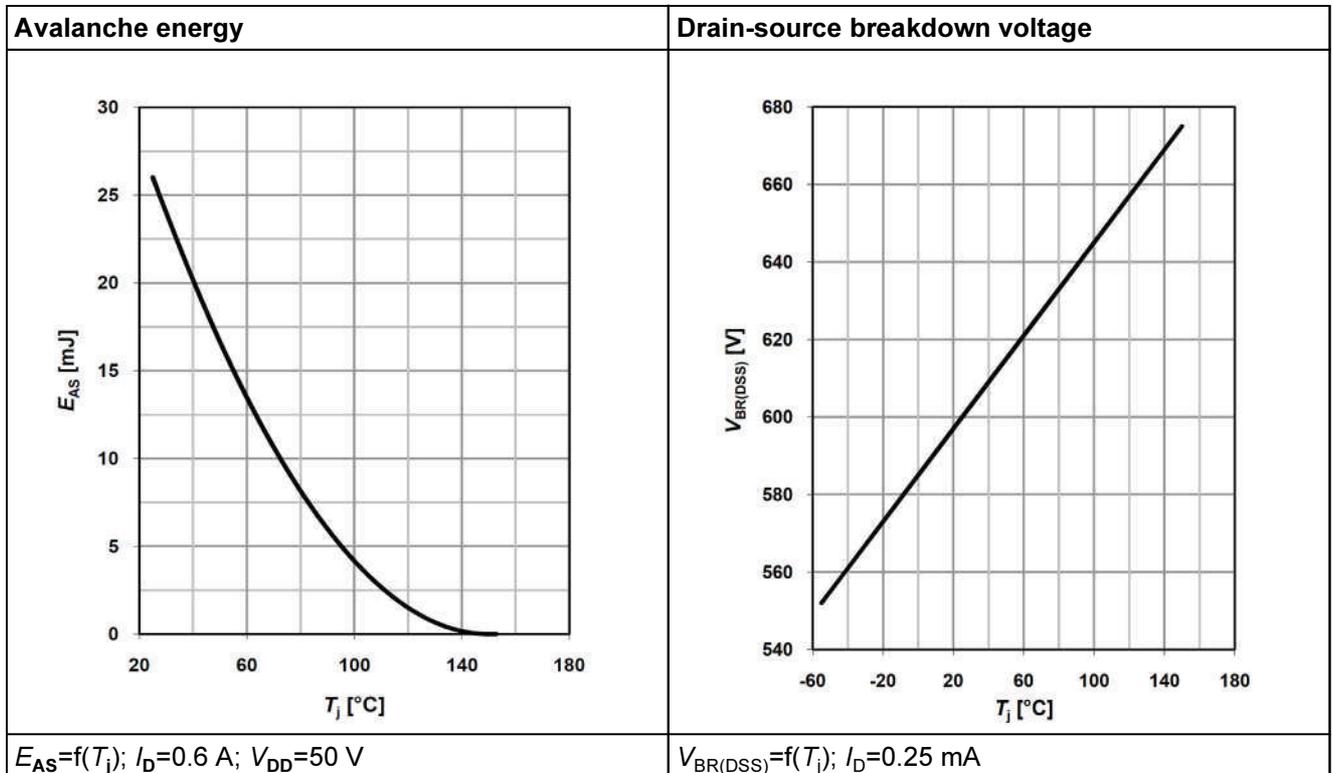


Table 14

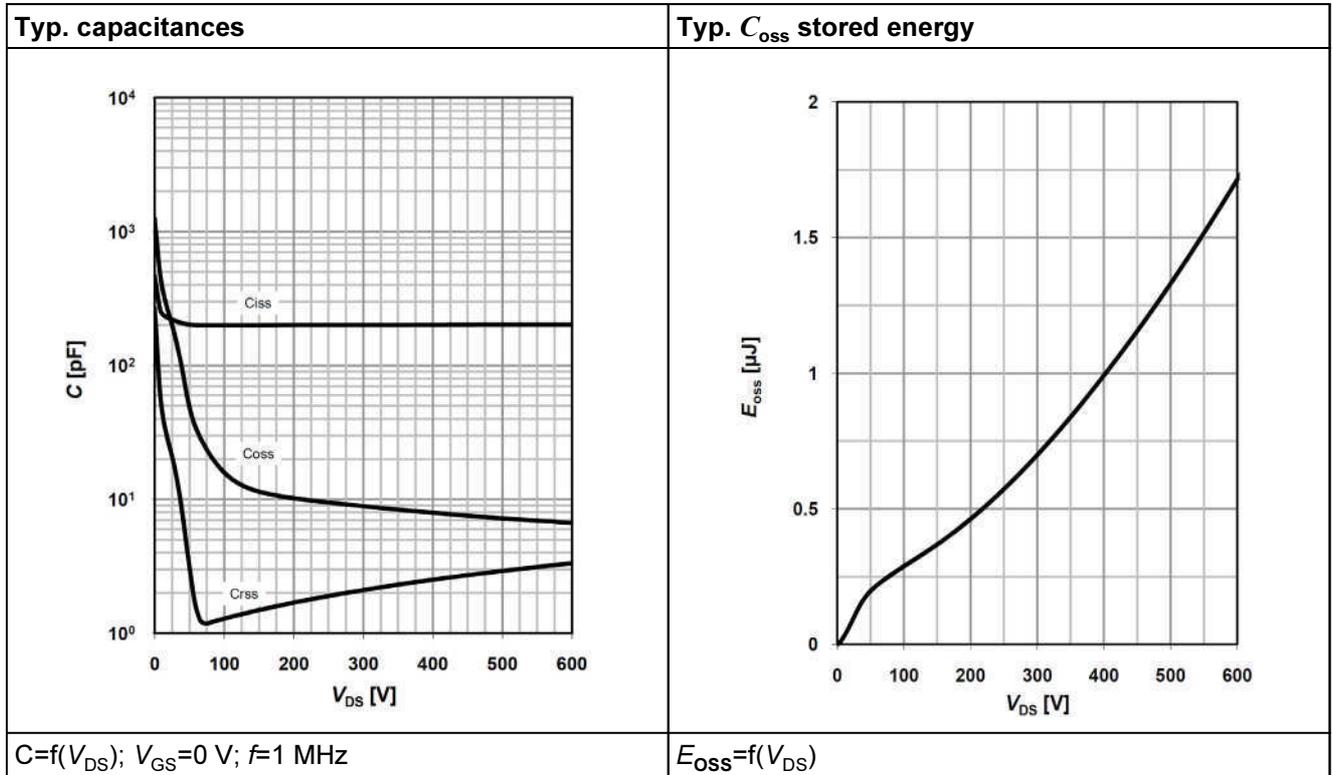
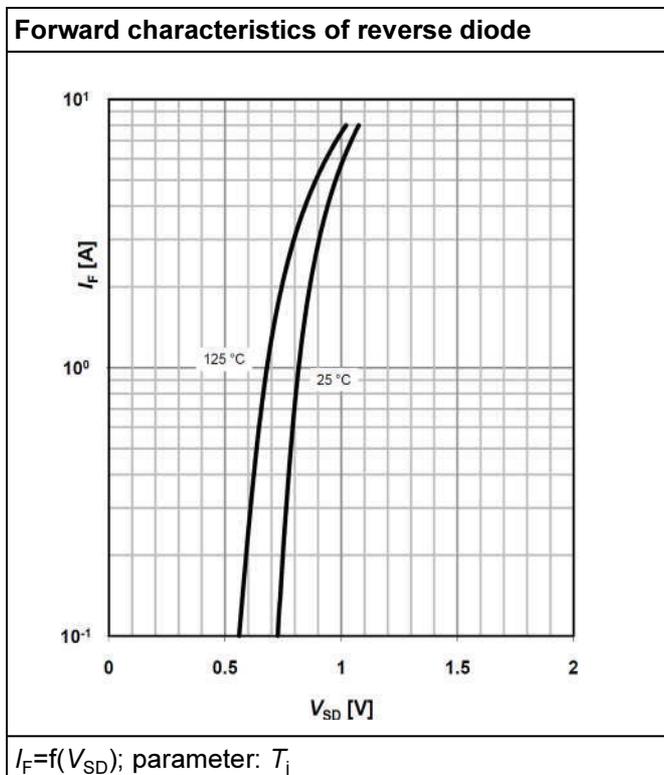


Table 15



## 6 Test circuits

Table 16 Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load	Switching time waveform

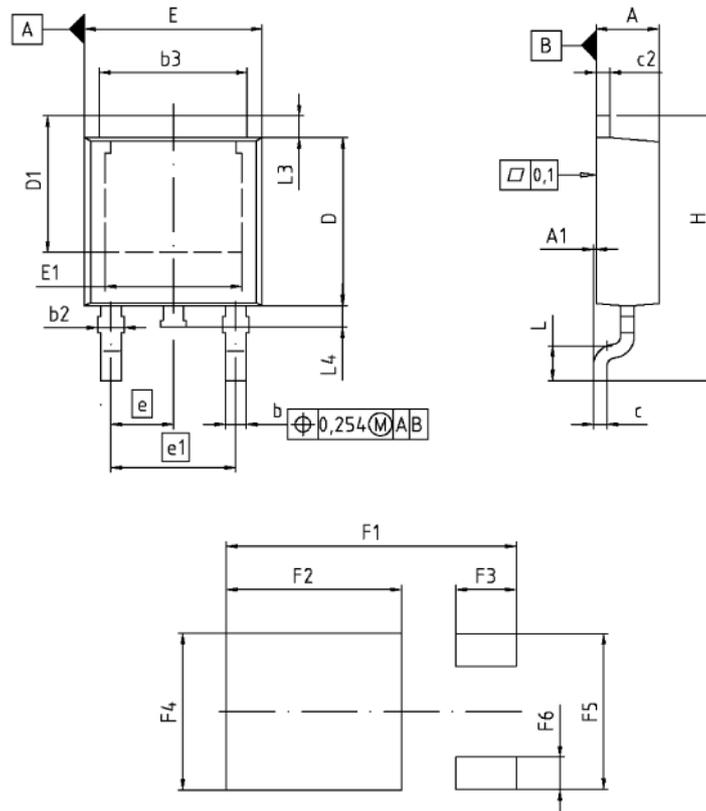
Table 17 Unclamped inductive load test circuit and waveform

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



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.16	2.41	0.085	0.095
A1	0.00	0.15	0.000	0.006
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b3	5.00	5.50	0.197	0.217
c	0.46	0.80	0.018	0.024
c2	0.46	0.98	0.018	0.039
D	5.97	6.22	0.235	0.245
D1	5.02	5.84	0.198	0.230
E	6.40	6.73	0.252	0.265
E1	4.70	5.21	0.185	0.205
e	2.29		0.090	
e1	4.57		0.180	
N	3		3	
H	9.40	10.48	0.370	0.413
L	1.18	1.70	0.046	0.067
L3	0.90	1.25	0.035	0.049
L4	0.51	1.00	0.020	0.039
F1	10.50	10.70	0.413	0.421
F2	6.30	6.50	0.248	0.256
F3	2.10	2.30	0.083	0.091
F4	5.70	5.90	0.224	0.232
F5	5.66	5.86	0.223	0.231
F6	1.10	1.30	0.043	0.051

DOCUMENT NO.  
Z8B00003328

SCALE

EUROPEAN PROJECTION

ISSUE DATE  
19-10-2007

REVISION  
03

Figure 1 Outlines TO-252, dimensions in mm/inches

## 8 Revision History

### CoolMOS C6 600V CoolMOS™ C6 Power Transistor

Revision History: 2010-07-19, Rev. 2.0

Previous Revision:	
Revision	Subjects (major changes since last revision)
2.0	Release of final data sheet

### We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all?  
Your feedback will help us to continuously improve the quality of this document.

Please send your proposal (including a reference to this document) to: [erratum@infineon.com](mailto:erratum@infineon.com)



Edition 2010-07-19

Published by  
Infineon Technologies AG  
81726 Munich, Germany

© 2010 Infineon Technologies AG  
All Rights Reserved.

### Legal Disclaimer

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics. With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation, warranties of non-infringement of intellectual property rights of any third party.

### Information

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office ([www.infineon.com](http://www.infineon.com)).

### Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

Infineon Technologies component described in this Data Sheet may be used in life-support devices or systems and/or automotive, aviation and aerospace applications or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support, automotive, aviation and aerospace device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

**Телефон:** 8 (812) 309 58 32 (многоканальный)

**Факс:** 8 (812) 320-02-42

**Электронная почта:** [org@eplast1.ru](mailto:org@eplast1.ru)

**Адрес:** 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.