

# 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.

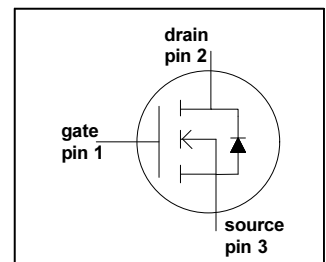
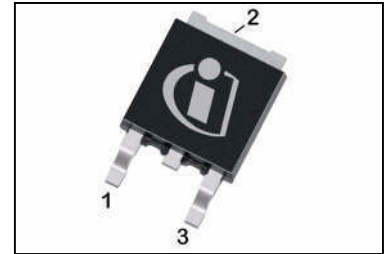


Table 1 Key Performance Parameters

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

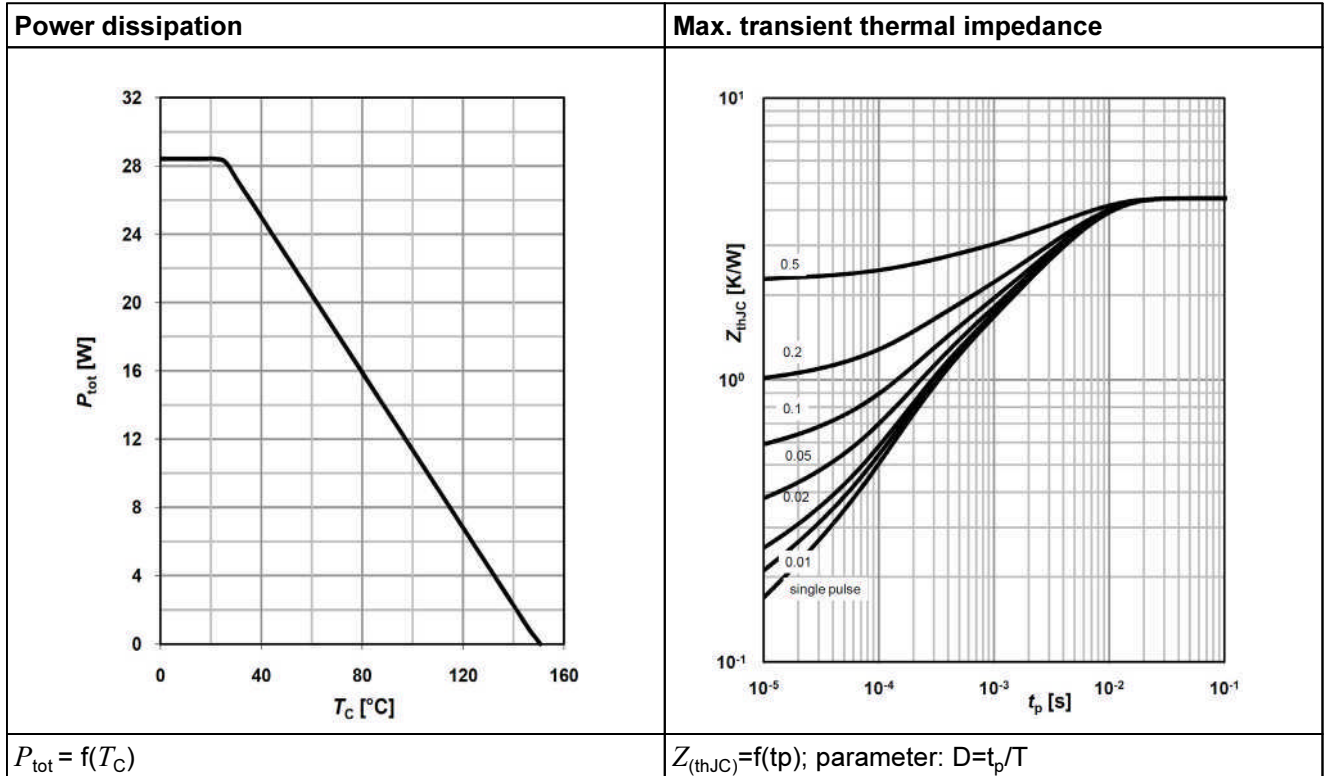


Table 9

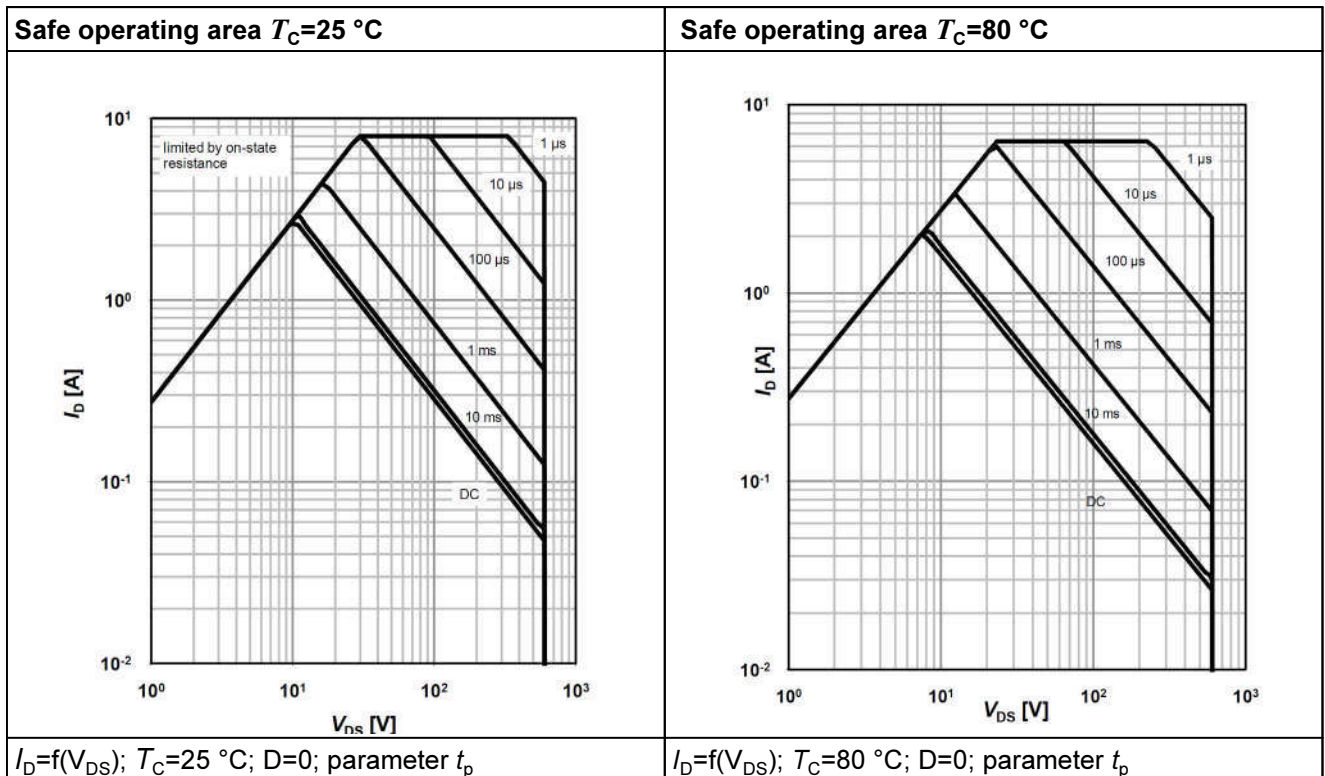




Table 10

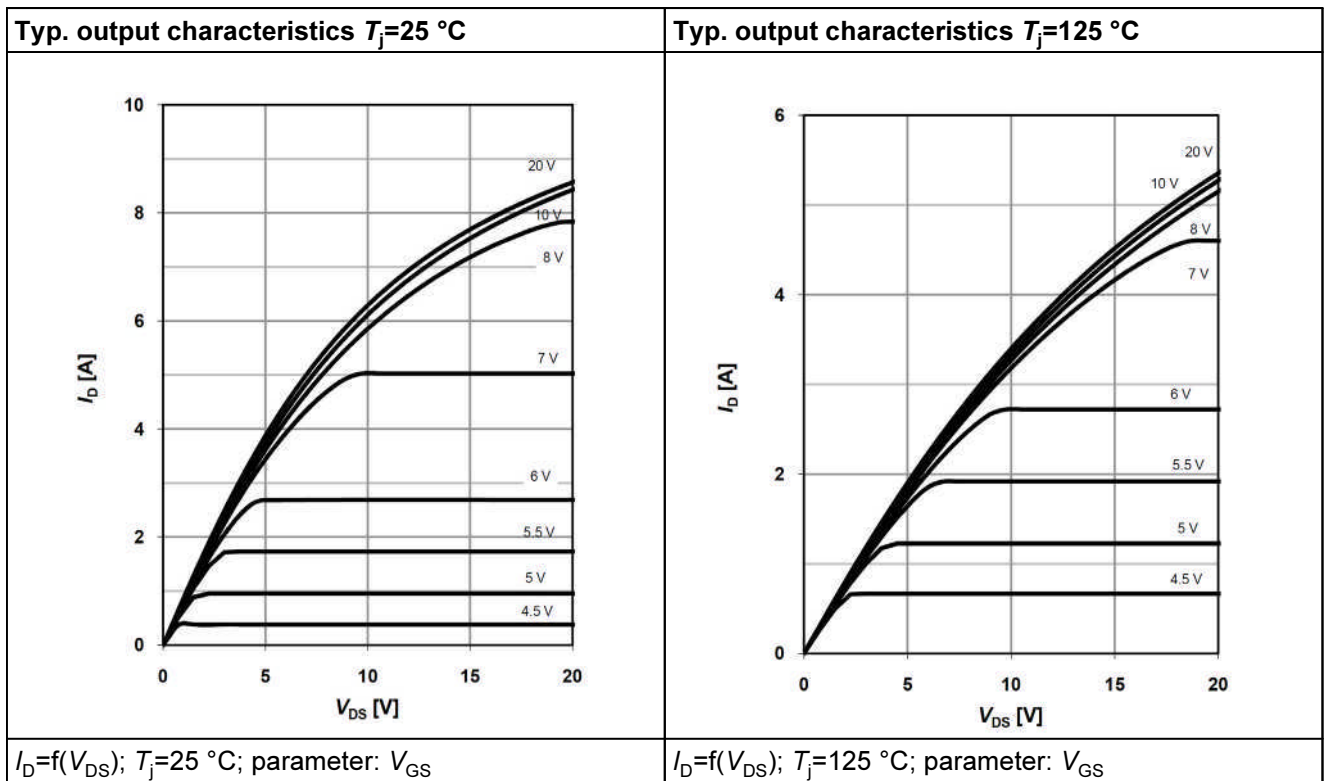


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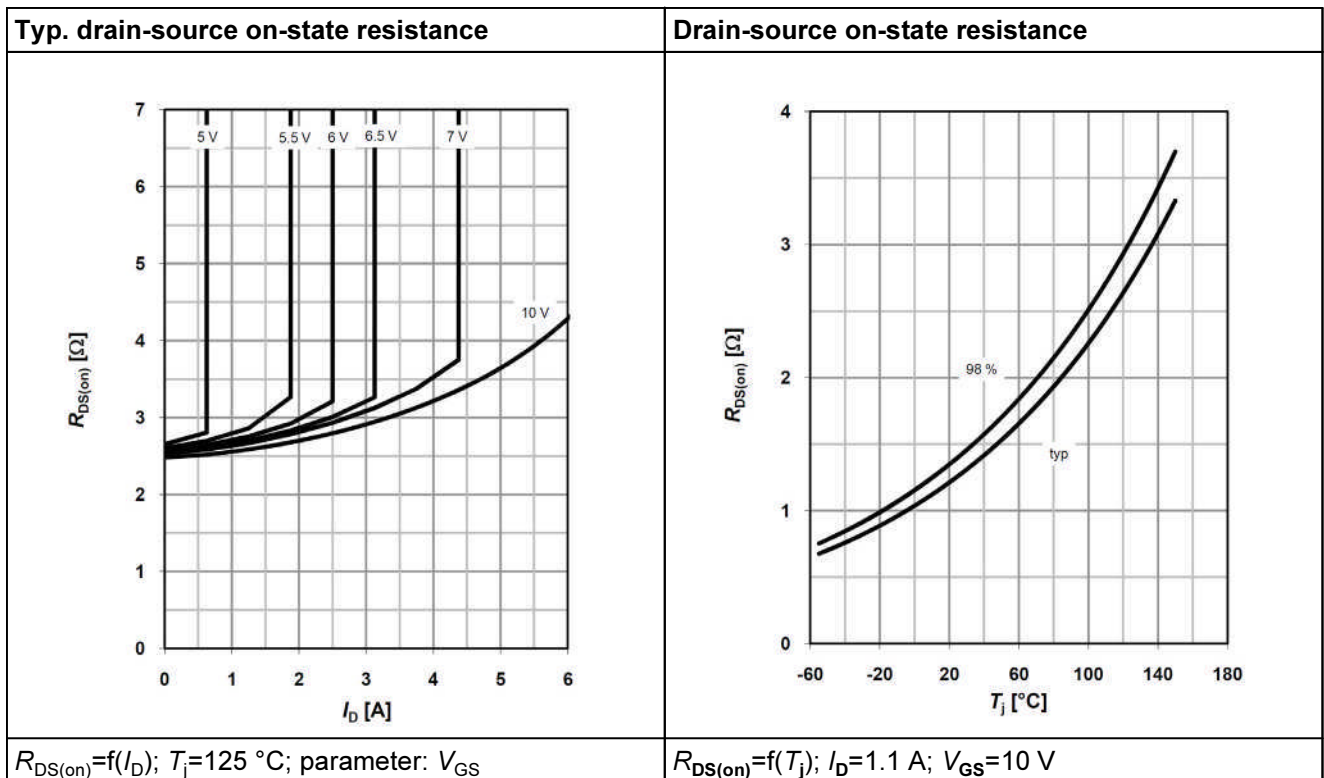


Table 12

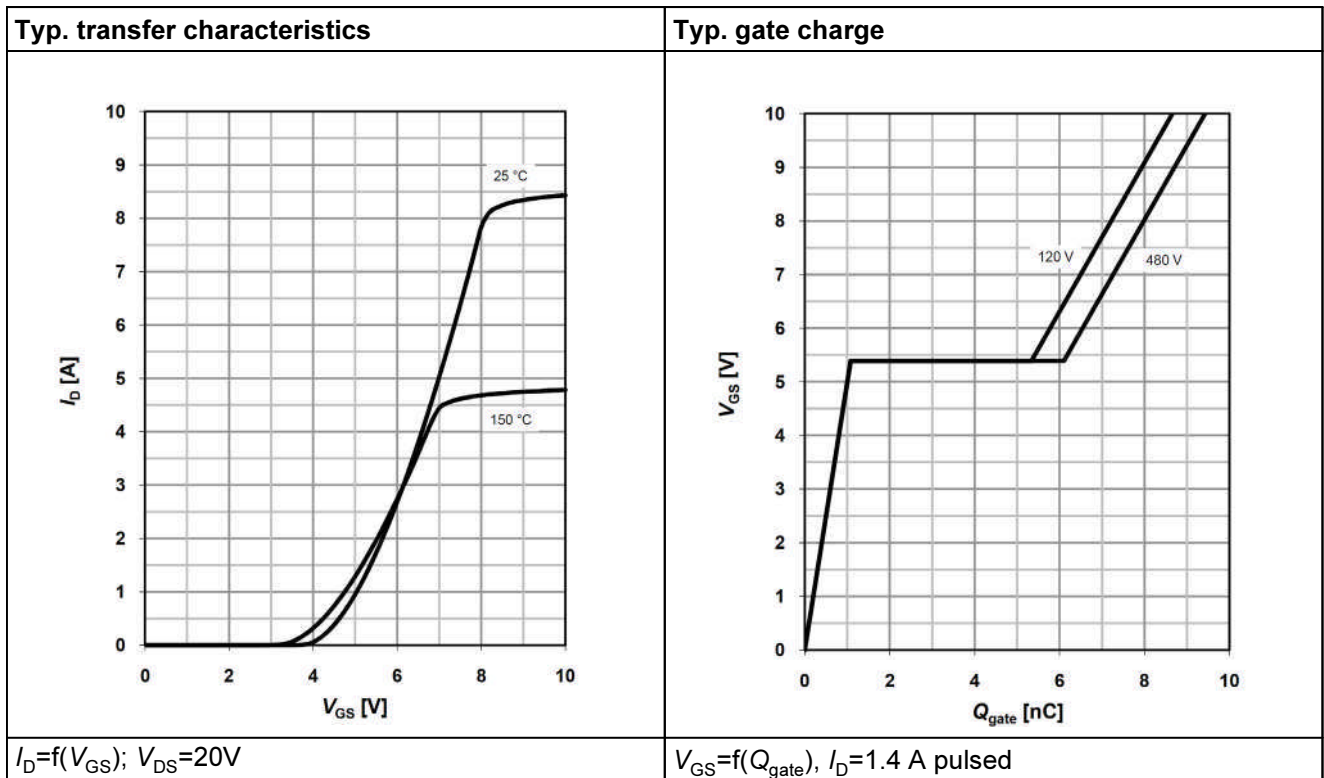


Table 13

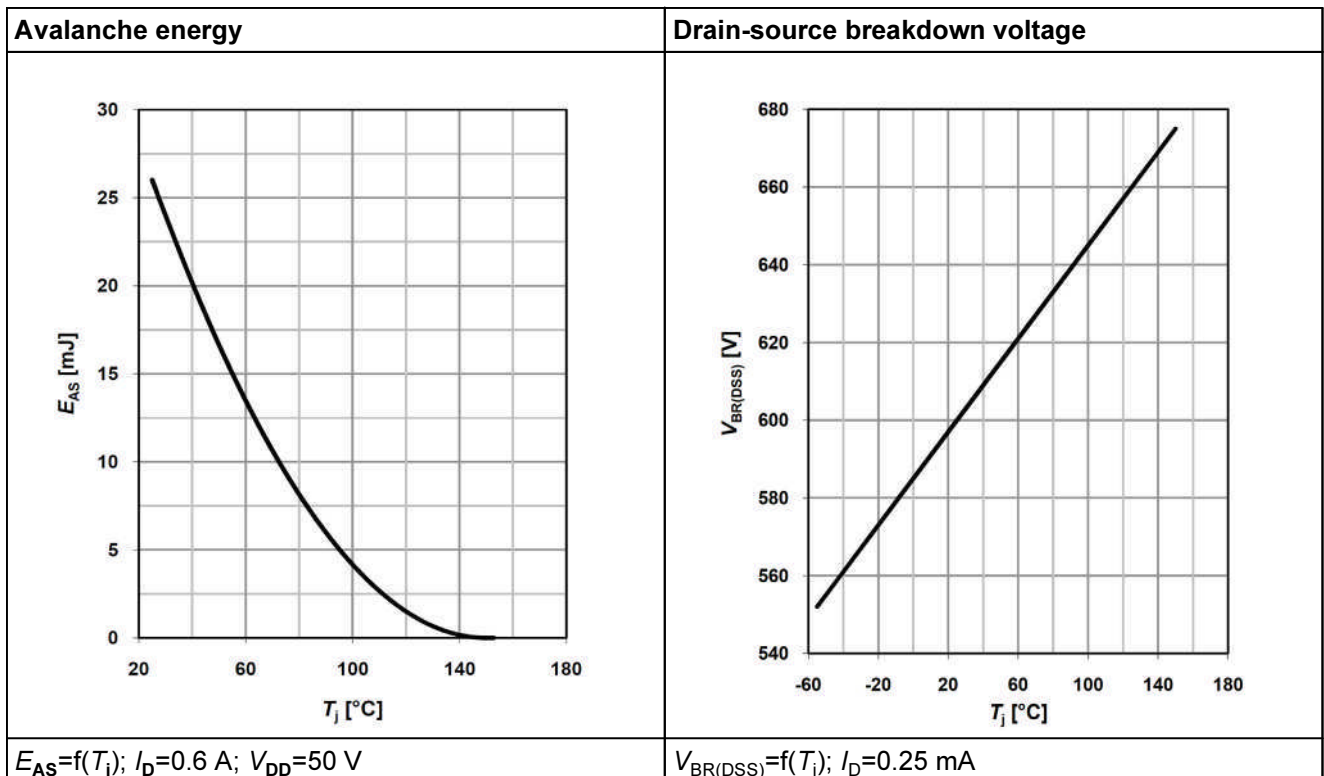


Table 14

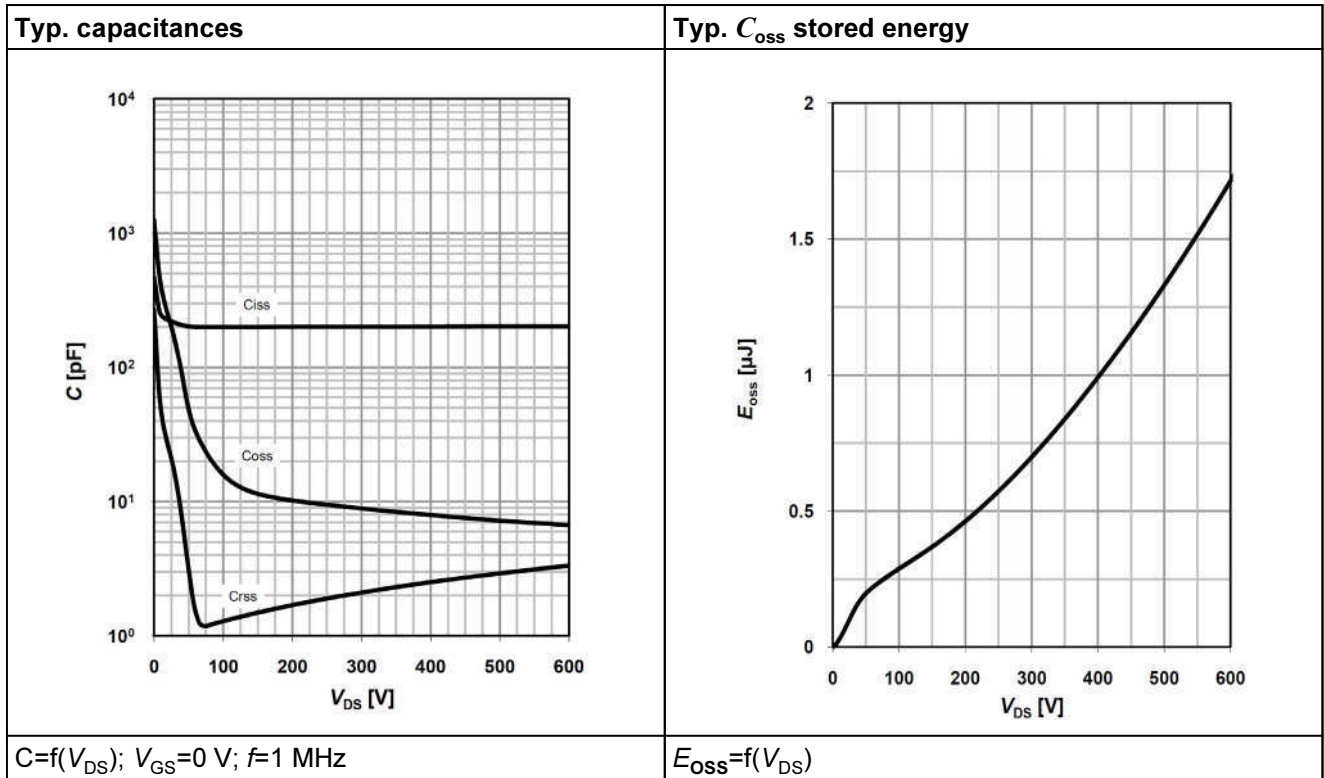
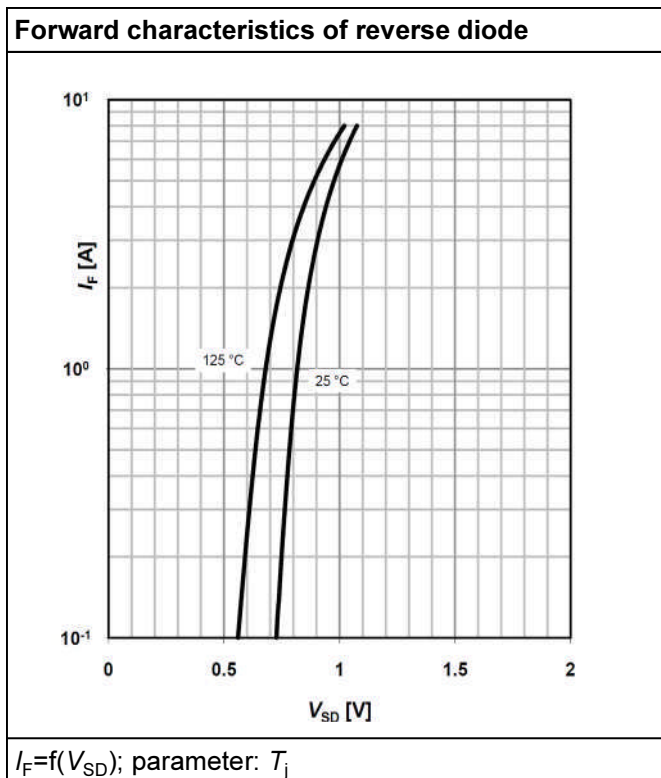


Table 15



## 6 Test circuits

Table 16 Switching times test circuit and waveform for inductive load

Switching times test circuit for inductive load	Switching time waveform

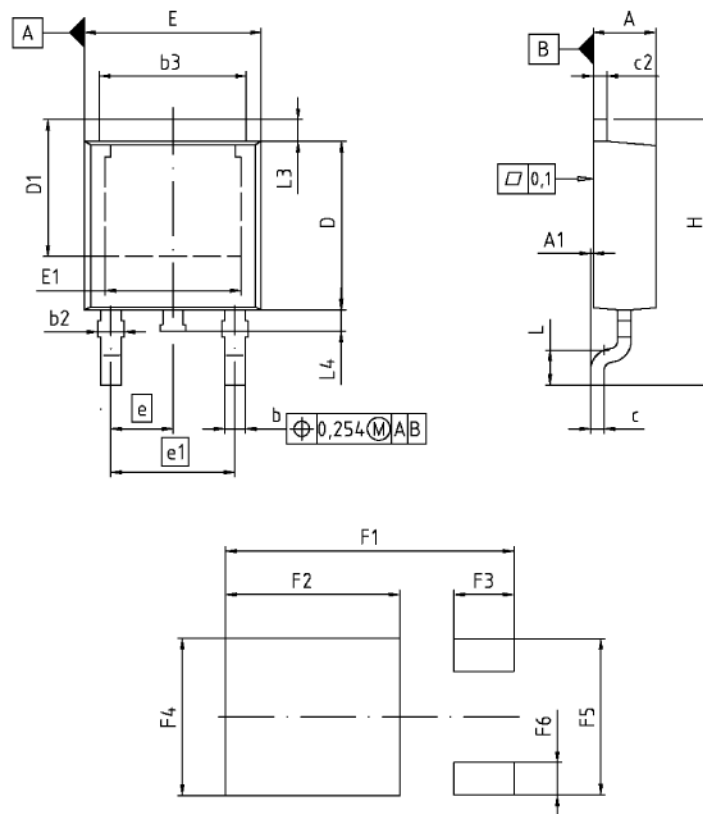
Table 17 Unclamped inductive load test circuit and waveform

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

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Edition 2010-07-19

Published by  
Infineon Technologies AG  
81726 Munich, Germany

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