

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C6 600V

600V CoolMOS™ C6 Power Transistor
IPU60R1K4C6

Data Sheet

Rev. 2.0
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
- Pb-free plating
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

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.

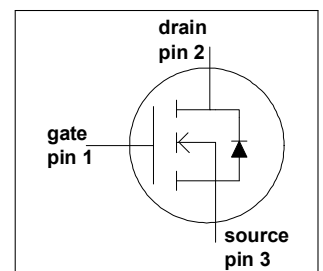


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j \max}$	650	V
$R_{DS(on), \max}$	1.4	Ω
Q_g, typ	9.4	nC
I_D, pulse	8	A
$E_{oss} @ 400V$	1	μJ
Body diode di/dt	500	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPU60R1K4C6	PG-TO 251	6R1K4C6	see Appendix A

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2 Maximum ratings

at $T_j = 25^\circ\text{C}$, unless otherwise specified

Table 2 Maximum ratings

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current ¹⁾	I_D			3.2	A	$T_C = 25^\circ\text{C}$
				2.0		$T_C = 100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$			8	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}			26	mJ	$I_D = 0.6\text{A}$, $V_{DD} = 50\text{V}$ (see table 18)
Avalanche energy, repetitive	E_{AR}			0.09	mJ	$I_D = 0.6\text{A}$, $V_{DD} = 50\text{V}$
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 ($f > 1\text{ Hz}$)
Operating and storage temperature	T_j, T_{stg}	-55		150	$^\circ\text{C}$	
Continuous diode forward current	I_S			2.8	A	$T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$			8	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt			15	V/ns	$V_{DS} = 0 \dots 480\text{V}$, $I_{SD} \leq I_D$, $T_j = 25^\circ\text{C}$ (see table 16)
Maximum diode commutation speed	di _f /dt			500	A/ μs	
Power dissipation	P_{tot}			28.4	W	$T_C = 25^\circ\text{C}$

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 IPAK

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}			4.4	°C/W	
Thermal resistance, junction - ambient ¹⁾	R_{thJA}			62	°C/W	leaded
			35			SMD version, device on PCB, 6cm ² cooling area
Soldering temperature, wave- & reflowsoldering allowed	T_{sold}			260	°C	1.6 mm (0.063 in.) from case for 10s

¹⁾ Device on 40mm*40mm*1.5mm one layer epoxy PCB FR4 with 6cm² copper area (thickness 70µm) for drain connection. PCB is vertical without air stream cooling.

4 Electrical characteristics

at $T_j = 25^\circ\text{C}$, 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	$V_{GS} = 0V$, $I_D = 0.25mA$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5	V	$V_{DS} = V_{GS}$, $I_D = 0.09mA$
Zero gate voltage drain current	I_{DSS}			1	μA	$V_{DS} = 600V$, $V_{GS} = 0V$, $T_j = 25^\circ\text{C}$
			10			$V_{DS} = 600V$, $V_{GS} = 0V$, $T_j = 150^\circ\text{C}$
Gate-source leakage current	I_{GSS}			100	nA	$V_{GS} = 20V$, $V_{DS} = 0V$
Drain-source on-state resistance	$R_{DS(on)}$		1.260	1.4	Ω	$V_{GS} = 10V$, $I_D = 1.1A$, $T_j = 25^\circ\text{C}$
			3.280			$V_{GS} = 10V$, $I_D = 1.1A$, $T_j = 150^\circ\text{C}$
Gate resistance	R_G		14		Ω	$f = 1MHz$, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}		200		pF	$V_{GS} = 0V$, $V_{DS} = 100V$, $f = 1MHz$
Output capacitance	C_{oss}		16		pF	
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$		11		pF	$V_{GS} = 0V$, $V_{DS} = 0 \dots 480V$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$		41.3		pF	$I_D = \text{constant}$, $V_{GS} = 0V$, $V_{DS} = 0 \dots 480V$
Turn-on delay time	$t_{d(on)}$		8		ns	$V_{DD} = 480V$, $V_{GS} = 10V$, $I_D = 1.4A$, $R_G = 12.2\Omega$ (see table 17)
Rise time	t_r		7		ns	
Turn-off delay time	$t_{d(off)}$		40		ns	
Fall time	t_f		20		ns	

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}		1.1		nC	$V_{DD} = 480V$, $I_D = 1.4A$, $V_{GS} = 0 \text{ to } 10V$
Gate to drain charge	Q_{gd}		5		nC	
Gate charge total	Q_g		9.4		nC	
Gate plateau voltage	$V_{plateau}$		5.4		V	

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 7 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}		0.9		V	$V_{GS} = 0V, I_F = 1.4A, T_j = 25^{\circ}C$
Reverse recovery time	t_{rr}		230		ns	$V_R = 400V, I_F = 1.4A,$ $di_F/dt = 100A/\mu s$ (see table 16)
Reverse recovery charge	Q_{rr}		1.1		μC	
Peak reverse recovery current	I_{rrm}		9.8		A	

5 Electrical characteristics diagrams

Table 8

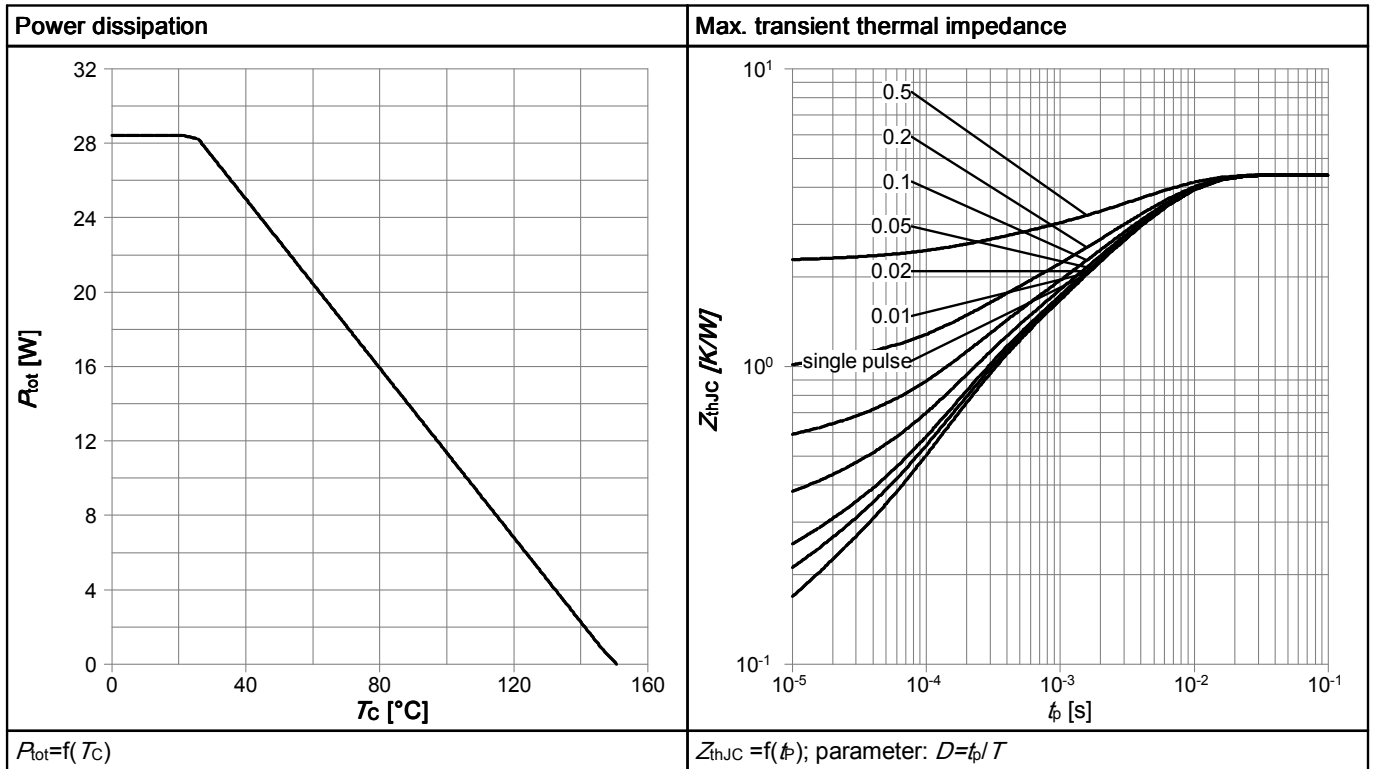


Table 9

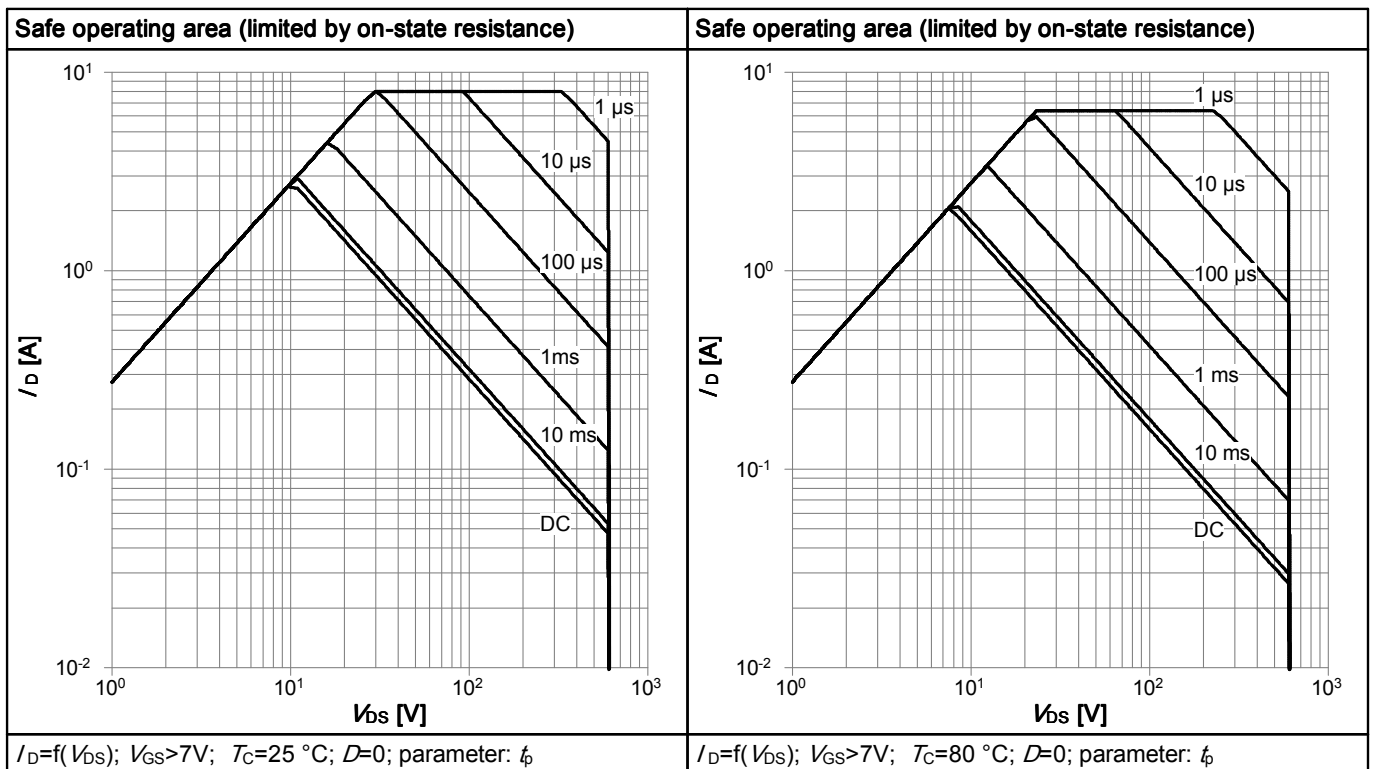


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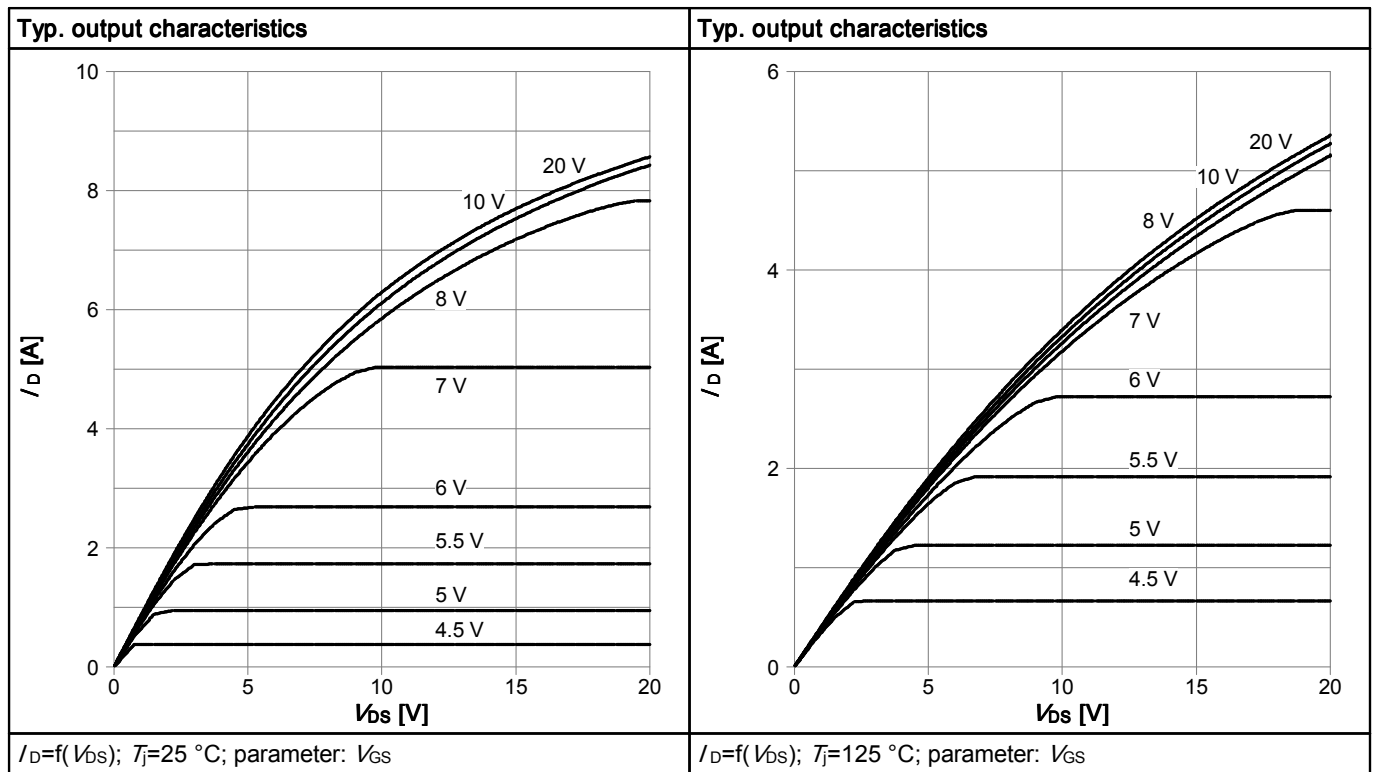


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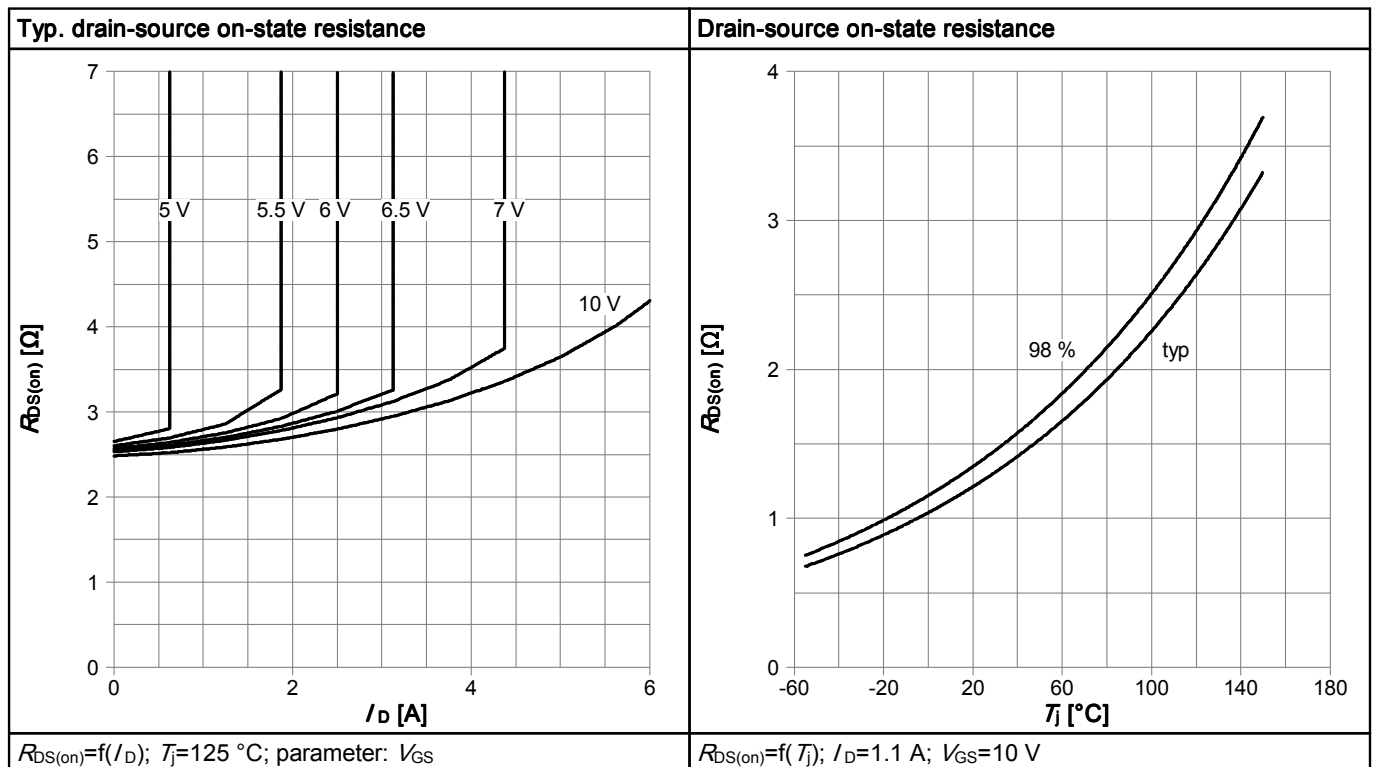


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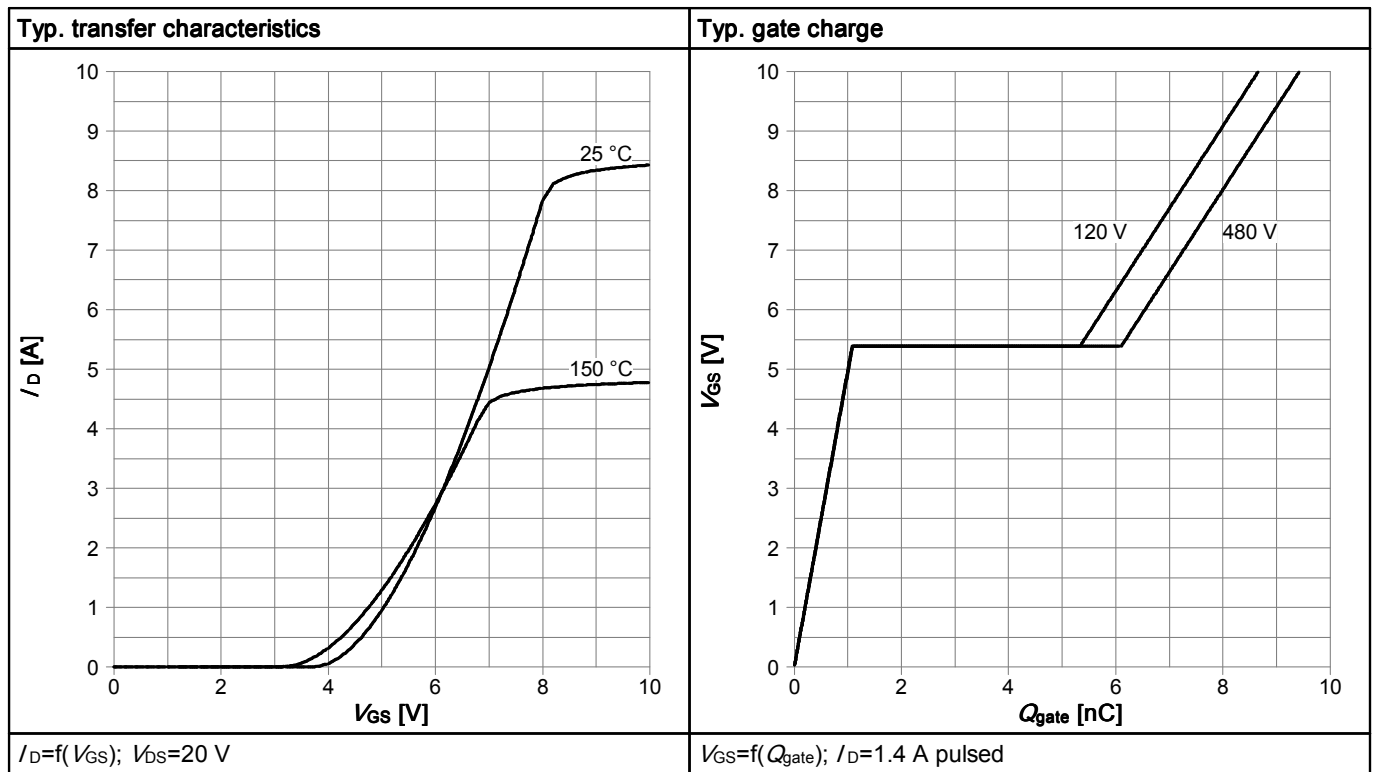


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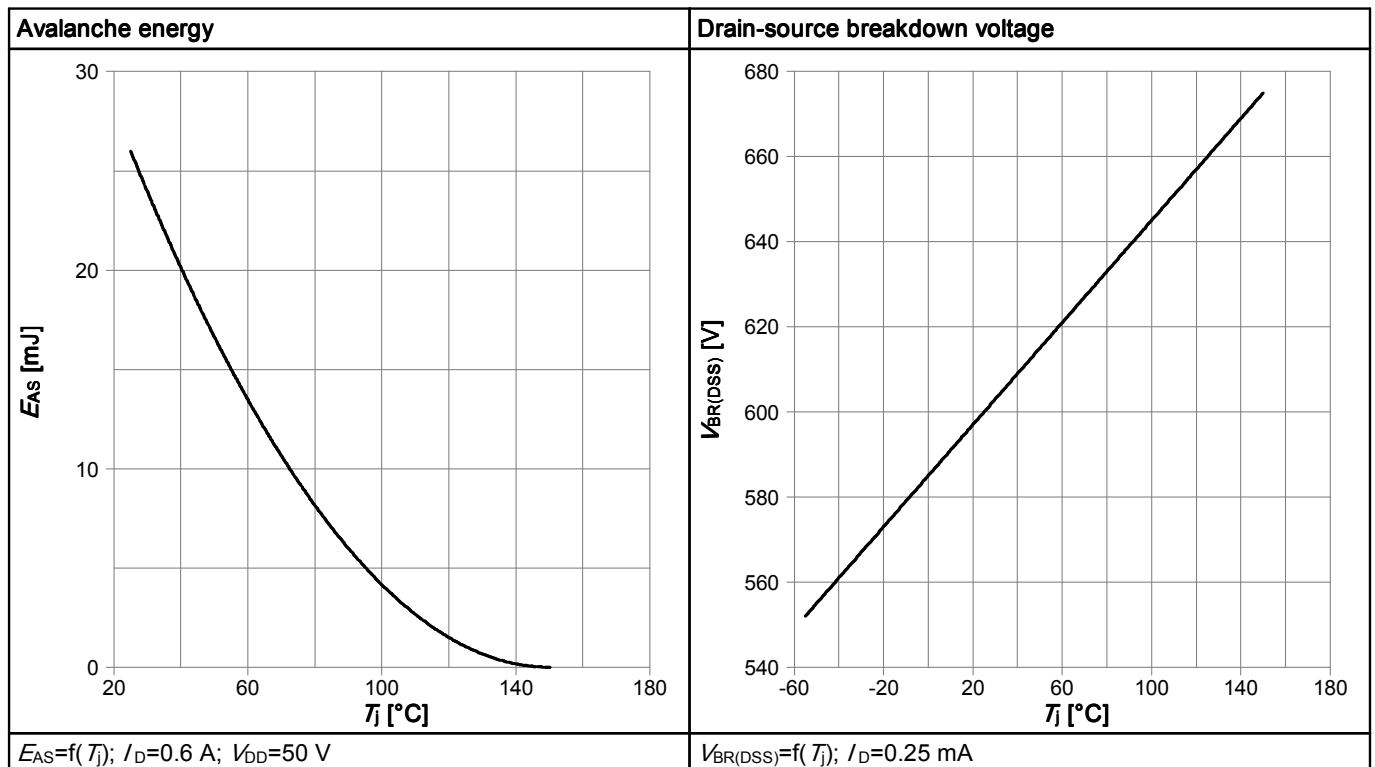


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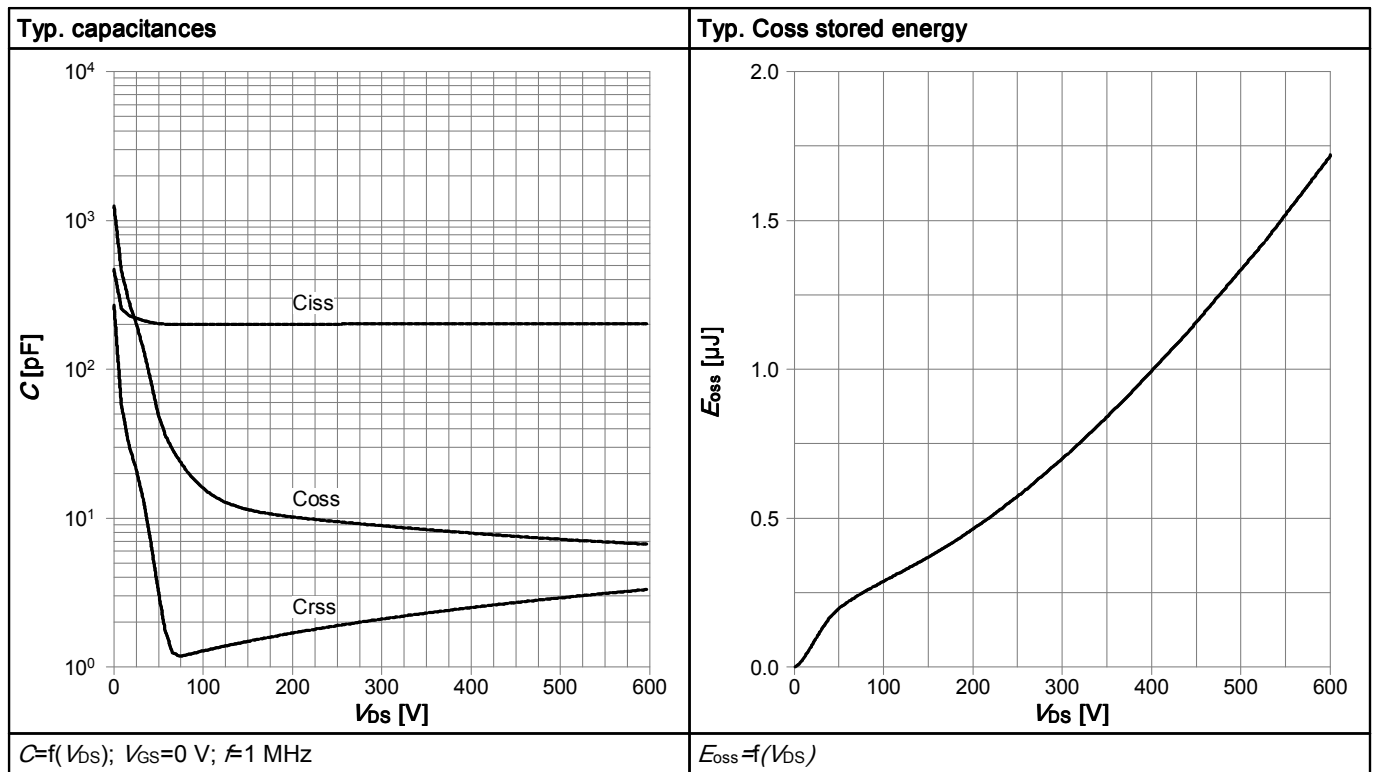
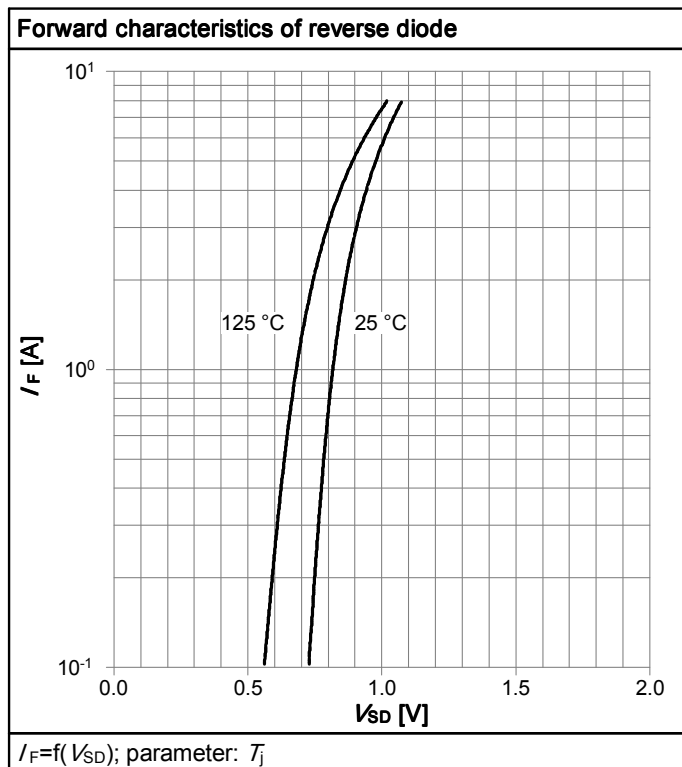


Table 15



6 Test Circuits

Table 16 Diode characteristics

Test circuit for diode characteristics

$R_{G1} = R_{G2}$

Diode recovery waveform

i_F
 $t_{\pi} = t_S + t_F$
 $Q_{\pi} = Q_S + Q_F$
 $10\% I_{RRM}$
 $90\% I_{RRM}$
 V

Table 17 Switching times

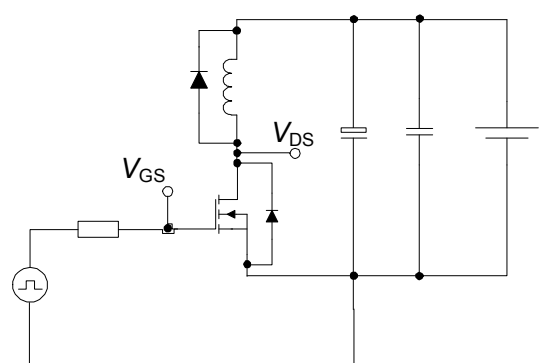
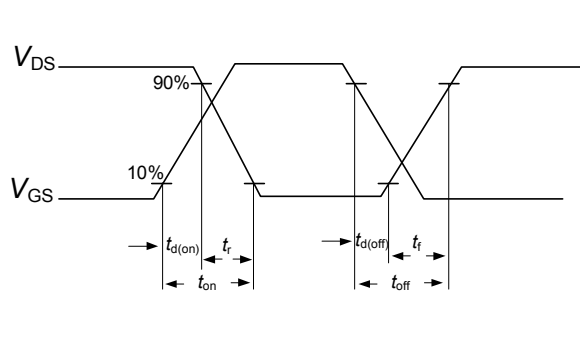
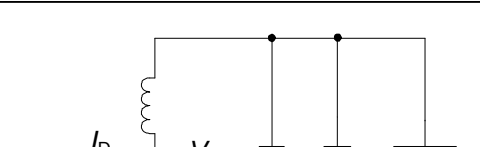
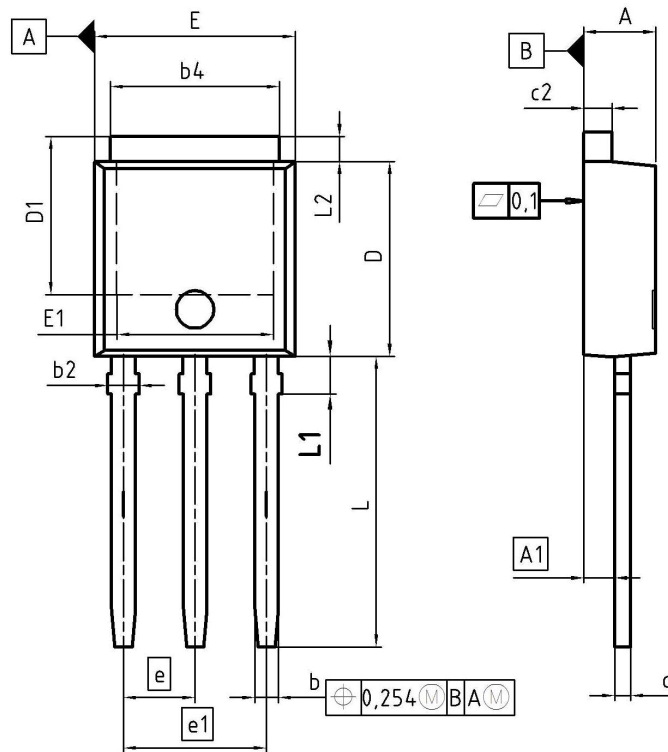
Switching times test circuit for inductive load	Switching times waveform
 The circuit diagram shows an AC voltage source connected in series with a resistor and the gate of an N-channel MOSFET. The gate voltage is labeled V_{GS}. The MOSFET's drain is connected to an inductor (representing an inductive load) and a diode (representing a freewheeling diode). The source of the MOSFET is connected to ground. The drain voltage is labeled V_{DS}. A parallel combination of a capacitor and a resistor is connected across the load, representing the load's parasitic capacitance and resistance.	 The waveform diagram shows the gate voltage V_{GS} and drain voltage V_{DS} over time. The MOSFET is driven by a square wave. The switching times are defined as follows: $t_{d(on)}$: Delay time from the 10% rise of V_{GS} to the 90% rise of V_{DS}. t_r: Rise time of V_{DS} from 90% to 100%. $t_{d(off)}$: Delay time from the 10% fall of V_{GS} to the 90% fall of V_{DS}. t_f: Fall time of V_{DS} from 90% to 10%. t_{on}: Total on-time from the 10% rise of V_{GS} to the 10% fall of V_{GS}. t_{off}: Total off-time from the 10% fall of V_{GS} to the 10% rise of V_{GS}.

Table 18 Unclamped inductive

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7 Package Outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.16	2.41	0.085	0.095
A1	0.90	1.14	0.035	0.045
b	0.64	0.89	0.025	0.035
b2	0.65	1.15	0.026	0.045
b4	4.95	5.50	0.195	0.217
c	0.46	0.60	0.018	0.024
c2	0.46	0.89	0.018	0.035
D	5.97	6.22	0.235	0.245
D1	5.04	5.77	0.198	0.227
E	6.35	6.73	0.250	0.265
E1	4.70	5.21	0.185	0.205
e	2.29		0.090	
e1	4.57		0.180	
N	3		3	
L	8.89	9.65	0.350	0.380
L1	1.90	2.29	0.075	0.090
L2	0.89	1.37	0.035	0.054

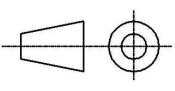
DOCUMENT NO. Z8B00003330
SCALE 0 2.0 4mm
EUROPEAN PROJECTION 
ISSUE DATE 19-03-2008
REVISION 03

Figure 1 Outline PG-TO 251, dimensions in mm/inches

8 Appendix A

Table 19 Related Links

- **IFX C6 Product Brief:**

<http://www.infineon.com/dgdl/Product+Brief+600V+CoolMOS+C6+.pdf?folderId=db3a3043156fd5730115939eb6b506db>

- **IFX C6 Portfolio:**

http://www.infineon.com/cms/en/product/findProductTypeByName.html?q=ip*c6

- **IFX CoolMOS Webpage:**

<http://www.infineon.com/cms/en/product/channel.html?channel=ff80808112ab681d0112ab6a628704d8>

- **IFX Design Tools:**

<http://www.infineon.com/cms/en/product/promopages/designtools/index.html>

Revision History

IPU60R1K4C6

Revision: 2012-02-02, Rev. 2.0

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2012-02-02	Final datasheet release

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