

# MOSFET

## 650V CoolMOS™ C6 Power Transistor

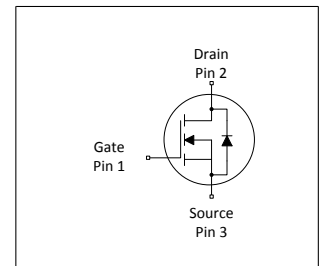
CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The resulting devices provide 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, Halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

### Potential 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
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	1.4	$\Omega$
$Q_g,typ$	10.5	nC
$I_D,pulse$	8.3	A
$E_{oss} @ 400V$	1.15	$\mu J$
Body diode $di/dt$	500	$A/\mu s$

Type / Ordering Code	Package	Marking	Related Links
IPS65R1K4C6	PG-TO 251-3	65C61K4	see Appendix A

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## 1 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 <sup>1)</sup>	$I_D$			3.2	A	$T_C = 25^\circ\text{C}$
				2.0		$T_C = 100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$			8.3	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 10)
Avalanche energy, repetitive	$E_{AR}$			0.10	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	$I_{S,pulse}$			8.3	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt			15	V/ns	$V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_D$ ,
Maximum diode commutation speed	di/dt			500	A/ $\mu\text{s}$	$T_j = 25^\circ\text{C}$ (see table 8)
Power dissipation	$P_{tot}$			28	W	$T_C = 25^\circ\text{C}$

<sup>1)</sup> Limited by  $T_{j,max}$ . Maximum duty cycle  $D=0.75$

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>3)</sup> Identical low side and high side switch with identical  $R_\theta$

## 2 Thermal characteristics

**Table 3 Thermal characteristics IPAK SL**

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

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

### 3 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	$V_{(BR)DSS}$	650			V	$V_{GS} = 0V, I_D = 1mA$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5	V	$V_{DS} = V_{GS}, I_D = 0.1mA$
Zero gate voltage drain current	$I_{DSS}$			1	$\mu A$	$V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$
			10			$V_{DS} = 650V, V_{GS} = 0V, T_j = 150^\circ C$
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	$\Omega$	$V_{GS} = 10V, I_D = 1.0A, T_j = 25^\circ C$
			3.280			$V_{GS} = 10V, I_D = 1A, T_j = 150^\circ C$
Gate resistance	$R_G$		6.5		$\Omega$	$f = 1MHz, \text{open drain}$

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$		225		pF	$V_{GS} = 0V, V_{DS} = 100V, f = 1MHz$
Output capacitance	$C_{oss}$		18		pF	
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$		10		pF	$V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$		42		pF	$I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Turn-on delay time	$t_{d(on)}$		7.7		ns	$V_{DD} = 400V, V_{GS} = 13V, I_D = 1.5A, R_G = 10.2\Omega$ (see table 9)
Rise time	$t_r$		5.9		ns	
Turn-off delay time	$t_{d(off)}$		33		ns	
Fall time	$t_f$		18.2		ns	

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$		1.3		nC	$V_{DD} = 480V, I_D = 1.5A, V_{GS} = 0 \text{ to } 10V$
Gate to drain charge	$Q_{gd}$		5.8		nC	
Gate charge total	$Q_g$		10.5		nC	
Gate plateau voltage	$V_{plateau}$		5.4		V	

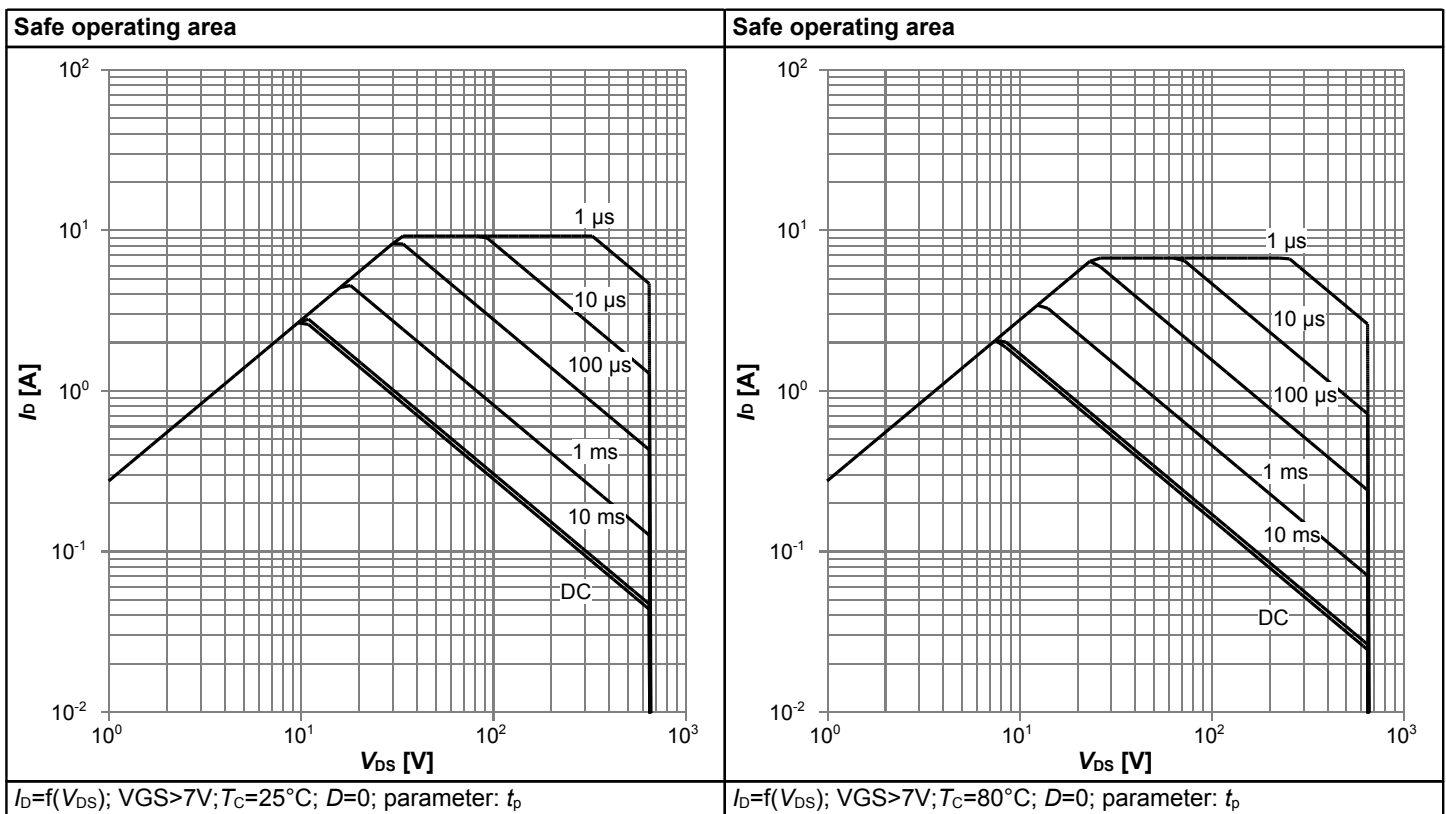
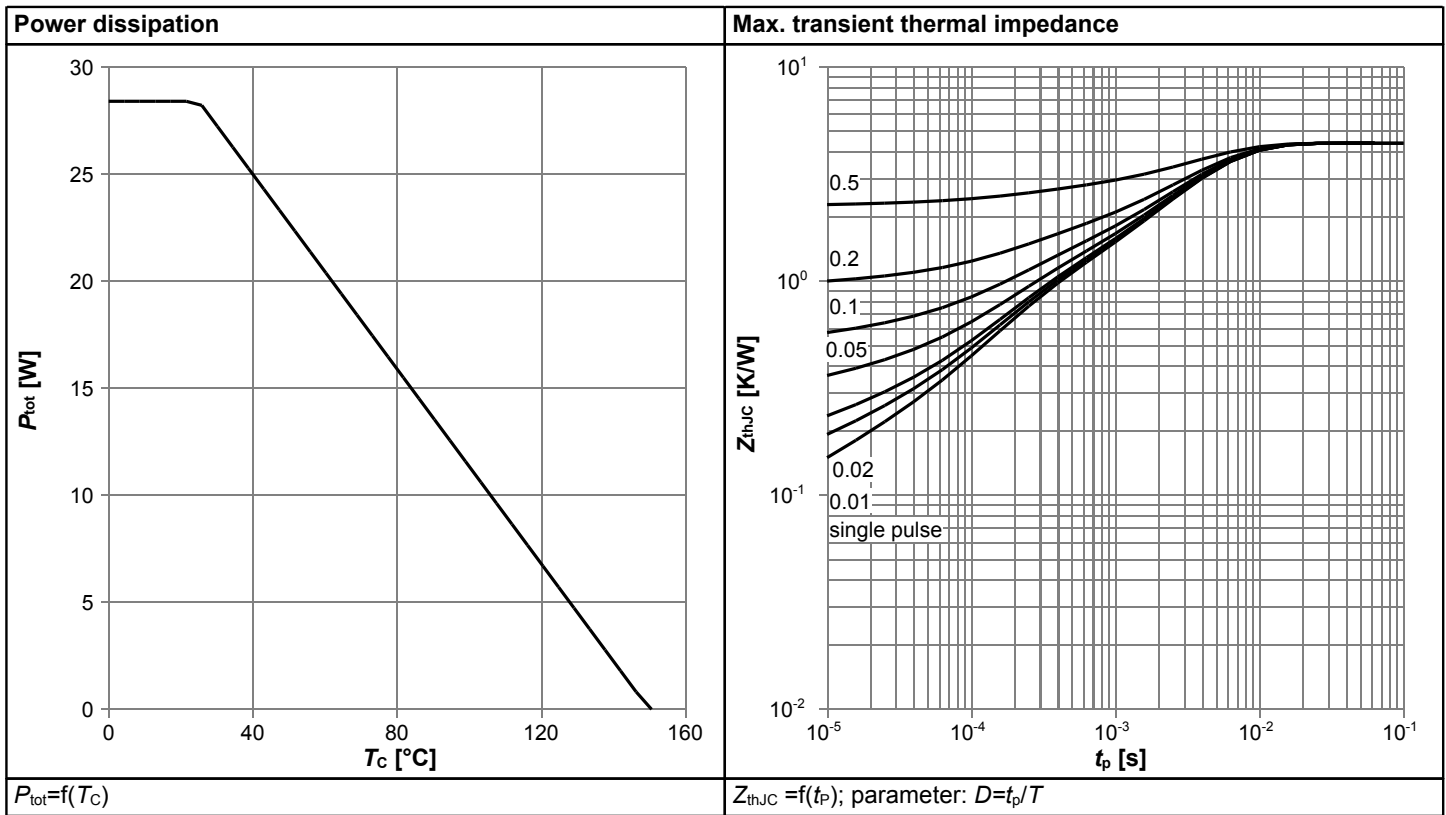
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

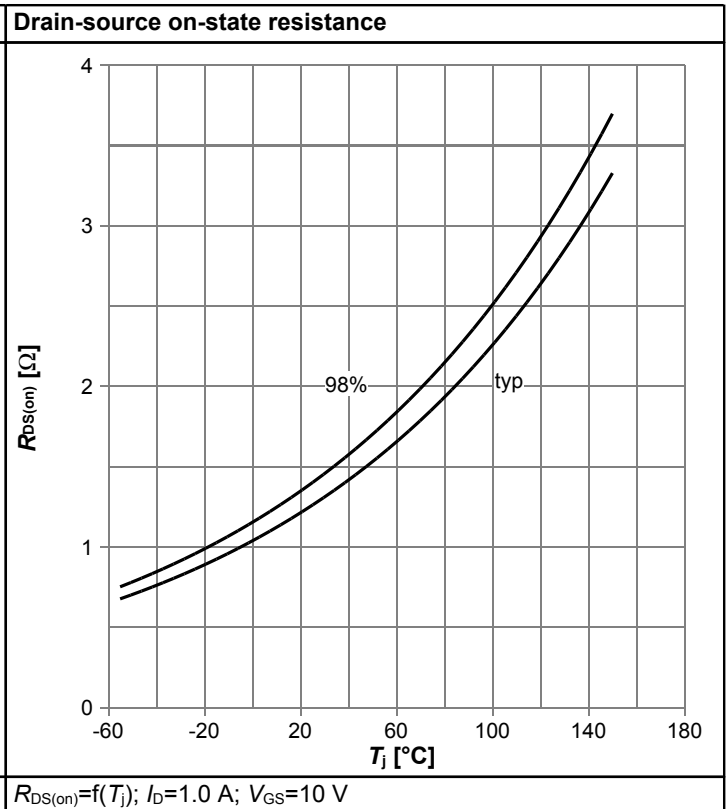
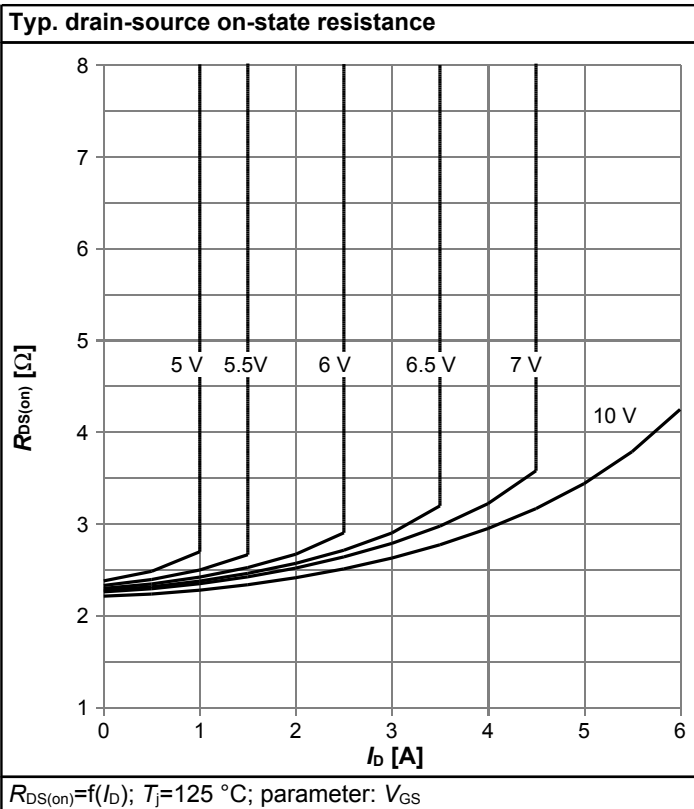
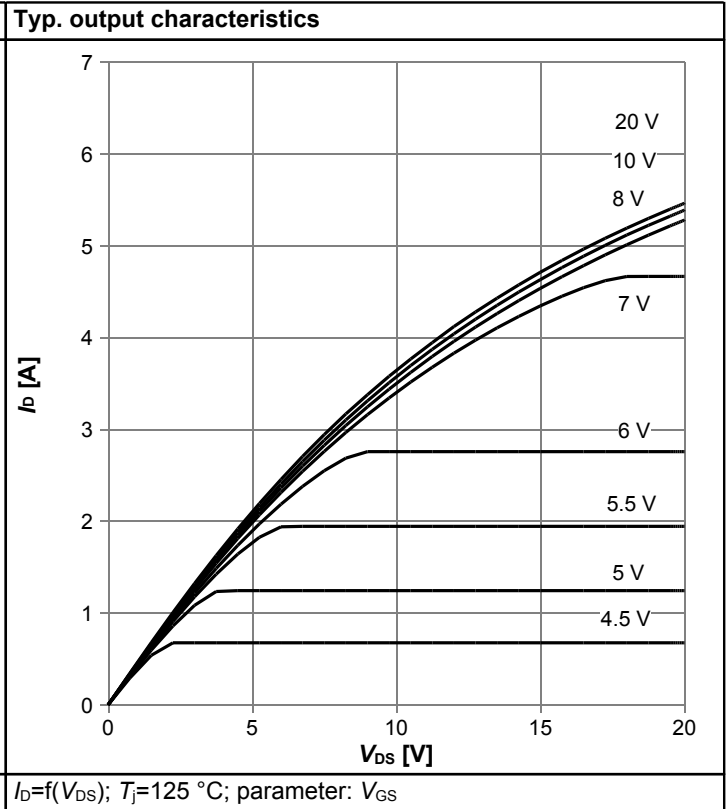
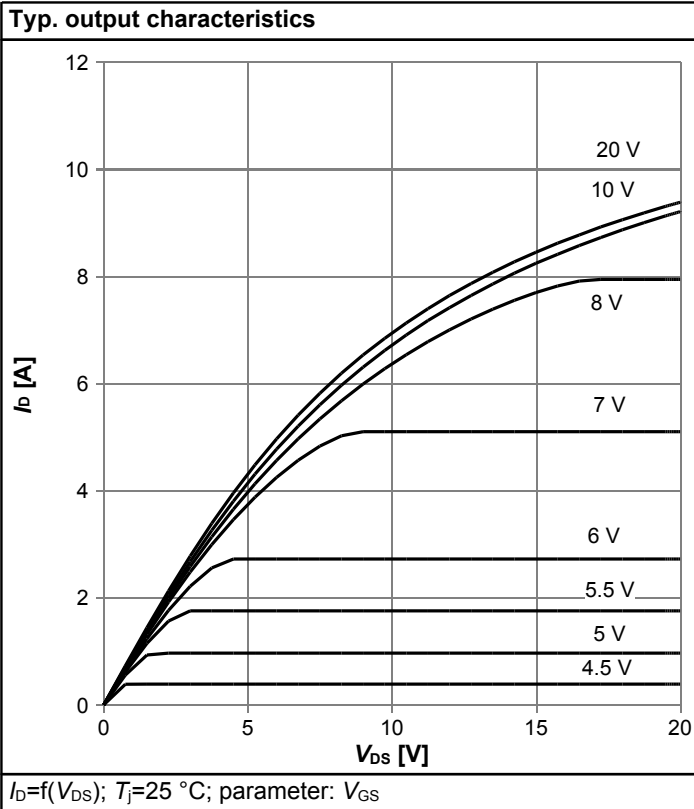
<sup>2)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

**Table 7 Reverse diode characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	$V_{SD}$		0.9		V	$V_{GS} = 0V, I_F = 1.5A, T_j = 25^\circ C$
Reverse recovery time	$t_{rr}$		200		ns	$V_R = 400V, I_F = 1.5A,$ $di_F/dt = 100A/\mu s$ (see table 8)
Reverse recovery charge	$Q_{rr}$		0.9		$\mu C$	
Peak reverse recovery current	$I_{rrm}$		8		A	

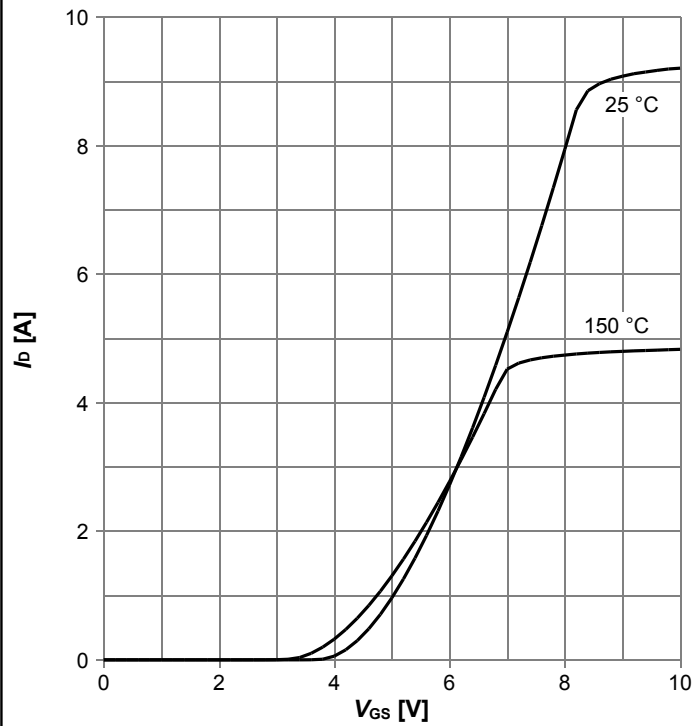
### 4 Electrical characteristics diagrams





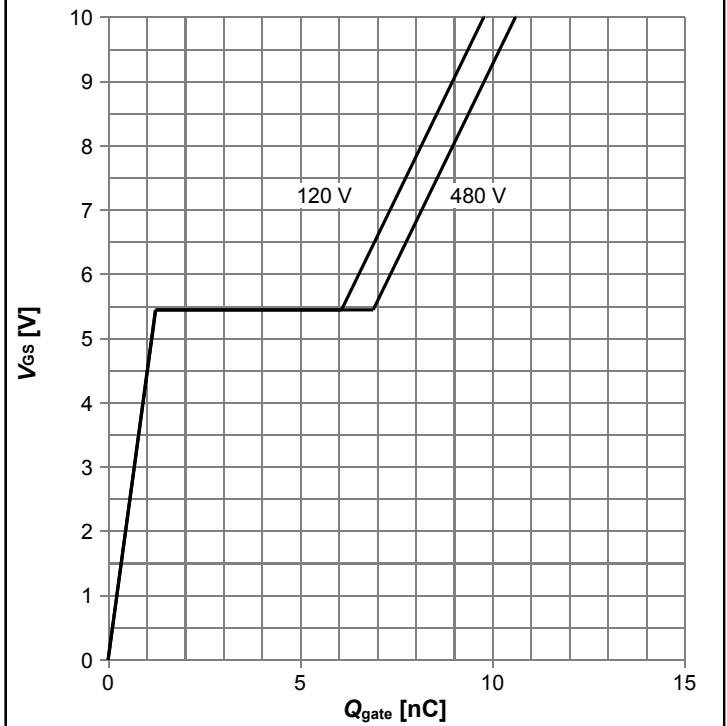


**Typ. transfer characteristics**



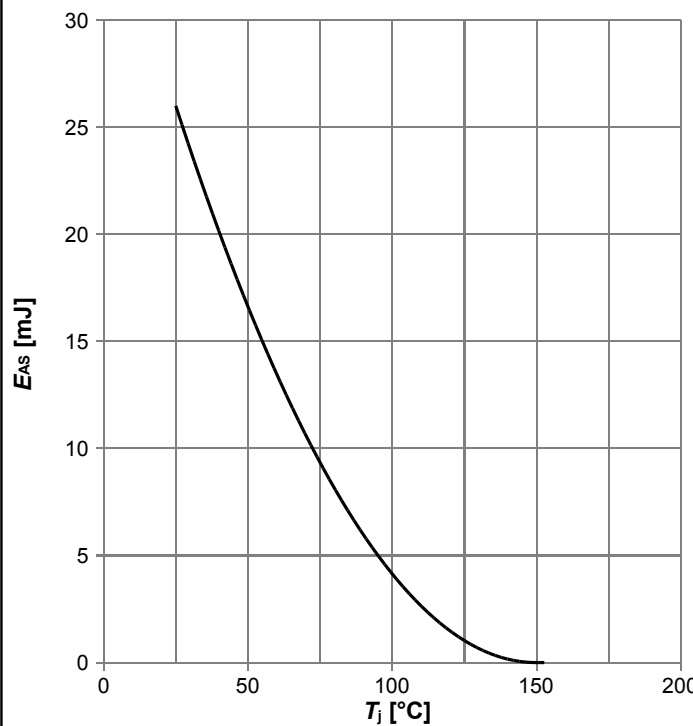
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

**Typ. gate charge**



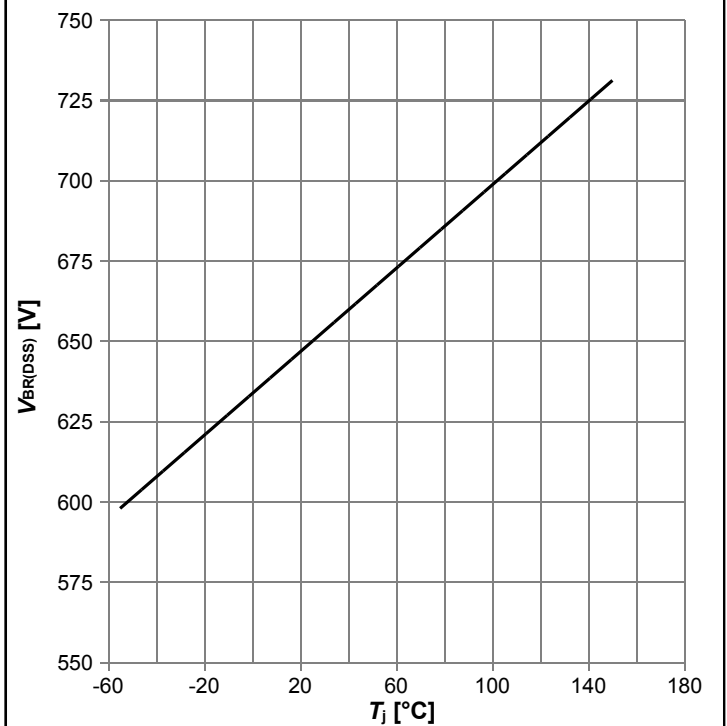
$V_{GS}=f(Q_{gate}); I_D=1.5 \text{ A pulsed}; \text{parameter: } V_{DD}$

**Avalanche energy**

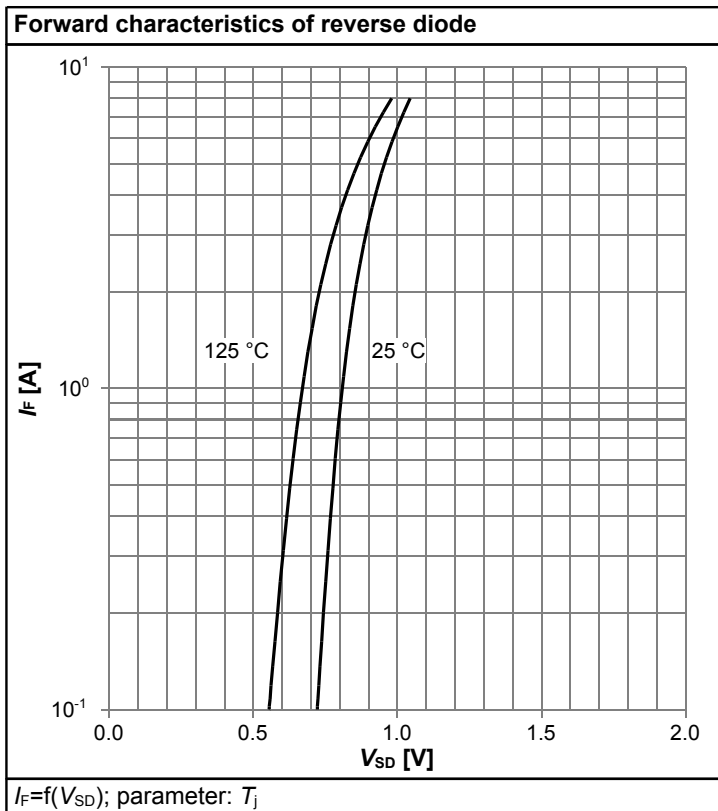
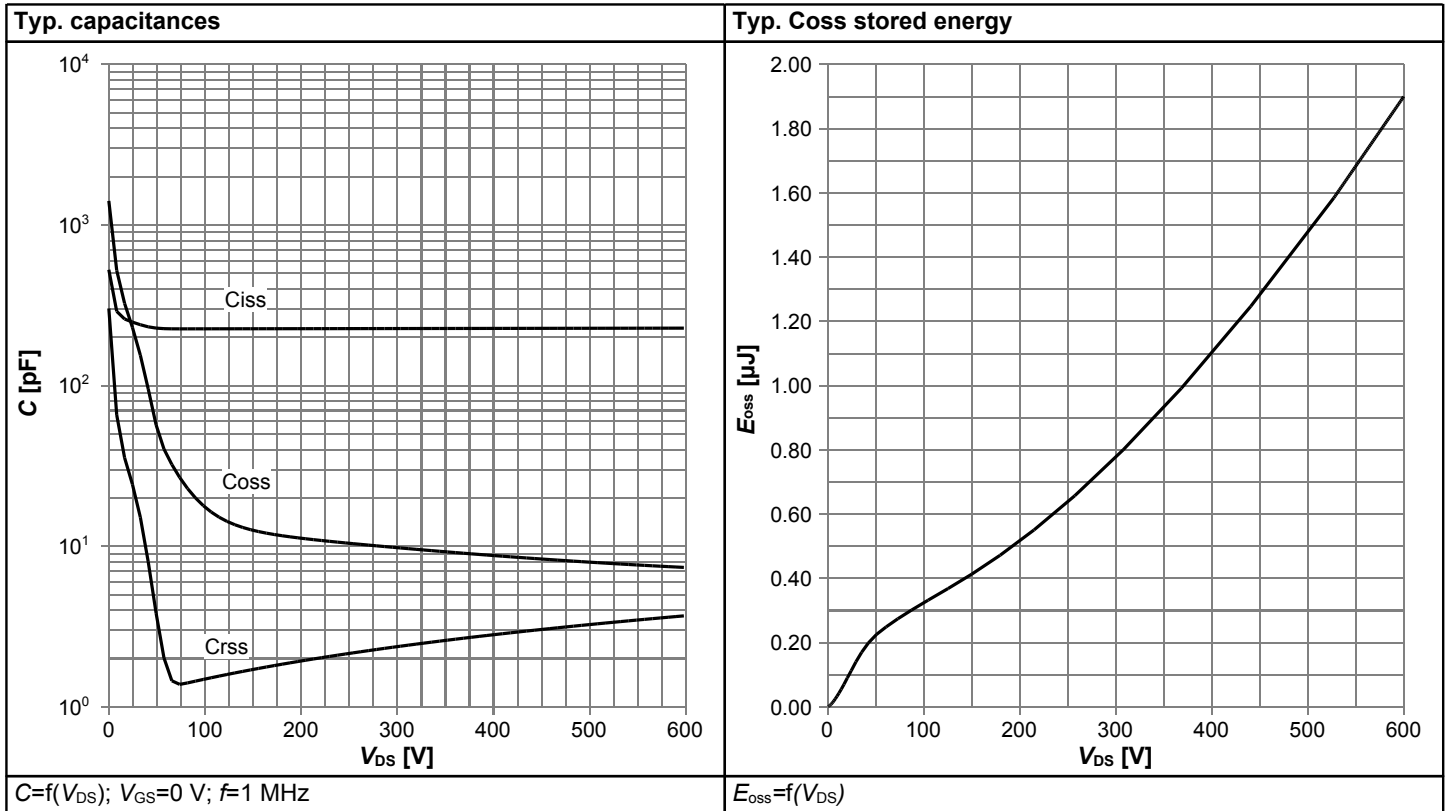


$E_{AS}=f(T_j); I_D=0.6 \text{ A}; V_{DD}=50 \text{ V}$

**Drain-source breakdown voltage**



$V_{BR(DSS)}=f(T_j); I_D=1.0 \text{ mA}$



## 5 Test Circuits

**Table 8 Diode characteristics**



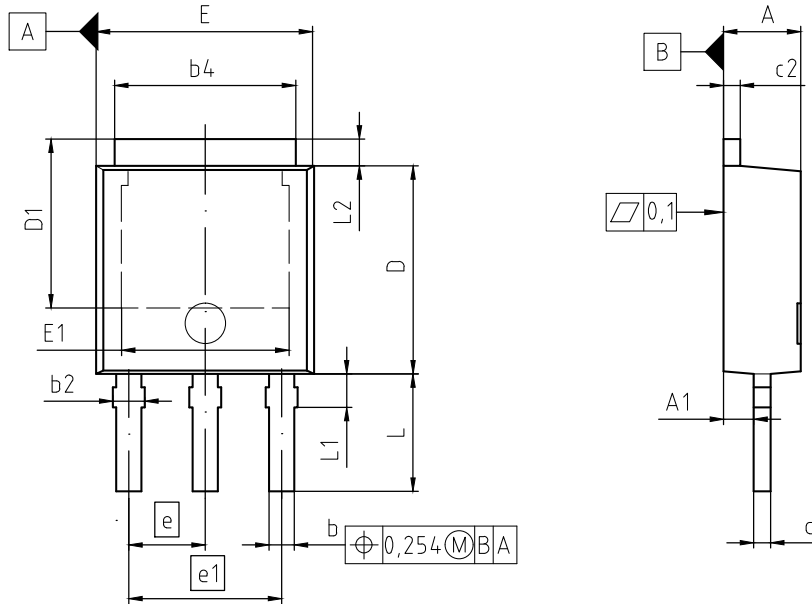
**Table 9 Switching times**



**Table 10 Unclamped inductive load**



## 6 Package Outlines



NOTES:

1. INDUSTRIAL QUALITY GRADE
2. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-251 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.20	2.35	0.087	0.093
A1	0.80	1.14	0.031	0.044
b	0.64	0.89	0.026	0.033
b2	0.65	1.15	0.026	0.045
b4	5.20	5.50	0.205	0.217
c	0.46	0.59	0.018	0.023
c2	0.46	0.89	0.018	0.023
D	6.00	6.22	0.236	0.245
D1	5.04	5.55	0.198	0.219
E	6.45	6.70	0.254	0.264
E1	4.60	5.10	0.181	0.201
e	2.28		0.090	
e1	4.56		0.180	
N	3		3	
L	3.00	3.60	0.118	0.142
L1	0.80	1.20	0.031	0.047
L2	0.90	1.25	0.035	0.049

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Figure 1 Outline PG-TO 251-3, dimensions in mm/inches

## **7 Appendix A**

### **Table 11 Related Links**

- **IFX C6 Product Brief:** [www.infineon.com](http://www.infineon.com)
- **IFX C6 Portfolio:** [www.infineon.com](http://www.infineon.com)
- **IFX CoolMOS Webpage:** [www.infineon.com](http://www.infineon.com)
- **IFX Design Tools:** [www.infineon.com](http://www.infineon.com)

## Revision History

IPS65R1K4C6

**Revision: 2017-07-25, Rev. 2.1**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
0.9	2011-12-19	Release of target datasheet
2.0	2012-07-06	Release of final version
2.1	2017-07-25	Updated package drawing on page 12

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