

# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ C6 650V

650V CoolMOS™ C6 Power Transistor  
IPD65R1K4C6

## Data Sheet

Rev. 2.1  
Final

Industrial & Multimarket

## 1 Description

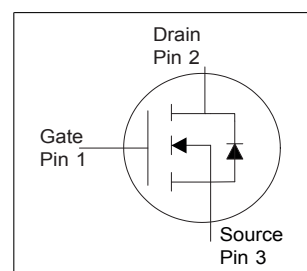
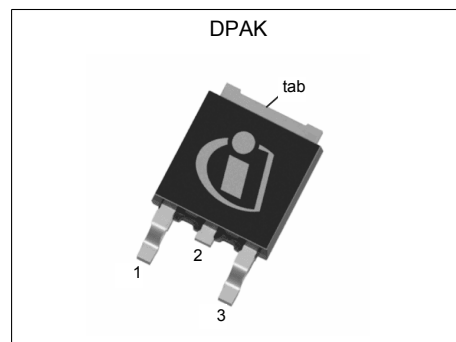
CoolMOS™ is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. CoolMOS™ C6 series combines the experience of the leading SJ MOSFET supplier with high class innovation. The resulting devices provide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

## Applications

Hard switching PWM stages and resonant switching PWM stages for e.g. PC Silverbox, Adapter, LCD & PDP TV and Lighting.



**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
IPD65R1K4C6	PG-TO 252	65C61K4	see Appendix A

**Table of Contents**

Description ..... 2

Table of Contents ..... 3

Maximum ratings ..... 4

Thermal characteristics ..... 5

Electrical characteristics ..... 6

Electrical characteristics diagrams ..... 8

Test Circuits ..... 12

Package Outlines ..... 13

Appendix A ..... 14

Revision History ..... 15

Disclaimer ..... 15

## 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 <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	$V_{DS} = 0 \dots 400\text{V}$ , $I_{SD} \leq I_D$ , $T_j = 25^\circ\text{C}$ (see table 8)
Maximum diode commutation speed	di/dt			500	A/ $\mu\text{s}$	
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  $R_G$

### 3 Thermal characteristics

**Table 3 Thermal characteristics DPAK**

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.

## 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	$V_{(BR)DSS}$	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	

## 5 Electrical characteristics diagrams

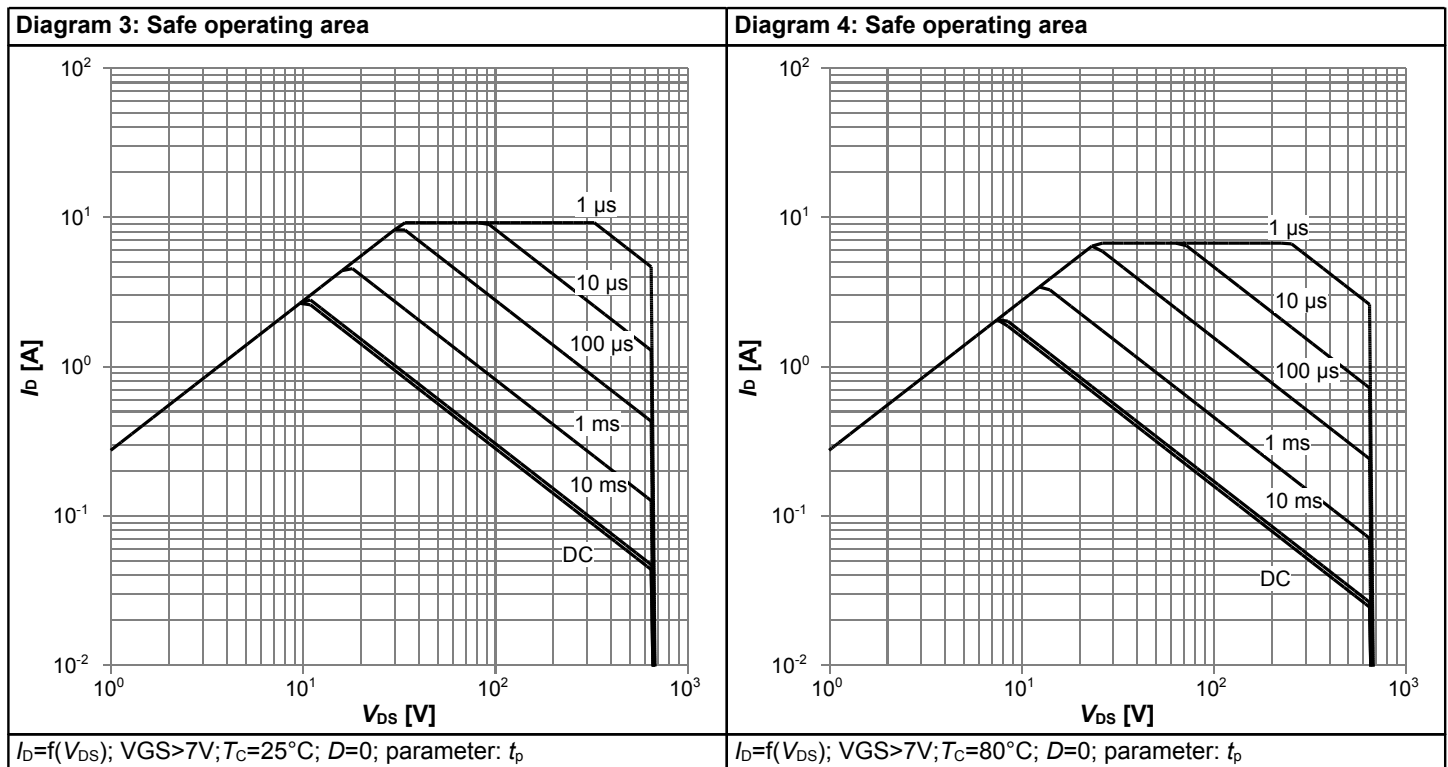
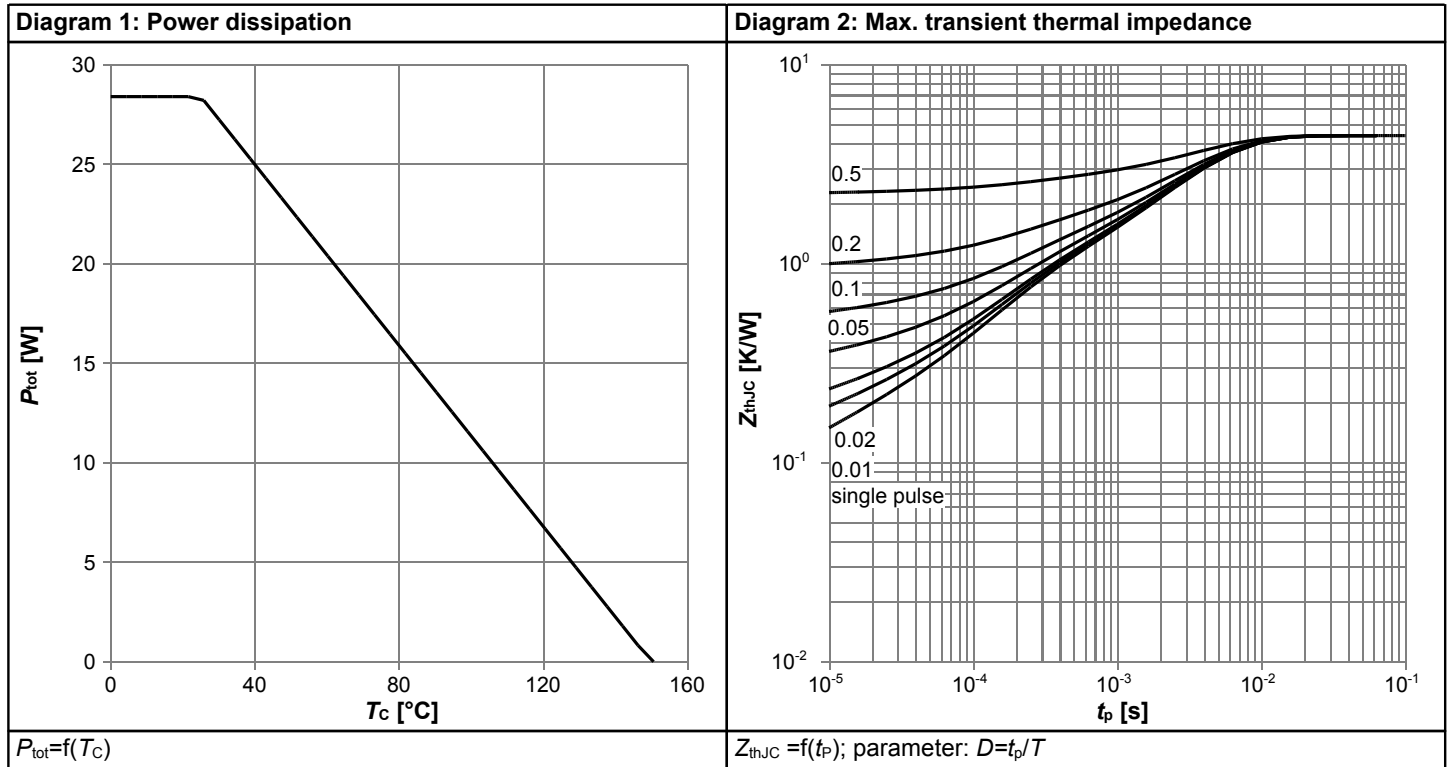
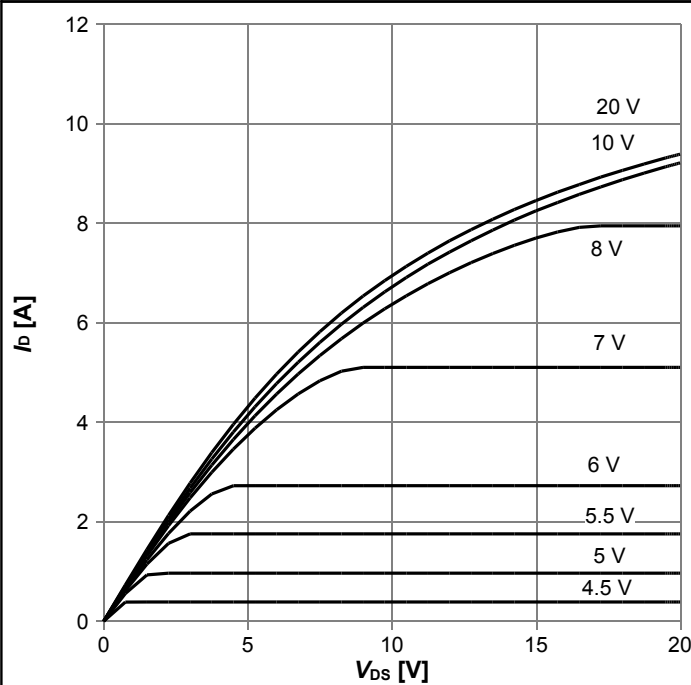


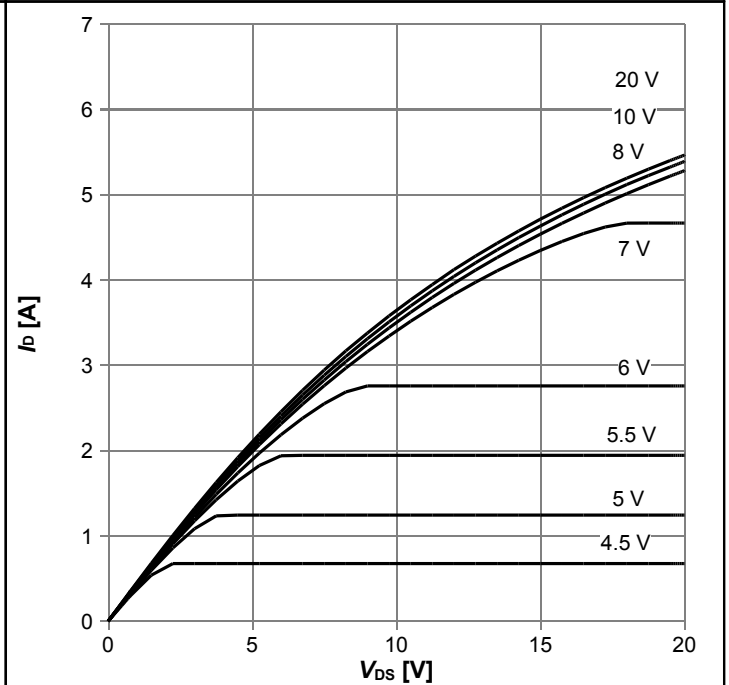


Diagram 5: Typ. output characteristics



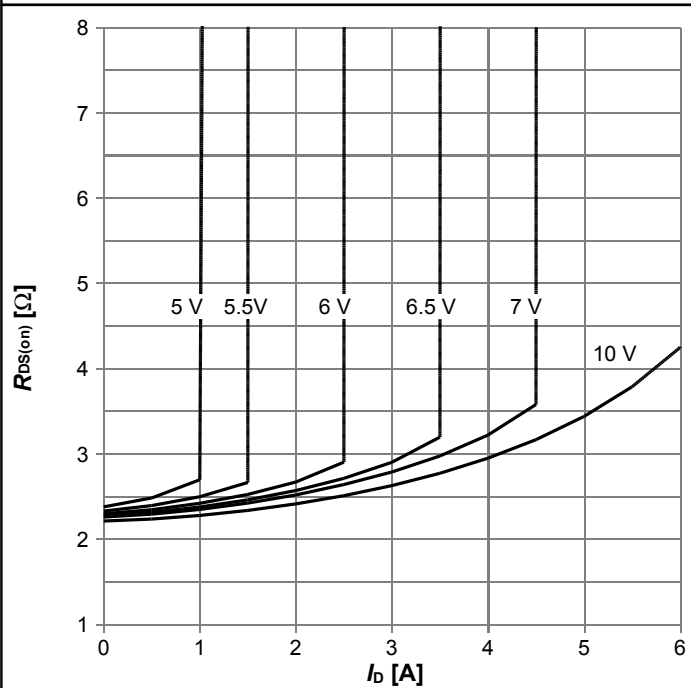
$I_D=f(V_{DS}); T_j=25\text{ °C};$  parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



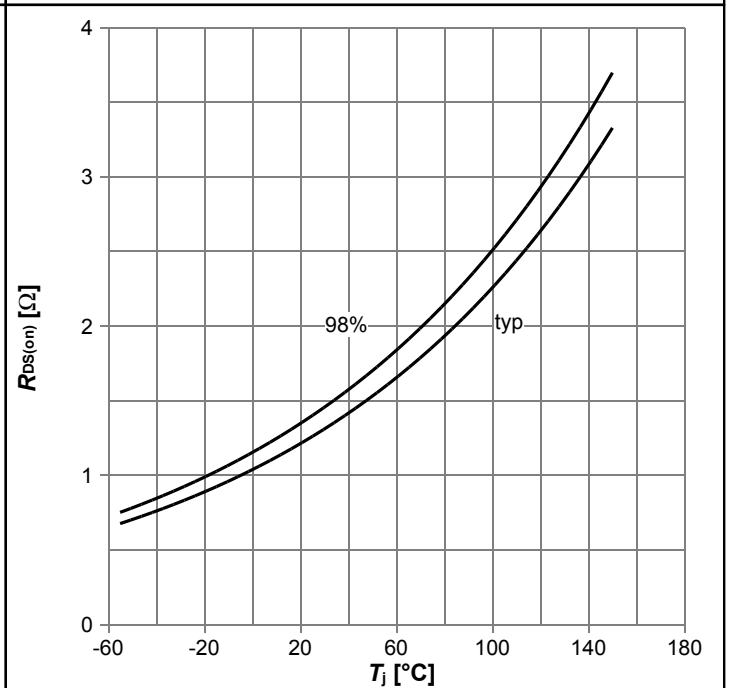
$I_D=f(V_{DS}); T_j=125\text{ °C};$  parameter:  $V_{GS}$

Diagram 7: Typ. drain-source on-state resistance



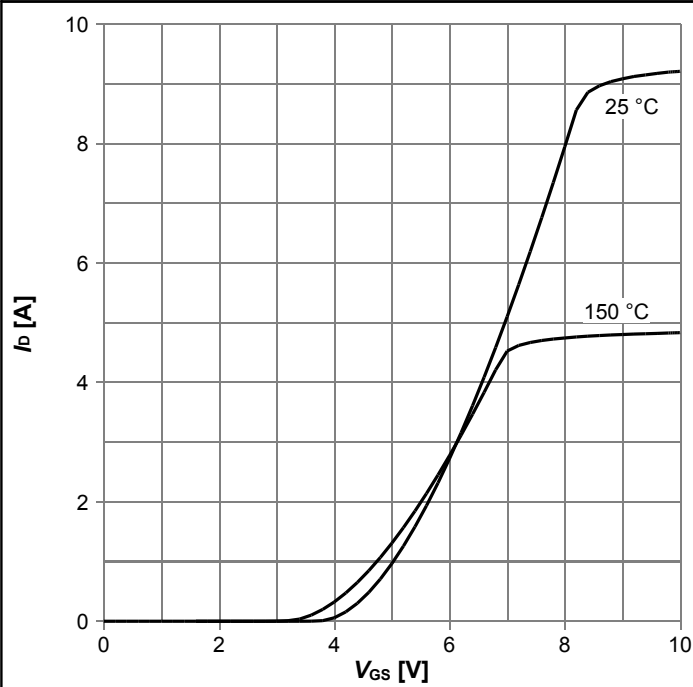
$R_{DS(on)}=f(I_D); T_j=125\text{ °C};$  parameter:  $V_{GS}$

Diagram 8: Drain-source on-state resistance



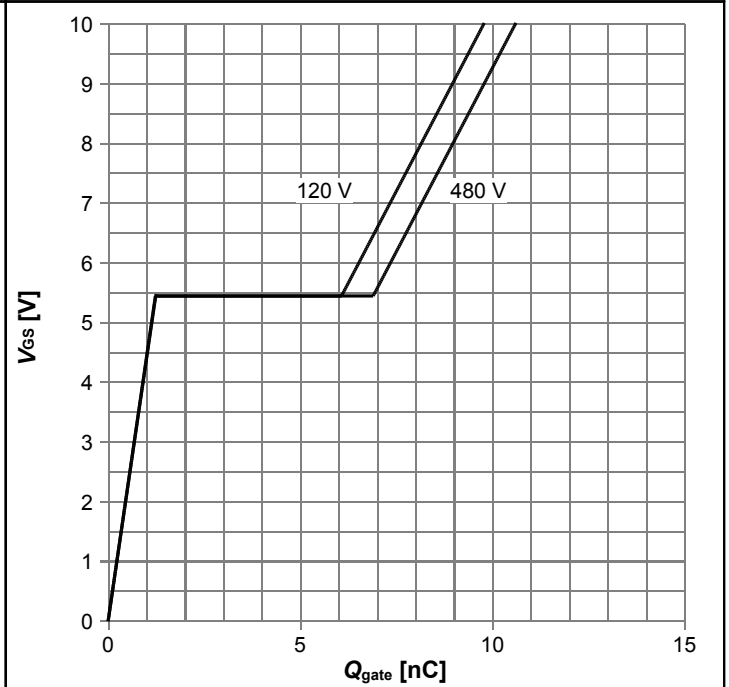
$R_{DS(on)}=f(T_j); I_D=1.0\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



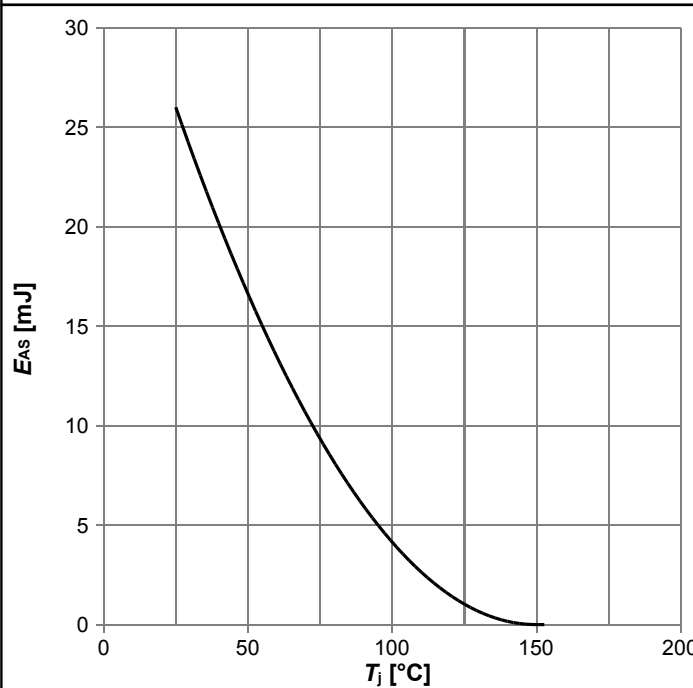
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



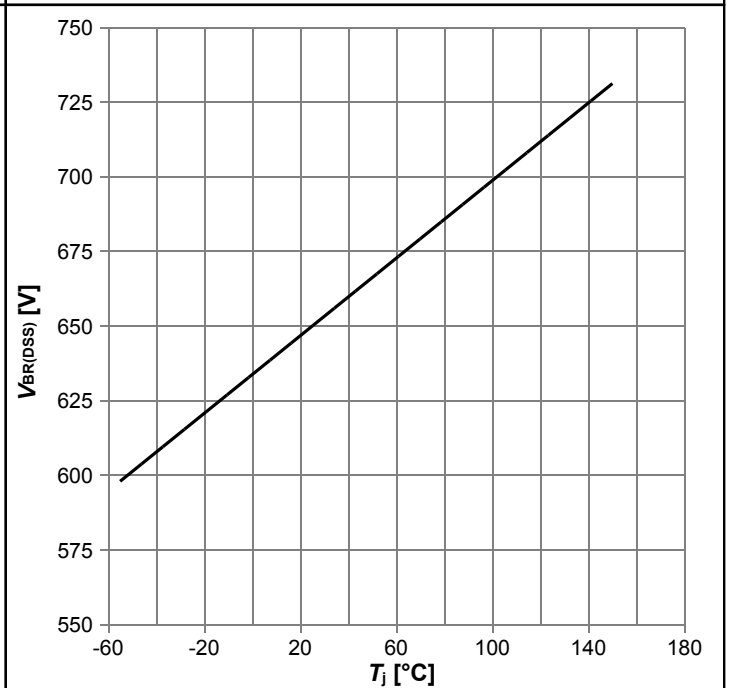
$V_{GS} = f(Q_{gate}); I_D = 1.5 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Avalanche energy



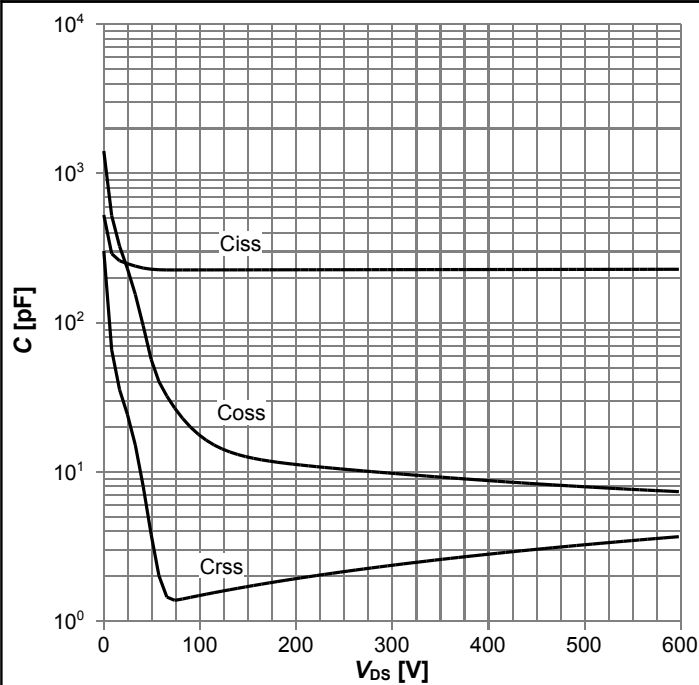
$E_{AS} = f(T_j); I_D = 0.6 \text{ A}; V_{DD} = 50 \text{ V}$

Diagram 12: Drain-source breakdown voltage



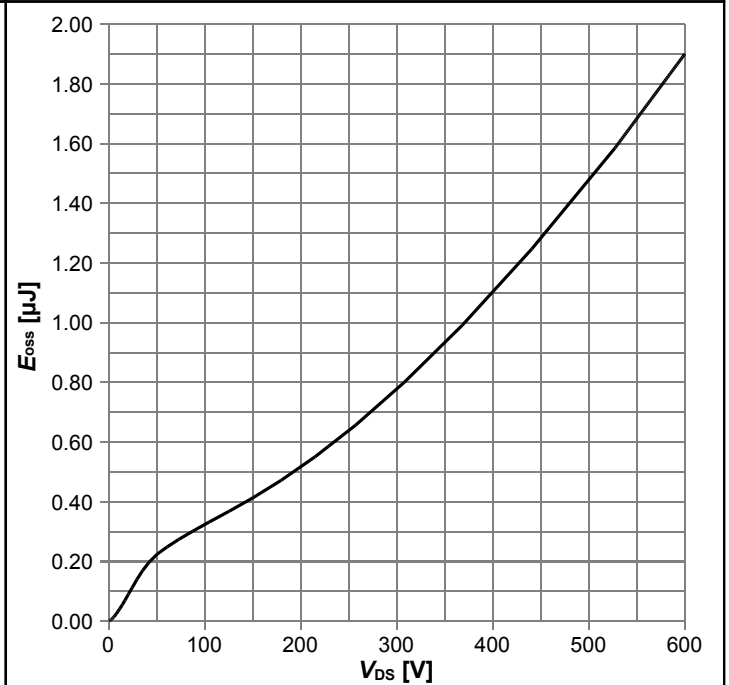
$V_{BR(DSS)} = f(T_j); I_D = 1.0 \text{ mA}$

Diagram 13: Typ. capacitances



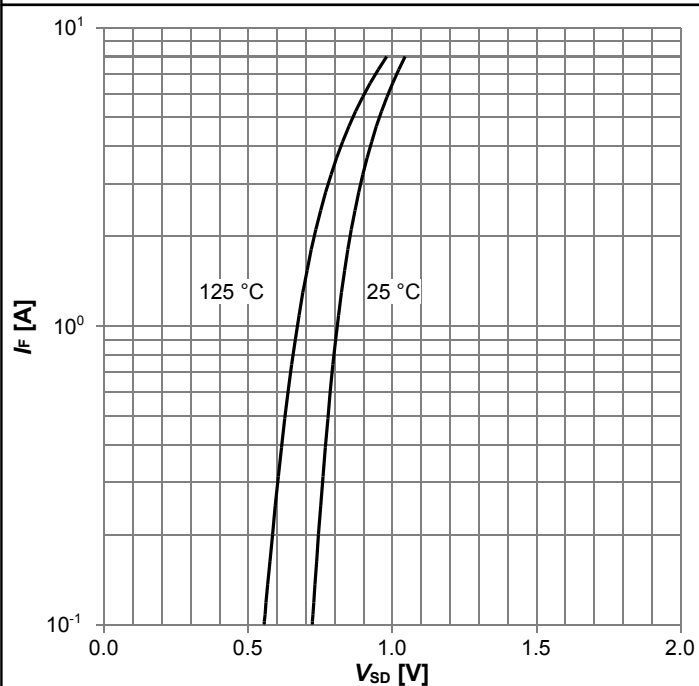
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$

Diagram 14: Typ. Coss stored energy



$E_{oss}=f(V_{DS})$

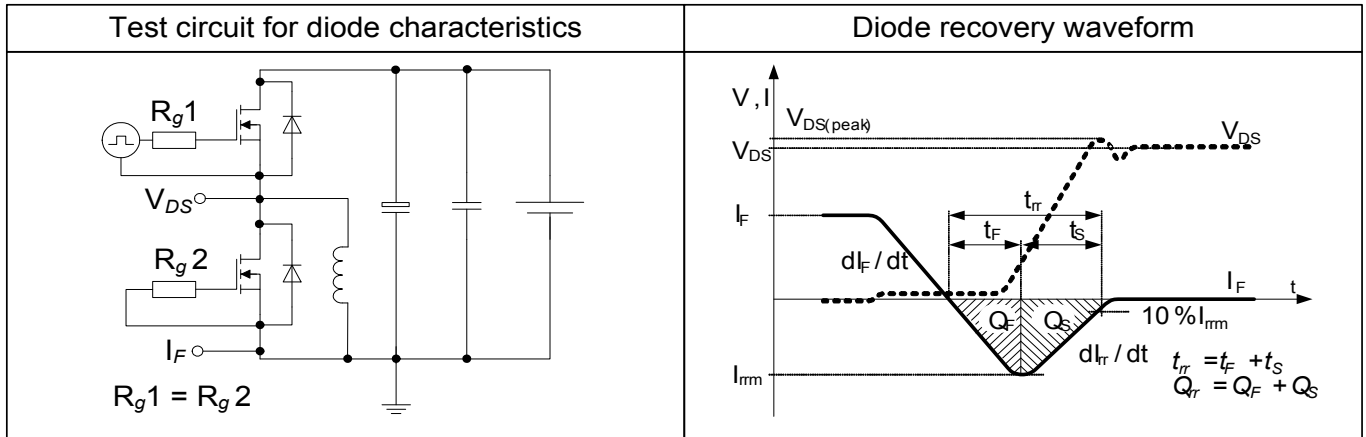
Diagram 15: Forward characteristics of reverse diode



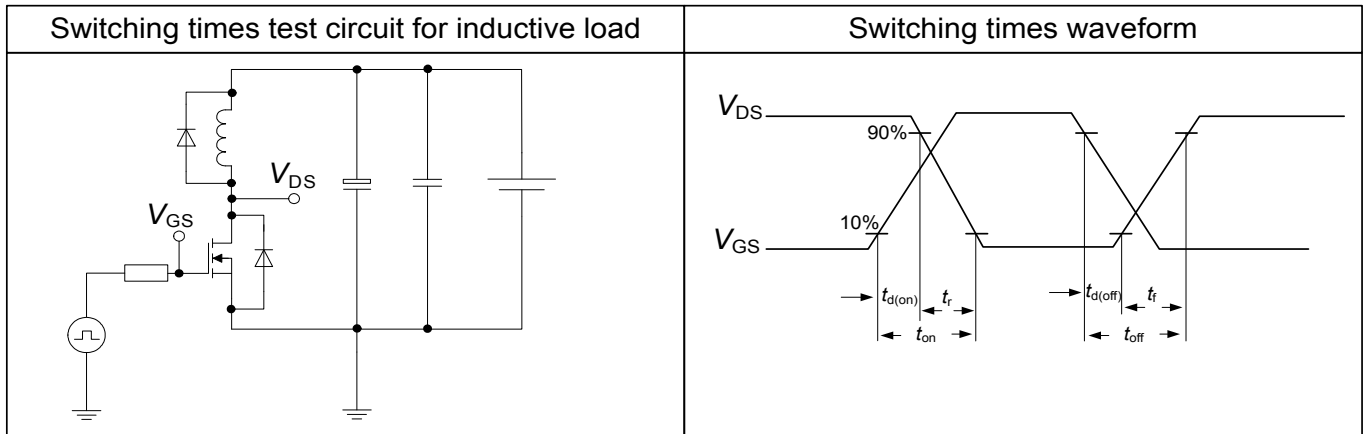
$I_F=f(V_{SD}); \text{parameter: } T_j$

## 6 Test Circuits

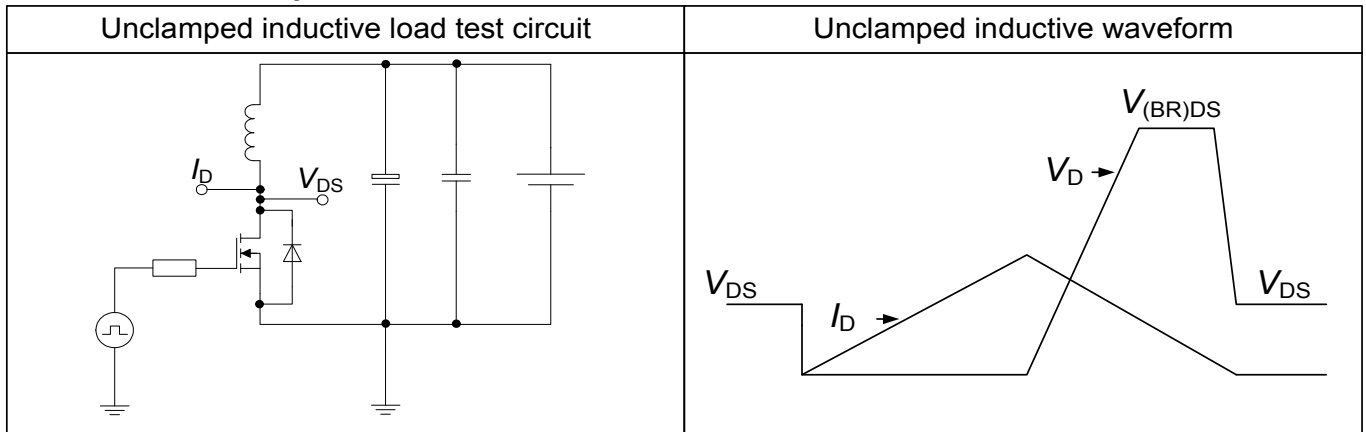
**Table 8 Diode characteristics**



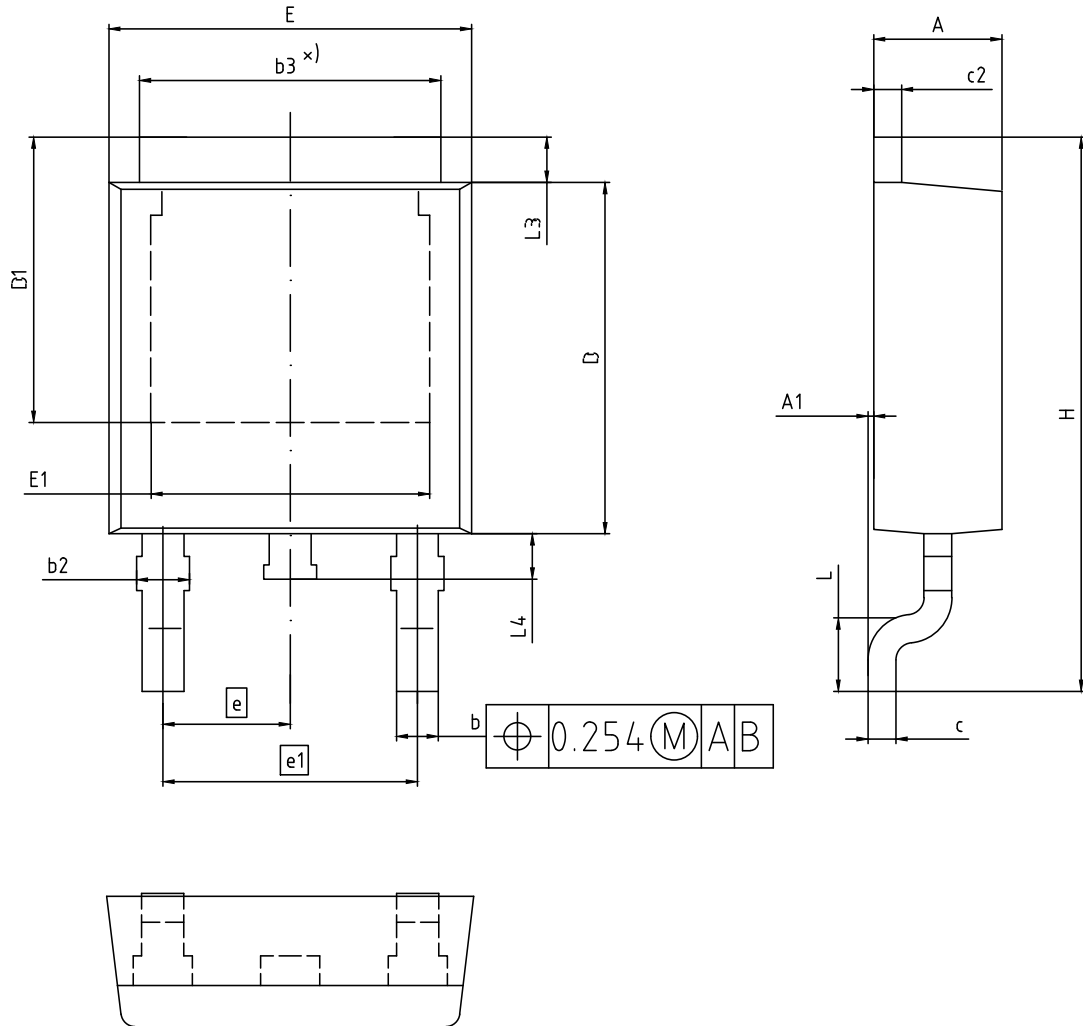
**Table 9 Switching times**



**Table 10 Unclamped inductive load**



## 7 Package Outlines



ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

DIMENSION	MILLIMETERS	
	MIN.	MAX.
A	2.16	2.41
A1	0.00	0.15
b	0.64	0.89
b2	0.65	1.15
b3	4.95	5.50
c	0.46	0.61
c2	0.40	0.98
D	5.97	6.22
D1	5.02	5.84
E	6.35	6.73
E1	4.32	5.50
e	2.29	
e1	4.57	
N	3	
H	9.40	10.48
L	1.18	1.78
L3	0.89	1.27
L4	0.51	1.02

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Figure 1 Outline PG-TO 252, dimensions in mm

## 8 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

IPD65R1K4C6

**Revision: 2020-05-26, Rev. 2.1**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2013-07-26	Release of final version
2.1	2020-05-26	Update of the package outlines

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