MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C6 650V

650V CoolMOS™ C6 Power Transistor
IPD65R1K4C6

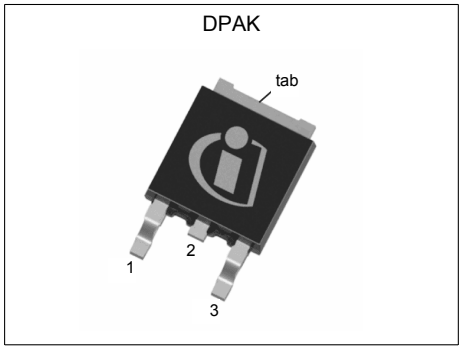
Data Sheet

Rev. 2.0
Final

Industrial & Multimarket

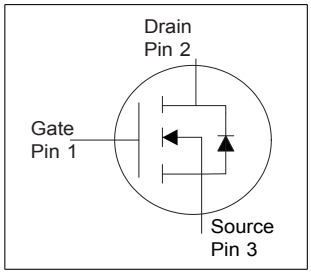
1 Description

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 Rdson*Qg and Eoss
- 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)



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
RDS(on),max	1.4	Ω
Qg,typ	10.5	nC
ID,pulse	8.3	A
Eoss @ 400V	1.15	µJ
Body diode di/dt	500	A/µs

Type / Ordering Code	Package	Marking	Related Links
IPD65R1K4C6	PG-TO 252	65C61K4	see Appendix A

Table of Contents

2 Maximum ratings

at T_j = 25°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°C
				2.0		T_C = 100°C
Pulsed drain current [2]	$I_{D,pulse}$			8.3	A	T_C = 25°C
Avalanche energy, single pulse	E_{AS}			26	mJ	I_D = 0.6A, V_{DD} = 50V (see table 10)
Avalanche energy, repetitive	E_{AR}			0.10	mJ	I_D = 0.6A, V_{DD} = 50V
Avalanche current, repetitive	I_{AR}			0.6	A	
MOSFET dv/dt ruggedness	dv/dt			50	V/ns	V_{DS} = 0 ... 480V
Gate source voltage	V_{GS}	-20		20	V	static
		-30		30		AC (f > 1 Hz)
Operating and storage temperature	T_j,T_{stg}	-55		150	°C	
Continuous diode forward current	I_S			2.8	A	T_C = 25°C
Diode pulse current	$I_{S,pulse}$			8.3	A	T_C = 25°C
Reverse diode dv/dt [3]	dv/dt			15	V/ns	V_{DS} = 0 ... 400V, $I_{SD} \le I_D$, T_j = 25°C (see table 8)
Maximum diode commutation speed	di_f/dt			500	A/µs	
Power dissipation	P_{tot}			28	W	T_C=25°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 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 [1)]	R_{thJA}			62	°C/W	leaded
			35			SMD version, device on PCB, 6cm² 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°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	µA	V_{DS} = 650V, V_{GS} = 0V, T_j = 25°C
			10			V_{DS} = 650V, V_{GS} = 0V, T_j = 150°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 = 1.0A, T_j = 25°C
			3.280			V_{GS} = 10V, I_D = 1A, T_j = 150°C
Gate resistance	R_G		6.5		Ω	f = 1MHz, 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 [1]	$C_{o(er)}$		10		pF	V_{GS} = 0V, V_{DS} = 0 ... 480V
Effective output capacitance, time related [2]	$C_{o(tr)}$		42		pF	I_D = constant, V_{GS} = 0V, V_{DS} = 0 ... 480V
Turn-on delay time	$t_{d(on)}$		7.7		ns	V_{DD} = 400V, V_{GS} = 13V, I_D = 1.5A, R_G = 10.2Ω (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 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	

[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% $V_{(BR)DSS}$

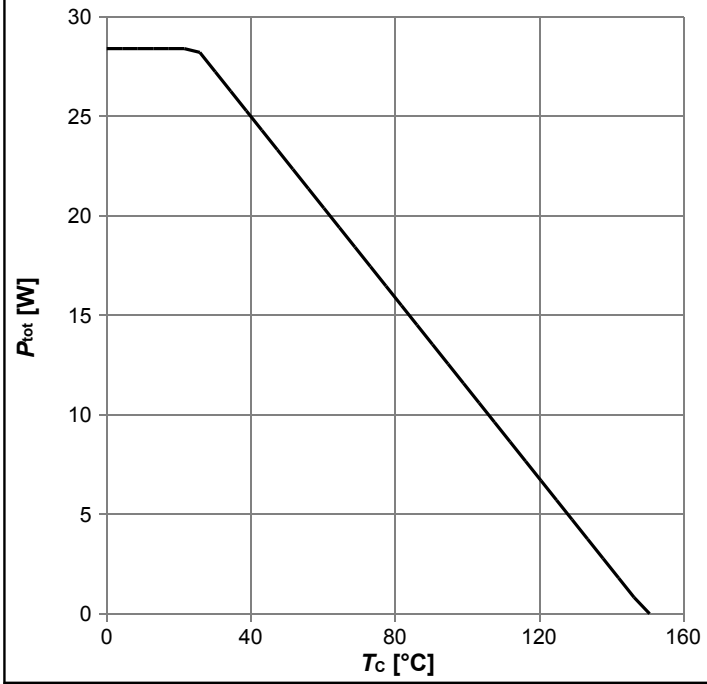
[2] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% $V_{(BR)DSS}$

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 = 1.5A, T_j = 25°C
Reverse recovery time	t_{rr}		200		ns	V_R = 400V, I_F = 1.5A, di_F/dt = 100A/µs (see table 8)
Reverse recovery charge	Q_{rr}		0.9		µC	
Peak reverse recovery current	I_{rrm}		8		A	

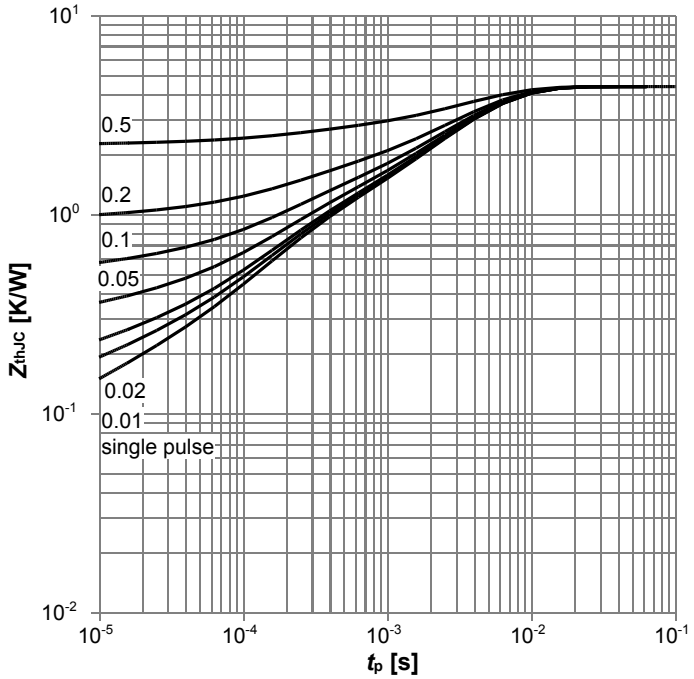
5 Electrical characteristics diagrams

Diagram 1: Power dissipation



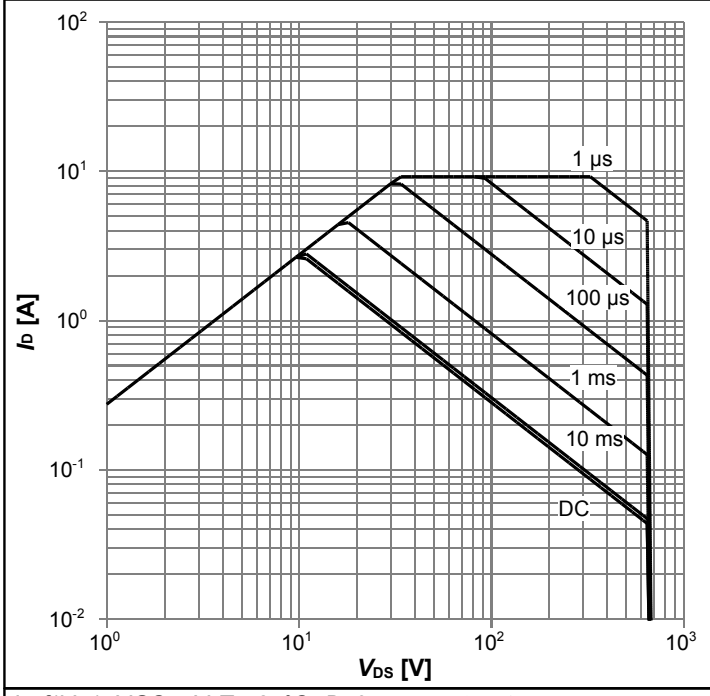
$P_{tot}=f(T_C)$

Diagram 2: Max. transient thermal impedance



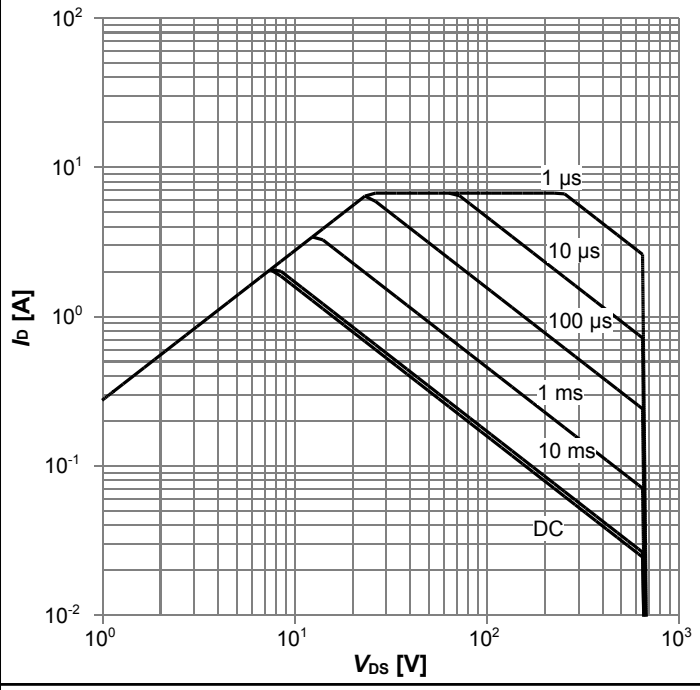
$Z_{thJC}=f(t_P)$; parameter: $D=t_p/T$

Diagram 3: Safe operating area



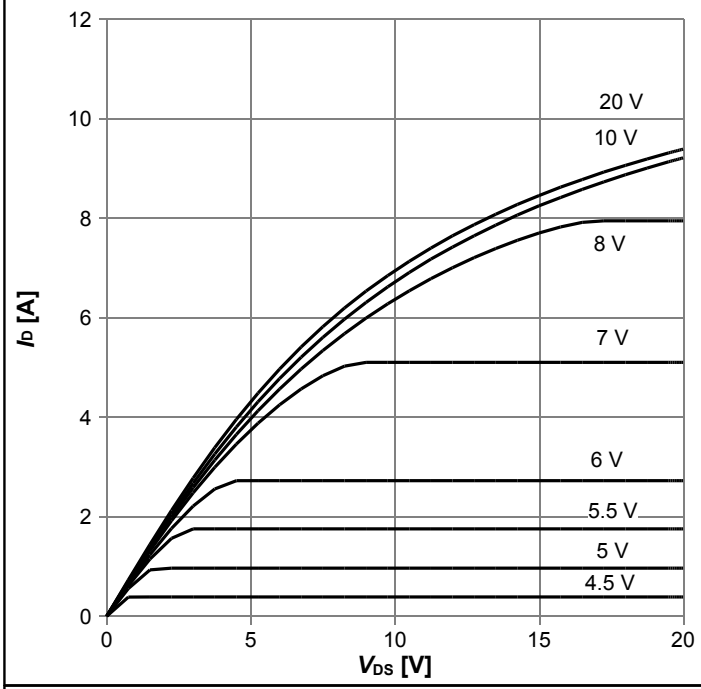
$I_D=f(V_{DS})$; VGS>7V; T_C=25°C; D=0; parameter: t_p

Diagram 4: Safe operating area



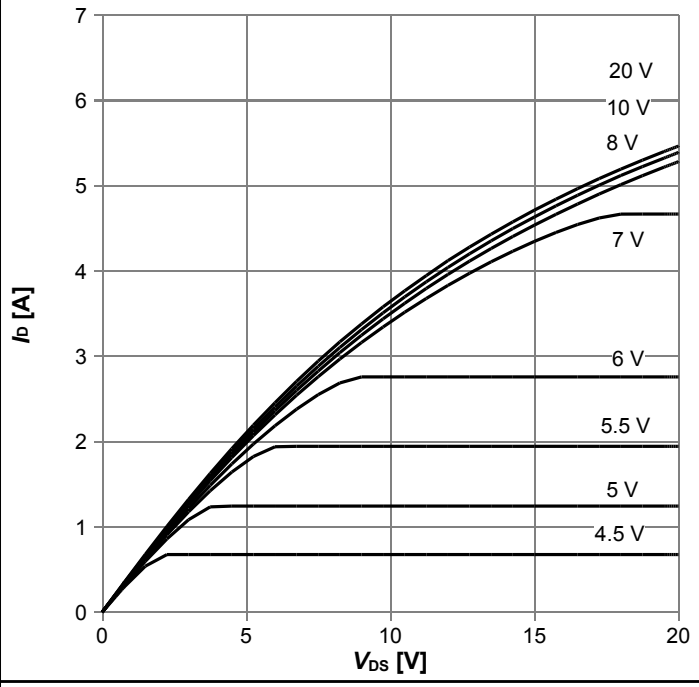
$I_D=f(V_{DS})$; VGS>7V; T_C=80°C; D=0; parameter: t_p

Diagram 5: Typ. output characteristics



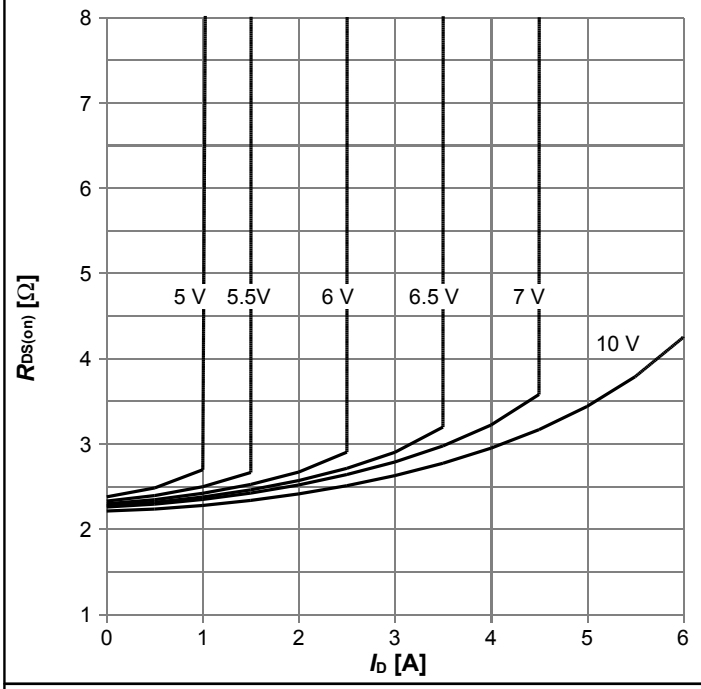
I_D=f(V_{DS}); T_j=25 °C; parameter: V_{GS}

Diagram 6: Typ. output characteristics



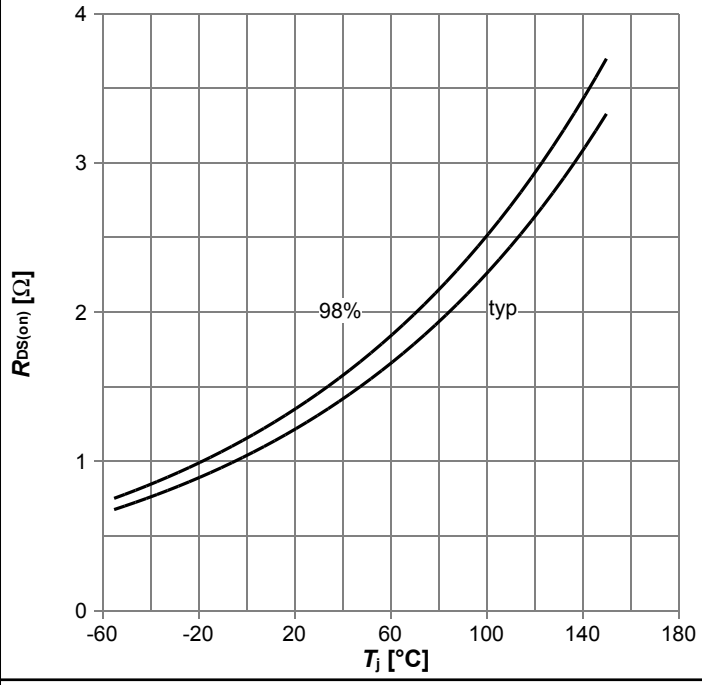
I_D=f(V_{DS}); T_j=125 °C; parameter: V_{GS}

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



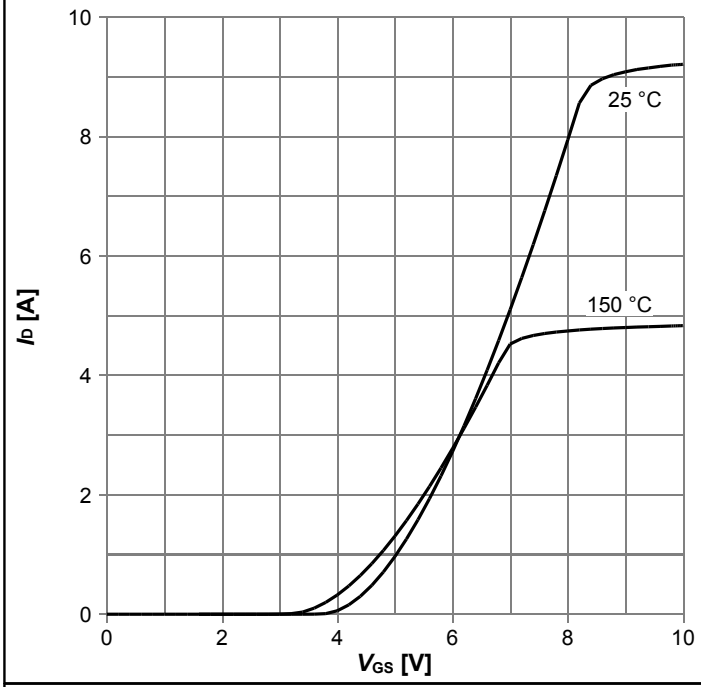
$R_{DS(on)}$=f(I_D); T_j=125 °C; parameter: V_{GS}

Diagram 8: Drain-source on-state resistance



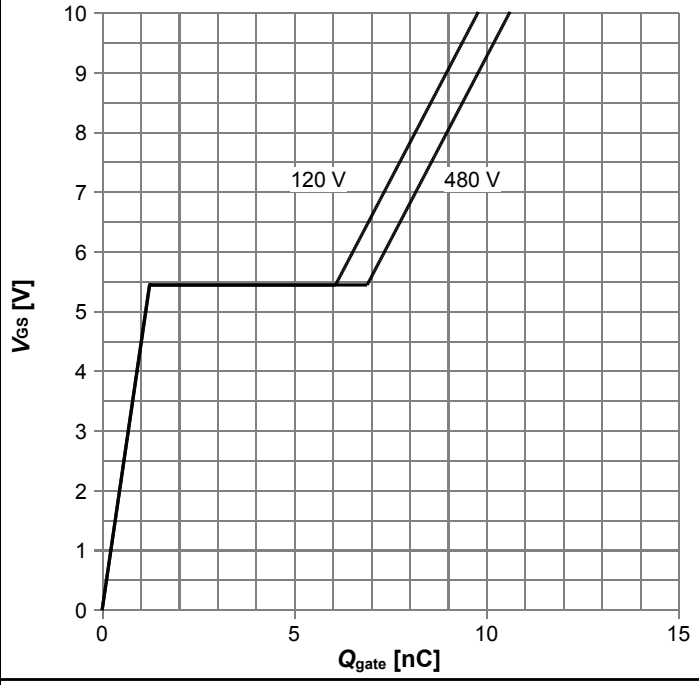
$R_{DS(on)}$=f(T_j); I_D=1.0 A; V_{GS}=10 V

Diagram 9: Typ. transfer characteristics



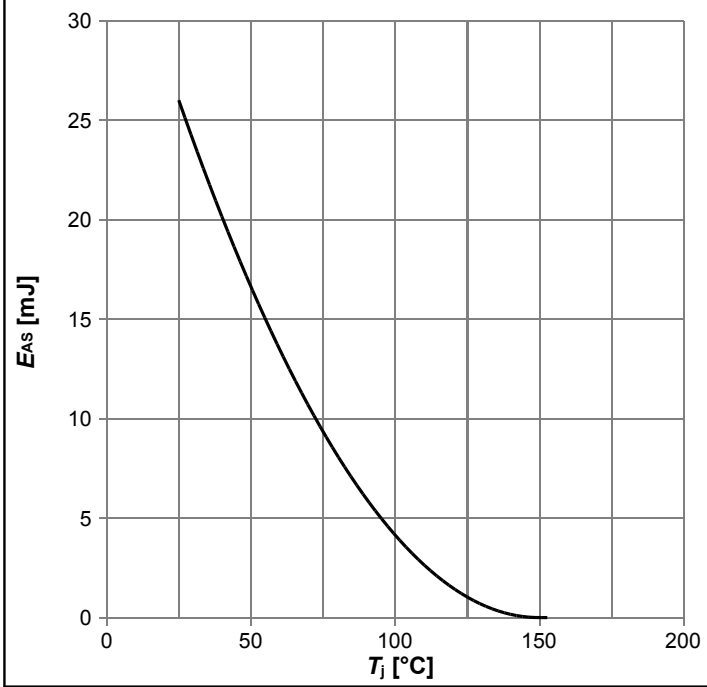
I_D=f(V_{GS}); V_{DS} = 20V; parameter: T_j

Diagram 10: Typ. gate charge



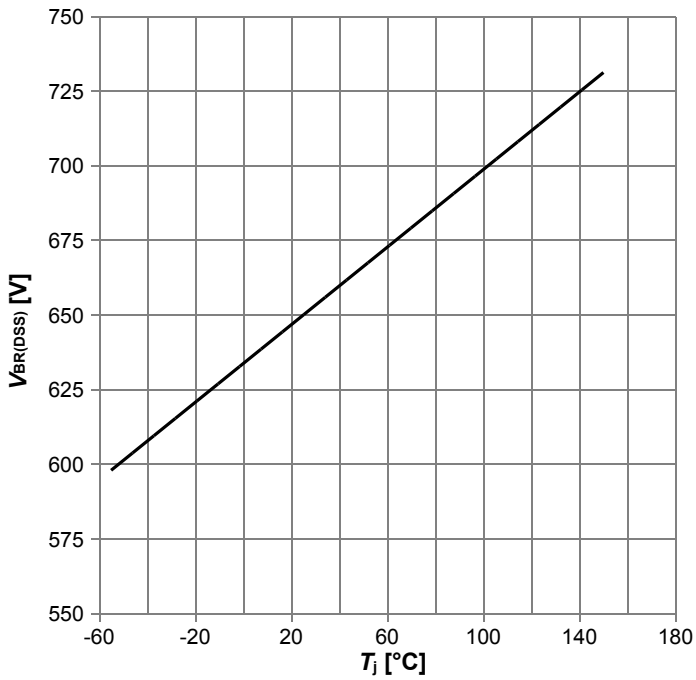
V_{GS}=f(Q_{gate}); I_D=1.5 A pulsed; parameter: V_{DD}

Diagram 11: Avalanche energy



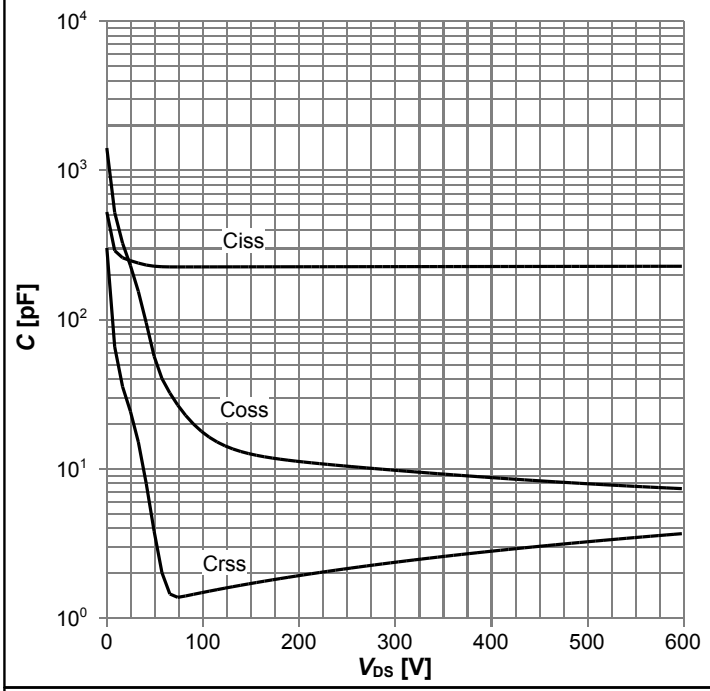
E_{AS}=f(T_j); I_D=0.6 A; V_{DD}=50 V

Diagram 12: Drain-source breakdown voltage



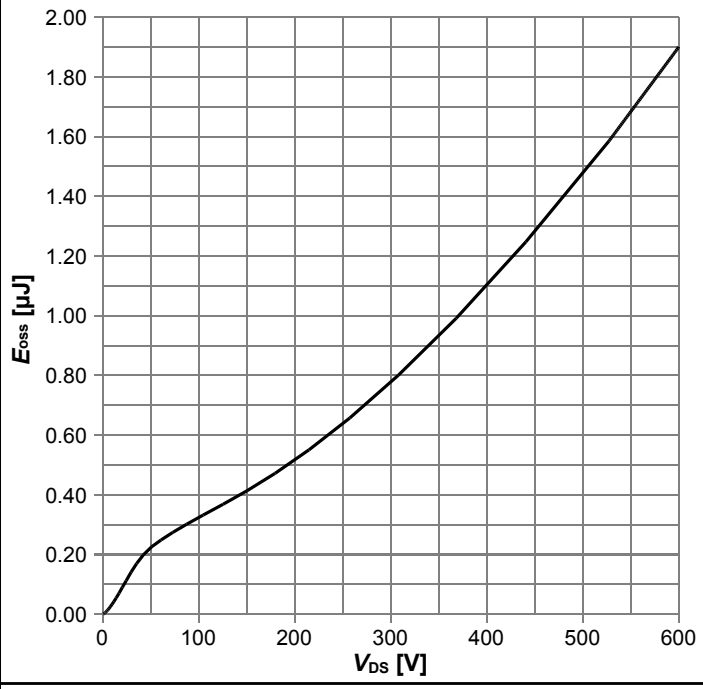
$V_{BR(DSS)}$=f(T_j); I_D=1.0 mA

Diagram 13: Typ. capacitances



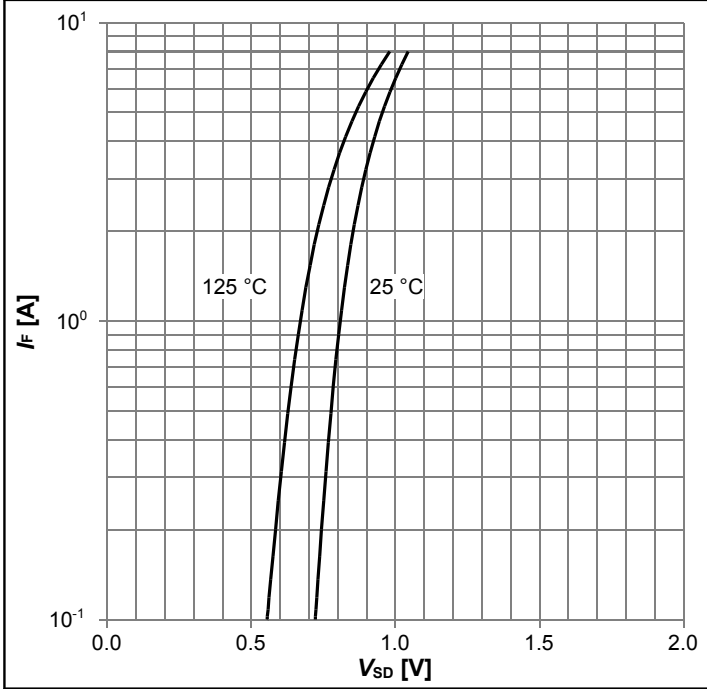
C=f(V_{DS}); V_{GS}=0 V; f=1 MHz

Diagram 14: Typ. Coss stored energy



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

Diagram 15: Forward characteristics of reverse diode



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

6 Test Circuits

Table 8 Diode characteristics

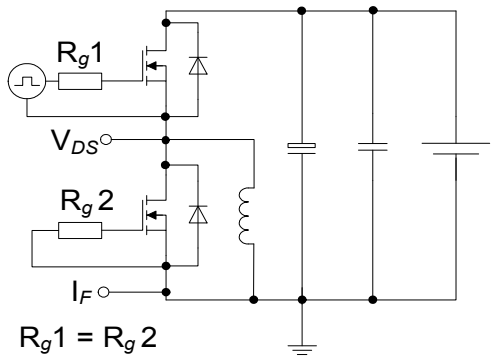
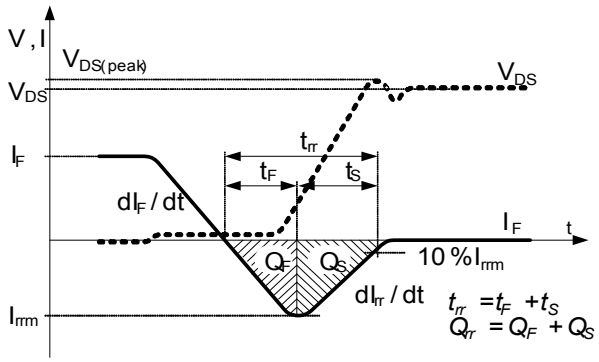
Test circuit for diode characteristics	Diode recovery waveform
	

Table 9 Switching times

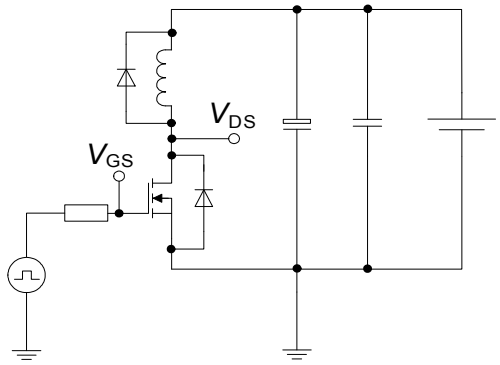
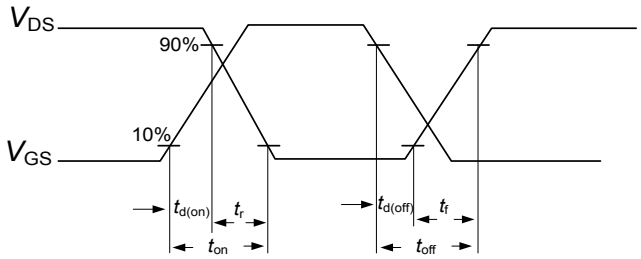
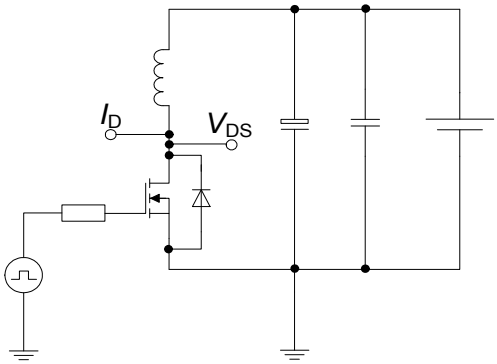
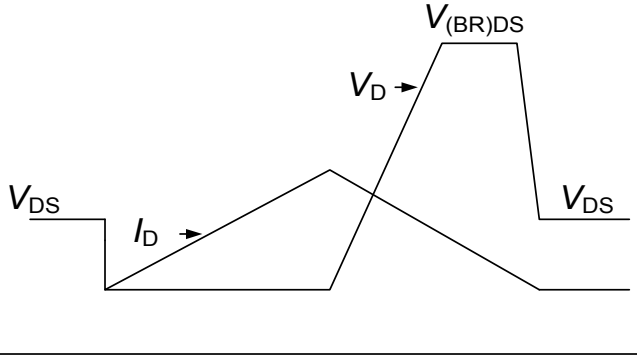
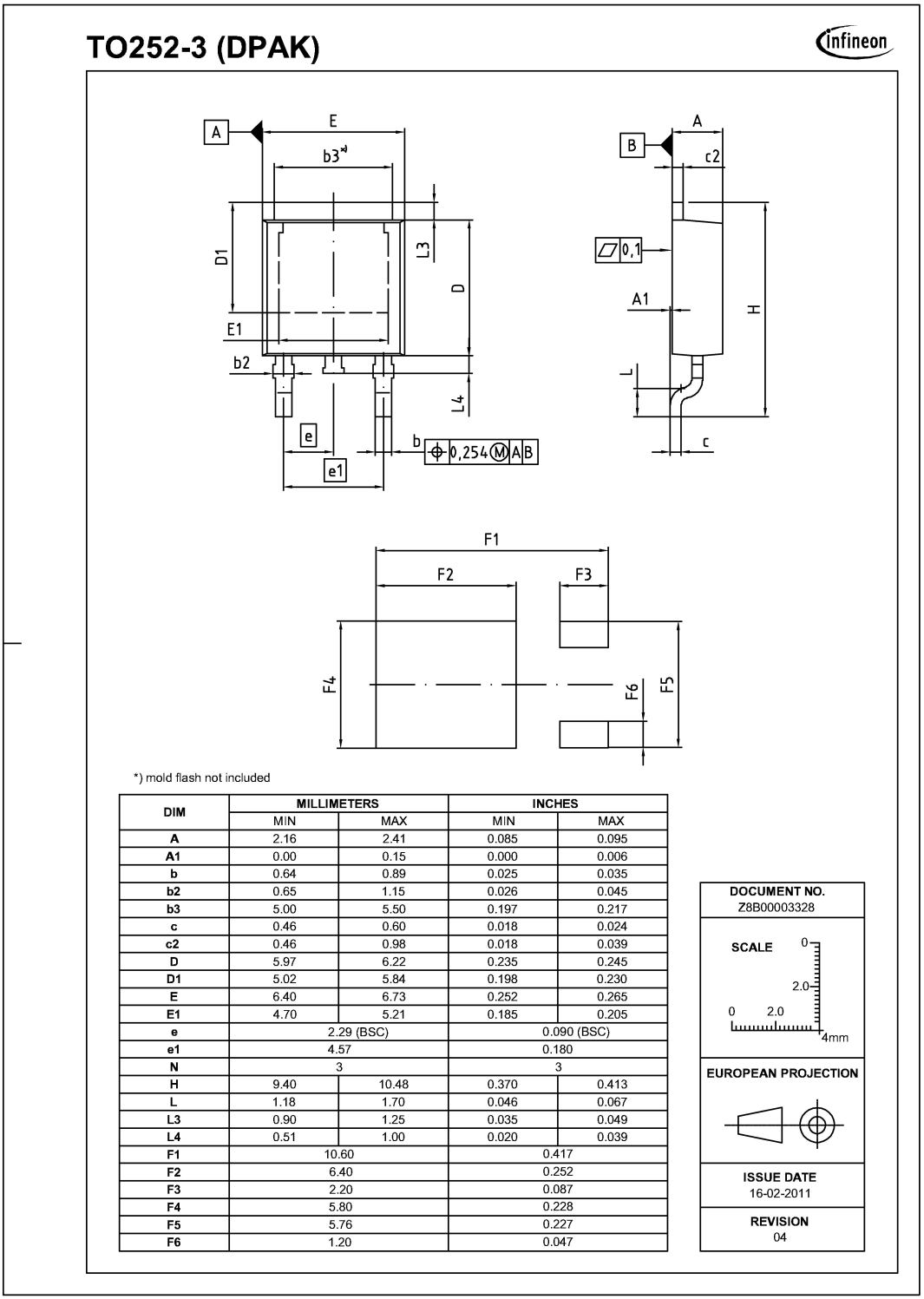
Switching times test circuit for inductive load	Switching times waveform
	

Table 10 Unclamped inductive load

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	0.00	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	0.60	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 (BSC)		0.090 (BSC)	
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	10.60		0.417	
F2	6.40		0.252	
F3	2.20		0.087	
F4	5.80		0.228	
F5	5.76		0.227	
F6	1.20		0.047	

Figure 1 Outline PG-TO 252, dimensions in mm/inches

8 Appendix A

Table 11 Related Links

- **IFX C6 Product Brief:** www.infineon.com
- **IFX C6 Portfolio:** www.infineon.com
- **IFX CoolMOS Webpage:** www.infineon.com
- **IFX Design Tools:** www.infineon.com

Revision History

IPD65R1K4C6

Revision: 2013-07-26, Rev. 2.0

Previous Revision		
Revision	Date	Subjects (major changes since last revision)
2.0	2013-07-26	Release of final version

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