

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C6 650V

650V CoolMOS™ C6 Power Transistor
IPD65R950C6

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, 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.

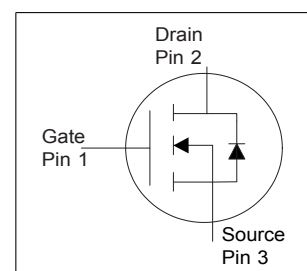
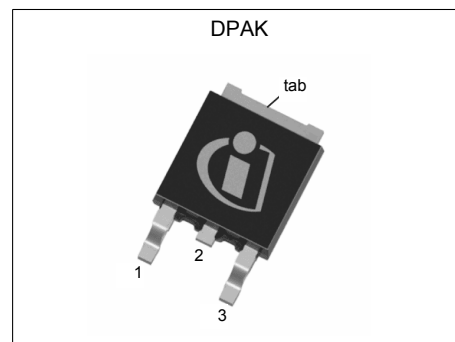


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	700	V
$R_{DS(on),max}$	0.95	Ω
Q_g,typ	15.3	nC
$I_D,pulse$	12	A
$E_{oss} @ 400V$	1.5	μJ
Body diode di/dt	500	A/ μs

Type / Ordering Code	Package	Marking	Related Links
IPD65R950C6	PG-TO 252	65C6950	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			4.5	A	$T_C = 25^\circ\text{C}$
				2.8		$T_C = 100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$			12	A	$T_C = 25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}			50	mJ	$I_D = 1.0\text{A}$, $V_{DD} = 50\text{V}$ (see table 10)
Avalanche energy, repetitive	E_{AR}			0.15	mJ	$I_D = 1.0\text{A}$, $V_{DD} = 50\text{V}$
Avalanche current, repetitive	I_{AR}			1.0	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			3.9	A	$T_C = 25^\circ\text{C}$
Diode pulse current	$I_{S,pulse}$			12	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt ³⁾	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/ μs	
Power dissipation	P_{tot}			37	W	$T_C = 25^\circ$

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}			3.4	°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	$V_{(BR)DSS}$	650			V	$V_{GS} = 0V, I_D = 1mA$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5	V	$V_{DS} = V_{GS}, I_D = 0.2mA$
Zero gate voltage drain current	I_{DSS}			1	μA	$V_{DS} = 650V, V_{GS} = 0V, T_j = 25^\circ C$
			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	$R_{DS(on)}$		0.855	0.95	Ω	$V_{GS} = 10V, I_D = 1.5A, T_j = 25^\circ C$
			2.223			$V_{GS} = 10V, I_D = 1.5A, T_j = 150^\circ C$
Gate resistance	R_G		5.5		Ω	$f = 1MHz$, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}		328		pF	$V_{GS} = 0V, V_{DS} = 100V, f = 1MHz$
Output capacitance	C_{oss}		23		pF	
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$		14		pF	$V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$		58.5		pF	$I_D = \text{constant}, V_{GS} = 0V, V_{DS} = 0 \dots 480V$
Turn-on delay time	$t_{d(on)}$		6.6		ns	$V_{DD} = 400V, V_{GS} = 13V, I_D = 2.2A, R_G = 10.2\Omega$ (see table 9)
Rise time	t_r		5.2		ns	
Turn-off delay time	$t_{d(off)}$		41		ns	
Fall time	t_f		13.6		ns	

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}		1.8		nC	$V_{DD} = 480V, I_D = 2.2A, V_{GS} = 0 \text{ to } 10V$
Gate to drain charge	Q_{gd}		8		nC	
Gate charge total	Q_g		15.3		nC	
Gate plateau voltage	$V_{plateau}$		5.1		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	$V_{GS} = 0V, I_F = 2.2A, T_j = 25^{\circ}C$
Reverse recovery time	t_{rr}		226		ns	$V_R = 400V, I_F = 2.2A,$ $di_F/dt = 100A/\mu s$ (see table 8)
Reverse recovery charge	Q_{rr}		1.3		μC	
Peak reverse recovery current	I_{rrm}		9.9		A	

5 Electrical characteristics diagrams

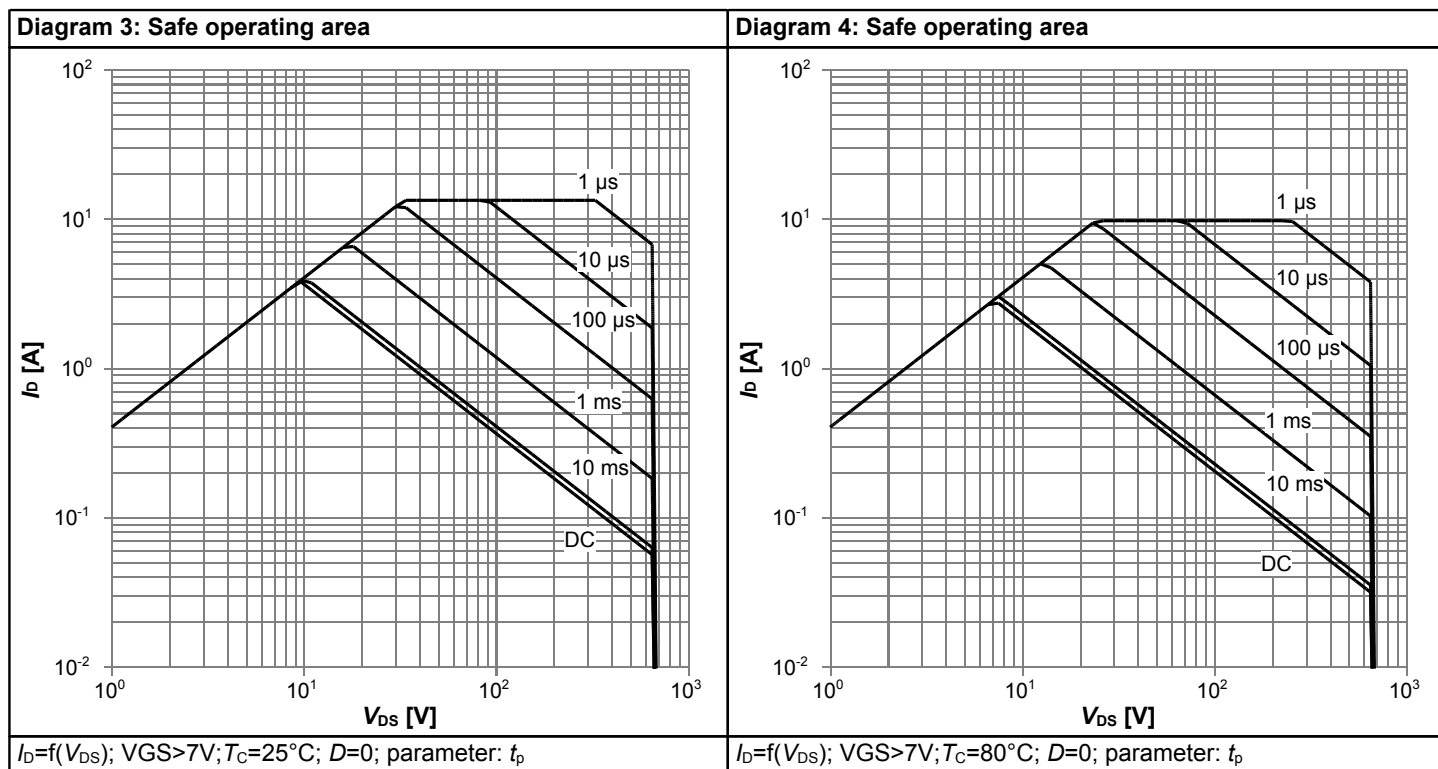
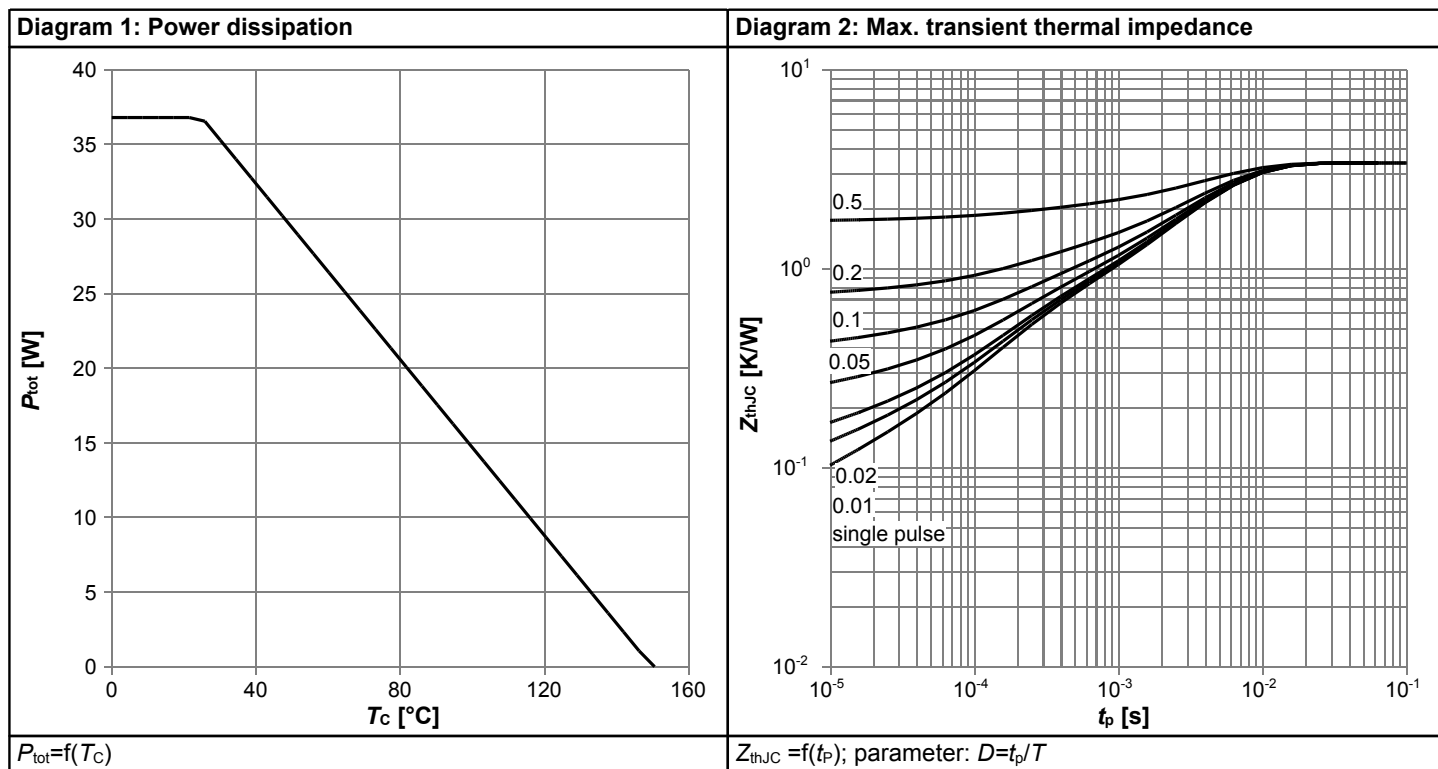


Diagram 5: Typ. output characteristics

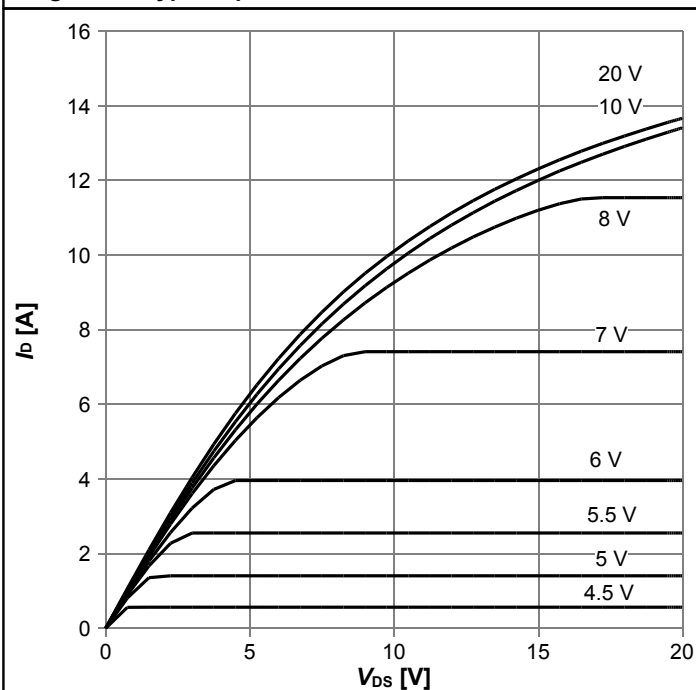

 $I_D = f(V_{DS}); T_J = 25^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics

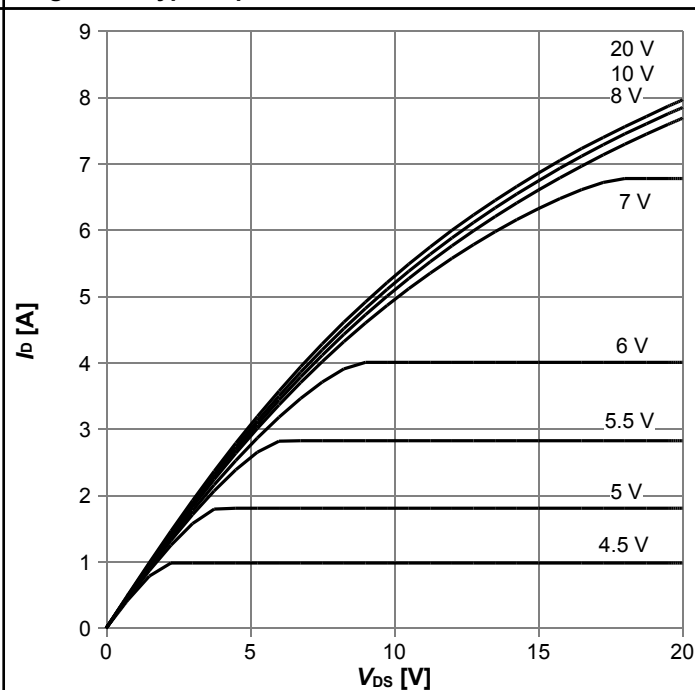

 $I_D = f(V_{DS}); T_J = 125^\circ\text{C}; \text{parameter: } V_{GS}$

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

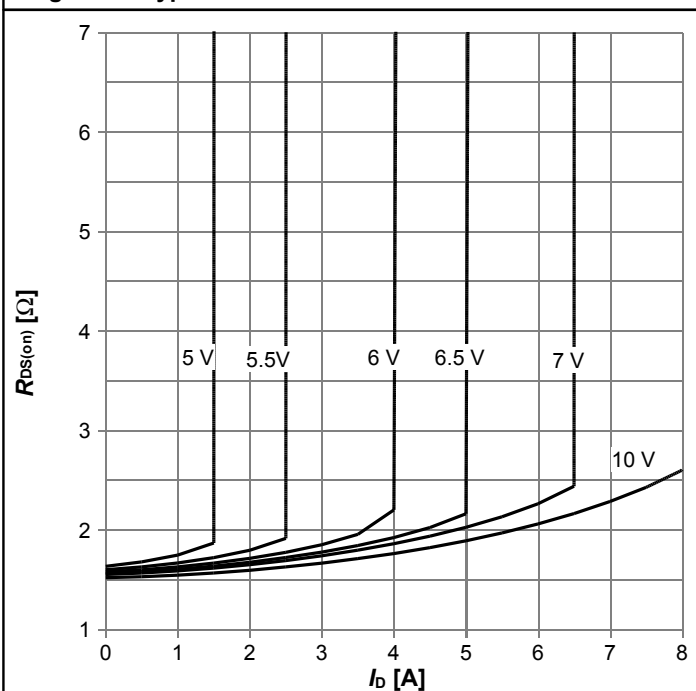

 $R_{DS(on)} = f(I_D); T_J = 125^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance

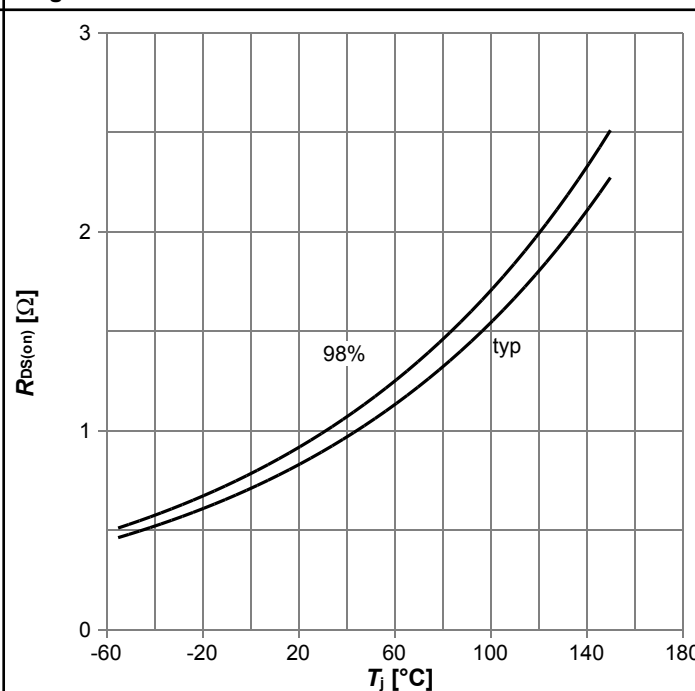

 $R_{DS(on)} = f(T_J); I_D = 1.5\text{ A}; V_{GS} = 10\text{ V}$

Diagram 9: Typ. transfer characteristics

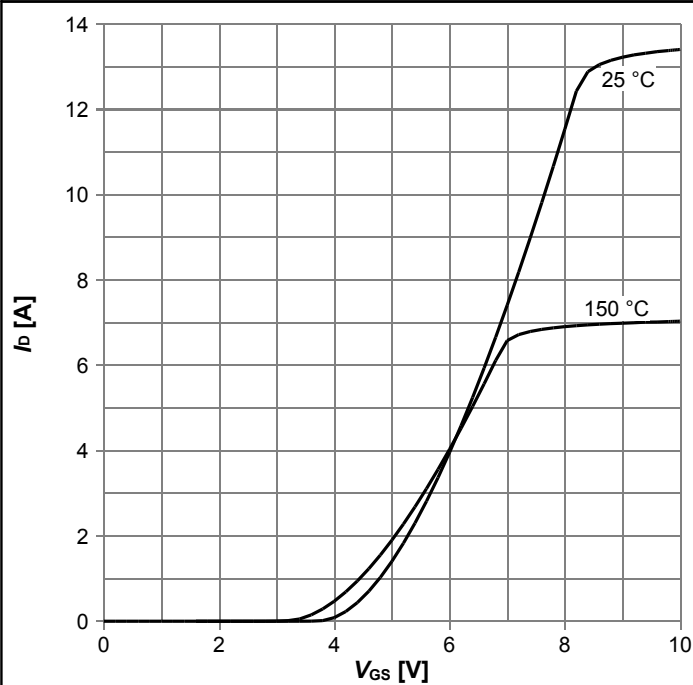

 $I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge

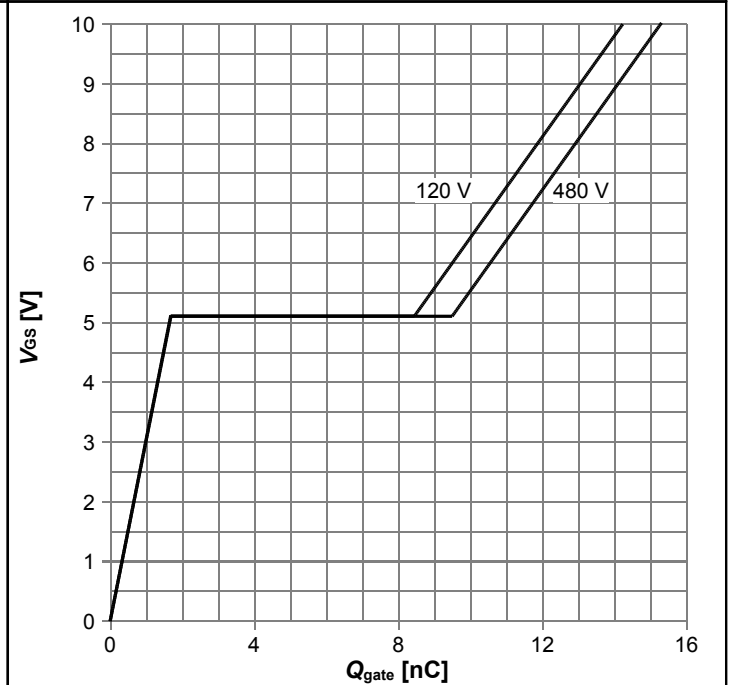

 $V_{GS} = f(Q_{gate}); I_D = 1.5 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Avalanche energy

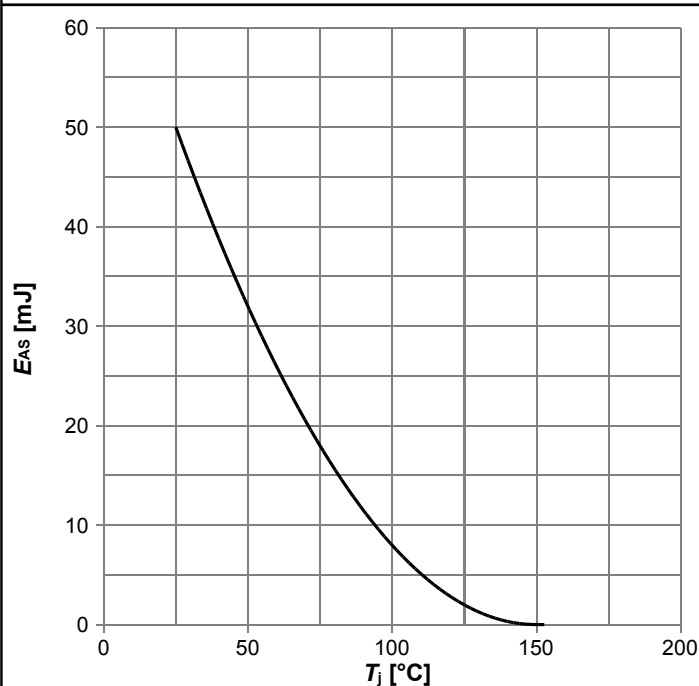

 $E_{AS} = f(T_j); I_D = 1.0 \text{ A}; V_{DD} = 50 \text{ V}$

Diagram 12: Drain-source breakdown voltage

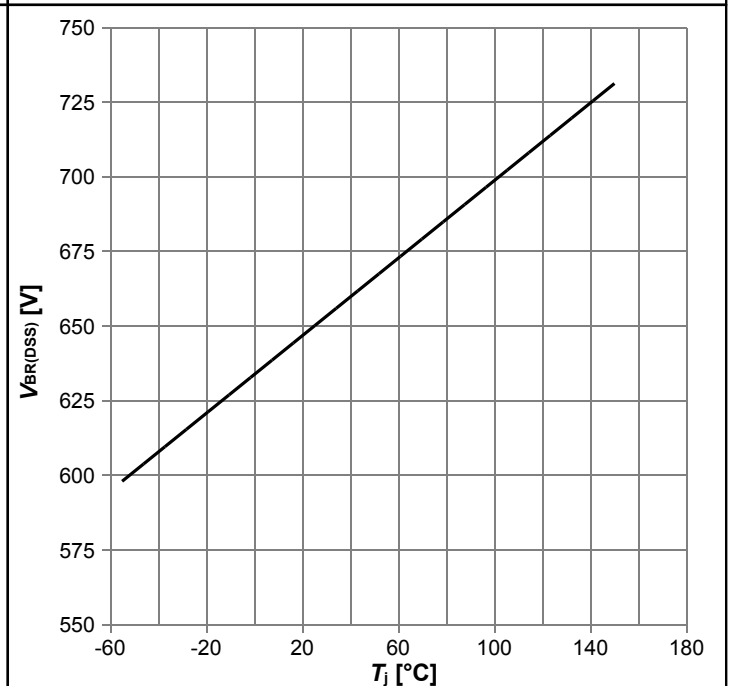
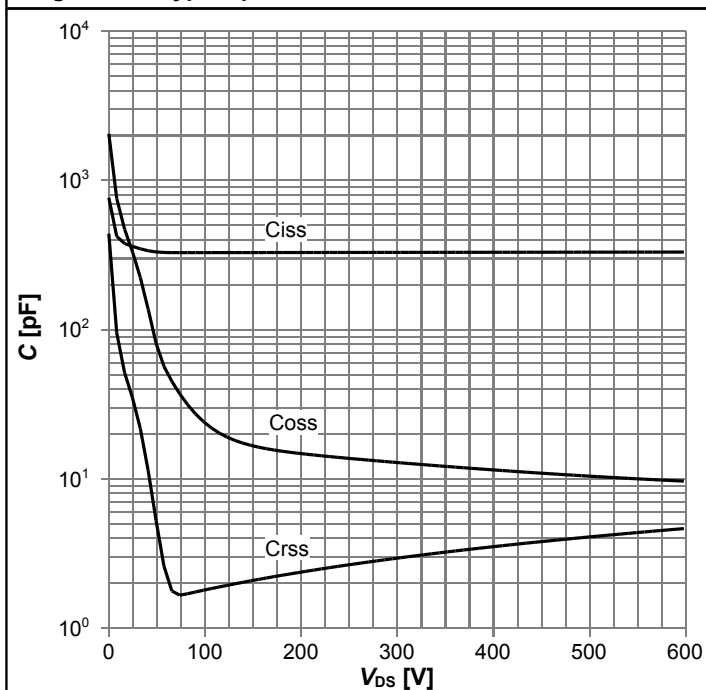
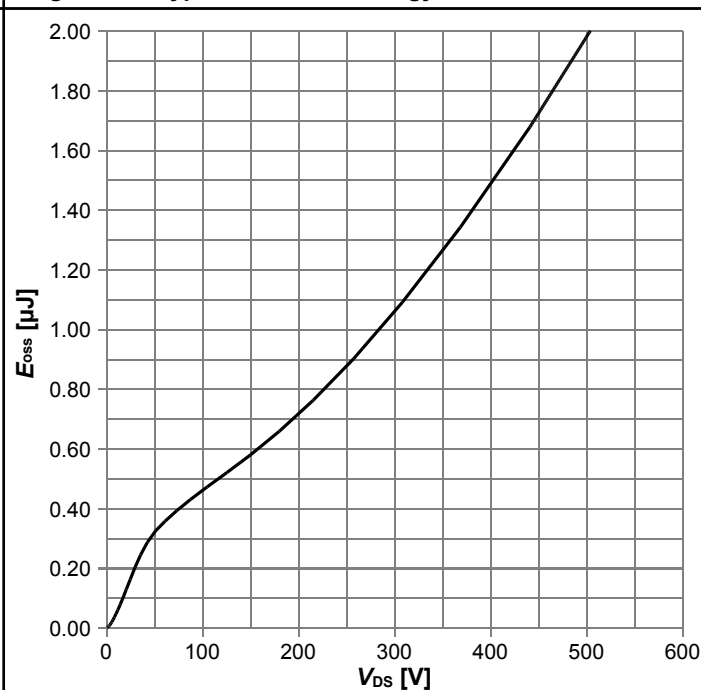

 $V_{BR(DSS)} = f(T_j); I_D = 1.0 \text{ mA}$

Diagram 13: Typ. capacitances



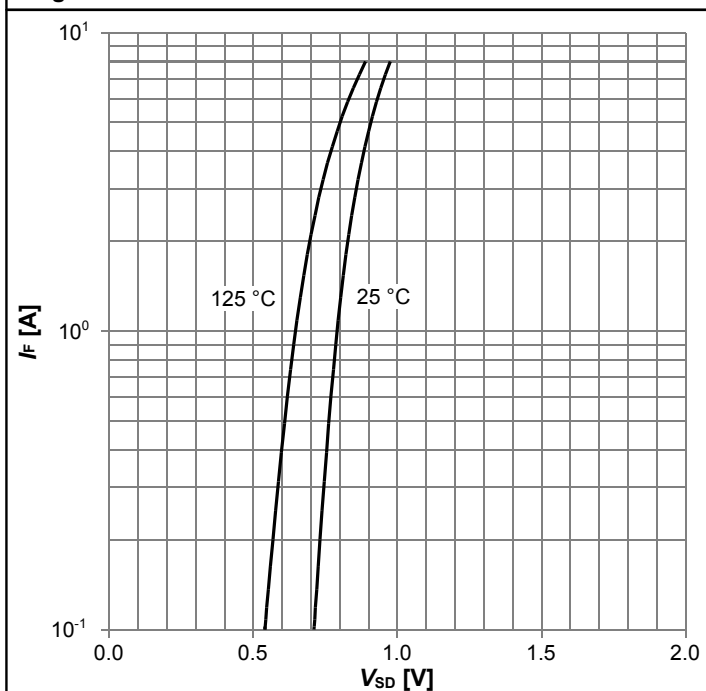
$$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$$

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

Test circuit for diode characteristics

$R_{g1} = R_{g2}$

Diode recovery waveform

Table 9 Switching times

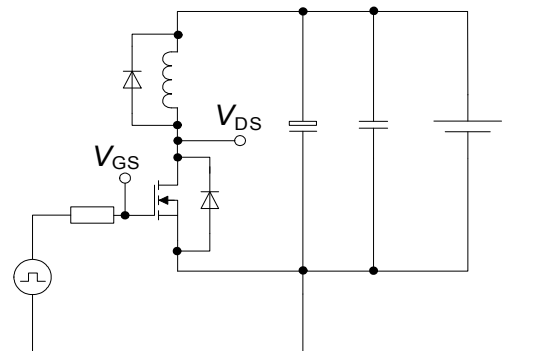
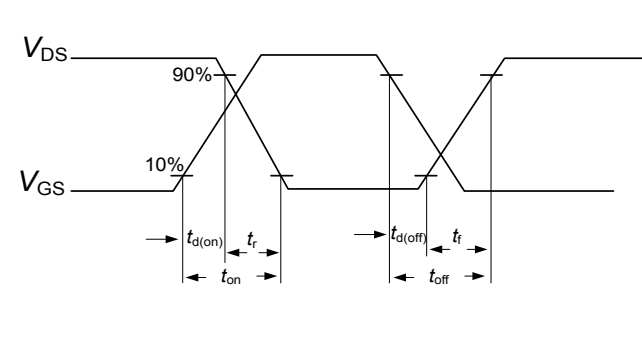
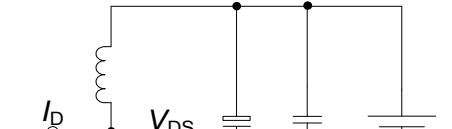
Switching times test circuit for inductive load	Switching times waveform
 The circuit diagram illustrates a switching test setup for an inductive load. A MOSFET is driven by a pulse generator connected to its gate through a resistor. The drain of the MOSFET is connected to an inductor, which is in series with a load resistor and a parallel combination of a load capacitor and a freewheeling diode. The source of the MOSFET is connected to ground. The drain-source voltage is labeled V_{DS} and the gate-source voltage is labeled V_{GS}.	 The timing diagram shows the relationship between the drain-source voltage (V_{DS}) and the gate-source voltage (V_{GS}) during switching transitions. The V_{GS} waveform is a square wave that transitions between a high level and a low level. The V_{DS} waveform shows the voltage across the inductive load. Key time intervals are marked: $t_{d(on)}$ (delay time to turn on), t_r (rise time), t_{on} (total turn-on time), $t_{d(off)}$ (delay time to turn off), t_f (fall time), and t_{off} (total turn-off time). The diagram also indicates the 10% and 90% voltage levels for the transitions.

Table 10 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7 Package Outlines

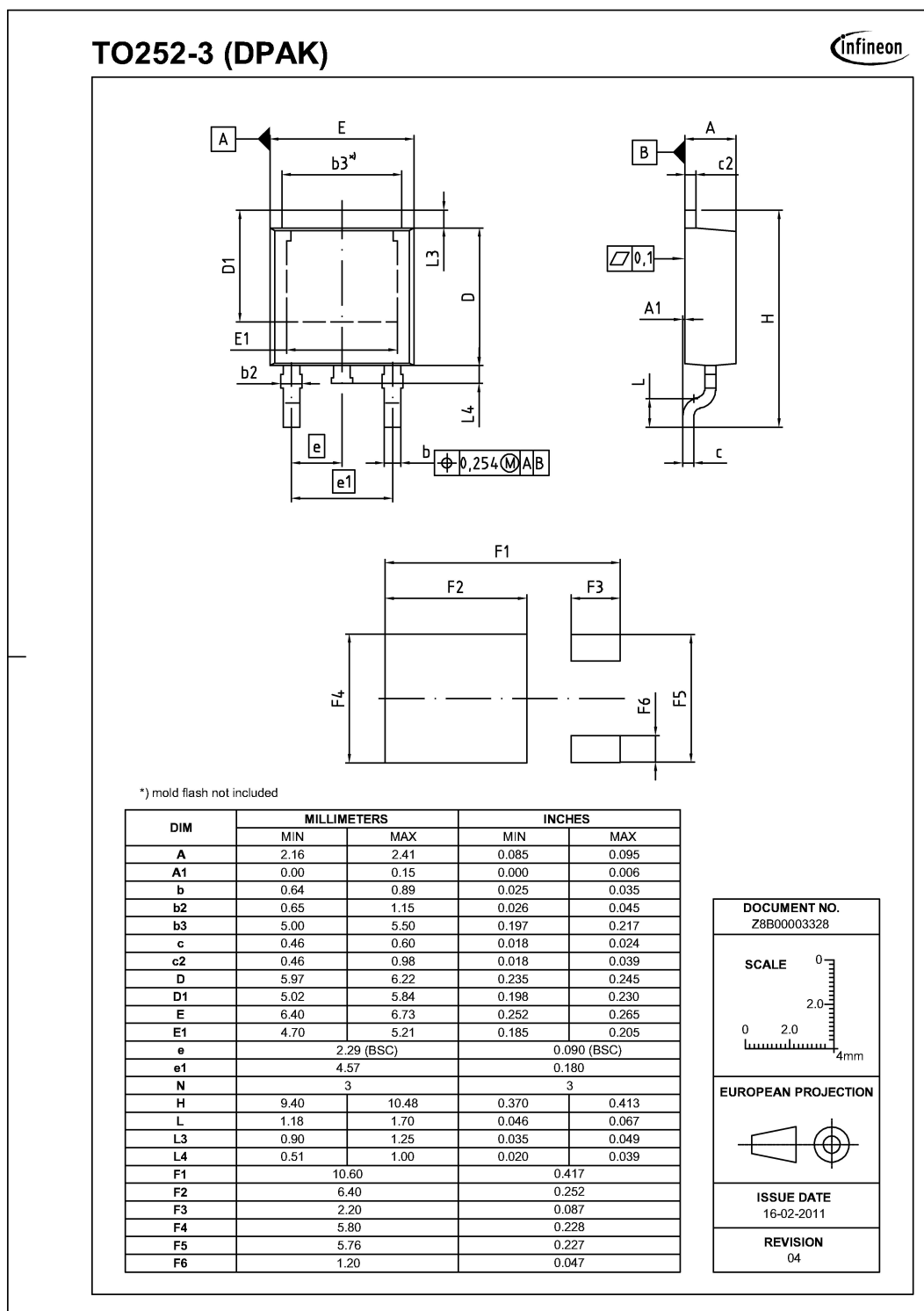


Figure 1 Outline PG-TO 252, dimensions in mm/inches

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

IPD65R950C6

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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