

MOSFET

Metal Oxide Semiconductor Field Effect Transistor

CoolMOS™ C7

600V CoolMOS™ C7 Power Transistor
IPA60R060C7

Data Sheet

Rev. 2.0
Final

1 Description

CoolMOS™ C7 is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies.

600V CoolMOS™ C7 series combines the experience of the leading SJ MOSFET supplier with high class innovation.

The 600V C7 is the first technology ever with $R_{DS(on)} \cdot A$ below $10\text{m}\Omega \cdot \text{mm}^2$.

Features

- Suitable for hard and soft switching (PFC and high performance LLC)
- Increased MOSFET dv/dt ruggedness to 120V/ns
- Increased efficiency due to best in class FOM $R_{DS(on)} \cdot E_{oss}$ and $R_{DS(on)} \cdot Q_g$
- Best in class $R_{DS(on)}$ /package
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)

Benefits

- Increased economies of scale by use in PFC and PWM topologies in the application
- Higher dv/dt limit enables faster switching leading to higher efficiency
- Enabling higher system efficiency by lower switching losses
- Increased power density solutions due to smaller packages
- Suitable for applications such as server, telecom and solar
- Higher switching frequencies possible without loss in efficiency due to low E_{oss} and Q_g

Applications

PFC stages and PWM stages (TTF, LLC) for high power/performance SMPS e.g. Computing, Server, Telecom, UPS and Solar.

Please note: For MOSFET paralleling the use of ferrite beads on the gate or separate totem poles is generally recommended.

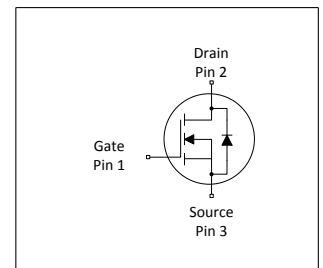


Table 1 Key Performance Parameters

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	60	$\text{m}\Omega$
$Q_{g,typ}$	68	nC
$I_{D,pulse}$	135	A
$I_{D,continuous} @ T_j < 150^\circ\text{C}$	54	A
$E_{oss}@400\text{V}$	8.1	μJ
Body diode di/dt	420	$\text{A}/\mu\text{s}$

Type / Ordering Code	Package	Marking	Related Links
IPA60R060C7	PG-TO 220 FullPAK	60C7060	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	-	-	16 10	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current ²⁾	$I_{D,pulse}$	-	-	135	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	E_{AS}	-	-	159	mJ	$I_D=6.4\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche energy, repetitive	E_{AR}	-	-	0.80	mJ	$I_D=6.4\text{A}$; $V_{DD}=50\text{V}$; see table 10
Avalanche current, single pulse	I_{AS}	-	-	6.4	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	120	V/ns	$V_{DS}=0\dots400\text{V}$
Gate source voltage (static)	V_{GS}	-20	-	20	V	static;
Gate source voltage (dynamic)	V_{GS}	-30	-	30	V	AC ($f>1\text{ Hz}$)
Power dissipation	P_{tot}	-	-	34	W	$T_C=25^\circ\text{C}$
Storage temperature	T_{stg}	-55	-	150	$^\circ\text{C}$	-
Operating junction temperature	T_j	-55	-	150	$^\circ\text{C}$	-
Mounting torque	-	-	-	50	Ncm	M2.5 screws
Continuous diode forward current	I_S	-	-	16	A	$T_C=25^\circ\text{C}$
Diode pulse current ²⁾	$I_{S,pulse}$	-	-	135	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt ³⁾	dv/dt	-	-	20	V/ns	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 9.9\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di/dt	-	-	420	A/ μs	$V_{DS}=0\dots400\text{V}$, $I_{SD}\leq 9.9\text{A}$, $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage	V_{ISO}	-	-	2500	V	V_{rms} , $T_C=25^\circ\text{C}$, $t=1\text{min}$

¹⁾ Limited by $T_{j,max}$.

²⁾ Pulse width t_p limited by $T_{j,max}$

³⁾ Identical low side and high side switch

3 Thermal characteristics

Table 3 Thermal characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	R_{thJC}	-	-	3.69	°C/W	-
Thermal resistance, junction - ambient	R_{thJA}	-	-	80	°C/W	leaded
Thermal resistance, junction - ambient for SMD version	R_{thJA}	-	-	-	°C/W	n.a.
Soldering temperature, wavesoldering only allowed at leads	T_{sold}	-	-	260	°C	1.6mm (0.063 in.) from case for 10s

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	$V_{GS}=0\text{V}$, $I_D=1\text{mA}$
Gate threshold voltage	$V_{(GS)th}$	3	3.5	4	V	$V_{DS}=V_{GS}$, $I_D=0.8\text{mA}$
Zero gate voltage drain current	I_{DSS}	-	-	1	μA	$V_{DS}=600$, $V_{GS}=0\text{V}$, $T_j=25^\circ\text{C}$ $V_{DS}=600$, $V_{GS}=0\text{V}$, $T_j=150^\circ\text{C}$
Gate-source leakage current	I_{GSS}	-	-	100	nA	$V_{GS}=20\text{V}$, $V_{DS}=0\text{V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.052 0.115	0.060 -	Ω	$V_{GS}=10\text{V}$, $I_D=15.9\text{A}$, $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$, $I_D=15.9\text{A}$, $T_j=150^\circ\text{C}$
Gate resistance	R_G	-	0.8	-	Ω	$f=1\text{MHz}$, open drain

Table 5 Dynamic characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	C_{iss}	-	2850	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Output capacitance	C_{oss}	-	54	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=400\text{V}$, $f=250\text{kHz}$
Effective output capacitance, energy related ¹⁾	$C_{o(er)}$	-	101	-	pF	$V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related ²⁾	$C_{o(tr)}$	-	1050	-	pF	$I_D=\text{constant}$, $V_{GS}=0\text{V}$, $V_{DS}=0\dots400\text{V}$
Turn-on delay time	$t_{d(on)}$	-	15.5	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=15.9\text{A}$, $R_G=3.3\Omega$; see table 9
Rise time	t_r	-	11	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=15.9\text{A}$, $R_G=3.3\Omega$; see table 9
Turn-off delay time	$t_{d(off)}$	-	79	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=15.9\text{A}$, $R_G=3.3\Omega$; see table 9
Fall time	t_f	-	4	-	ns	$V_{DD}=400\text{V}$, $V_{GS}=13\text{V}$, $I_D=15.9\text{A}$, $R_G=3.3\Omega$; see table 9

Table 6 Gate charge characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	Q_{gs}	-	14	-	nC	$V_{DD}=400\text{V}$, $I_D=15.9\text{A}$, $V_{GS}=0$ to 10V
Gate to drain charge	Q_{gd}	-	23	-	nC	$V_{DD}=400\text{V}$, $I_D=15.9\text{A}$, $V_{GS}=0$ to 10V
Gate charge total	Q_g	-	68	-	nC	$V_{DD}=400\text{V}$, $I_D=15.9\text{A}$, $V_{GS}=0$ to 10V
Gate plateau voltage	V_{plateau}	-	5.0	-	V	$V_{DD}=400\text{V}$, $I_D=15.9\text{A}$, $V_{GS}=0$ to 10V

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 400V

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 400V

Table 7 Reverse diode characteristics

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	V_{SD}	-	0.9	-	V	$V_{GS}=0V$, $I_F=15.9A$, $T_J=25^{\circ}C$
Reverse recovery time	t_{rr}	-	390	-	ns	$V_R=400V$, $I_F=15.9A$, $di_F/dt=100A/\mu s$; see table 8
Reverse recovery charge	Q_{rr}	-	6	-	μC	$V_R=400V$, $I_F=15.9A$, $di_F/dt=100A/\mu s$; see table 8
Peak reverse recovery current	I_{rrm}	-	32	-	A	$V_R=400V$, $I_F=15.9A$, $di_F/dt=100A/\mu s$; see table 8

5 Electrical characteristics diagrams

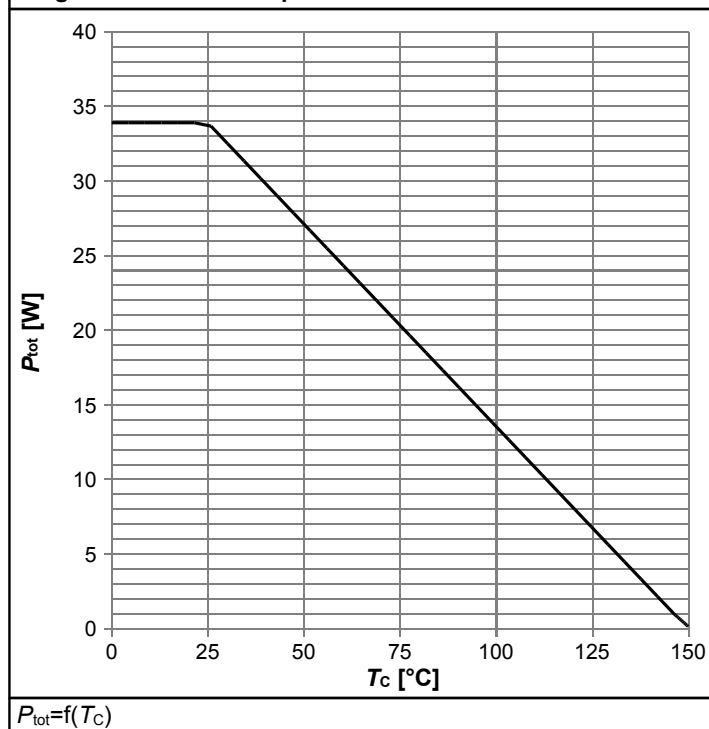
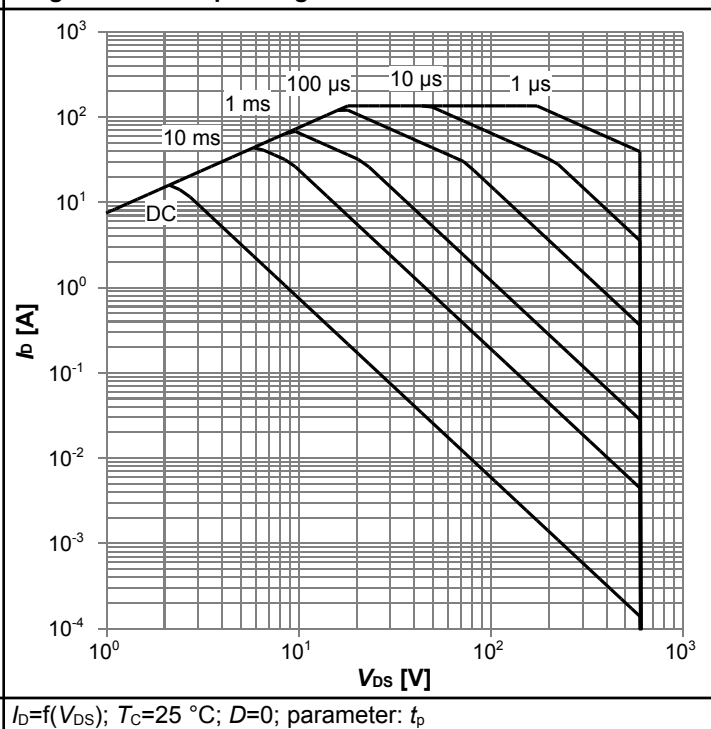
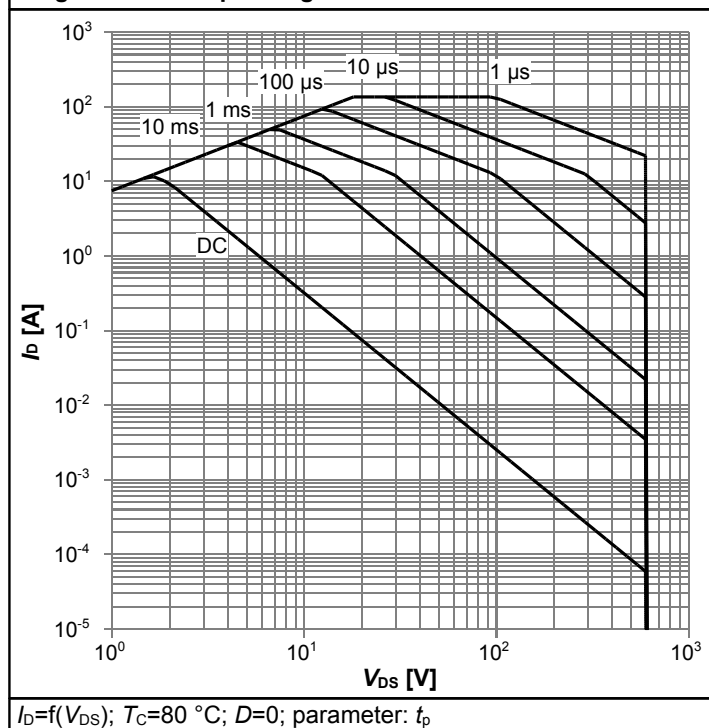
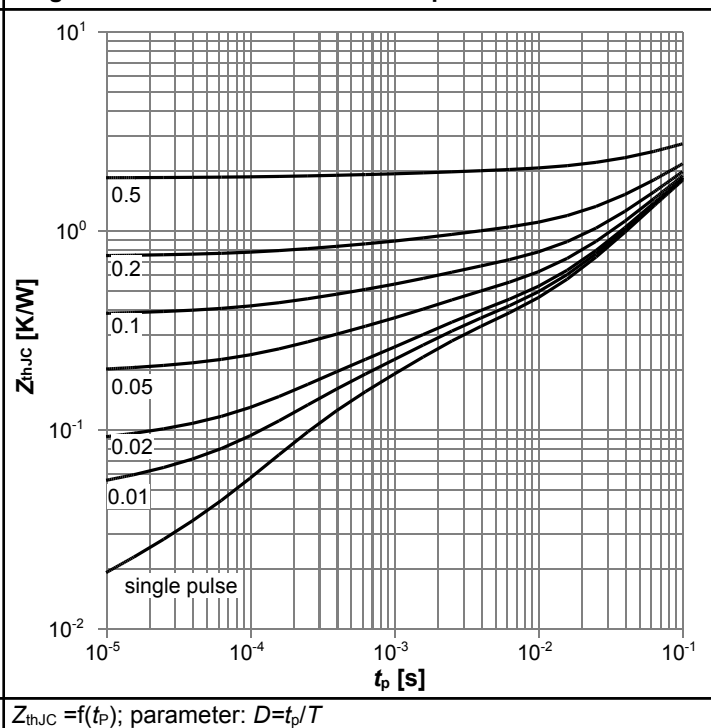
Diagram 1: Power dissipation

Diagram 2: Safe operating area

Diagram 3: Safe operating area

Diagram 4: Max. transient thermal impedance


Diagram 5: Typ. output characteristics

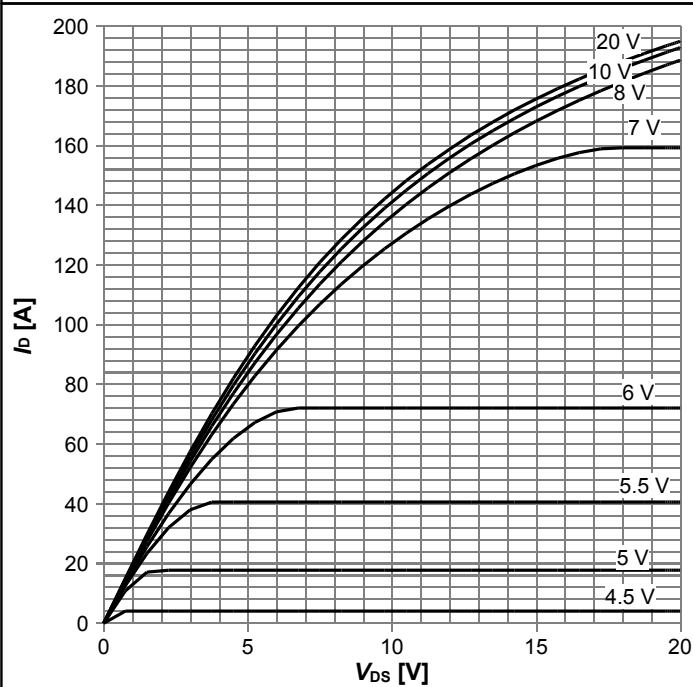

 $I_D = f(V_{DS}); T_J = 25^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics

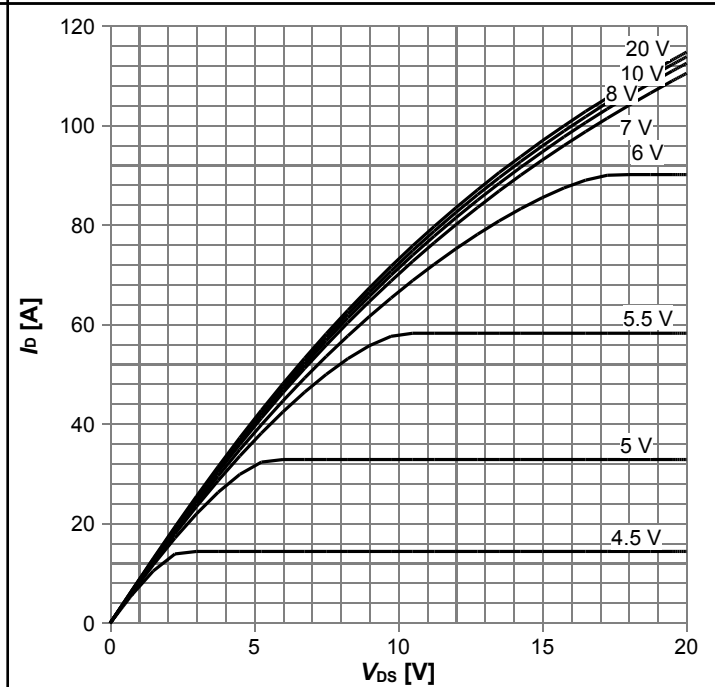

 $I_D = f(V_{DS}); T_J = 125^\circ\text{C}; \text{parameter: } V_{GS}$

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

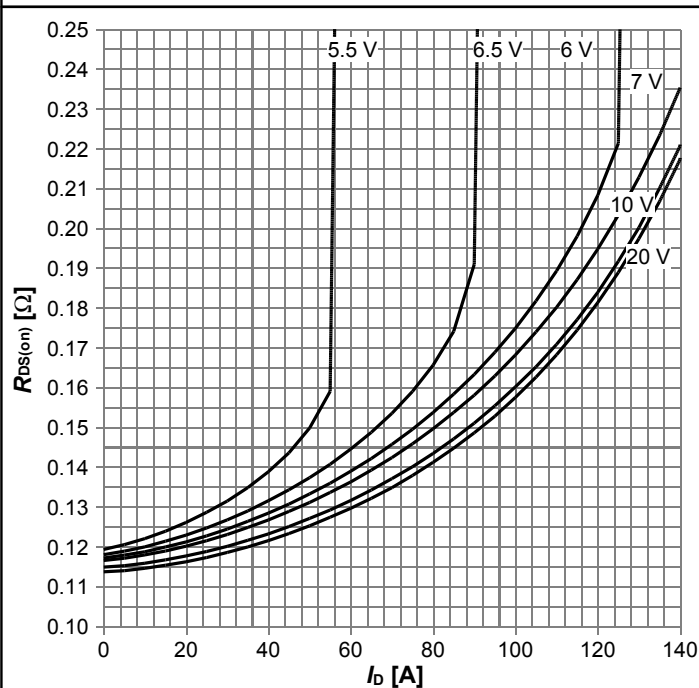

 $R_{DS(on)} = f(I_D); T_J = 125^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance

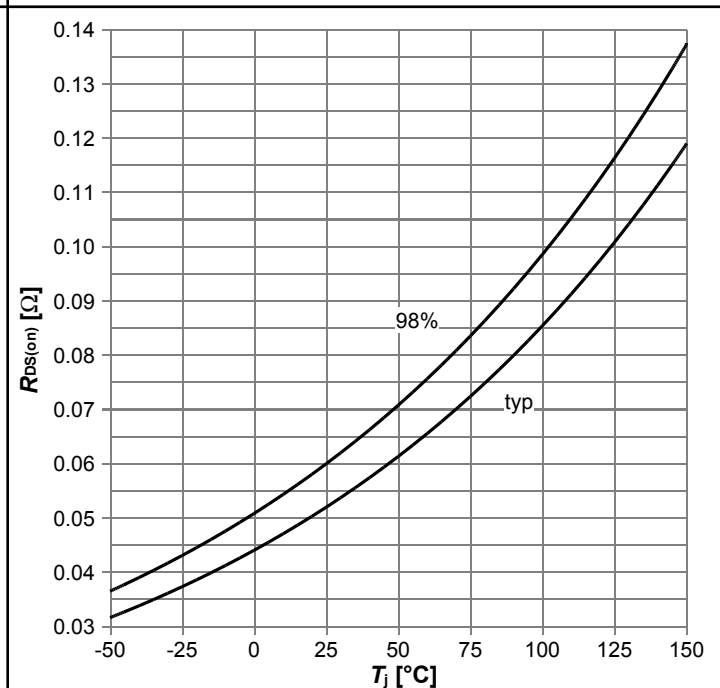

 $R_{DS(on)} = f(T_J); I_D = 15.9\text{ A}; V_{GS} = 10\text{ V}$

Diagram 9: Typ. transfer characteristics

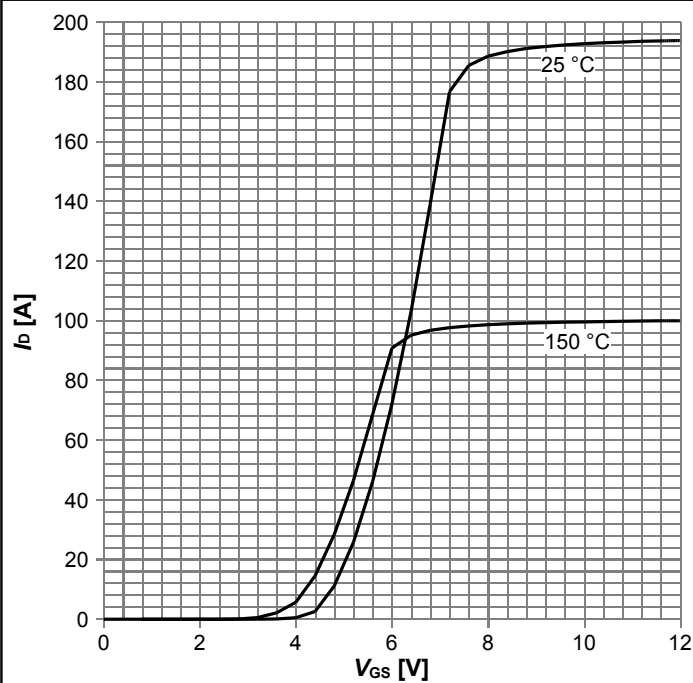

 $I_D = f(V_{GS}); V_{DS} = 20\text{ V}; \text{parameter: } T_j$

Diagram 10: Typ. gate charge

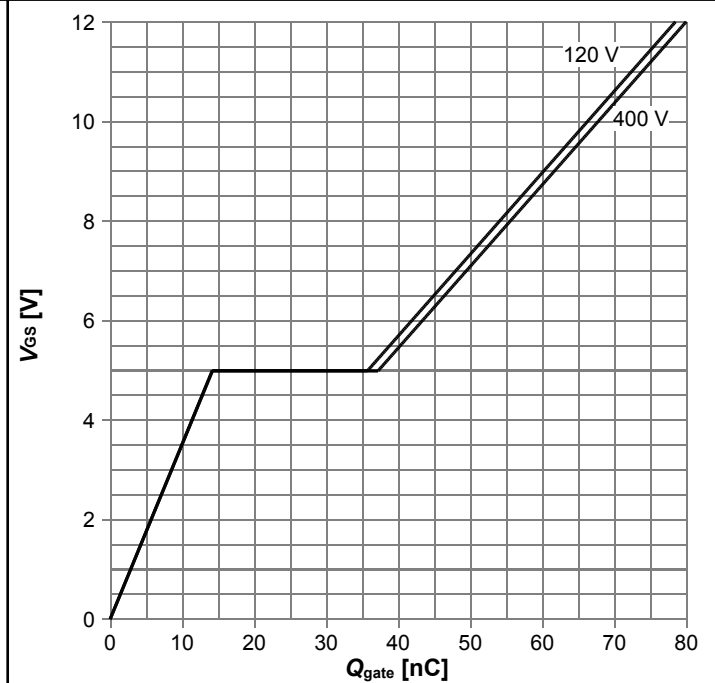

 $V_{GS} = f(Q_{gate}); I_D = 15.9\text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode

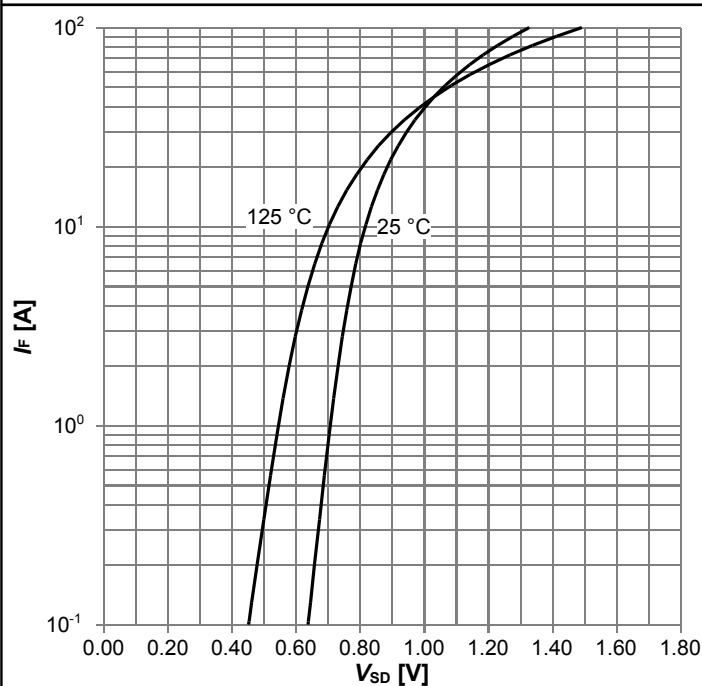

 $I_F = f(V_{SD}); \text{parameter: } T_j$

Diagram 12: Avalanche energy

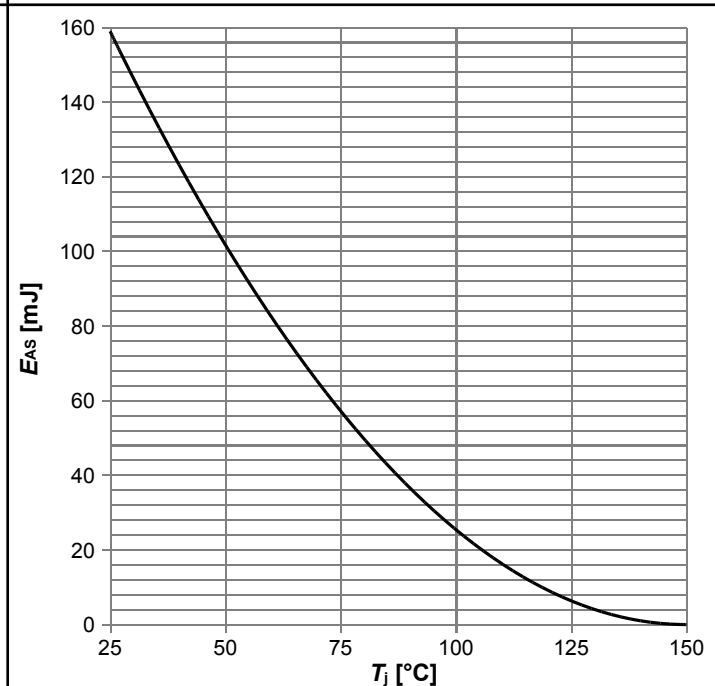
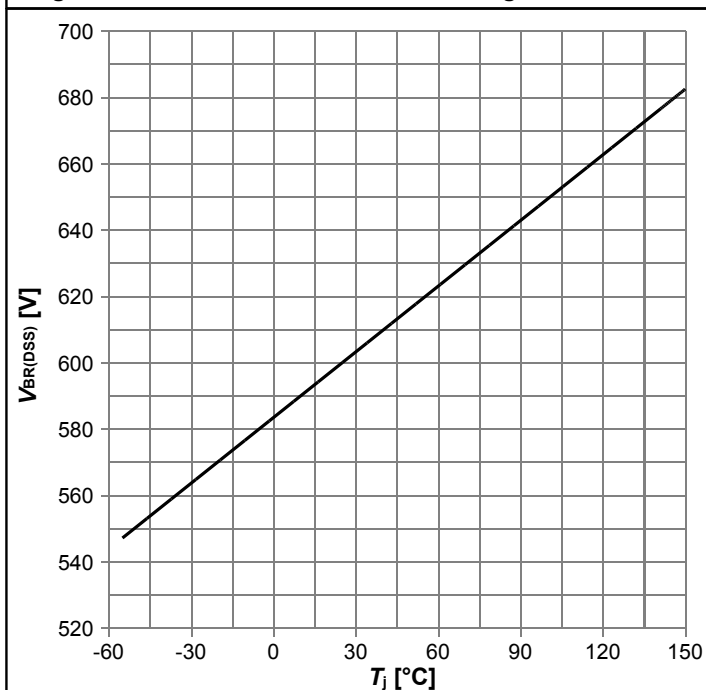
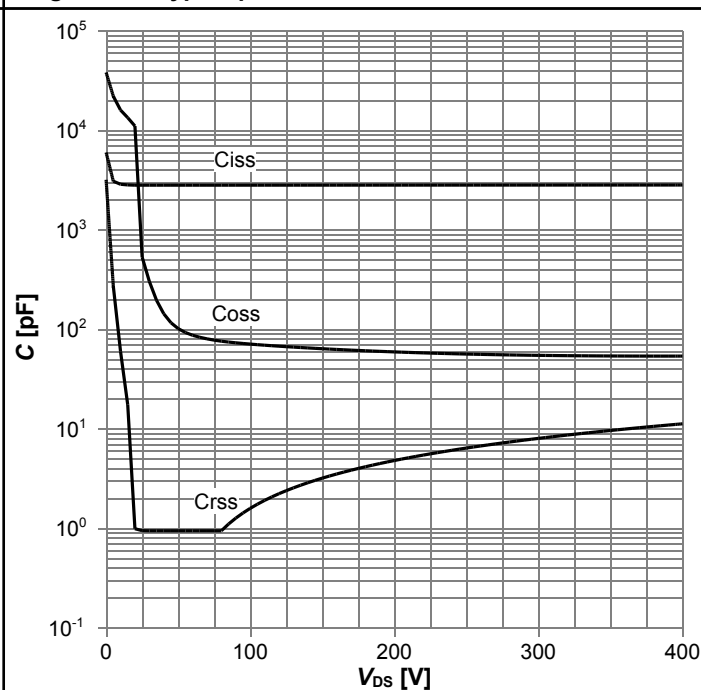

 $E_{AS} = f(T_j); I_D = 6.4\text{ A}; V_{DD} = 50\text{ V}$

Diagram 13: Drain-source breakdown voltage



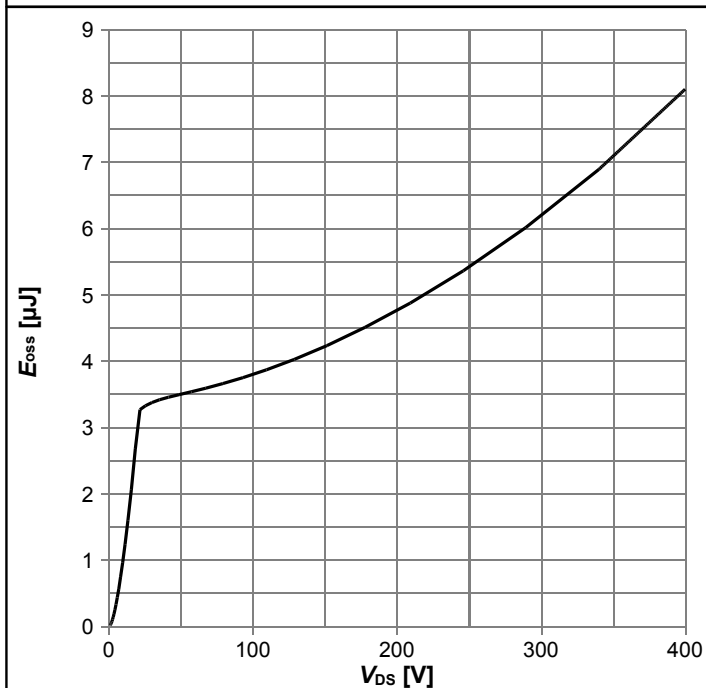
$$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$$

Diagram 14: Typ. capacitances



$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 250 \text{ kHz}$$

Diagram 15: Typ. Coss stored energy



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

6 Test Circuits

Table 8 Diode characteristics

Test circuit for diode characteristics

The circuit consists of two diodes connected in series. The first diode is driven by a voltage source V_{DS} through a gate resistor R_{g1} . The second diode is driven by a current source I_F through a gate resistor R_{g2} . A common load resistor R_L is connected across both diodes. The condition $R_{g1} = R_{g2}$ is specified.

Diode recovery waveform

The waveform shows the voltage V_{DS} and current I_F versus time t . The forward conduction phase is at I_F . The reverse recovery phase is characterized by the reverse current I_{rr} and the reverse recovery time t_{rr} . The storage time t_S is the time from the end of forward conduction to the start of reverse conduction. The total reverse recovery time is $t_{rr} = t_F + t_S$, where t_F is the forward time constant. The charge Q_F and Q_S are the forward and storage charges, respectively, and the total reverse recovery charge is $Q_{rr} = Q_F + Q_S$.

Table 9 Switching times

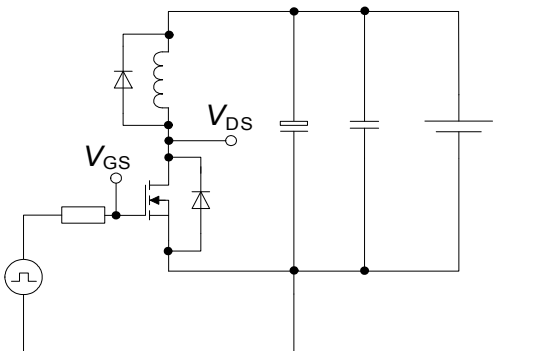
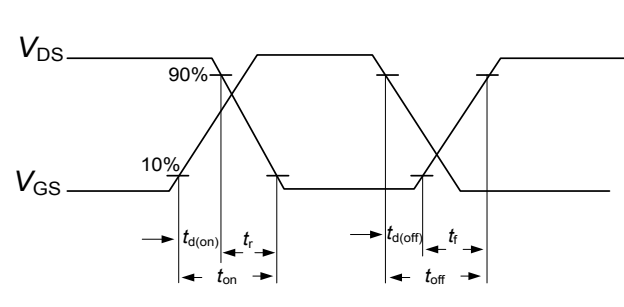
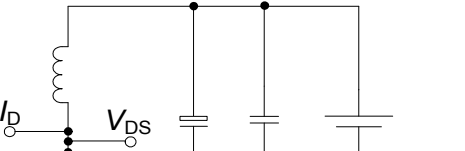
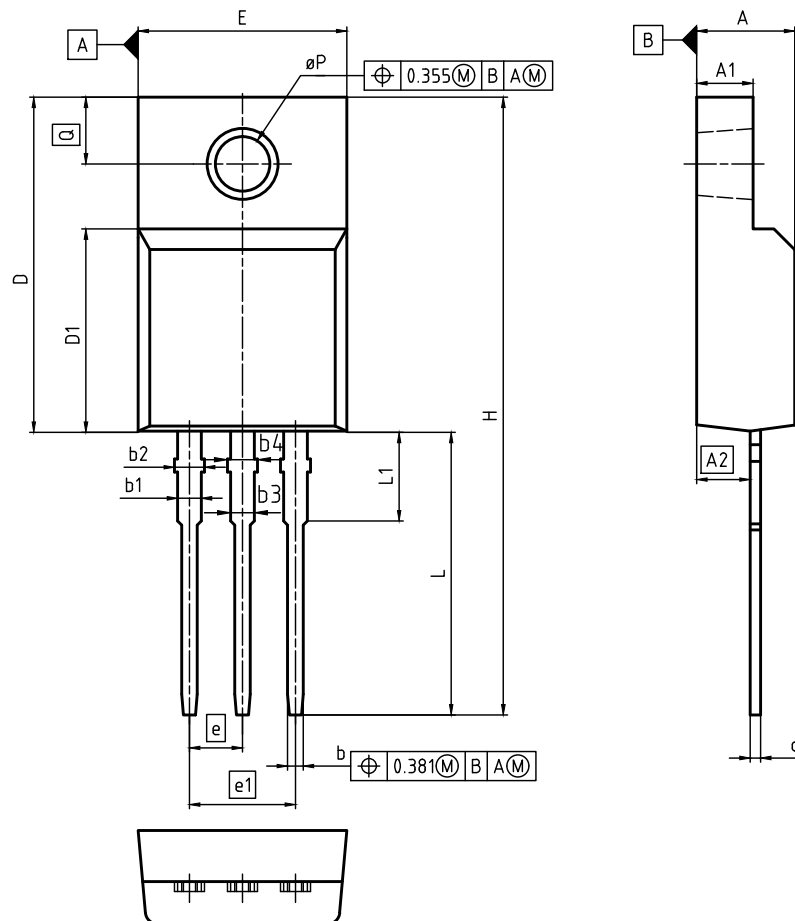
Switching times test circuit for inductive load	Switching times waveform
 The circuit diagram shows a MOSFET switching an inductive load. A square-wave voltage source is connected to the gate of an N-channel MOSFET through a gate resistor. The MOSFET's drain is connected to an inductor, which is in series with a diode (freewheeling diode) connected to ground. The MOSFET's source is also connected to ground. A load capacitor is connected in parallel with the inductor and diode. The drain-source voltage is labeled V_{DS} and the gate-source voltage is labeled V_{GS}.	 The waveform diagram shows the switching transitions of the MOSFET. The top trace is the drain-source voltage V_{DS} and the bottom trace is the gate-source voltage V_{GS}. The diagram illustrates the turn-on and turn-off processes. Key time intervals are marked: $t_{d(on)}$ (delay time), t_r (rise time), $t_{d(off)}$ (delay time), and t_f (fall time). The total turn-on time is t_{on} and the total turn-off time is t_{off}. The 10% and 90% voltage levels are indicated for the transitions.

Table 10 Unclamped inductive load

Unclamped inductive load test circuit	Unclamped inductive waveform
	

7 Package Outlines



DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.50	4.90	0.177	0.193
A1	2.34	2.85	0.092	0.112
A2	2.42	2.86	0.095	0.113
b	0.65	0.90	0.026	0.035
b1	0.95	1.38	0.037	0.054
b2	0.95	1.51	0.037	0.059
b3	0.65	1.38	0.026	0.054
b4	0.65	1.51	0.026	0.059
c	0.40	0.63	0.016	0.025
D	15.67	16.15	0.617	0.636
D1	8.97	9.83	0.353	0.387
E	10.00	10.65	0.394	0.419
e	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	3		3	
H	28.70	29.75	1.130	1.171
L	12.78	13.75	0.503	0.541
L1	2.83	3.45	0.111	0.136
øP	2.95	3.38	0.116	0.133
Q	3.15	3.50	0.124	0.138

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EUROPEAN PROJECTION 	
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REVISION 05	

Figure 1 Outline PG-TO 220 FullPAK, dimensions in mm/inches

8 Appendix A

Table 11 Related Links

- IFX CoolMOS™ C7 Webpage: www.infineon.com
- IFX CoolMOS™ C7 application note: www.infineon.com
- IFX CoolMOS™ C7 simulation model: www.infineon.com
- IFX Design tools: www.infineon.com

Revision History

IPA60R060C7

Revision: 2015-12-01, Rev. 2.0

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2015-12-01	Release of final version

We Listen to Your Comments

Any information within this document that you feel is wrong, unclear or missing at all? Your feedback will help us to continuously improve the quality of this document. Please send your proposal (including a reference to this document) to:

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The Infineon Technologies component described in this Data Sheet may be used in life-support devices or systems and/or automotive, aviation and aerospace applications or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support, automotive, aviation and aerospace device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.



**Стандарт
Электрон
Связь**

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России , а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научно-исследовательскими институтами России.

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