

## MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS™ C7

600V CoolMOS™ C7 Power Transistor  
IPZ60R040C7

## 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  $10\text{Ohm} \cdot \text{mm}^2$ .

## 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
- Easy to use/drive
- Pb-free plating, halogen free mold compound
- Qualified for industrial grade applications according to JEDEC (J-STD20 and JESD22)
- 4pin kelvin source concept

## 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
- Up to 0.5% better full load efficiency @100kHz compared to conventional 3pin package

## Applications

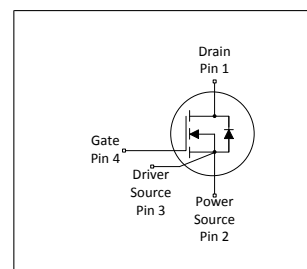
PFC stages and PWM stages (TTF, LLC) for high power/performance SMPS e.g. Computing, Server, Telecom, UPS and Solar.

*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
$R_{DS(on),max}$	40	$m\Omega$
$Q_{g,typ}$	107	nC
$I_{D,pulse}$	211	A
$I_{D,continuous} @ T_j < 150^\circ\text{C}$	73	A
$E_{oss}@400\text{V}$	12.6	$\mu\text{J}$
Body diode $di/dt$	480	$\text{A}/\mu\text{s}$

Type / Ordering Code	Package	Marking	Related Links
IPZ60R040C7	PG-TO 247-4	60C7040	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 <sup>1)</sup>	$I_D$	-	-	50 32	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	211	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	249	mJ	$I_D=7.4\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche energy, repetitive	$E_{AR}$	-	-	1.24	mJ	$I_D=7.4\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche current, single pulse	$I_{AS}$	-	-	7.4	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	$P_{tot}$	-	-	227	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	-	-	-	60	Ncm	M3 and M3.5 screws
Continuous diode forward current	$I_S$	-	-	50	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	211	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	20	V/ns	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 11.4\text{A}$ , $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di/dt	-	-	480	A/ $\mu\text{s}$	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 11.4\text{A}$ , $T_j=25^\circ\text{C}$ see table 8
Insulation withstand voltage	$V_{ISO}$	-	-	n.a.	V	$V_{rms}$ , $T_C=25^\circ\text{C}$ , $t=1\text{min}$

<sup>1)</sup> Limited by  $T_{j,max}$ .

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

<sup>3)</sup> 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	$R_{thJC}$	-	-	0.55	°C/W	-
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	62	°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	$V_{DS}=V_{GS}$ , $I_D=1.24\text{mA}$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=600$ , $V_{GS}=0\text{V}$ , $T_j=25^\circ\text{C}$ $V_{DS}=600$ , $V_{GS}=0\text{V}$ , $T_j=150^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.034 0.077	0.040 -	$\Omega$	$V_{GS}=10\text{V}$ , $I_D=24.9\text{A}$ , $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$ , $I_D=24.9\text{A}$ , $T_j=150^\circ\text{C}$
Gate resistance	$R_G$	-	0.77	-	$\Omega$	$f=1\text{MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	4340	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$
Output capacitance	$C_{oss}$	-	85	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	158	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	1640	-	pF	$I_D=\text{constant}$ , $V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$
Turn-on delay time	$t_{d(on)}$	-	18	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=24.9\text{A}$ , $R_G=3.3\Omega$ ; see table 9
Rise time	$t_r$	-	8	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=24.9\text{A}$ , $R_G=3.3\Omega$ ; see table 9
Turn-off delay time	$t_{d(off)}$	-	81	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=24.9\text{A}$ , $R_G=3.3\Omega$ ; see table 9
Fall time	$t_f$	-	3.2	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=24.9\text{A}$ , $R_G=3.3\Omega$ ; see table 9

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	22	-	nC	$V_{DD}=400\text{V}$ , $I_D=24.9\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate to drain charge	$Q_{gd}$	-	36	-	nC	$V_{DD}=400\text{V}$ , $I_D=24.9\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate charge total	$Q_g$	-	107	-	nC	$V_{DD}=400\text{V}$ , $I_D=24.9\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate plateau voltage	$V_{plateau}$	-	5.0	-	V	$V_{DD}=400\text{V}$ , $I_D=24.9\text{A}$ , $V_{GS}=0$ to $10\text{V}$

<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 400V

<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 400V

**Table 7 Reverse diode characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	$V_{SD}$	-	0.9	-	V	$V_{GS}=0V, I_F=24.9A, T_j=25^\circ C$
Reverse recovery time	$t_{rr}$	-	460	-	ns	$V_R=400V, I_F=24.9A, di_F/dt=100A/\mu s$ ; see table 8
Reverse recovery charge	$Q_{rr}$	-	9.2	-	$\mu C$	$V_R=400V, I_F=24.9A, di_F/dt=100A/\mu s$ ; see table 8
Peak reverse recovery current	$I_{rrm}$	-	40	-	A	$V_R=400V, I_F=24.9A, di_F/dt=100A/\mu s$ ; see table 8

## 5 Electrical characteristics diagrams

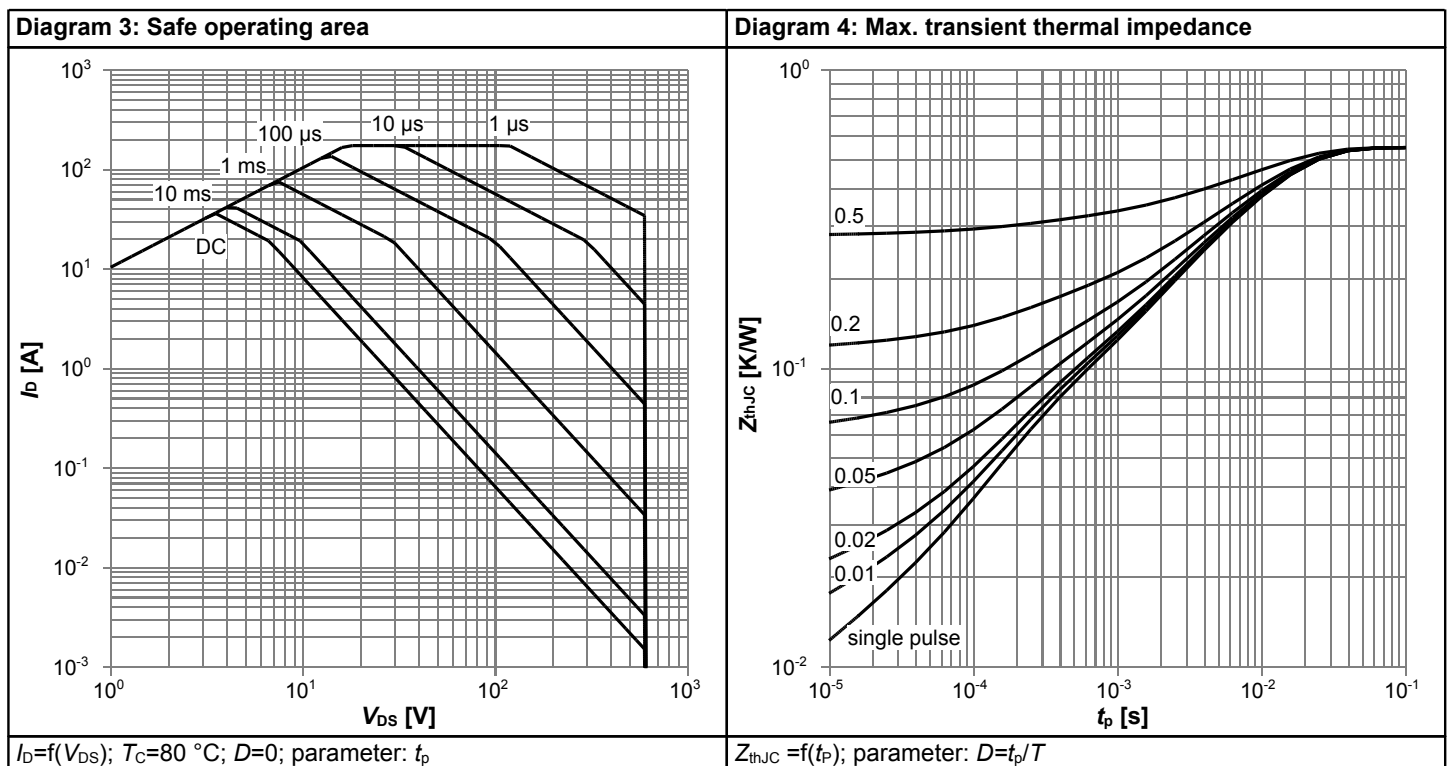
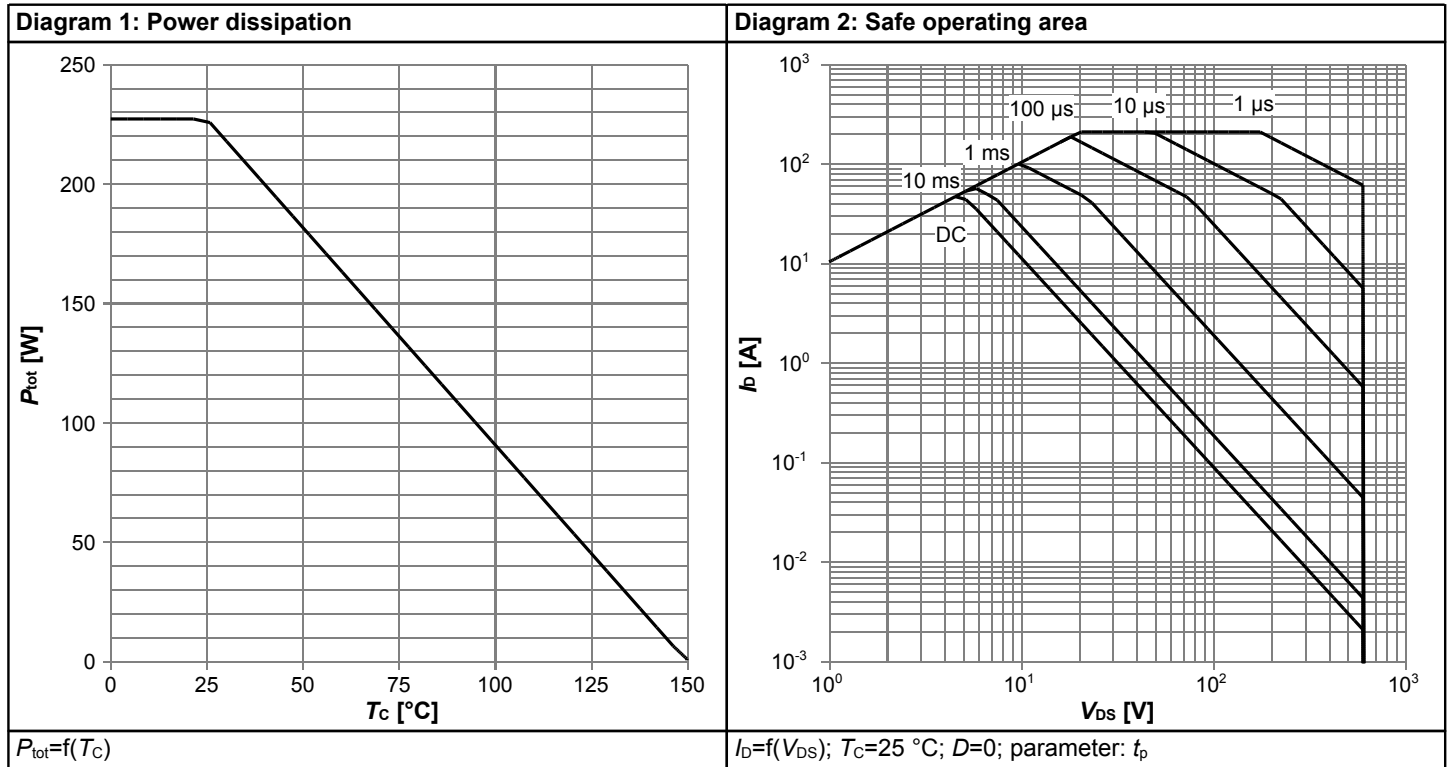
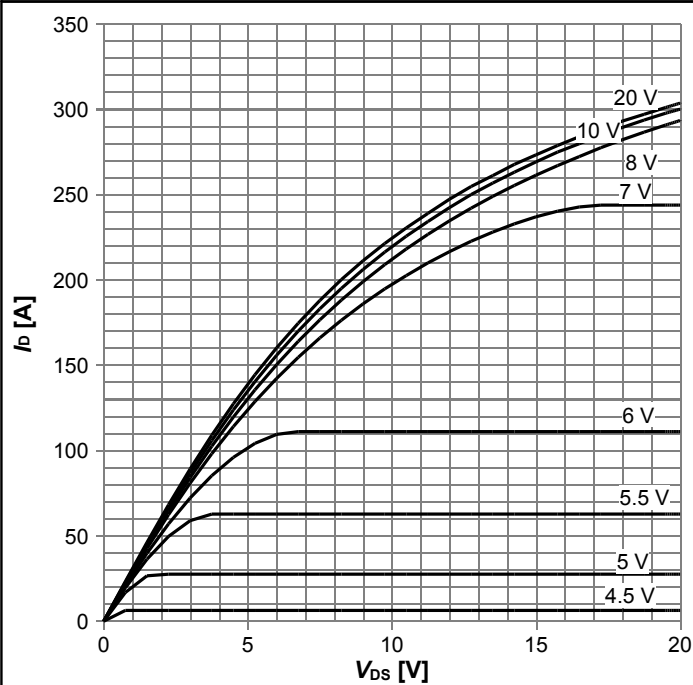


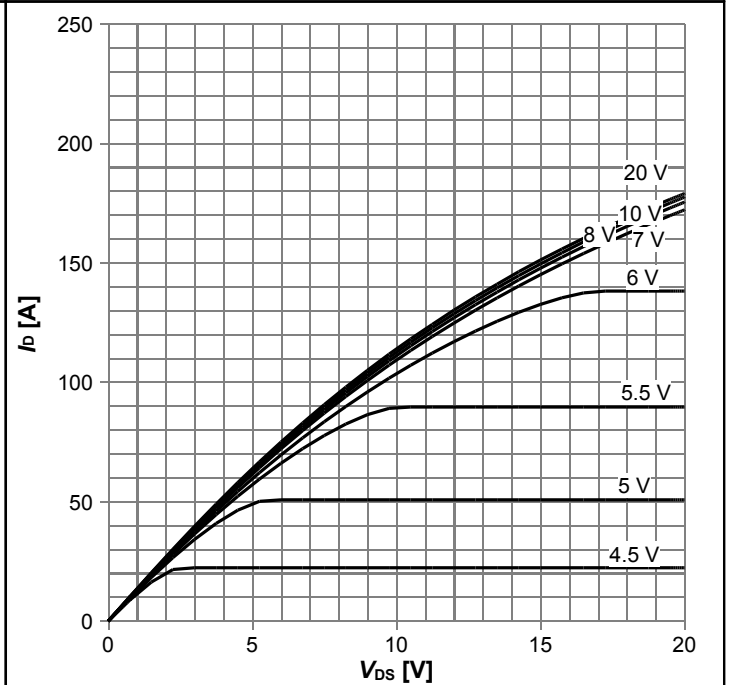


Diagram 5: Typ. output characteristics



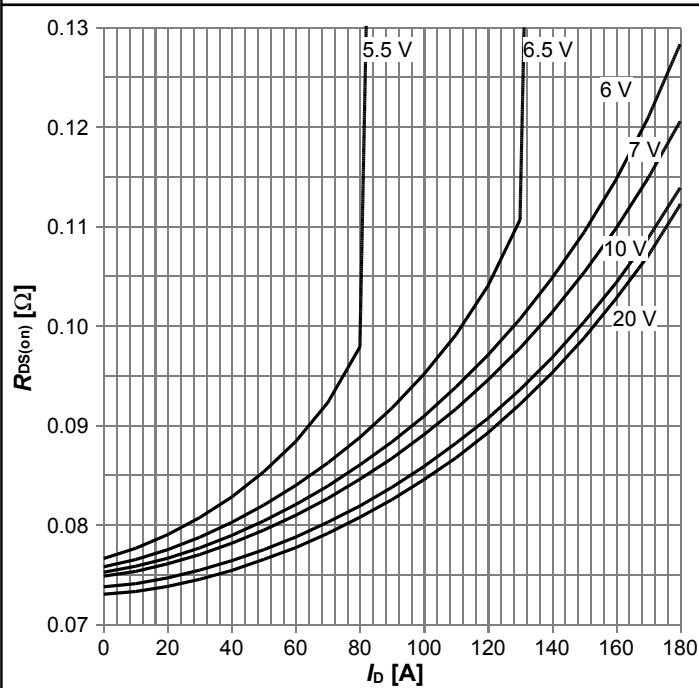
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 6: Typ. output characteristics



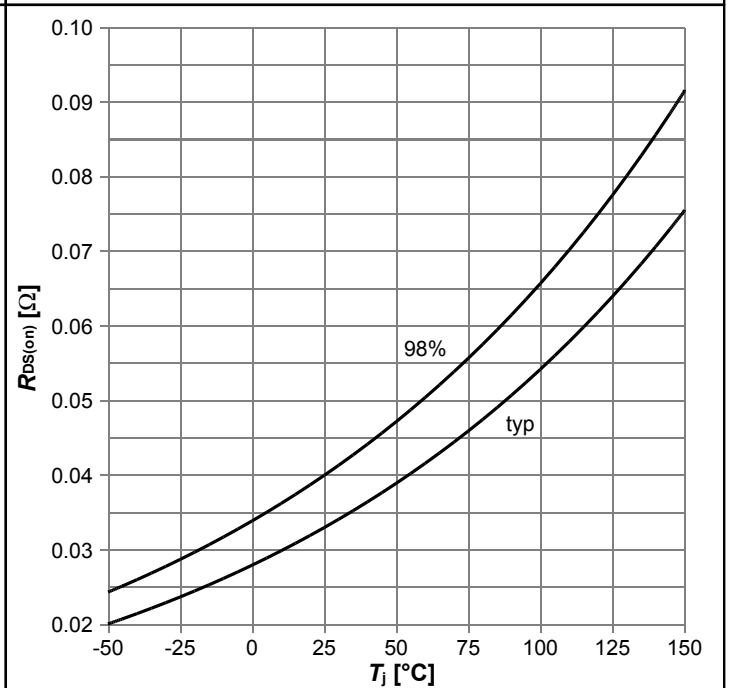
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

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



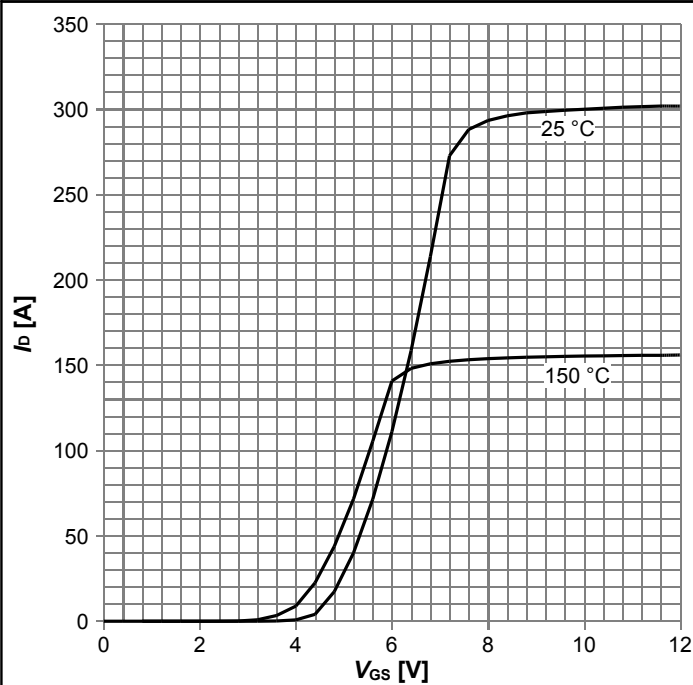
$R_{DS(on)}=f(I_D); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

Diagram 8: Drain-source on-state resistance



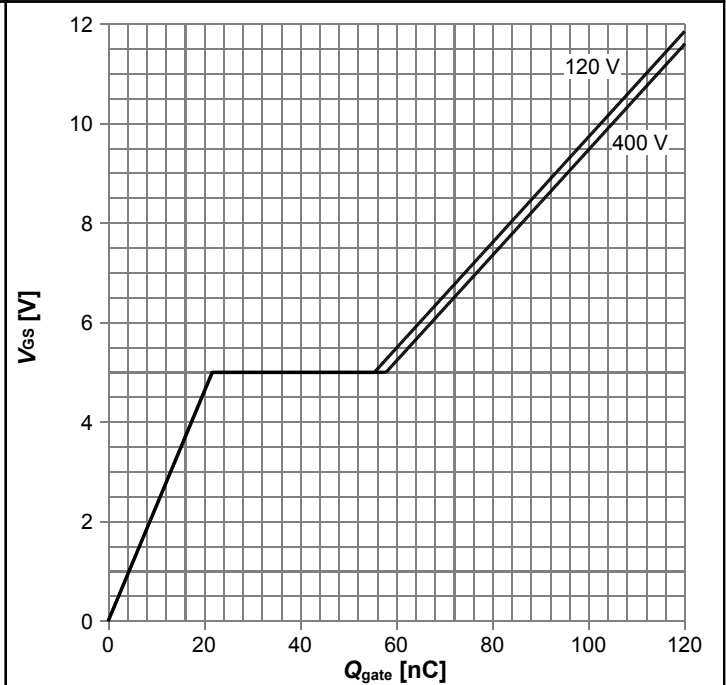
$R_{DS(on)}=f(T_j); I_D=24.9\text{ A}; V_{GS}=10\text{ V}$

**Diagram 9: Typ. transfer characteristics**



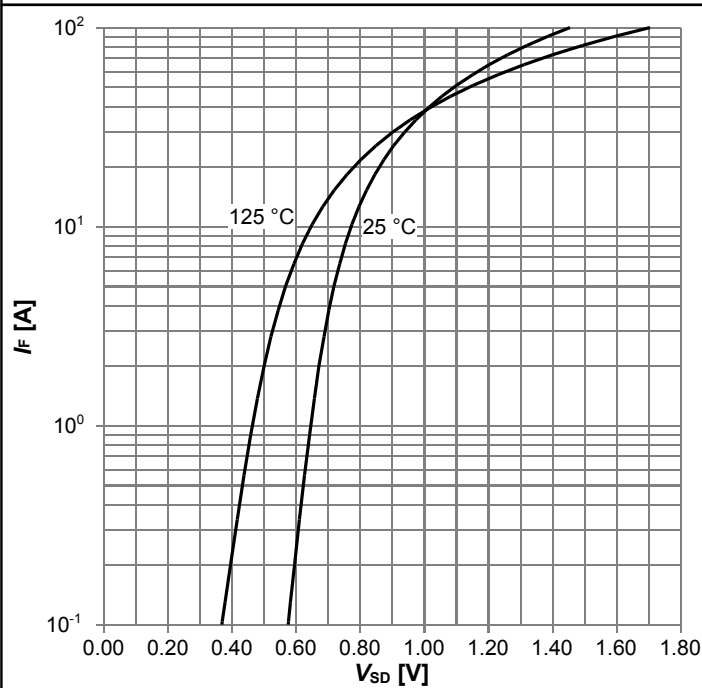
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

**Diagram 10: Typ. gate charge**



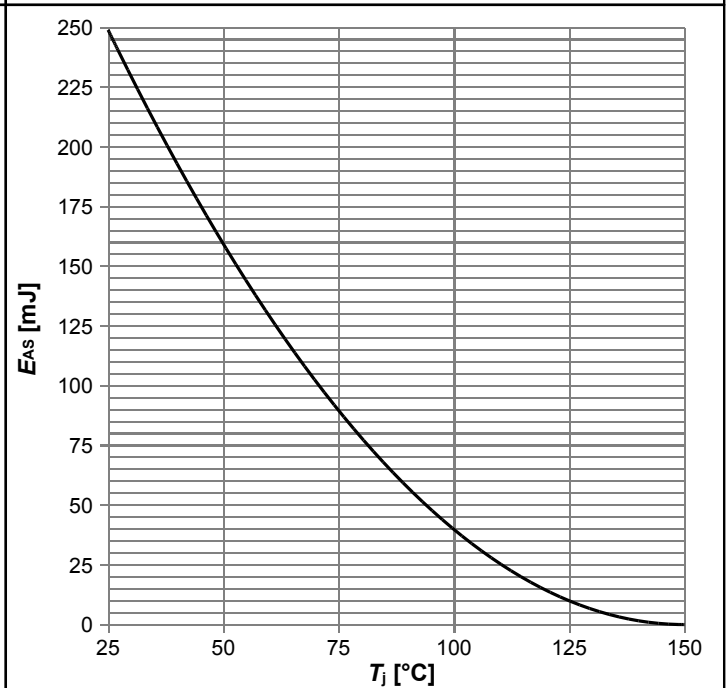
$V_{GS}=f(Q_{gate}); I_D=24.9 \text{ A pulsed}; \text{parameter: } V_{DD}$

**Diagram 11: Forward characteristics of reverse diode**



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

**Diagram 12: Avalanche energy**



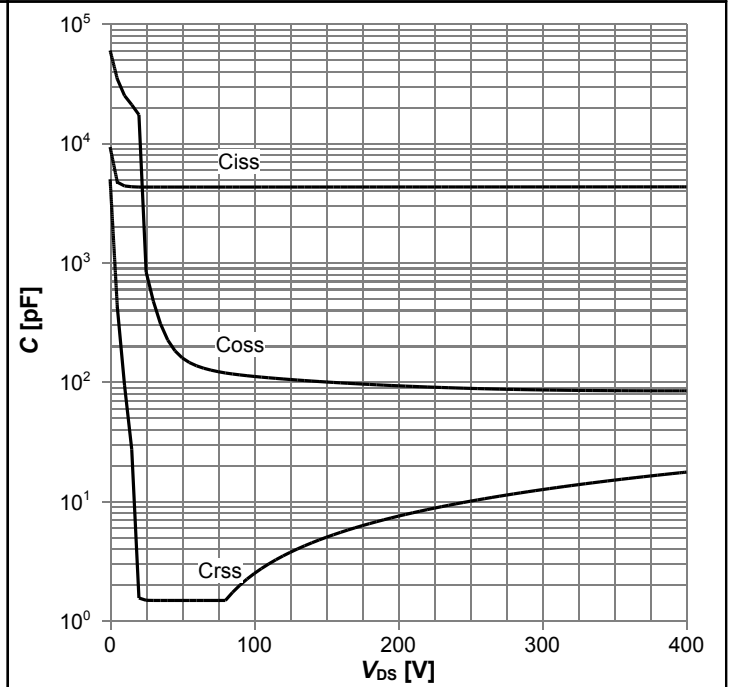
$E_{AS}=f(T_j); I_D=7.4 \text{ A}; V_{DD}=50 \text{ V}$

Diagram 13: Drain-source breakdown voltage



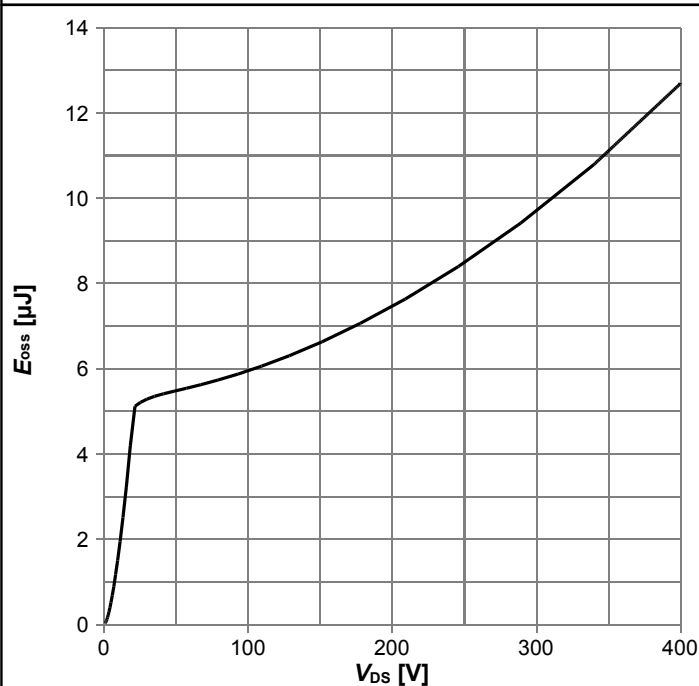
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

Diagram 14: Typ. capacitances



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

Diagram 15: Typ. Coss stored energy



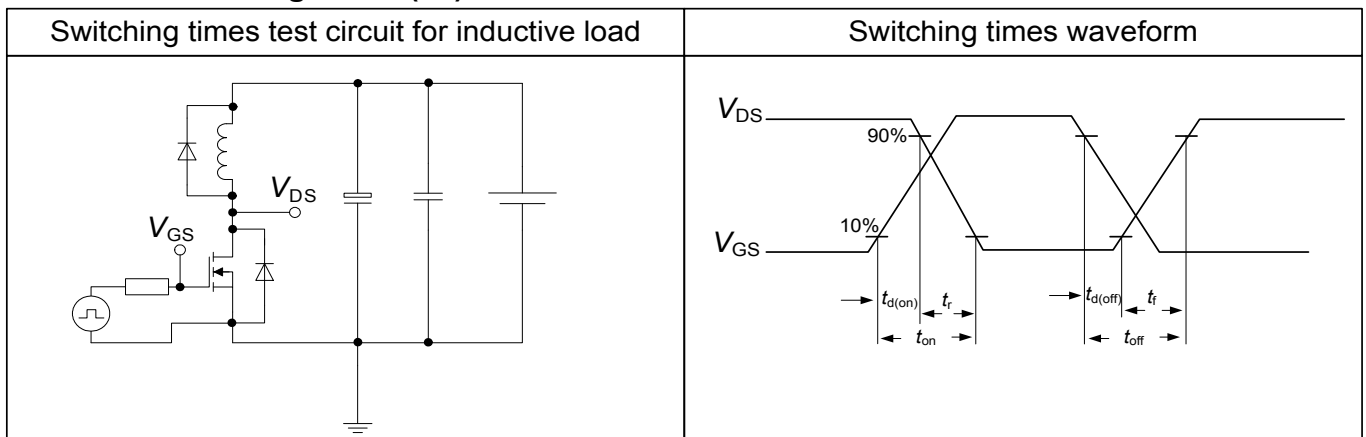
$E_{oss}=f(V_{DS})$

## 6 Test Circuits

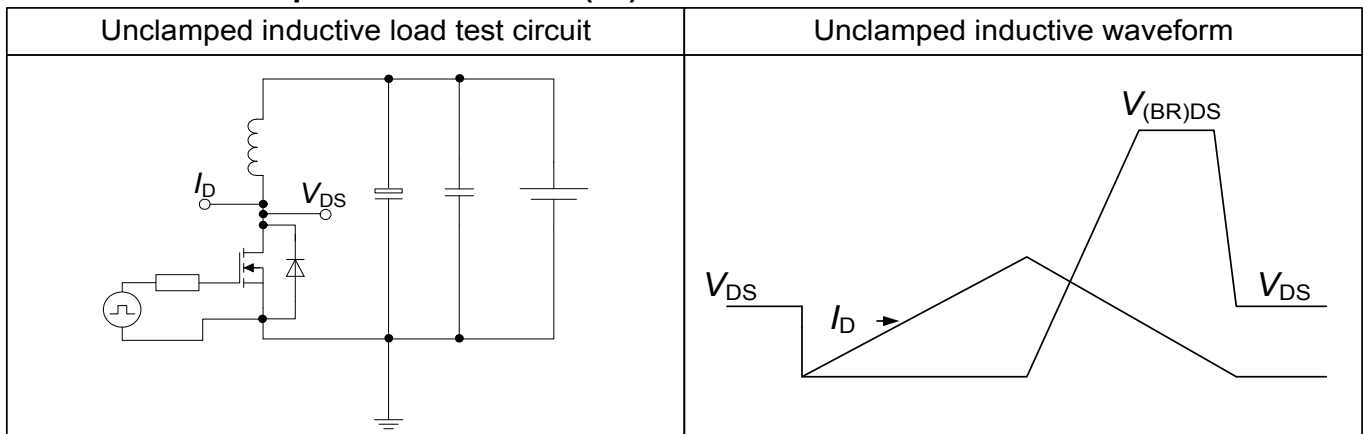
**Table 8 Diode characteristics**



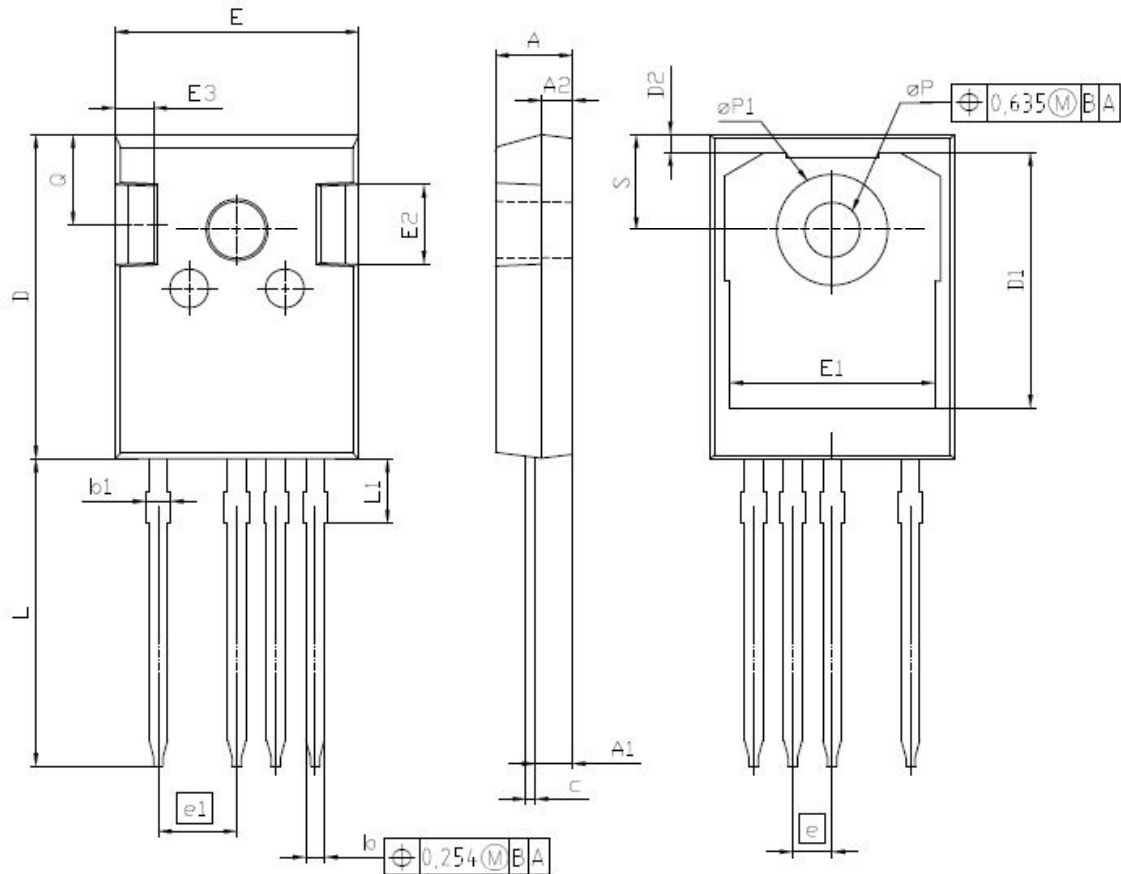
**Table 9 switching times (ss)**



**Table 10 Unclamped inductive load (ss)**



## 7 Package Outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.29	2.54	0.090	0.100
A2	1.90	2.16	0.075	0.085
b	1.07	1.33	0.042	0.052
b1	1.10	1.70	0.043	0.067
c	0.50	0.70	0.020	0.028
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	2.54 (BSC)		0.100 (BSC)	
e1	5.08		0.200	
N	4		4	
L	19.72	20.32	0.776	0.800
L1	4.02	4.40	0.158	0.173
$\varnothing P$	3.50	3.70	0.138	0.146
$\varnothing P1$	7.00	7.40	0.276	0.291
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

DOCUMENT NO. Z8B00168124
SCALE 0 5 5 7.5mm
EUROPEAN PROJECTION 
ISSUE DATE 29-01-2013
REVISION 1

Figure 1 Outline PG-TO 247-4

## 8 Appendix A

### Table 11 Related Links

- IFX CoolMOS™ C7 Webpage: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ C7 application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ C7 simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

## Revision History

IPZ60R040C7

**Revision: 2015-05-08, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2015-05-08	Release of final version

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### Published by

**Infineon Technologies AG**

**81726 München, Germany**

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