

## MOSFET

### 600V CoolMOS™ C7 Power Transistor

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
- SMD package with very low parasitic inductance for easy device control
- 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
- Optimized PCB assembly and layout solutions
- Suitable for applications such as server, telecom and solar
- Up to 0.5% better full load efficiency @100kHz compared to conventional 3pin package

### Potential applications

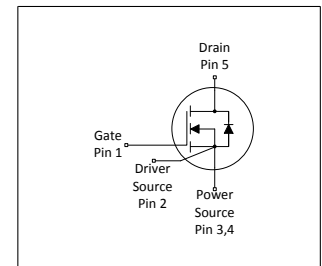
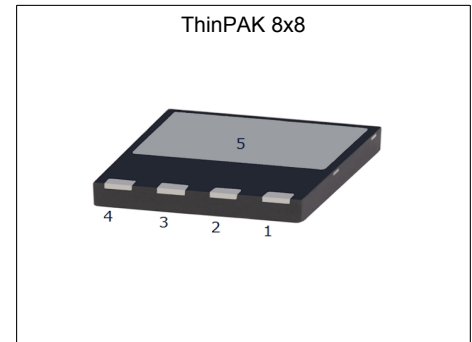
PFC stages and PWM stages (TTF, LLC) for high power/performance SMPS e.g. Computing, Server, Telecom, UPS and Solar.

*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
$R_{DS(on),max}$	104	mΩ
$Q_{g,typ}$	42	nC
$I_{D,pulse}$	83	A
$I_{D,continuous} @ T_j < 150^\circ\text{C}$	35	A
$E_{oss} @ 400\text{V}$	4.95	μJ
Body diode $di_f/dt$	375	A/μs

Type / Ordering Code	Package	Marking	Related Links
IPL60R104C7	PG-VSON-4	60C7104	see Appendix A



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## 1 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>	$I_D$	-	-	20 15	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	83	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	97	mJ	$I_D=5.0\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche energy, repetitive	$E_{AR}$	-	-	0.49	mJ	$I_D=5.0\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche current, single pulse	$I_{AS}$	-	-	5.0	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	$P_{tot}$	-	-	122	W	$T_C=25^\circ\text{C}$
Storage temperature	$T_{stg}$	-40	-	150	$^\circ\text{C}$	-
Operating junction temperature	$T_j$	-40	-	150	$^\circ\text{C}$	-
Mounting torque	-	-	-	n.a.	Ncm	-
Continuous diode forward current	$I_S$	-	-	20	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	83	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	20	V/ns	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 7.7\text{A}$ , $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di <sub>F</sub> /dt	-	-	375	A/ $\mu\text{s}$	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 7.7\text{A}$ , $T_j=25^\circ\text{C}$ 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

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	1.026	°C/W	-
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	62	°C/W	device on PCB, minimal footprint
Thermal resistance, junction - ambient for SMD version	$R_{thJA}$	-	35	45	°C/W	Device on 40mm*40mm*1.5mm epoxy PCB FR4 with 6cm <sup>2</sup> (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling.
Reflow soldering temperature	$T_{sold}$	-	-	260	°C	reflow MSL2a

### 3 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	$V_{DS}=V_{GS}$ , $I_D=0.49\text{mA}$
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	$R_{DS(on)}$	-	0.090 0.200	0.104 -	$\Omega$	$V_{GS}=10\text{V}$ , $I_D=9.7\text{A}$ , $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$ , $I_D=9.7\text{A}$ , $T_j=150^\circ\text{C}$
Gate resistance	$R_G$	-	0.82	-	$\Omega$	$f=1\text{MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	1819	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$
Output capacitance	$C_{oss}$	-	33	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	62	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	641	-	pF	$I_D=\text{constant}$ , $V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$
Turn-on delay time	$t_{d(on)}$	-	11.8	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=9.7\text{A}$ , $R_G=5.3\Omega$ ; see table 9
Rise time	$t_r$	-	8	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=9.7\text{A}$ , $R_G=5.3\Omega$ ; see table 9
Turn-off delay time	$t_{d(off)}$	-	48	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=9.7\text{A}$ , $R_G=5.3\Omega$ ; see table 9
Fall time	$t_f$	-	8	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=9.7\text{A}$ , $R_G=5.3\Omega$ ; see table 9

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{GS}$	-	9	-	nC	$V_{DD}=400\text{V}$ , $I_D=9.7\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate to drain charge	$Q_{gd}$	-	14	-	nC	$V_{DD}=400\text{V}$ , $I_D=9.7\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate charge total	$Q_g$	-	42	-	nC	$V_{DD}=400\text{V}$ , $I_D=9.7\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate plateau voltage	$V_{plateau}$	-	5.0	-	V	$V_{DD}=400\text{V}$ , $I_D=9.7\text{A}$ , $V_{GS}=0$ to $10\text{V}$

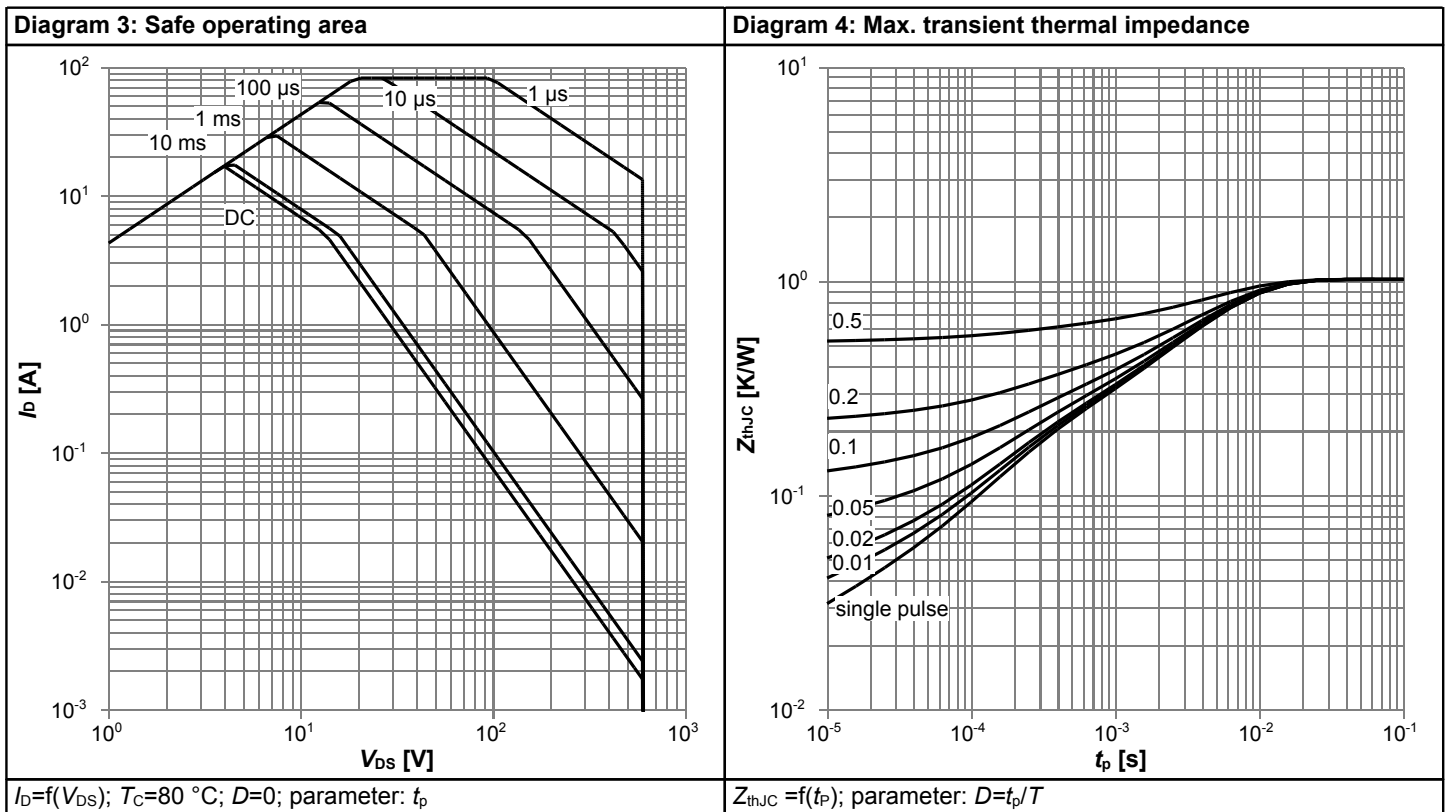
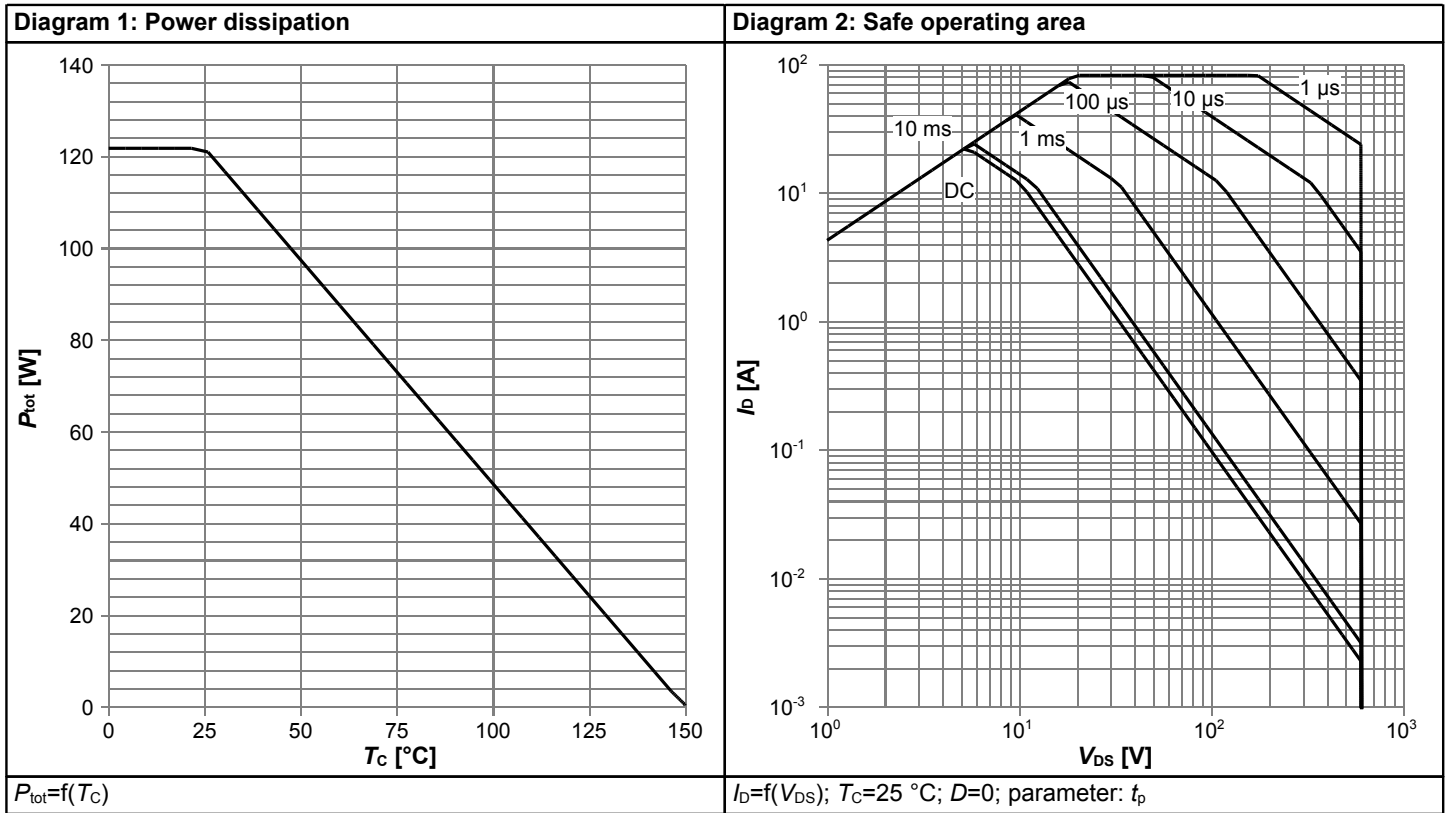
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<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

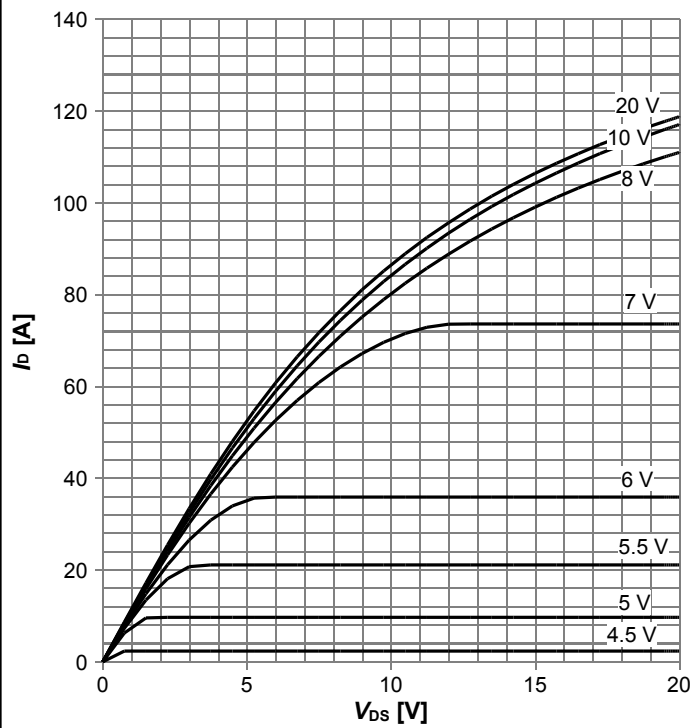
**Table 7 Reverse diode characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	$V_{SD}$	-	0.9	-	V	$V_{GS}=0V, I_F=9.7A, T_j=25^\circ C$
Reverse recovery time	$t_{rr}$	-	350	-	ns	$V_R=400V, I_F=9.7A, di_F/dt=100A/\mu s$ ; see table 8
Reverse recovery charge	$Q_{rr}$	-	4.4	-	$\mu C$	$V_R=400V, I_F=9.7A, di_F/dt=100A/\mu s$ ; see table 8
Peak reverse recovery current	$I_{rrm}$	-	27	-	A	$V_R=400V, I_F=9.7A, di_F/dt=100A/\mu s$ ; see table 8

### 4 Electrical characteristics diagrams

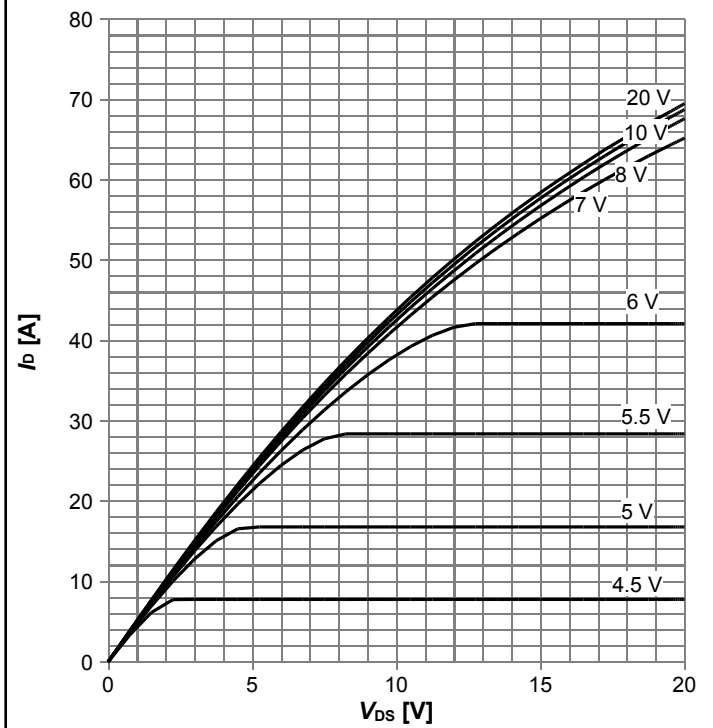


**Diagram 5: Typ. output characteristics**



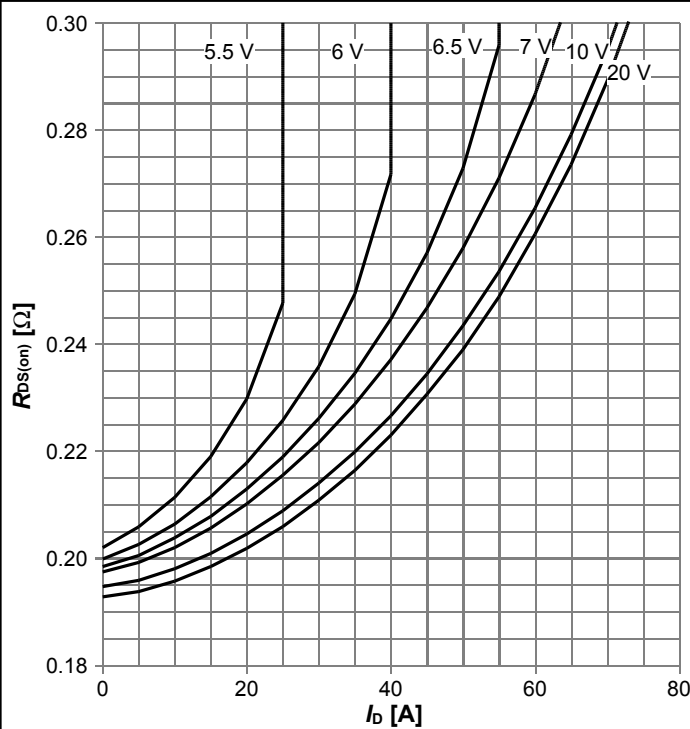
$I_D=f(V_{DS}); T_j=25\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

**Diagram 6: Typ. output characteristics**



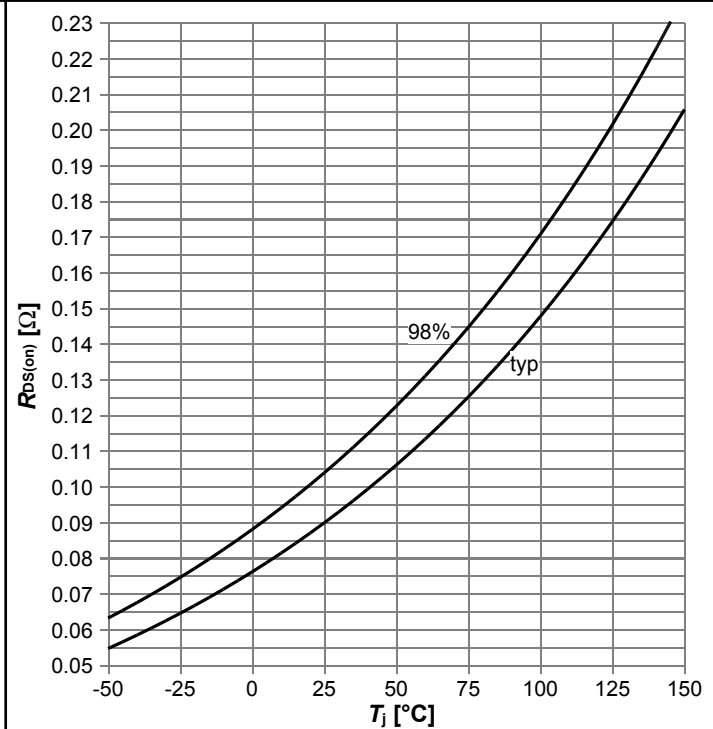
$I_D=f(V_{DS}); T_j=125\text{ }^\circ\text{C}; \text{parameter: } V_{GS}$

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



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

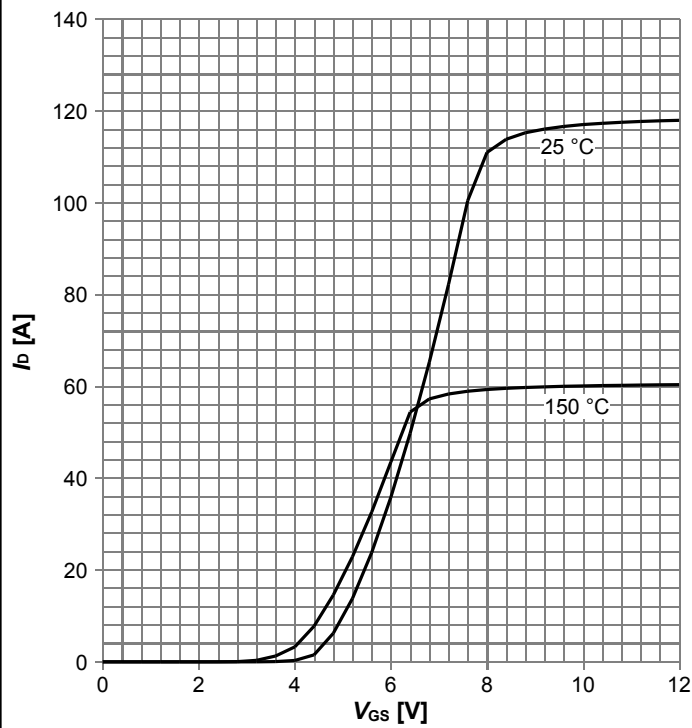
**Diagram 8: Drain-source on-state resistance**



$R_{DS(on)}=f(T_j); I_D=9.7\text{ A}; V_{GS}=10\text{ V}$

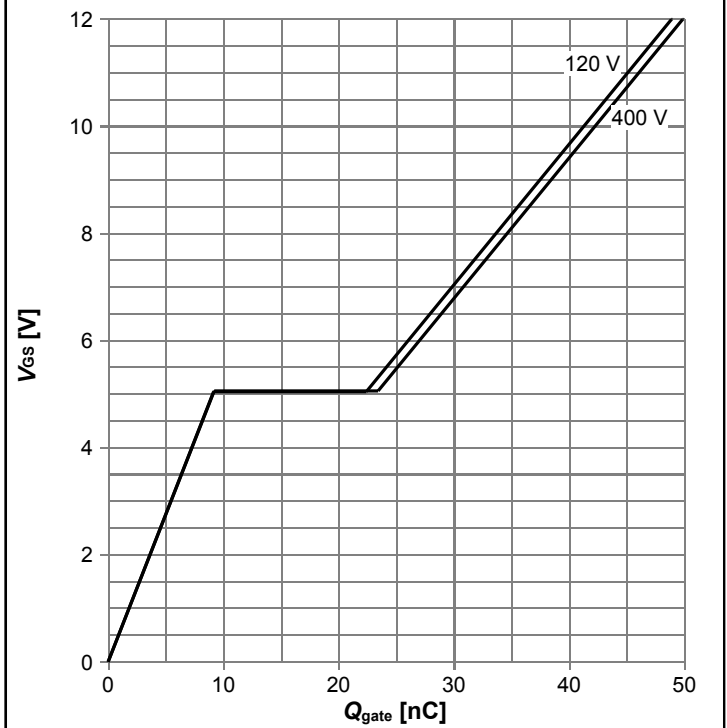


Diagram 9: Typ. transfer characteristics



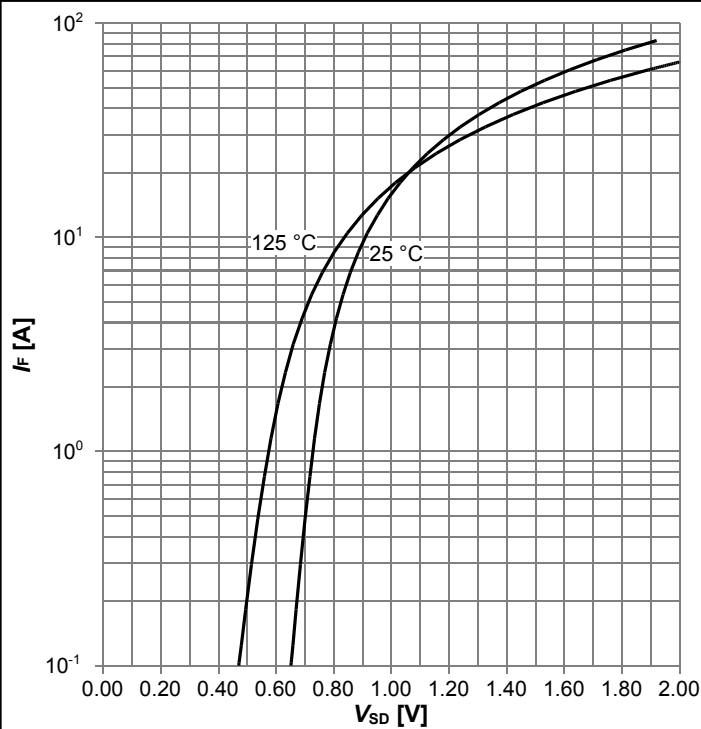
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



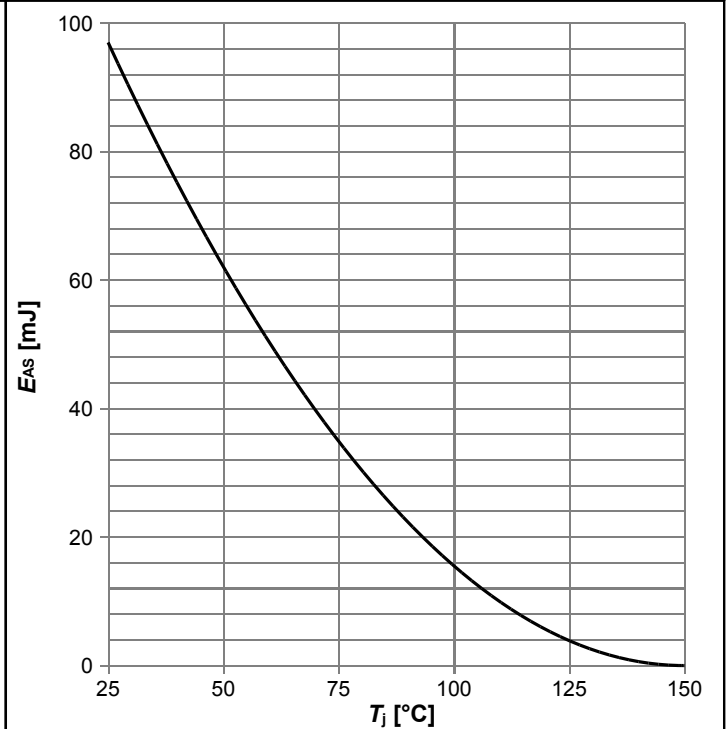
$V_{GS} = f(Q_{gate}); I_D = 9.7 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



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

Diagram 12: Avalanche energy

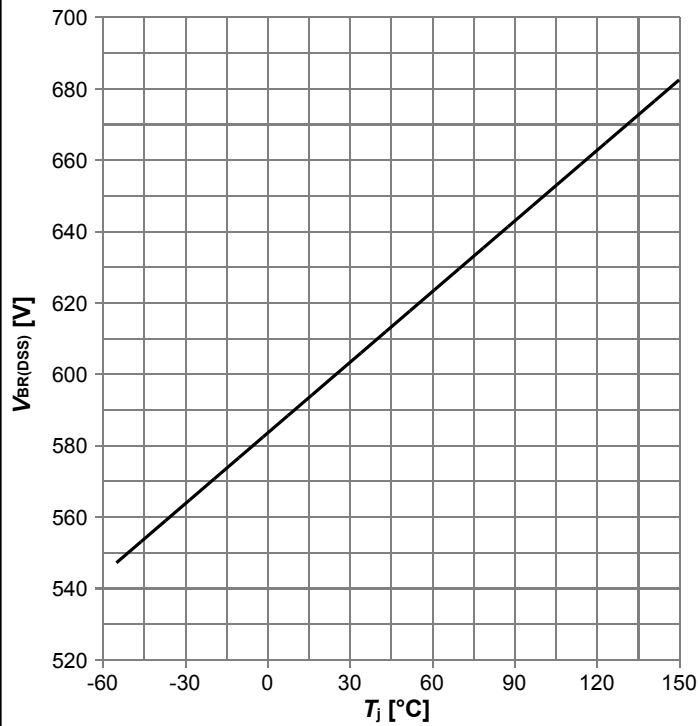


$E_{AS} = f(T_j); I_D = 5.0 \text{ A}; V_{DD} = 50 \text{ V}$

# 600V CoolMOS™ C7 Power Transistor

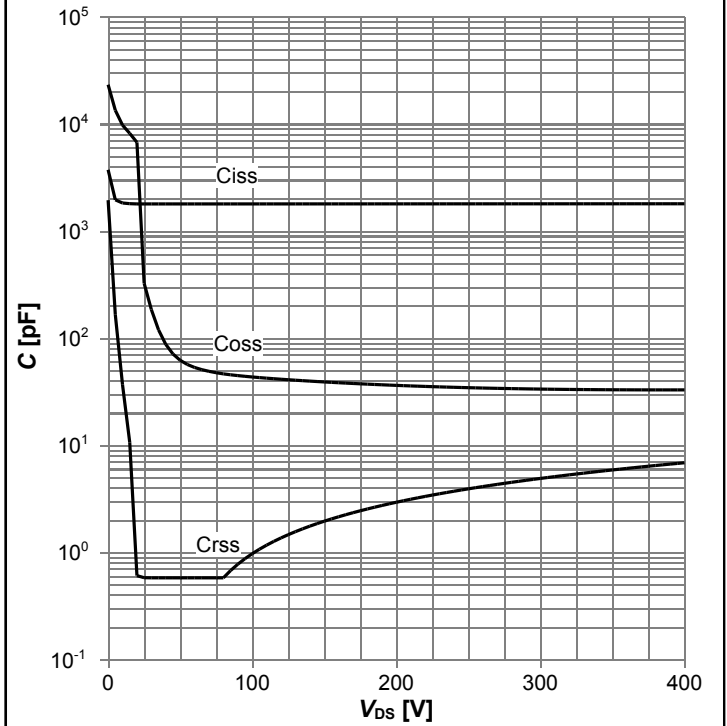
## IPL60R104C7

**Diagram 13: Drain-source breakdown voltage**



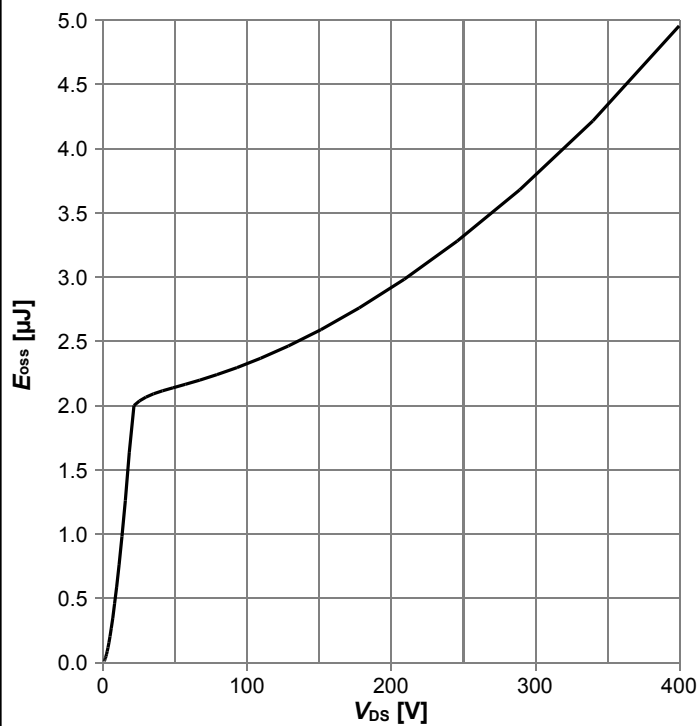
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

**Diagram 14: Typ. capacitances**



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

**Diagram 15: Typ. Coss stored energy**



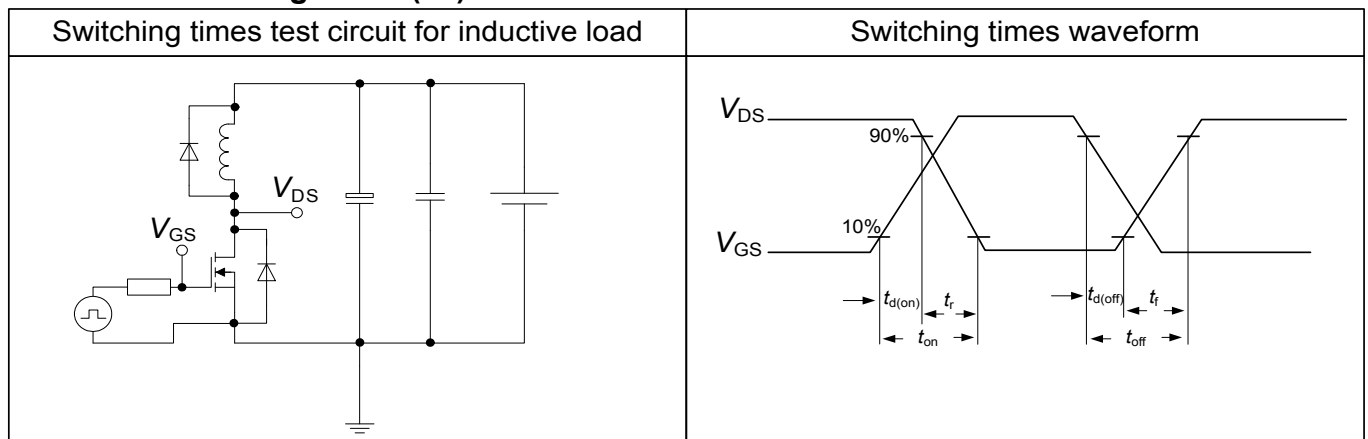
$E_{oss}=f(V_{DS})$

## 5 Test Circuits

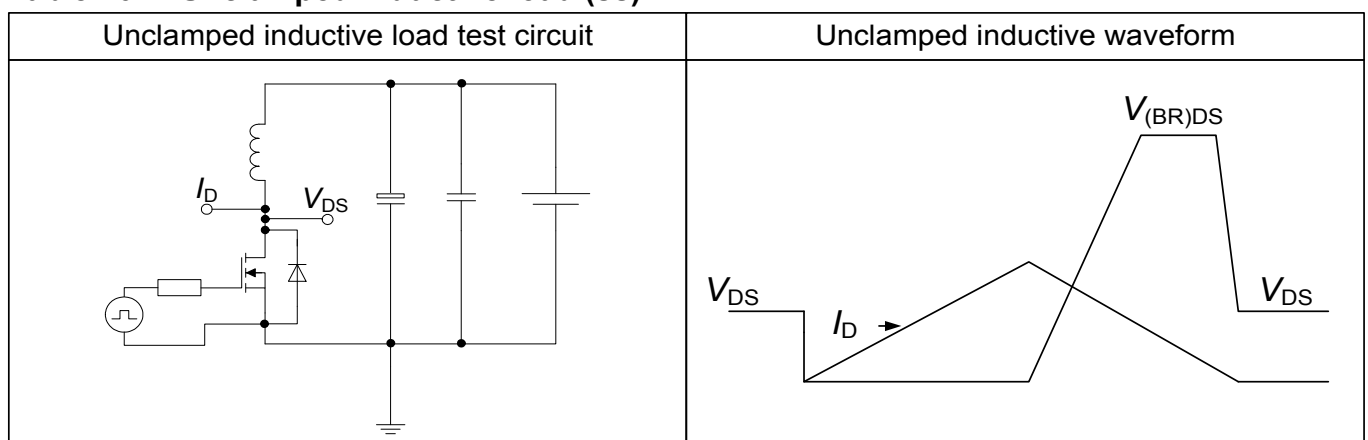
**Table 8 Diode characteristics**



**Table 9 switching times (ss)**



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



## 6 Package Outlines



Figure 1 Outline PG-VSON-4, dimensions in mm/inches

## 7 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

IPL60R104C7

**Revision: 2017-08-30, Rev. 2.1**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2015-12-11	Release of final version
2.1	2017-08-30	Updated MSL

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