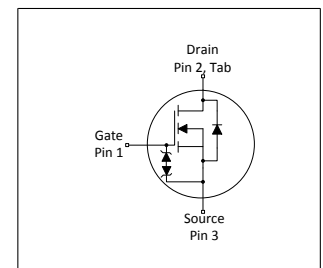
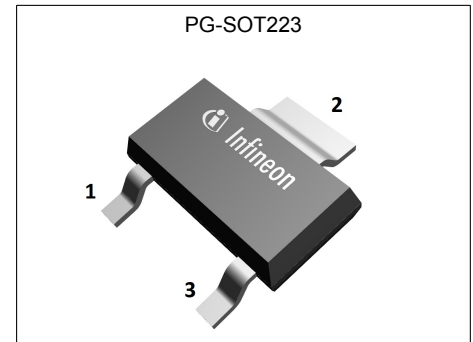


## MOSFET

### 600V CoolMOS™ P7 Power Transistor

The CoolMOS™ 7th generation platform is a revolutionary technology for high voltage power MOSFETs, designed according to the superjunction (SJ) principle and pioneered by Infineon Technologies. The 600V CoolMOS™ P7 series combines the experience of the leading SJMOSFET supplier with high class innovation, and is the only platform that enables an  $R_{DS(on)} \cdot A$  below  $10\text{Ohm} \cdot \text{mm}^2$ . The 600V CoolMOS™ P7 series is the successor to the CoolMOS™ P6 series and continues to offer all the 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

- Suitable for hard and soft switching (PFC and LLC)
- Integrated Gate Resistor to enable excellent balance between efficiency and ease of use
- $R_{DS(on)} \cdot A$  below  $10\text{Ohm} \cdot \text{mm}^2$ , enables low  $R_{DS(on)}$ /package
- ESD diode from  $180\text{mOhms}$  and above
- Series qualified for a variety of industrial and consumer grade applications according to JEDEC (J-STD20 and JESD22)

### Benefits

- Increased economies of scale by use in PFC and PWM topologies in the application
- Can be in a wide variety of applications and power ranges
- Increased power density solutions due to smaller packages
- Protection in various manufacturing environments
- Products tailored for either consumer or industrial applications



### Potential applications

PFC stages, hard switching PWM stages and resonant switching stages for e.g. PC Silverbox, Adapter, LCD & PDP TV, Lighting, Server, Telecom and UPS.

*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
$R_{DS(on),max}$	360	$\text{m}\Omega$
$Q_{g,typ}$	13	nC
$I_{D,pulse}$	26	A
$E_{oss@400V}$	1.6	$\mu\text{J}$
Body diode $di/dt$	900	$\text{A}/\mu\text{s}$

Type / Ordering Code	Package	Marking	Related Links
IPN60R360P7S	PG-SOT223	60S360	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>	$I_D$	-	-	9 6.0	A	$T_C=25^\circ\text{C}$ $T_C=100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	26	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	27	mJ	$I_D=2.50\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche energy, repetitive	$E_{AR}$	-	-	0.14	mJ	$I_D=2.50\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10
Avalanche current, single pulse	$I_{AS}$	-	-	2.50	A	-
MOSFET dv/dt ruggedness	dv/dt	-	-	80	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	$P_{tot}$	-	-	7	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	n.a.
Continuous diode forward current	$I_S$	-	-	9.0	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	26	A	$T_C=25^\circ\text{C}$
Reverse diode dv/dt <sup>3)</sup>	dv/dt	-	-	50	V/ns	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 9\text{A}$ , $T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	di/dt	-	-	900	A/ $\mu\text{s}$	$V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 9\text{A}$ , $T_j=25^\circ\text{C}$ 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  $T_{j,max}$ . Maximum Duty Cycle  $D = 0.50$ ; DPAK / IPAK equivalent.

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

<sup>3)</sup> Identical low side and high side switch with identical  $R_g$

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - solder point	$R_{thJS}$	-	-	17.4	°C/W	-
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	160	°C/W	device on PCB, minimal footprint
Thermal resistance, junction - ambient for SMD version	$R_{thJA}$	-	35	75	°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.
Soldering temperature, wavesoldering only allowed at leads	$T_{sold}$	-	-	260	°C	reflow MSL1

### 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	$V_{DS}=V_{GS}$ , $I_D=0.14\text{mA}$
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	$I_{GSS}$	-	-	1000	nA	$V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.300 0.697	0.360 -	$\Omega$	$V_{GS}=10\text{V}$ , $I_D=2.7\text{A}$ , $T_j=25^\circ\text{C}$ $V_{GS}=10\text{V}$ , $I_D=2.7\text{A}$ , $T_j=150^\circ\text{C}$
Gate resistance	$R_G$	-	6.2	-	$\Omega$	$f=1\text{MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	555	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$
Output capacitance	$C_{oss}$	-	10	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	20	-	pF	$V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	214	-	pF	$I_D=\text{constant}$ , $V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$
Turn-on delay time	$t_{d(on)}$	-	8	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=2.7\text{A}$ , $R_G=10.0\Omega$ ; see table 9
Rise time	$t_r$	-	7	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=2.7\text{A}$ , $R_G=10.0\Omega$ ; see table 9
Turn-off delay time	$t_{d(off)}$	-	42	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=2.7\text{A}$ , $R_G=10.0\Omega$ ; see table 9
Fall time	$t_f$	-	10	-	ns	$V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=2.7\text{A}$ , $R_G=10.0\Omega$ ; see table 9

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{GS}$	-	3	-	nC	$V_{DD}=400\text{V}$ , $I_D=2.7\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate to drain charge	$Q_{gd}$	-	4	-	nC	$V_{DD}=400\text{V}$ , $I_D=2.7\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate charge total	$Q_g$	-	13	-	nC	$V_{DD}=400\text{V}$ , $I_D=2.7\text{A}$ , $V_{GS}=0$ to $10\text{V}$
Gate plateau voltage	$V_{\text{plateau}}$	-	5.2	-	V	$V_{DD}=400\text{V}$ , $I_D=2.7\text{A}$ , $V_{GS}=0$ 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	$V_{GS}=0V, I_F=2.7A, T_j=25^{\circ}C$
Reverse recovery time	$t_{rr}$	-	145	-	ns	$V_R=400V, I_F=1.0A, di_F/dt=100A/\mu s$ ; see table 8
Reverse recovery charge	$Q_{rr}$	-	0.74	-	$\mu C$	$V_R=400V, I_F=1.0A, di_F/dt=100A/\mu s$ ; see table 8
Peak reverse recovery current	$I_{rrm}$	-	11	-	A	$V_R=400V, I_F=1.0A, di_F/dt=100A/\mu s$ ; see table 8

**4 Electrical characteristics diagrams**

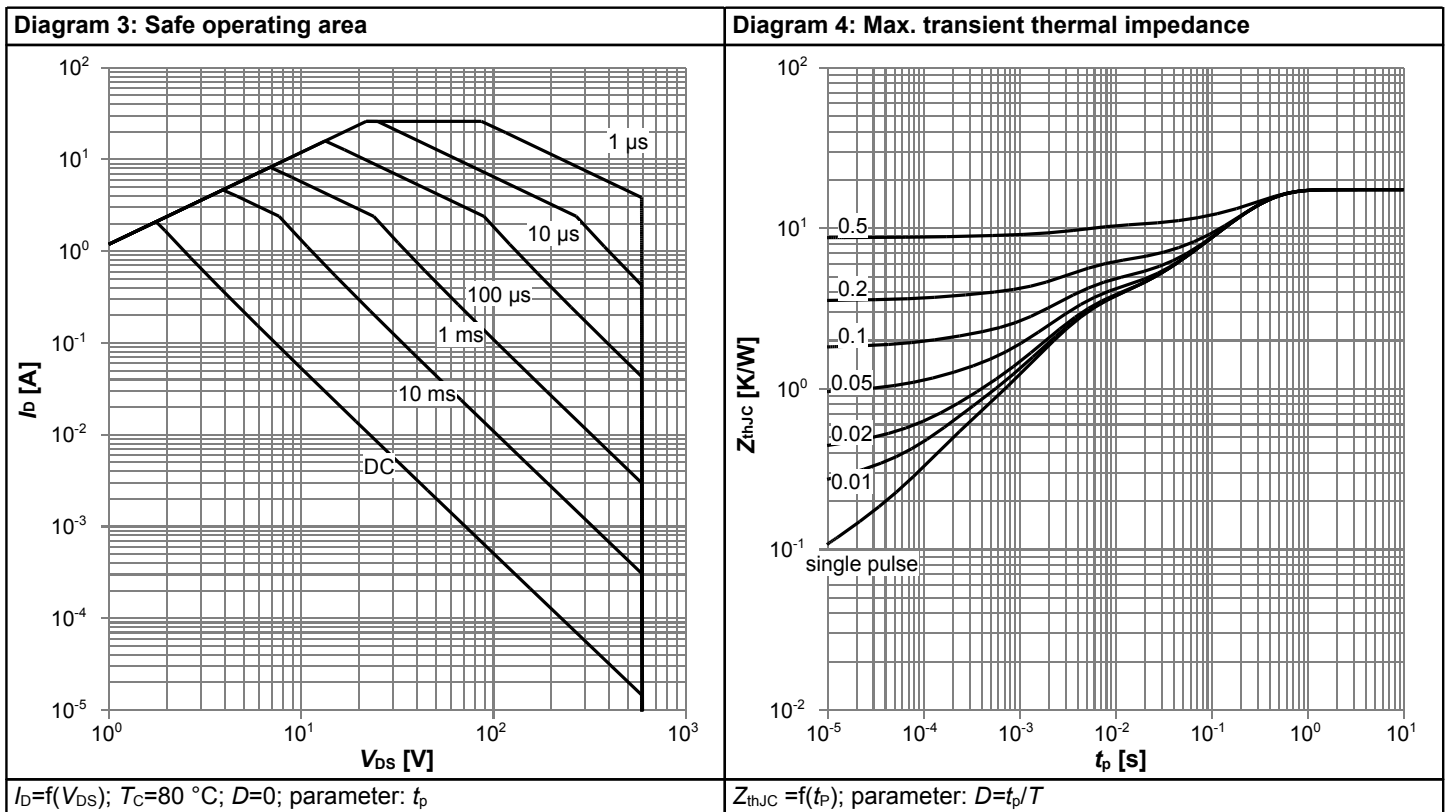
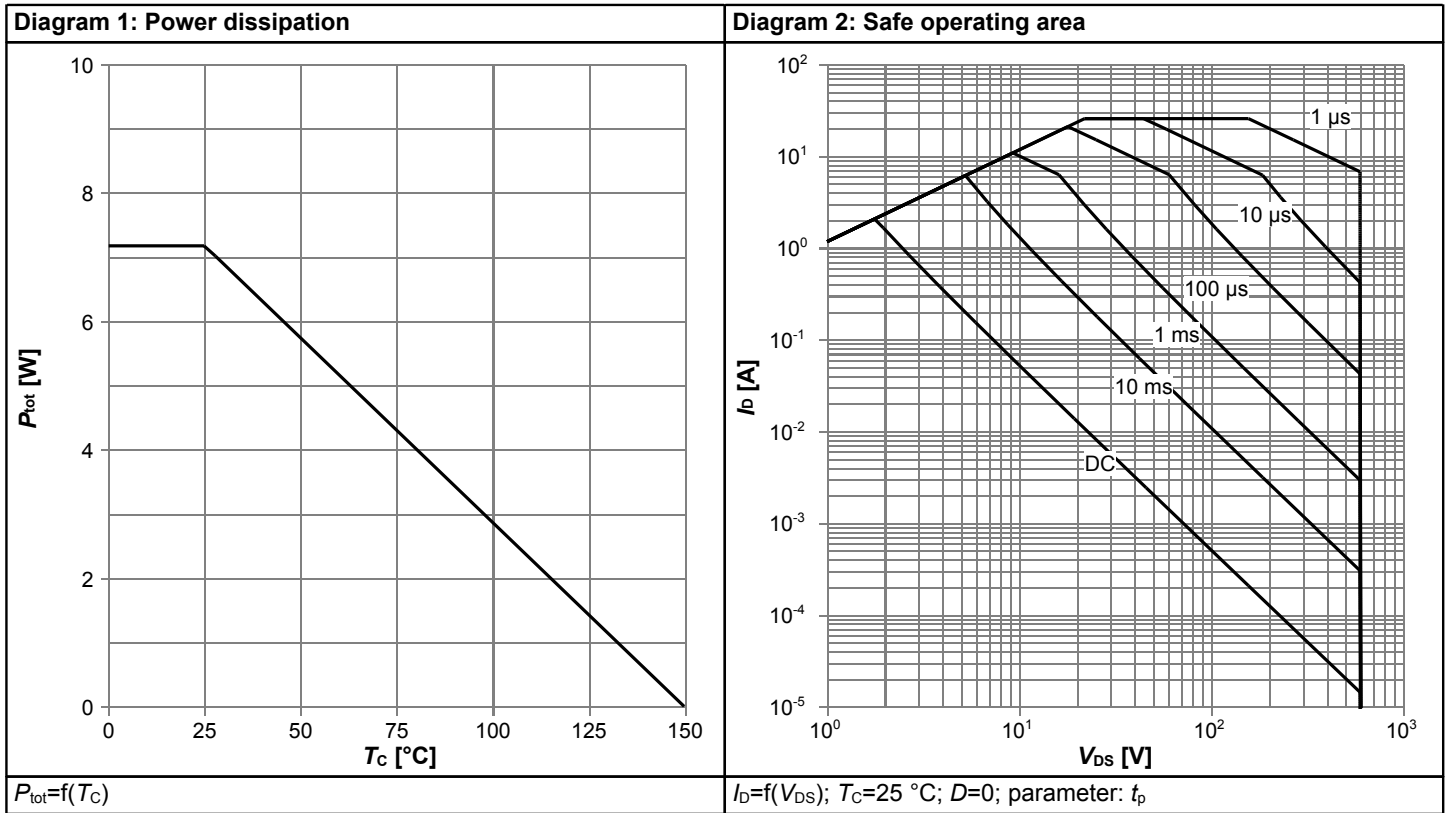
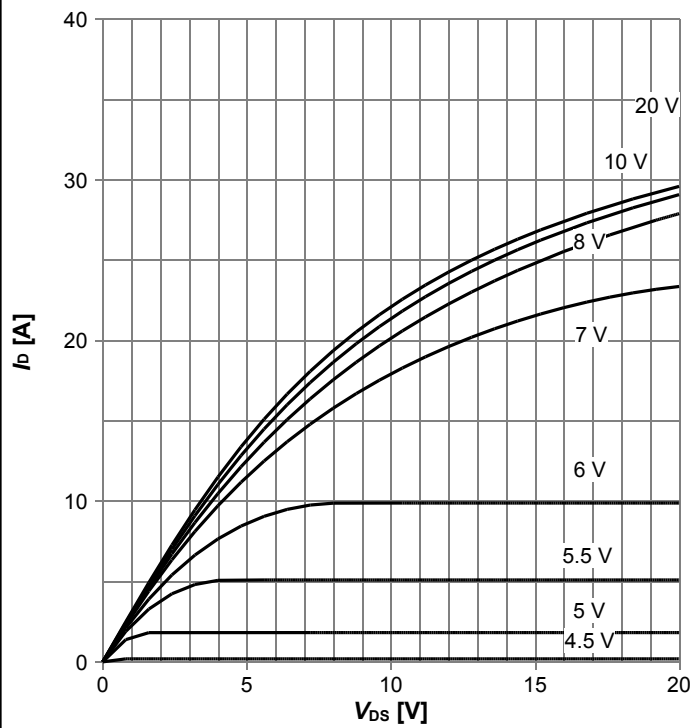
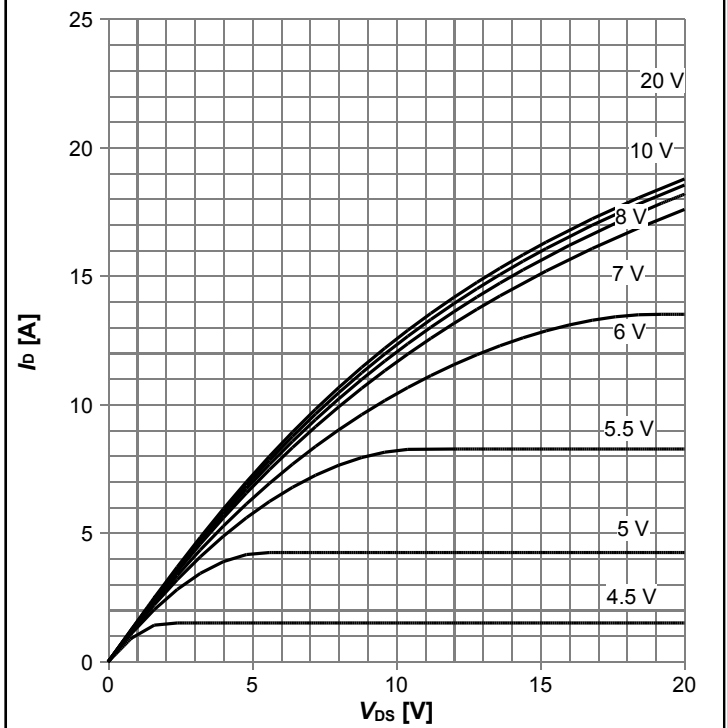


Diagram 5: Typ. output characteristics



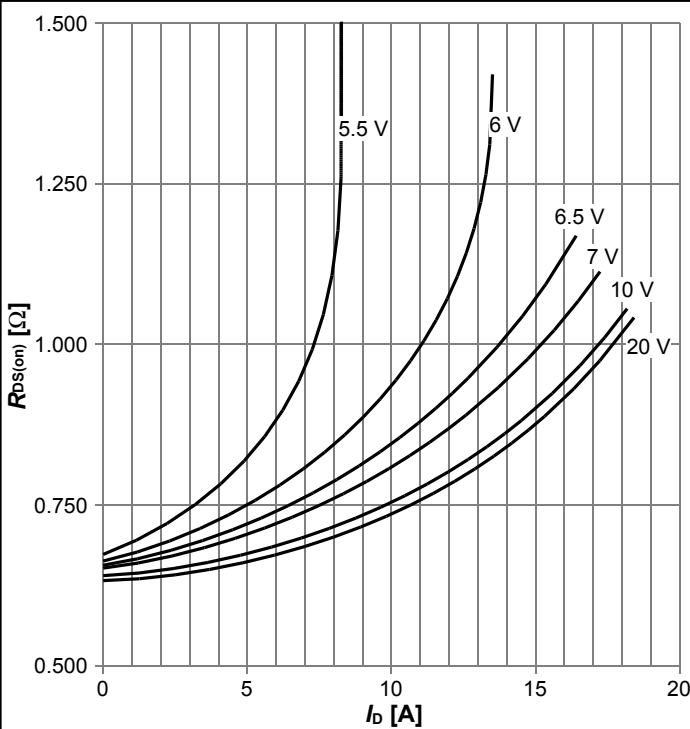
$I_D = f(V_{DS})$ ;  $T_j = 25^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



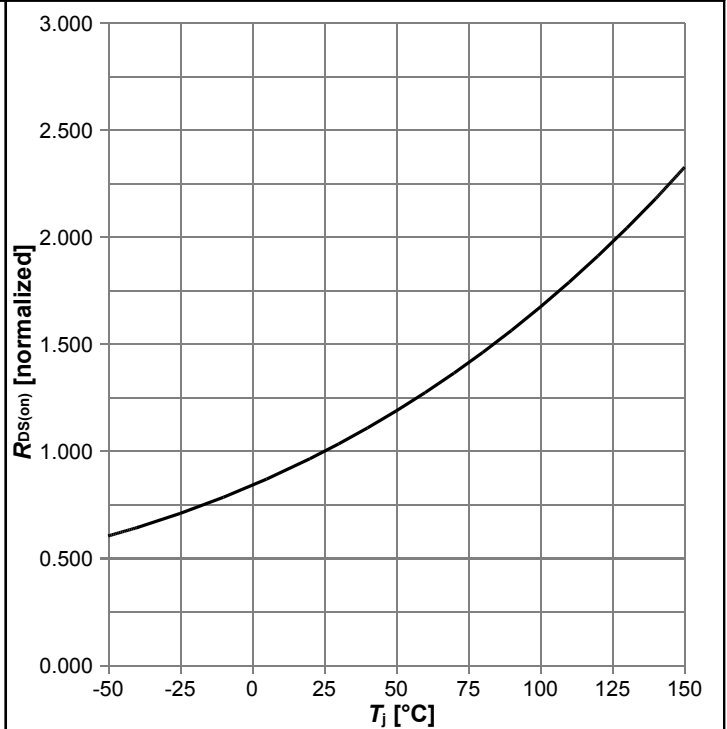
$I_D = f(V_{DS})$ ;  $T_j = 125^\circ\text{C}$ ; parameter:  $V_{GS}$

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



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

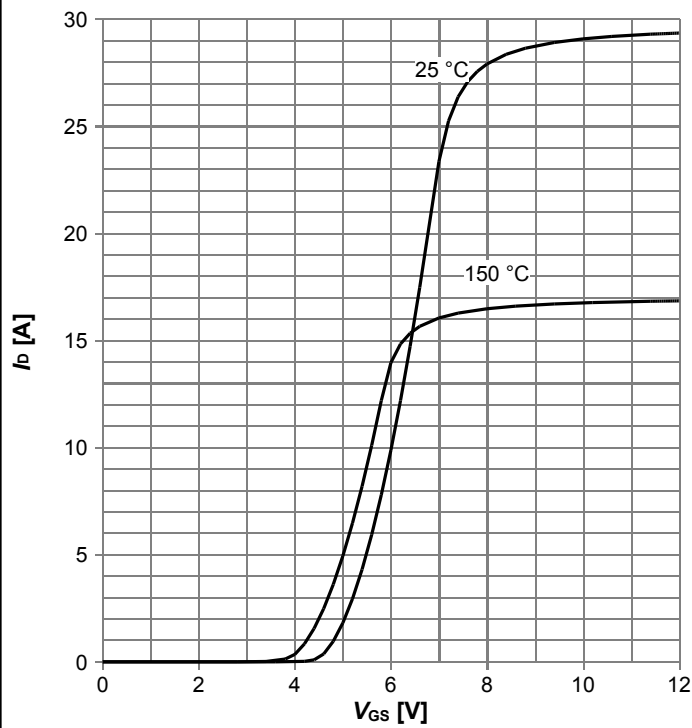
Diagram 8: Drain-source on-state resistance



$R_{DS(on)} = f(T_j)$ ;  $I_D = 2.7\text{ A}$ ;  $V_{GS} = 10\text{ V}$

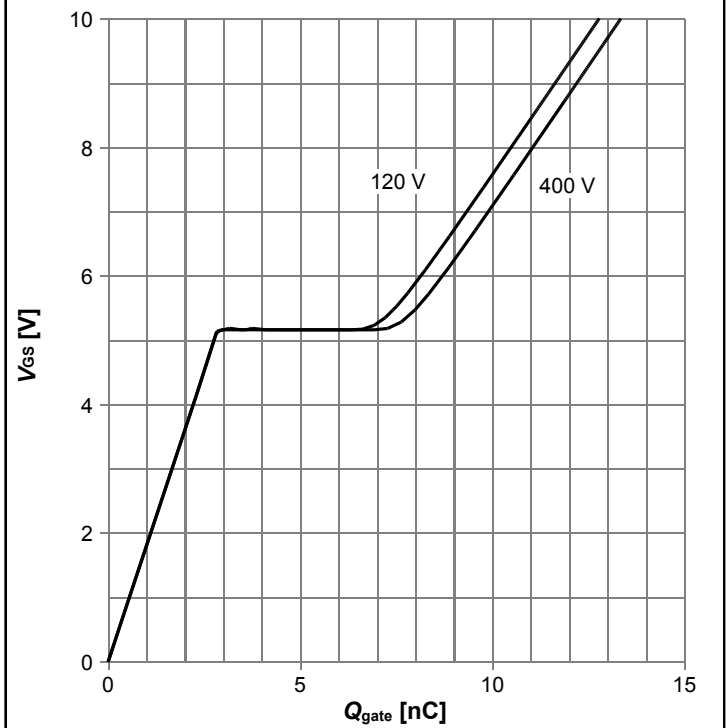


**Diagram 9: Typ. transfer characteristics**



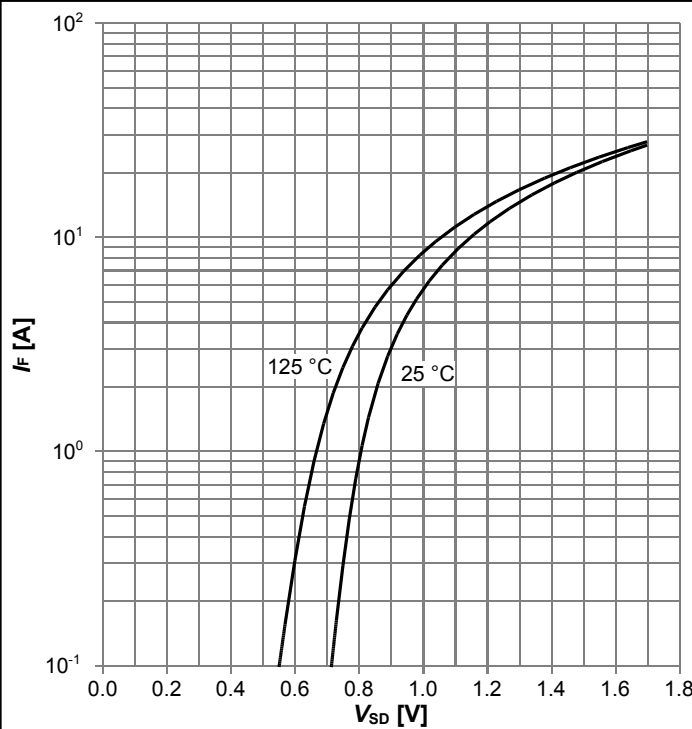
$I_D=f(V_{GS}); V_{DS}=20V; \text{parameter: } T_j$

**Diagram 10: Typ. gate charge**



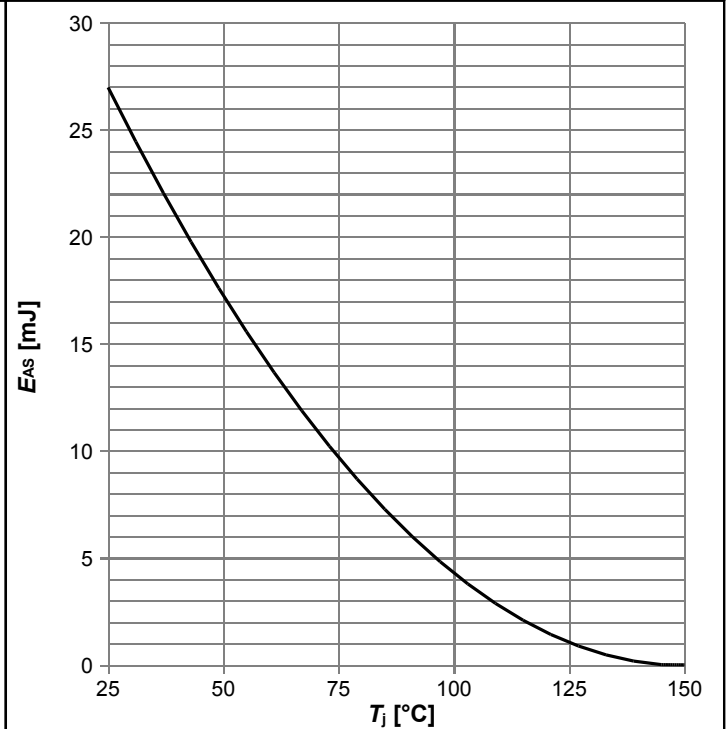
$V_{GS}=f(Q_{gate}); I_D=2.7 \text{ A pulsed}; \text{parameter: } V_{DD}$

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



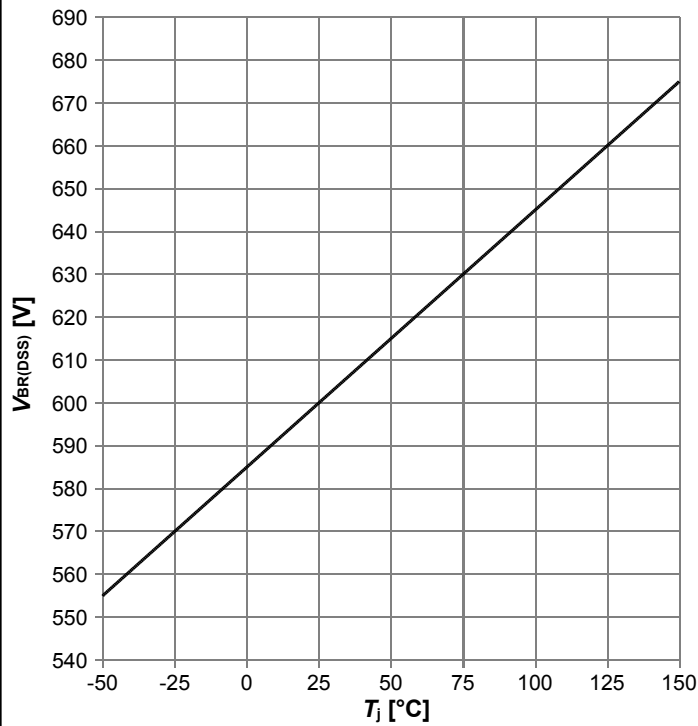
$I_F=f(V_{SD}); \text{parameter: } T_j$

**Diagram 12: Avalanche energy**



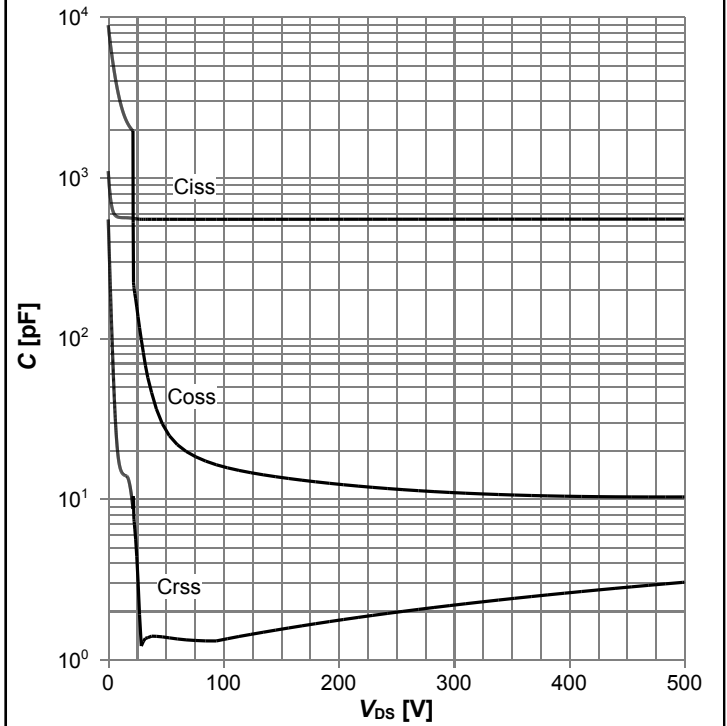
$E_{AS}=f(T_j); I_D=2.5 \text{ A}; V_{DD}=50 \text{ V}$

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



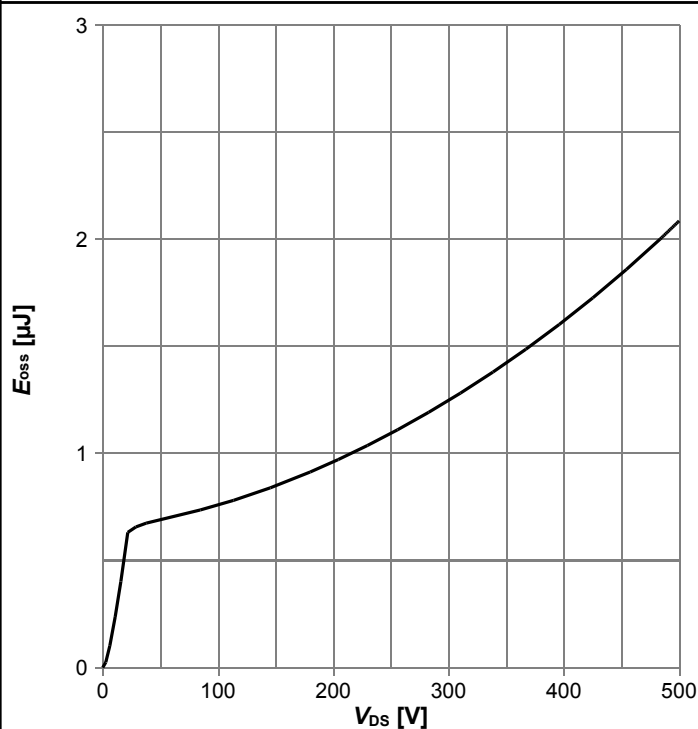
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

**Diagram 14: Typ. capacitances**



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

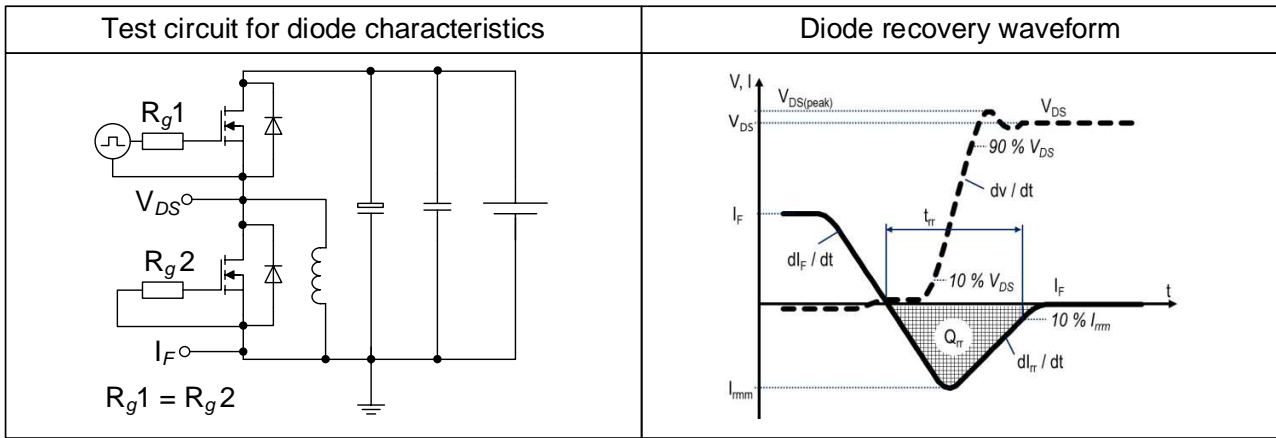
**Diagram 15: Typ. Coss stored energy**



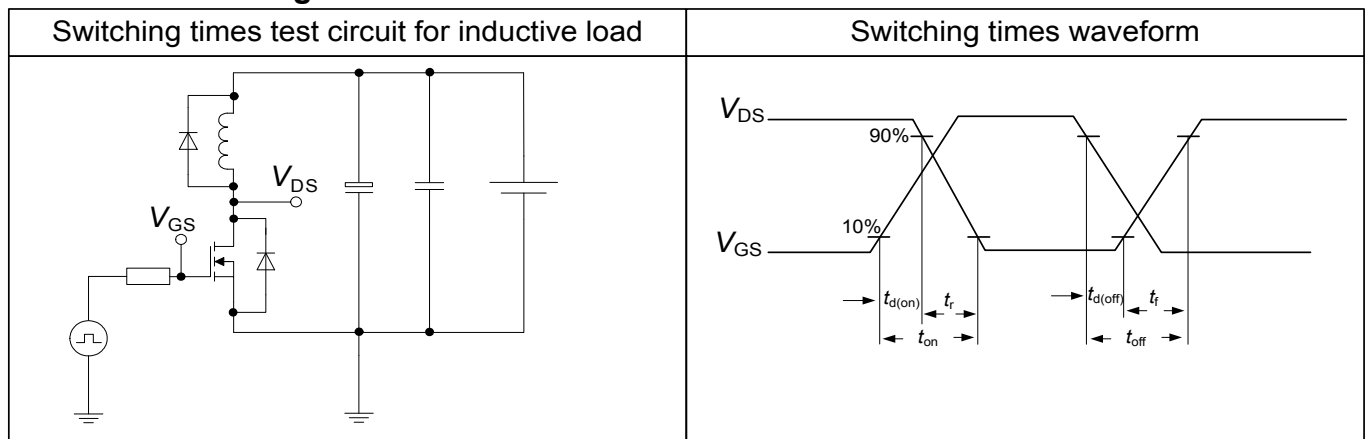
$E_{oss}=f(V_{DS})$

## 5 Test Circuits

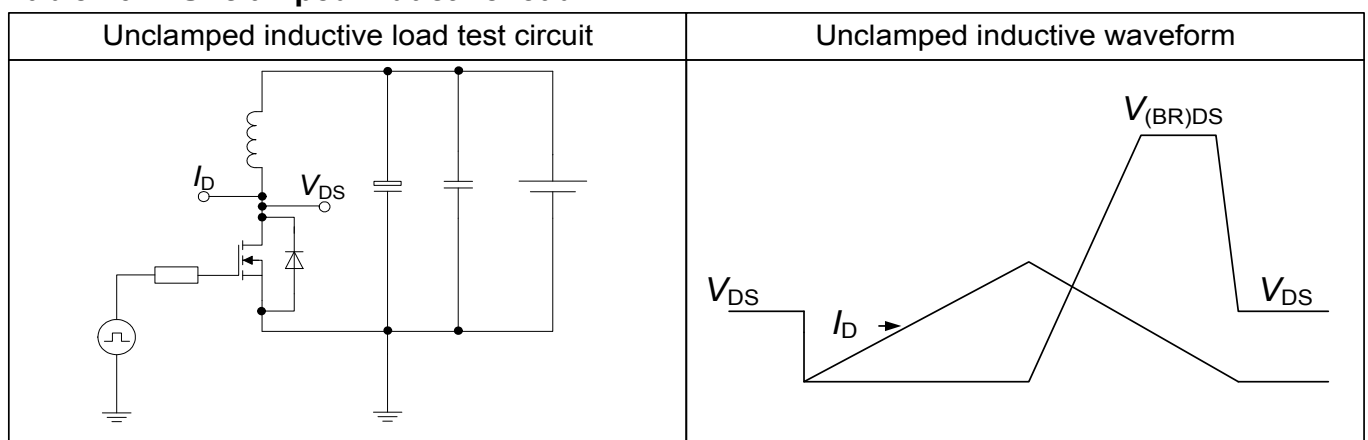
**Table 8 Diode characteristics**



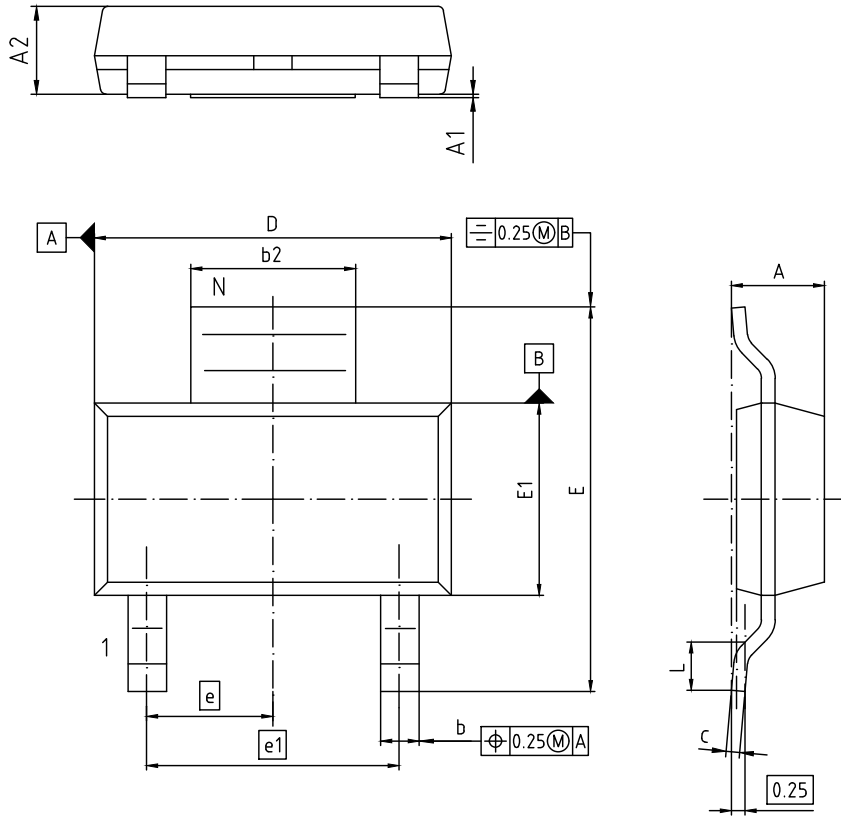
**Table 9 Switching times**



**Table 10 Unclamped inductive load**



## 6 Package Outlines



NOTES:

1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-261

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.52	1.80	0.060	0.071
A1	-	0.10	-	0.004
A2	1.50	1.70	0.059	0.067
b	0.60	0.80	0.024	0.031
b2	2.95	3.10	0.116	0.122
c	0.24	0.32	0.009	0.013
D	6.30	6.70	0.248	0.264
E	6.70	7.30	0.264	0.287
E1	3.30	3.70	0.130	0.146
e	2.3 BASIC		0.091 BASIC	
e1	4.6 BASIC		0.181 BASIC	
L	0.75	1.10	0.030	0.043
N	3		3	
O	0°	10°	0°	10°

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Figure 1 Outline PG-SOT223, dimensions in mm/inches

## **7 Appendix A**

### **Table 11 Related Links**

- **IFX CoolMOS P7 Webpage:** [www.infineon.com](http://www.infineon.com)
- **IFX CoolMOS P7 application note:** [www.infineon.com](http://www.infineon.com)
- **IFX CoolMOS P7 simulation model:** [www.infineon.com](http://www.infineon.com)
- **IFX Design tools:** [www.infineon.com](http://www.infineon.com)

# 600V CoolMOS™ P7 Power Transistor

## IPN60R360P7S

### Revision History

IPN60R360P7S

**Revision: 2017-06-23, Rev. 2.0**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.0	2017-06-23	Release of final version

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