

# MOSFET

Metal Oxide Semiconductor Field Effect Transistor

## CoolMOS CP

600V CoolMOS™ CP Power Transistor  
IPL60R385CP

## Data Sheet

Rev. 2.1, 2012-01-10  
Final

Industrial & Multimarket

## 1 Description

The CoolMOS™ CP series offers devices which 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.

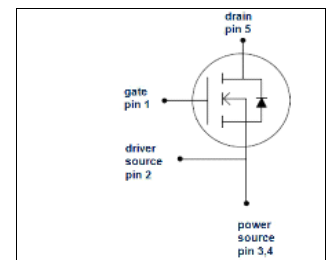
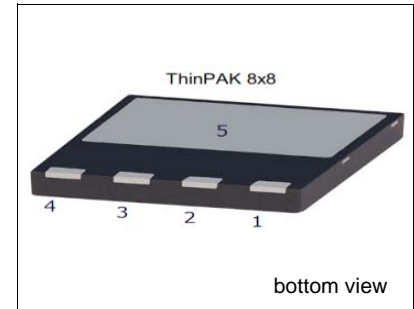
### ThinPAK

ThinPAK is a new leadless SMD package for HV MOSFETs. The new package has a very small footprint of only 64mm<sup>2</sup> (vs. 150mm<sup>2</sup> for the D<sup>2</sup>PAK) and a very low profile with only 1mm height (vs. 4.4mm for the D<sup>2</sup>PAK). The significantly smaller package size, combined with benchmark low parasitic inductances, provides designers with a new and effective way to decrease system solution size in power-density driven designs.

### Features

- Reduced board space consumption
- Increased power density
- Short commutation loop
- Smooth switching waveform
- easy to use products
- Extremely low losses due to very low FOM  $R_{DS(on)} \cdot Q_g$  and  $E_{oss}$
- Qualified according to JEDEC<sup>1)</sup> for target applications (Server, Adapter)
- Pb-free plating, Halogen free

**Applications:** Server, Adapter



**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max}$	0.385	$\Omega$
$Q_{g,typ}$	17	nC
$I_{D,pulse}$	27	A
$E_{oss} @ 400V$	3.2	$\mu J$
Body diode $di/dt$	400	A/ $\mu s$

### Related Links

- [IFX CP Product Brief](#)
- [IFX CP Portfolio](#)
- [IFX ThinPAK Webpage](#)
- [IFX Design tools](#)

Type	Package	Marking
IPL60R385CP	PG-VSON-4	6R385P

1) J-STD20 and JESD22

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## 2 Maximum ratings

at  $T_j = 25\text{ °C}$ , unless otherwise specified.

**Table 2 Maximum ratings**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous drain current <sup>1)</sup>	$I_D$	-	-	9.0	A	$T_C = 25\text{ °C}$
				5.7		$T_C = 100\text{ °C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	27	A	$T_C = 25\text{ °C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	227	mJ	$I_D = 3.4\text{ A}$ , $V_{DD} = 50\text{ V}$ (see table 17)
Avalanche energy, repetitive <sup>2)3)</sup>	$E_{AR}$	-	-	0.34		$I_D = 3.4\text{ A}$ , $V_{DD} = 50\text{ V}$
Avalanche current, repetitive <sup>2)3)</sup>	$I_{AR}$	-	-	3.4	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 ( $f > 1\text{ Hz}$ )
Power dissipation	$P_{tot}$	-	-	83	W	$T_C = 25\text{ °C}$
Operating temperature	$T_j$	-40	-	150	°C	
Storage temperature	$T_{stg}$	-40	-	125	°C	
Continuous diode forward current	$I_S$	-	-	9.0	A	$T_C = 25\text{ °C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	27	A	$T_C = 25\text{ °C}$
Reverse diode dv/dt <sup>4)</sup>	dv/dt	-	-	15	V/ns	$V_{DS} = 0 \dots 400\text{ V}$ , $I_{SD} \leq I_D$ , $T_j = 25\text{ °C}$
Maximum diode commutation speed <sup>4)</sup>	di/dt	-	-	400	A/ $\mu\text{s}$	(see table 18)

1) Limited by  $T_{j,max}$ . Maximum duty cycle

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

3) Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV} = E_{AR} \cdot f$ .

4) Identical low side and high side switch with identical  $R_G$

## 3 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	1.5	°C/W	
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	45		SMD version, device on PCB, 6cm <sup>2</sup> cooling area <sup>1)</sup>
Reflow soldering temperature	$T_{sold}$	-	-	260	°C	reflow MSL 3

1) Device on 40mm\*40mm\*1.5mm one layer epoxy PCB FR4 with 6cm<sup>2</sup> copper area (thickness 70 $\mu\text{m}$ ) for drain connection. PCB is vertical without air stream cooling.

## 4 Electrical characteristics

Electrical characteristics, at  $T_J=25\text{ °C}$ , 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	$V_{GS}=0\text{ V}$ , $I_D=0.25\text{ mA}$
Gate threshold voltage	$V_{GS(th)}$	2.5	3	3.5		$V_{DS}=V_{GS}$ , $I_D=0.34\text{ mA}$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_J=25\text{ °C}$
		-	10	-		$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_J=150\text{ °C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.35	0.385	$\Omega$	$V_{GS}=10\text{ V}$ , $I_D=5.2\text{ A}$ , $T_J=25\text{ °C}$
		-	0.90	-		$V_{GS}=10\text{ V}$ , $I_D=5.2\text{ A}$ , $T_J=150\text{ °C}$
Gate resistance	$R_G$	-	1.8	-	$\Omega$	$f=1\text{ MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	790	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	38	-		
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	36	-		
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	96	-		$I_D=\text{constant}$ , $V_{GS}=0\text{ V}$ $V_{DS}=0\dots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	10	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=5.2\text{ A}$ , $R_G=3.3\text{ }\Omega$ (see table 16)
Rise time	$t_r$	-	5	-		
Turn-off delay time	$t_{d(off)}$	-	40	-		
Fall time	$t_f$	-	5	-		

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 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	4	-	nC	$V_{DD}=480\text{ V}$ , $I_D=5.2\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate to drain charge	$Q_{gd}$	-	6	-		
Gate charge total	$Q_g$	-	17	-		
Gate plateau voltage	$V_{plateau}$	-	5	-	V	

**Table 7 Reverse diode characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Diode forward voltage	$V_{SD}$	-	0.9	-	V	$V_{GS}=0\text{ V}$ , $I_F=5.2\text{ A}$ , $T_j=25\text{ °C}$
Reverse recovery time	$t_{rr}$	-	260	-	ns	$V_R=400\text{ V}$ , $I_F=5.2\text{ A}$ , $di_F/dt=100\text{ A}/\mu\text{s}$ (see table 18)
Reverse recovery charge	$Q_{rr}$	-	3.1	-	$\mu\text{C}$	
Peak reverse recovery current	$I_{rrm}$	-	24	-	A	

5 Electrical characteristics diagrams

Table 8

Power dissipation	Max. transient thermal impedance
$P_{tot} = f(T_C)$	$Z_{(thJC)} = f(t_p)$ ; parameter: $D = t_p/T$

Table 9

Safe operating area $T_C=25\text{ °C}$	Safe operating area $T_C=80\text{ °C}$
$I_D = f(V_{DS}); T_C = 25\text{ °C}; D = 0$ ; parameter $t_p$	$I_D = f(V_{DS}); T_C = 80\text{ °C}; D = 0$ ; parameter $t_p$

Table 10

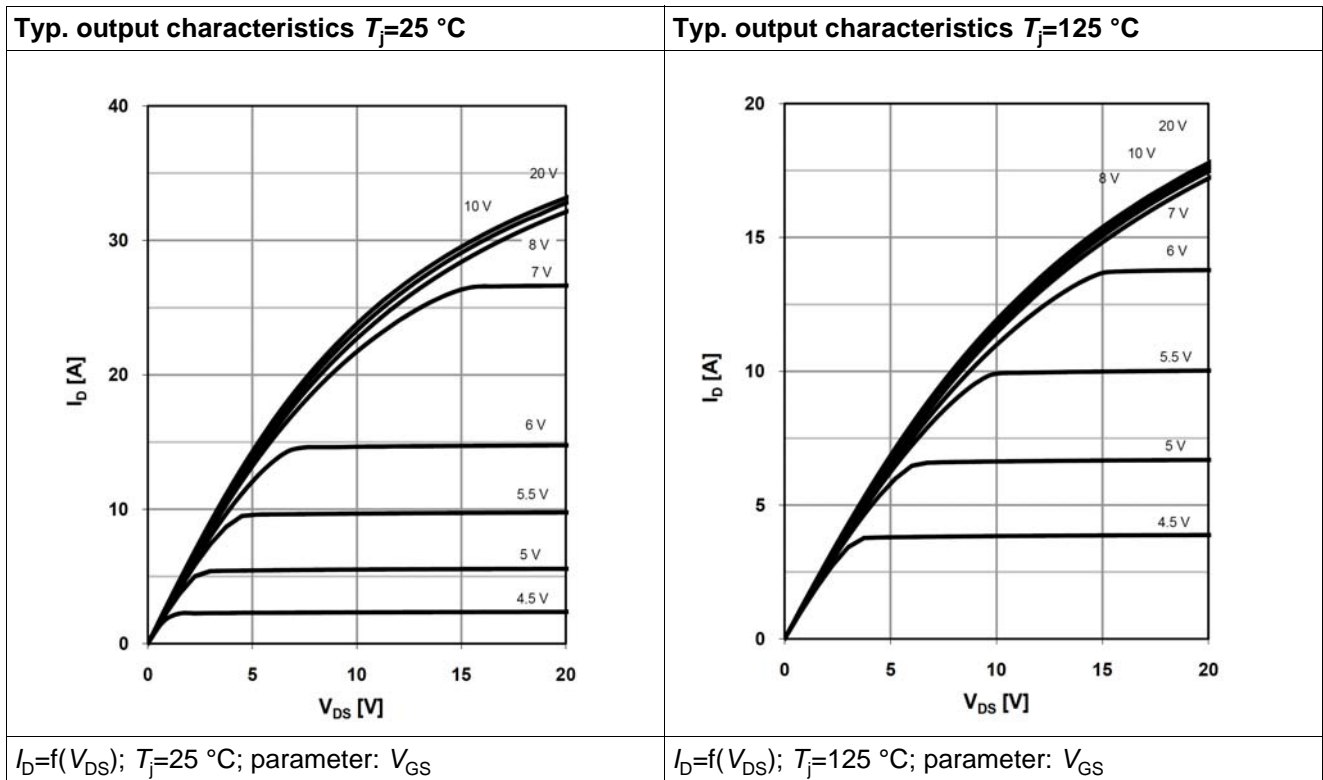


Table 11

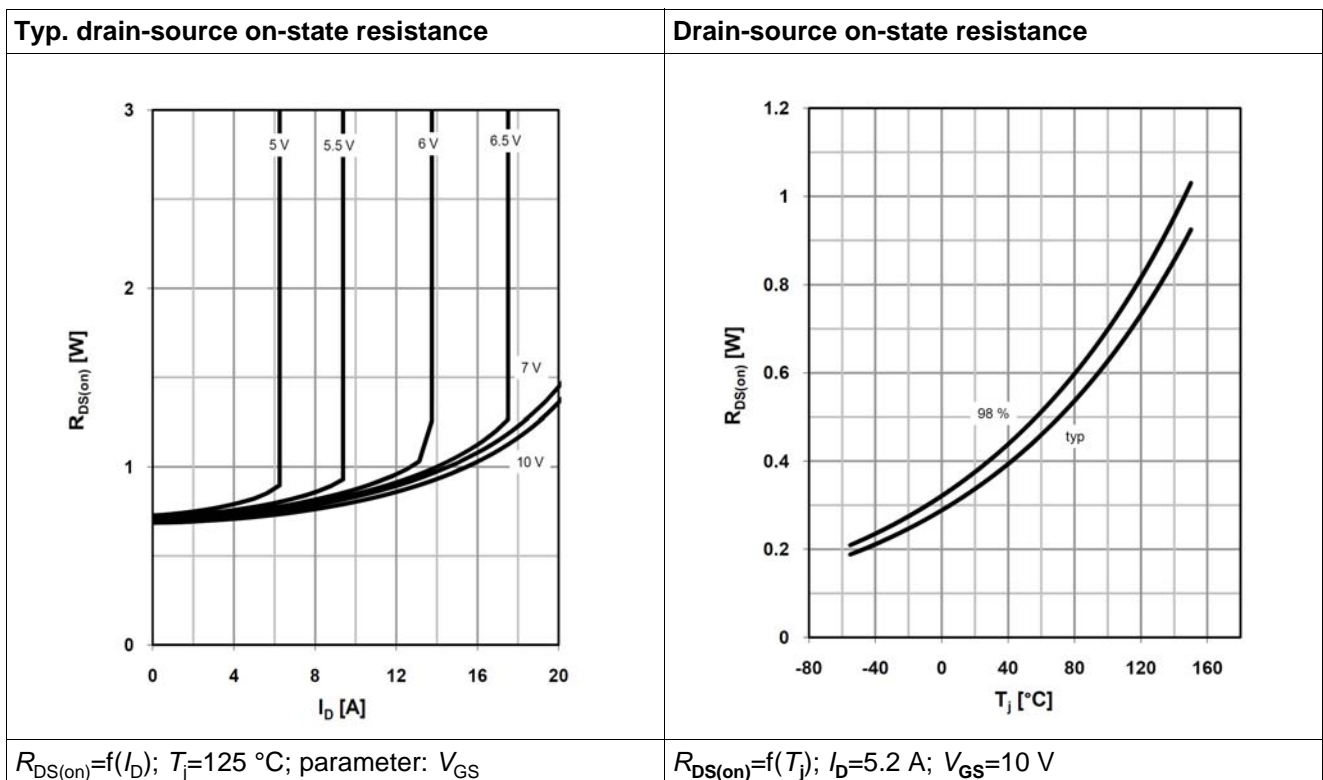




Table 12

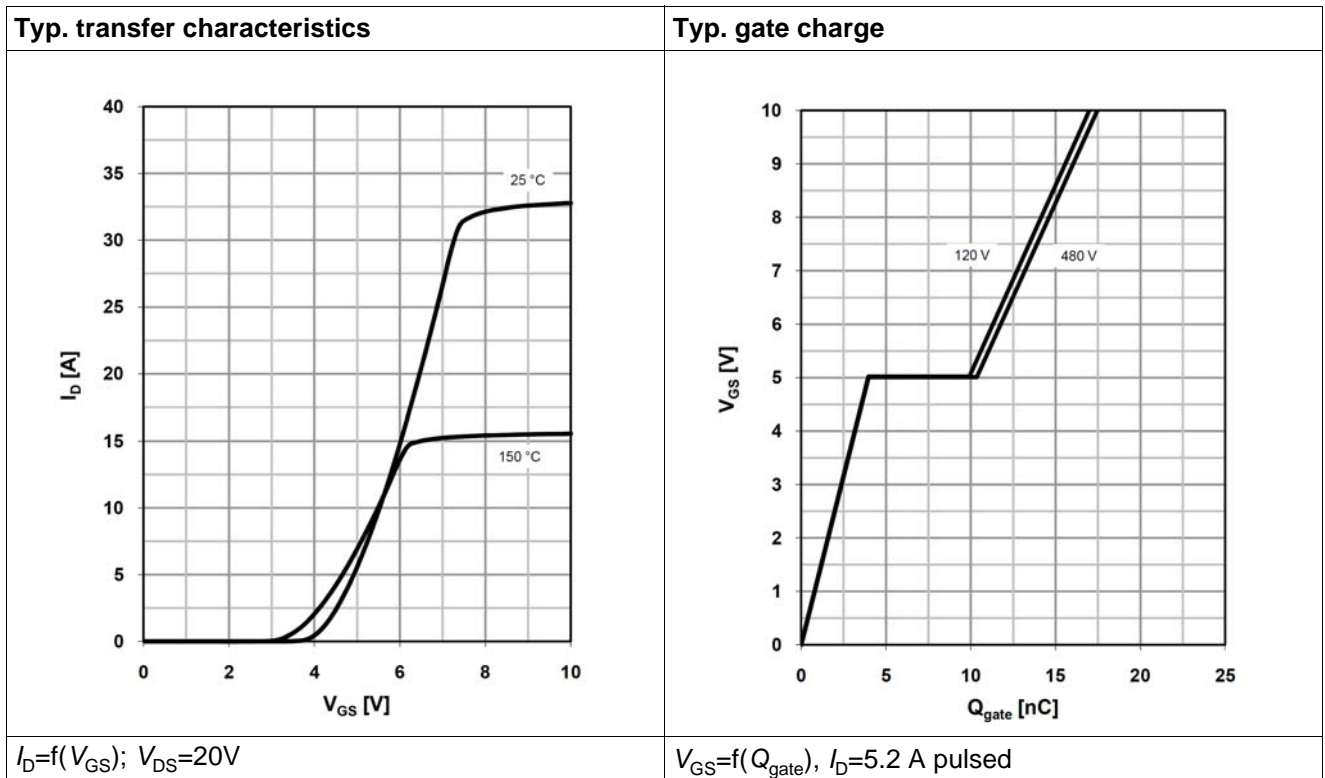


Table 13

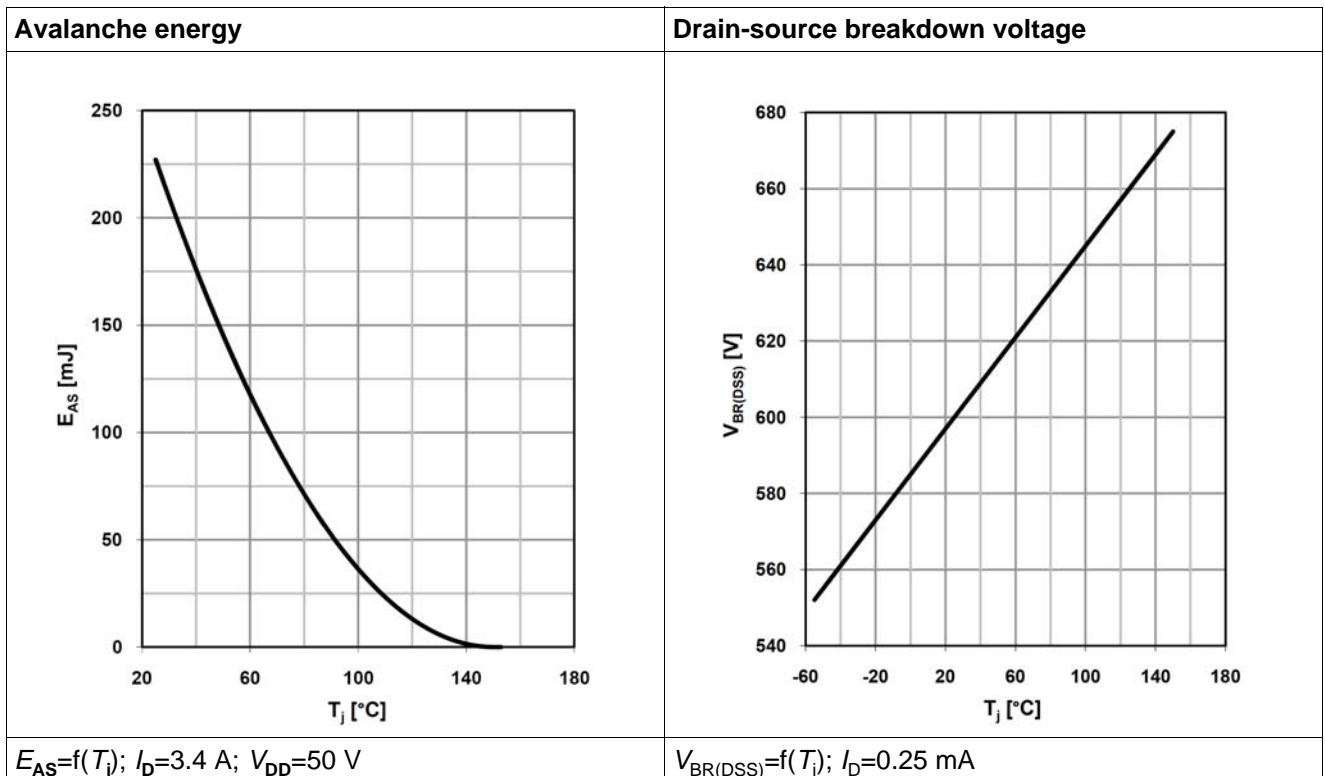


Table 14

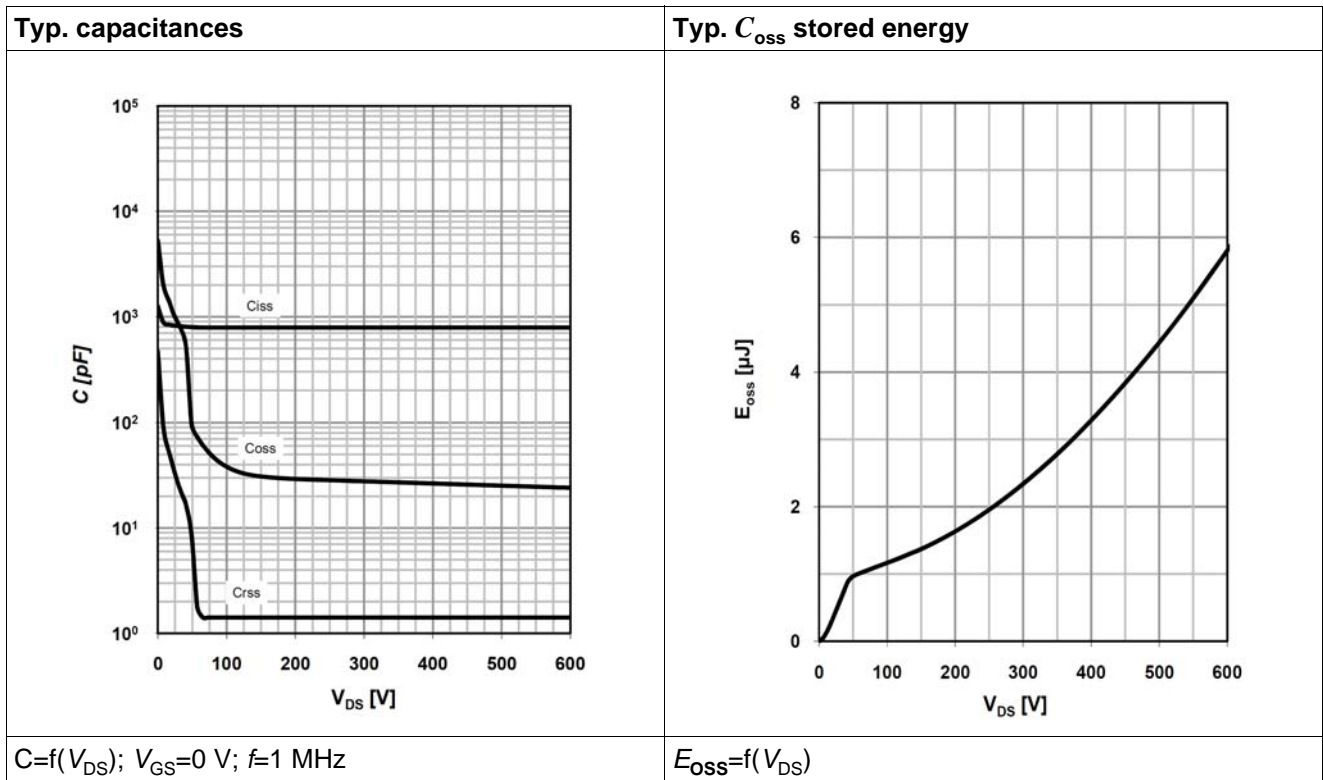
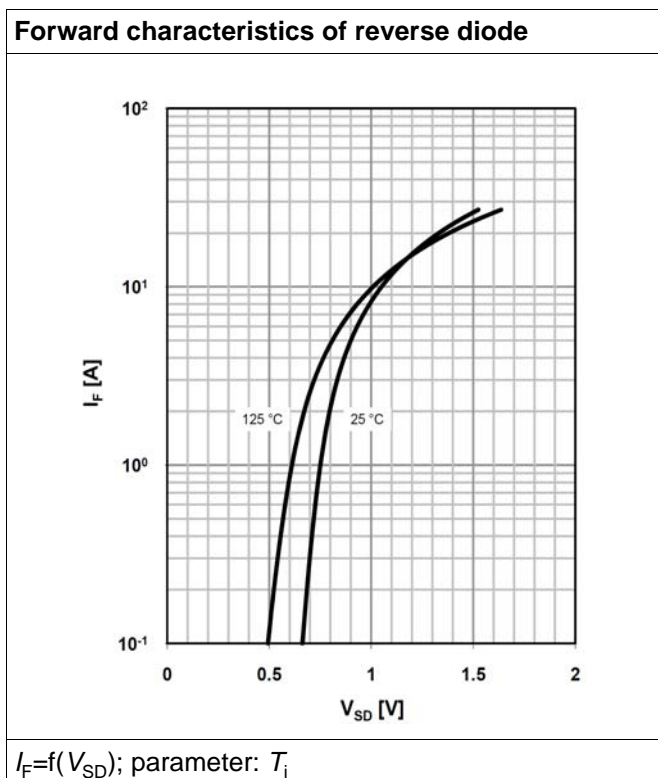


Table 15



## 6 Test circuits

Table 16 Switching times test circuit and waveform for inductive load

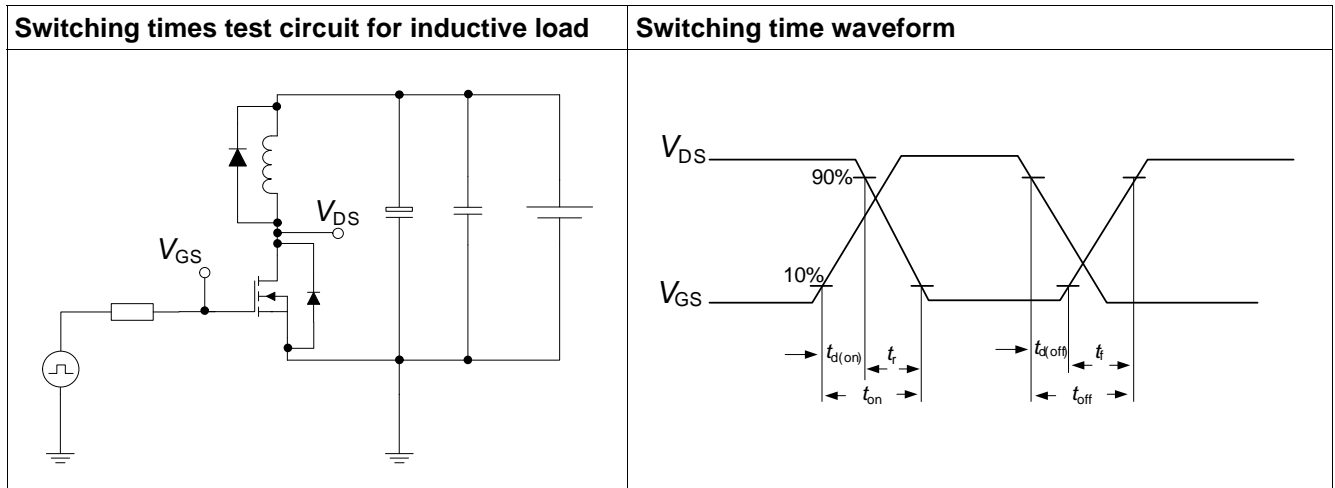


Table 17 Unclamped inductive load test circuit and waveform

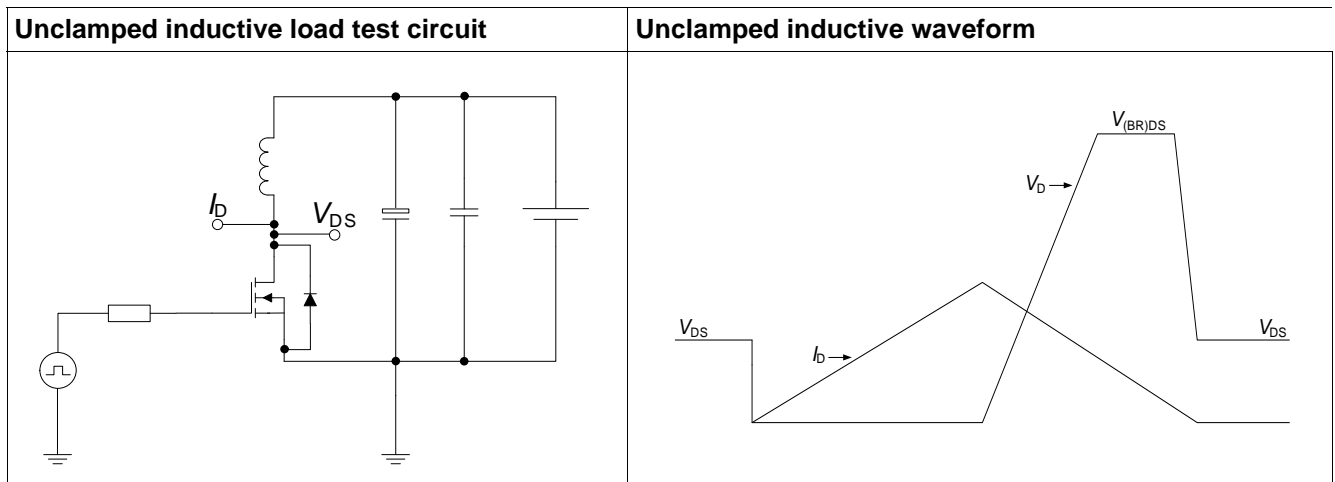
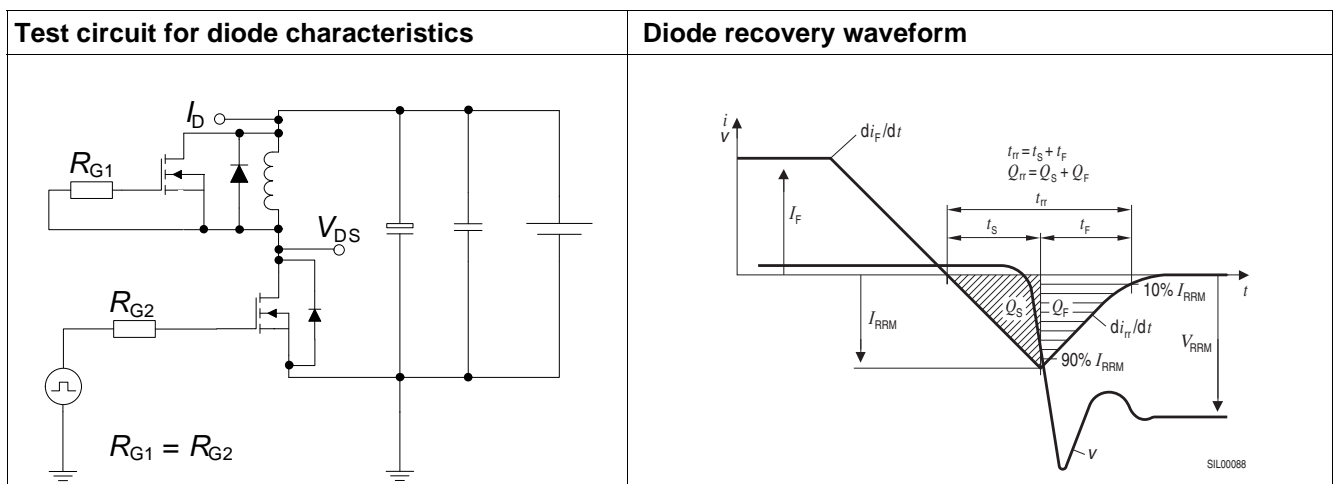
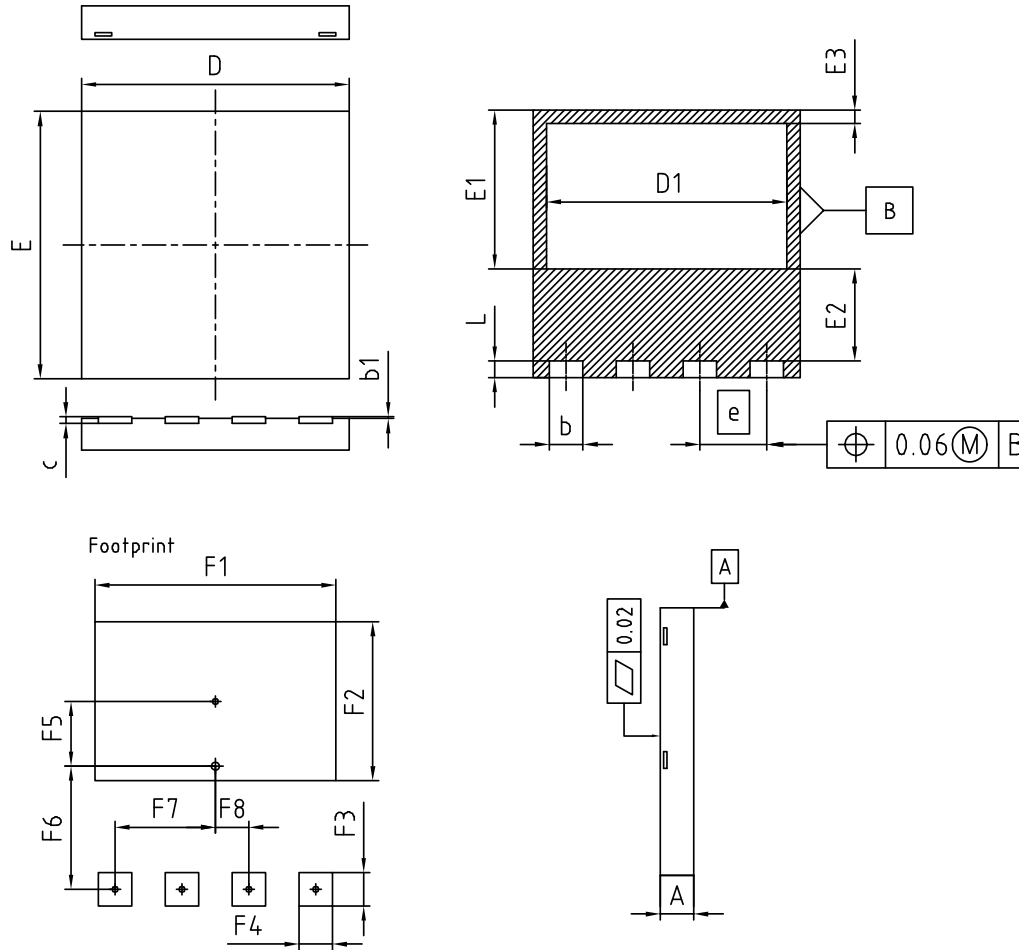


Table 18 Test circuit and waveform for diode characteristics



7 Package outlines



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	0.90	1.10	0.035	0.043
b	0.90	1.10	0.035	0.043
b1	0.00	0.05	0.000	0.002
c	0.10	0.30	0.004	0.012
D	7.90	8.10	0.311	0.319
D1	7.10	7.30	0.280	0.287
E	7.90	8.10	0.311	0.319
E1	4.65	4.85	0.183	0.191
E2	2.65	2.85	0.104	0.112
E3	0.30	0.50	0.012	0.020
e	2.00 (BSC)		0.079 (BSC)	
L	0.40	0.60	0.016	0.024
N	4		4	
F1	7.20		0.283	
F2	4.75		0.187	
F3	1.00		0.039	
F4	1.00		0.039	
F5	1.43		0.056	
F6	4.20		0.165	
F7	3.00		0.118	
F8	1.00		0.039	

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REVISION  
01

Figure 1 Outlines ThinPAK 8x8, dimensions in mm/inches

## 8 Revision History

Revision History: 2012-01-10, Rev. 2.1

Previous Revision:

Page	Subjects (major changes since last revision)
2.0	Release of final data sheet
2.1	Update package drawing and schematic

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