

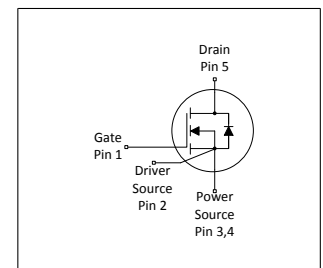
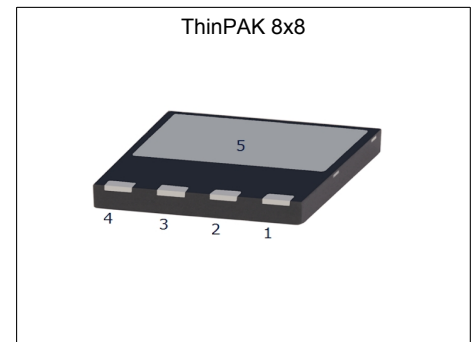
## MOSFET

### 600V CoolMOS™ CP Power Transistor

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 (J-STD20 and JESD22) for target applications (Server, Adapter)
- Pb-free plating, Halogen free

### Potential applications

Server, Adapter



**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{ds} @ T_{jmax}$	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 $di_f/dt$	400	A/ $\mu s$

Type / Ordering Code	Package	Marking	Related Links
IPL60R385CP	PG-VSON-4	6R385P	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 5.7	A	$T_C = 25^\circ\text{C}$ $T_C = 100^\circ\text{C}$
Pulsed drain current <sup>2)</sup>	$I_{D,pulse}$	-	-	27	A	$T_C=25^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	227	mJ	$I_D=3.4\text{ A}; V_{DD} = 50\text{ V}$
Avalanche energy, repetitive <sup>3)</sup>	$E_{AR}$	-	-	0.34	mJ	$I_D=3.4\text{ A}; V_{DD} = 50\text{ V}$
Avalanche current, repetitive <sup>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 -30	-	20 30	V	static; AC ( $f > 1\text{ Hz}$ )
Power dissipation	$P_{tot}$	-	-	83	W	$T_C=25^\circ\text{C}$
Operating Temperature	$T_j$	-40	-	150	$^\circ\text{C}$	-
Storage Temperature	$T_{stg}$	-40	-	125	$^\circ\text{C}$	-
Continuous diode forward current	$I_S$	-	-	9.0	A	$T_C=25^\circ\text{C}$
Diode pulse current <sup>2)</sup>	$I_{S,pulse}$	-	-	27	A	$T_C = 25^\circ\text{C}$
Reverse diode dv/dt <sup>4)</sup>	dv/dt	-	-	15	V/ns	$V_{DS} = 0\dots 400\text{ V}, I_{SD} \leq I_D, T_j=25^\circ\text{C}$ see table 8
Maximum diode commutation speed	$di_f/dt$	-	-	400	A/ $\mu\text{s}$	$V_{DS} = 0\dots 400\text{ V}, I_{SD} \leq I_D, T_j=25^\circ\text{C}$ see table 8

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	1.5	$^\circ\text{C/W}$	-
Thermal resistance, junction - ambient <sup>5)</sup>	$R_{thJA}$	-	-	45	$^\circ\text{C/W}$	SMD version, device on PCB, 6cm <sup>2</sup> cooling area
Soldering temperature, wavesoldering only allowed at leads	$T_{sold}$	-	-	260	$^\circ\text{C}$	reflow MSL2a

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

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

<sup>3)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ ; Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>4)</sup> Identical low side and high side switch with identical  $R_G$

<sup>5)</sup> 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.

### 3 Electrical characteristics

**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	$V_{DS}=V_{GS}$ , $I_D=0.34\text{ mA}$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ }^\circ\text{C}$ $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ }^\circ\text{C}$
Gate-source leakage current	$I_{GSS}$	-	-	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	0.35	0.385	$\Omega$	$V_{GS}=10\text{ V}$ , $I_D=5.2\text{ A}$ , $T_j=25\text{ }^\circ\text{C}$ $V_{GS}=10\text{ V}$ , $I_D=5.2\text{ A}$ , $T_j=150\text{ }^\circ\text{C}$
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	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=100\text{ V}$ , $f=1\text{ MHz}$
Effective output capacitance, energy related <sup>1)</sup>	$C_{o(er)}$	-	36	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=0\dots480\text{ V}$
Effective output capacitance, time related <sup>2)</sup>	$C_{o(tr)}$	-	96	-	pF	$I_D=\text{constant}$ , $V_{GS}=0\text{ V}$ , $V_{DS}=0\dots480\text{ V}$
Turn-on delay time	$t_{d(on)}$	-	10	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=5.2\text{ A}$ , $R_G=3.3\Omega$ ; see table 9
Rise time	$t_r$	-	5	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=5.2\text{ A}$ , $R_G=3.3\Omega$ ; see table 9
Turn-off delay time	$t_{d(off)}$	-	40	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=5.2\text{ A}$ , $R_G=3.3\Omega$ ; see table 9
Fall time	$t_f$	-	5	-	ns	$V_{DD}=400\text{ V}$ , $V_{GS}=13\text{ V}$ , $I_D=5.2\text{ A}$ , $R_G=3.3\Omega$ ; see table 9

**Table 6 Gate charge characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	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	-	nC	$V_{DD}=480\text{ V}$ , $I_D=5.2\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate charge total	$Q_g$	-	17	-	nC	$V_{DD}=480\text{ V}$ , $I_D=5.2\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$
Gate plateau voltage	$V_{plateau}$	-	5.0	-	V	$V_{DD}=480\text{ V}$ , $I_D=5.2\text{ A}$ , $V_{GS}=0\text{ to }10\text{ V}$

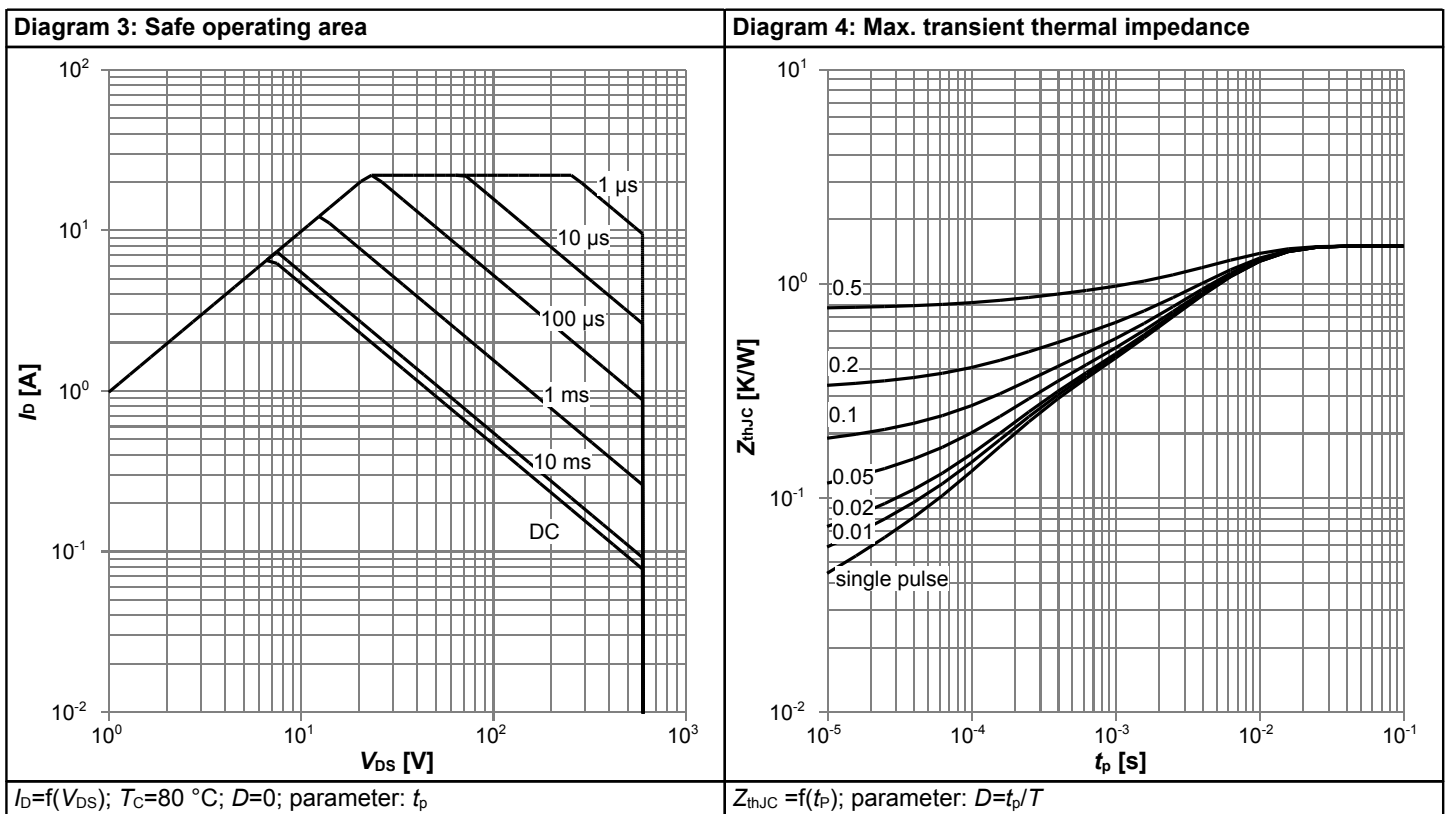
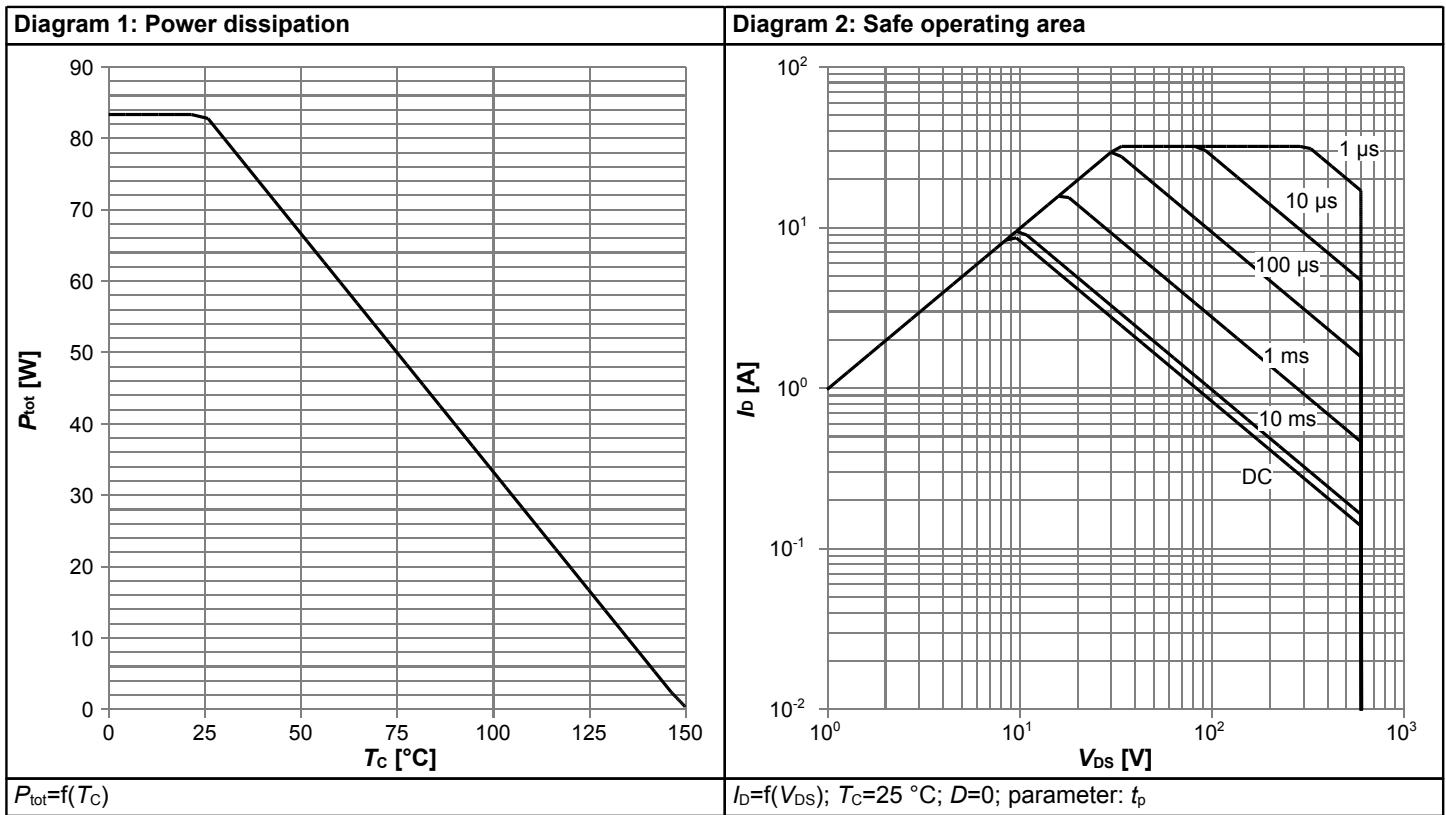
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{(BR)DSS}$

<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 80%  $V_{(BR)DSS}$

**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	$V_R=400\text{ V}$ , $I_F=5.2$ $di_F/dt=100\text{ A}/\mu\text{s}$ see table 8
Reverse recovery charge	$Q_{rr}$	-	3.1	-	$\mu\text{C}$	$V_R=400\text{ V}$ , $I_F=5.2$ $di_F/dt=100\text{ A}/\mu\text{s}$ see table 8
Peak reverse recovery current	$I_{rrm}$	-	24	-	A	$V_R=400\text{ V}$ , $I_F=5.2$ $di_F/dt=100\text{ A}/\mu\text{s}$ see table 8

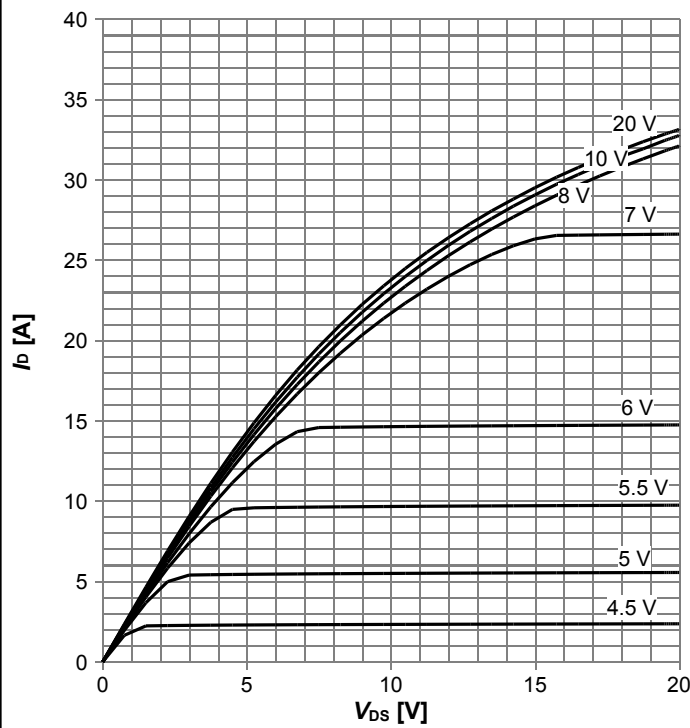
### 4 Electrical characteristics diagrams



# 600V CoolMOS™ CP Power Transistor

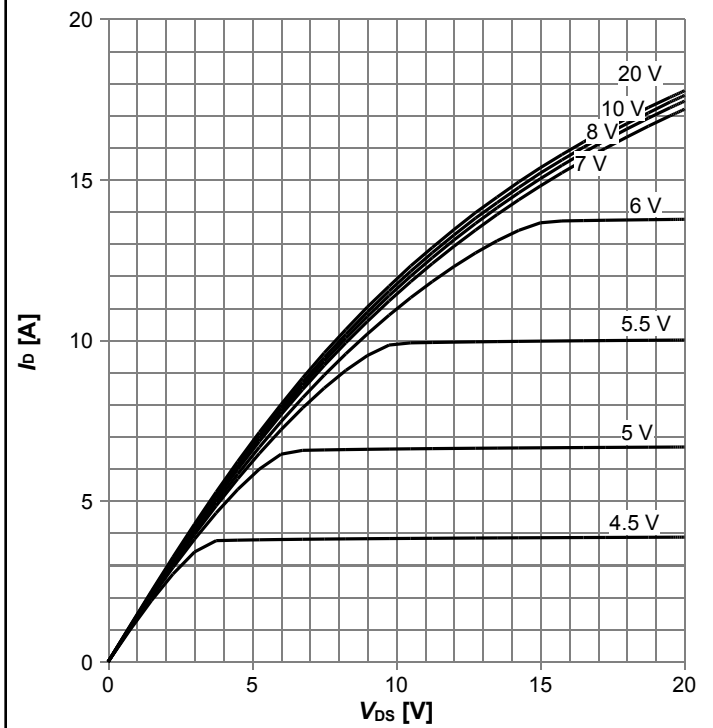
## IPL60R385CP

Diagram 5: Typ. output characteristics



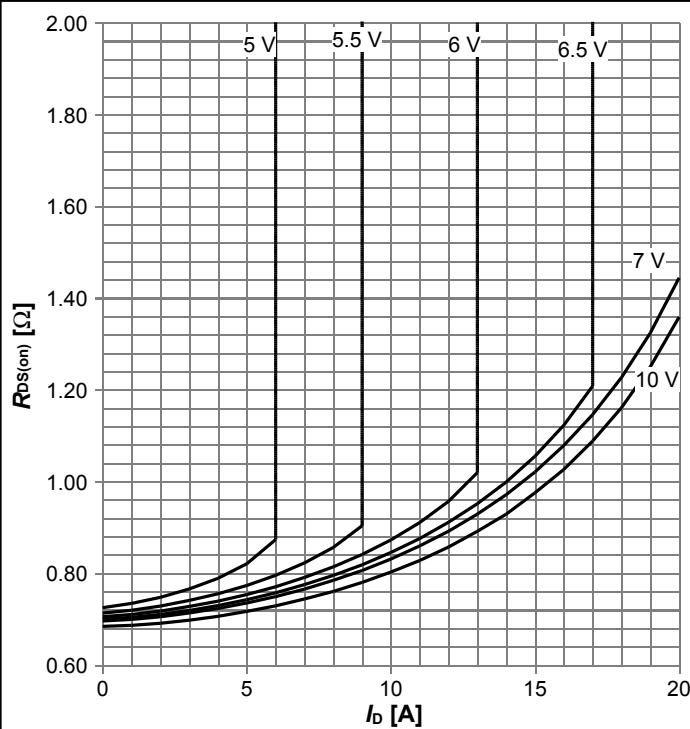
$I_D=f(V_{DS})$ ;  $T_j=25\text{ }^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



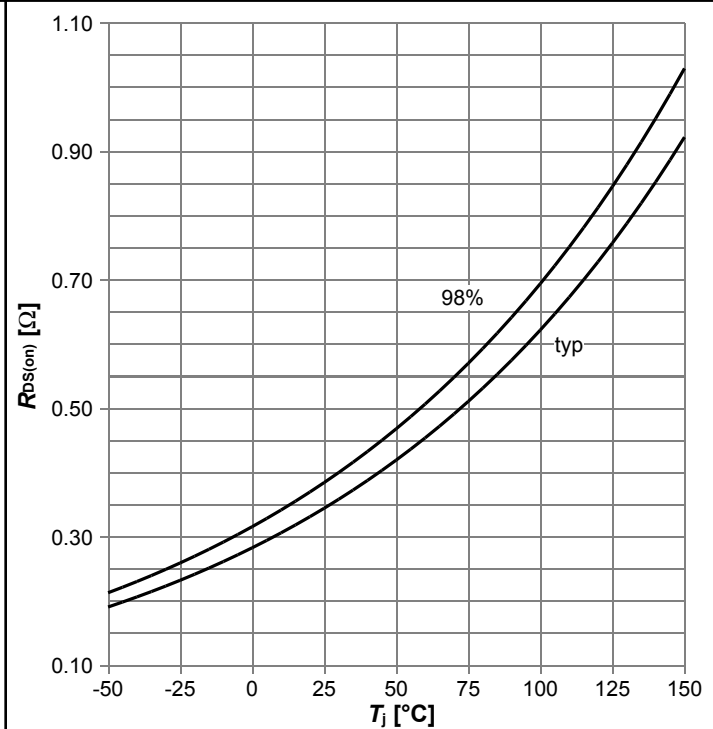
$I_D=f(V_{DS})$ ;  $T_j=125\text{ }^\circ\text{C}$ ; parameter:  $V_{GS}$

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



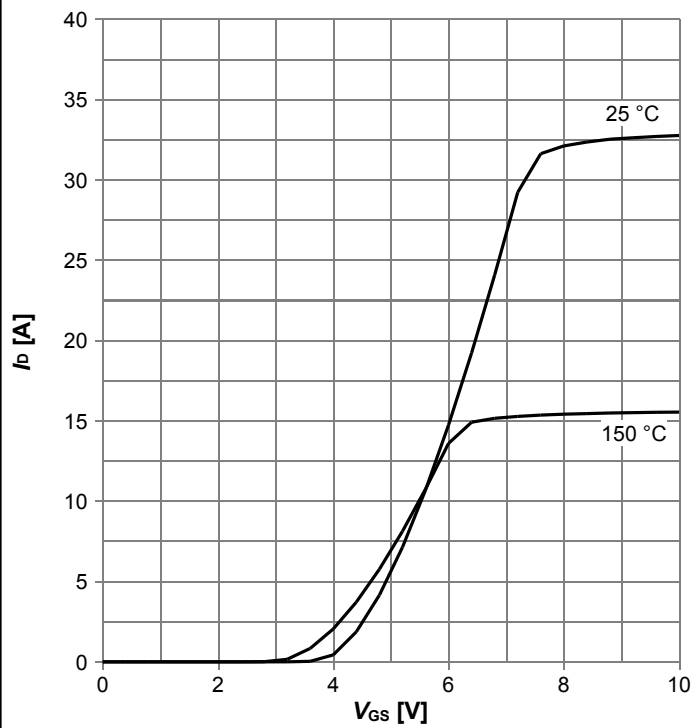
$R_{DS(on)}=f(I_D)$ ;  $T_j=125\text{ }^\circ\text{C}$ ; parameter:  $V_{GS}$

Diagram 8: Drain-source on-state resistance



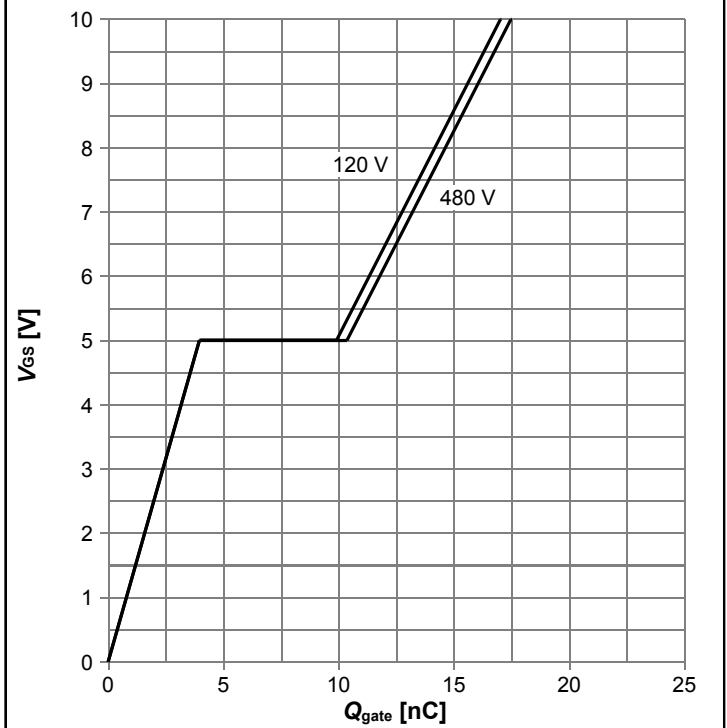
$R_{DS(on)}=f(T_j)$ ;  $I_D=5.2\text{ A}$ ;  $V_{GS}=10\text{ V}$

**Diagram 9: Typ. transfer characteristics**



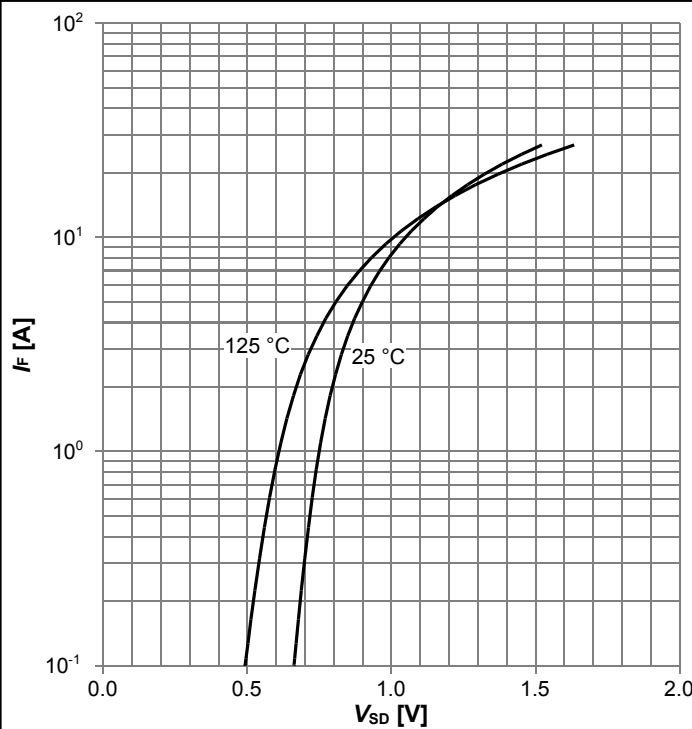
$I_D = f(V_{GS})$ ;  $V_{DS} = 20V$ ; parameter:  $T_j$

**Diagram 10: Typ. gate charge**



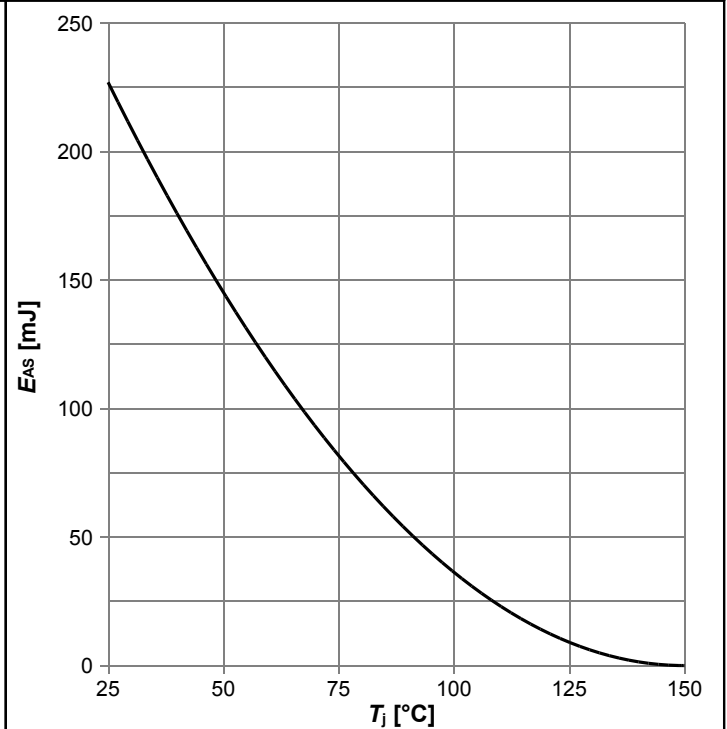
$V_{GS} = f(Q_{gate})$ ;  $I_D = 5.2 A$  pulsed; parameter:  $V_{DD}$

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



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

**Diagram 12: Avalanche energy**

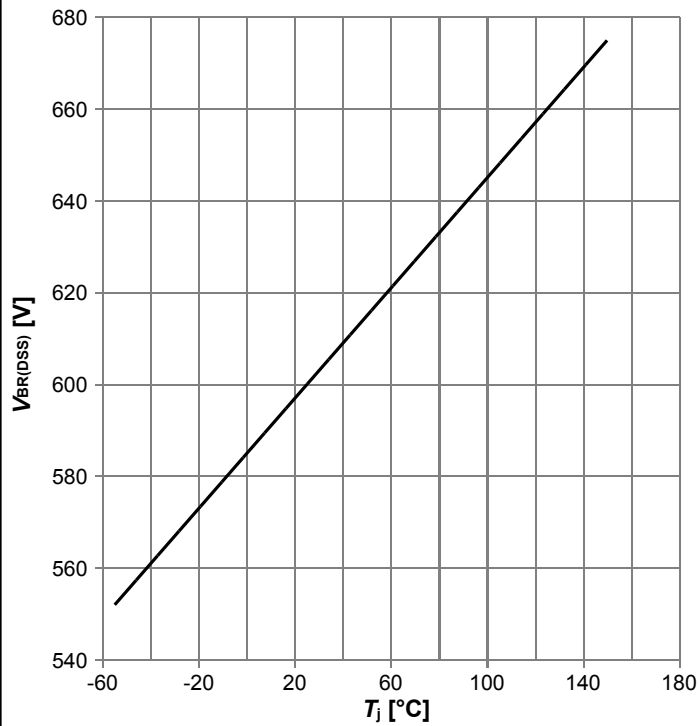


$E_{AS} = f(T_j)$ ;  $I_D = 3.4 A$ ;  $V_{DD} = 50 V$



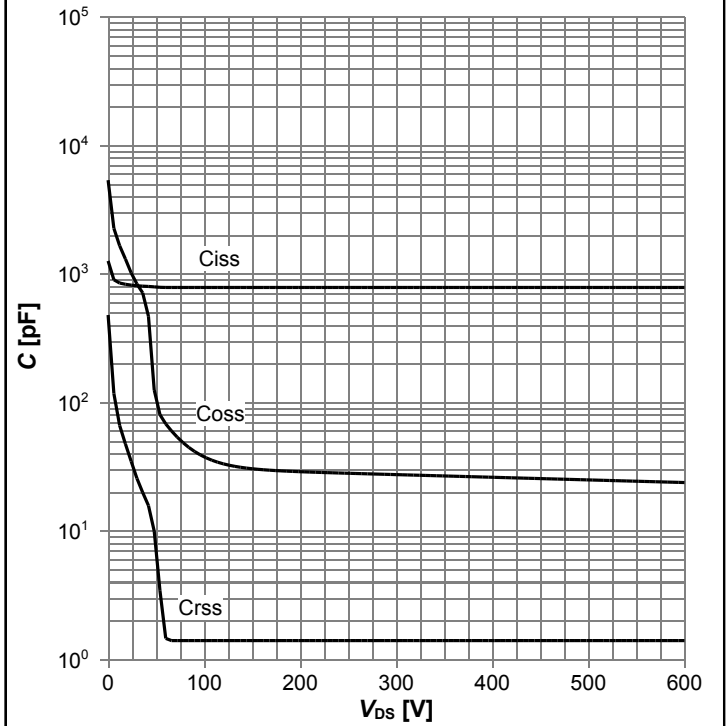
**600V CoolMOS™ CP Power Transistor**  
**IPL60R385CP**

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



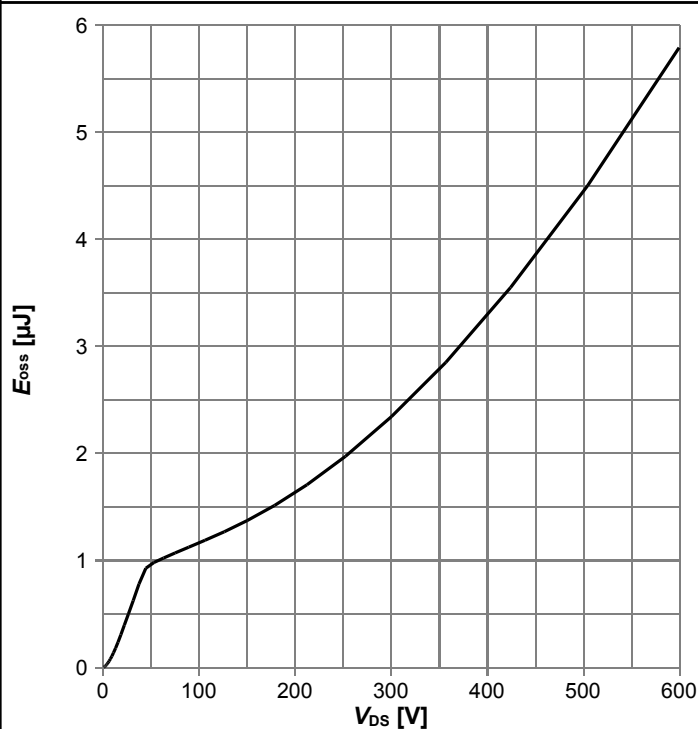
$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$

**Diagram 14: Typ. capacitances**



$C=f(V_{DS}); V_{GS}=0 \text{ V}; f=1 \text{ MHz}$

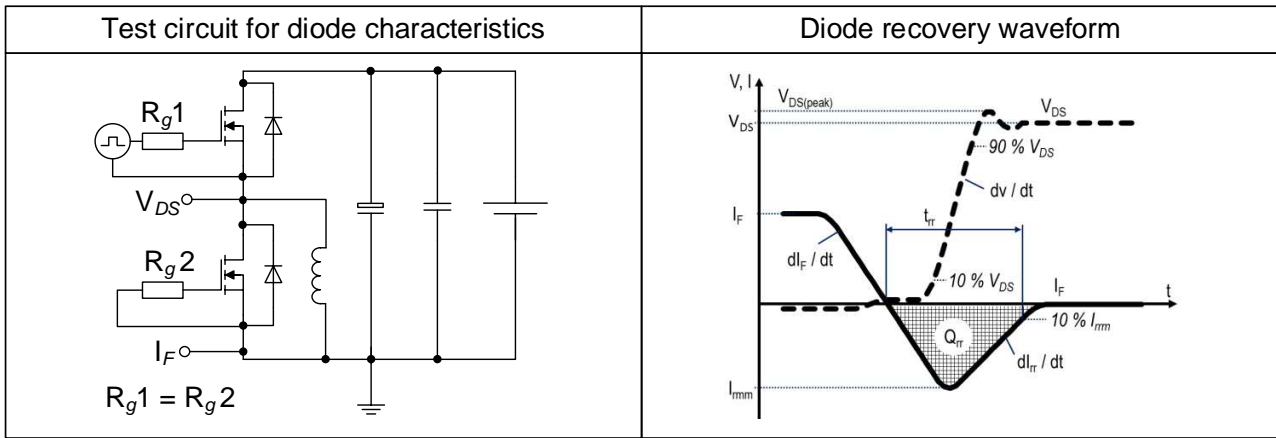
**Diagram 15: Typ. Coss stored energy**



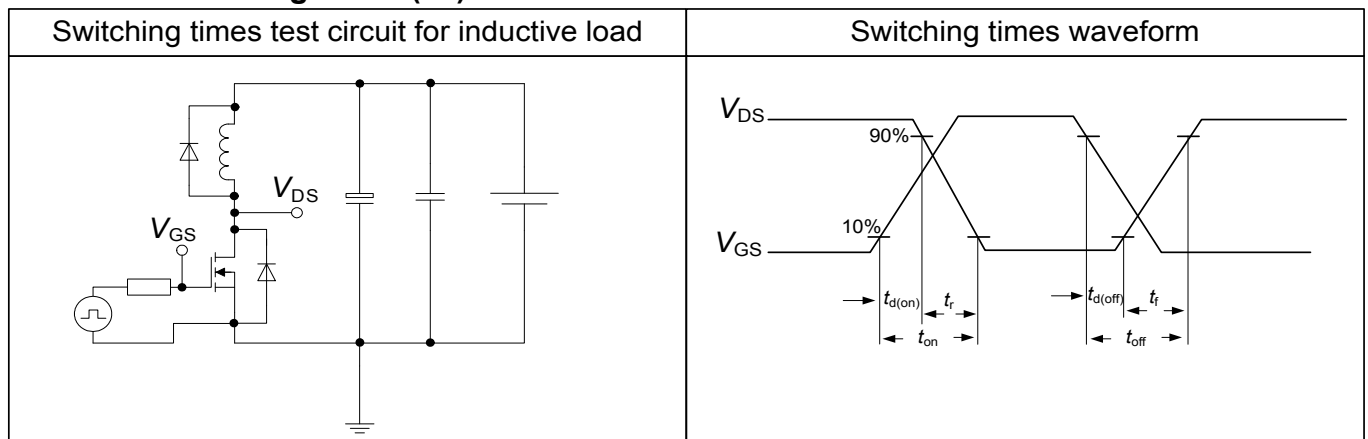
$E_{oss}=f(V_{DS})$

## 5 Test Circuits

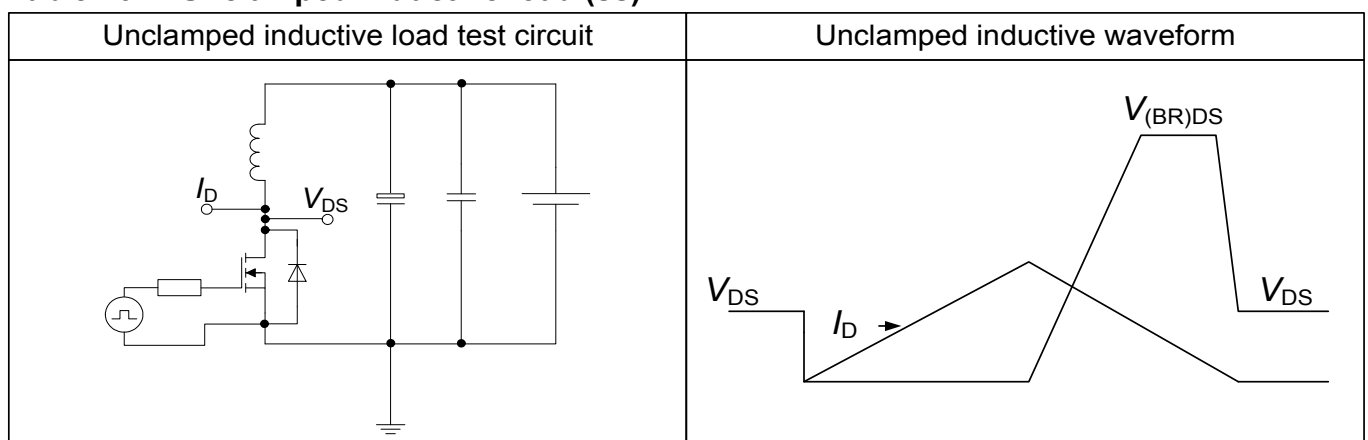
**Table 8 Diode characteristics**



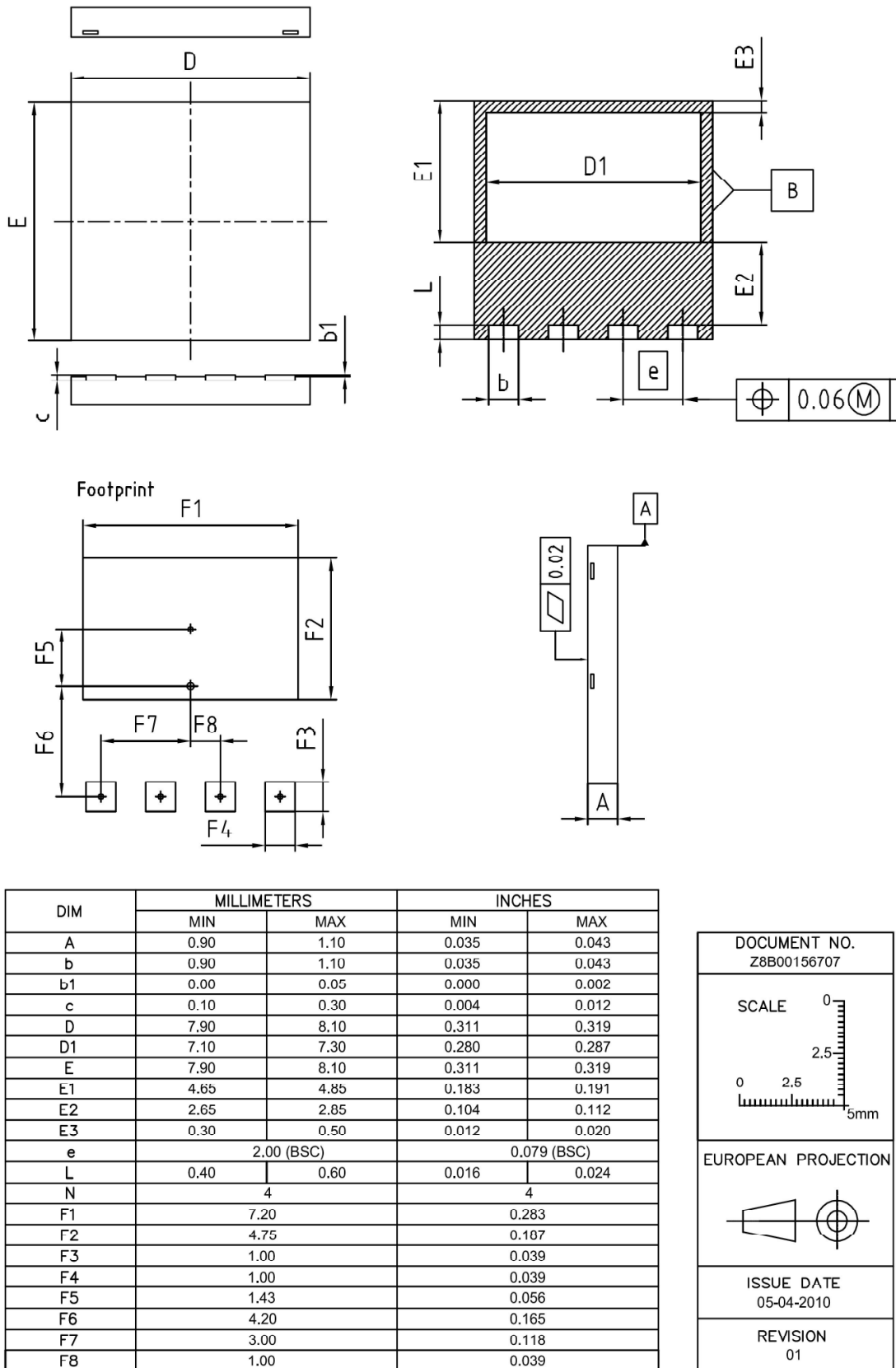
**Table 9 switching times (ss)**



**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 Webpage: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

# 600V CoolMOS™ CP Power Transistor IPL60R385CP

## Revision History

IPL60R385CP

**Revision: 2017-09-06, Rev. 2.2**

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.2	2017-09-06	Updated MSL; style updated

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