



**THE DATASHEET OF  
IPL60R185C7AUMA1**



## 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

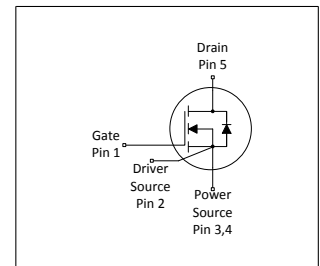
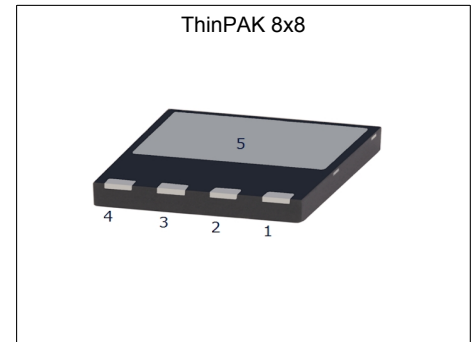
PFC stages and PWM stages (TTF, LLC) for high power/performance SMPS e.g. Computing, Server, Telecom, UPS and Solar.

*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    |
| $R_{DS(on),max}$                             | 185   | mΩ   |
| $Q_{g,typ}$                                  | 24    | nC   |
| $I_{D,pulse}$                                | 45    | A    |
| $I_{D,continuous} @ T_j < 150^\circ\text{C}$ | 21    | A    |
| $E_{oss} @ 400\text{V}$                      | 2.7   | μJ   |
| Body diode $di_f/dt$                         | 400   | A/μs |

| Type / Ordering Code | Package   | Marking | Related Links  |
|----------------------|-----------|---------|----------------|
| IPL60R185C7          | PG-VSON-4 | 60C7185 | see Appendix A |



## Table of Contents

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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> | $I_D$               | -      | -    | 13<br>9 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$   |
| Pulsed drain current <sup>2)</sup>     | $I_{D,pulse}$       | -      | -    | 45      | A                | $T_C=25^\circ\text{C}$  |
| Avalanche energy, single pulse         | $E_{AS}$            | -      | -    | 53      | mJ               | $I_D=3.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10  |
| Avalanche energy, repetitive           | $E_{AR}$            | -      | -    | 0.26    | mJ               | $I_D=3.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10  |
| Avalanche current, single pulse        | $I_{AS}$            | -      | -    | 3.3     | 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                      | $P_{tot}$           | -      | -    | 77      | 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       | $I_S$               | -      | -    | 13.0    | A                | $T_C=25^\circ\text{C}$  |
| Diode pulse current <sup>2)</sup>      | $I_{S,pulse}$       | -      | -    | 45      | A                | $T_C=25^\circ\text{C}$  |
| Reverse diode dv/dt <sup>3)</sup>      | dv/dt               | -      | -    | 15      | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 5.2\text{A}$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Maximum diode commutation speed        | di <sub>F</sub> /dt | -      | -    | 400     | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq 5.2\text{A}$ , $T_j=25^\circ\text{C}$<br>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                    | $R_{thJC}$ | -      | -    | 1.617 | °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             | $V_{DS}=V_{GS}$ , $I_D=0.26\text{mA}$   |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -              | 1          | $\mu\text{A}$ | $V_{DS}=600$ , $V_{GS}=0\text{V}$ , $T_j=25^\circ\text{C}$<br>$V_{DS}=600$ , $V_{GS}=0\text{V}$ , $T_j=150^\circ\text{C}$             |
| Gate-source leakage current      | $I_{GSS}$     | -      | -              | 100        | nA            | $V_{GS}=20\text{V}$ , $V_{DS}=0\text{V}$  |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.159<br>0.356 | 0.185<br>- | $\Omega$      | $V_{GS}=10\text{V}$ , $I_D=5.3\text{A}$ , $T_j=25^\circ\text{C}$<br>$V_{GS}=10\text{V}$ , $I_D=5.3\text{A}$ , $T_j=150^\circ\text{C}$ |
| Gate resistance                  | $R_G$         | -      | 0.85           | -          | $\Omega$      | $f=1\text{MHz}$ , open drain  |

**Table 5 Dynamic characteristics**

| Parameter  | Symbol       | Values |      |      | Unit | Note / Test Condition  |
|--|--------------|--------|------|------|------|--|
|  |              | Min.   | Typ. | Max. |      |  |
| Input capacitance  | $C_{iss}$    | -      | 1080 | -    | pF   | $V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$                                      |
| Output capacitance   | $C_{oss}$    | -      | 18   | -    | pF   | $V_{GS}=0\text{V}$ , $V_{DS}=400\text{V}$ , $f=250\text{kHz}$                                      |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 34   | -    | pF   | $V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$  |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 349  | -    | pF   | $I_D=\text{constant}$ , $V_{GS}=0\text{V}$ , $V_{DS}=0\dots400\text{V}$                            |
| Turn-on delay time   | $t_{d(on)}$  | -      | 9    | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=5.3\text{A}$ ,<br>$R_G=10.0\Omega$ ; see table 9 |
| Rise time  | $t_r$        | -      | 4    | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=5.3\text{A}$ ,<br>$R_G=10.0\Omega$ ; see table 9 |
| Turn-off delay time  | $t_{d(off)}$ | -      | 46   | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=5.3\text{A}$ ,<br>$R_G=10.0\Omega$ ; see table 9 |
| Fall time  | $t_f$        | -      | 6    | -    | ns   | $V_{DD}=400\text{V}$ , $V_{GS}=13\text{V}$ , $I_D=5.3\text{A}$ ,<br>$R_G=10.0\Omega$ ; see table 9 |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol               | Values |      |      | Unit | Note / Test Condition   |
|-----------------------|----------------------|--------|------|------|------|---|
|                       |                      | Min.   | Typ. | Max. |      |   |
| Gate to source charge | $Q_{GS}$             | -      | 5    | -    | nC   | $V_{DD}=400\text{V}$ , $I_D=5.3\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |
| Gate to drain charge  | $Q_{gd}$             | -      | 8    | -    | nC   | $V_{DD}=400\text{V}$ , $I_D=5.3\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |
| Gate charge total     | $Q_g$                | -      | 24   | -    | nC   | $V_{DD}=400\text{V}$ , $I_D=5.3\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |
| Gate plateau voltage  | $V_{\text{plateau}}$ | -      | 5.0  | -    | V    | $V_{DD}=400\text{V}$ , $I_D=5.3\text{A}$ , $V_{GS}=0$ to $10\text{V}$ |

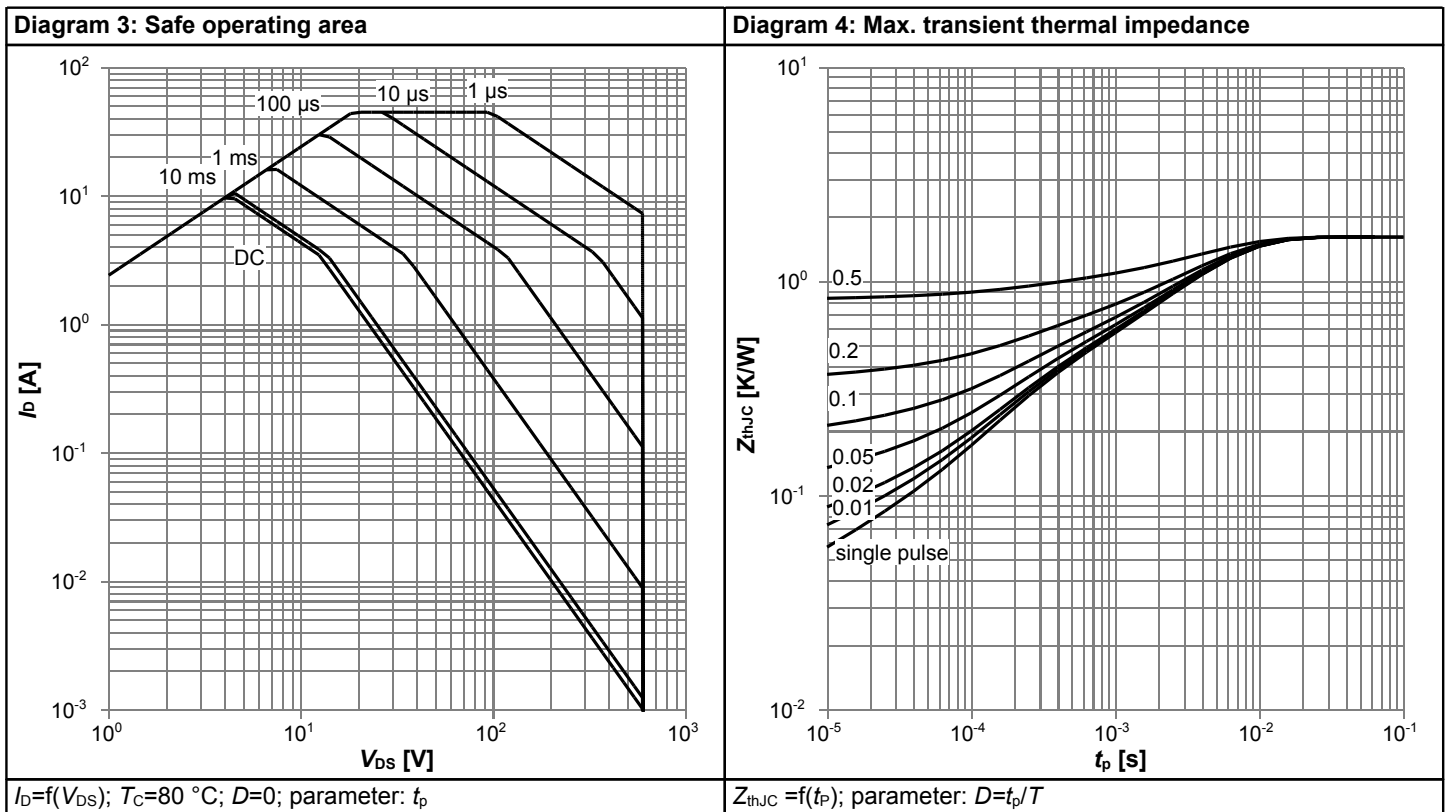
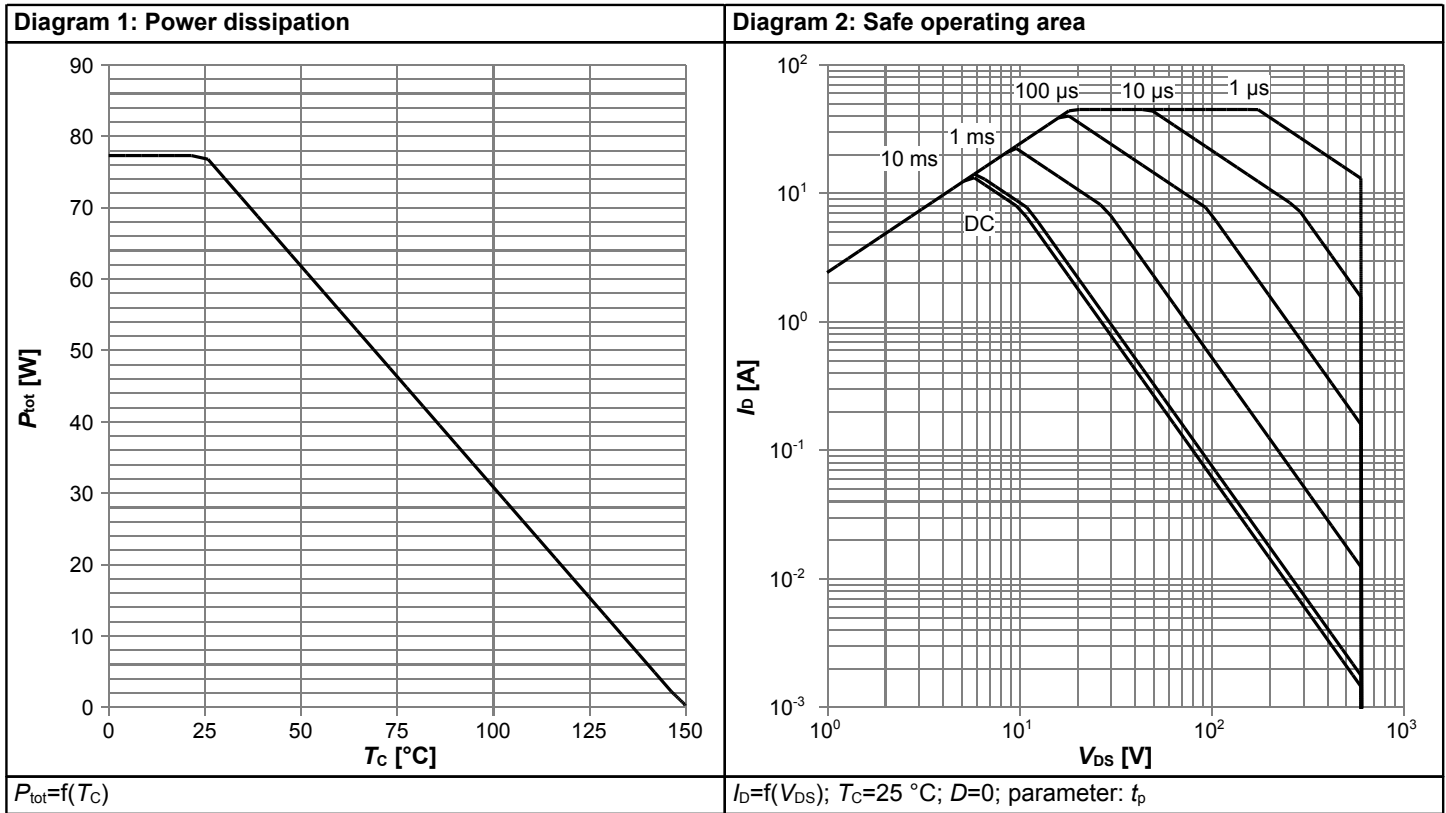
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<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

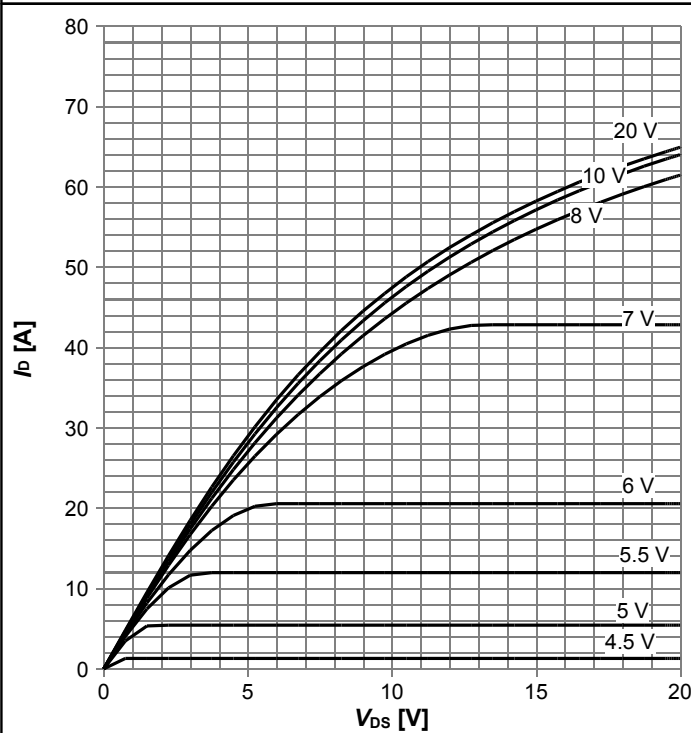
**Table 7 Reverse diode characteristics**

| Parameter                     | Symbol    | Values |      |      | Unit    | Note / Test Condition                                     |
|-------------------------------|-----------|--------|------|------|---------|---|
|                               |           | Min.   | Typ. | Max. |         |   |
| Diode forward voltage         | $V_{SD}$  | -      | 0.9  | -    | V       | $V_{GS}=0V, I_F=5.3A, T_j=25^\circ C$                     |
| Reverse recovery time         | $t_{rr}$  | -      | 290  | -    | ns      | $V_R=400V, I_F=5.3A, di_F/dt=100A/\mu s$ ;<br>see table 8 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 2.9  | -    | $\mu C$ | $V_R=400V, I_F=5.3A, di_F/dt=100A/\mu s$ ;<br>see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 21   | -    | A       | $V_R=400V, I_F=5.3A, di_F/dt=100A/\mu s$ ;<br>see table 8 |

### 4 Electrical characteristics diagrams

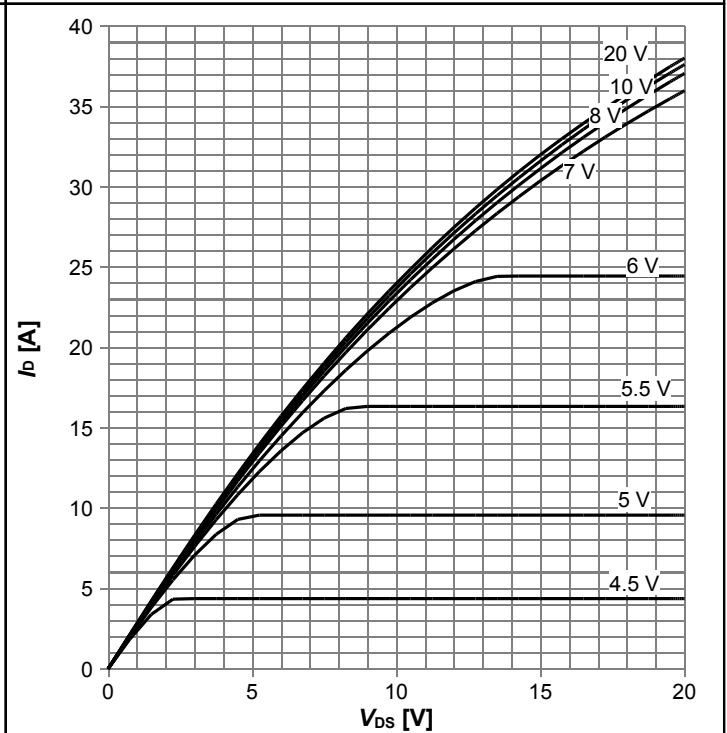


**Diagram 5: Typ. output characteristics**



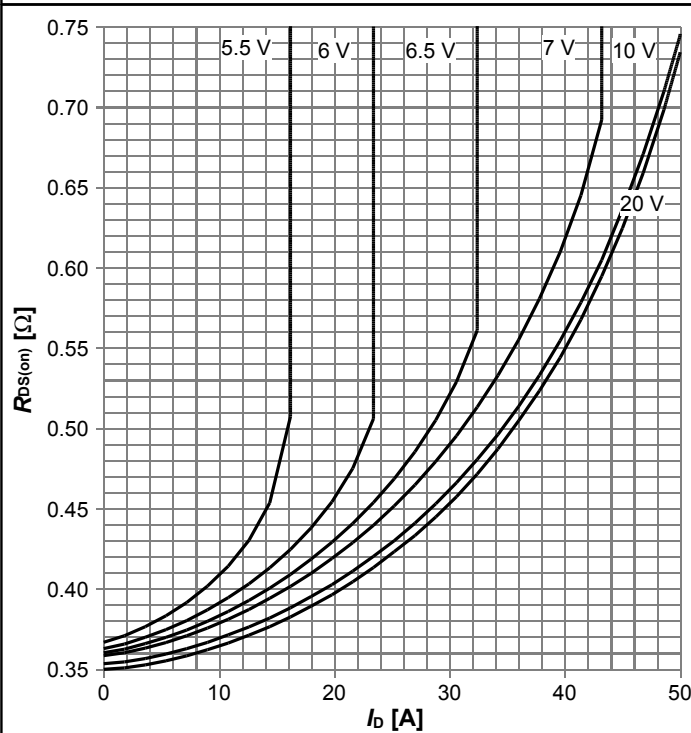
$I_D=f(V_{DS}); T_j=25\text{ °C}; \text{parameter: } V_{GS}$

**Diagram 6: Typ. output characteristics**



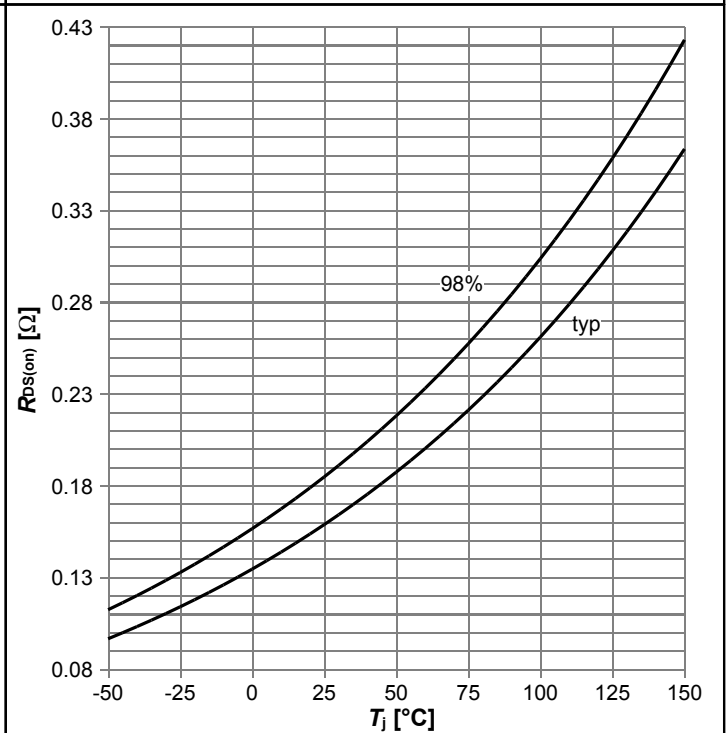
$I_D=f(V_{DS}); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

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



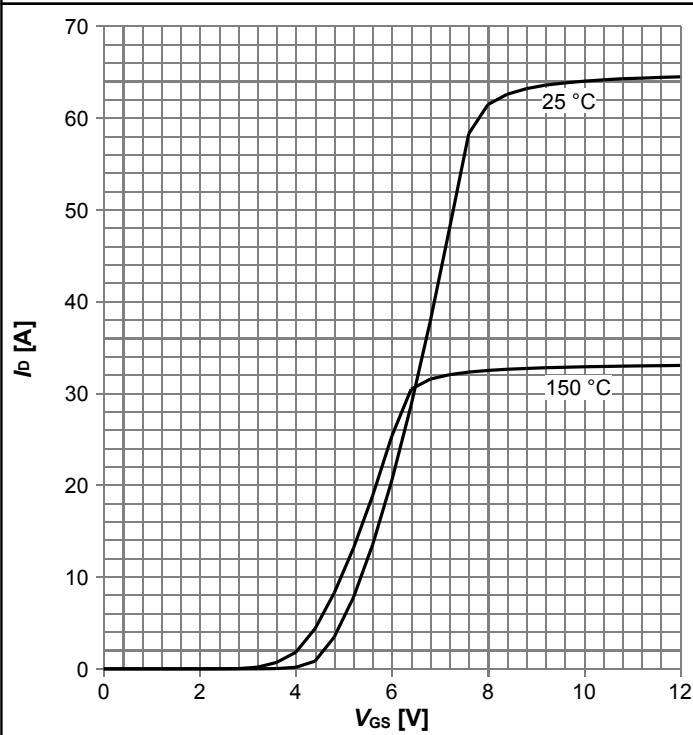
$R_{DS(on)}=f(I_D); T_j=125\text{ °C}; \text{parameter: } V_{GS}$

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



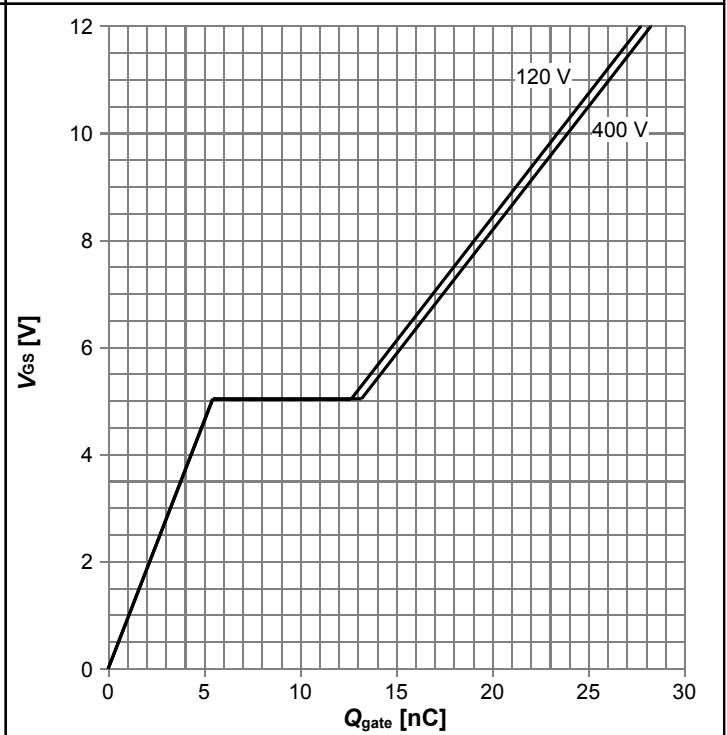
$R_{DS(on)}=f(T_j); I_D=5.3\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



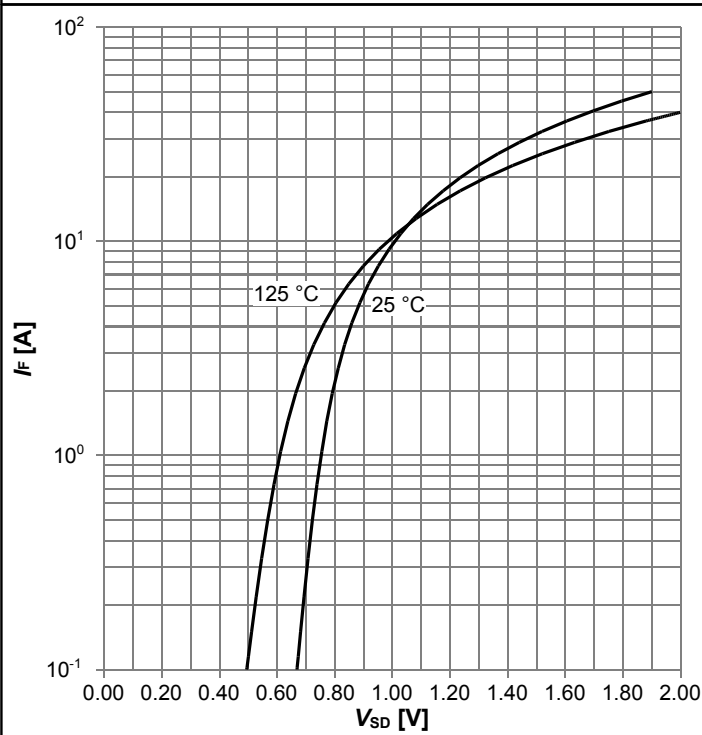
$I_D = f(V_{GS}); V_{DS} = 20V; \text{parameter: } T_j$

Diagram 10: Typ. gate charge



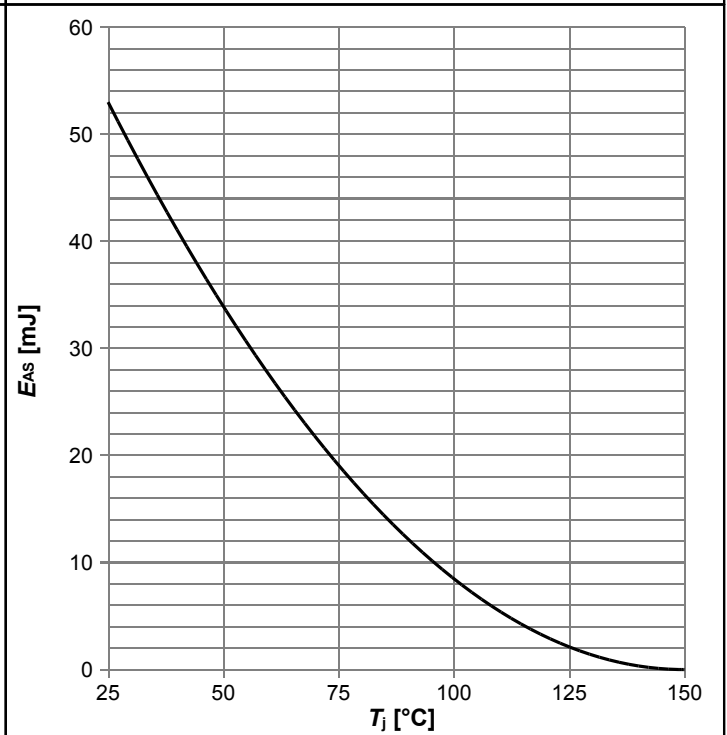
$V_{GS} = f(Q_{gate}); I_D = 5.3 \text{ A pulsed}; \text{parameter: } V_{DD}$

Diagram 11: Forward characteristics of reverse diode



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

Diagram 12: Avalanche energy

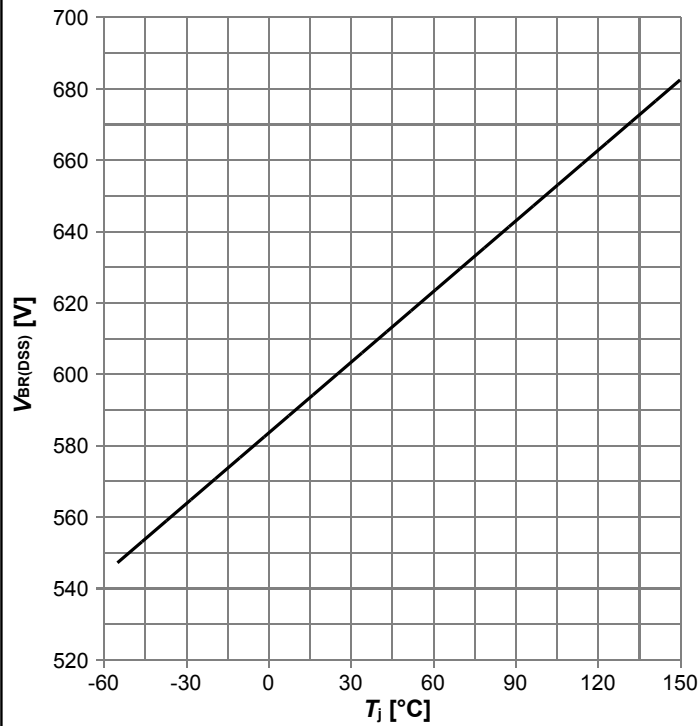


$E_{AS} = f(T_j); I_D = 3.3 \text{ A}; V_{DD} = 50 \text{ V}$

# 600V CoolMOS™ C7 Power Transistor

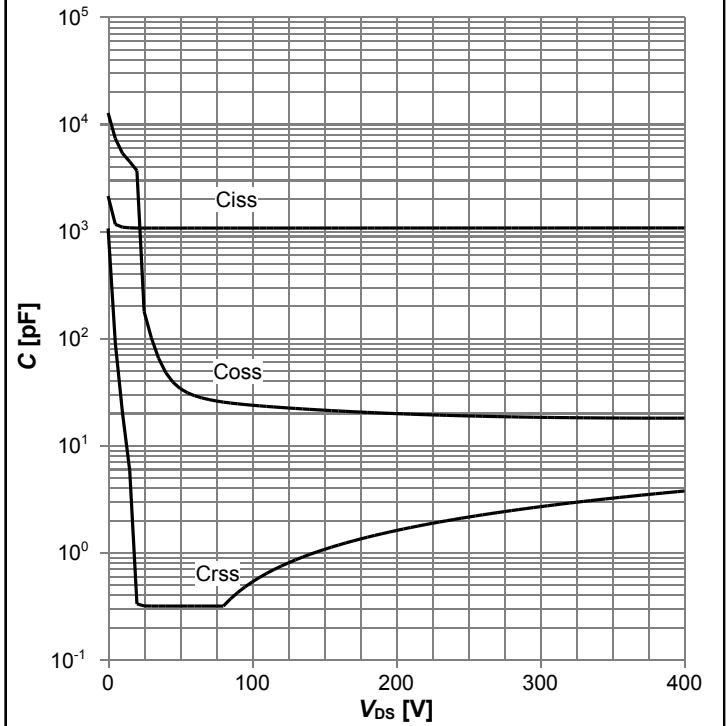
## IPL60R185C7

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



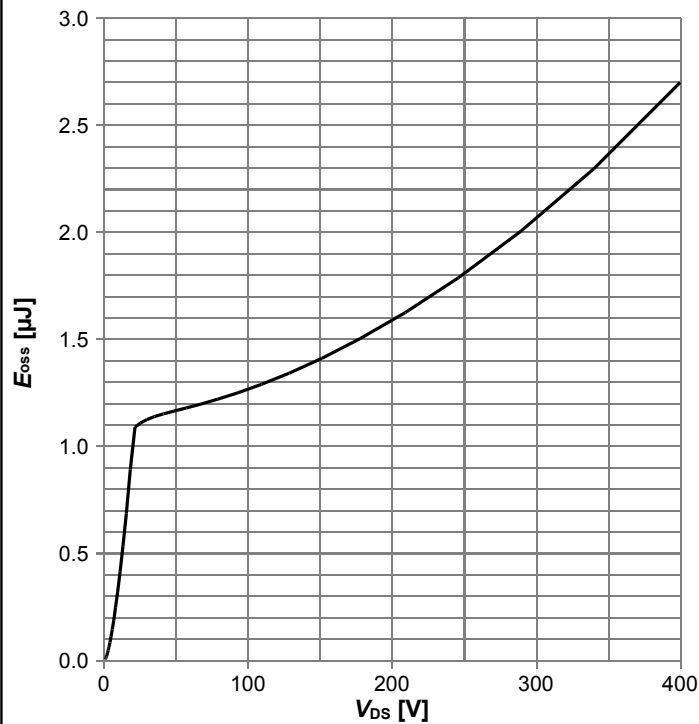
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$

**Diagram 14: Typ. capacitances**



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

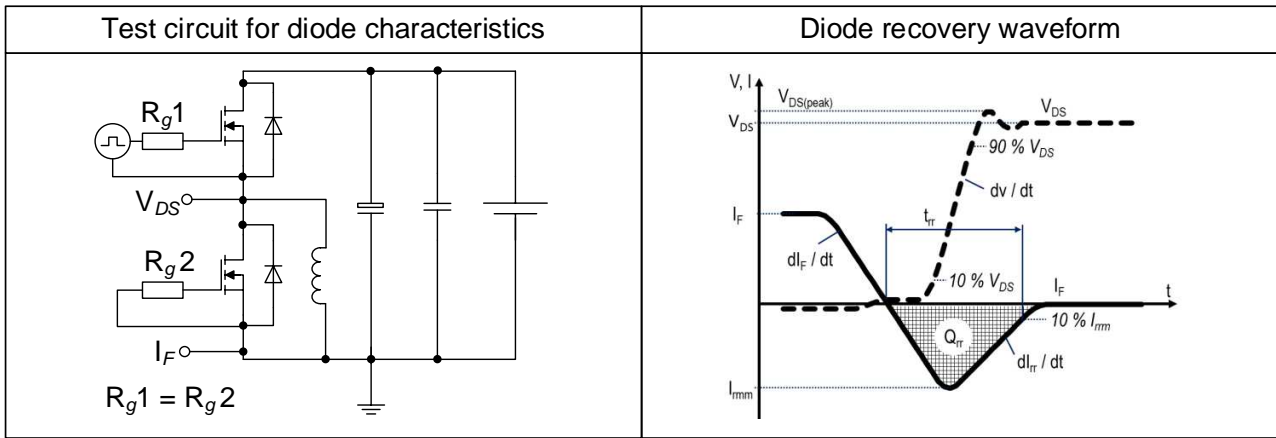
**Diagram 15: Typ. Coss stored energy**



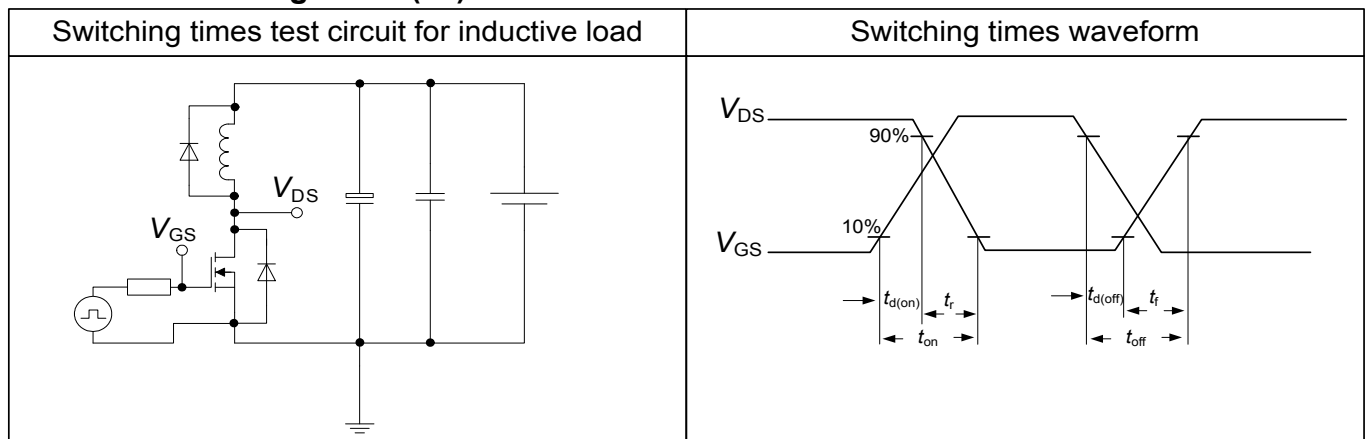
$E_{oss}=f(V_{DS})$

## 5 Test Circuits

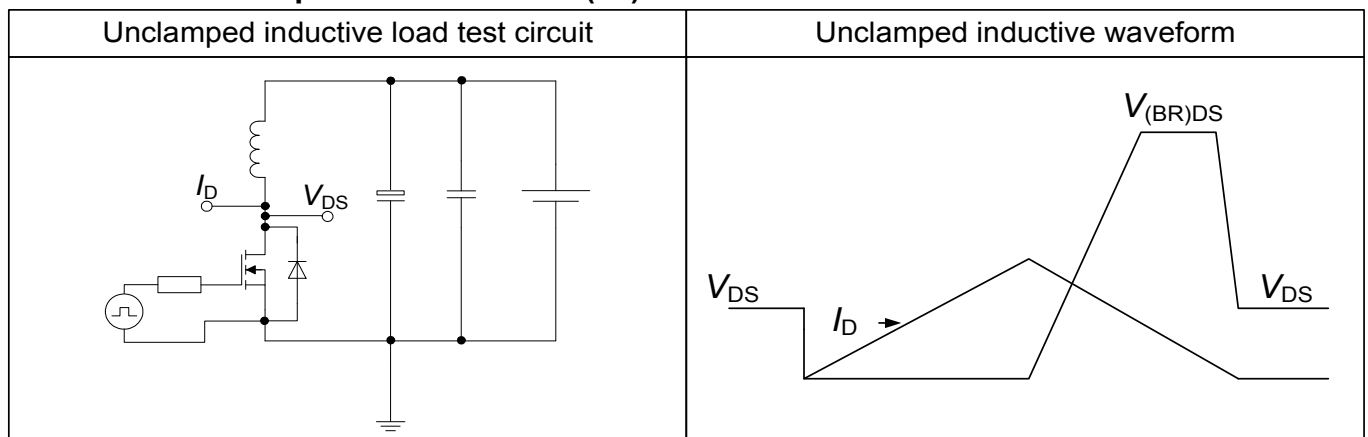
**Table 8 Diode characteristics**



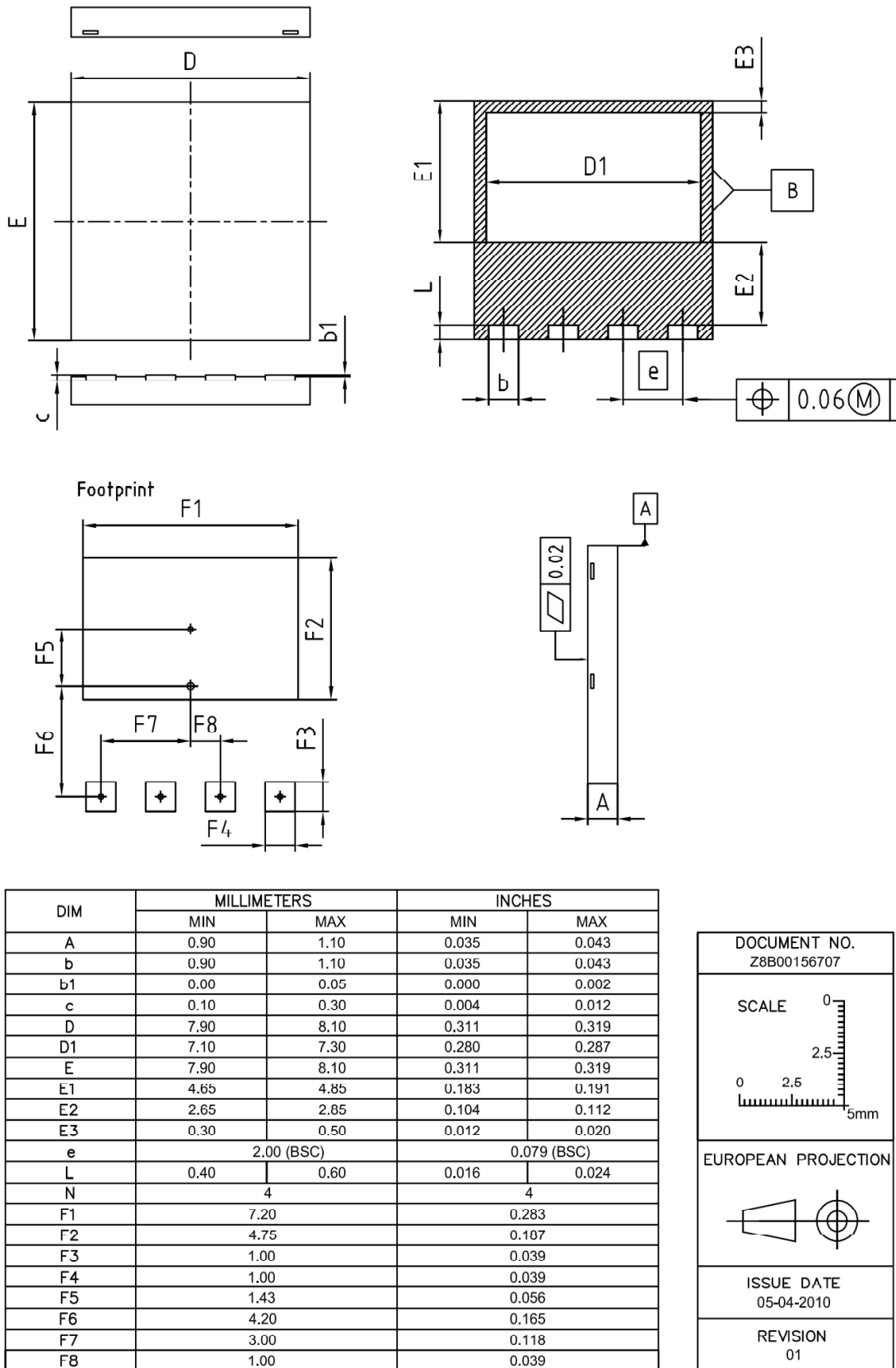
**Table 9 switching times (ss)**



**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)

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## IPL60R185C7

### Revision History

IPL60R185C7

**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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