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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> | $I_D$         | -      | -    | 19.2<br>12.1 | A                | $T_C=25^\circ\text{C}$<br>$T_C=100^\circ\text{C}$                                     |
| Pulsed drain current <sup>2)</sup>     | $I_{D,pulse}$ | -      | -    | 52           | A                | $T_C=25^\circ\text{C}$  |
| Avalanche energy, single pulse         | $E_{AS}$      | -      | -    | 419          | mJ               | $I_D=3.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                |
| Avalanche energy, repetitive           | $E_{AR}$      | -      | -    | 0.63         | mJ               | $I_D=3.3\text{A}$ ; $V_{DD}=50\text{V}$ ; see table 10                                |
| Avalanche current, repetitive          | $I_{AR}$      | -      | -    | 3.3          | A                | -   |
| MOSFET dv/dt ruggedness                | dv/dt         | -      | -    | 100          | 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                      | $P_{tot}$     | -      | -    | 151          | W                | $T_C=25^\circ\text{C}$  |
| Storage temperature                    | $T_{stg}$     | -40    | -    | 150          | $^\circ\text{C}$ | -   |
| Operating junction temperature         | $T_j$         | -40    | -    | 150          | $^\circ\text{C}$ | -   |
| Continuous diode forward current       | $I_S$         | -      | -    | 16.6         | A                | $T_C=25^\circ\text{C}$  |
| Diode pulse current <sup>2)</sup>      | $I_{S,pulse}$ | -      | -    | 52           | A                | $T_C=25^\circ\text{C}$  |
| Reverse diode dv/dt <sup>3)</sup>      | dv/dt         | -      | -    | 15           | V/ns             | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$<br>see table 8 |
| Maximum diode commutation speed        | $di_f/dt$     | -      | -    | 500          | A/ $\mu\text{s}$ | $V_{DS}=0\dots400\text{V}$ , $I_{SD}\leq I_S$ , $T_j=25^\circ\text{C}$<br>see table 8 |

<sup>1)</sup> Limited by  $T_{j,max}$ . Maximum duty cycle  $D=0.75$

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

<sup>3)</sup> Identical low side and high side switch with identical  $R_\theta$

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

| Parameter  | Symbol     | Values |      |      | Unit | Note / Test Condition   |
|--|------------|--------|------|------|------|---|
|  |            | Min.   | Typ. | Max. |      |   |
| Thermal resistance, junction - case                    | $R_{thJC}$ | -      | -    | 0.83 | °C/W | -   |
| Thermal resistance, junction - ambient                 | $R_{thJA}$ | -      | -    | 62   | °C/W | device on PCB, minimal footprint  |
| Thermal resistance, junction - ambient for SMD version | $R_{thJA}$ | -      | -    | 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. |
| Soldering temperature, wave & reflow soldering allowed | $T_{sold}$ | -      | -    | 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             | $V_{GS}=0V, I_D=1mA$  |
| Gate threshold voltage           | $V_{(GS)th}$  | 3.5    | 4.0            | 4.5        | V             | $V_{DS}=V_{GS}, I_D=0.63mA$   |
| Zero gate voltage drain current  | $I_{DSS}$     | -      | -              | 1          | $\mu\text{A}$ | $V_{DS}=600, V_{GS}=0V, T_j=25^\circ\text{C}$<br>$V_{DS}=600, V_{GS}=0V, T_j=150^\circ\text{C}$ |
| Gate-source leakage current      | $I_{GSS}$     | -      | -              | 100        | nA            | $V_{GS}=20V, V_{DS}=0V$   |
| Drain-source on-state resistance | $R_{DS(on)}$  | -      | 0.189<br>0.491 | 0.210<br>- | $\Omega$      | $V_{GS}=10V, I_D=7.6A, T_j=25^\circ\text{C}$<br>$V_{GS}=10V, I_D=7.6A, T_j=150^\circ\text{C}$   |
| Gate resistance                  | $R_G$         | -      | 3.4            | -          | $\Omega$      | $f=1\text{MHz}$ , open drain  |

**Table 5 Dynamic characteristics**

| Parameter  | Symbol       | Values |      |      | Unit | Note / Test Condition   |
|--|--------------|--------|------|------|------|---|
|  |              | Min.   | Typ. | Max. |      |   |
| Input capacitance  | $C_{iss}$    | -      | 1750 | -    | pF   | $V_{GS}=0V, V_{DS}=100V, f=1\text{MHz}$                               |
| Output capacitance   | $C_{oss}$    | -      | 76   | -    | pF   | $V_{GS}=0V, V_{DS}=100V, f=1\text{MHz}$                               |
| Effective output capacitance, energy related <sup>1)</sup> | $C_{o(er)}$  | -      | 61   | -    | pF   | $V_{GS}=0V, V_{DS}=0\dots400V$  |
| Effective output capacitance, time related <sup>2)</sup>   | $C_{o(tr)}$  | -      | 264  | -    | pF   | $I_D=\text{constant}, V_{GS}=0V, V_{DS}=0\dots400V$                   |
| Turn-on delay time   | $t_{d(on)}$  | -      | 15   | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=9.5A,$<br>$R_G=3.4\Omega$ ; see table 9 |
| Rise time  | $t_r$        | -      | 8    | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=9.5A,$<br>$R_G=3.4\Omega$ ; see table 9 |
| Turn-off delay time  | $t_{d(off)}$ | -      | 45   | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=9.5A,$<br>$R_G=3.4\Omega$ ; see table 9 |
| Fall time  | $t_f$        | -      | 7    | -    | ns   | $V_{DD}=400V, V_{GS}=13V, I_D=9.5A,$<br>$R_G=3.4\Omega$ ; see table 9 |

**Table 6 Gate charge characteristics**

| Parameter             | Symbol        | Values |      |      | Unit | Note / Test Condition                    |
|-----------------------|---------------|--------|------|------|------|--|
|                       |               | Min.   | Typ. | Max. |      |  |
| Gate to source charge | $Q_{GS}$      | -      | 11   | -    | nC   | $V_{DD}=400V, I_D=9.5A, V_{GS}=0$ to 10V |
| Gate to drain charge  | $Q_{gd}$      | -      | 13   | -    | nC   | $V_{DD}=400V, I_D=9.5A, V_{GS}=0$ to 10V |
| Gate charge total     | $Q_g$         | -      | 37   | -    | nC   | $V_{DD}=400V, I_D=9.5A, V_{GS}=0$ to 10V |
| Gate plateau voltage  | $V_{plateau}$ | -      | 6.1  | -    | V    | $V_{DD}=400V, I_D=9.5A, V_{GS}=0$ to 10V |

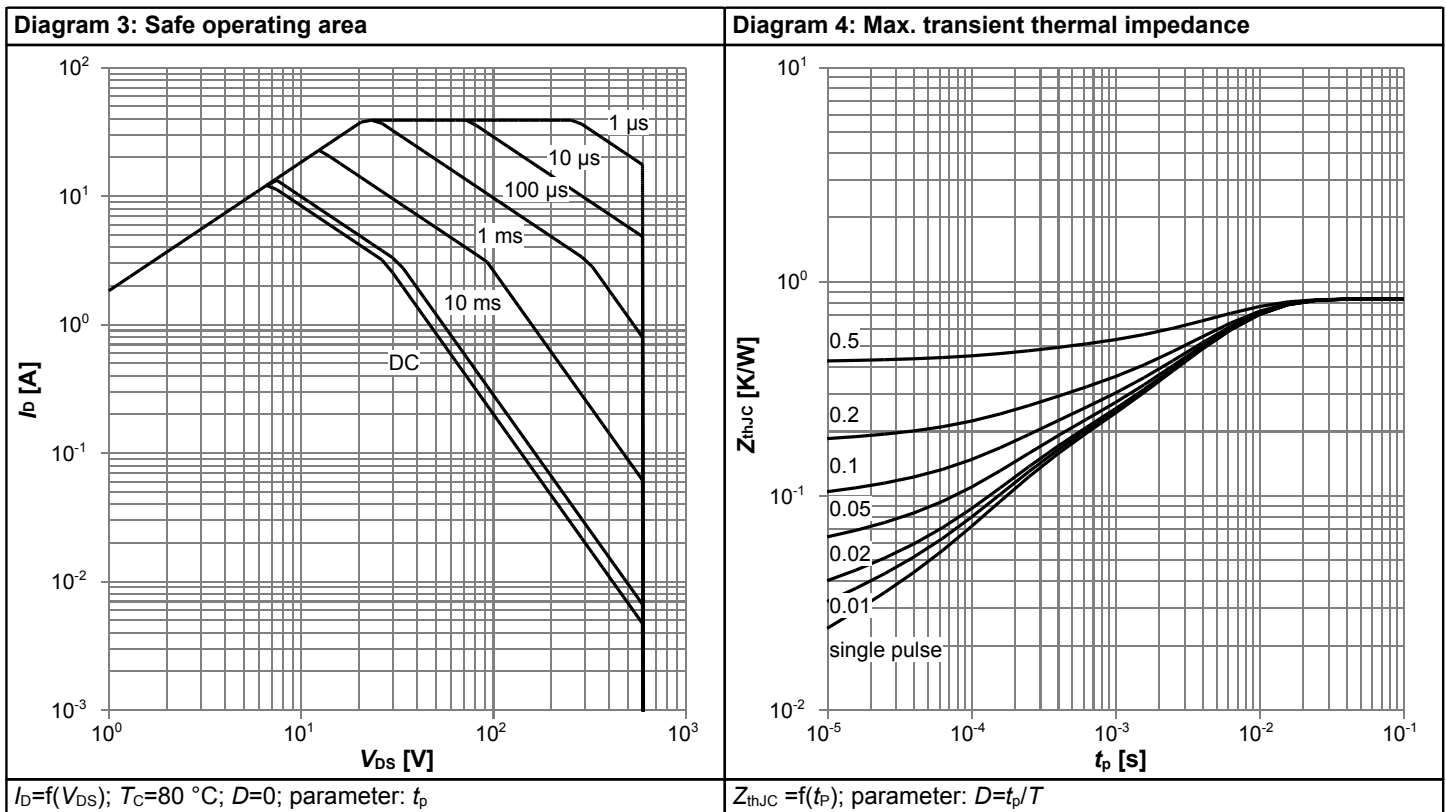
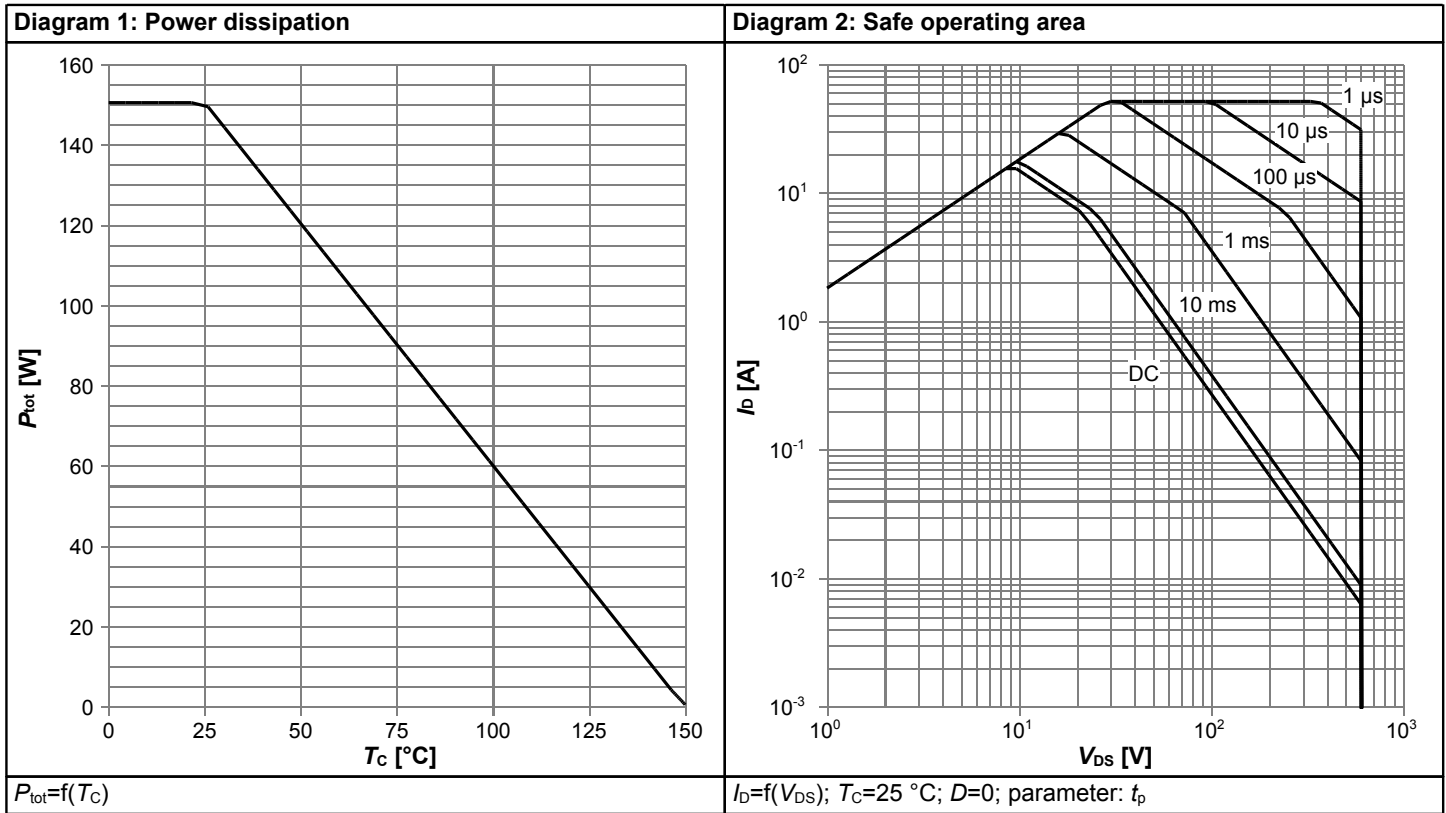
<sup>1)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 400V

<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       | $V_{GS}=0V, I_F=9.5A, T_j=25^\circ C$                     |
| Reverse recovery time         | $t_{rr}$  | -      | 310  | -    | ns      | $V_R=400V, I_F=9.5A, di_F/dt=100A/\mu s$ ;<br>see table 8 |
| Reverse recovery charge       | $Q_{rr}$  | -      | 4    | -    | $\mu C$ | $V_R=400V, I_F=9.5A, di_F/dt=100A/\mu s$ ;<br>see table 8 |
| Peak reverse recovery current | $I_{rrm}$ | -      | 25   | -    | A       | $V_R=400V, I_F=9.5A, di_F/dt=100A/\mu s$ ;<br>see table 8 |

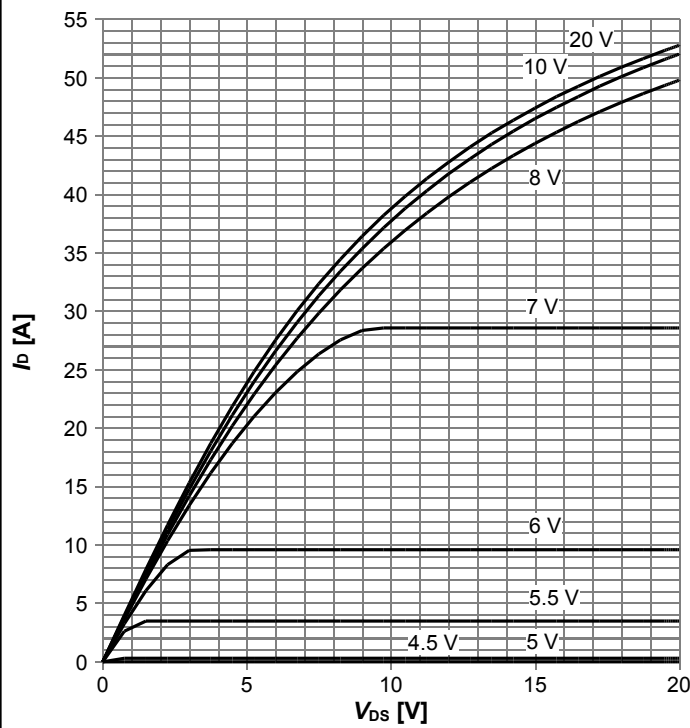
### 4 Electrical characteristics diagrams



# 600V CoolMOS™ P6 Power Transistor

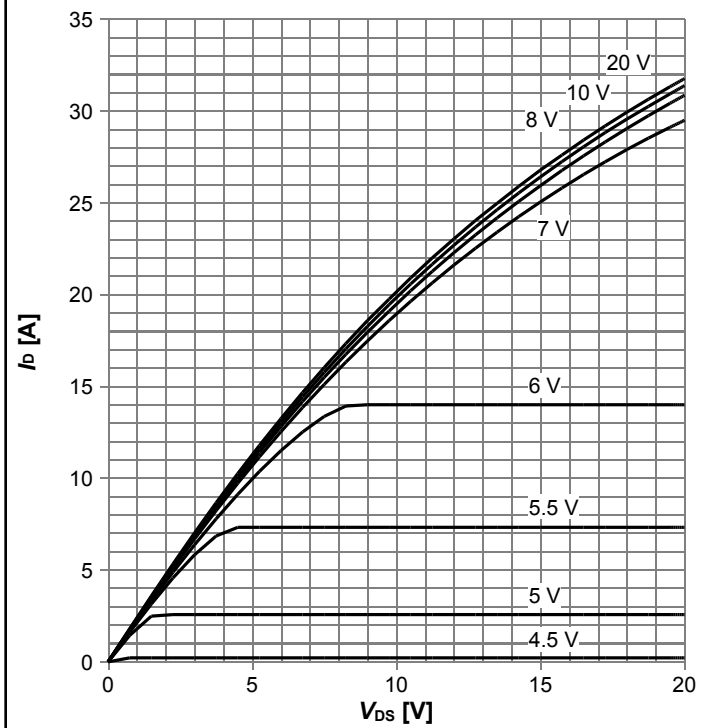
## IPL60R210P6

Diagram 5: Typ. output characteristics



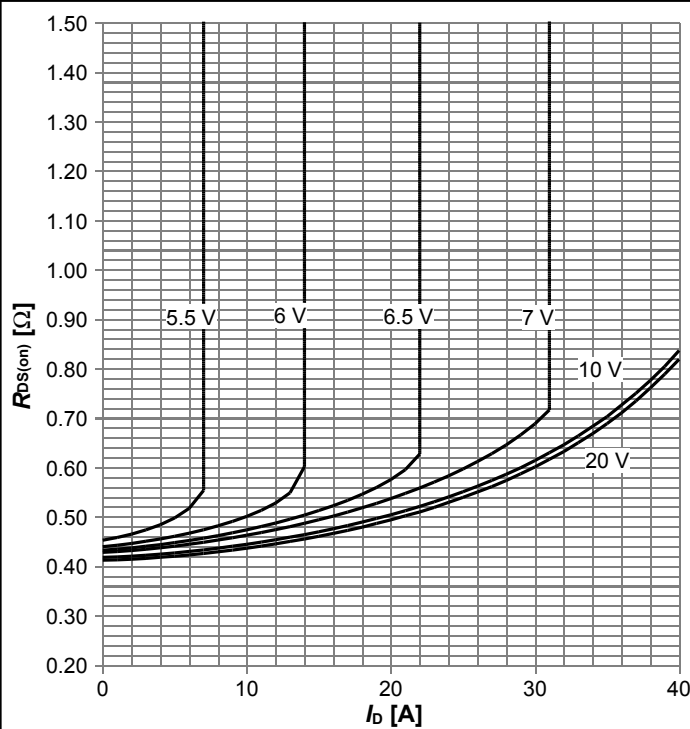
$I_D=f(V_{DS}); T_j=25\text{ °C};$  parameter:  $V_{GS}$

Diagram 6: Typ. output characteristics



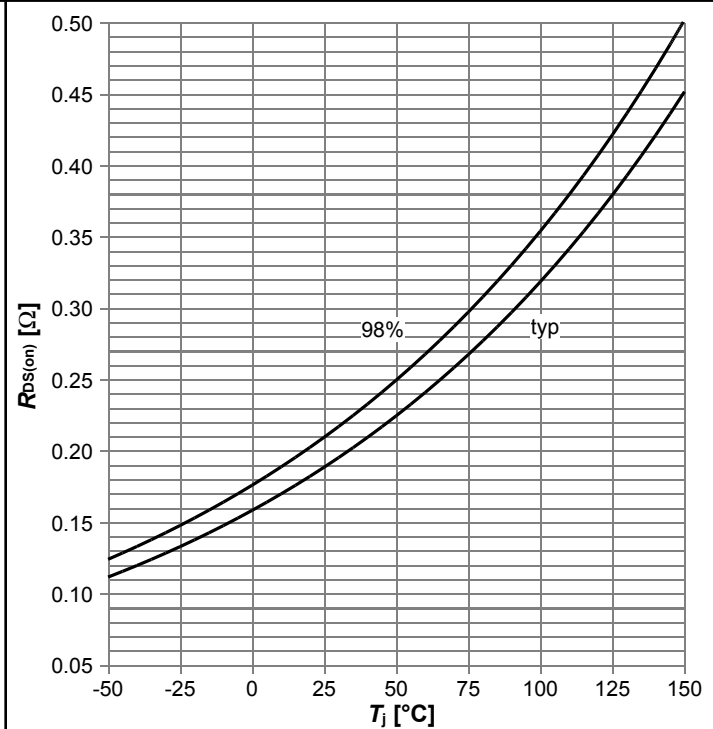
$I_D=f(V_{DS}); T_j=125\text{ °C};$  parameter:  $V_{GS}$

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



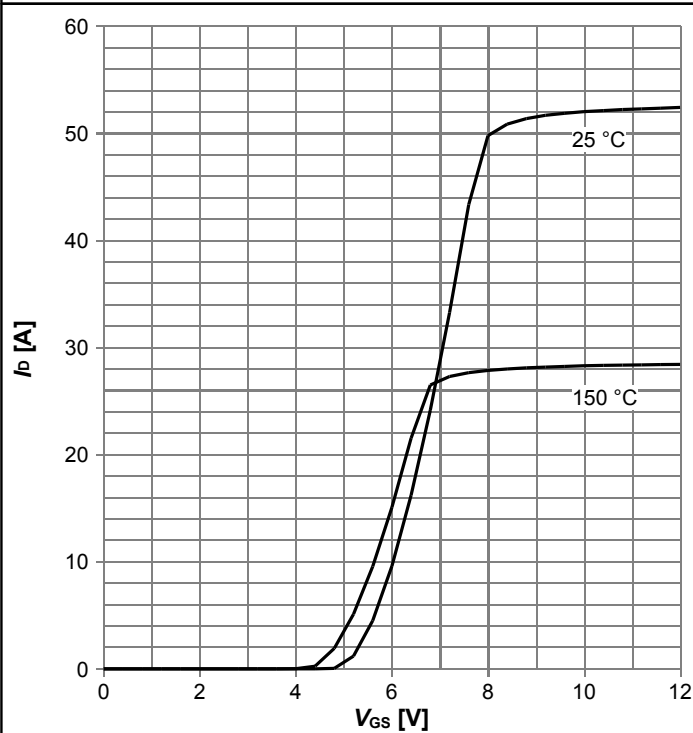
$R_{DS(on)}=f(I_D); T_j=125\text{ °C};$  parameter:  $V_{GS}$

Diagram 8: Drain-source on-state resistance



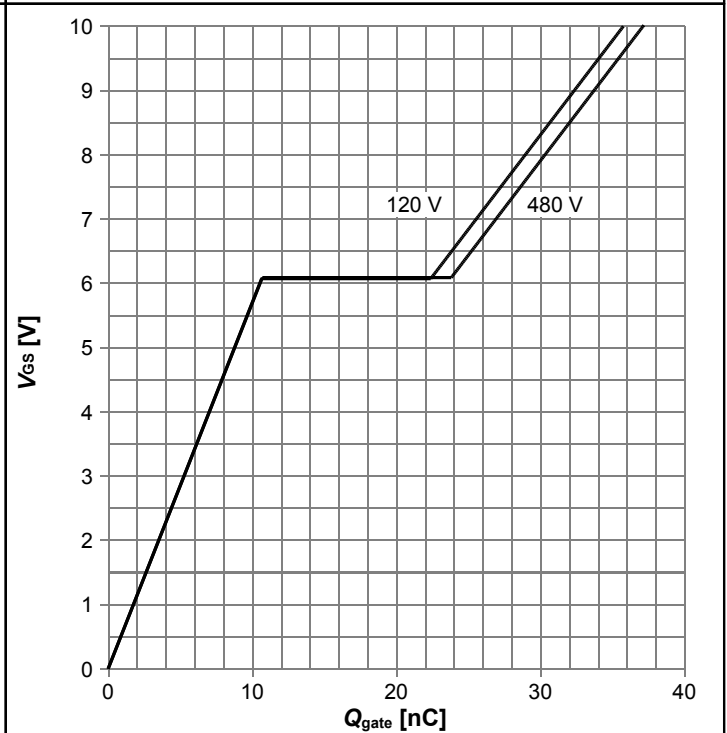
$R_{DS(on)}=f(T_j); I_D=7.6\text{ A}; V_{GS}=10\text{ V}$

Diagram 9: Typ. transfer characteristics



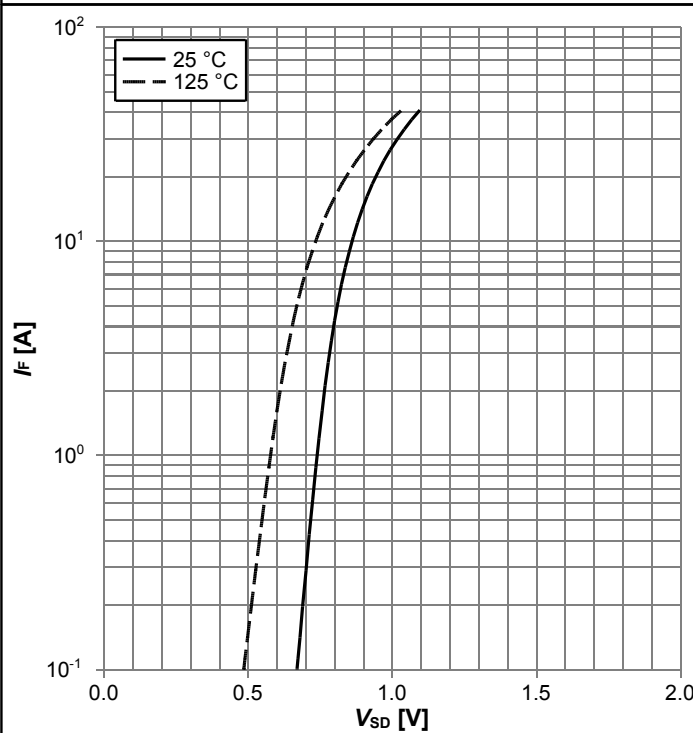
$I_D=f(V_{GS})$ ;  $V_{DS}=20V$ ; parameter:  $T_j$

Diagram 10: Typ. gate charge



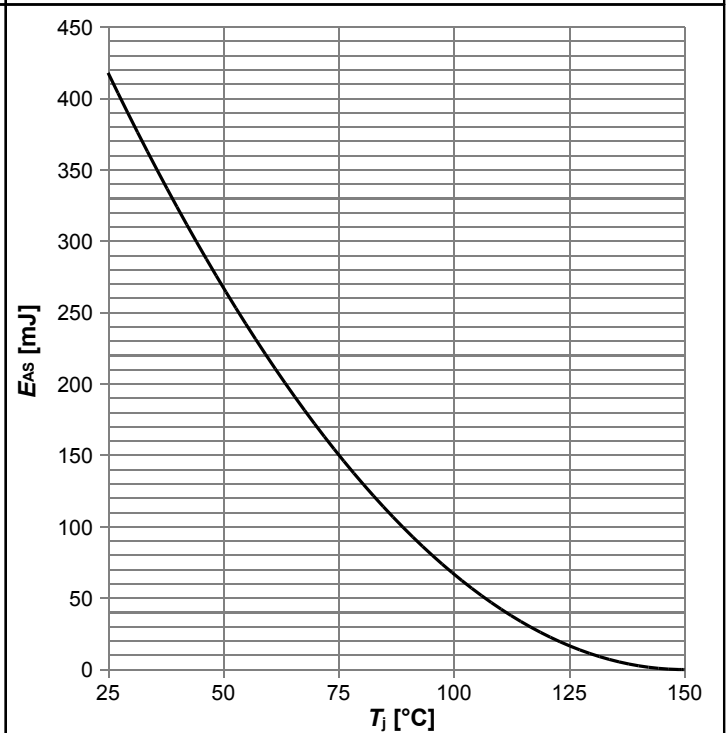
$V_{GS}=f(Q_{gate})$ ;  $I_D=9.5 A$  pulsed; parameter:  $V_{DD}$

Diagram 11: Forward characteristics of reverse diode



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

Diagram 12: Avalanche energy



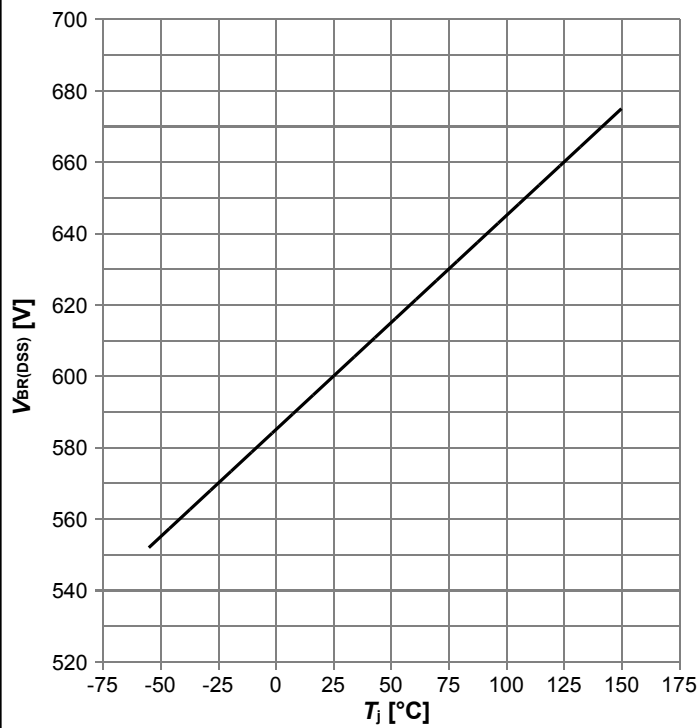
$E_{AS}=f(T_j)$ ;  $I_D=3.3 A$ ;  $V_{DD}=50 V$



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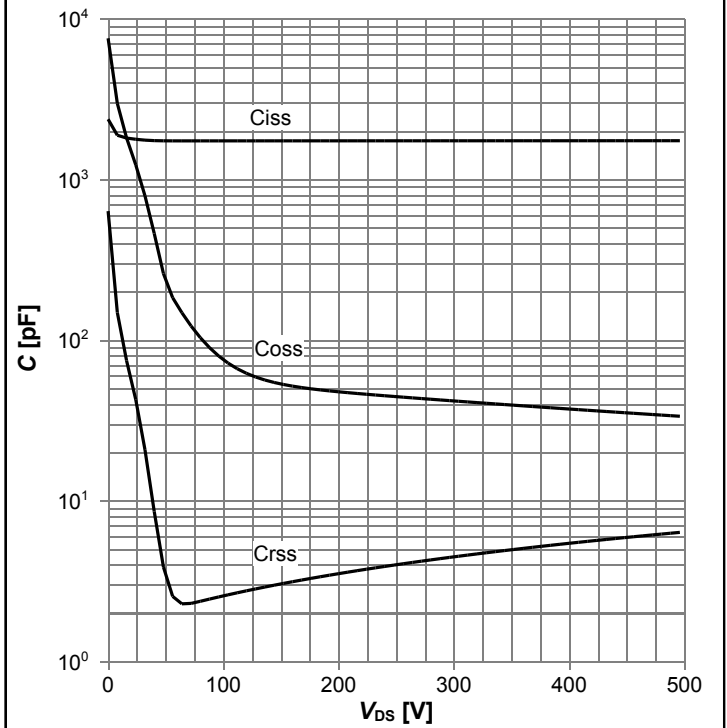
## IPL60R210P6

Diagram 13: Drain-source breakdown voltage



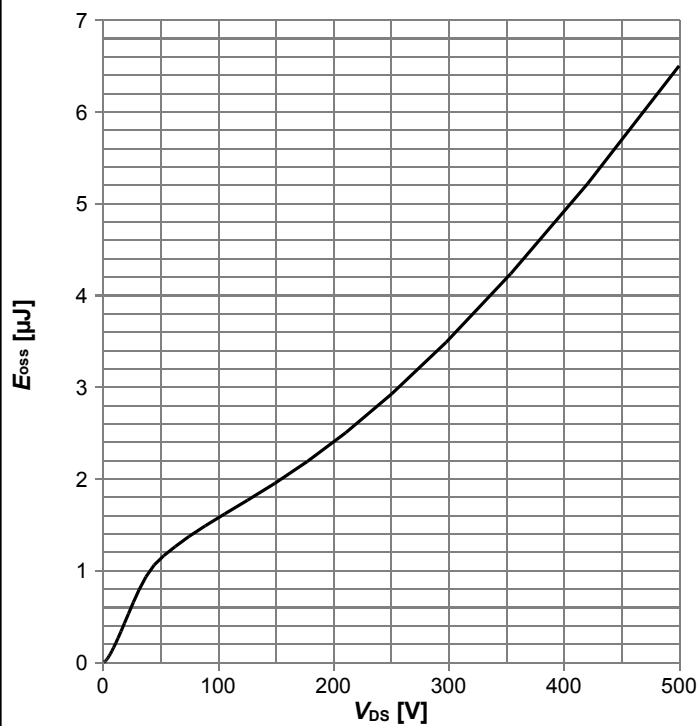
$V_{BR(DSS)}=f(T_j); I_D=1\text{ mA}$

Diagram 14: Typ. capacitances



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

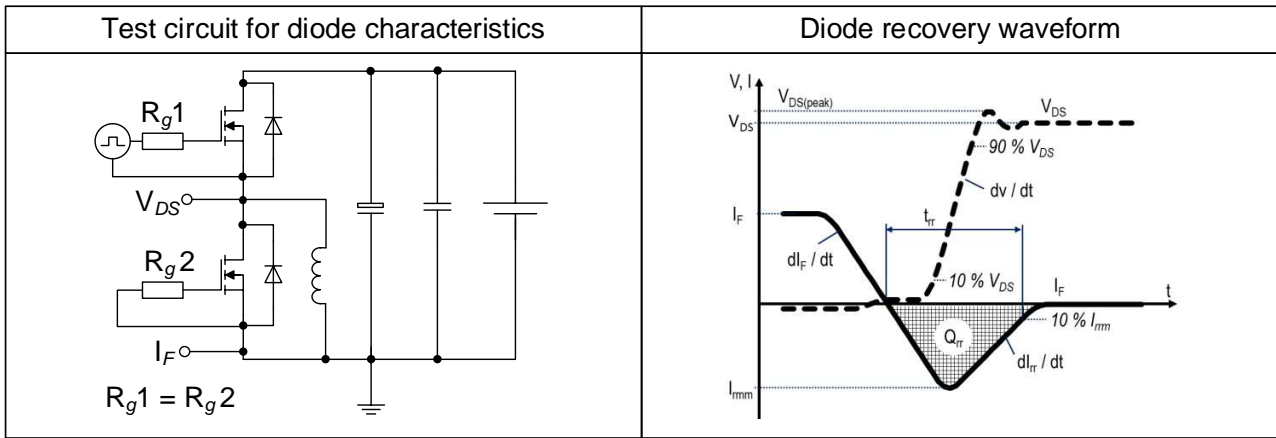
Diagram 15: Typ. Coss stored energy



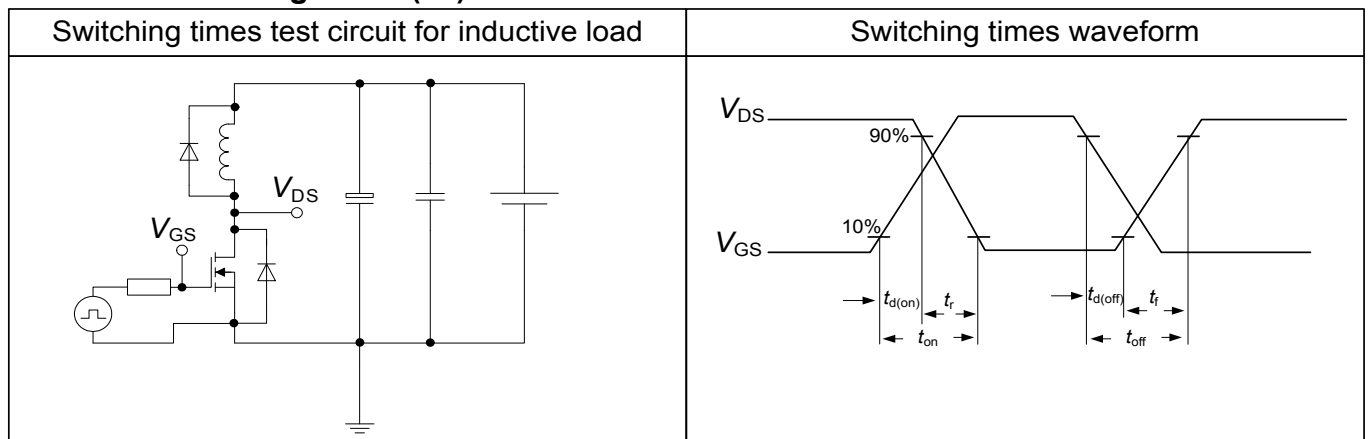
$E_{oss}=f(V_{DS})$

## 5 Test Circuits

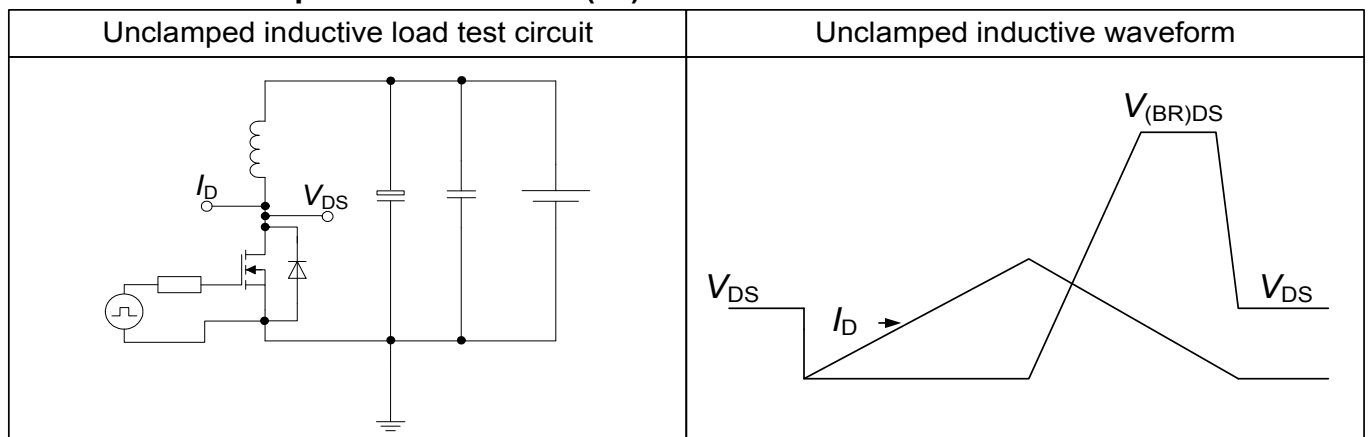
**Table 8 Diode characteristics**



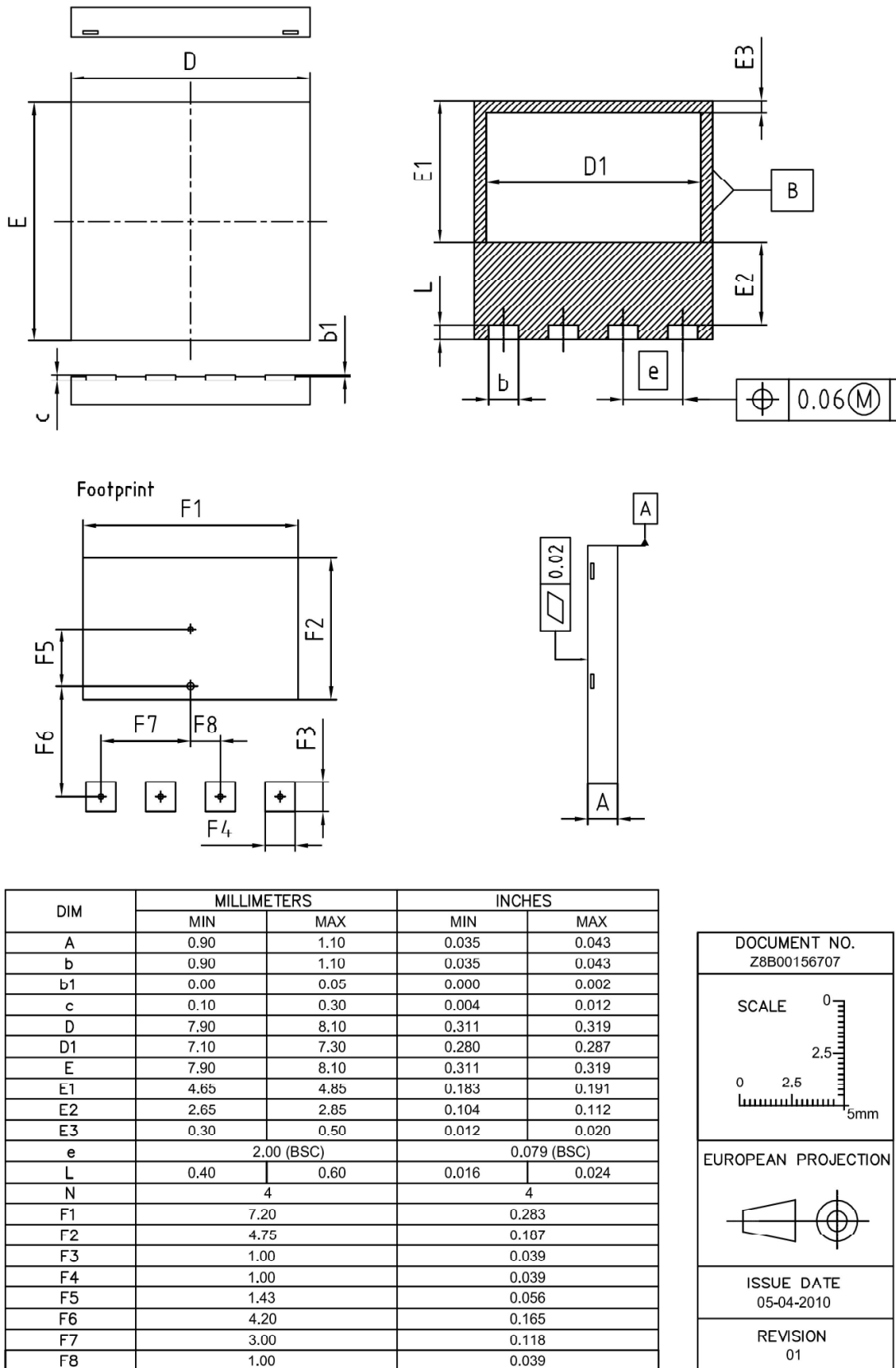
**Table 9 switching times (ss)**



**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™ P6 Webpage: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ P6 application note: [www.infineon.com](http://www.infineon.com)
- IFX CoolMOS™ P6 simulation model: [www.infineon.com](http://www.infineon.com)
- IFX Design tools: [www.infineon.com](http://www.infineon.com)

# 600V CoolMOS™ P6 Power Transistor

## IPL60R210P6

### Revision History

IPL60R210P6

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

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.0      | 2014-05-16 | Release of final version                     |
| 2.1      | 2017-08-30 | Updated MSL; style updated                   |

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