

# IPW60R190C6FKSA-VB Datasheet

## N-Channel 600V (D-S) Super Junction Power MOSFET

**PRODUCT SUMMARY**

|                                    |                 |       |
|------------------------------------|-----------------|-------|
| $V_{DS}$ (V) at $T_J$ max.         | 600             |       |
| $R_{DS(on)}$ at 25 °C ( $\Omega$ ) | $V_{GS} = 10$ V | 0.160 |

**FEATURES**

- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Reduced switching and conduction losses
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)

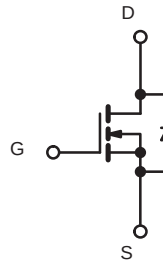
**APPLICATIONS**

- Server and telecom power supplies
- Switch mode power supplies (SMPS)
- Power factor correction power supplies (PFC)
- Lighting
  - High-intensity discharge (HID)
  - Fluorescent ballast lighting

TO-247



Top View



N-Channel MOSFET

**ABSOLUTE MAXIMUM RATINGS** ( $T_C = 25$  °C, unless otherwise noted)

| PARAMETER                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT |
|-----------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|------|
| Drain-Source Voltage                                      |                         |                         | V <sub>DS</sub>                   | 600         | V    |
| Gate-Source Voltage                                       |                         |                         | V <sub>GS</sub>                   | ± 30        |      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C)        | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 20          | A    |
|                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 12          |      |
| Pulsed Drain Current <sup>a</sup>                         |                         |                         | I <sub>DM</sub>                   | 60          |      |
| Linear Derating Factor                                    |                         |                         |                                   | 1.67        | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                |                         |                         | E <sub>AS</sub>                   | 1000        | mJ   |
| Maximum Power Dissipation                                 |                         |                         | P <sub>D</sub>                    | 160         | W    |
| Operating Junction and Storage Temperature Range          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |
| Drain-Source Voltage Slope                                | T <sub>J</sub> = 125 °C |                         | dV/dt                             | 50          | V/ns |
| Reverse Diode dV/dt <sup>d</sup>                          |                         | 15                      |                                   |             |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup> | for 10 s                |                         |                                   | 260         | °C   |

**Notes**

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 100$  V, starting  $T_J = 25$  °C,  $L = 30$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 13$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

**THERMAL RESISTANCE RATINGS**

| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.38 |      |

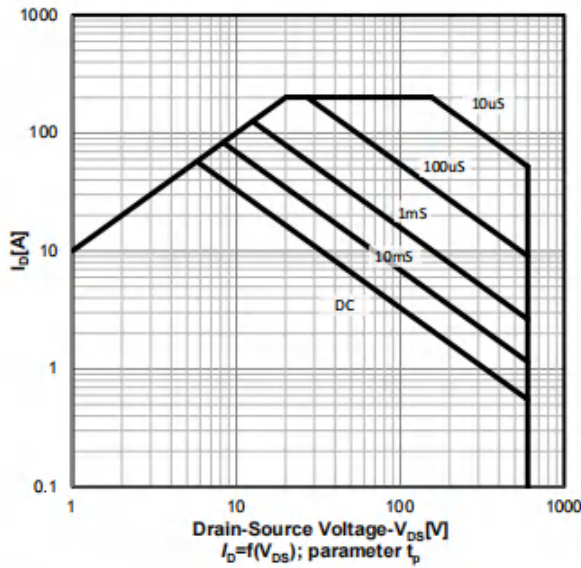
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| PARAMETER                                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                          | MIN. | TYP.  | MAX.      | UNIT          |
|-----------------------------------------------------------|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|-----------|---------------|
| <b>Static</b>                                             |                     |                                                                                                                                                          |      |       |           |               |
| Drain-Source Breakdown Voltage                            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$                                                                                                              | 600  | -     | -         | V             |
| $V_{DS}$ Temperature Coefficient                          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^{\circ}\text{C}$ , $I_D = 1\text{ mA}$                                                                                          | -    | 0.70  | -         | V/°C          |
| Gate-Source Threshold Voltage (N)                         | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                       | 2.5  | -     | 4.5       | V             |
| Gate-Source Leakage                                       | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                               | -    | -     | $\pm 100$ | nA            |
|                                                           |                     | $V_{GS} = \pm 30\text{ V}$                                                                                                                               | -    | -     | $\pm 1$   | $\mu\text{A}$ |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$           | $V_{DS} = 600\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                          | -    | -     | 1         | $\mu\text{A}$ |
|                                                           |                     | $V_{DS} = 480\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$                                                                    | -    | -     | 100       |               |
| Drain-Source On-State Resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$ , $I_D = 7\text{ A}$                                                                                                              | -    | 0.160 | -         | $\Omega$      |
| Forward Transconductance                                  | $g_{fs}$            | $V_{DS} = 30\text{ V}$ , $I_D = 7\text{ A}$                                                                                                              | -    | 5.6   | -         | S             |
| <b>Dynamic</b>                                            |                     |                                                                                                                                                          |      |       |           |               |
| Input Capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                               | -    | 2300  | -         | pF            |
| Output Capacitance                                        | $C_{oss}$           |                                                                                                                                                          | -    | 330   | -         |               |
| Reverse Transfer Capacitance                              | $C_{rss}$           |                                                                                                                                                          | -    | 4     | -         |               |
| Effective Output Capacitance, Energy Related <sup>a</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 520\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                           | -    | 63    | -         |               |
| Effective Output Capacitance, Time Related <sup>b</sup>   | $C_{o(tr)}$         |                                                                                                                                                          | -    | 213   | -         |               |
| Total Gate Charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$ , $I_D = 20\text{ A}$ , $V_{DS} = 520\text{ V}$                                                                                   | -    | 62    | -         | nC            |
| Gate-Source Charge                                        | $Q_{gs}$            |                                                                                                                                                          | -    | 39    | -         |               |
| Gate-Drain Charge                                         | $Q_{gd}$            |                                                                                                                                                          | -    | 4.7   | -         |               |
| Turn-On Delay Time                                        | $t_{d(on)}$         | $V_{DD} = 520\text{ V}$ , $I_D = 20\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$                                                    | -    | 18    | 25        | ns            |
| Rise Time                                                 | $t_r$               |                                                                                                                                                          | -    | 24    | 55        |               |
| Turn-Off Delay Time                                       | $t_{d(off)}$        |                                                                                                                                                          | -    | 8.0   | -         |               |
| Fall Time                                                 | $t_f$               |                                                                                                                                                          | -    | 1.2   | -         |               |
| Gate Input Resistance                                     | $R_g$               | $f = 1\text{ MHz}$ , open drain                                                                                                                          | -    | 0.8   | -         | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>            |                     |                                                                                                                                                          |      |       |           |               |
| Continuous Source-Drain Diode Current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> | -    | -     | 20        | A             |
| Pulsed Diode Forward Current                              | $I_{SM}$            |                                                                                                                                                          | -    | -     | 60        |               |
| Diode Forward Voltage                                     | $V_{SD}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_S = 8\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                          | -    | -     | 1.5       | V             |
| Reverse Recovery Time                                     | $t_{rr}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_F = I_S = 8\text{ A}$ ,<br>$dI/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 400\text{ V}$                             | -    | 520   | -         | ns            |
| Reverse Recovery Charge                                   | $Q_{rr}$            |                                                                                                                                                          | -    | 5.8   | -         | $\mu\text{C}$ |
| Reverse Recovery Current                                  | $I_{RRM}$           |                                                                                                                                                          | -    | 4.5   | -         | A             |

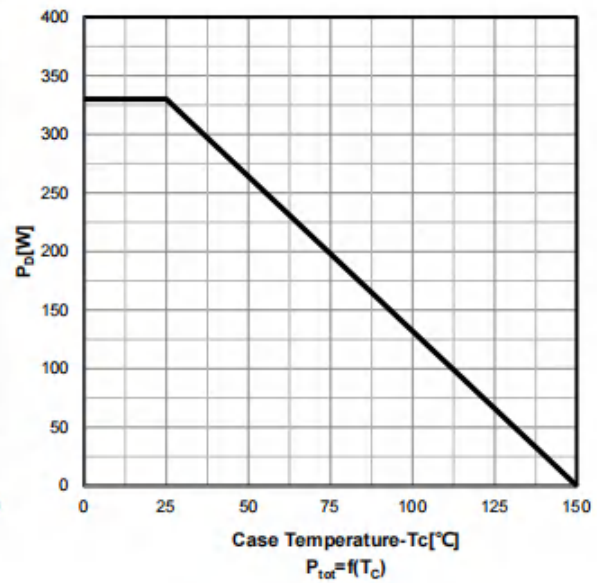
**Notes**

- a.  $C_{oss(er)}$  is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .  
 b.  $C_{oss(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DSS}$ .

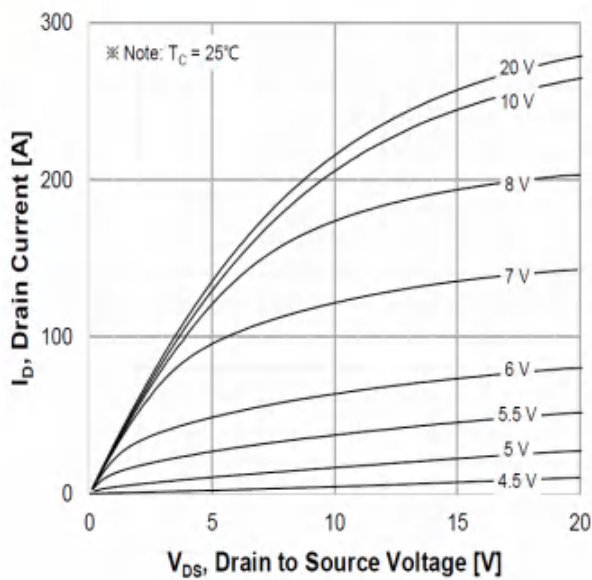
Safe operating area TC=25 °C  
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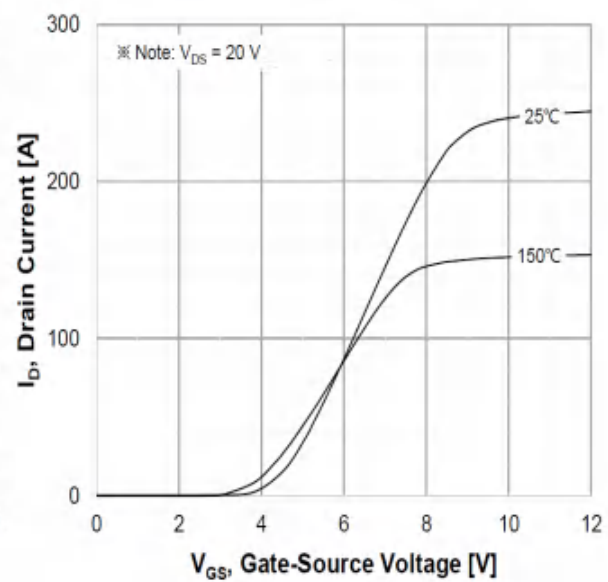
Power dissipation



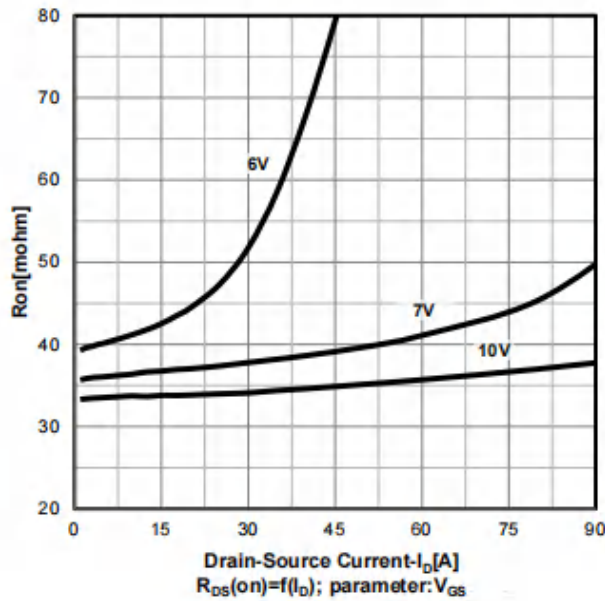
Typ. output characteristics  $T_J=25\text{ }^{\circ}\text{C}$



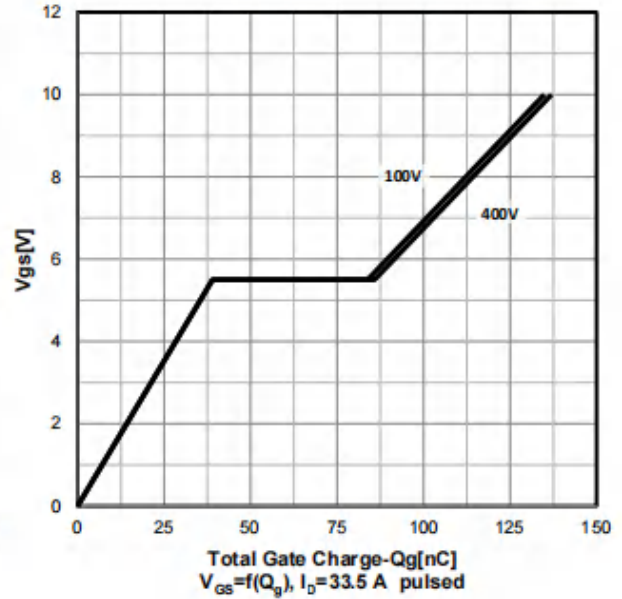
Transfer characteristics



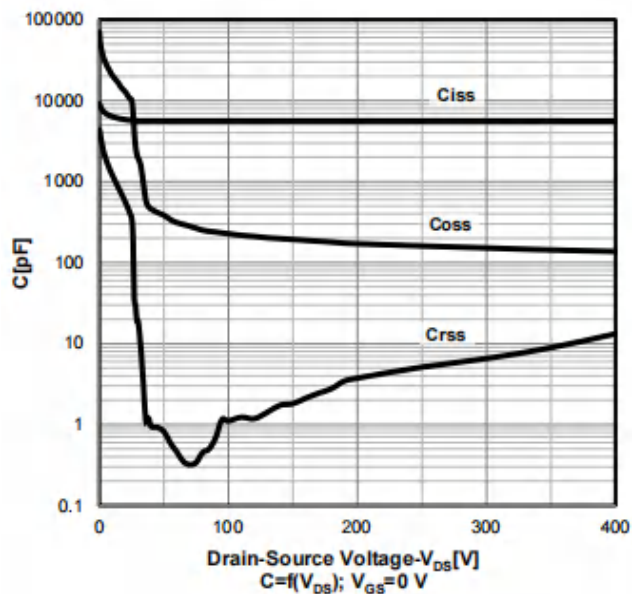
Typ. drain-source on-state resistance



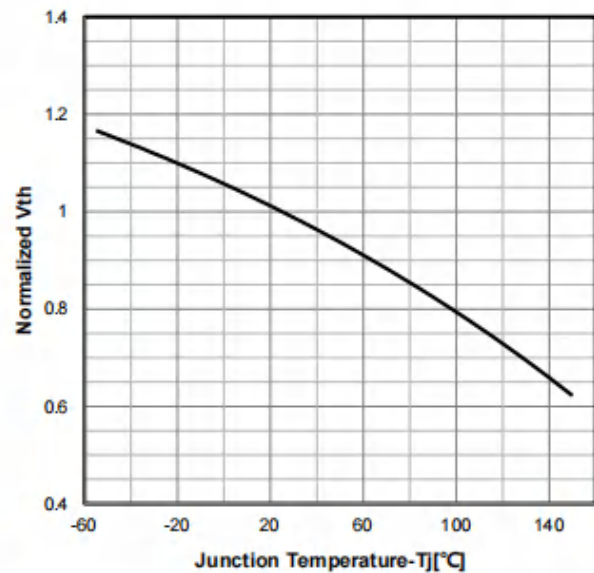
Typ. gate charge characteristics



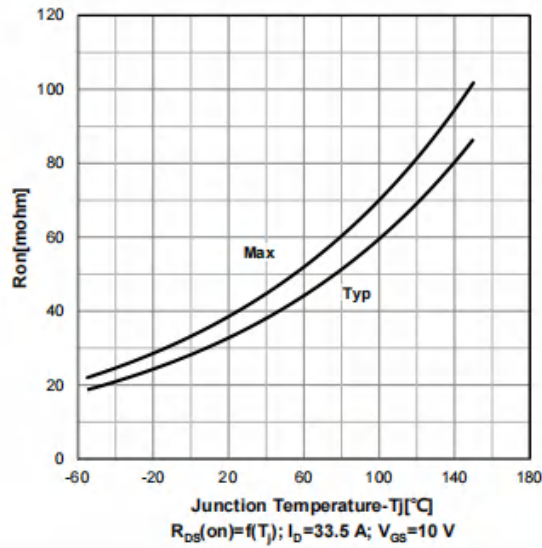
Typ. capacitances



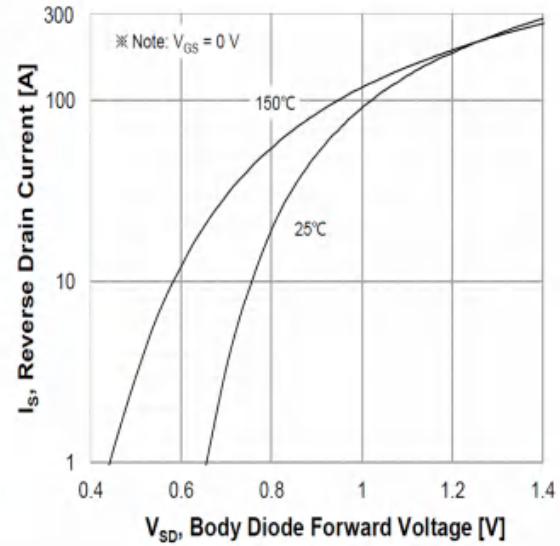
Normalized  $V_{GS(th)}$  characteristics



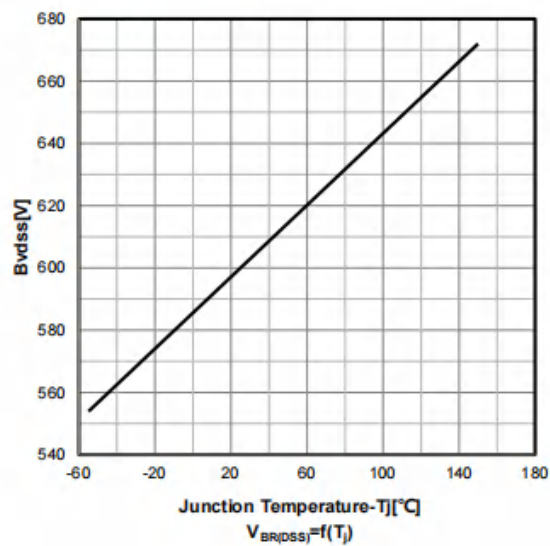
On-resistance vs temperature



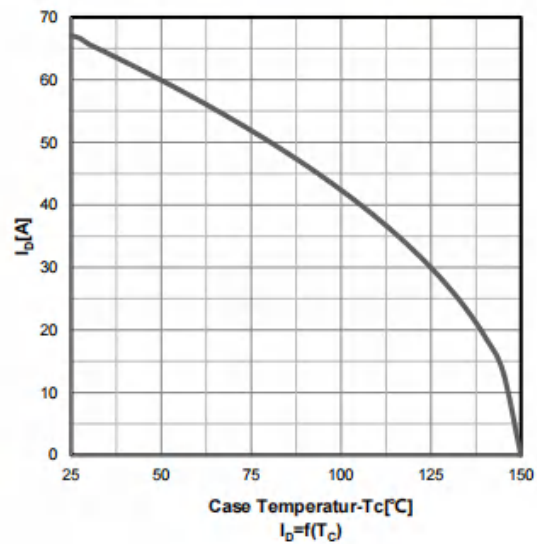
Forward characteristics of reverse diode



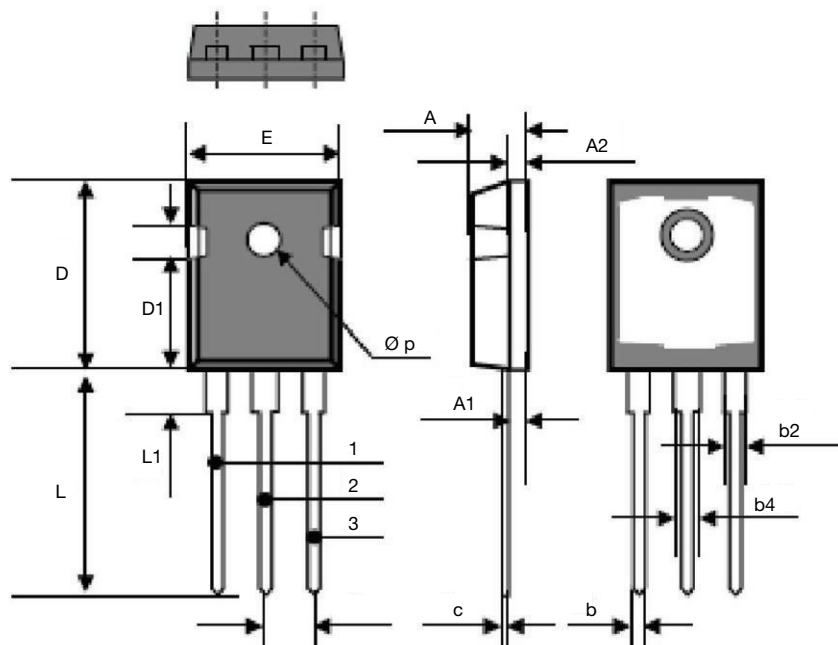
Drain-source breakdown voltage



Drain current vs temperature



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| DIM. | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
|      | MIN.        | MAX.  | MIN.      | MAX.  |
| A    | 4.70        | 5.31  | 0.185     | 0.209 |
| A1   | 2.21        | 2.59  | 0.087     | 0.102 |
| A2   | 1.50        | 2.49  | 0.059     | 0.098 |
| b    | 0.99        | 1.40  | 0.039     | 0.055 |
| b2   | 1.65        | 2.41  | 0.065     | 0.095 |
| b4   | 2.59        | 3.43  | 0.102     | 0.135 |
| c    | 0.61 BSC    |       | 0.024 BSC |       |
| D    | 20.80       | 21.46 | 0.819     | 0.845 |
| D1   | 3.68        | 5.49  | 0.145     | 0.216 |
| (e)  | 5.46 BSC    |       | 0.215 BSC |       |
| E    | 15.49       | 16.26 | 0.610     | 0.640 |
| L    | 19.81       | 20.32 | 0.780     | 0.800 |
| L1   | 4.06        | 4.50  | 0.160     | 0.177 |
| Ø p  | 3.51        | 3.66  | 0.138     | 0.144 |

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