# N-Channel 650 V (D-S) Super Junction Power MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) at $T_J$ max. | 650 | |
| $R_{DS(on)}$ at 25 °C (Ω) | $V_{GS}$ = 10 V | 0.160 |

## FEATURES

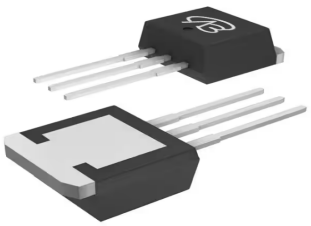
- Low figure-of-merit (FOM) $R_{on}$ x $Q_g$
- Low input capacitance ($C_{iss}$)
- Reduced switching and conduction losses
- Ultra low gate charge ($Q_g$)
- Avalanche energy rated (UIS)

RoHS

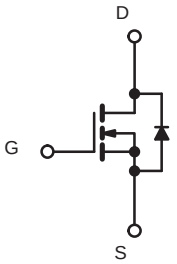
## APPLICATIONS

- 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-262



Top View




N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS ($T_C$ = 25 °C, unless otherwise noted) | | | | | |
|---|---|---|---|---|---|
| PARAMETER | | | SYMBOL | LIMIT | UNIT |
| Drain-Source Voltage | | | $V_{DS}$ | 650 | V |
| Gate-Source Voltage | | | $V_{GS}$ | ± 30 | |
| Continuous Drain Current ($T_J$ = 150 °C) | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 20 | A |
| | | $T_C$ = 100 °C | | 12 | |
| Pulsed Drain Current [a] | | | $I_{DM}$ | 60 | |
| Linear Derating Factor | | | | 1.67 | W/°C |
| Single Pulse Avalanche Energy [b] | | | $E_{AS}$ | 950 | mJ |
| Maximum Power Dissipation | | | $P_D$ | 165 | W |
| Operating Junction and Storage Temperature Range | | | $T_J$, $T_{stg}$ | -55 to +150 | °C |
| Drain-Source Voltage Slope | $T_J$ = 125 °C | | dV/dt | 50 | V/ns |
| Reverse Diode dV/dt [d] | | | | 15 | |
| Soldering Recommendations (Peak Temperature) [c] | for 10 s | | | 260 | °C |

**Notes**

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

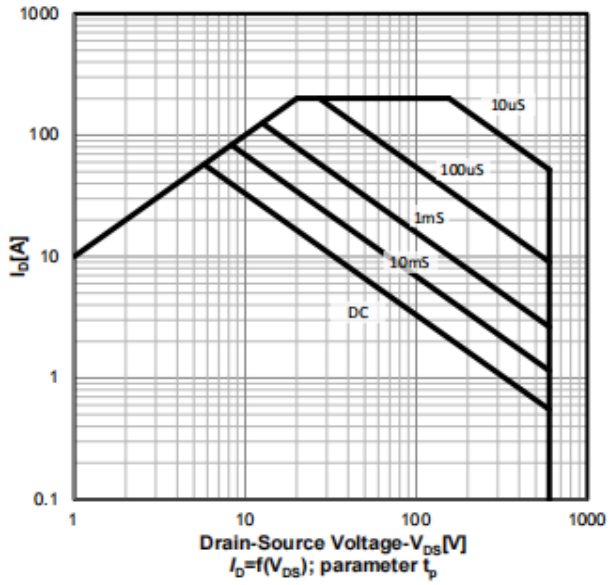
| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TYP.** | **MAX.** | **UNIT** |
| Maximum Junction-to-Ambient | $R_{thJA}$ | - | 62 | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | - | 0.38 | |

| **SPECIFICATIONS** ($T_J$ = 25 °C, unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 1 mA | 650 | - | - | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 0.70 | - | V/°C |
| Gate-Source Threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 2.5 | - | 4.5 | V |
| Gate-Source Leakage | $I_{GSS}$ | $V_{GS}$ = ± 20 V | - | - | ± 100 | nA |
| | | $V_{GS}$ = ± 30 V | - | - | ± 1 | µA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = 650V, $V_{GS}$ = 0 V | - | - | 1 | µA |
| | | $V_{DS}$ = 520 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 100 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ =7A | - | 0.160 | - | Ω |
| Forward Transconductance | $g_{fs}$ | $V_{DS}$ = 30 V, $I_D$ = 7A | - | 5.6 | - | S |
| **Dynamic** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 100 V, f = 1 MHz | - | 2390 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 330 | - | |
| Reverse Transfer Capacitance | $C_{rss}$ | | - | 4 | - | |
| Effective Output Capacitance, Energy Related [a] | $C_{o(er)}$ | $V_{DS}$ = 0 V to 520 V, $V_{GS}$ = 0 V | - | 63 | - | |
| Effective Output Capacitance, Time Related [b] | $C_{o(tr)}$ | | - | 213 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = 10 V; $I_D$ = 20 A, $V_{DS}$ = 520 V | - | 62 | - | nC |
| Gate-Source Charge | $Q_{gs}$ | | - | 39 | - | |
| Gate-Drain Charge | $Q_{gd}$ | | - | 47 | - | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 520 V, $I_D$ = 20A, $V_{GS}$ = 10 V, $R_g$ = 9.1 Ω | - | 18 | 25 | ns |
| Rise Time | $t_r$ | | - | 24 | 55 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 80 | - | |
| Fall Time | $t_f$ | | - | 12 | - | |
| Gate Input Resistance | $R_g$ | f = 1 MHz, open drain | - | 0.8 | - | Ω |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode | - | - | 20 | A |
| Pulsed Diode Forward Current | $I_{SM}$ | | - | - | 60 | |
| Diode Forward Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 8 A, $V_{GS}$ = 0 V | - | - | 1.5 | V |
| Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = $I_S$ = 8 A, dI/dt = 100 A/µs, $V_R$ = 400 V | - | 60 | - | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | - | 5.8 | - | µC |
| Reverse Recovery Current | $I_{RRM}$ | | - | 45 | - | A |

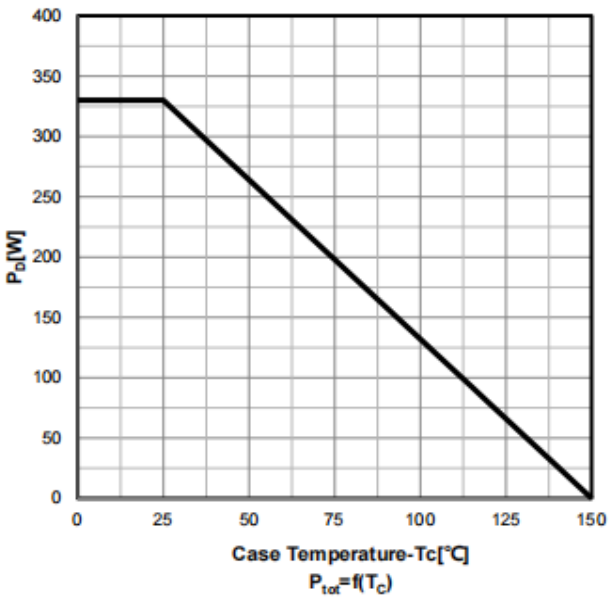
**Notes**

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 % $V_{DSS}$.

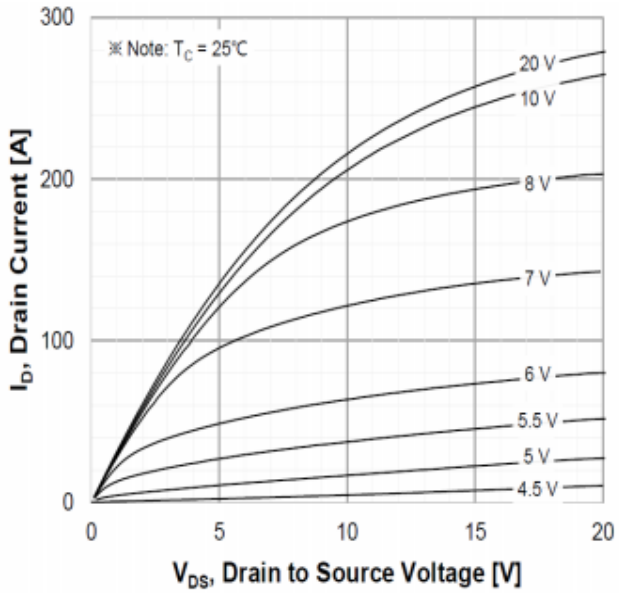
Safe operating area TC=25 ℃
TO-247



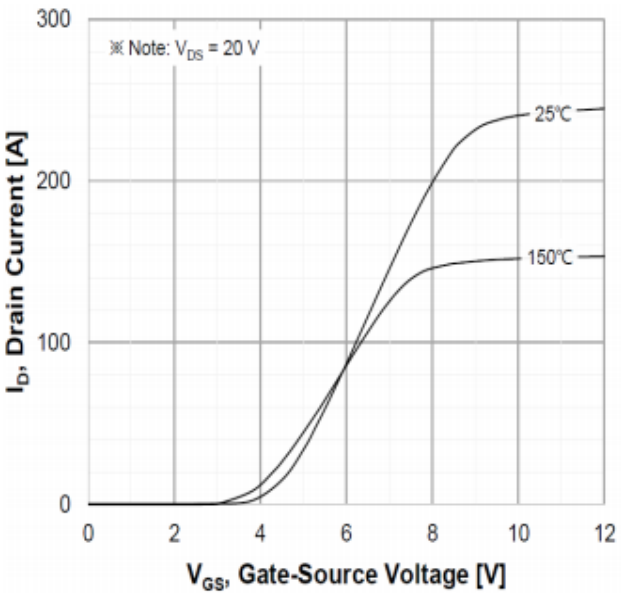

Power dissipation



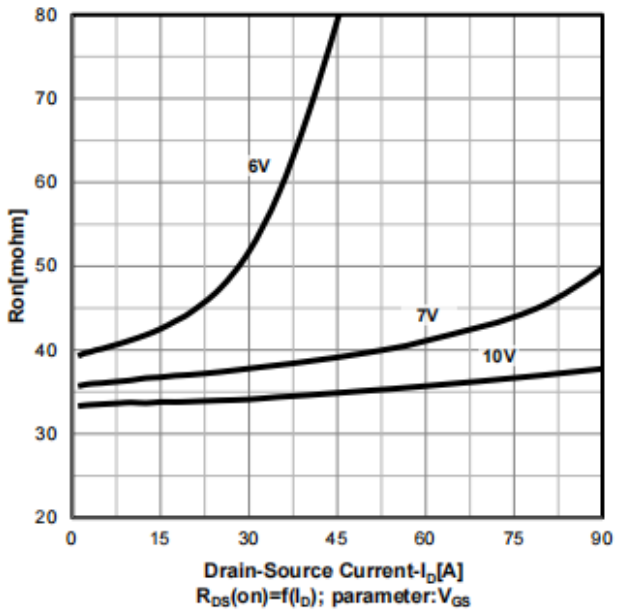

Typ. output characteristics $T_j$=25 ℃



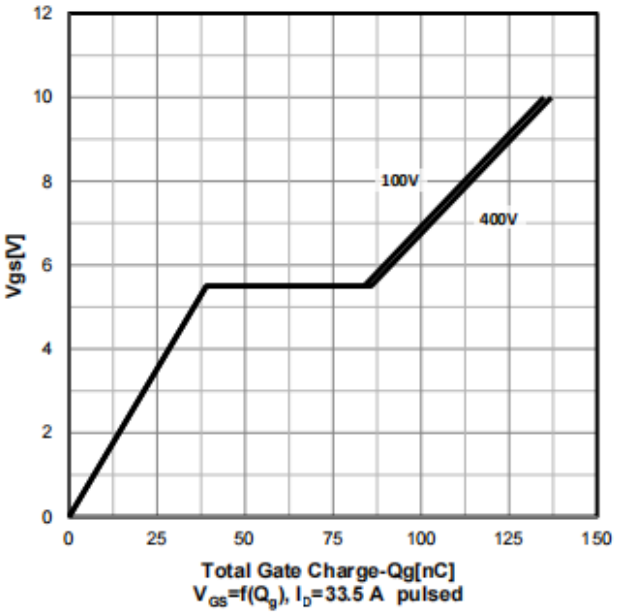

Transfer characteristics



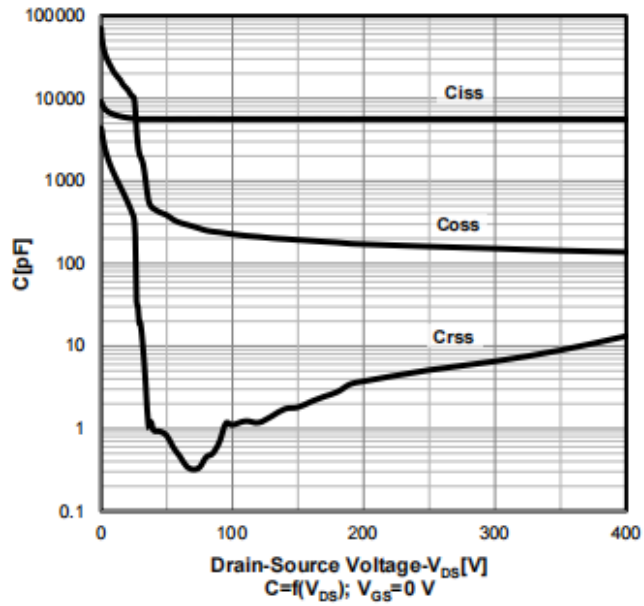
Typ. drain-source on-state resistance



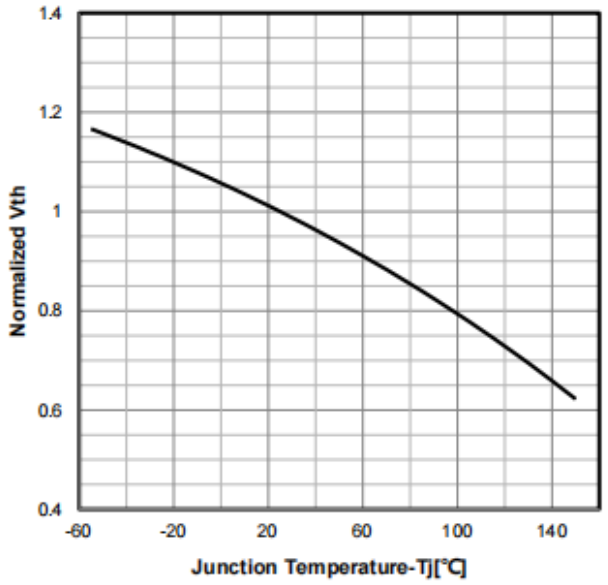

Typ. gate charge characteristics



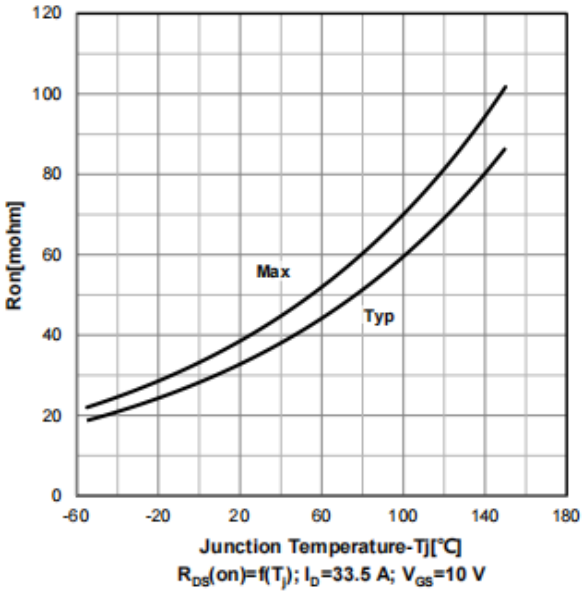

Typ. capacitances



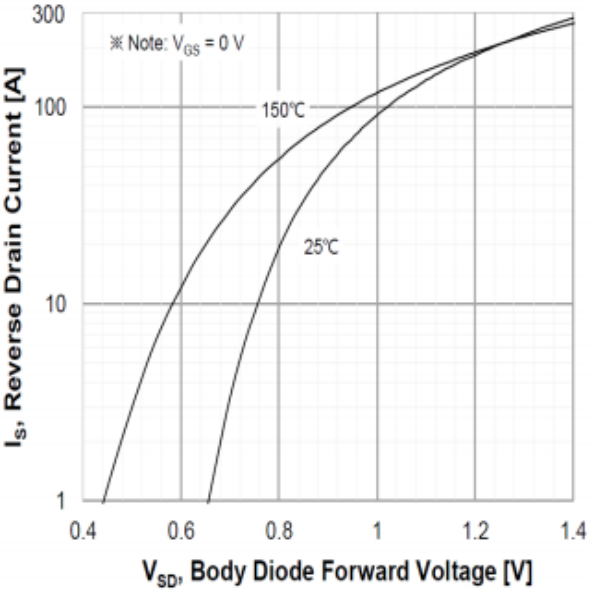

Normalized $V_{GS(th)}$ characteristics



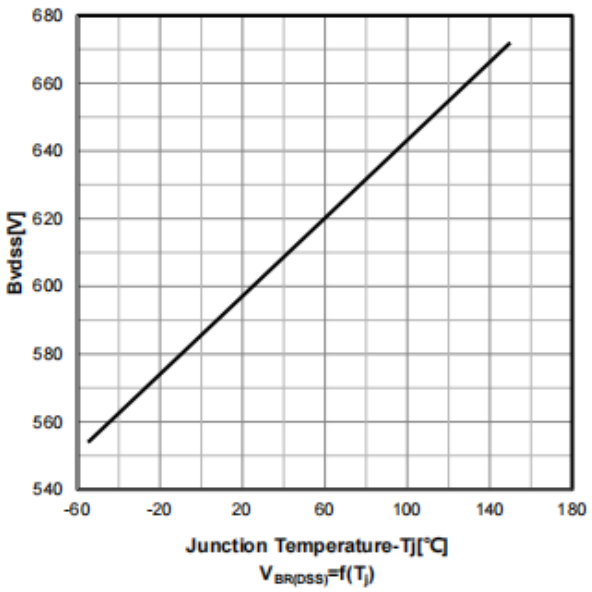
On-resistance vs temperature



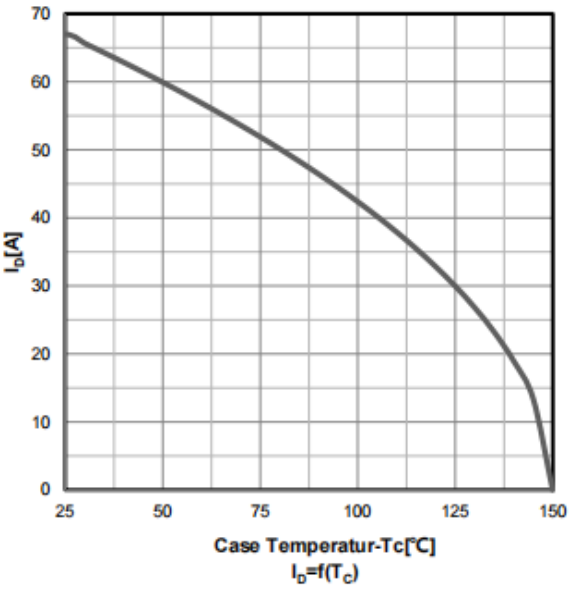

Forward characteristics of reverse diode



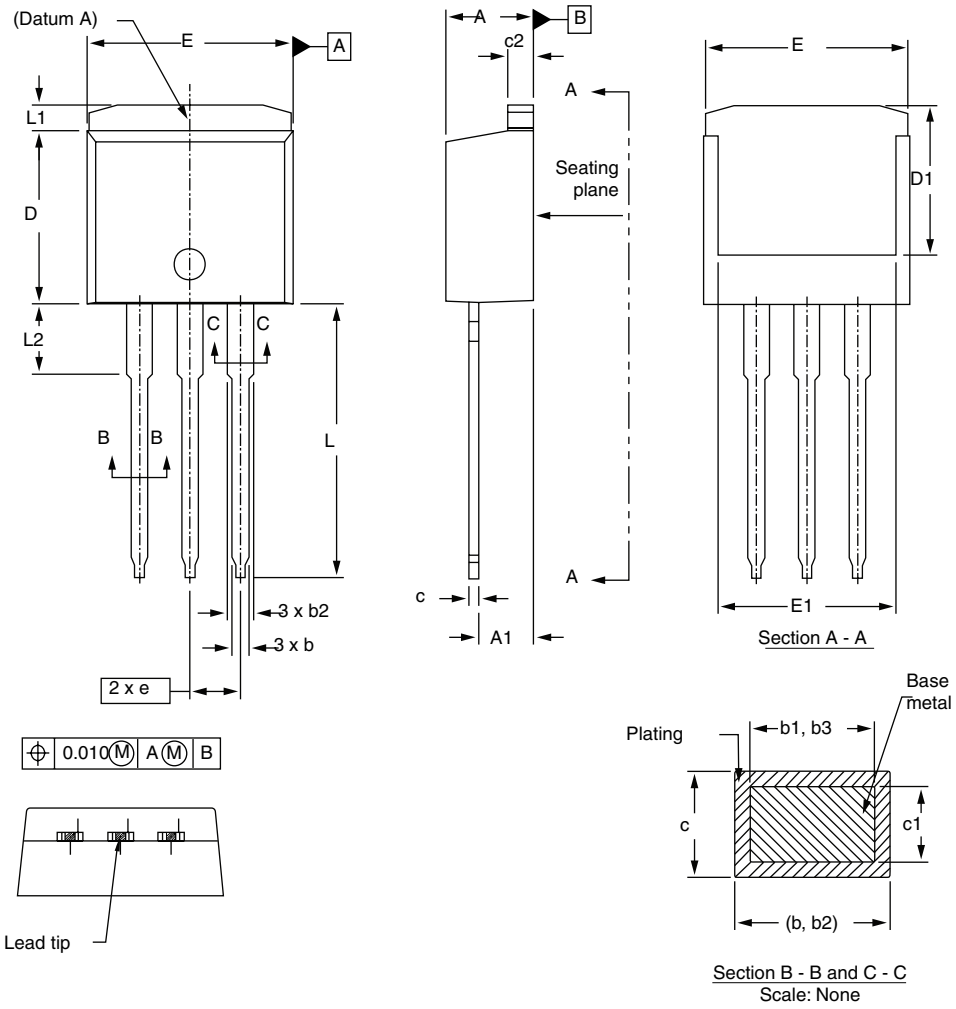

Drain-source breakdown voltage




Drain current vs temperature



## I²PAK (TO-262)




| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM. | MIN. | MAX. | MIN. | MAX. |
| A | 4.06 | 4.83 | 0.160 | 0.190 |
| A1 | 2.03 | 3.02 | 0.080 | 0.119 |
| b | 0.51 | 0.99 | 0.020 | 0.039 |
| b1 | 0.51 | 0.89 | 0.020 | 0.035 |
| b2 | 1.14 | 1.78 | 0.045 | 0.070 |
| b3 | 1.14 | 1.73 | 0.045 | 0.068 |
| c | 0.38 | 0.74 | 0.015 | 0.029 |
| c1 | 0.38 | 0.58 | 0.015 | 0.023 |
| c2 | 1.14 | 1.65 | 0.045 | 0.065 |

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM. | MIN. | MAX. | MIN. | MAX. |
| D | 8.38 | 9.65 | 0.330 | 0.380 |
| D1 | 6.86 | - | 0.270 | - |
| E | 9.65 | 10.67 | 0.380 | 0.420 |
| E1 | 6.22 | - | 0.245 | - |
| e | 2.54 BSC | | 0.100 BSC | |
| L | 13.46 | 14.10 | 0.530 | 0.555 |
| L1 | - | 1.65 | - | 0.065 |
| L2 | 3.56 | 3.71 | 0.140 | 0.146 |

**Notes**

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm per side. These dimensions are measured at the outmost extremes of the plastic body.
3. Thermal pad contour optional within dimension E, L1, D1, and E1.4

. Dimension b1 and c1 apply to base metal only.

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