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

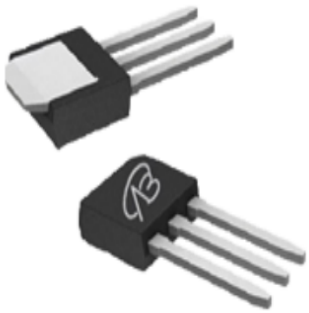
| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) at $T_J$ max. | 650 | |
| $R_{DS(on)}$ typ. (Ω) at 25 °C | $V_{GS}$ = 10 V | 0.460 |

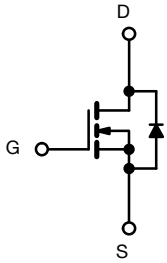
## FEATURES

- 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 COMPLIANT
HALOGEN FREE

TO-251






N-Channel MOSFET

## 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
- Industrial
  - Welding
  - Induction heating
  - Motor drives
  - Battery chargers
  - Renewable energy
  - Solar (PV inverters)

**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 | $I_D$ | 8 | A |
| | | $T_C$ = 100 °C | | 5 | |
| Pulsed drain current [a] | | | $I_{DM}$ | 24 | |
| Linear derating factor | | | | 1.7 | W/°C |
| Single pulse avalanche energy [b] | | | $E_{AS}$ | 185 | mJ |
| Maximum power dissipation | | | $P_D$ | 128 | 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] | | | | 5.1 | |
| 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 = 30 mH, $R_g$ = 25 Ω, $I_{AS}$ = 8.0 A
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) | $R_{thJC}$ | - | 0.65 | |

| **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, $I_D$ = 250 µA | 650 | - | - | V |
| $V_{DS}$ temperature coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 1.08 | - | V/°C |
| Gate-source threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 2.0 | - | 4.0 | V |
| Gate-source leakage | $I_{GSS}$ | $V_{GS}$ = ± 20 V | - | - | ± 100 | nA |
| | | $V_{GS}$ = ± 30 V | - | - | ± 1 | µA |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | - | - | 1 | µA |
| | | $V_{DS}$ = 520 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 10 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ =2.5 A | - | 0.460 | - | Ω |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 30 V, $I_D$ = 2.5A | - | 8.7 | - | S |
| **Dynamic** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 100 V, f = 1 MHz | - | 980 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 81 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 9 | - | |
| Effective output capacitance, energy related [a] | $C_{o(er)}$ | $V_{DS}$ = 0 V to 480 V, $V_{GS}$ = 0 V | - | 58 | - | |
| Effective output capacitance, time related [b] | $C_{o(tr)}$ | | - | 296 | - | |
| Total gate charge | $Q_g$ | $V_{GS}$ = 10 V; $I_D$ = 5 A, $V_{DS}$ = 480 V | - | 40 | 122 | nC |
| Gate-source charge | $Q_{gs}$ | | - | 16 | - | |
| Gate-drain charge | $Q_{gd}$ | | - | 20 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 480 V, $I_D$ = 5 A, $V_{GS}$ = 10 V, $R_g$ = 9.1 Ω | - | 22 | 44 | ns |
| Rise time | $t_r$ | | - | 24 | 48 | |
| Turn-off delay time | $t_{d(off)}$ | | - | 71 | 142 | |
| Fall time | $t_f$ | | - | 26 | 52 | |
| Gate input resistance | $R_g$ | f = 1 MHz, open drain | 0.3 | 0.7 | 1.4 | Ω |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous source-drain diode current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 8 | A |
| Pulsed diode forward current | $I_{SM}$ | | - | - | 24 | |
| Diode forward voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 5 A, $V_{GS}$ = 0 V | - | - | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = $I_S$ = 5 A, dI/dt = 100 A/µs, $V_R$ = 25 V | - | 80 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 6.4 | 12.8 | µC |
| Reverse recovery current | $I_{RRM}$ | | - | 27 | - | A |

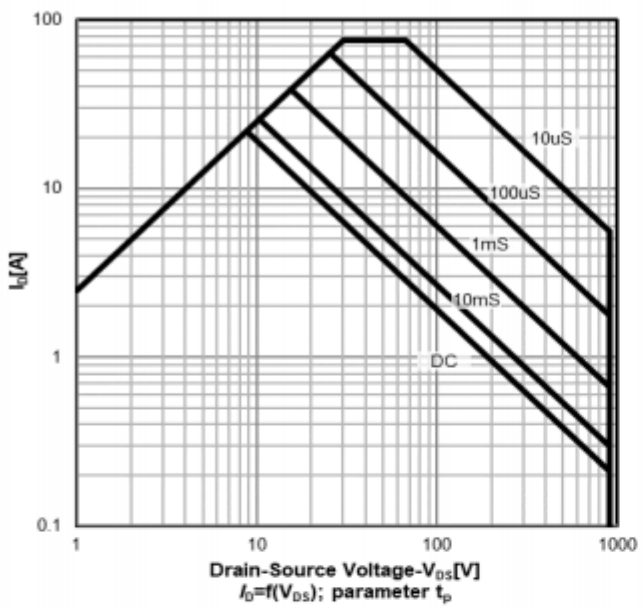
**Notes**

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 % $V_{DSS}$

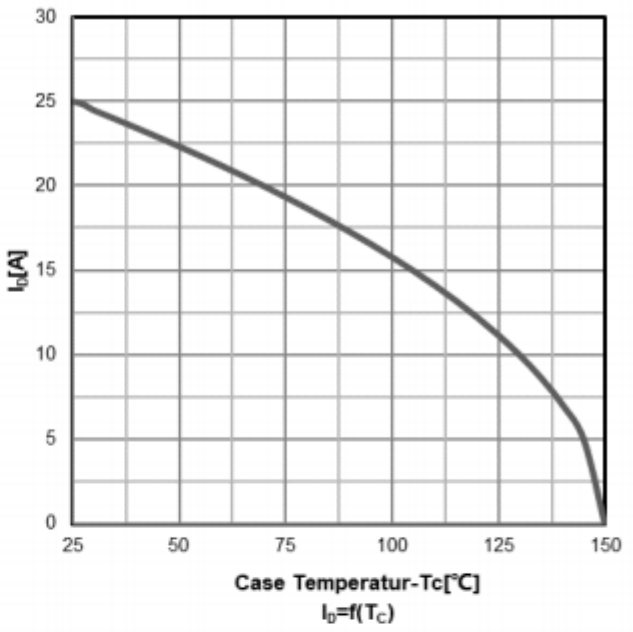
b. $C_{oss(tr)}$ is a fixed capacitance that gives the same charging time as $C_{oss}$ while $V_{DS}$ is rising from 0 % to 80 % $V_{DSS}$

**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

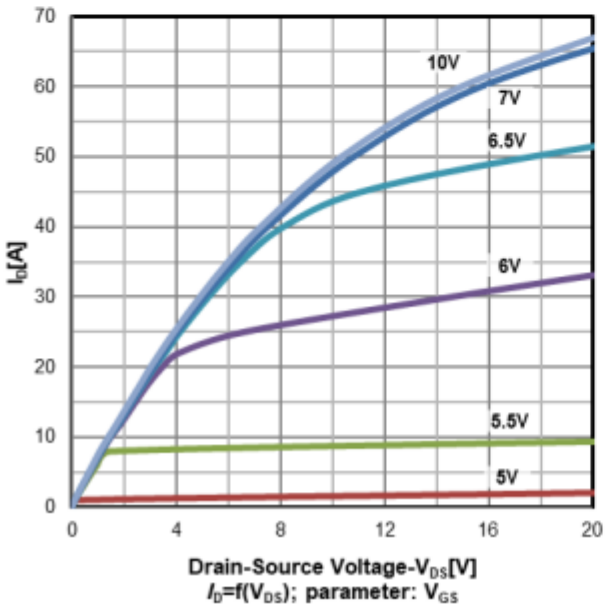
Safe operating area TC=25 ℃
Non FullPAK



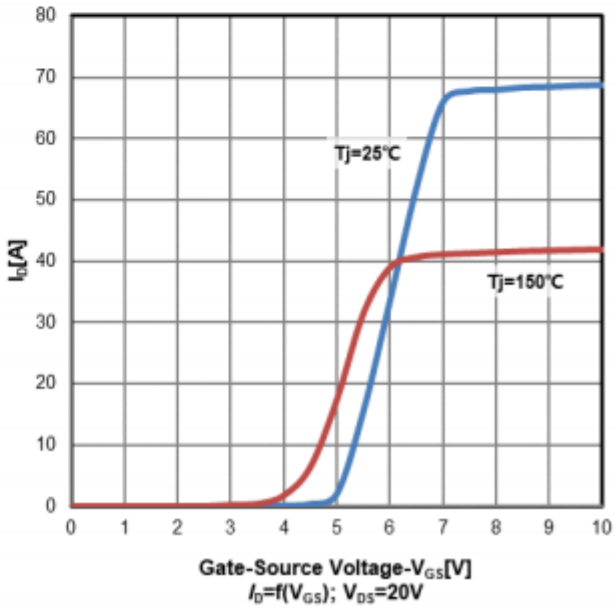

Drain current vs temperature



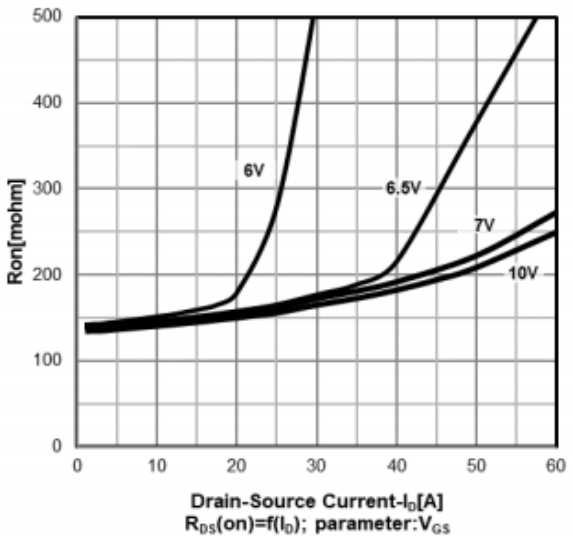

Typ. output characteristics $T_j$=25 ℃



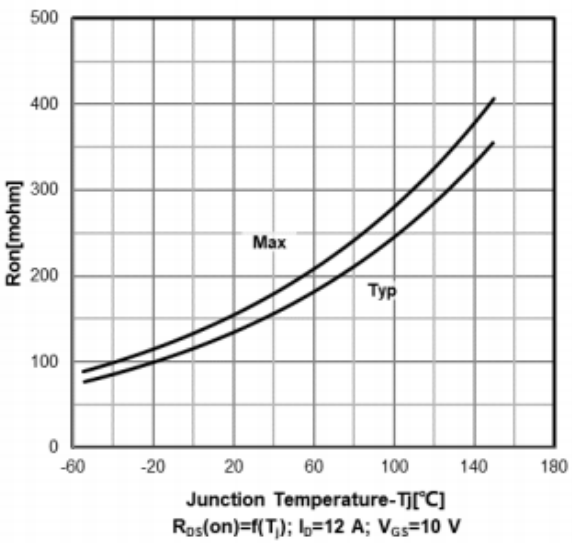

Typ. transfer characteristics



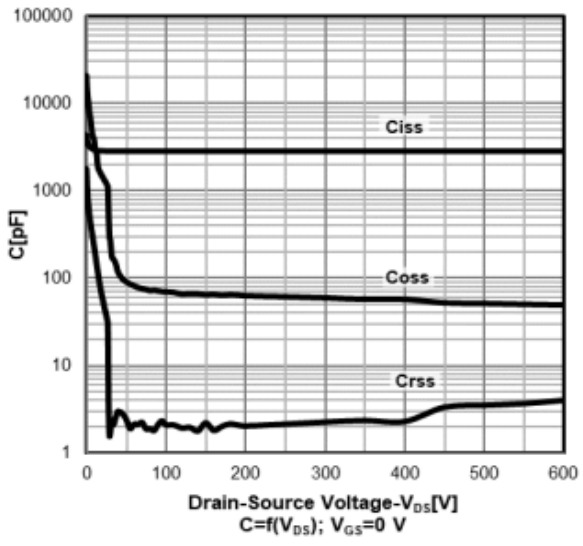
Typ. drain-source on-state resistance



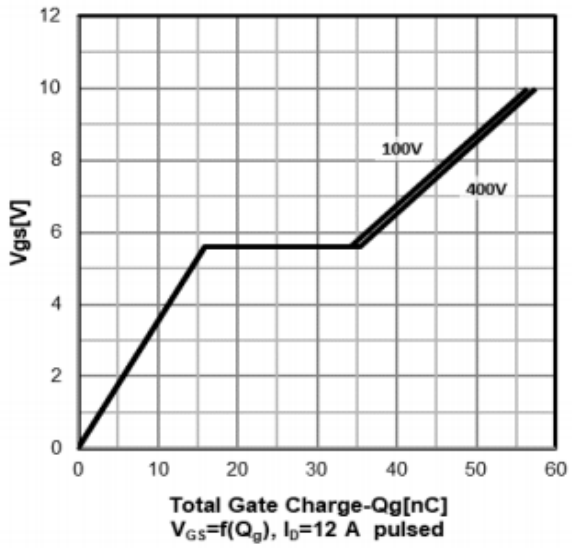

On resistance vs temperature



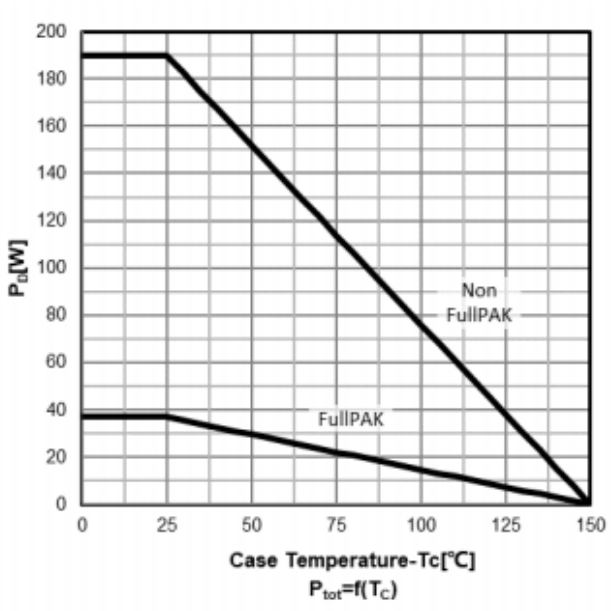

Typ. capacitances



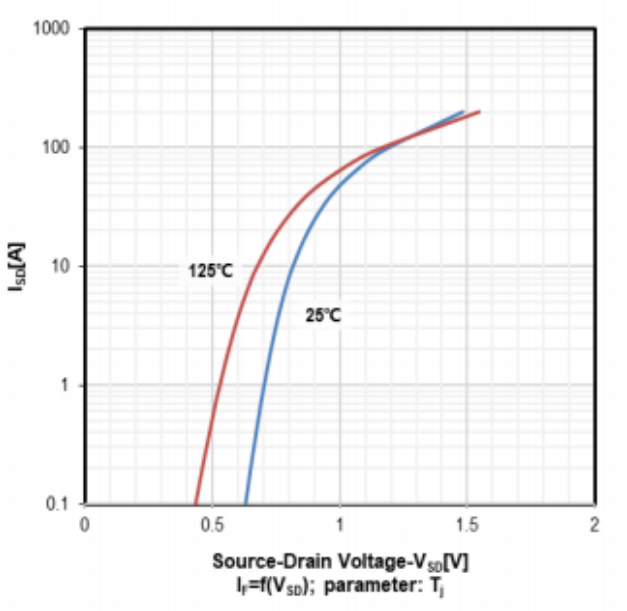

Typ. gate charge characteristics



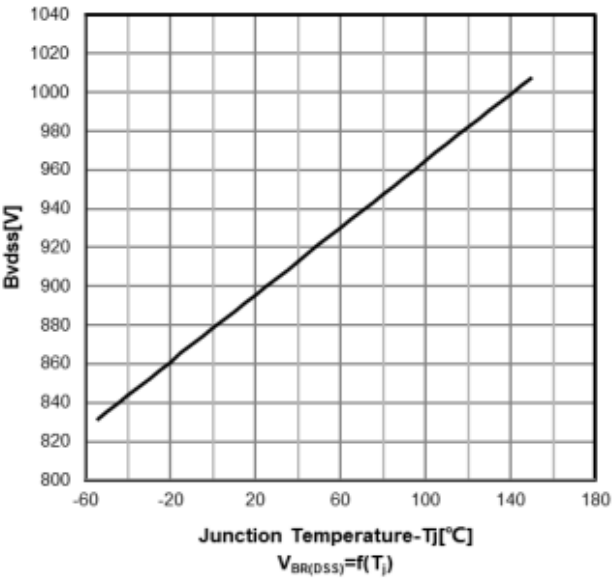
Power dissipation



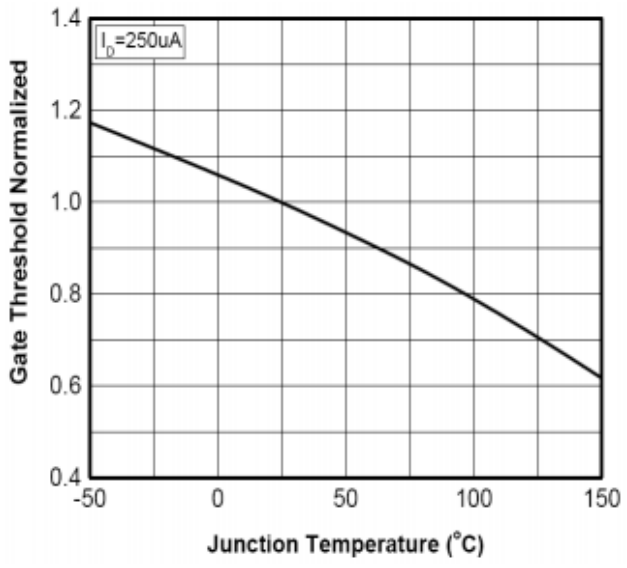

Forward characteristics of reverse diode



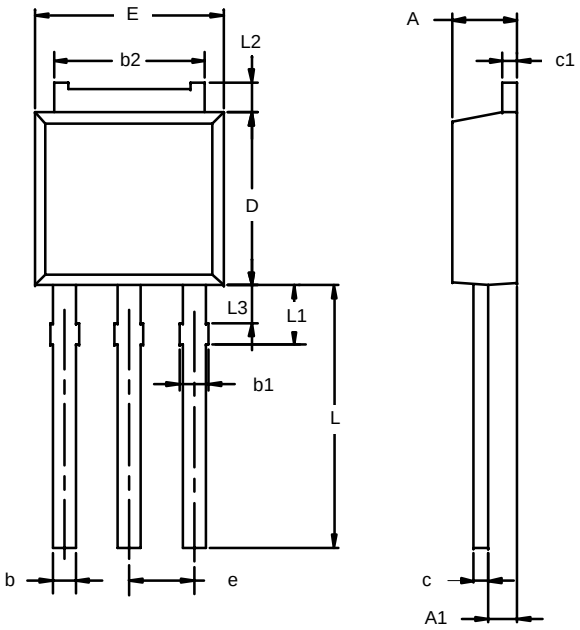

Drain-source breakdown voltage




Normalized $V_{GS(th)}$ characteristics



## TO-251




| Dim | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 2.21 | 2.38 | 0.087 | 0.094 |
| A1 | 0.89 | 1.14 | 0.035 | 0.045 |
| b | 0.71 | 0.89 | 0.028 | 0.035 |
| b1 | 0.76 | 1.14 | 0.030 | 0.045 |
| b2 | 5.23 | 5.43 | 0.206 | 0.214 |
| c | 0.46 | 0.58 | 0.018 | 0.023 |
| c1 | 0.46 | 0.58 | 0.018 | 0.023 |
| D | 5.97 | 6.22 | 0.235 | 0.245 |
| E | 6.48 | 6.73 | 0.255 | 0.265 |
| e | 2.28 BSC | | 0.090 BSC | |
| L | 8.89 | 9.53 | 0.350 | 0.375 |
| L1 | 1.91 | 2.28 | 0.075 | 0.090 |
| L2 | 0.89 | 1.27 | 0.035 | 0.050 |
| L3 | 1.15 | 1.52 | 0.045 | 0.060 |

Note: Dimension L3 is for reference only.

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