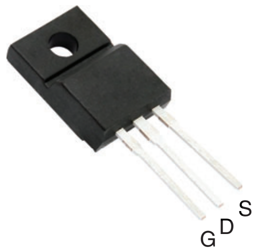
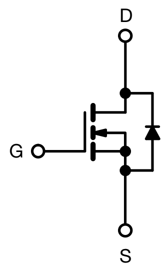
# Power MOSFET

TO-220 FULLPAK




N-Channel MOSFET

## FEATURES

- Isolated package
- High voltage isolation = 2.5 $kV_{RMS}$ (t = 60 s; f = 60 Hz)
- Sink to lead creepage distance = 4.8 mm
- Dynamic dV/dt rating
- Low thermal resistance
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

## DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220 FULLPAK eliminates the need for additional insulating hardware in commercial-industrial applications. The molding compound used provides a high isolation capability and a low thermal resistance between the tab and external heatsink. This isolation is equivalent to using a 100 micron mica barrier with standard TO-220 product. The FULLPAK is mounted to a heatsink using a single clip or by a single screw fixing.

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) | 400 | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = 10 V | 1.0 |
| $Q_g$ max. (nC) | 38 | |
| $Q_{gs}$ (nC) | 5.7 | |
| $Q_{gd}$ (nC) | 22 | |
| Configuration | Single | |

| ORDERING INFORMATION | |
|---|---|
| Package | TO-220 FULLPAK |
| Lead (Pb)-free | IRFI730GPbF |

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

| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DS}$ | 400 | V |
| Gate-source voltage | | | $V_{GS}$ | ± 20 | |
| Continuous drain current | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 3.7 | A |
| | | $T_C$ = 100 °C | | 2.3 | |
| Pulsed drain current [a] | | | $I_{DM}$ | 15 | |
| Linear derating factor | | | | 0.28 | W/°C |
| Single pulse avalanche energy [b] | | | $E_{AS}$ | 200 | mJ |
| Repetitive avalanche current [a] | | | $I_{AR}$ | 3.7 | A |
| Repetitive avalanche energy [a] | | | $E_{AR}$ | 3.5 | mJ |
| Maximum power dissipation | $T_C$ = 25 °C | | $P_D$ | 35 | W |
| Peak diode recovery dV/dt [c] | | | dV/dt | 4.0 | V/ns |
| Operating junction and storage temperature range | | | $T_J$, $T_{stg}$ | -55 to +150 | °C |
| Soldering recommendations (peak temperature) [d] | For 10 s | | | 300 | |
| Mounting torque | M3 screw | | | 0.6 | Nm |

**Notes**

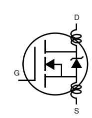
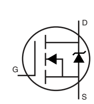
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)

b. $V_{DD}$ = 50 V, starting $T_J$ = 25 °C, L = 25 mH, $R_g$ = 25 Ω, $I_{AS}$ = 3.7 A (see fig. 12)

c. $I_{SD} \leq$ 3.7 A, dI/dt $\leq$ 90 A/μs, $V_{DD} \leq V_{DS}$, $T_J \leq$ 150 °C

d. 1.6 mm from case

| THERMAL RESISTANCE RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TYP.** | **MAX.** | **UNIT** |
| Maximum junction-to-ambient | $R_{thJA}$ | - | 65 | °C/W |
| Maximum junction-to-case (drain) | $R_{thJC}$ | - | 3.6 | |

| **SPECIFICATIONS** ($T_J$ = 25 °C, unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Static** | | | | | | |
| Drain-ssource breakdown voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 μA | 400 | - | - | V |
| $V_{DS}$ temperature coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 0.54 | - | V/°C |
| Gate-source threshold voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | 2.0 | - | 4.0 | V |
| Gate-source leakage | $I_{GSS}$ | $V_{GS}$ = ± 20 V | - | - | ± 100 | nA |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | - | - | 25 | μA |
| | | $V_{DS}$ = 320 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 250 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V; $I_D$ = 2.1 A [b] | - | - | 1.0 | Ω |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 2.1 A [b] | 3.6 | - | - | S |
| **Dynamic** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1.0 MHz, see fig. 5 | - | 700 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 170 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 64 | - | |
| Drain to sink capacitance | C | f = 1.0 MHz | - | 12 | - | |
| Total gate charge | $Q_g$ | $V_{GS}$ = 10 V; $I_D$ = 3.7 A, $V_{DS}$ = 320 V, see fig. 6 and 13 [b] | - | - | 38 | nC |
| Gate-source charge | $Q_{gs}$ | | - | - | 5.7 | |
| Gate-drain charge | $Q_{gd}$ | | - | - | 22 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 200 V, $I_D$ = 3.7 A, $R_g$ = 12 Ω, $R_D$= 57 Ω, see fig. 10 [b] | - | 10 | - | ns |
| Rise time | $t_r$ | | - | 15 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 38 | - | |
| Fall time | $t_f$ | | - | 14 | - | |
| Gate input resistance | $R_g$ | f = 1 MHz, open drain | 0.6 | - | 2.3 | Ω |
| Internal drain inductance | $L_D$ | Between lead, 6 mm (0.25") from package and center of die contact  | - | 4.5 | - | nH |
| Internal source inductance | $L_S$ | | - | 7.5 | - | |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous source-drain diode current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 3.7 | A |
| Pulsed diode forward current [a] | $I_{SM}$ | | - | - | 15 | |
| Body diode voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 3.7 A, $V_{GS}$ = 0 V [b] | - | - | 1.6 | V |
| Body diode reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 3.7 A, dI/dt = 100 A/μs [b] | - | 260 | 530 | ns |
| Body diode reverse recovery charge | $Q_{rr}$ | | - | 1.2 | 2.2 | μC |
| Forward turn-on time | $t_{on}$ | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$) | | | | |

**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)

b. Pulse width ≤ 300 μs; duty cycle ≤ 2 %

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

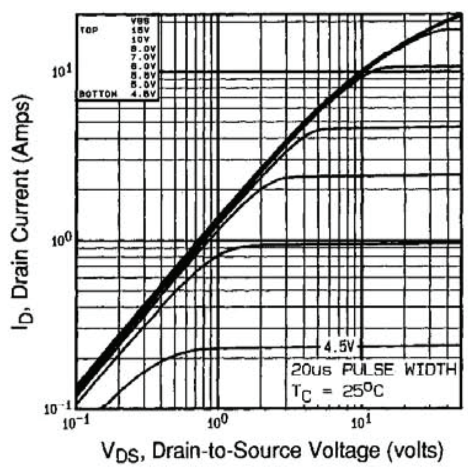



Fig. 1 - Typical Output Characteristics, $T_C$ = 25 °C

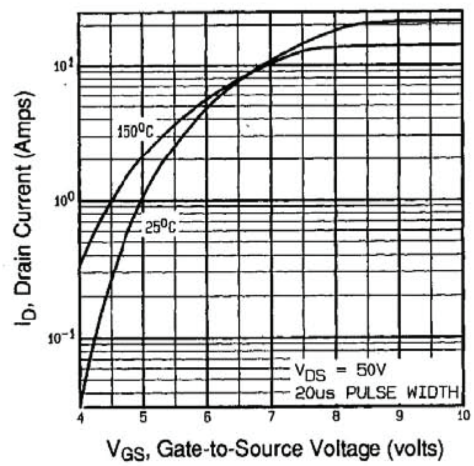



Fig. 3 - Typical Transfer Characteristics

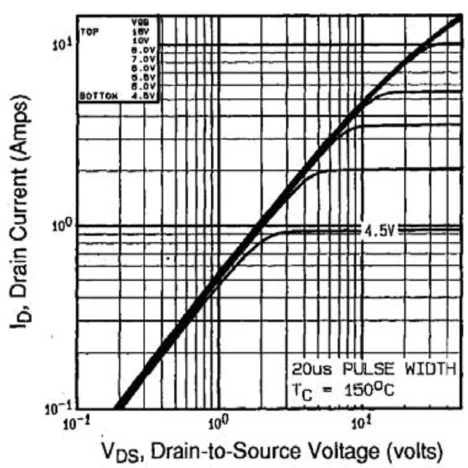



Fig. 2 - Typical Output Characteristics, $T_C$ = 150 °C

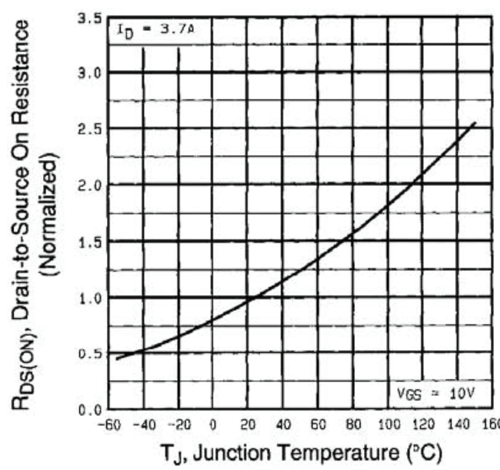



Fig. 4 - Normalized On-Resistance vs. Temperature

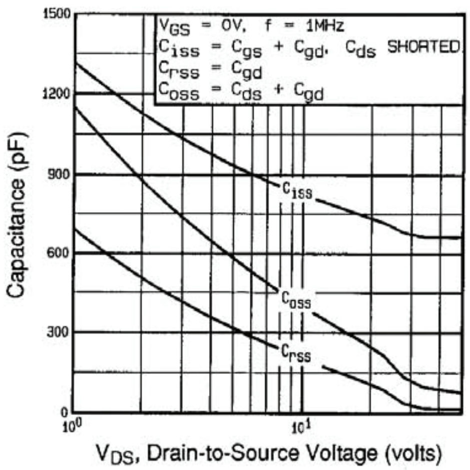



Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

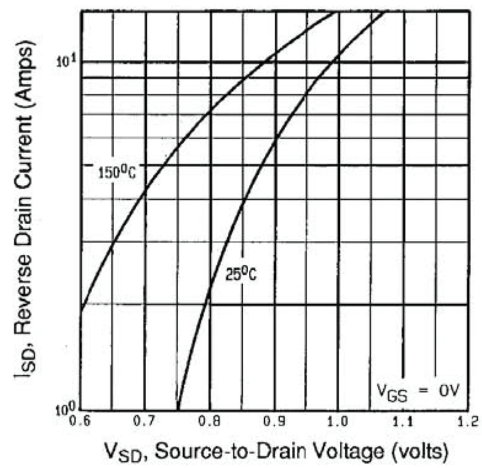



Fig. 7 - Typical Source-Drain Diode Forward Voltage

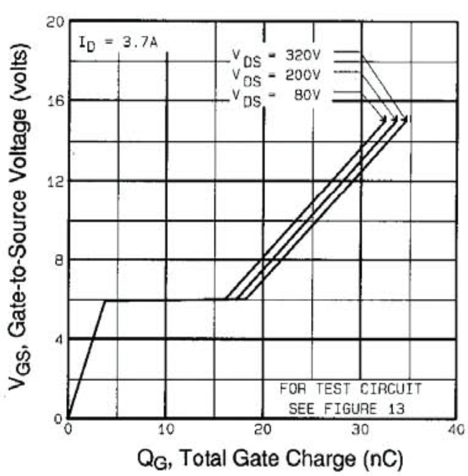



Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

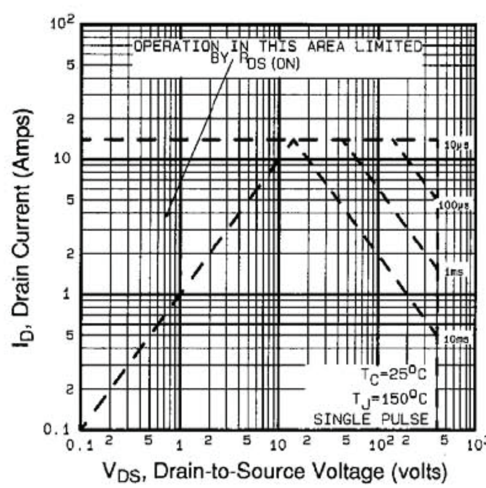



Fig. 8 - Maximum Safe Operating Area

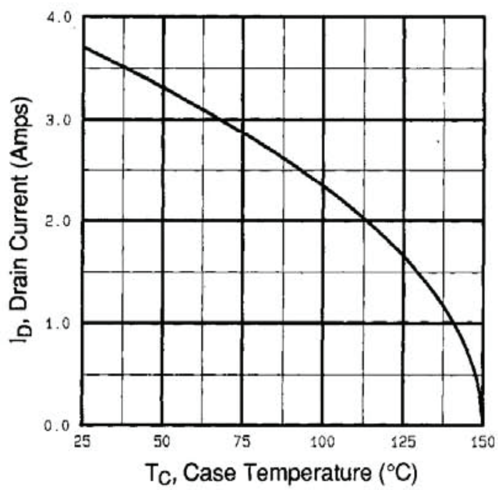



Fig. 9 - Maximum Drain Current vs. Case Temperature

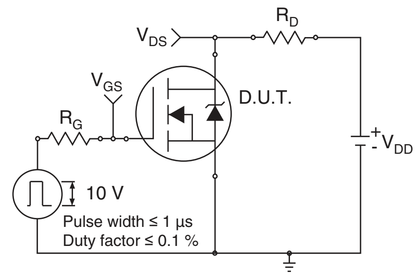



Fig. 10a - Switching Time Test Circuit

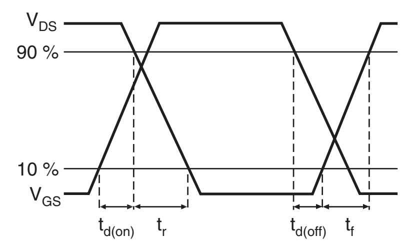



Fig. 10b - Switching Time Waveforms

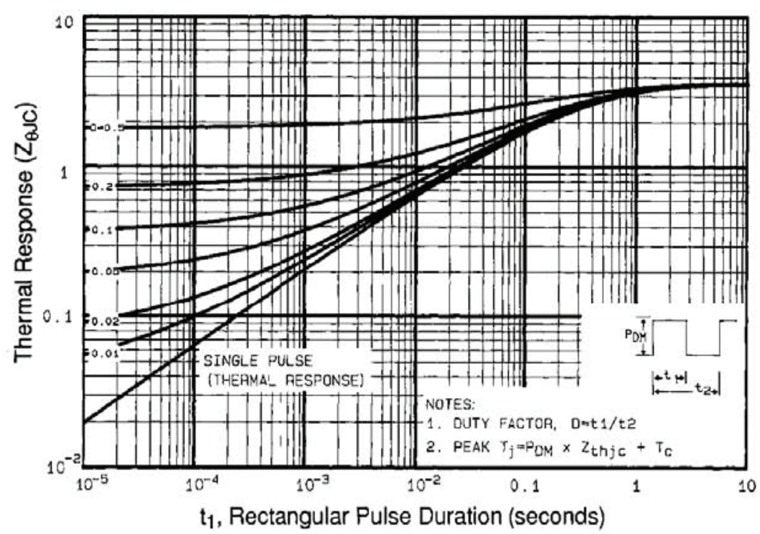



Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

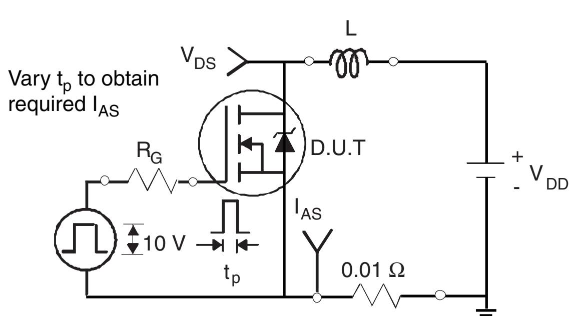



Fig. 12a - Unclamped Inductive Test Circuit

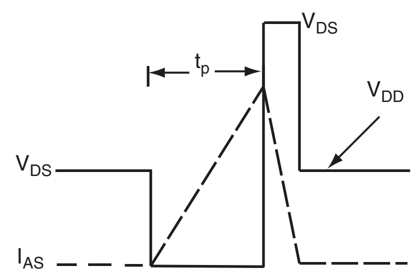



Fig. 12b - Unclamped Inductive Waveforms

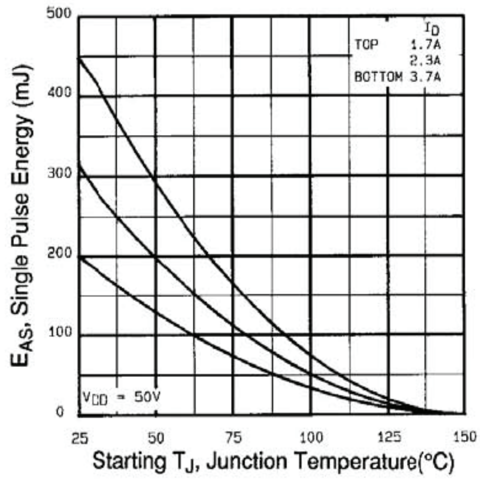



**Fig. 12c - Maximum Avalanche Energy vs. Drain Current**

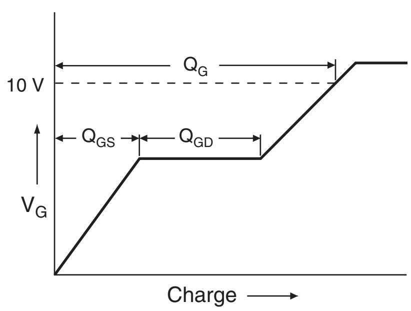



**Fig. 13a - Basic Gate Charge Waveform**

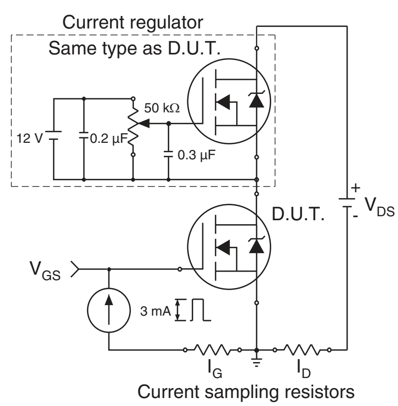
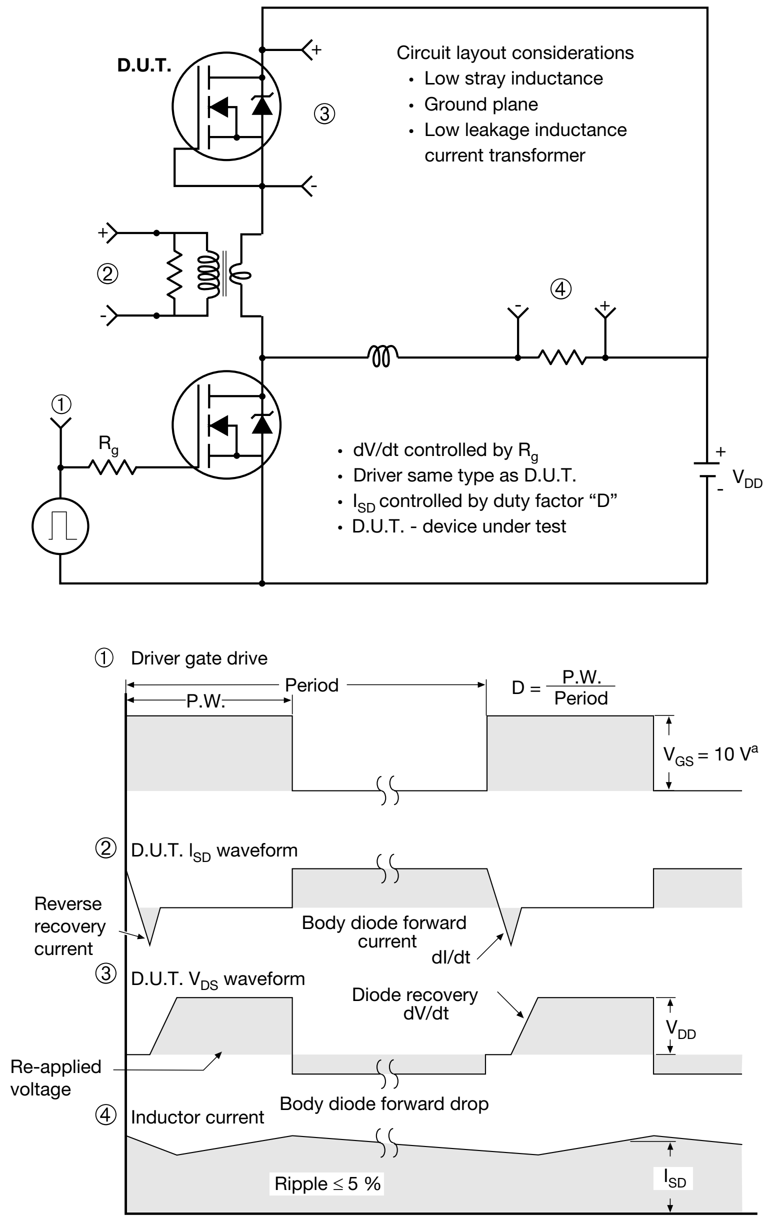



**Fig. 13b - Gate Charge Test Circuit**

**Peak Diode Recovery dV/dt Test Circuit**



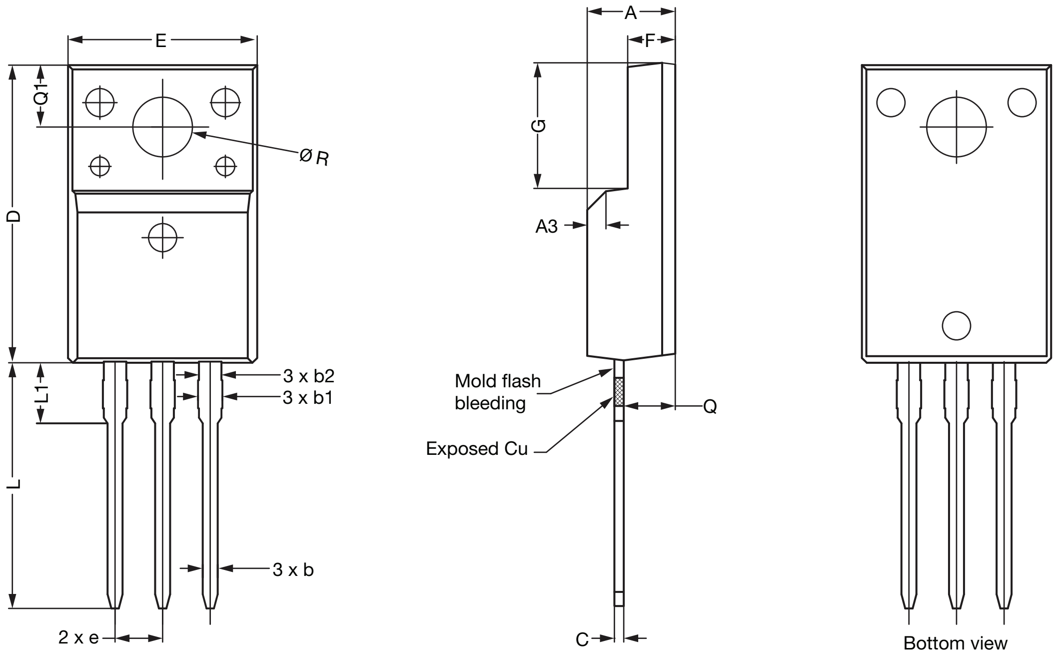

**Note**

a. $V_{GS}$ = 5 V for logic level devices

**Fig. 14 - For N-Channel**

# TO-220 FULLPAK (High Voltage)

## OPTION 1: FACILITY CODE = 9

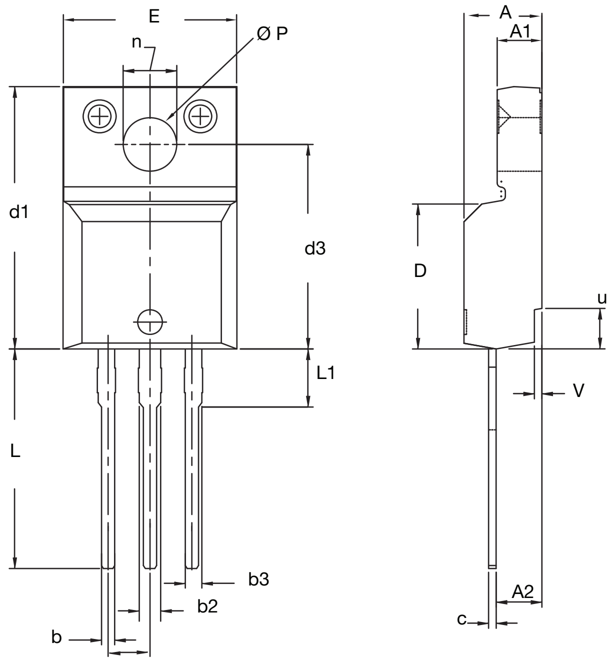



| | MILLIMETERS | | |
|---|---|---|---|
| DIM. | MIN. | NOM. | MAX. |
| A | 4.60 | 4.70 | 4.80 |
| b | 0.70 | 0.80 | 0.91 |
| b1 | 1.20 | 1.30 | 1.47 |
| b2 | 1.10 | 1.20 | 1.30 |
| C | 0.45 | 0.50 | 0.63 |
| D | 15.80 | 15.87 | 15.97 |
| e | | 2.54 BSC | |
| E | 10.00 | 10.10 | 10.30 |
| F | 2.44 | 2.54 | 2.64 |
| G | 6.50 | 6.70 | 6.90 |
| L | 12.90 | 13.10 | 13.30 |
| L1 | 3.13 | 3.23 | 3.33 |
| Q | 2.65 | 2.75 | 2.85 |
| Q1 | 3.20 | 3.30 | 3.40 |
| Ø R | 3.08 | 3.18 | 3.28 |

**Notes**

1. To be used only for process drawing
2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
6. Facility code will be the 1st character located at the 2nd row of the unit marking

**OPTION 2: FACILITY CODE = Y**




| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| **DIM.** | **MIN.** | **MAX.** | **MIN.** | **MAX.** |
| A | 4.570 | 4.830 | 0.180 | 0.190 |
| A1 | 2.570 | 2.830 | 0.101 | 0.111 |
| A2 | 2.510 | 2.850 | 0.099 | 0.112 |
| b | 0.622 | 0.890 | 0.024 | 0.035 |
| b2 | 1.229 | 1.400 | 0.048 | 0.055 |
| b3 | 1.229 | 1.400 | 0.048 | 0.055 |
| c | 0.440 | 0.629 | 0.017 | 0.025 |
| D | 8.650 | 9.800 | 0.341 | 0.386 |
| d1 | 15.88 | 16.120 | 0.622 | 0.635 |
| d3 | 12.300 | 12.920 | 0.484 | 0.509 |
| E | 10.360 | 10.630 | 0.408 | 0.419 |
| e | 2.54 BSC | | 0.100 BSC | |
| L | 13.200 | 13.730 | 0.520 | 0.541 |
| L1 | 3.100 | 3.500 | 0.122 | 0.138 |
| n | 6.050 | 6.150 | 0.238 | 0.242 |
| Ø P | 3.050 | 3.450 | 0.120 | 0.136 |
| u | 2.400 | 2.500 | 0.094 | 0.098 |
| V | 0.400 | 0.500 | 0.016 | 0.020 |
| ECN: E19-0180-Rev. D, 08-Apr-2019<br>DWG: 5972 | | | | |

**Notes**

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2. These dimensions apply to all TO-220 FULLPAK leadframe versions 3 leads
3. All critical dimensions should C meet $C_{pk} > 1.33$
4. All dimensions include burrs and plating thickness
5. No chipping or package damage
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