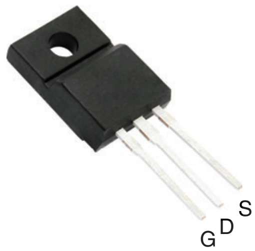
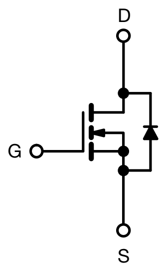
# Power MOSFET

**TO-220 FULLPAK**




N-Channel MOSFET

## FEATURES

- Ultra low gate charge
- Reduced gate drive requirement
- Enhanced 30 V $V_{GS}$ rating
- Isolated package
- High voltage isolation = 2.5 $kV_{RMS}$ (t = 60 s, f = 60 Hz)
- Sink to lead creepage distance = 4.8 mm
- Repetitive avalanche rated
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) | 400 | |
| $R_{DS(on)}$ (Ω) | $V_{GS}$ = 10 V | 0.55 |
| $Q_g$ max. (nC) | 39 | |
| $Q_{gs}$ (nC) | 10 | |
| $Q_{gd}$ (nC) | 19 | |
| Configuration | Single | |

## DESCRIPTION

This series of low charge power MOSFETs achieve significantly lower gate charge over conventional MOSFETs. Utilizing advanced power MOSFETs technology, the device improvements allow for reduced gate drive requirements, faster switching speeds and increased total system savings. These device improvements combined with the proven ruggedness and reliability that are characteristic of Power MOSFETs offer the designer a new standard in power transistors for switching applications.

The TO-220 FULLPAK eliminates the need for additional insulating hardware. The molding compound used provides a high isolation capability and low thermal resistance between the tab and external heatsink.

| ORDERING INFORMATION | |
|---|---|
| Package | TO-220 FULLPAK |
| Lead (Pb)-free | IRFI740GLCPbF |

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

| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DS}$ | 400 | V |
| Gate-source voltage | | | $V_{GS}$ | ± 30 | |
| Continuous drain current | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 5.7 | A |
| | | $T_C$ = 100 °C | | 3.6 | |
| Pulsed drain current [a] | | | $I_{DM}$ | 23 | |
| Linear derating factor | | | | 0.32 | W/°C |
| Single pulse avalanche energy [b] | | | $E_{AS}$ | 310 | mJ |
| Repetitive avalanche current [a] | | | $I_{AR}$ | 5.7 | A |
| Repetitive avalanche energy [a] | | | $E_{AR}$ | 4.0 | mJ |
| Maximum power dissipation | $T_C$ = 25 °C | | $P_D$ | 40 | 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**

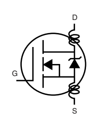
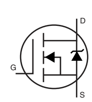
a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)

b. $V_{DD}$ = 50 V, starting $T_J$ = 25 °C, L = 16 mH, $R_g$ = 25 Ω, $I_{AS}$ = 5.7 A (see fig. 12)

c. $I_{SD} \leq$ 10 A, dI/dt $\leq$ 120 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) | $R_{thJC}$ | - | 3.1 | |

| **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 | | - | 0.76 | - | 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 | $I_D$ = 3.4 A [b] | - | - | 0.55 | Ω |
| Forward transconductance | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 6.0 A [b] | | 3.0 | - | - | S |
| **Dynamic** | | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1.0 MHz, see fig. 5 | | - | 1100 | - | pF |
| Output capacitance | $C_{oss}$ | | | - | 190 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | | - | 18 | - | |
| Drain to sink capacitance | C | f = 1.0 MHz | | - | 12 | - | |
| Total gate charge | $Q_g$ | $V_{GS}$ = 10 V | $I_D$ = 10 A, $V_{DS}$ = 320 V, see fig. 6 and 13 [b] | - | - | 39 | nC |
| Gate-source charge | $Q_{gs}$ | | | - | - | 10 | |
| Gate-drain charge | $Q_{gd}$ | | | - | - | 19 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 200 V, $I_D$ = 10 A, $R_g$ = 9.1Ω, $R_D$= 20 Ω, see fig. 10 [b] | | - | 11 | - | ns |
| Rise time | $t_r$ | | | - | 31 | - | |
| Turn-off delay time | $t_{d(off)}$ | | | - | 25 | - | |
| Fall time | $t_f$ | | | - | 20 | - | |
| Gate input resistance | $R_g$ | f = 1 MHz, open drain | | 0.3 | - | 1.7 | 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 |  | - | - | 5.7 | A |
| Pulsed diode forward current [a] | $I_{SM}$ | | | - | - | 23 | |
| Body diode voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 5.7 A, $V_{GS}$ = 0 V [b] | | - | - | 2.0 | V |
| Body diode reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = 10 A, dI/dt = 100 A/μs [b] | | - | 380 | 570 | ns |
| Body diode reverse recovery charge | $Q_{rr}$ | | | - | 2.8 | 4.2 | 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)

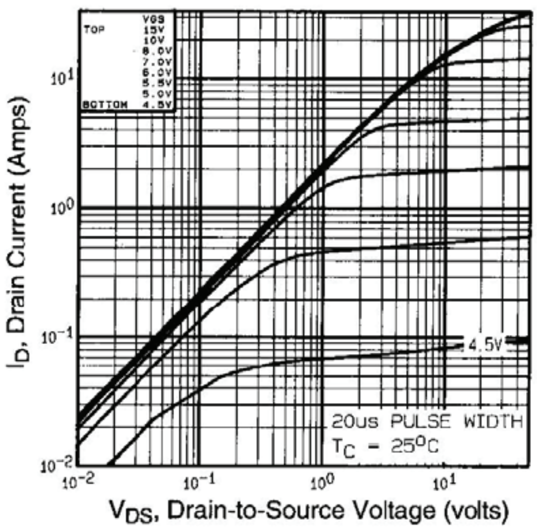



Fig. 1 - Typical Output Characteristics, $T_C$ = 25 °C

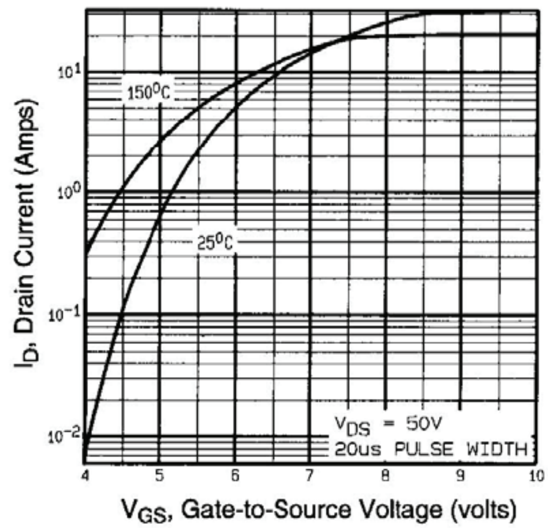



Fig. 3 - Typical Transfer Characteristics

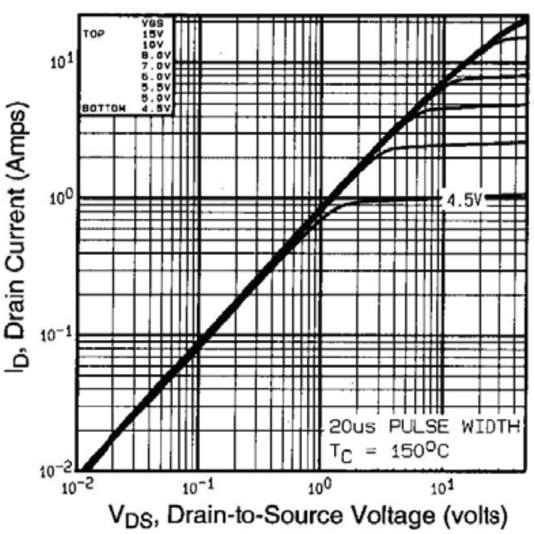



Fig. 2 - Typical Output Characteristics, $T_C$= 150 °C

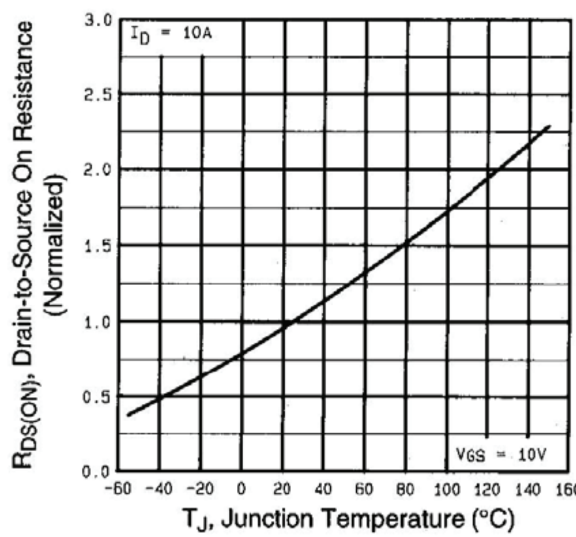



Fig. 4 - Normalized On-Resistance vs. Temperature

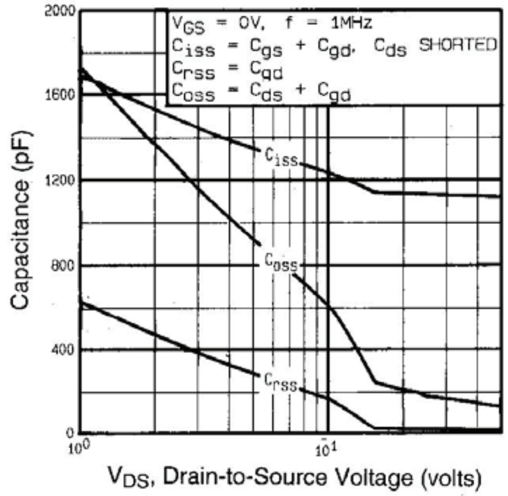



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

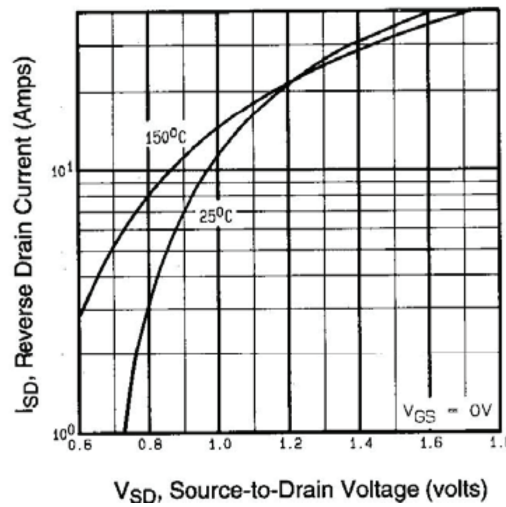



**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

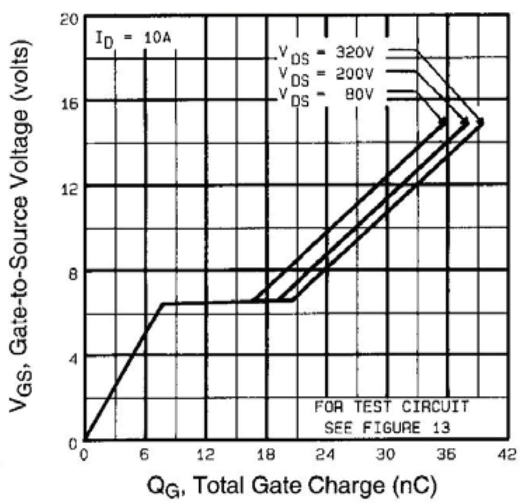



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

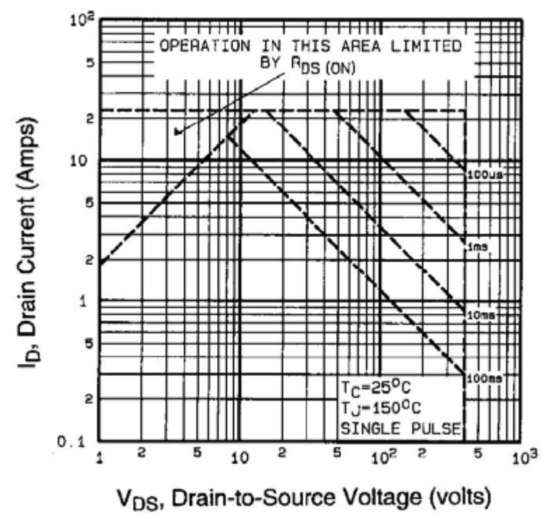



**Fig. 8 - Maximum Safe Operating Area**

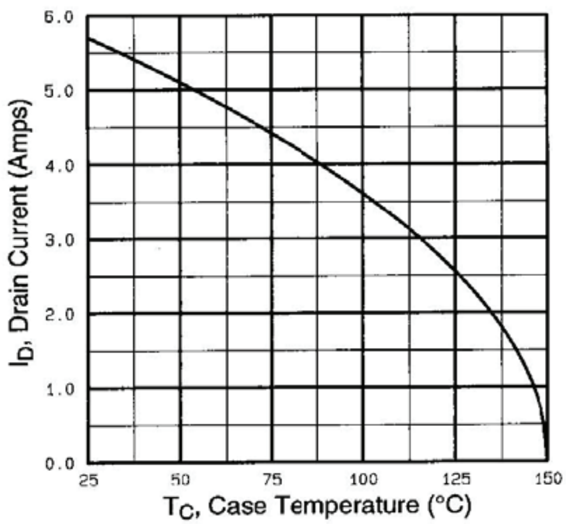



**Fig. 9 - Maximum Drain Current vs. Case Temperature**

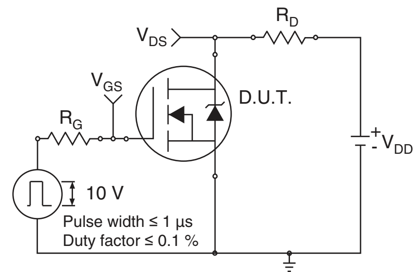



**Fig. 10a - Switching Time Test Circuit**

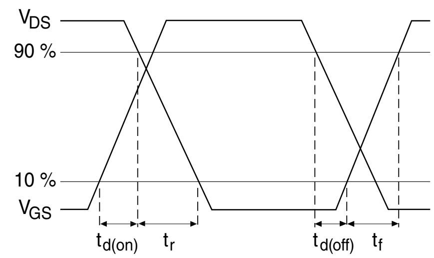



**Fig. 10b - Switching Time Waveforms**

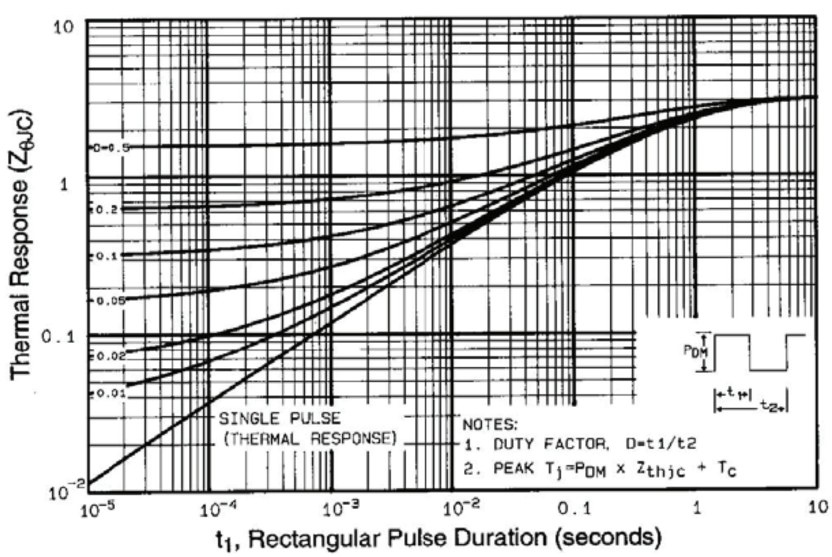



**Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

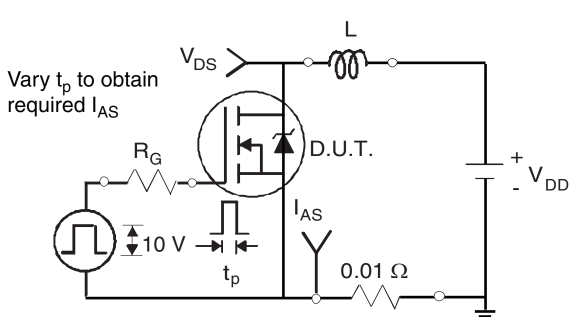



**Fig. 12a - Unclamped Inductive Test Circuit**

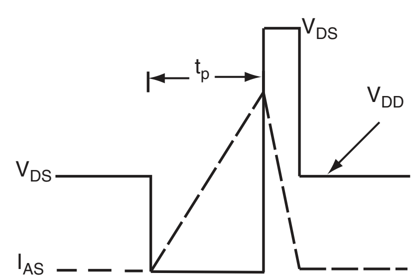



**Fig. 12b - Unclamped Inductive Waveforms**

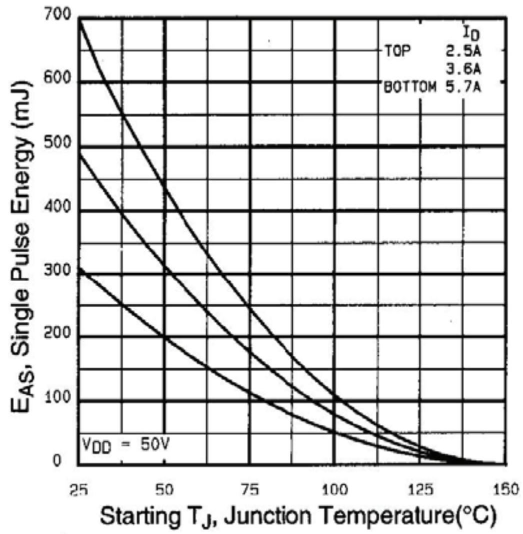



**Fig. 12c - Maximum Avalanche Energy vs. Drain Current**

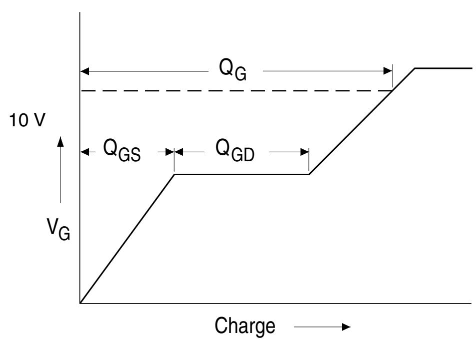



**Fig. 13a - Basic Gate Charge Waveform**

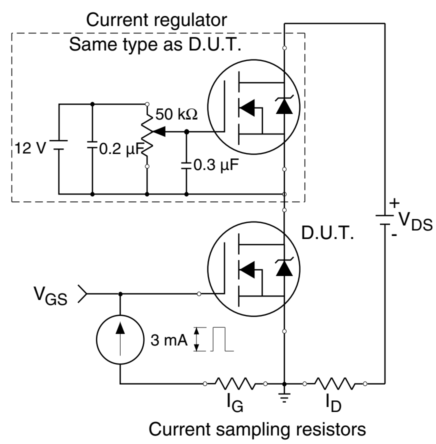
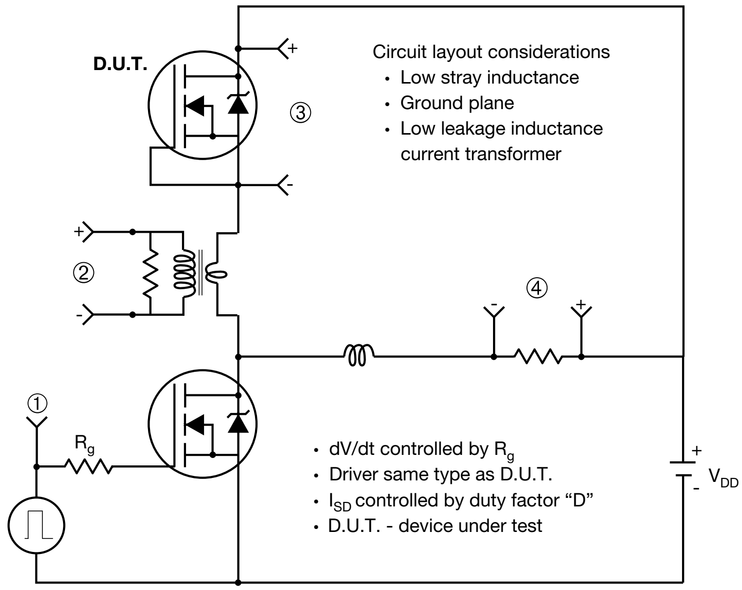
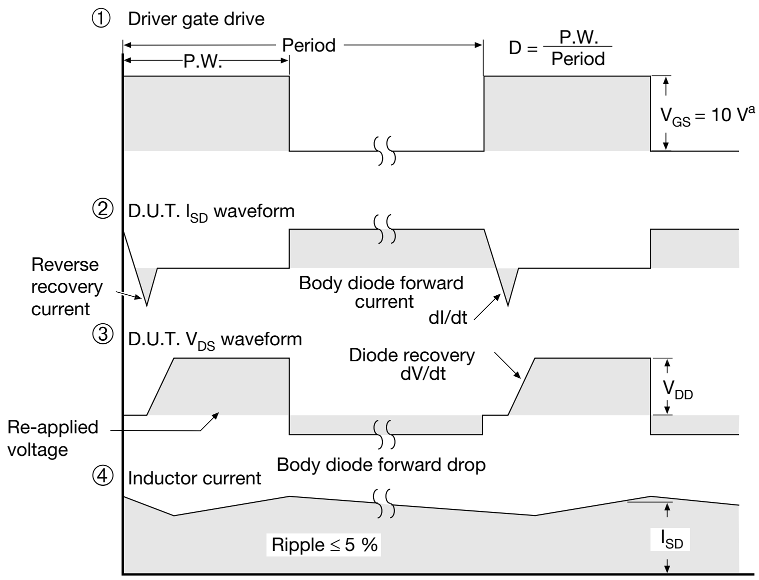



**Fig. 13b - Gate Charge Test Circuit**

### Peak Diode Recovery dV/dt Test Circuit



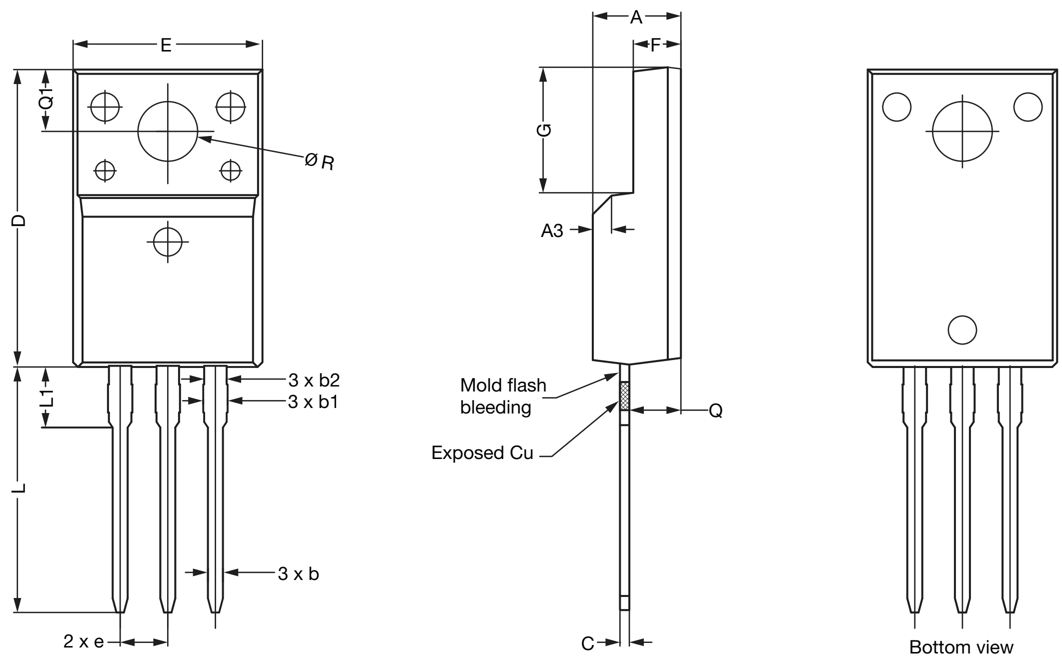

**Note**

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

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

# TO-220 FULLPAK (High Voltage)

## OPTION 1: FACILITY CODE = 9

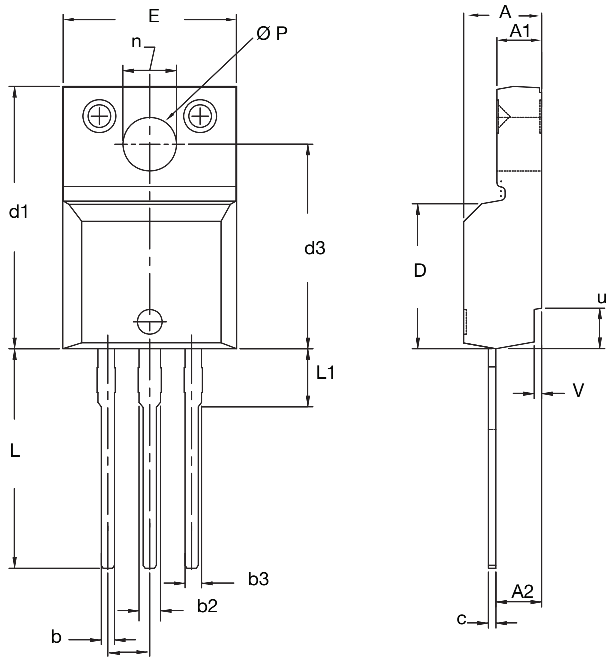



| | MILLIMETERS | | |
|---|---|---|---|
| DIM. | MIN. | NOM. | MAX. |
| A | 4.60 | 4.70 | 4.80 |
| b | 0.70 | 0.80 | 0.91 |
| b1 | 1.20 | 1.30 | 1.47 |
| b2 | 1.10 | 1.20 | 1.30 |
| C | 0.45 | 0.50 | 0.63 |
| D | 15.80 | 15.87 | 15.97 |
| e | 2.54 BSC | | |
| E | 10.00 | 10.10 | 10.30 |
| F | 2.44 | 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
6. Facility code will be the 1st character located at the 2nd row of the unit marking

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