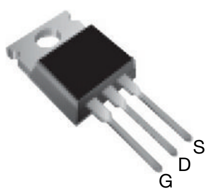
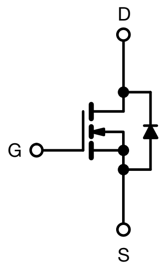
# Power MOSFET

TO-220AB




N-Channel MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) at $T_J$ max. | 550 | |
| $R_{DS(on)}$ typ. (Ω) at 25 °C | $V_{GS}$ = 10 V | 0.740 |
| $Q_g$ max. (nC) | 39 | |
| $Q_{gs}$ (nC) | 9 | |
| $Q_{gd}$ (nC) | 12 | |
| Configuration | Single | |

## FEATURES

- Low figure-of-merit (FOM) $R_{on}$ x $Q_g$
- Low effective capacitance ($C_{o(er)}$)
- Reduced switching and conduction losses
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT
HALOGEN FREE

## 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
  - Solar (PV inverters)

| ORDERING INFORMATION | |
|---|---|
| Package | TO-220AB |
| Lead (Pb)-free and halogen-free | IRF840HPBF |

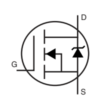
**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25 °C, unless otherwise noted)

| PARAMETER | | | SYMBOL | LIMIT | UNIT |
|---|---|---|---|---|---|
| Drain-source voltage | | | $V_{DS}$ | 500 | V |
| Gate-source voltage | | | $V_{GS}$ | ± 30 | |
| Continuous drain current ($T_J$ = 150 °C) | $V_{GS}$ at 10 V | $T_C$ = 25 °C | $I_D$ | 7.3 | A |
| | | $T_C$ = 100 °C | | 4.6 | |
| Pulsed drain current [a] | | | $I_{DM}$ | 17 | |
| Linear derating factor | | | | 1.0 | W/°C |
| Single pulse avalanche energy [b] | | | $E_{AS}$ | 175 | mJ |
| Maximum power dissipation | | | $P_D$ | 125 | 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 | 100 | V/ns |
| Reverse diode dv/dt [d] | | | | 0.2 | |
| Soldering recommendations (peak temperature) [c] | For 10 s | | | 260 | °C |

**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature
b. $V_{DD}$ = 120 V, starting $T_J$ = 25 °C, L = 14 mH, $R_g$ = 25 Ω, $I_{AS}$ = 5 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) | $R_{thJC}$ | - | 1.0 | |

| **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 | 500 | - | - | V |
| $V_{DS}$ temperature coefficient | $\Delta V_{DS}/T_J$ | Reference to 25 °C, $I_D$ = 1 mA | - | 0.56 | - | 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 | $I_{DSS}$ | $V_{DS}$ = 500 V, $V_{GS}$ = 0 V | - | - | 1 | μA |
| | | $V_{DS}$ = 400 V, $V_{GS}$ = 0 V, $T_J$ = 125 °C | - | - | 100 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ = 4.8 A | - | 0.740 | 0.850 | Ω |
| Forward transconductance [a] | $g_{fs}$ | $V_{DS}$ = 50 V, $I_D$ = 4.8 A | - | 2.8 | - | S |
| **Dynamic** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 25 V, f = 1 MHz | - | 1059 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 125 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 14 | - | |
| Effective output capacitance, energy related [a] | $C_{o(er)}$ | $V_{DS}$ = 0 V to 400 V, $V_{GS}$ = 0 V | - | 40 | - | |
| Effective output capacitance, time related [b] | $C_{o(tr)}$ | | - | 72 | - | |
| Total gate charge | $Q_g$ | $V_{GS}$ = 10 V, $I_D$ = 8 A, $V_{DS}$ = 400 V | - | 26 | 39 | nC |
| Gate-source charge | $Q_{gs}$ | | - | 9 | - | |
| Gate-drain charge | $Q_{gd}$ | | - | 12 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 400 V, $I_D$ = 8 A, $V_{GS}$ = 10 V, $R_g$ = 9.1 Ω | - | 15 | 30 | ns |
| Rise time | $t_r$ | | - | 30 | 60 | |
| Turn-off delay time | $t_{d(off)}$ | | - | 23 | 46 | |
| Fall time | $t_f$ | | - | 17 | 34 | |
| Gate input resistance | $R_g$ | f = 1 MHz, open drain | 0.5 | 1.0 | 2.0 | Ω |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous source-drain diode current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 7.3 | A |
| Pulsed diode forward current | $I_{SM}$ | | - | - | 17 | |
| Diode forward voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 8 A, $V_{GS}$ = 0 V | - | - | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = $I_S$ = 8 A, di/dt = 100 A/μs, $V_R$ = 25 V | - | 441 | 882 | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 2.9 | 5.8 | μC |
| Reverse recovery current | $I_{RRM}$ | | - | 12 | - | A |

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

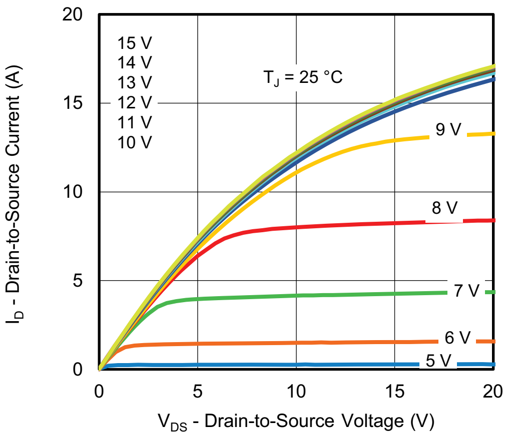



**Fig. 1 - Typical Output Characteristics**

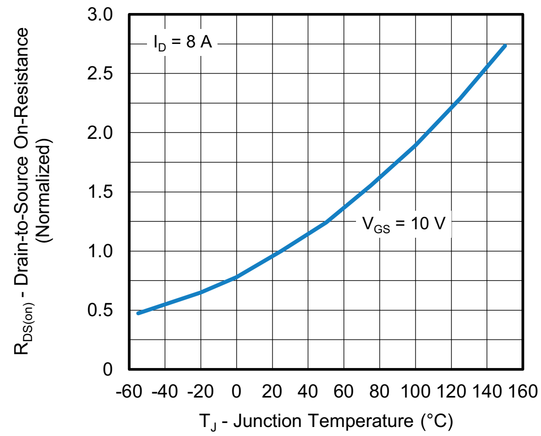



**Fig. 4 - Normalized On-Resistance vs. Temperature**

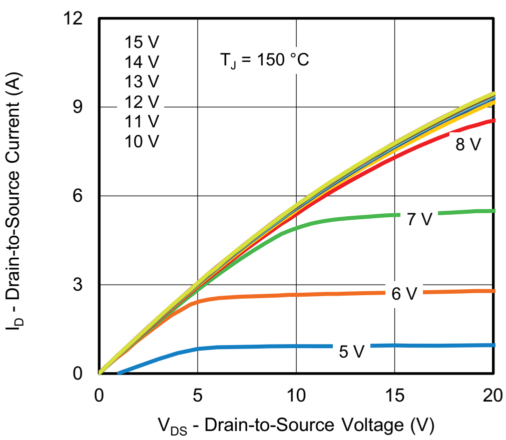



**Fig. 2 - Typical Output Characteristics**

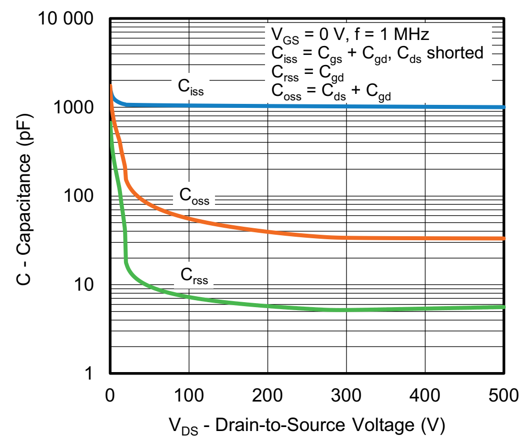



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

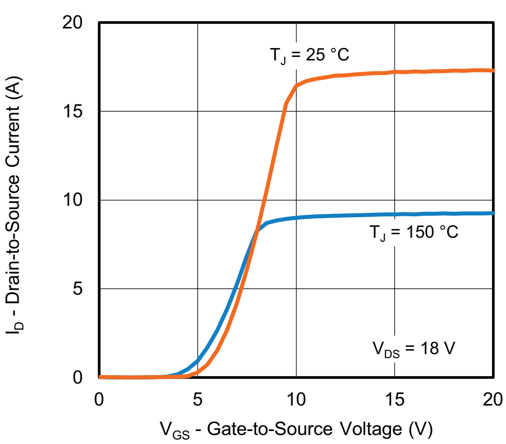



**Fig. 3 - Typical Transfer Characteristics**

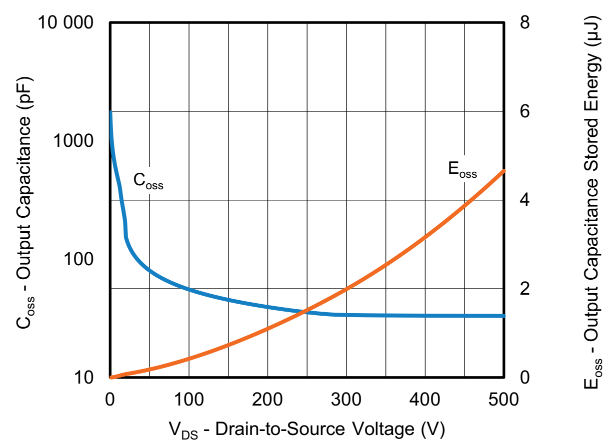



**Fig. 6 - $C_{oss}$ and $E_{oss}$ vs. $V_{DS}$**

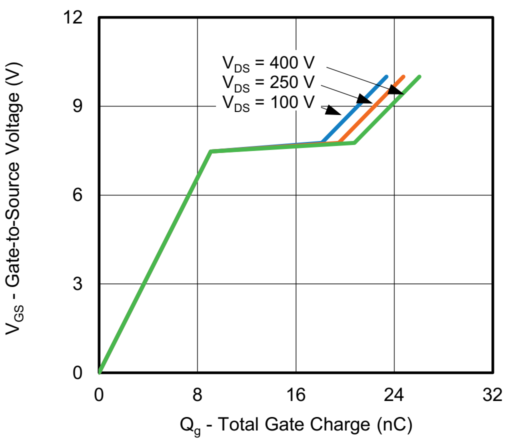



**Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage**

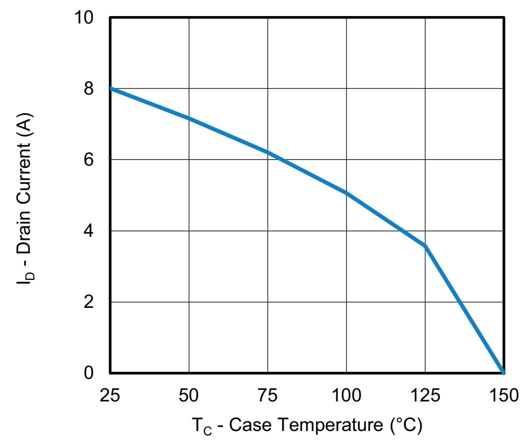



**Fig. 10 - Maximum Drain Current vs. Case Temperature**

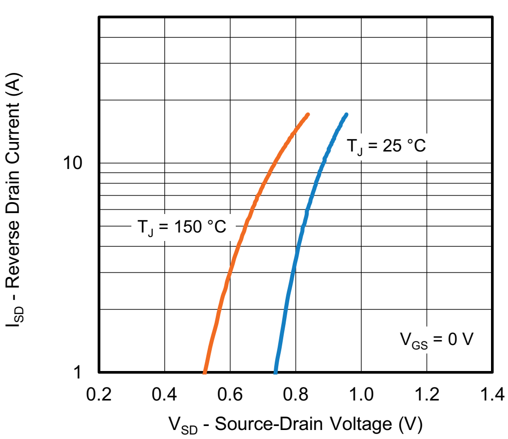



**Fig. 8 - Typical Source-Drain Diode Forward Voltage**

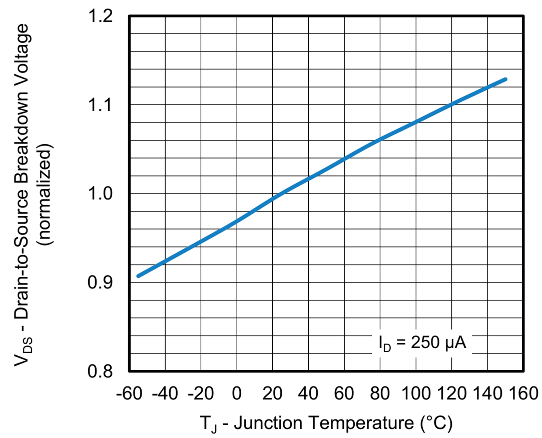



**Fig. 11 - Temperature vs. Drain-to-Source Voltage**

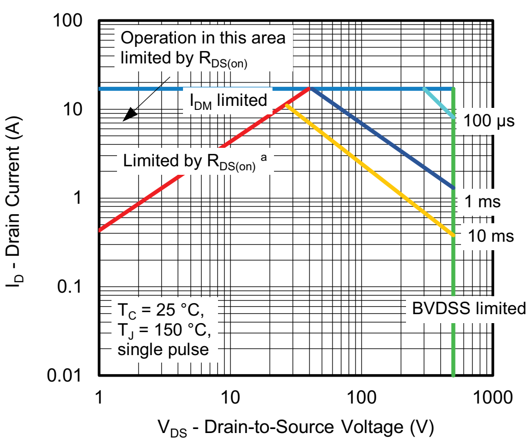



**Fig. 9 - Maximum Safe Operating Area**

**Note**

a. $V_{GS}$ > minimum $V_{GS}$ at which $R_{DS(on)}$ is specified

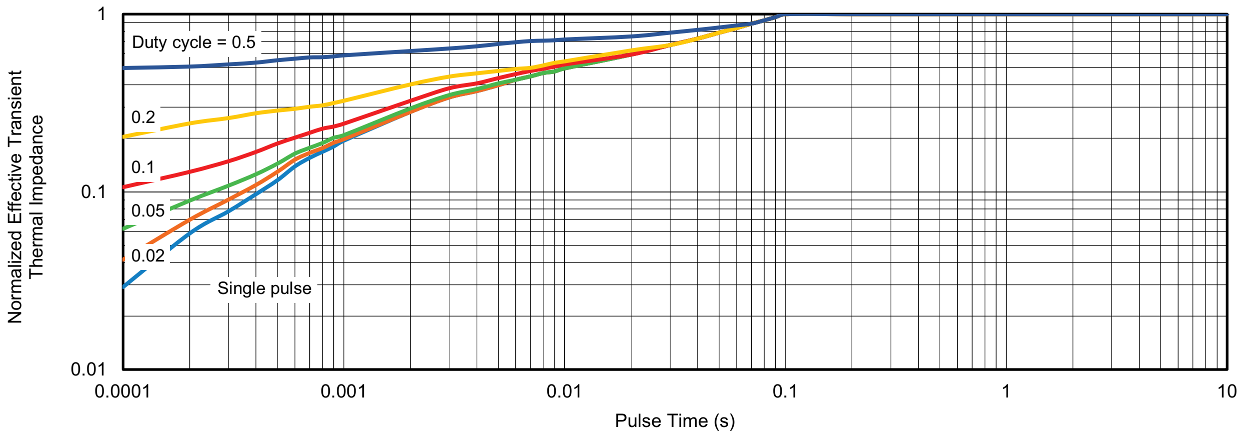



**Fig. 12 - Normalized Transient Thermal Impedance, Junction-to-Case**

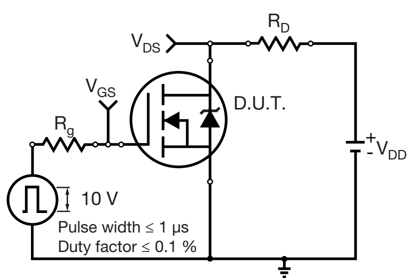



**Fig. 13 - Switching Time Test Circuit**

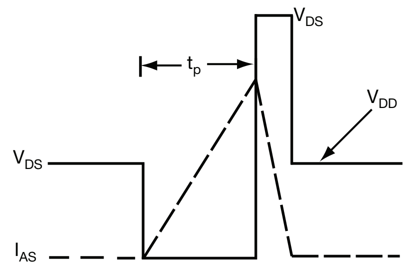



**Fig. 16 - Unclamped Inductive Waveforms**

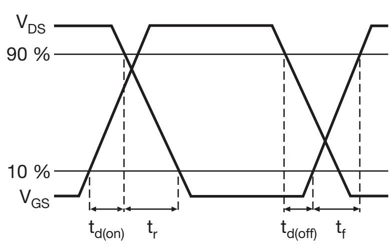



**Fig. 14 - Switching Time Waveforms**

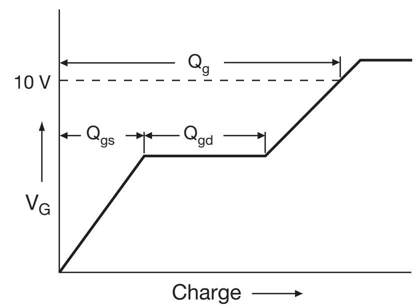



**Fig. 17 - Basic Gate Charge Waveform**

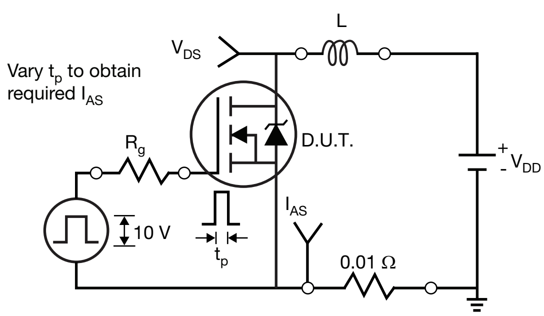



**Fig. 15 - Unclamped Inductive Test Circuit**

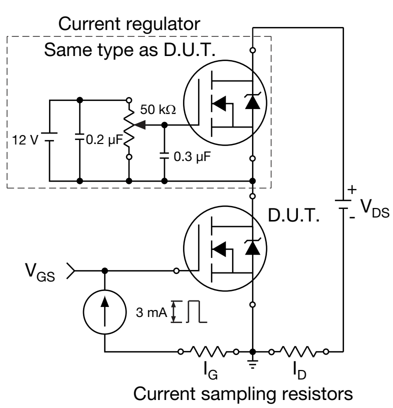
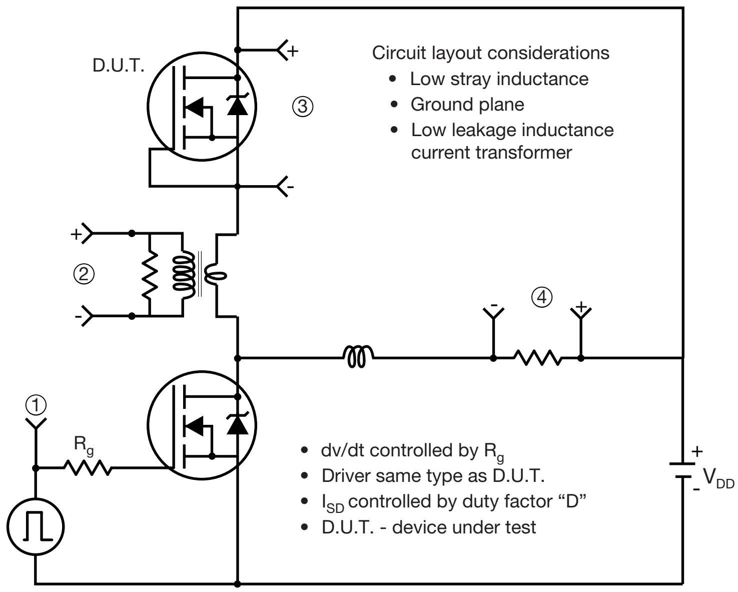
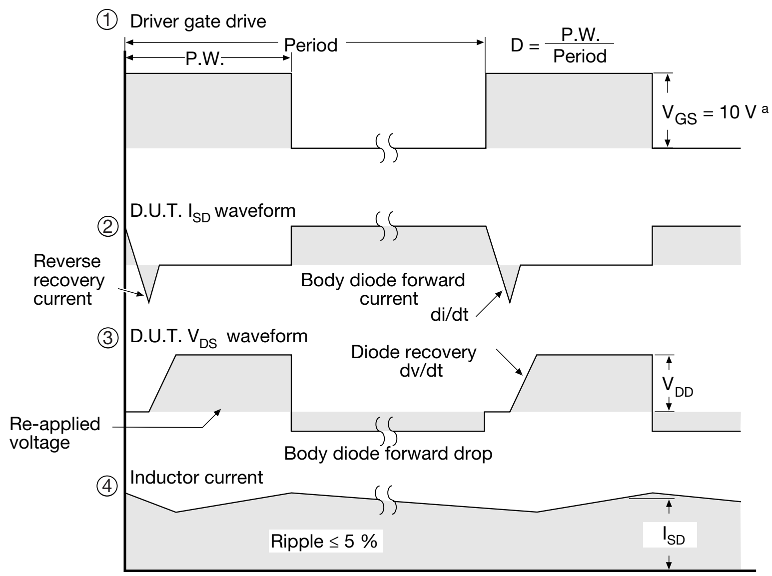



**Fig. 18 - Gate Charge Test Circuit**

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




**Note**

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

**Fig. 19 - For N-Channel**

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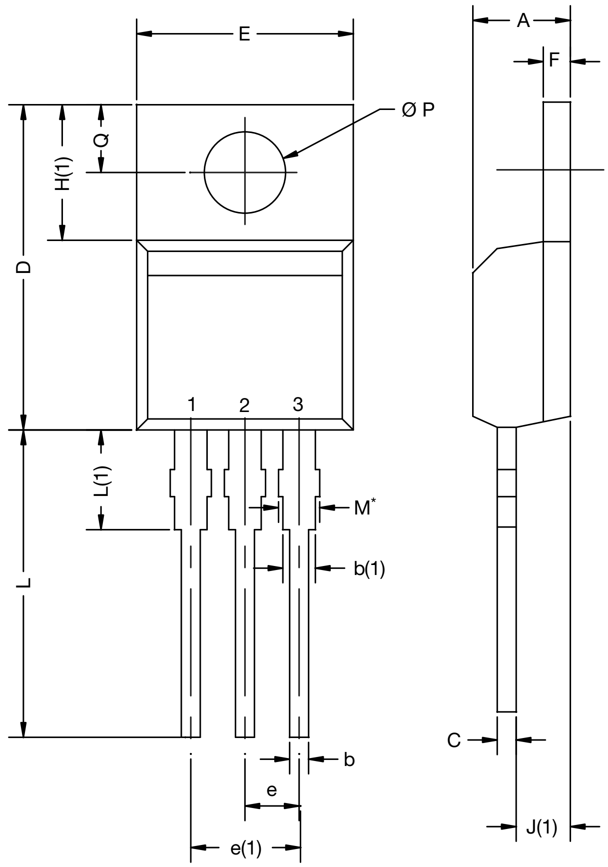
# TO-220-1




| DIM. | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.24 | 4.65 | 0.167 | 0.183 |
| b | 0.69 | 1.02 | 0.027 | 0.040 |
| b(1) | 1.14 | 1.78 | 0.045 | 0.070 |
| c | 0.36 | 0.61 | 0.014 | 0.024 |
| D | 14.33 | 15.85 | 0.564 | 0.624 |
| E | 9.96 | 10.52 | 0.392 | 0.414 |
| e | 2.41 | 2.67 | 0.095 | 0.105 |
| e(1) | 4.88 | 5.28 | 0.192 | 0.208 |
| F | 1.14 | 1.40 | 0.045 | 0.055 |
| H(1) | 6.10 | 6.71 | 0.240 | 0.264 |
| J(1) | 2.41 | 2.92 | 0.095 | 0.115 |
| L | 13.36 | 14.40 | 0.526 | 0.567 |
| L(1) | 3.33 | 4.04 | 0.131 | 0.159 |
| Ø P | 3.53 | 3.94 | 0.139 | 0.155 |
| Q | 2.54 | 3.00 | 0.100 | 0.118 |

ECN: E21-0621-Rev. D, 04-Nov-2021
DWG: 6031

**Note**

- M* = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM

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