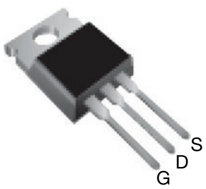
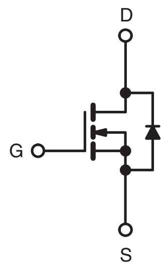
# E Series Power MOSFET

| PRODUCT SUMMARY | | |
|---|---|---|
| $V_{DS}$ (V) at $T_J$ max. | 700 | |
| $R_{DS(on)}$ max. at 25 °C (Ω) | $V_{GS}$ = 10 V | 0.145 |
| $Q_g$ max. (nC) | 122 | |
| $Q_{gs}$ (nC) | 21 | |
| $Q_{gd}$ (nC) | 37 | |
| Configuration | Single | |

TO-220AB




N-Channel MOSFET

## 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)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

HALOGEN FREE Available

## 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)

| ORDERING INFORMATION | |
|---|---|
| Package | TO-220AB |
| Lead (Pb)-free | SiHP24N65E-E3 |
| Lead (Pb)-free and Halogen-free | SiHP24N65E-GE3 |

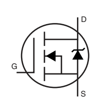
**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25 °C, unless otherwise noted)

| 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 | $I_D$ | 24 | A |
| | | $T_C$ = 100 °C | | 16 | |
| Pulsed Drain Current [a] | | | $I_{DM}$ | 70 | |
| Linear Derating Factor | | | | 2 | W/°C |
| Single Pulse Avalanche Energy [b] | | | $E_{AS}$ | 508 | mJ |
| Maximum Power Dissipation | | | $P_D$ | 250 | 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 | 37 | V/ns |
| Reverse Diode dV/dt [d] | | | | 11 | |
| Soldering Recommendations (Peak Temperature) [c] | for 10 s | | | 300 | °C |

**Notes**

a. Repetitive rating; pulse width limited by maximum junction temperature.
b. $V_{DD}$ = 50 V, starting $T_J$ = 25 °C, L = 28.2 mH, $R_g$ = 25 Ω, $I_{AS}$ = 6 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) | $R_{thJC}$ | - | 0.5 | |

| **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, $I_D$ = 250 μA | - | 0.72 | - | V/°C |
| Gate-Source Threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | 2 | - | 4 | 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, $I_D$ = 12 A | - | 0.120 | 0.145 | Ω |
| Forward Transconductance | $g_{fs}$ | $V_{DS}$ = 8 V, $I_D$ = 5 A | - | 7.1 | - | S |
| **Dynamic** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{GS}$ = 0 V, $V_{DS}$ = 100 V, f = 1 MHz | - | 2740 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 122 | - | |
| 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 | - | 93 | - | |
| Effective Output Capacitance, Time Related [b] | $C_{o(tr)}$ | | - | 352 | - | |
| Total Gate Charge | $Q_g$ | $V_{GS}$ = 10 V, $I_D$ = 12 A, $V_{DS}$ = 520 V | - | 81 | 122 | nC |
| Gate-Source Charge | $Q_{gs}$ | | - | 21 | - | |
| Gate-Drain Charge | $Q_{gd}$ | | - | 37 | - | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = 520 V, $I_D$ = 12 A, $V_{GS}$ = 10 V, $R_g$ = 9.1 Ω | - | 24 | 48 | ns |
| Rise Time | $t_r$ | | - | 84 | 126 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 70 | 105 | |
| Fall Time | $t_f$ | | - | 69 | 104 | |
| Gate Input Resistance | $R_g$ | f = 1 MHz, open drain | - | 0.68 | - | Ω |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 24 | A |
| Pulsed Diode Forward Current | $I_{SM}$ | | - | - | 70 | |
| Diode Forward Voltage | $V_{SD}$ | $T_J$ = 25 °C, $I_S$ = 12 A, $V_{GS}$ = 0 V | - | - | 1.2 | V |
| Reverse Recovery Time | $t_{rr}$ | $T_J$ = 25 °C, $I_F$ = $I_S$ = 12 A, dI/dt = 100 A/μs, $V_R$ = 25 V | - | 433 | - | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | - | 7.3 | - | μC |
| Reverse Recovery Current | $I_{RRM}$ | | - | 28 | - | 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)

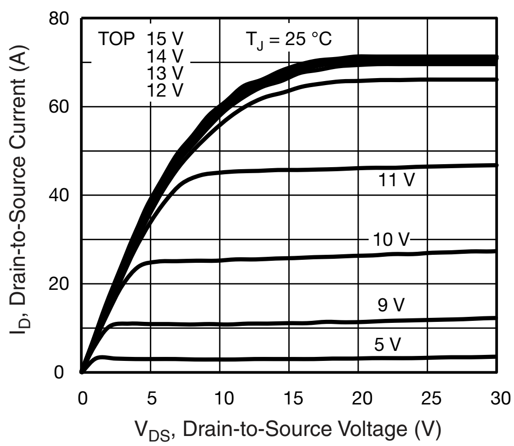



**Fig. 1 - Typical Output Characteristics**

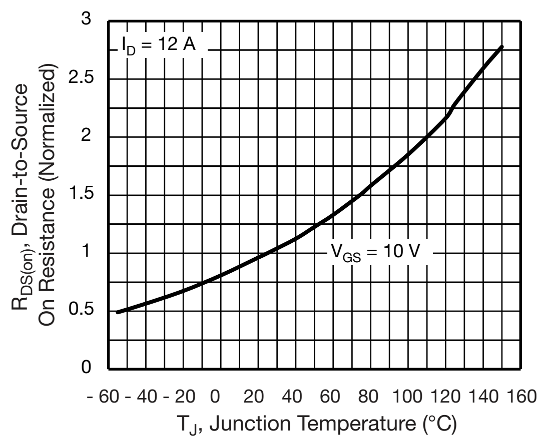



**Fig. 4 - Normalized On-Resistance vs. Temperature**

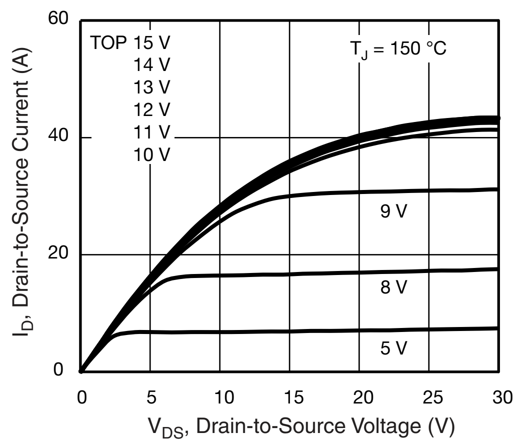



**Fig. 2 - Typical Output Characteristics**

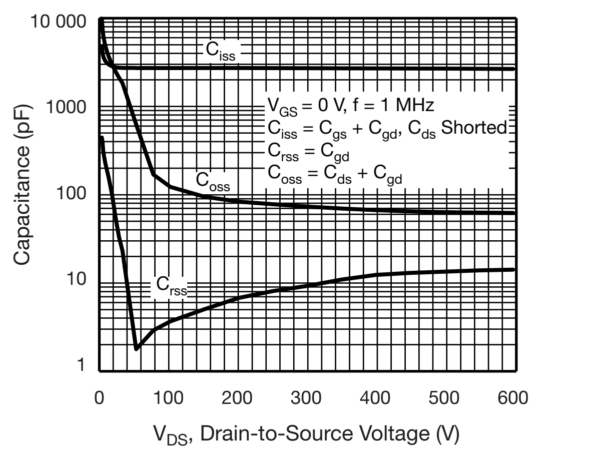



**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**

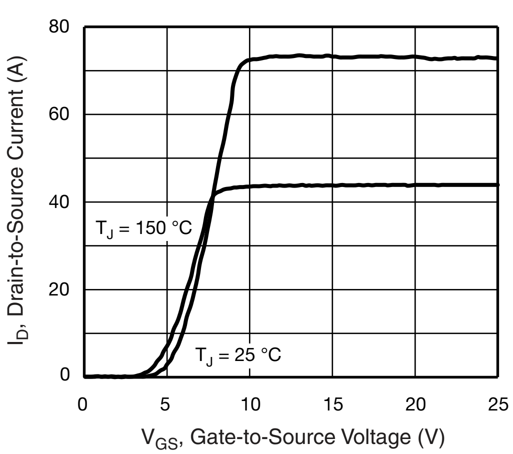



**Fig. 3 - Typical Transfer Characteristics**

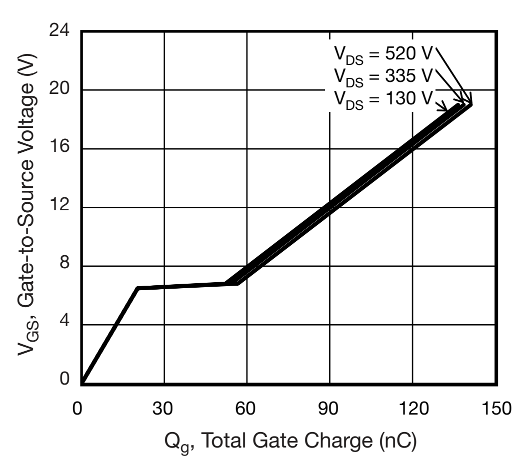



**Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage**

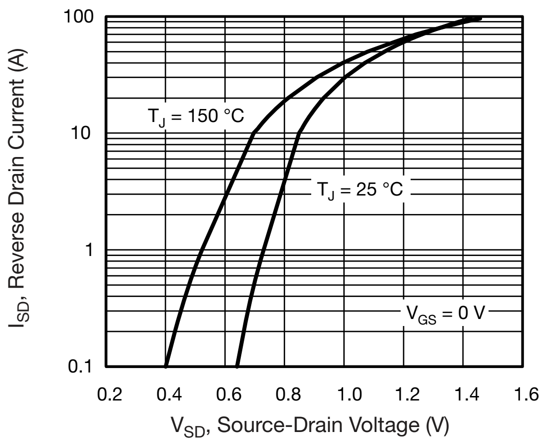



**Fig. 7 - Typical Source-Drain Diode Forward Voltage**

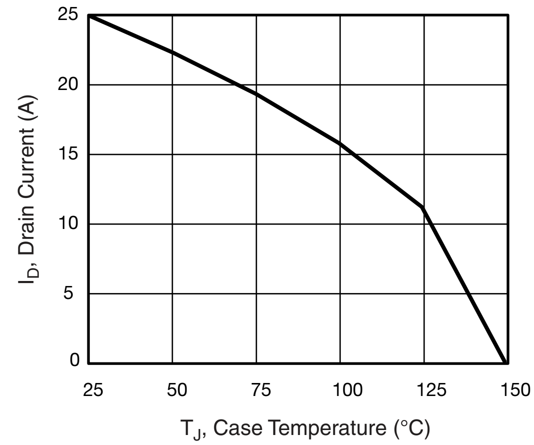



**Fig. 9 - Maximum Drain Current vs. Case Temperature**

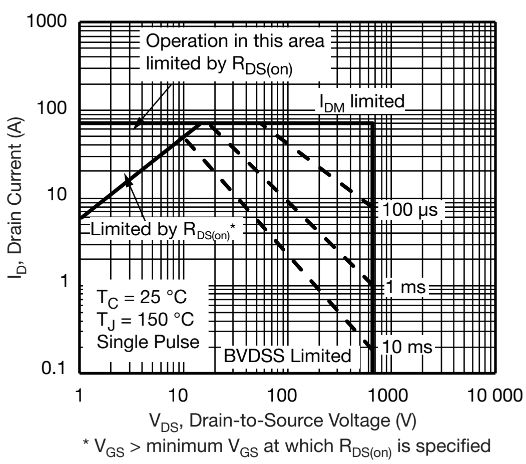



**Fig. 8 - Maximum Safe Operating Area**

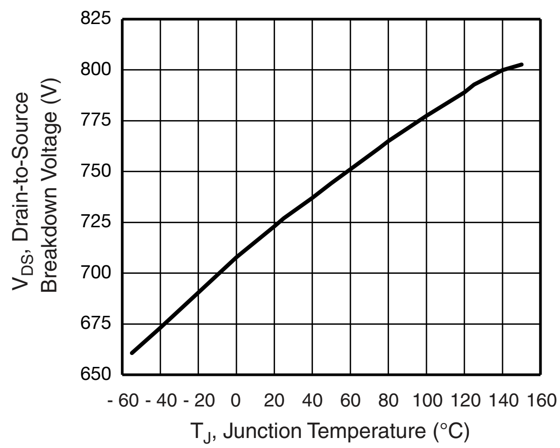



**Fig. 10 - Temperature vs. Drain-to-Source Voltage**

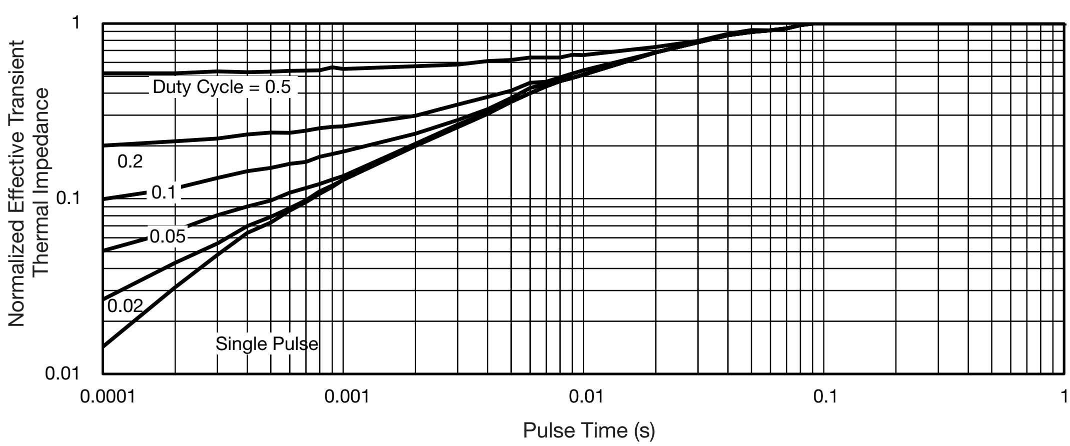



**Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case**

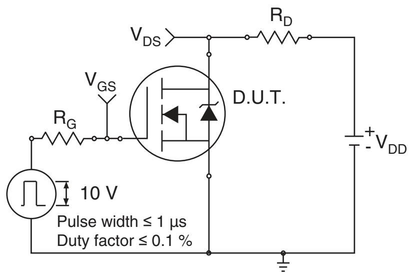



**Fig. 12 - Switching Time Test Circuit**

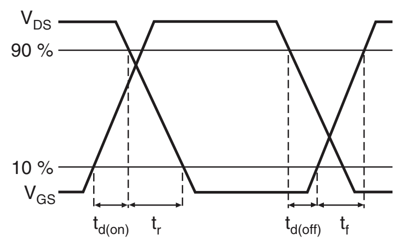



**Fig. 13 - Switching Time Waveforms**

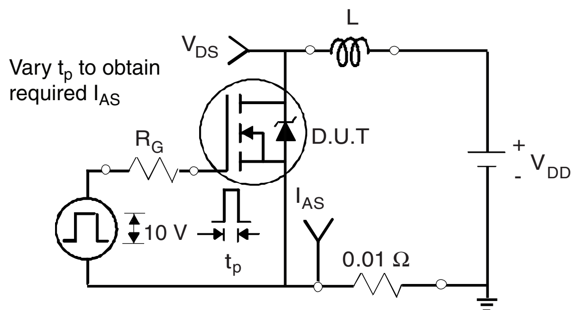



**Fig. 14 - Unclamped Inductive Test Circuit**

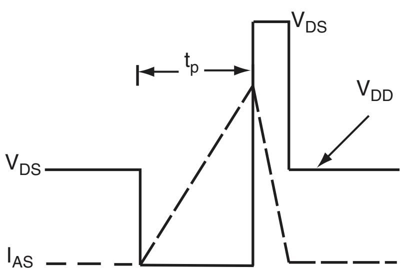



**Fig. 15 - Unclamped Inductive Waveforms**

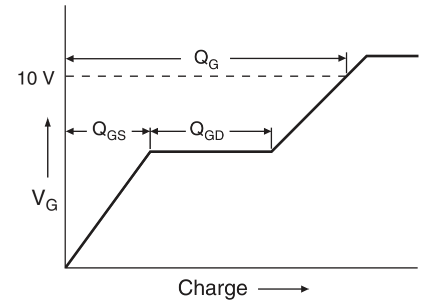



**Fig. 16 - Basic Gate Charge Waveform**

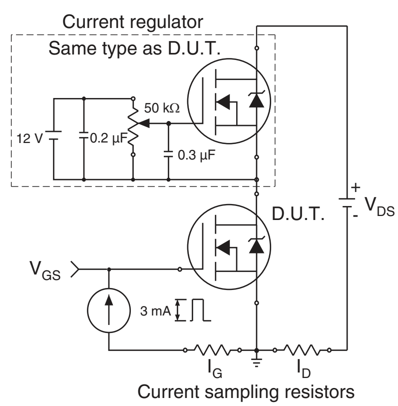
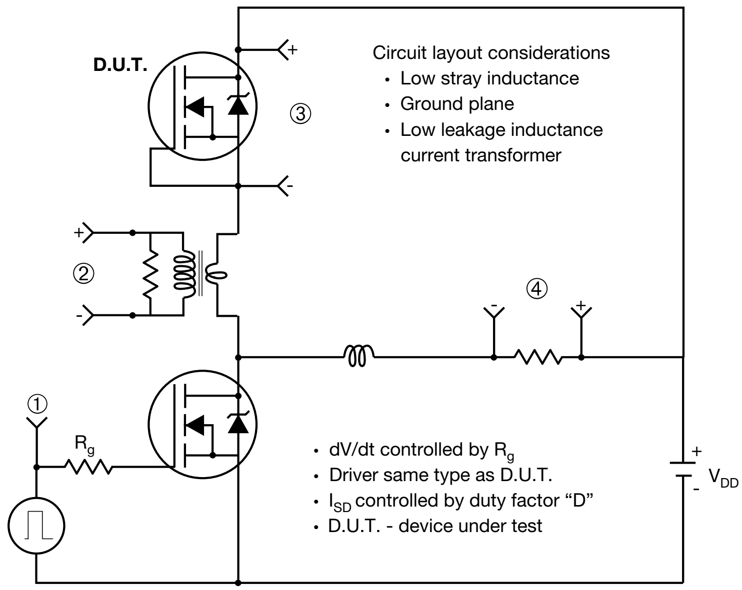
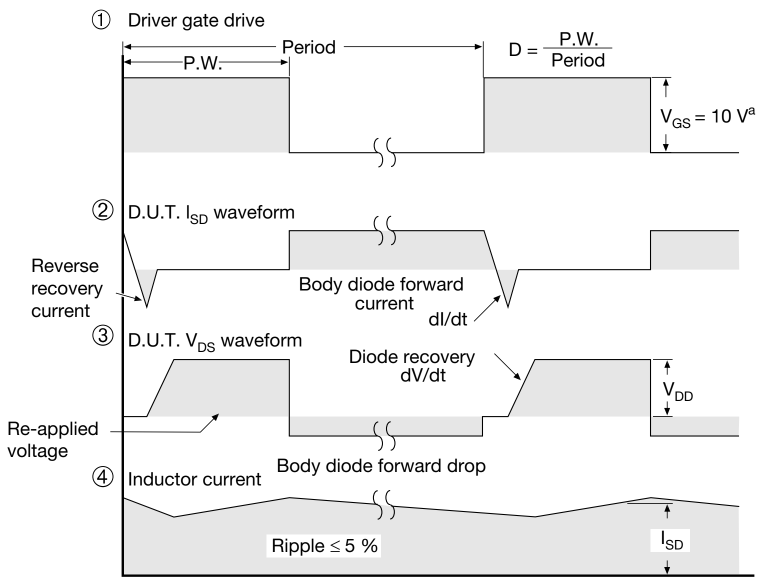



**Fig. 17 - Gate Charge Test Circuit**

## Peak Diode Recovery dV/dt Test Circuit




**Note**

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

**Fig. 18 - For N-Channel**

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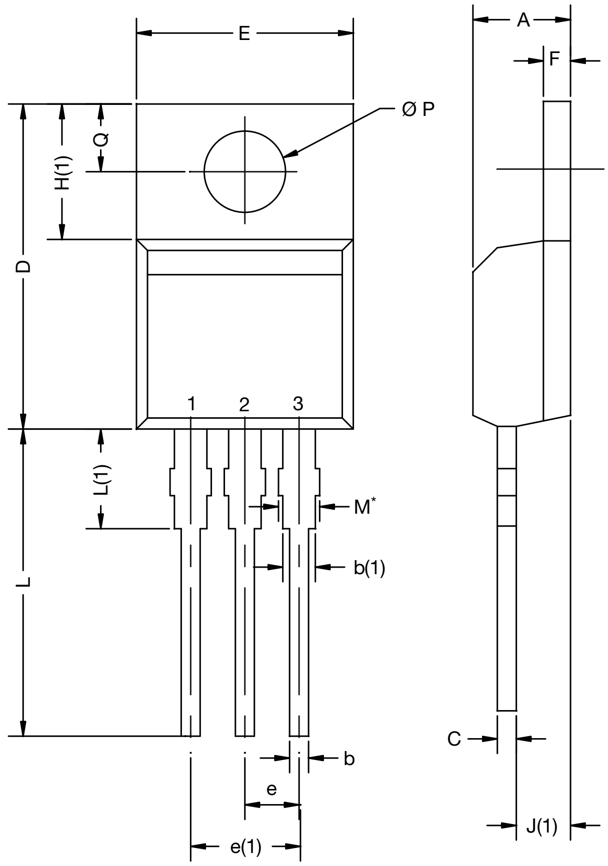
# TO-220-1

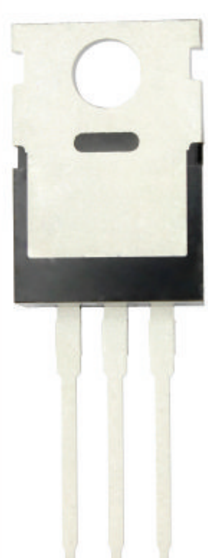
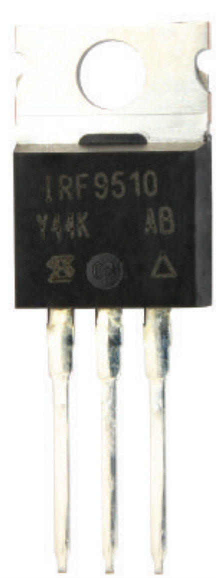
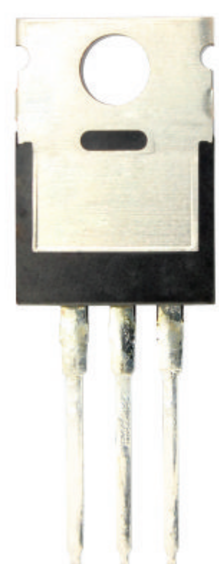



| DIM. | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.24 | 4.65 | 0.167 | 0.183 |
| b | 0.69 | 1.02 | 0.027 | 0.040 |
| b(1) | 1.14 | 1.78 | 0.045 | 0.070 |
| c | 0.36 | 0.61 | 0.014 | 0.024 |
| D | 14.33 | 15.85 | 0.564 | 0.624 |
| E | 9.96 | 10.52 | 0.392 | 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: X15-0364-Rev. C, 14-Dec-15<br>DWG: 6031 | | | | |

**Note**

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

**Package Picture**

| ASE | | Xi'an | |
|---|---|---|---|
|  |  |  |  |

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