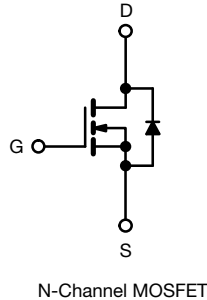
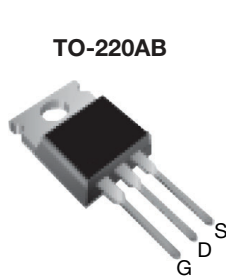


EF Series Power MOSFET with Fast Body Diode

| PRODUCT SUMMARY | | |
|---|-----------------|-------|
| V_{DS} (V) at T_J max. | 650 | |
| $R_{DS(on)}$ max. at 25 °C (Ω) | $V_{GS} = 10$ V | 0.098 |
| Q_g (Max.) (nC) | 155 | |
| Q_{gs} (nC) | 22 | |
| Q_{gd} (nC) | 43 | |
| Configuration | Single | |



FEATURES

- Fast body diode MOSFET using E series technology
- Reduced t_{rr} , Q_{rr} , and I_{RRM}
- Low figure-of-merit (FOM): $R_{on} \times Q_g$
- 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

APPLICATIONS

- Telecommunications
 - Server and telecom power supplies
- Lighting
 - High-intensity discharge (HID)
 - Light emitting diodes (LEDs)
- Consumer and computing
 - ATX power supplies
- Industrial
 - Welding
 - Battery chargers
- Renewable energy
 - Solar (PV inverters)
- Switch mode power supplies (SMPS)
 - LLC
 - Phase shifted bridge (ZVS)
 - 3-level inverter
 - AC/DC bridge

| ORDERING INFORMATION | |
|---------------------------------|-----------------|
| Package | TO-220AB |
| Lead (Pb)-free and Halogen-free | SiHP33N60EF-GE3 |


| ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted) | | | | |
|---|------------------|----------------|------|------|
| PARAMETER | SYMBOL | LIMIT | UNIT | |
| Drain-Source Voltage | V_{DS} | 600 | V | |
| Gate-Source Voltage | V_{GS} | ± 30 | | |
| Continuous Drain Current ($T_J = 150$ °C) | V_{GS} at 10 V | $T_C = 25$ °C | 33 | A |
| | | $T_C = 100$ °C | 21 | |
| Pulsed Drain Current (Typical) ^a | | 100 | | |
| Linear Derating Factor | | 2.2 | W/°C | |
| Single Pulse Avalanche Energy ^b | E_{AS} | 691 | mJ | |
| Maximum Power Dissipation | P_D | 278 | W | |
| Operating Junction and Storage Temperature Range | T_J, T_{stg} | -55 to +150 | °C | |
| Drain-Source Voltage Slope | dV/dt | $T_J = 125$ °C | 70 | V/ns |
| Reverse Diode dV/dt ^d | | 50 | | |
| Soldering Recommendations (Peak Temperature) ^c | for 10 s | 300 | °C | |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$ V, starting $T_J = 25$ °C, $L = 28.2$ mH, $R_g = 25$ Ω , $I_{AS} = 7$ A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$, $dI/dt = 900$ A/ μ s, 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} | - | 0.45 | |

| SPECIFICATIONS ($T_J = 25\text{ }^\circ\text{C}$, unless otherwise noted) | | | | | | | |
|---|---------------------|---|--|------|-------|-----------|---------------|
| PARAMETER | SYMBOL | TEST CONDITIONS | | MIN. | TYP. | MAX. | UNIT |
| Static | | | | | | | |
| Drain-Source Breakdown Voltage | V_{DS} | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | | 600 | - | - | V |
| V_{DS} Temperature Coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}, I_D = 1\text{ mA}$ | | - | 0.72 | - | V/°C |
| Gate-Source Threshold Voltage (N) | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$ | | 2.0 | - | 4.0 | V |
| Gate-Source Leakage | I_{GSS} | $V_{GS} = \pm 20\text{ V}$ | | - | - | ± 100 | nA |
| | | $V_{GS} = \pm 30\text{ V}$ | | - | - | ± 1 | μA |
| Zero Gate Voltage Drain Current | I_{DSS} | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}$ | | - | - | 1 | μA |
| | | $V_{DS} = 480\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | | - | - | 500 | |
| Drain-Source On-State Resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$ | $I_D = 16.5\text{ A}$ | - | 0.085 | 0.098 | Ω |
| Forward Transconductance ^a | g_{fs} | $V_{DS} = 30\text{ V}, I_D = 16.5\text{ A}$ | | - | 12 | - | S |
| Dynamic | | | | | | | |
| Input Capacitance | C_{iss} | $V_{GS} = 0\text{ V},$ $V_{DS} = 100\text{ V},$ $f = 1\text{ MHz}$ | | - | 3454 | - | pF |
| Output Capacitance | C_{oss} | | | - | 154 | - | |
| Reverse Transfer Capacitance | C_{riss} | | | - | 8 | - | |
| Effective Output Capacitance, Energy Related ^b | $C_{o(er)}$ | | | - | 121 | - | |
| Effective Output Capacitance, Time Related ^c | $C_{o(tr)}$ | $V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to } 480\text{ V}$ | | - | 437 | - | |
| Total Gate Charge | Q_g | $V_{GS} = 10\text{ V}$ | $I_D = 16.5\text{ A}, V_{DS} = 480\text{ V}$ | - | 103 | 155 | nC |
| Gate-Source Charge | Q_{gs} | | | - | 22 | - | |
| Gate-Drain Charge | Q_{gd} | | | - | 43 | - | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD} = 480\text{ V}, I_D = 16.5\text{ A}$ $R_g = 9.1\text{ }\Omega, V_{GS} = 10\text{ V}$ | | - | 28 | 56 | ns |
| Rise Time | t_r | | | - | 43 | 86 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | - | 161 | 242 | |
| Fall Time | t_f | | | - | 48 | 96 | |
| Gate Input Resistance | R_g | $f = 1\text{ MHz}, \text{open drain}$ | | 0.2 | 0.5 | 1.0 | Ω |
| Drain-Source Body Diode Characteristics | | | | | | | |
| Continuous Source-Drain Diode Current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | | - | - | 33 | A |
| Pulsed Diode Forward Current | I_{SM} | | | - | 100 | - | |
| Diode Forward Voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = 16.5\text{ A}, V_{GS} = 0\text{ V}$ | | - | 0.9 | 1.2 | V |
| Reverse Recovery Time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 16.5\text{ A},$ $di/dt = 100\text{ A}/\mu\text{s}, V_R = 400\text{ V}$ | | - | 162 | 324 | ns |
| Reverse Recovery Charge | Q_{rr} | | | - | 1.0 | 2.0 | μC |
| Reverse Recovery Current | I_{RRM} | | | - | 13 | - | A |

Notes

- a. Repetitive rating; pulse width limited by maximum junction temperature.
- b. $C_{oss(er)}$ is a fixed capacitance that gives the same energy as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS} .
- c. $C_{oss(tr)}$ is a fixed capacitance that gives the charging time as C_{oss} while V_{DS} is rising from 0 % to 80 % V_{DS} .



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

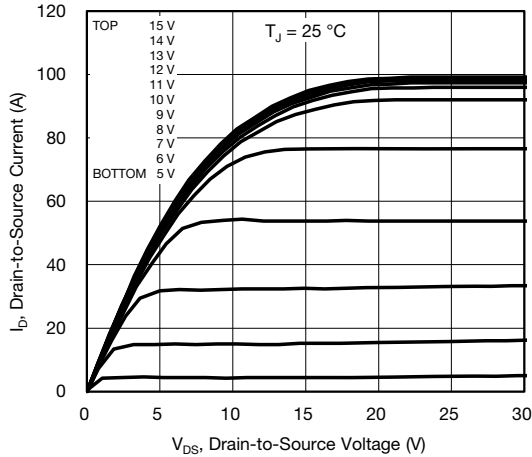


Fig. 1 - Typical Output Characteristics

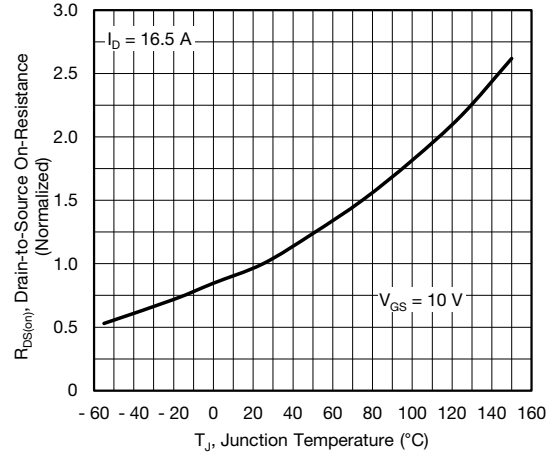


Fig. 4 - Normalized On-Resistance vs. Temperature

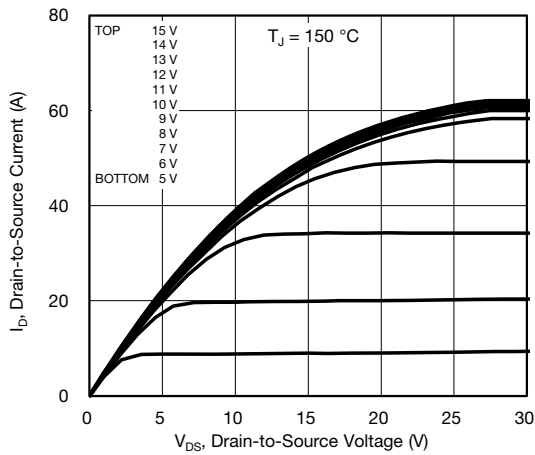


Fig. 2 - Typical Output Characteristics

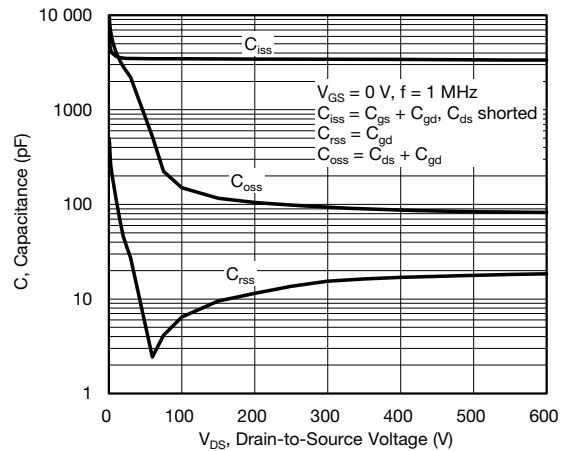


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

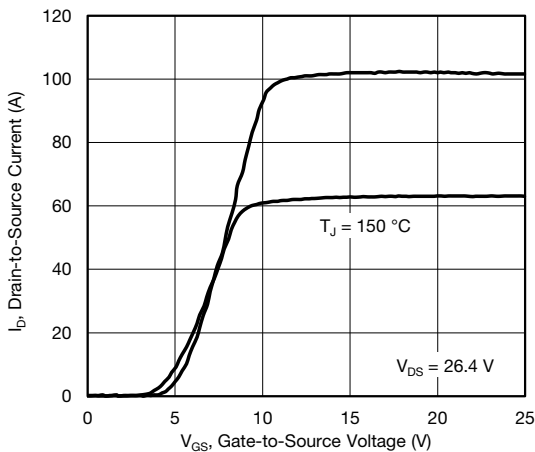


Fig. 3 - Typical Transfer Characteristics

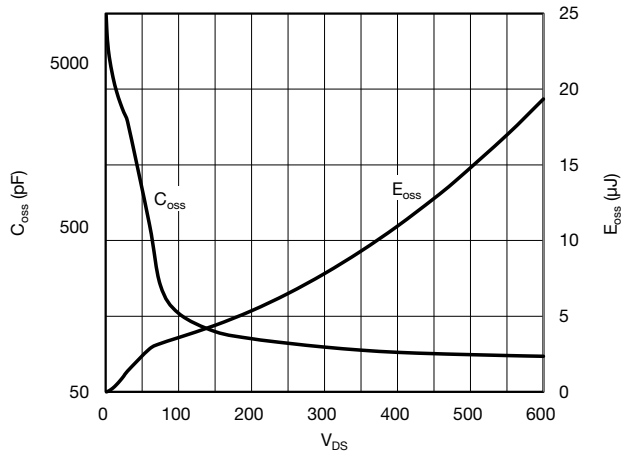


Fig. 6 - Coss and Eoss vs. Vds

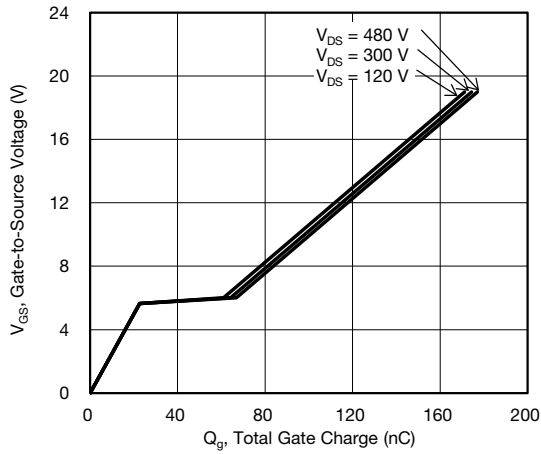


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

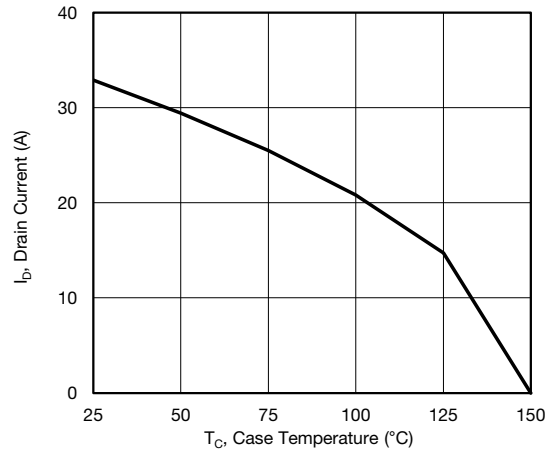


Fig. 10 - Maximum Drain Current vs. Case Temperature

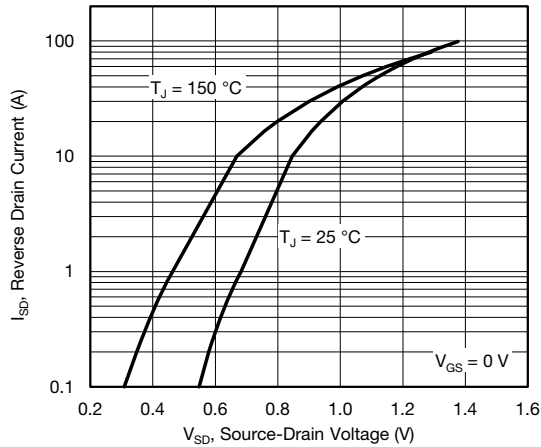


Fig. 8 - Typical Source-Drain Diode Forward Voltage

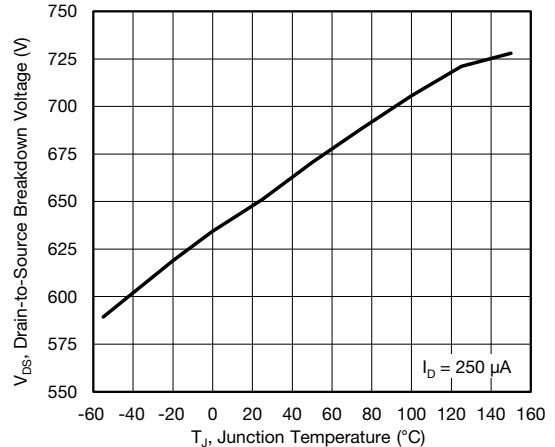


Fig. 11 - Typical Drain-to-Source Voltage vs. Temperature

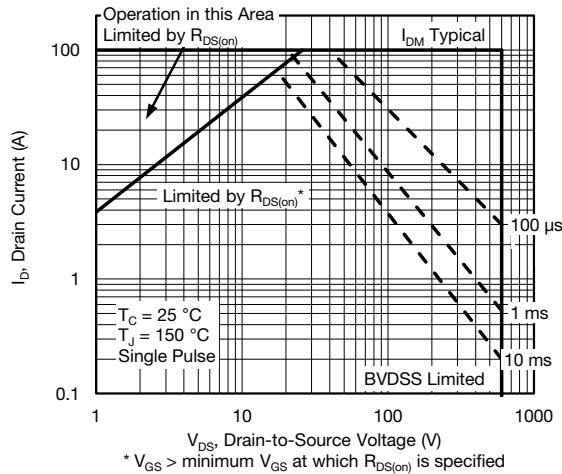


Fig. 9 - Maximum Safe Operating Area

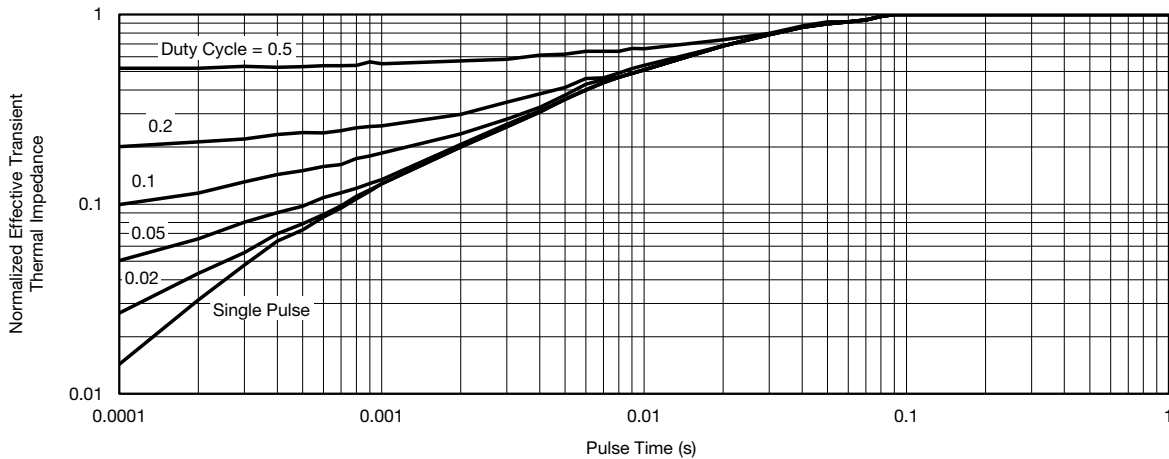


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

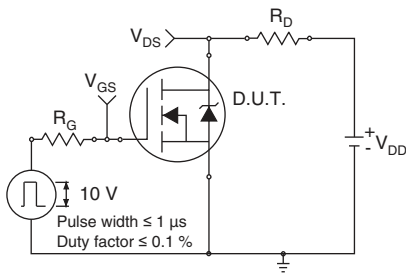


Fig. 13 - Switching Time Test Circuit

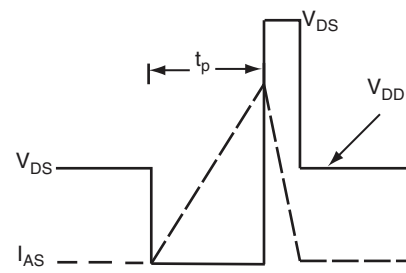


Fig. 16 - Unclamped Inductive Waveforms

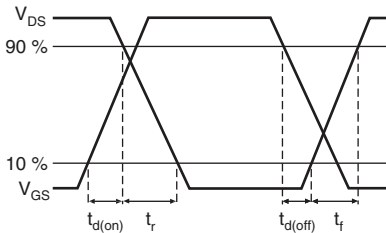


Fig. 14 - Switching Time Waveforms

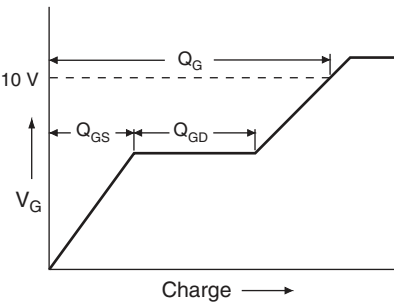


Fig. 17 - Basic Gate Charge Waveform

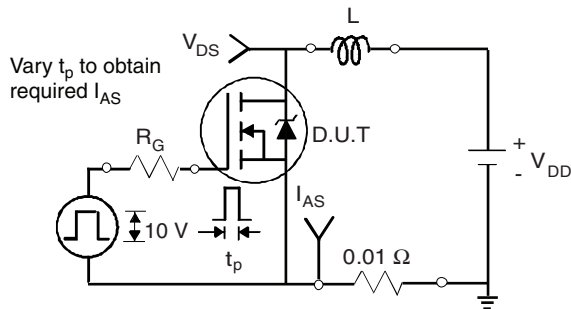


Fig. 15 - Unclamped Inductive Test Circuit

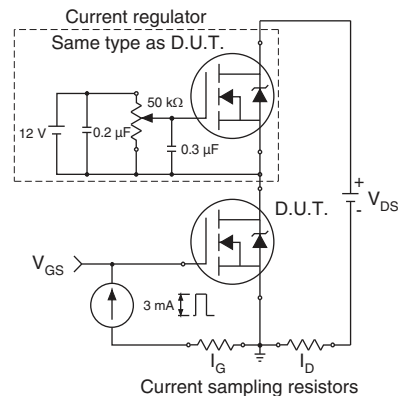
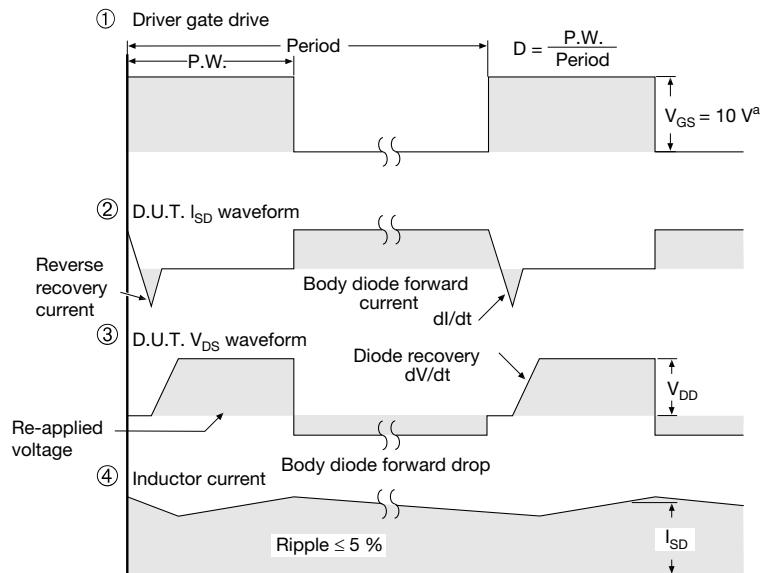
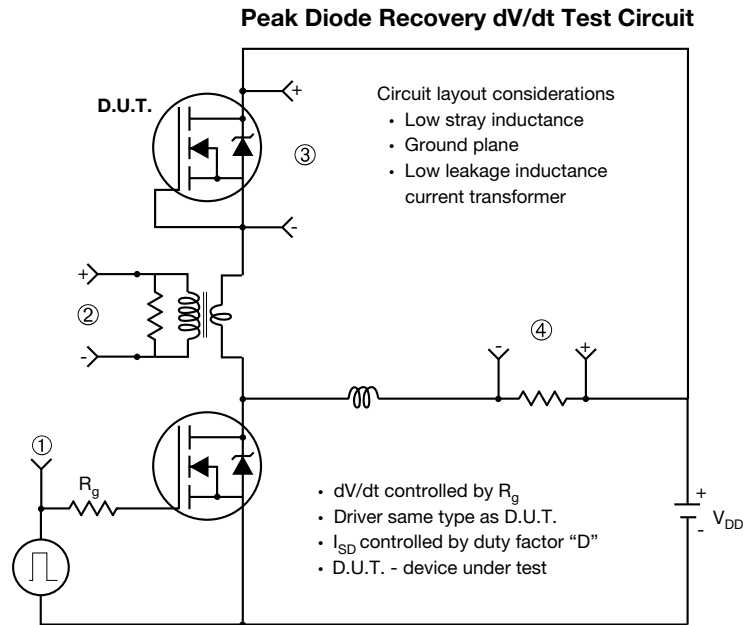


Fig. 18 - Gate Charge Test Circuit

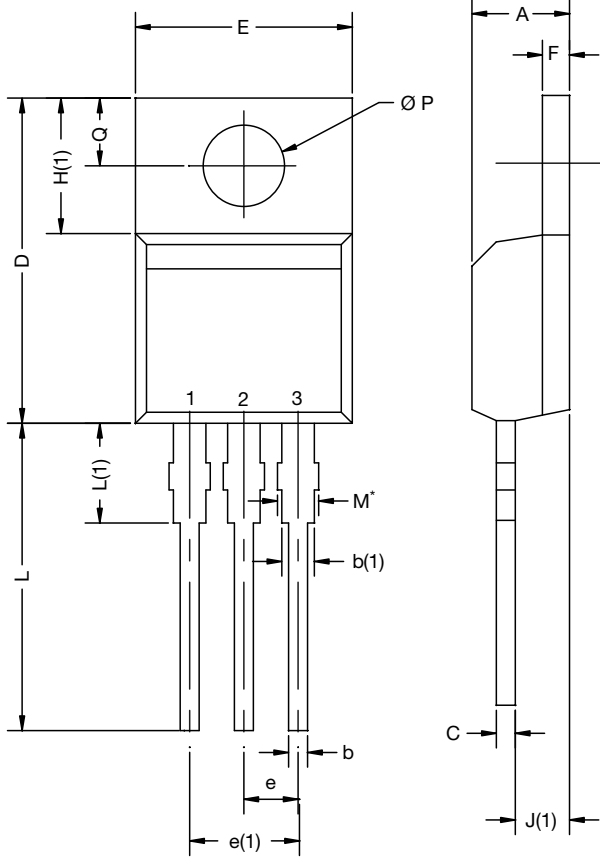


Note
a. $V_{GS} = 5\text{ V}$ for logic level devices

Fig. 19 - For N-Channel

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TO-220-1

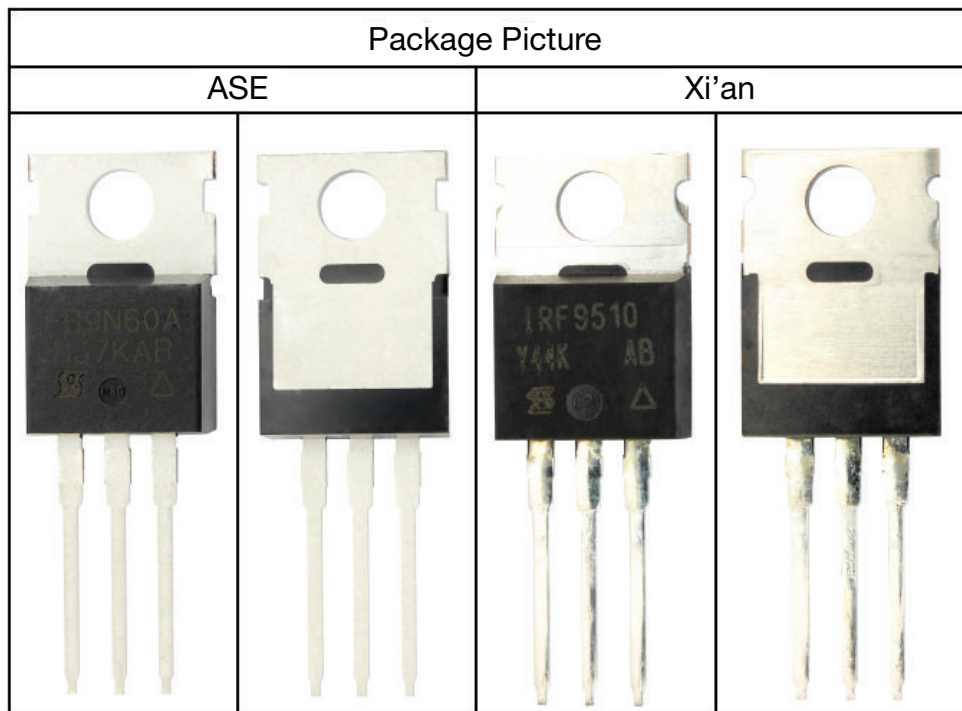


| DIM. | MILLIMETERS | | INCHES | |
|------|-------------|-------|--------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.24 | 4.65 | 0.167 | 0.183 |
| b | 0.69 | 1.02 | 0.027 | 0.040 |
| b(1) | 1.14 | 1.78 | 0.045 | 0.070 |
| c | 0.36 | 0.61 | 0.014 | 0.024 |
| D | 14.33 | 15.85 | 0.564 | 0.624 |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

Note

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





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