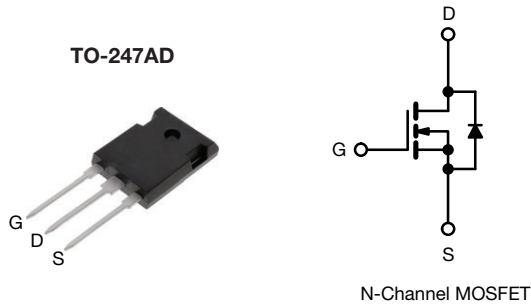


E Series Power MOSFET With Fast Body Diode



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})
- Low switching losses due to reduced Q_{rr}
- 175 °C operating temperature
- AEC-Q101 qualified
- Ultra low gate charge (Q_g)
- Avalanche energy rated (UIS)
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE


RoHS
 COMPLIANT
 HALOGEN
FREE

APPLICATIONS

- Automotive onboard charger
- Automotive DC/DC converter

| PRODUCT SUMMARY | |
|---|-------------------------|
| V_{DS} (V) at T_J max. | 700 |
| $R_{DS(on)}$ typ. (Ω) at 25 °C | $V_{GS} = 10$ V 0.095 |
| Q_g typ. (nC) | 115 |
| Q_{gs} (nC) | 26 |
| Q_{gd} (nC) | 44 |
| Configuration | Single |


| ORDERING INFORMATION | |
|---------------------------------|----------------|
| Package | TO-247AD |
| Lead (Pb)-free and halogen-free | SQW33N65EF-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 | 34 | A |
| | | $T_C = 100$ °C | 24 | |
| Pulsed drain current ^a | I_{DM} | 95 | | |
| Linear derating factor | | 2.5 | W/°C | |
| Single pulse avalanche energy ^b | E_{AS} | 508 | mJ | |
| Maximum power dissipation | P_D | 375 | W | |
| Operating junction and storage temperature range | T_J, T_{stg} | -55 to +175 | °C | |
| Drain-source voltage slope | dV/dt | 100 | V/ns | |
| Reverse diode dV/dt ^d | | 50 | | |
| Soldering recommendations (peak temperature) ^c | For 10 s | 260 | °C | |

Notes

- Repetitive rating; pulse width limited by maximum junction temperature
- $V_{DD} = 140$ V, starting $T_J = 25$ °C, $L = 28.2$ mH, $R_g = 25$ Ω , $I_{AS} = 6.0$ A
- 1.6 mm from case
- $I_{SD} \leq I_D$, $dI/dt = 160$ A/ μ s, starting $T_J = 25$ °C

| THERMAL RESISTANCE RATINGS | | | | |
|----------------------------------|------------|------|------|------|
| PARAMETER | SYMBOL | TYP. | MAX. | UNIT |
| Maximum junction-to-ambient | R_{thJA} | - | 40 | °C/W |
| Maximum junction-to-case (drain) | R_{thJC} | - | 0.4 | |

| 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} | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$ | 650 | - | - | V |
| V_{DS} temperature coefficient | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$, $I_D = 10\text{ mA}$ | - | 0.69 | - | V/ $^\circ\text{C}$ |
| 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} | $V_{DS} = 520\text{ V}, V_{GS} = 0\text{ V}$ | - | - | 1 | μA |
| | | $V_{DS} = 520\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | - | - | 500 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$ $I_D = 16.5\text{ A}$ | - | 0.095 | 0.109 | Ω |
| Forward transconductance ^a | g_{fs} | $V_{DS} = 30\text{ V}, I_D = 16.5\text{ A}$ | - | 13 | - | S |
| Dynamic | | | | | | |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{ V},$ $V_{DS} = 100\text{ V},$ $f = 1\text{ MHz}$ | - | 3972 | - | pF |
| Output capacitance | C_{oss} | | - | 163 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 5 | - | |
| Effective output capacitance, energy related ^a | $C_{o(er)}$ | $V_{GS} = 0\text{ V}, V_{DS} = 0\text{ V to } 520\text{ V}$ | - | 117 | - | |
| Effective output capacitance, time related ^b | $C_{o(tr)}$ | | - | 482 | - | |
| Total gate charge | Q_g | $V_{GS} = 10\text{ V}$ $I_D = 16.5\text{ A}, V_{DS} = 520\text{ V}$ | - | 115 | 173 | nC |
| Gate-source charge | Q_{gs} | | - | 26 | - | |
| Gate-drain charge | Q_{gd} | | - | 44 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = 520\text{ V}, I_D = 16.5\text{ A}$ $R_g = 9.1\text{ }\Omega, V_{GS} = 10\text{ V}$ | - | 32 | 64 | ns |
| Rise time | t_r | | - | 51 | 77 | |
| Turn-off delay time | $t_{d(off)}$ | | - | 134 | 201 | |
| Fall time | t_f | | - | 62 | 93 | |
| Gate input resistance | R_g | | $f = 1\text{ MHz, open drain}$ | 0.4 | 0.9 | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Continuous source-drain diode current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | 34 | A |
| Pulsed diode forward current | I_{SM} | | - | - | 95 | |
| 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} | $T_J = 25\text{ }^\circ\text{C}, I_F = I_S = 16.5\text{ A},$ $di/dt = 100\text{ A}/\mu\text{s}, V_R = 400\text{ V}$ | - | 178 | 356 | ns |
| Reverse recovery charge | Q_{rr} | | - | 1.4 | 2.8 | μC |
| Reverse recovery current | I_{RRM} | | - | 17 | - | 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_{DS}
 b. $C_{oss(tr)}$ 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)

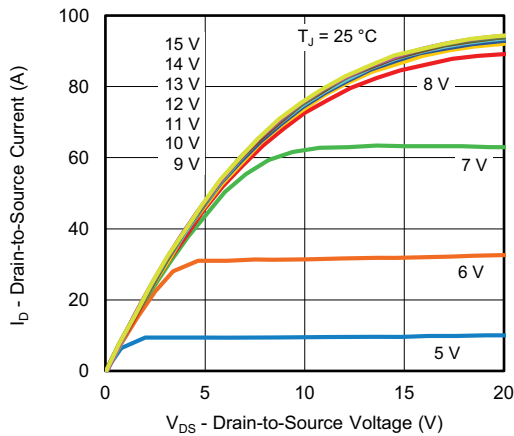


Fig. 1 - Typical Output Characteristics

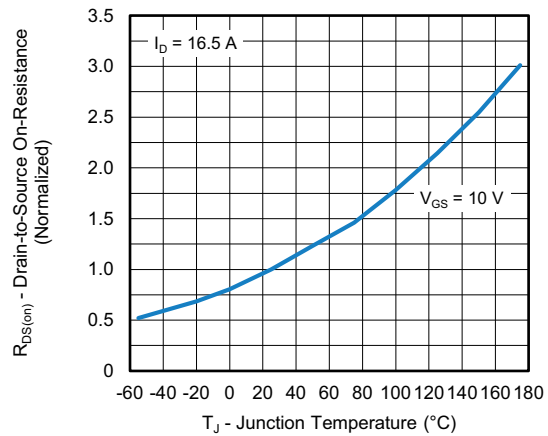


Fig. 4 - Normalized On-Resistance vs. Temperature

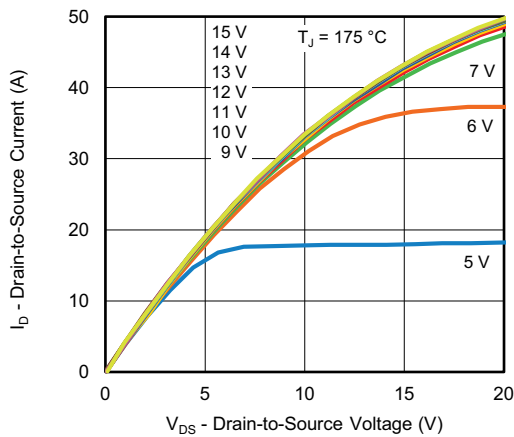


Fig. 2 - Typical Output Characteristics

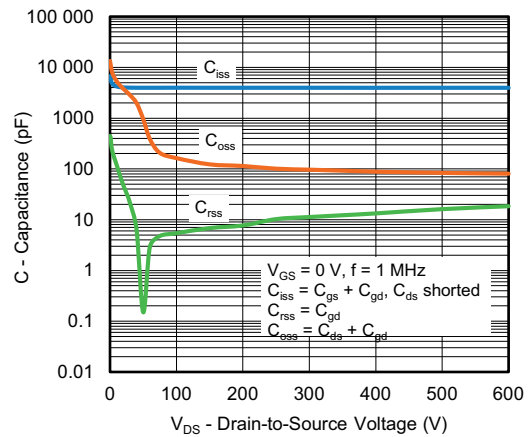


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

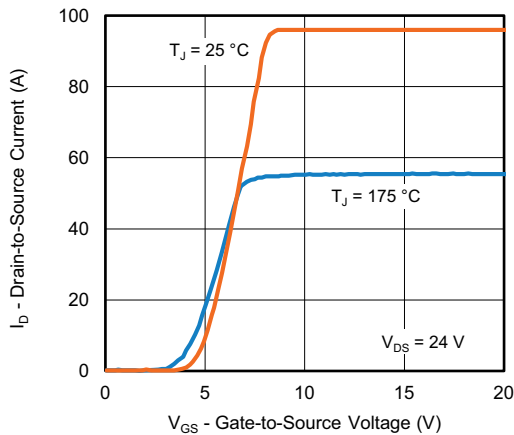


Fig. 3 - Typical Transfer Characteristics

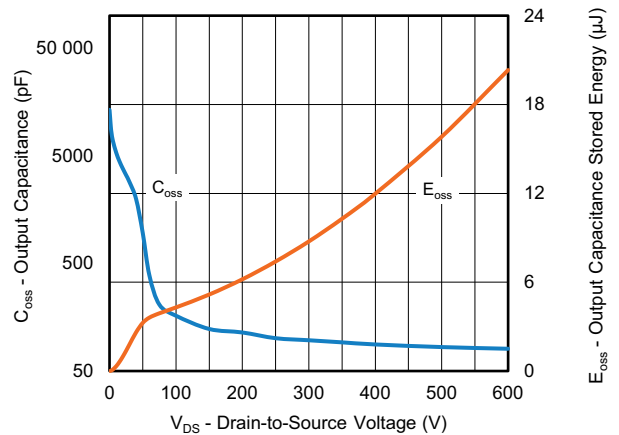


Fig. 6 - C_{oss} and E_{oss} vs. V_{DS}

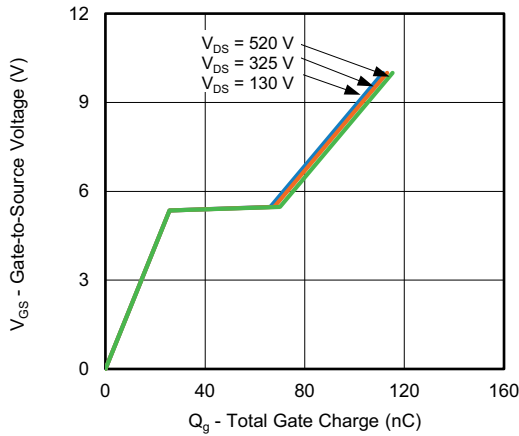


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

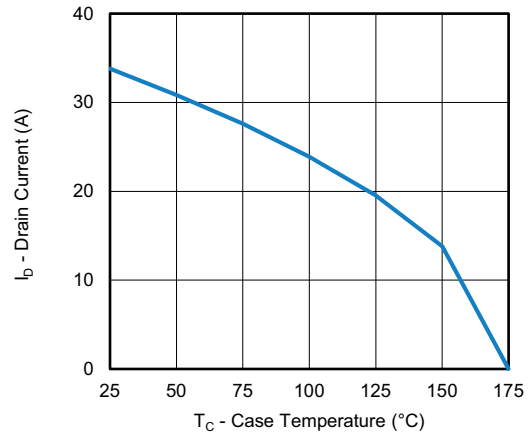


Fig. 10 - Maximum Drain Current vs. Case Temperature

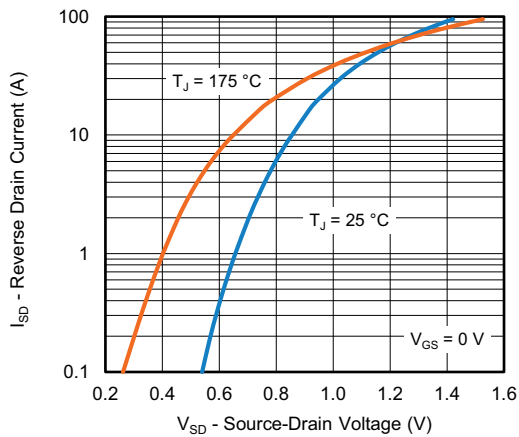


Fig. 8 - Typical Source-Drain Diode Forward Voltage

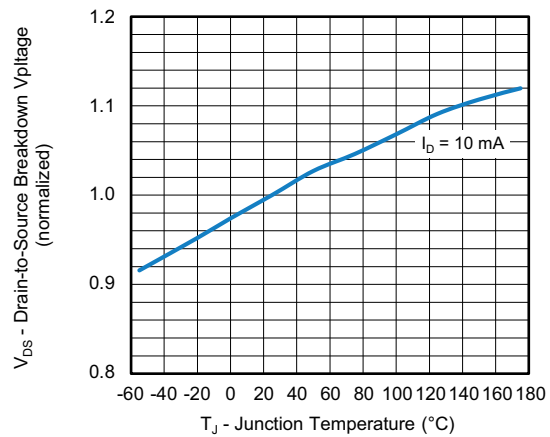


Fig. 11 - Typical Drain-to-Source Voltage vs. Temperature

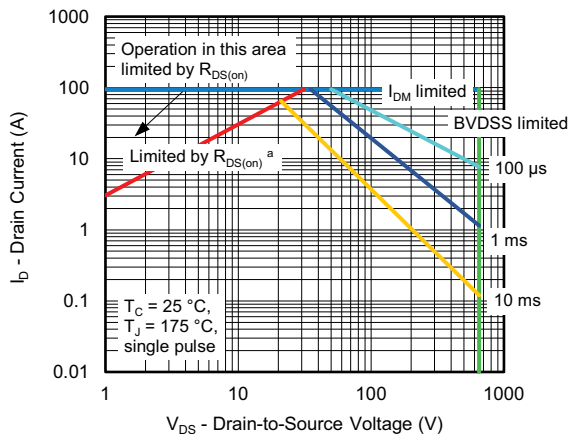


Fig. 9 - Maximum Safe Operating Area

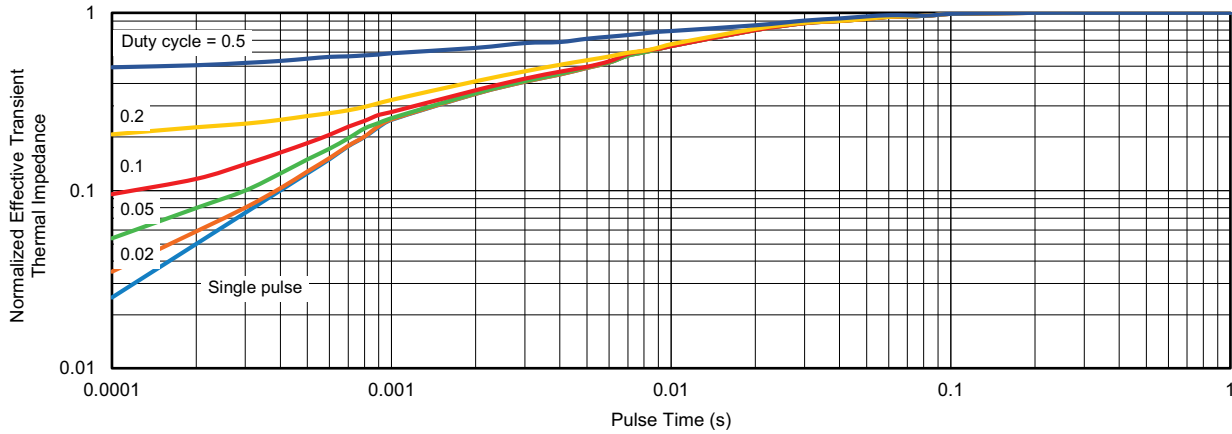


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

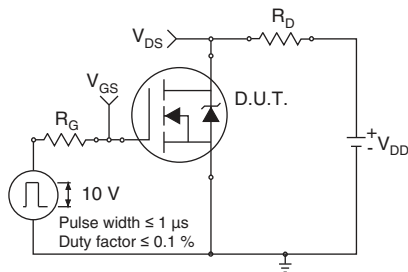


Fig. 13 - Switching Time Test Circuit

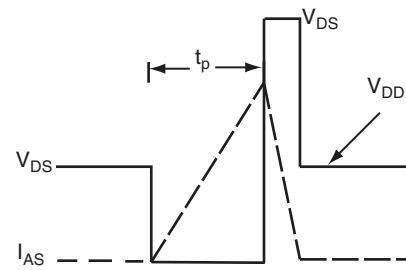


Fig. 16 - Unclamped Inductive Waveforms

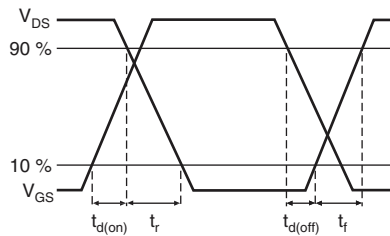


Fig. 14 - Switching Time Waveforms

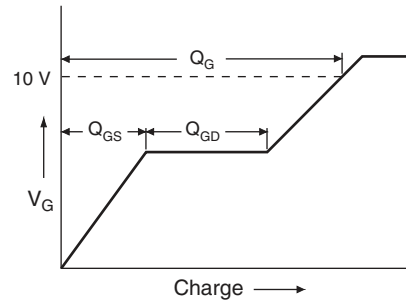


Fig. 17 - Basic Gate Charge Waveform

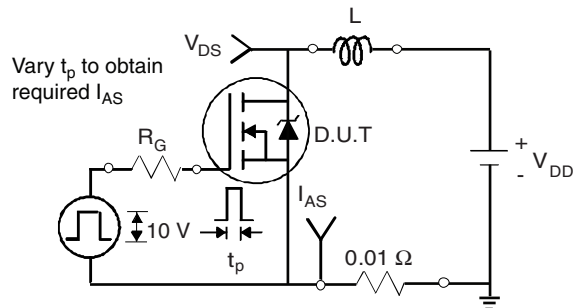


Fig. 15 - Unclamped Inductive Test Circuit

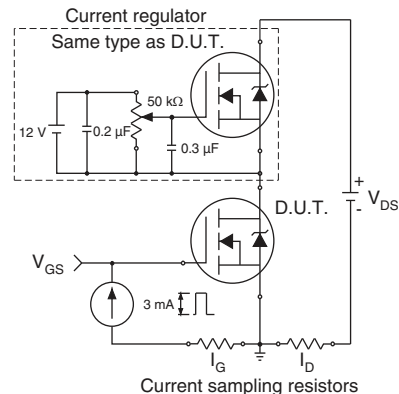
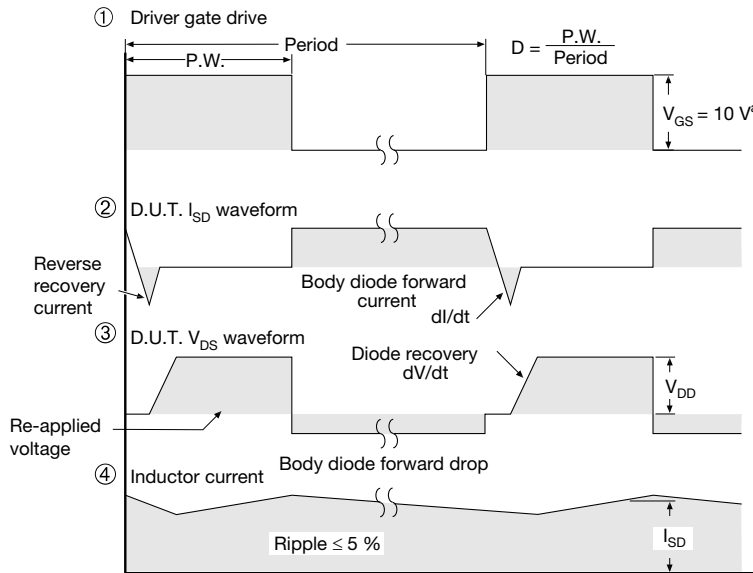
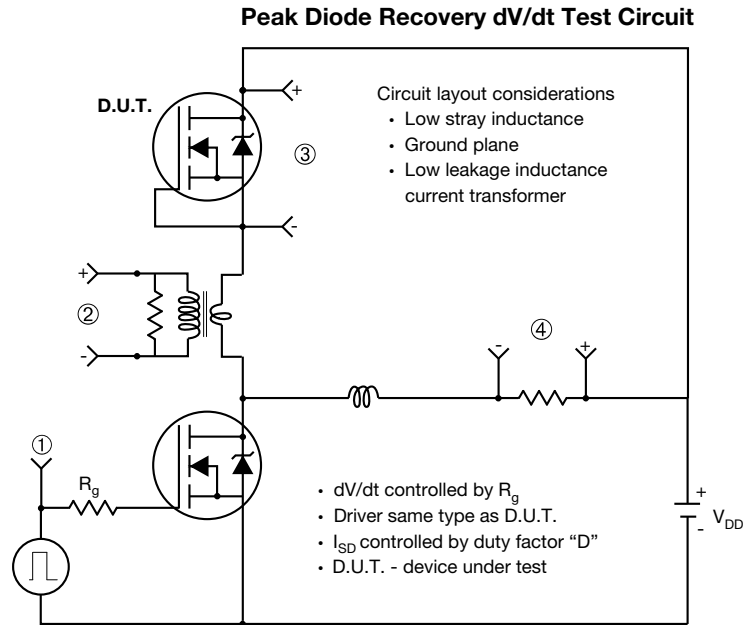


Fig. 18 - Gate Charge Test Circuit

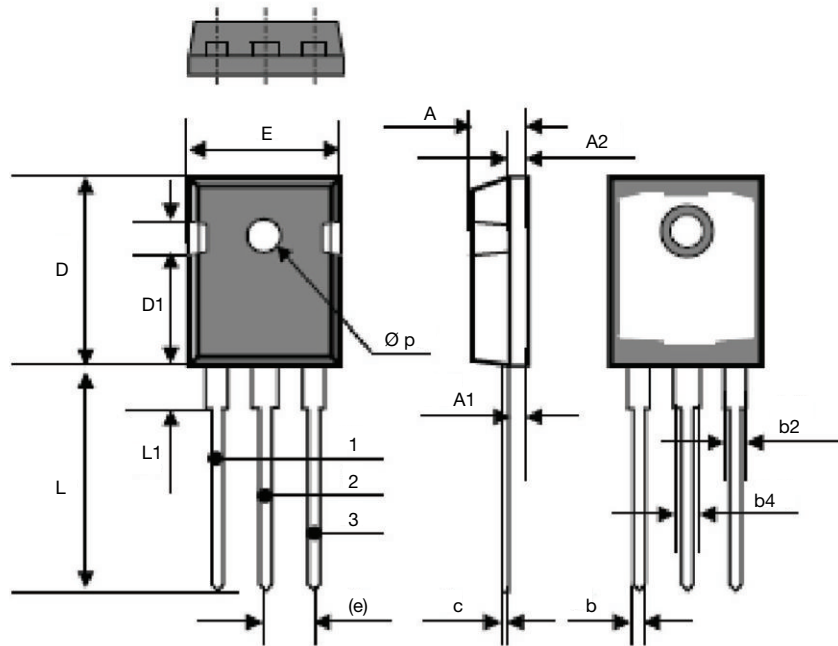


Note
a. $V_{GS} = 5\text{ V}$ for logic level devices

Fig. 19 - For N-Channel

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TO-247AD (High Voltage)



| DIM. | MILLIMETERS | | INCHES | |
|---------------------------------|-------------|-------|-----------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 4.70 | 5.31 | 0.185 | 0.209 |
| A1 | 2.21 | 2.59 | 0.087 | 0.102 |
| A2 | 1.50 | 2.49 | 0.059 | 0.098 |
| b | 0.99 | 1.40 | 0.039 | 0.055 |
| b2 | 1.65 | 2.41 | 0.065 | 0.095 |
| b4 | 2.59 | 3.43 | 0.102 | 0.135 |
| c | 0.61 BSC | | 0.024 BSC | |
| D | 20.80 | 21.46 | 0.819 | 0.845 |
| D1 | 3.68 | 5.49 | 0.145 | 0.216 |
| (e) | 5.46 BSC | | 0.215 BSC | |
| E | 15.49 | 16.26 | 0.610 | 0.640 |
| L | 19.81 | 20.32 | 0.780 | 0.800 |
| L1 | 4.06 | 4.50 | 0.160 | 0.177 |
| Ø p | 3.51 | 3.66 | 0.138 | 0.144 |
| ECN: S17-0178-Rev. B, 06-Feb-17 | | | | |
| DWG: 6010 | | | | |



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