

## AOK20N60L-VB Datasheet

### N-Channel 650 V (D-S) Super Junction Power MOSFET

| PRODUCT SUMMARY                    |                 |      |
|------------------------------------|-----------------|------|
| $V_{DS}$ (V) at $T_J$ max.         | 700             |      |
| $R_{DS(on)}$ at 25 °C ( $\Omega$ ) | $V_{GS} = 10$ V | 0.23 |
| $Q_g$ Typ. (nC)                    | 24              |      |
| $Q_{gs}$ (nC)                      | 6               |      |
| $Q_{gd}$ (nC)                      | 11              |      |
| Configuration                      | Single          |      |

#### FEATURES

- 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)

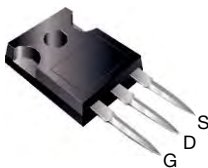


**RoHS\***  
Available  
**HALOGEN**  
**FREE**  
Available

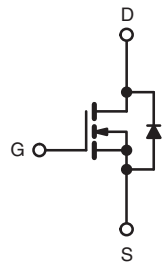
#### APPLICATIONS

- 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)

TO-247AC



Top View



N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                         |                         |                                   |             |      |
|---------------------------------------------------------------------------|-------------------------|-------------------------|-----------------------------------|-------------|------|
| PARAMETER                                                                 |                         |                         | SYMBOL                            | LIMIT       | UNIT |
| Drain-Source Voltage                                                      |                         |                         | V <sub>DS</sub>                   | 650         | V    |
| Gate-Source Voltage                                                       |                         |                         | V <sub>GS</sub>                   | ± 30        |      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C)                        | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 15          | A    |
|                                                                           |                         | T <sub>C</sub> = 100 °C |                                   | 10          |      |
| Pulsed Drain Current <sup>a</sup>                                         |                         |                         | I <sub>DM</sub>                   | 45          |      |
| Linear Derating Factor                                                    |                         |                         |                                   | 1.4         | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>                                |                         |                         | E <sub>AS</sub>                   | 286         | mJ   |
| Maximum Power Dissipation                                                 |                         |                         | P <sub>D</sub>                    | 180         | W    |
| Operating Junction and Storage Temperature Range                          |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150 | °C   |
| Drain-Source Voltage Slope                                                | T <sub>J</sub> = 125 °C |                         | dV/dt                             | 37          | V/ns |
| Reverse Diode dV/dt <sup>d</sup>                                          |                         | 23                      |                                   |             |      |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>                 | 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,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 4.5$  A.  
 c. 1.6 mm from case.  
 d.  $I_{SD} \leq I_D$ ,  $dI/dt = 100$  A/ $\mu$ s, starting  $T_J = 25$  °C.

**THERMAL RESISTANCE RATINGS**

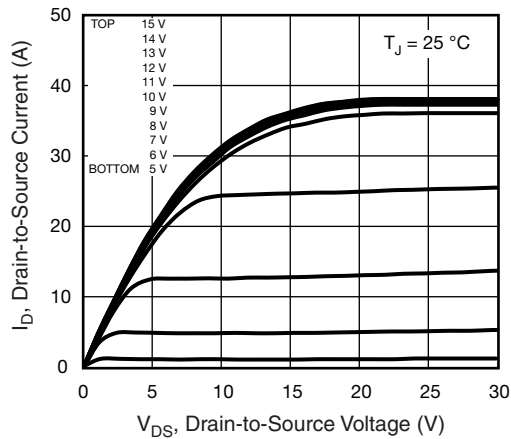
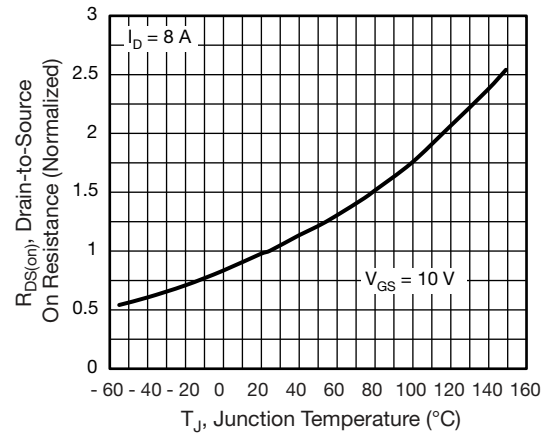
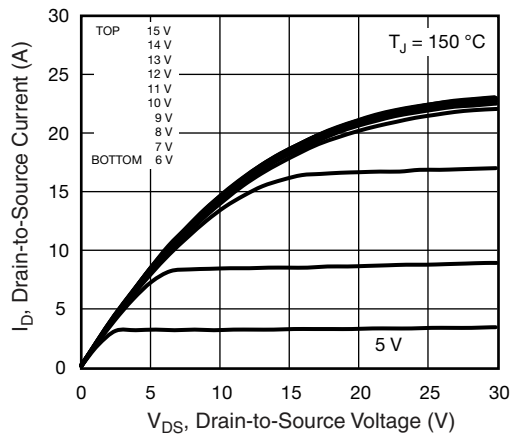
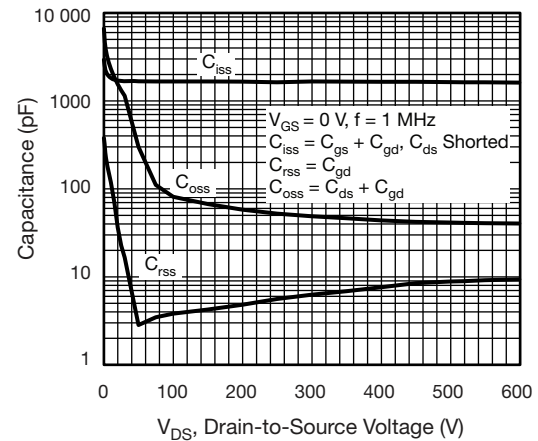
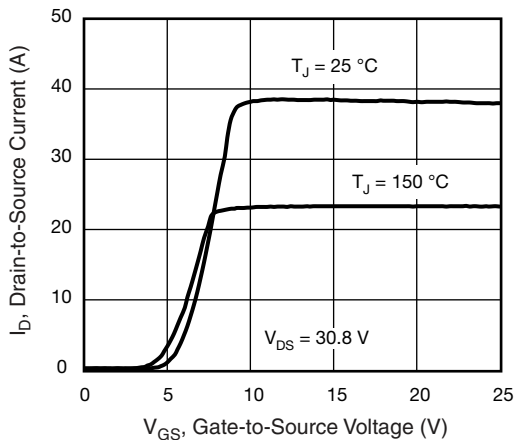
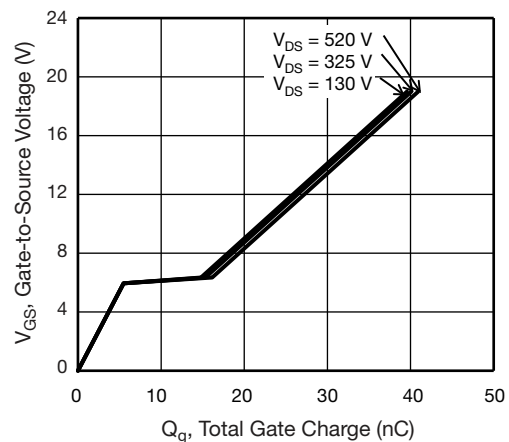
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.7  |      |

**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 $25\text{ }^{\circ}\text{C}$ , $I_D = 1\text{ mA}$                                                                                          |                                              | -    | 0.75 | -         | V/ $^{\circ}\text{C}$ |
| Gate-Source Threshold Voltage (N)                         | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                       |                                              | 2    | -    | 4         | V                     |
| Gate-Source Leakage                                       | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                               |                                              | -    | -    | $\pm 100$ | nA                    |
|                                                           |                     | $V_{GS} = \pm 30\text{ V}$                                                                                                                               |                                              | -    | -    | $\pm 1$   | $\mu\text{A}$         |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$           | $V_{DS} = 650\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                          |                                              | -    | -    | 1         | $\mu\text{A}$         |
|                                                           |                     | $V_{DS} = 520\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^{\circ}\text{C}$                                                                    |                                              | -    | -    | 10        |                       |
| Drain-Source On-State Resistance                          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 8\text{ A}$                           | -    | 0.23 | -         | $\Omega$              |
| Forward Transconductance                                  | $g_{fs}$            | $V_{DS} = 30\text{ V}$ , $I_D = 8\text{ A}$                                                                                                              |                                              | -    | 5.6  | -         | S                     |
| Dynamic                                                   |                     |                                                                                                                                                          |                                              |      |      |           |                       |
| Input Capacitance                                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 100\text{ V}$ ,<br>$f = 1\text{ MHz}$                                                                               |                                              | -    | 1640 | -         | pF                    |
| Output Capacitance                                        | $C_{oss}$           |                                                                                                                                                          |                                              | -    | 80   | -         |                       |
| Reverse Transfer Capacitance                              | $C_{rss}$           |                                                                                                                                                          |                                              | -    | 4    | -         |                       |
| Effective Output Capacitance, Energy Related <sup>a</sup> | $C_{o(er)}$         | $V_{DS} = 0\text{ V to } 520\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                           |                                              | -    | 63   | -         |                       |
| Effective Output Capacitance, Time Related <sup>b</sup>   | $C_{o(tr)}$         |                                                                                                                                                          |                                              | -    | 213  | -         |                       |
| Total Gate Charge                                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                   | $I_D = 8\text{ A}$ , $V_{DS} = 520\text{ V}$ | -    | 24   | 48        | nC                    |
| Gate-Source Charge                                        | $Q_{gs}$            |                                                                                                                                                          |                                              | -    | 6    | -         |                       |
| Gate-Drain Charge                                         | $Q_{gd}$            |                                                                                                                                                          |                                              | -    | 11   | -         |                       |
| Turn-On Delay Time                                        | $t_{d(on)}$         | $V_{DD} = 520\text{ V}$ , $I_D = 8\text{ A}$ ,<br>$V_{GS} = 10\text{ V}$ , $R_g = 9.1\text{ }\Omega$                                                     |                                              | -    | 18   | 36        | ns                    |
| Rise Time                                                 | $t_r$               |                                                                                                                                                          |                                              | -    | 24   | 48        |                       |
| Turn-Off Delay Time                                       | $t_{d(off)}$        |                                                                                                                                                          |                                              | -    | 48   | 96        |                       |
| Fall Time                                                 | $t_f$               |                                                                                                                                                          |                                              | -    | 25   | 50        |                       |
| Gate Input Resistance                                     | $R_g$               | $f = 1\text{ MHz}$ , open drain                                                                                                                          |                                              | -    | 0.8  | -         | $\Omega$              |
| Drain-Source Body Diode Characteristics                   |                     |                                                                                                                                                          |                                              |      |      |           |                       |
| Continuous Source-Drain Diode Current                     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                              | -    | -    | 15        | A                     |
| Pulsed Diode Forward Current                              | $I_{SM}$            |                                                                                                                                                          |                                              | -    | -    | 38        |                       |
| Diode Forward Voltage                                     | $V_{SD}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_S = 8\text{ A}$ , $V_{GS} = 0\text{ V}$                                                                          |                                              | -    | -    | 1.2       | V                     |
| Reverse Recovery Time                                     | $t_{rr}$            | $T_J = 25\text{ }^{\circ}\text{C}$ , $I_F = I_S = 8\text{ A}$ ,<br>$dI/dt = 100\text{ A}/\mu\text{s}$ , $V_R = 400\text{ V}$                             |                                              | -    | 325  | -         | ns                    |
| Reverse Recovery Charge                                   | $Q_{rr}$            |                                                                                                                                                          |                                              | -    | 4.6  | -         | $\mu\text{C}$         |
| Reverse Recovery Current                                  | $I_{RRM}$           |                                                                                                                                                          |                                              | -    | 20   | -         | 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**

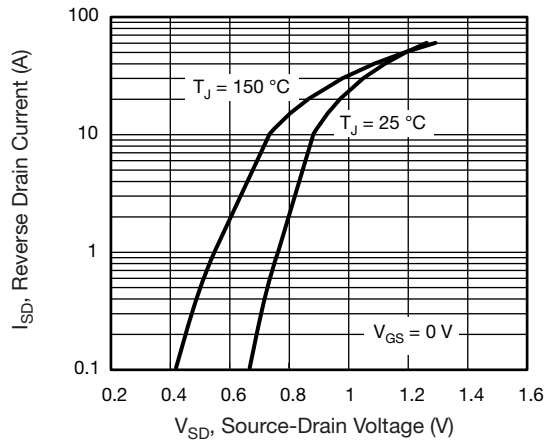


Fig. 7 - Typical Source-Drain Diode Forward Voltage

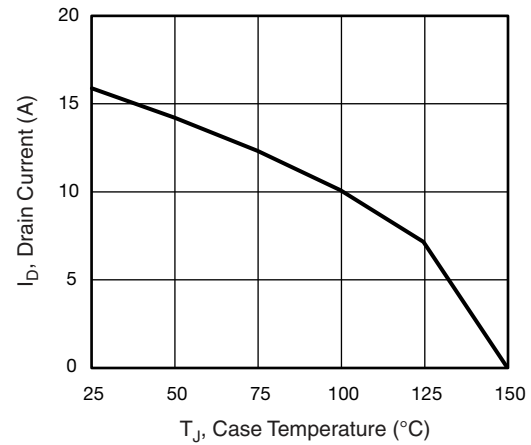


Fig. 9 - Maximum Drain Current vs. Case Temperature

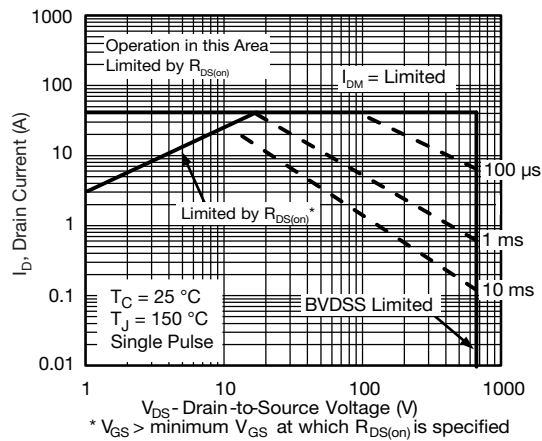


Fig. 8 - Maximum Safe Operating Area

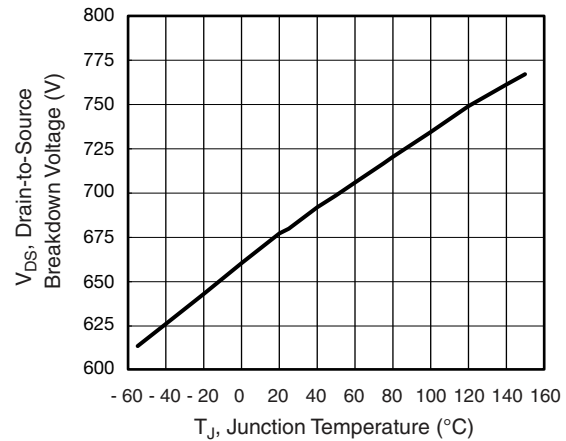


Fig. 10 - Temperature vs. Drain-to-Source Voltage

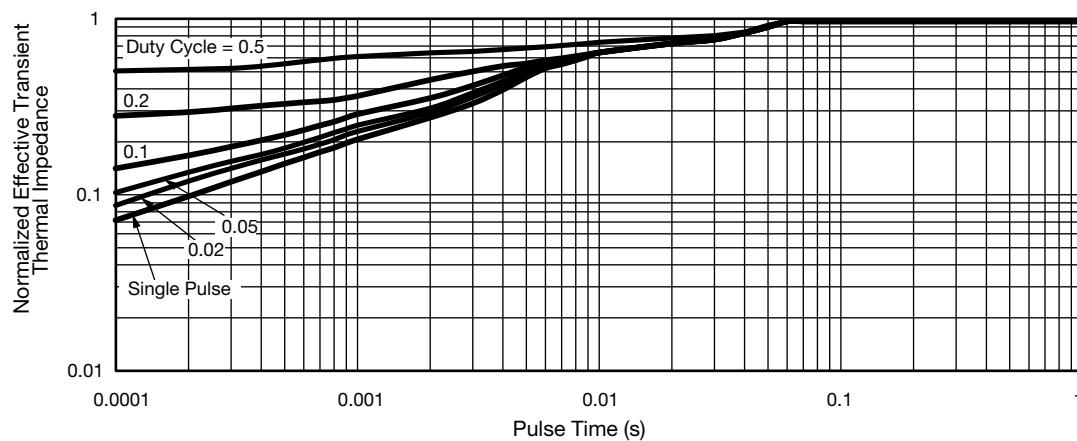


Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case

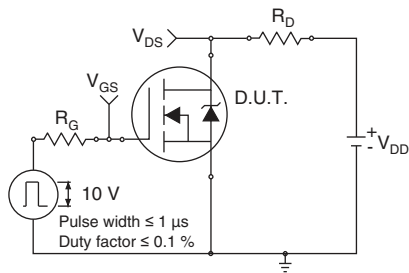


Fig. 12 - Switching Time Test Circuit

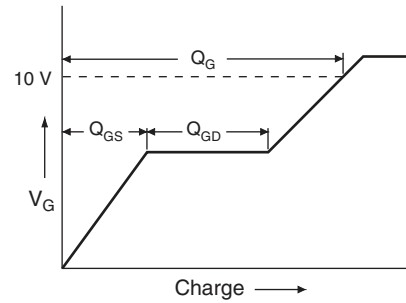


Fig. 16 - Basic Gate Charge Waveform

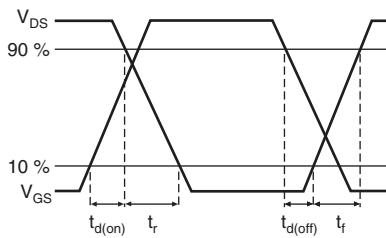


Fig. 13 - Switching Time Waveforms

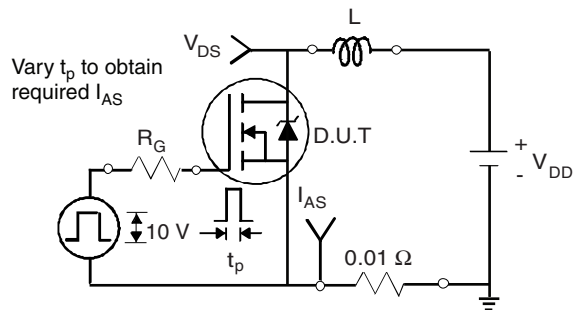


Fig. 14 - Unclamped Inductive Test Circuit

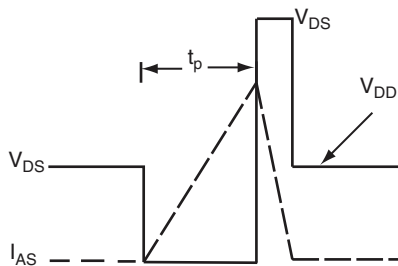


Fig. 15 - Unclamped Inductive Waveforms

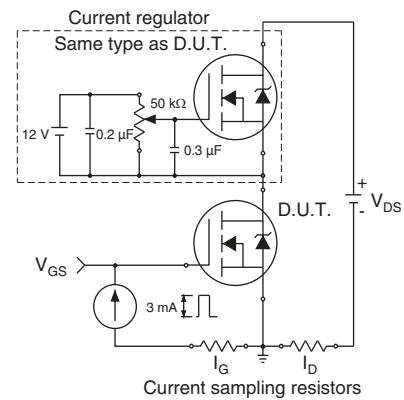
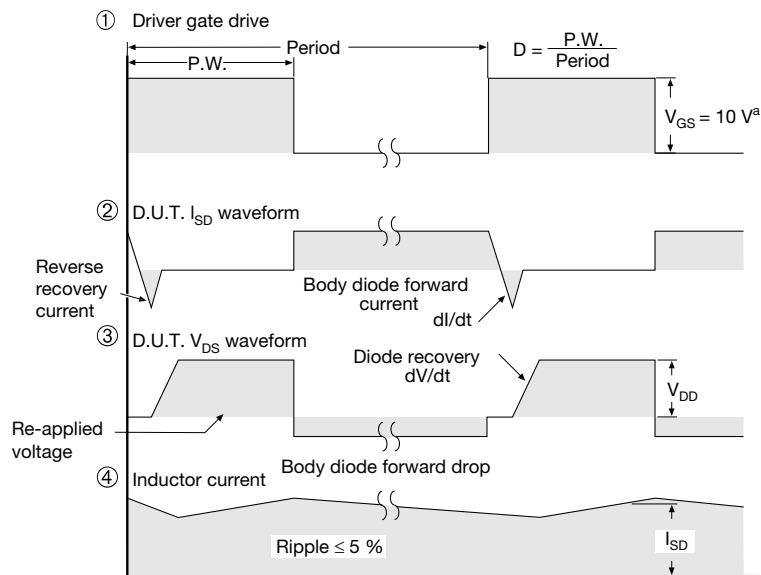
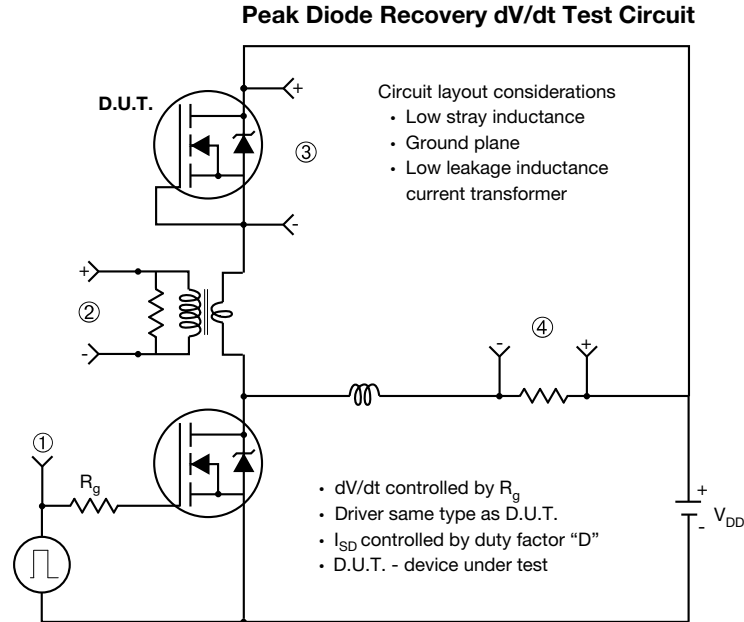
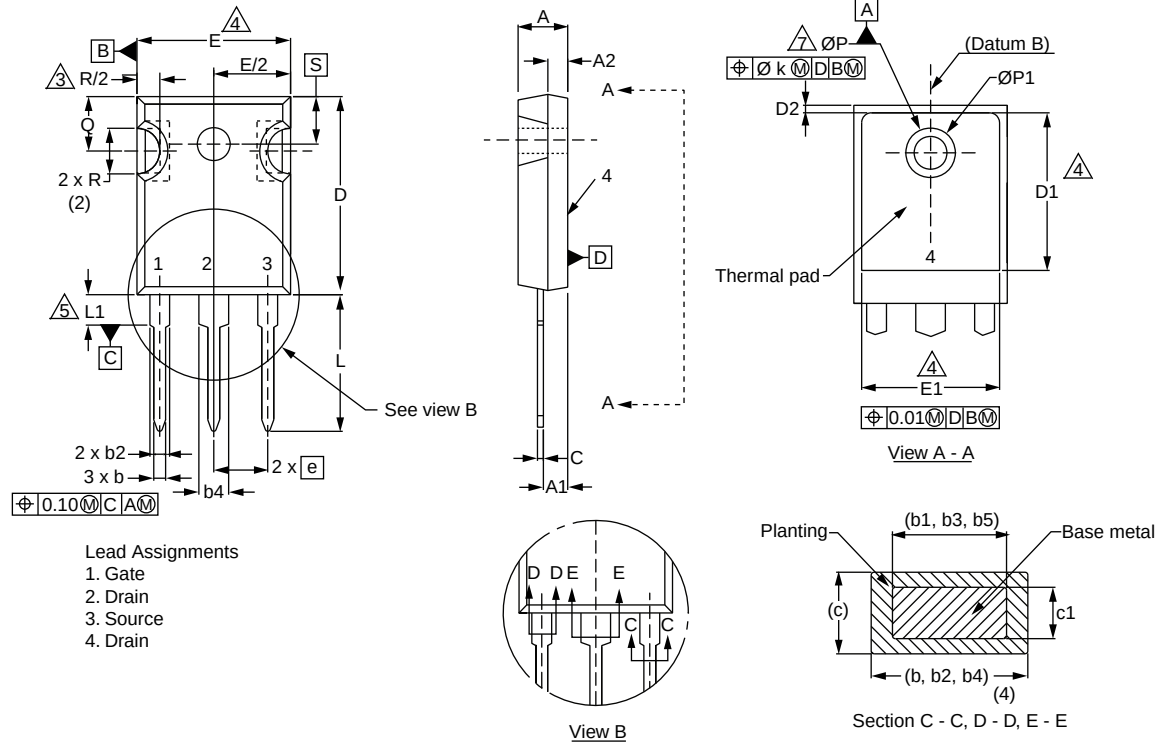


Fig. 17 - Gate Charge Test Circuit

**Note**a.  $V_{GS} = 5\text{ V}$  for logic level devices**Fig. 18 - For N-Channel**

## TO-247AC (High Voltage)



| DIM. | MILLIMETERS |       | INCHES |       |
|------|-------------|-------|--------|-------|
|      | MIN.        | MAX.  | MIN.   | MAX.  |
| A    | 4.58        | 5.31  | 0.180  | 0.209 |
| A1   | 2.21        | 2.59  | 0.087  | 0.102 |
| A2   | 1.17        | 2.49  | 0.046  | 0.098 |
| b    | 0.99        | 1.40  | 0.039  | 0.055 |
| b1   | 0.99        | 1.35  | 0.039  | 0.053 |
| b2   | 1.53        | 2.39  | 0.060  | 0.094 |
| b3   | 1.65        | 2.37  | 0.065  | 0.093 |
| b4   | 2.42        | 3.43  | 0.095  | 0.135 |
| b5   | 2.59        | 3.38  | 0.102  | 0.133 |
| c    | 0.38        | 0.86  | 0.015  | 0.034 |
| c1   | 0.38        | 0.76  | 0.015  | 0.030 |
| D    | 19.71       | 20.82 | 0.776  | 0.820 |
| D1   | 13.08       | -     | 0.515  | -     |

| DIM. | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
|      | MIN.        | MAX.  | MIN.      | MAX.  |
| D2   | 0.51        | 1.30  | 0.020     | 0.051 |
| E    | 15.29       | 15.87 | 0.602     | 0.625 |
| E1   | 13.72       | -     | 0.540     | -     |
| e    | 5.46 BSC    |       | 0.215 BSC |       |
| Ø k  | 0.254       |       | 0.010     |       |
| L    | 14.20       | 16.25 | 0.559     | 0.640 |
| L1   | 3.71        | 4.29  | 0.146     | 0.169 |
| N    | 7.62 BSC    |       | 0.300 BSC |       |
| Ø P  | 3.51        | 3.66  | 0.138     | 0.144 |
| Ø P1 | -           | 7.39  | -         | 0.291 |
| Q    | 5.31        | 5.69  | 0.209     | 0.224 |
| R    | 4.52        | 5.49  | 0.178     | 0.216 |
| S    | 5.51 BSC    |       | 0.217 BSC |       |

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