

# NTHL082N65S3HF-VB Datasheet

## SJ\_Multi-EPI Single-N 650V TO247 MOSFET

### PRODUCT SUMMARY

|                                    |                        |      |
|------------------------------------|------------------------|------|
| $V_{DS}$ (V) at $T_J$ max.         | 700                    |      |
| $R_{DS(on)}$ at 25 °C ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.06 |
| $Q_g$ max. (nC)                    | 273                    |      |
| $Q_{gs}$ (nC)                      | 46                     |      |
| $Q_{gd}$ (nC)                      | 79                     |      |
| Configuration                      | Single                 |      |

### FEATURES

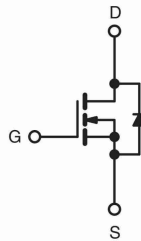
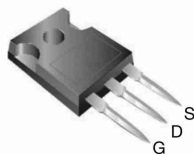
- Low figure-of-merit (FOM)  $R_{on} \times Q_g$
- Low input capacitance ( $C_{iss}$ )
- Reduced switching and conduction losses
- Ultra low gate charge ( $Q_g$ )
- Avalanche energy rated (UIS)


**RoHS**  
 COMPLIANT

### 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



N-Channel MOSFET

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                                        |                                     |                                     |       | SYMBOL         | LIMIT       | UNIT                  |
|------------------------------------------------------------------|-------------------------------------|-------------------------------------|-------|----------------|-------------|-----------------------|
| Drain-Source Voltage                                             |                                     |                                     |       | $V_{DS}$       | 650         | V                     |
| Gate-Source Voltage                                              |                                     |                                     |       | $V_{GS}$       | $\pm 30$    |                       |
| Continuous Drain Current ( $T_J = 150\text{ }^{\circ}\text{C}$ ) | $V_{GS}$ at 10 V                    | $T_C = 25\text{ }^{\circ}\text{C}$  | $I_D$ | 47             | A           |                       |
|                                                                  |                                     | $T_C = 100\text{ }^{\circ}\text{C}$ |       | 30             |             |                       |
| Pulsed Drain Current <sup>a</sup>                                |                                     |                                     |       | $I_{DM}$       | 142         |                       |
| Linear Derating Factor                                           |                                     |                                     |       |                | 3.3         | W/ $^{\circ}\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>                       |                                     |                                     |       | $E_{AS}$       | 1410        | mJ                    |
| Maximum Power Dissipation                                        |                                     |                                     |       | $P_D$          | 415         | W                     |
| Operating Junction and Storage Temperature Range                 |                                     |                                     |       | $T_J, T_{stg}$ | -55 to +150 | $^{\circ}\text{C}$    |
| Drain-Source Voltage Slope                                       | $T_J = 125\text{ }^{\circ}\text{C}$ |                                     |       | $dV/dt$        | 37          | V/ns                  |
| Reverse Diode $dV/dt$ <sup>d</sup>                               |                                     |                                     |       |                | 9           |                       |
| Soldering Recommendations (Peak Temperature) <sup>c</sup>        | for 10 s                            |                                     |       |                | 300         | $^{\circ}\text{C}$    |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ °C}$ ,  $L = 28.2\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 10\text{ A}$ .
- 1.6 mm from case.
- $I_{SD} \leq I_D$ ,  $dI/dt = 100\text{ A}/\mu\text{s}$ , starting  $T_J = 25\text{ °C}$ .

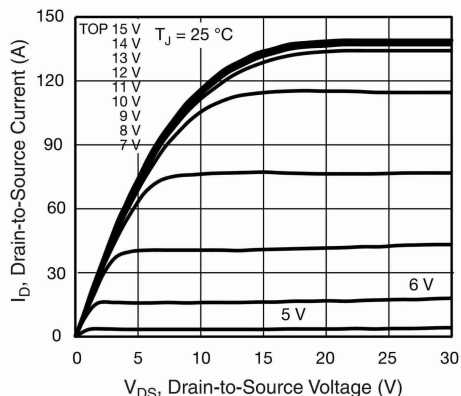
| THERMAL RESISTANCE RATINGS       |            |      |      |      |
|----------------------------------|------------|------|------|------|
| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 40   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.3  |      |

| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted) |                                  |                                                                                                                                                          |                                                |      |      |       |      |
|-----------------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------|------|-------|------|
| PARAMETER                                                       | SYMBOL                           | TEST CONDITIONS                                                                                                                                          |                                                | MIN. | TYP. | MAX.  | UNIT |
| Static                                                          |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                           |                                                | 650  | -    | -     | V    |
| V <sub>DS</sub> Temperature Coefficient                         | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 1 mA                                                                                                                |                                                | -    | 0.70 | -     | V/°C |
| Gate-Source Threshold Voltage (N)                               | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                              |                                                | 2    | -    | 4     | V    |
| Gate-Source Leakage                                             | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V                                                                                                                                 |                                                | -    | -    | ± 100 | nA   |
|                                                                 |                                  | V <sub>GS</sub> = ± 30 V                                                                                                                                 |                                                | -    | -    | ± 1   | μA   |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>                 | V <sub>DS</sub> = 650 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                | -    | -    | 1     | μA   |
|                                                                 |                                  | V <sub>DS</sub> = 520 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                                | -    | -    | 25    |      |
| Drain-Source On-State Resistance                                | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 24 A                          | -    | 0.06 | -     | Ω    |
| Forward Transconductance                                        | g <sub>fs</sub>                  | V <sub>DS</sub> = 30 V, I <sub>D</sub> = 24 A                                                                                                            |                                                | -    | 16.7 | -     | S    |
| Dynamic                                                         |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Input Capacitance                                               | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V,<br>f = 1 MHz                                                                                          |                                                | -    | 5682 | -     | pF   |
| Output Capacitance                                              | C <sub>oss</sub>                 |                                                                                                                                                          |                                                | -    | 251  | -     |      |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>                 |                                                                                                                                                          |                                                | -    | 1    | -     |      |
| Effective Output Capacitance, Energy Related <sup>a</sup>       | C <sub>o(er)</sub>               | V <sub>DS</sub> = 0 V to 520 V, V <sub>GS</sub> = 0 V                                                                                                    |                                                | -    | 192  | -     | pF   |
| Effective Output Capacitance, Time Related <sup>b</sup>         | C <sub>o(tr)</sub>               |                                                                                                                                                          |                                                | -    | 665  | -     |      |
| Total Gate Charge                                               | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 24 A, V <sub>DS</sub> = 520 V | -    | 182  | 273   | nC   |
| Gate-Source Charge                                              | Q <sub>gs</sub>                  |                                                                                                                                                          |                                                | -    | 46   | -     |      |
| Gate-Drain Charge                                               | Q <sub>gd</sub>                  |                                                                                                                                                          |                                                | -    | 79   | -     |      |
| Turn-On Delay Time                                              | t <sub>d(on)</sub>               | V <sub>DD</sub> = 520 V, I <sub>D</sub> = 6 A,<br>V <sub>GS</sub> = 10 V, R <sub>g</sub> = 9.1 Ω                                                         |                                                | -    | 47   | 94    | ns   |
| Rise Time                                                       | t <sub>r</sub>                   |                                                                                                                                                          |                                                | -    | 87   | 131   |      |
| Turn-Off Delay Time                                             | t <sub>d(off)</sub>              |                                                                                                                                                          |                                                | -    | 156  | 234   |      |
| Fall Time                                                       | t <sub>f</sub>                   |                                                                                                                                                          |                                                | -    | 103  | 206   |      |
| Gate Input Resistance                                           | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                    |                                                | -    | 0.64 | -     | Ω    |
| Drain-Source Body Diode Characteristics                         |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Continuous Source-Drain Diode Current                           | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                | -    | -    | 47    | A    |
| Pulsed Diode Forward Current                                    | I <sub>SM</sub>                  |                                                                                                                                                          |                                                | -    | -    | 139   |      |
| Diode Forward Voltage                                           | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 24 A, V <sub>GS</sub> = 0 V                                                                                     |                                                | -    | 0.9  | 1.2   | V    |
| Reverse Recovery Time                                           | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 24 A,<br>dI/dt = 100 A/μs, V <sub>R</sub> = 25 V                                               |                                                | -    | 753  | 1506  | ns   |
| Reverse Recovery Charge                                         | Q <sub>rr</sub>                  |                                                                                                                                                          |                                                | -    | 14   | 28    | μC   |
| Reverse Recovery Current                                        | I <sub>RRM</sub>                 |                                                                                                                                                          |                                                | -    | 28   | -     | A    |

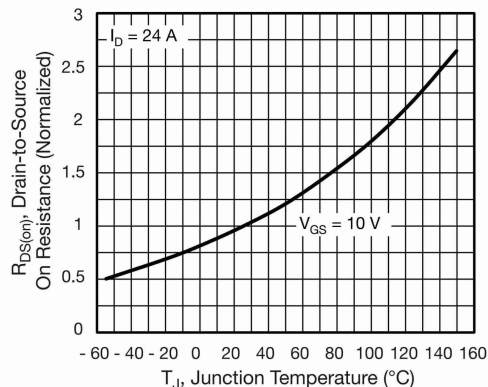
**Notes**

- 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 %  $V_{DSS}$ .

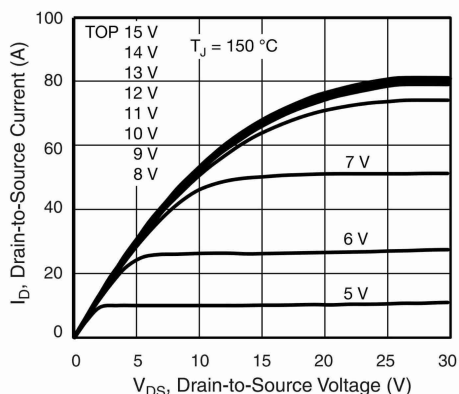
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



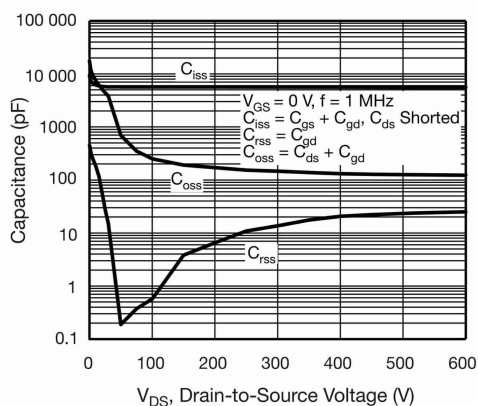
**Fig. 1 - Typical Output Characteristics**



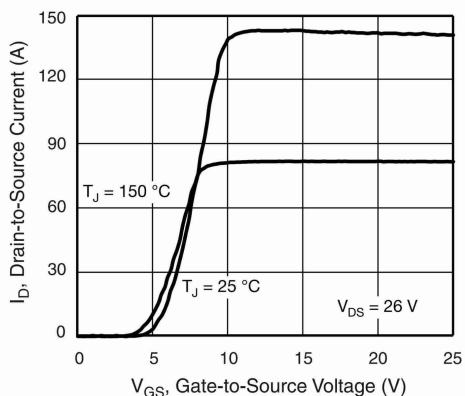
**Fig. 4 - Normalized On-Resistance vs. Temperature**



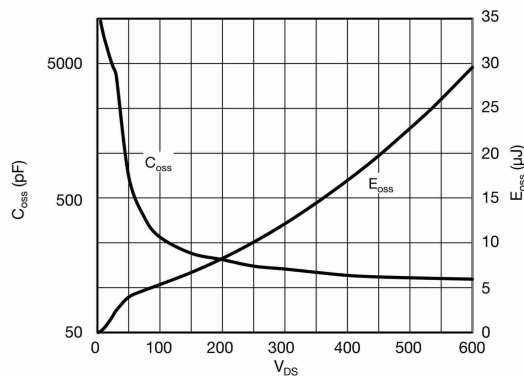
**Fig. 2 - Typical Output Characteristics**



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



**Fig. 3 - Typical Transfer Characteristics**



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

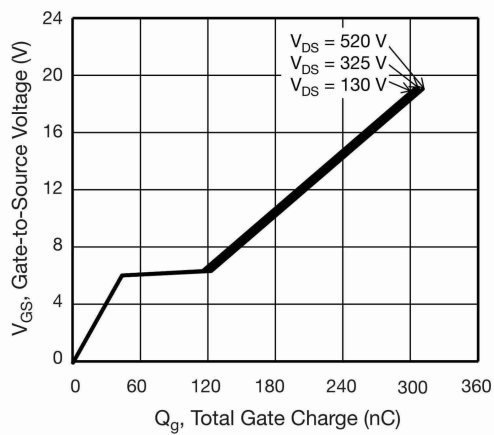


Fig. 7 - Typical Gate Charge vs. Gate-to-Source Voltage

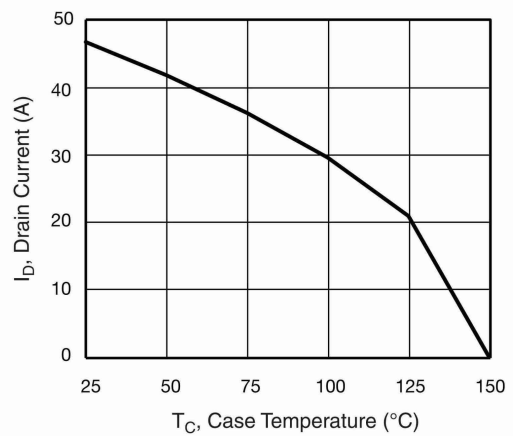


Fig. 10 - Maximum Drain Current vs. Case Temperature

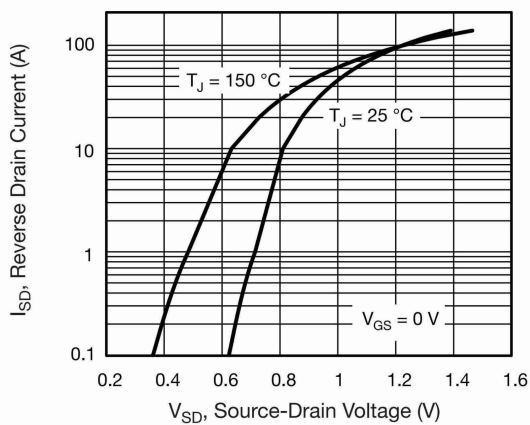


Fig. 8 - Typical Source-Drain Diode Forward Voltage

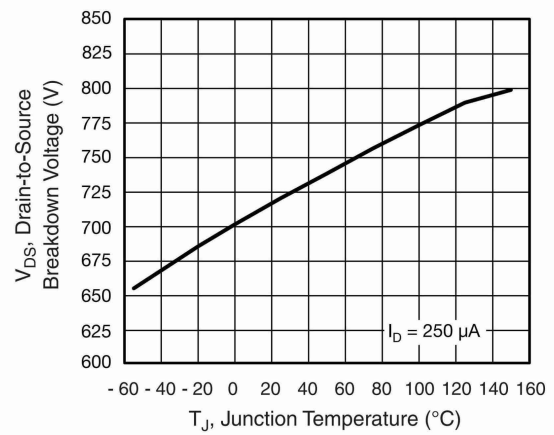


Fig. 11 - Temperature vs. Drain-to-Source Voltage

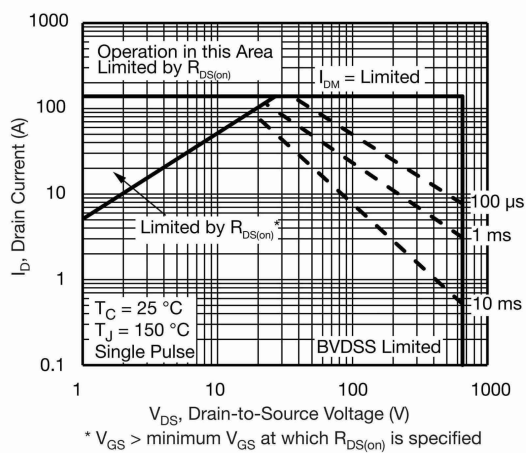


Fig. 9 - Maximum Safe Operating Area

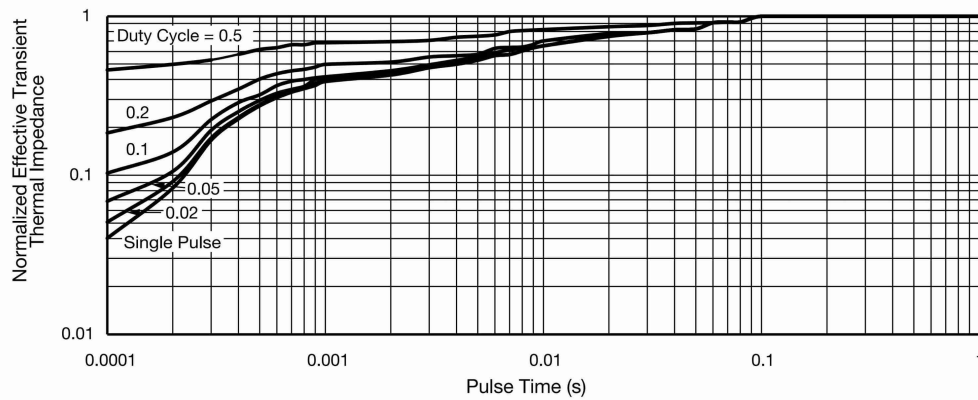


Fig. 12 - Normalized Thermal Transient Impedance, Junction-to-Case

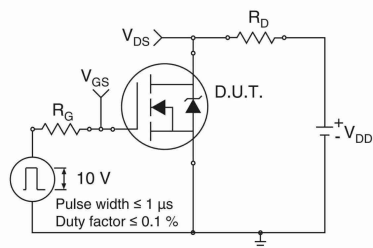


Fig. 13 - Switching Time Test Circuit

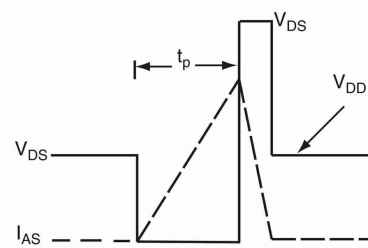


Fig. 16 - Unclamped Inductive Waveforms

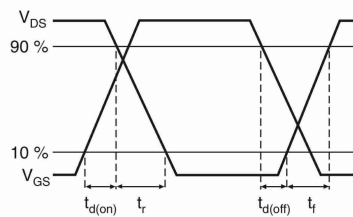


Fig. 14 - Switching Time Waveforms

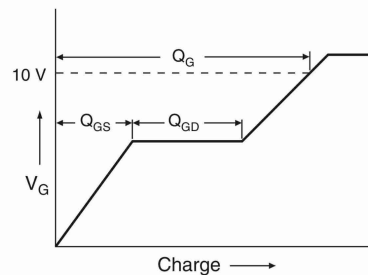


Fig. 17 - Basic Gate Charge Waveform

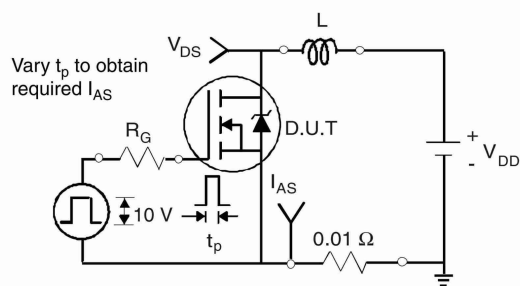


Fig. 15 - Unclamped Inductive Test Circuit

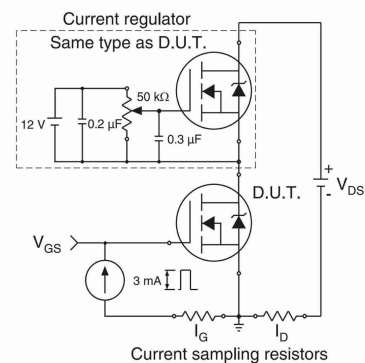
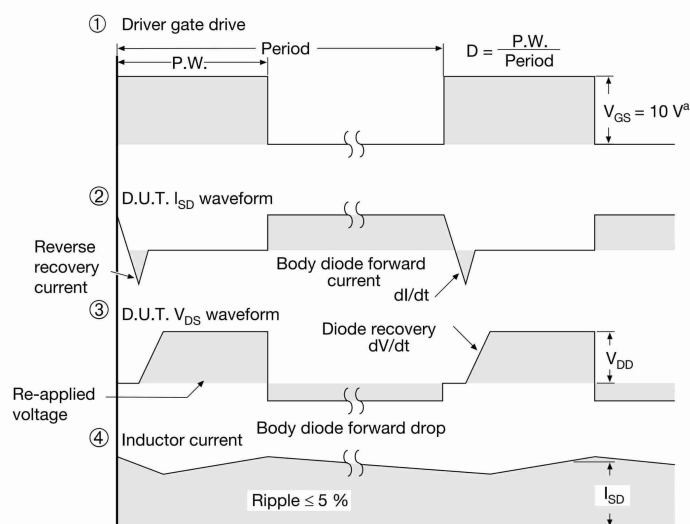
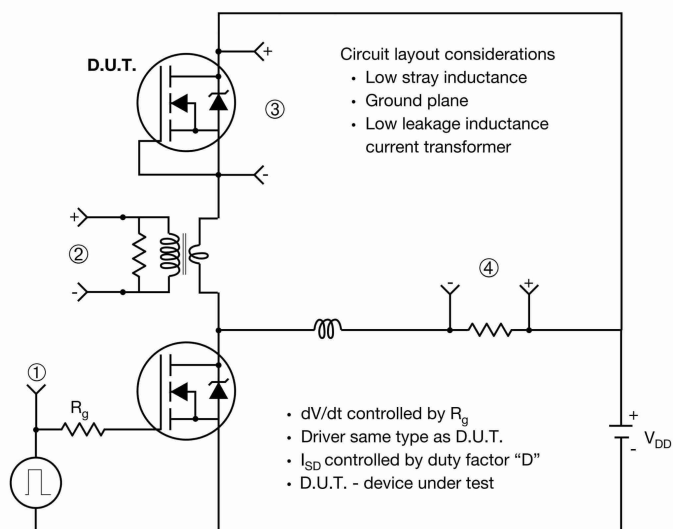


Fig. 18 - Gate Charge Test Circuit

### Peak Diode Recovery $dV/dt$ Test Circuit

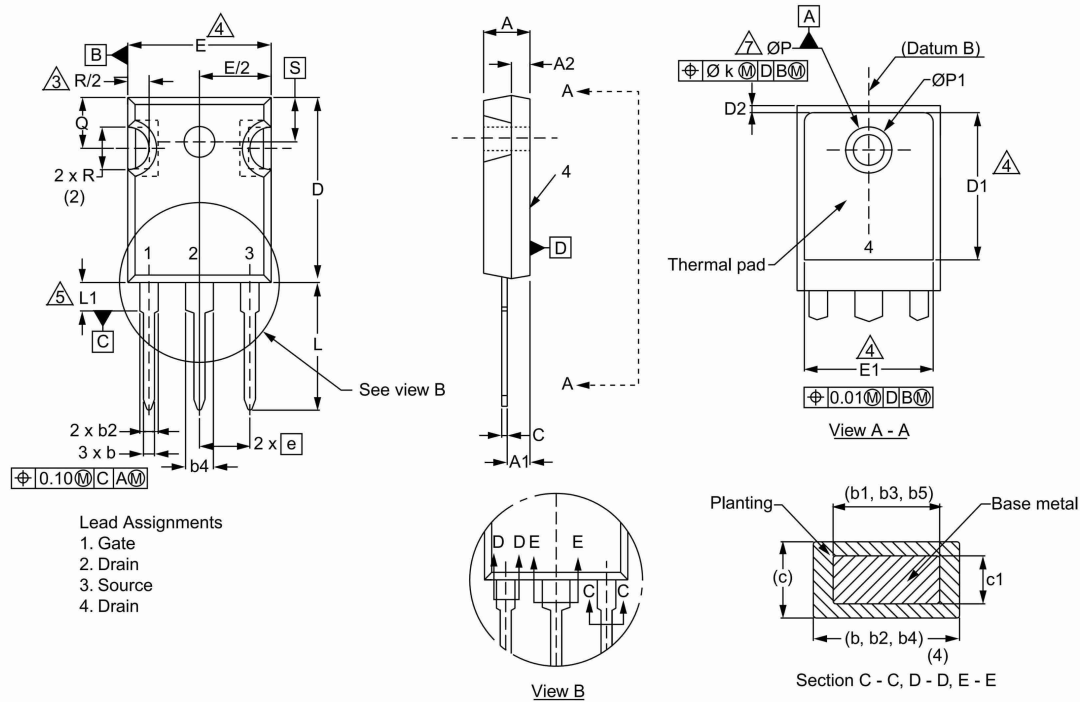


#### Note

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

Fig. 19 - 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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