

## PHW8ND50E-VB Datasheet

## N-Channel 500V(D-S) Super Junction Power MOSFET

## PRODUCT SUMMARY

|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 500                    |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.080 |
| $Q_g$ (Max.) (nC)         | 350                    |       |
| $Q_{gs}$ (nC)             | 85                     |       |
| $Q_{gd}$ (nC)             | 180                    |       |
| Configuration             | Single                 |       |

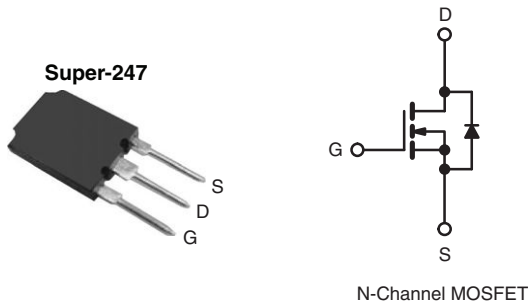
## FEATURES

- Low Gate Charge  $Q_g$  Results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic  $dV/dt$  Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Low  $R_{DS(on)}$
- Compliant to RoHS Directive 2002/95/EC



## APPLICATIONS

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply
- High Speed Power Switching
- Hard Switched and High Frequency Circuits

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

| PARAMETER                                        |                         |                         | SYMBOL                            | LIMIT            | UNIT |
|--------------------------------------------------|-------------------------|-------------------------|-----------------------------------|------------------|------|
| Drain-Source Voltage                             |                         |                         | V <sub>DS</sub>                   | 500              | V    |
| Gate-Source Voltage                              |                         |                         | V <sub>GS</sub>                   | ± 30             |      |
| Continuous Drain Current                         | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 40               | A    |
|                                                  |                         | T <sub>C</sub> = 100 °C |                                   | 25               |      |
| Pulsed Drain Current <sup>a</sup>                |                         |                         | I <sub>DM</sub>                   | 180              |      |
| Linear Derating Factor                           |                         |                         |                                   | 4.3              | W/°C |
| Single Pulse Avalanche Energy <sup>b</sup>       |                         |                         | E <sub>AS</sub>                   | 910              | mJ   |
| Repetitive Avalanche Current <sup>a</sup>        |                         |                         | I <sub>AR</sub>                   | 40               | A    |
| Repetitive Avalanche Energy <sup>a</sup>         |                         |                         | E <sub>AR</sub>                   | 51               | mJ   |
| Maximum Power Dissipation                        | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>                    | 530              | W    |
| Peak Diode Recovery dV/dt <sup>c</sup>           |                         |                         | dV/dt                             | 9.0              | V/ns |
| Operating Junction and Storage Temperature Range |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | - 55 to + 150    | °C   |
| Soldering Recommendations (Peak Temperature)     | for 10 s                |                         |                                   | 300 <sup>d</sup> |      |

## Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 0.82\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 47\text{ A}$  (see fig. 12c).
- $I_{SD} \leq 47\text{ A}$ ,  $dI/dt \leq 230\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

**THERMAL RESISTANCE RATINGS**

| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient         | $R_{thJA}$ | -    | 40   | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.24 | -    |      |
| Maximum Junction-to-Case (Drain)    | $R_{thJC}$ | -    | 0.23 |      |

**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 <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                          |                                                                                                     | 500  | -     | -     | 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                                                                                                               |                                                                                                     | -    | 0.60  | -     | V/°C |
| Gate-Source Threshold Voltage             | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                             |                                                                                                     | 3.0  | -     | 5.0   | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 30 V                                                                                                                                |                                                                                                     | -    | -     | ± 100 | nA   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V                                                                                                          |                                                                                                     | -    | -     | 50    | μA   |
|                                           |                                  | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                 |                                                                                                     | -    | -     | 250   |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                  | I <sub>D</sub> = 28 A <sup>b</sup>                                                                  | -    | 0.080 | -     | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 28 A                                                                                                           |                                                                                                     | 23   | -     | -     | S    |
| Dynamic                                   |                                  |                                                                                                                                                         |                                                                                                     |      |       |       |      |
| Input Capacitance                         | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 25 V,<br>f = 1.0 MHz, see fig. 5                                                                            |                                                                                                     | -    | 8310  | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                         |                                                                                                     | -    | 960   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                         |                                                                                                     | -    | 120   | -     |      |
| Output Capacitance                        | C <sub>oss</sub>                 | V <sub>GS</sub> = 0 V                                                                                                                                   | V <sub>DS</sub> = 1.0 V, f = 1.0 MHz                                                                | -    | 10170 | -     |      |
|                                           |                                  |                                                                                                                                                         | V <sub>DS</sub> = 400 V, f = 1.0 MHz                                                                | -    | 240   | -     |      |
| Effective Output Capacitance              | C <sub>oss eff.</sub>            |                                                                                                                                                         | V <sub>DS</sub> = 0 V to 400 V <sup>c</sup>                                                         | -    | 440   | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   |                                                                                                                                                         | I <sub>D</sub> = 47 A, V <sub>DS</sub> = 400 V,<br>see fig. 6 and 13 <sup>b</sup>                   | -    | -     | 350   | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                         |                                                                                                     | -    | -     | 85    |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                         |                                                                                                     | -    | -     | 180   |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>GS</sub> = 10 V                                                                                                                                  | V <sub>DD</sub> = 250 V, I <sub>D</sub> = 47 A,<br>R <sub>G</sub> = 1.0 Ω, see fig. 10 <sup>b</sup> | -    | 25    | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                                         |                                                                                                     | -    | 140   | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                                         |                                                                                                     | -    | 55    | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                                         |                                                                                                     | -    | 74    | -     |      |
| 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 <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                         |                                                                                                     | -    | -     | 190   |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 47 A, V <sub>GS</sub> = 0 V <sup>b</sup>                                                                       |                                                                                                     | -    | -     | 1.5   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 47 A, dI/dt = 100 A/μs <sup>b</sup>                                                                            |                                                                                                     | -    | 620   | 940   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                                         |                                                                                                     | -    | 14    | 21    | μC   |
| Body Diode Recovery Current               | I <sub>RRM</sub>                 |                                                                                                                                                         |                                                                                                     | -    | 38    | -     | A    |
| Forward Turn-On Time                      | t <sub>on</sub>                  | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> and L <sub>D</sub> )                                                       |                                                                                                     |      |       |       |      |

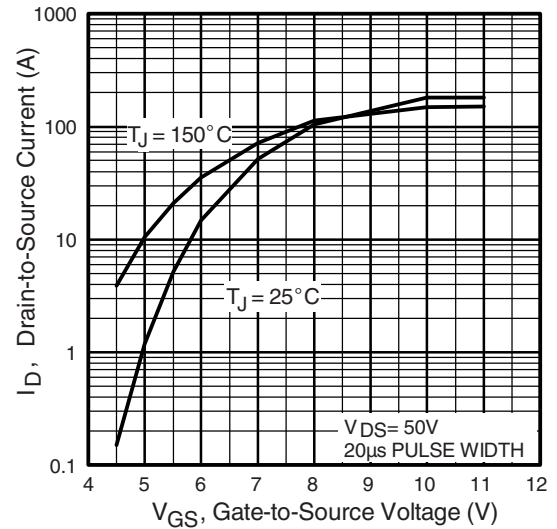
**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).  
 b. Pulse width  $\leq 400\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .  
 c.  $C_{oss\text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 % to 80 %  $V_{DS}$ .

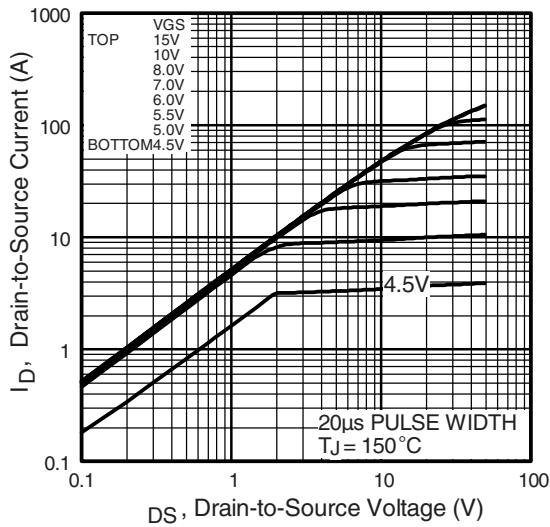
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



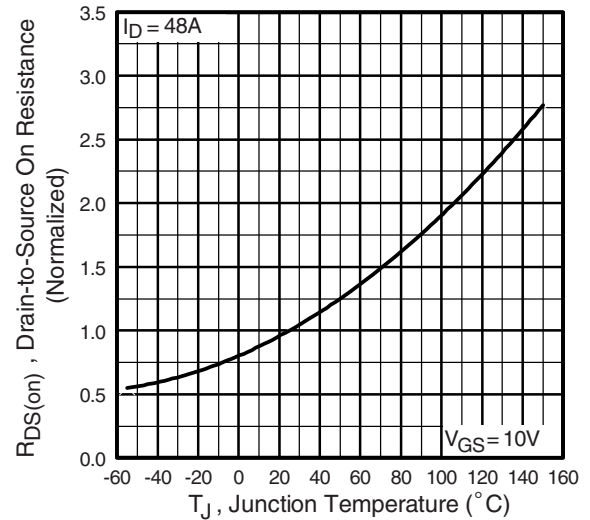
**Fig. 1 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics**



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

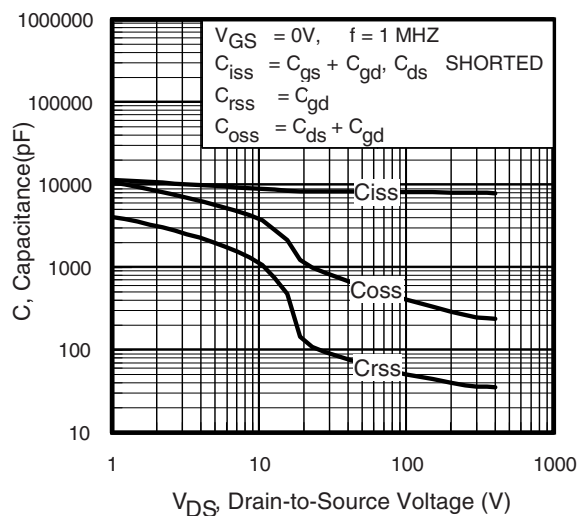


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

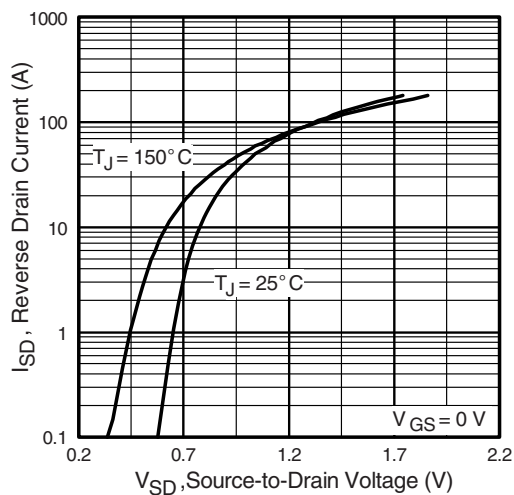


Fig. 7 - Typical Source-Drain Diode Forward Voltage

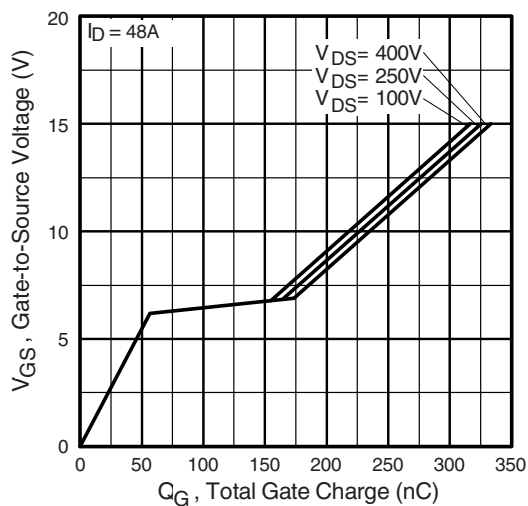


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

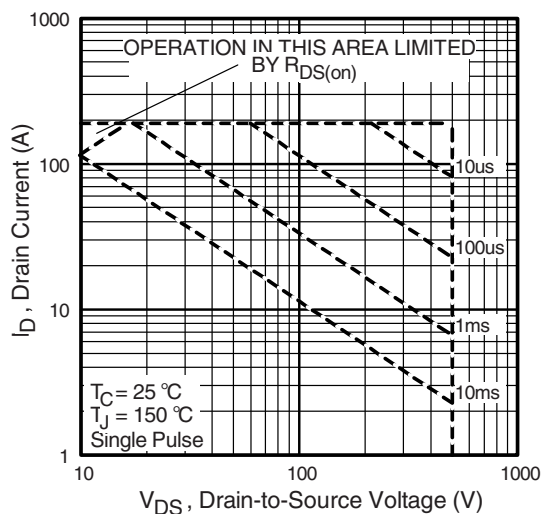


Fig. 8 - Maximum Safe Operating Area

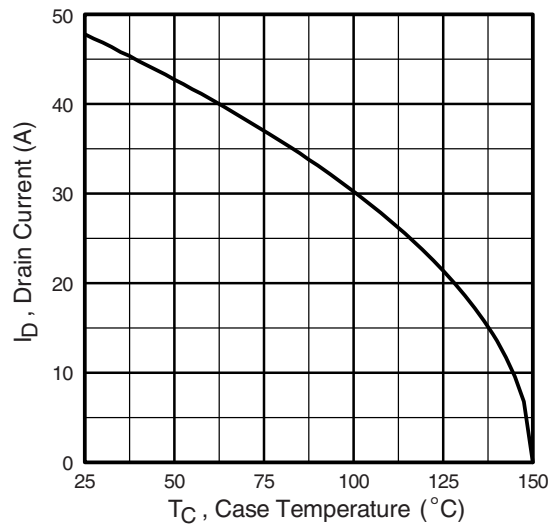


Fig. 9 - Maximum Drain Current vs. Case Temperature

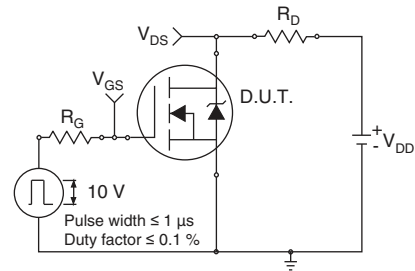


Fig. 10a - Switching Time Test Circuit

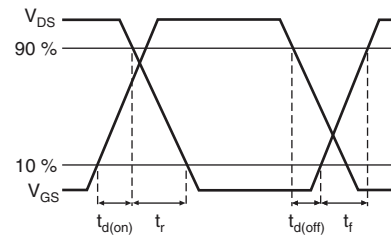


Fig. 10b - Switching Time Waveforms

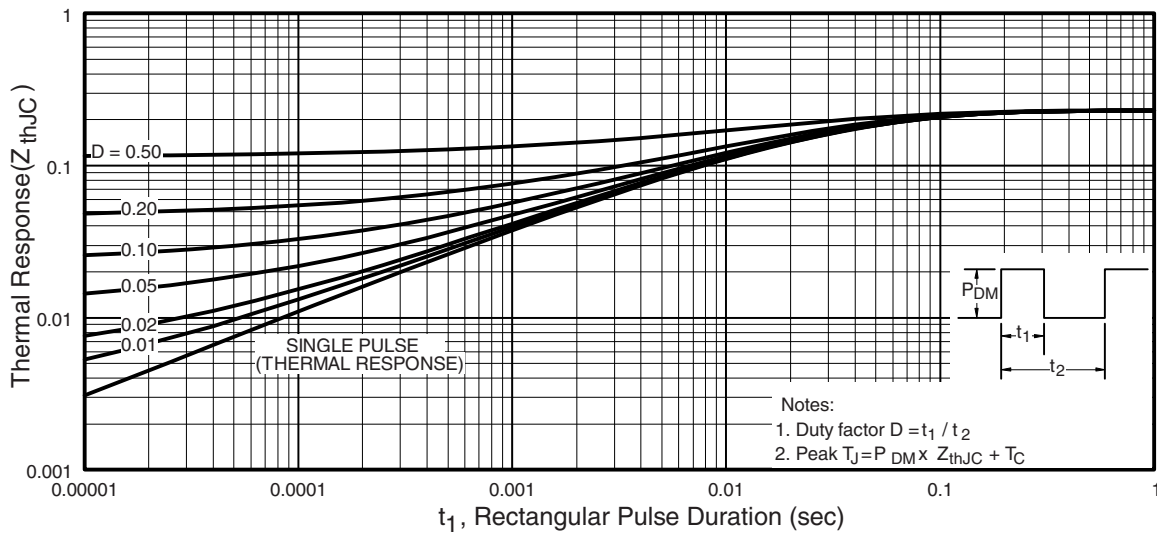


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

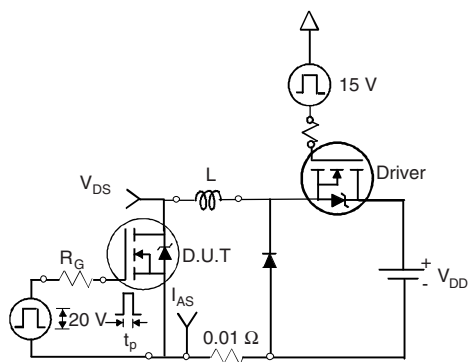


Fig. 12a - Unclamped Inductive Test Circuit

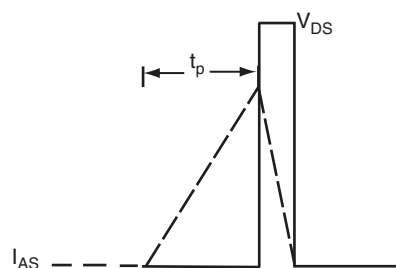


Fig. 12b - Unclamped Inductive Waveforms

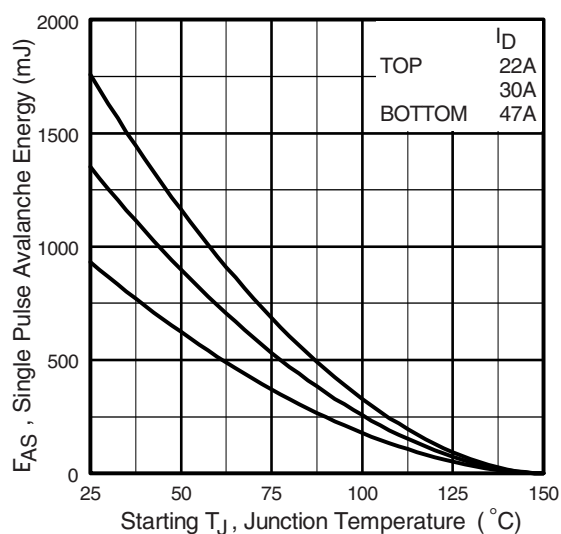


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

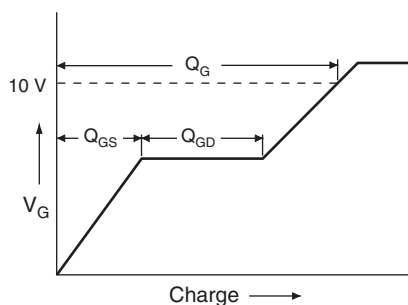


Fig. 13a - Basic Gate Charge Waveform

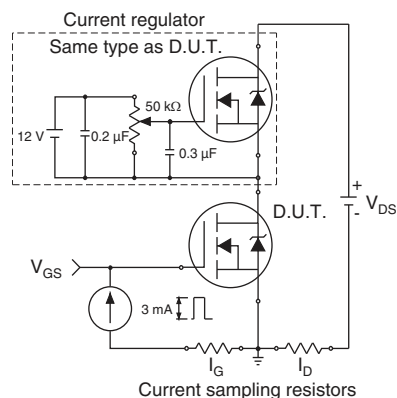
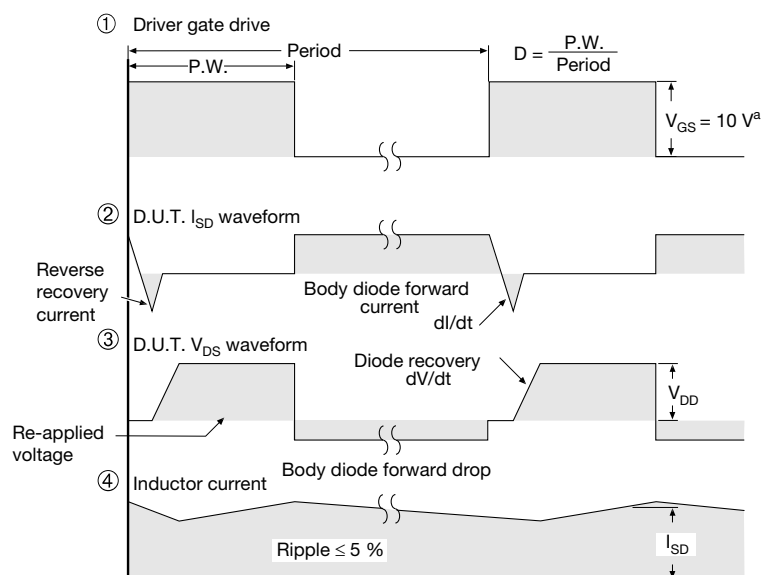
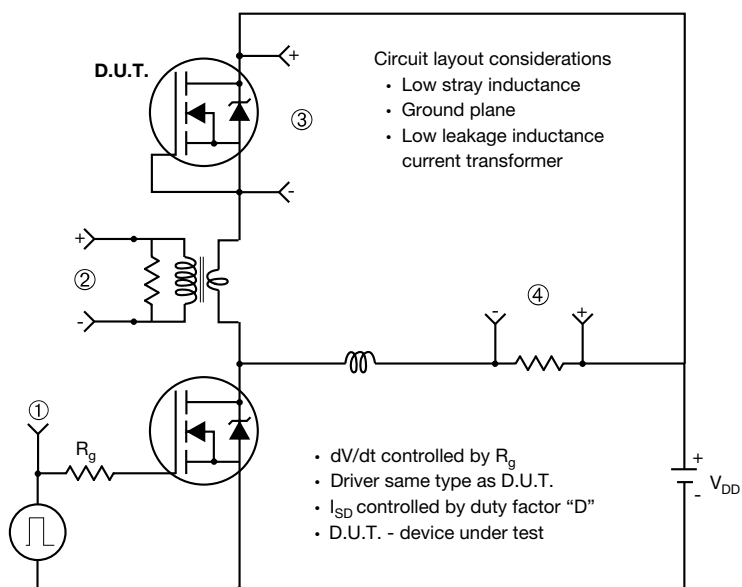


Fig. 13b - Gate Charge Test Circuit

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

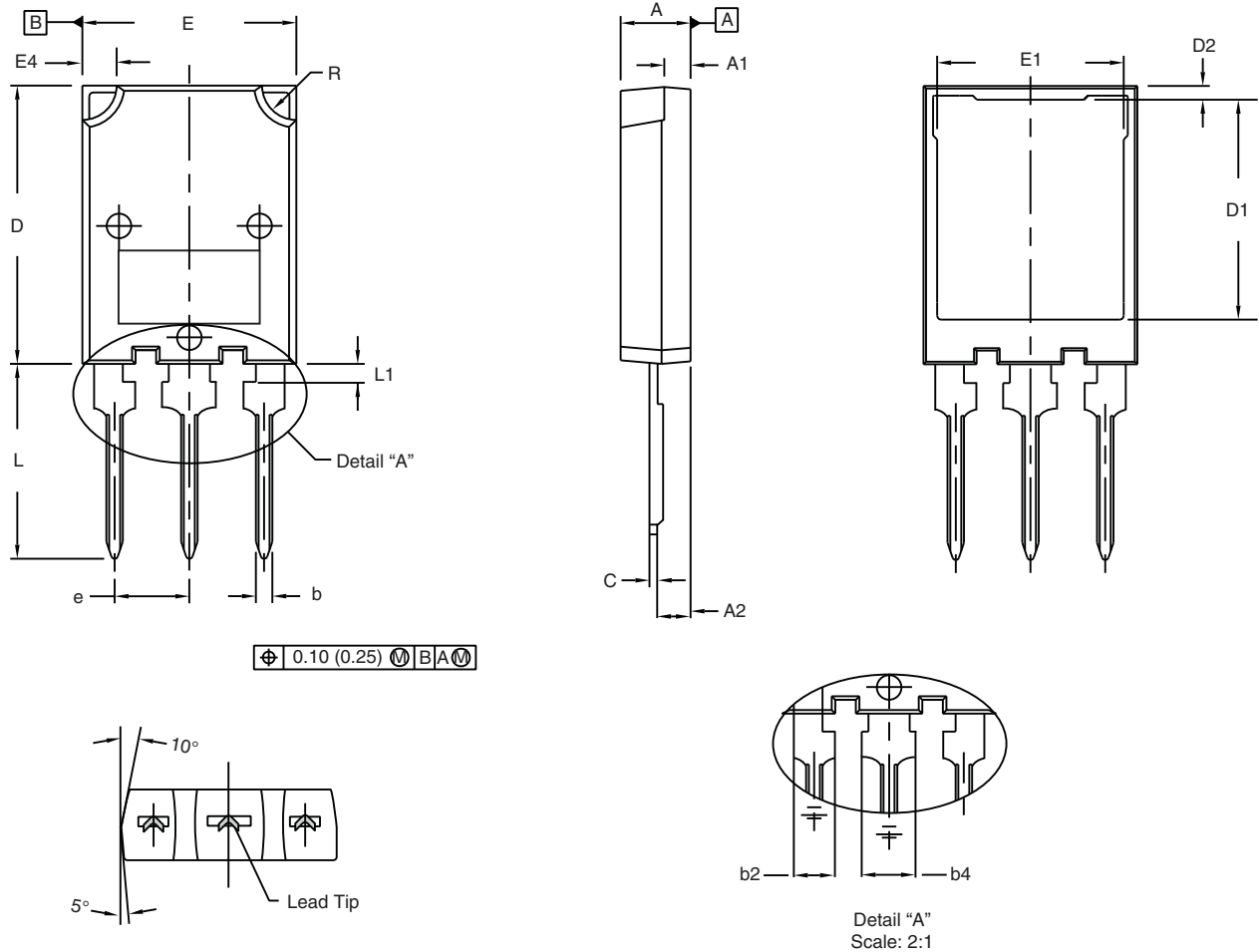


#### Note

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

**Fig. 14 - For N-Channel**

## TO-274AA (High Voltage)



| DIM.             | MILLIMETERS |       | INCHES |       |
|------------------|-------------|-------|--------|-------|
|                  | MIN.        | MAX.  | MIN.   | MAX.  |
| A                | 4.70        | 5.30  | 0.185  | 0.209 |
| A1               | 1.50        | 2.50  | 0.059  | 0.098 |
| A2               | 2.25        | 2.65  | 0.089  | 0.104 |
| b                | 1.30        | 1.60  | 0.051  | 0.063 |
| b2               | 1.80        | 2.20  | 0.071  | 0.087 |
| b4               | 3.00        | 3.25  | 0.118  | 0.128 |
| c <sup>(1)</sup> | 0.38        | 0.89  | 0.015  | 0.035 |
| D                | 19.80       | 20.80 | 0.780  | 0.819 |

| DIM. | MILLIMETERS |       | INCHES    |       |
|------|-------------|-------|-----------|-------|
|      | MIN.        | MAX.  | MIN.      | MAX.  |
| D1   | 15.50       | 16.10 | 0.610     | 0.634 |
| D2   | 0.70        | 1.30  | 0.028     | 0.051 |
| E    | 15.10       | 16.10 | 0.594     | 0.634 |
| E1   | 13.30       | 13.90 | 0.524     | 0.547 |
| e    | 5.45 BSC    |       | 0.215 BSC |       |
| L    | 13.70       | 14.70 | 0.539     | 0.579 |
| L1   | 1.00        | 1.60  | 0.039     | 0.063 |
| R    | 2.00        | 3.00  | 0.079     | 0.118 |

ECN: X17-0056-Rev. B, 27-Mar-17  
 DWG: 5975

### Notes

- Dimensioning and tolerancing per ASME Y14.5M-1994
- Dimension D and E do not include mold flash. Mold flash shall not exceed 0.127 mm (0.005") per side. These dimensions are measured at the outer extremes of the plastic body
- Outline conforms to JEDEC® outline to TO-274AA

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