

## FDH50N50-VB Datasheet

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

#### PRODUCT SUMMARY

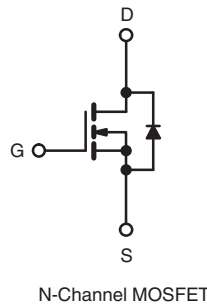
|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 500                    |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.080 |
| $Q_g$ (Max.) (nC)         | 350               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



TO-247



#### 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**

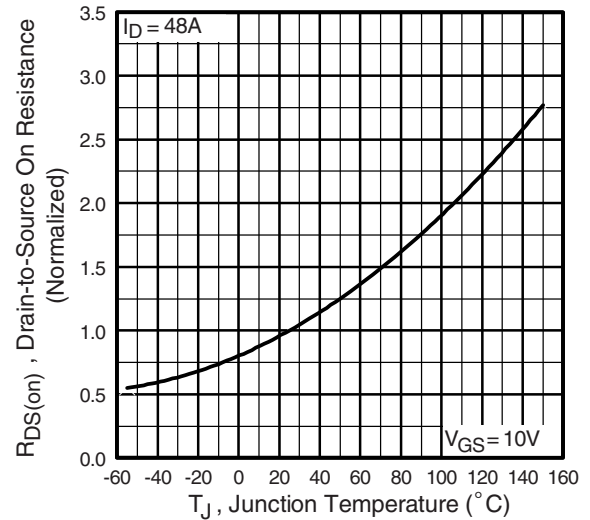
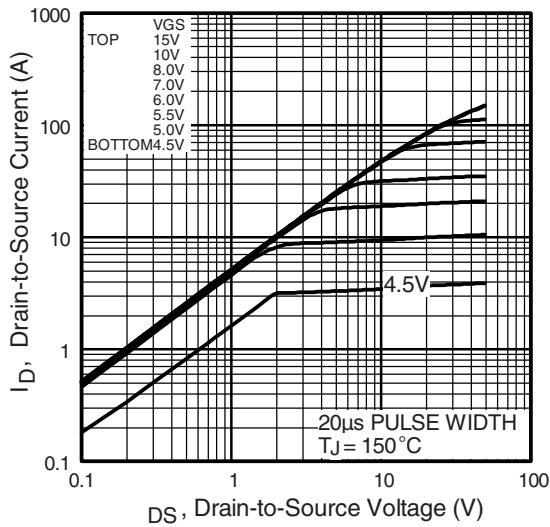
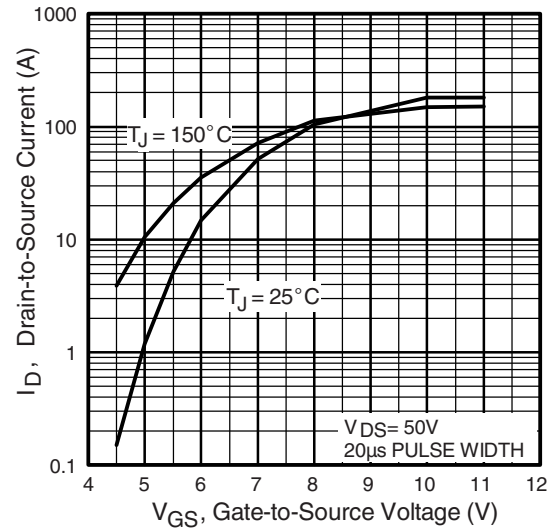
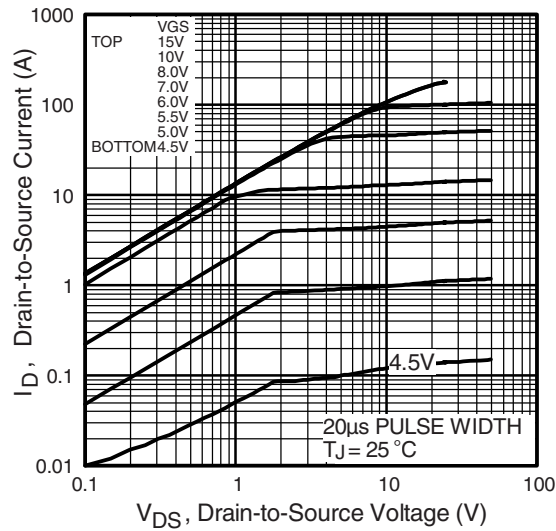
| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient         | $R_{thJA}$ | -    | 40   | °C/W |
| Case-to-Sink, Flat, Greased Surface | $R_{thCS}$ | 0.24 | -    |      |
| Maximum 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 | -     | pF   |
|                                           |                                  |                                                                                                                                                         | 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>                   | V <sub>GS</sub> = 10 V                                                                                                                                  | 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    | -    |
| 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>                                                                            |                                                                                   | -                                                                                                   | 150   | -     | 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)


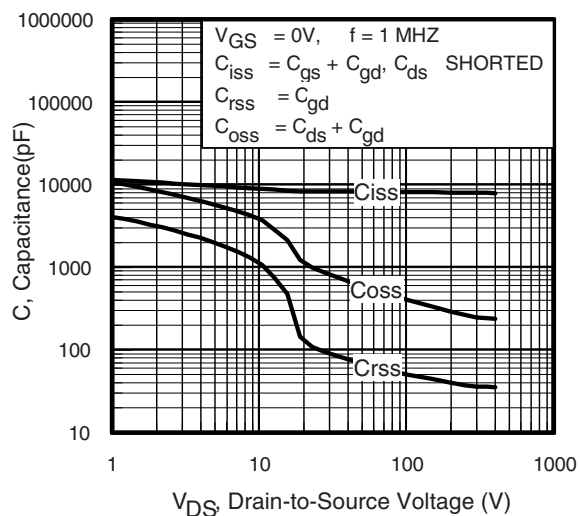


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



Fig. 7 - Typical Source-Drain Diode Forward Voltage

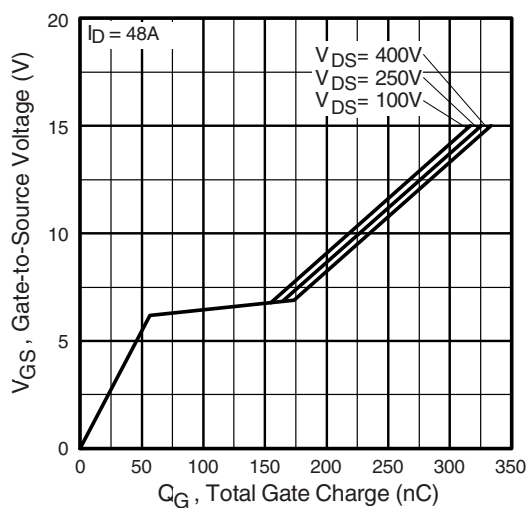


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

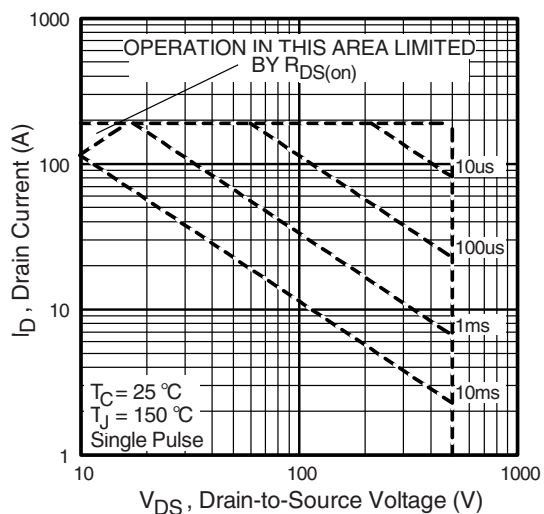


Fig. 8 - Maximum Safe Operating Area

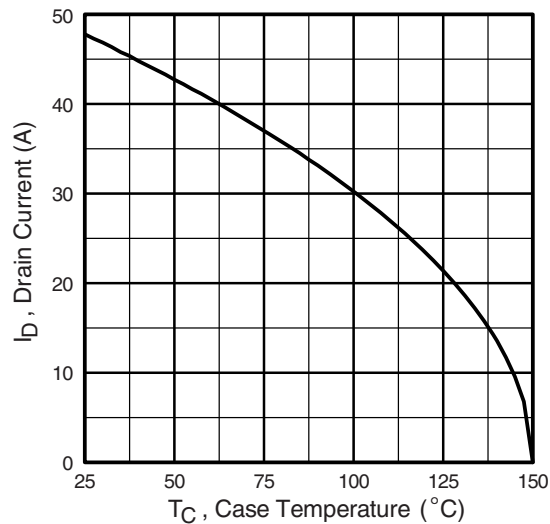


Fig. 9 - Maximum Drain Current vs. Case Temperature

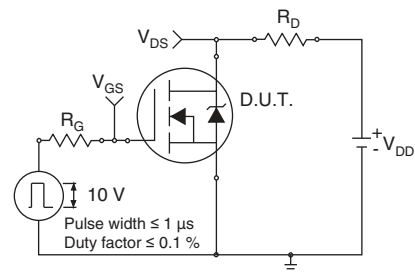


Fig. 10a - Switching Time Test Circuit

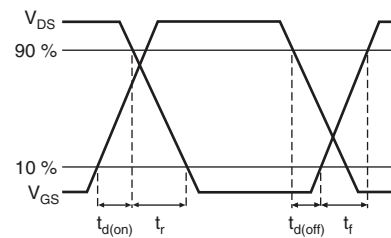


Fig. 10b - Switching Time Waveforms

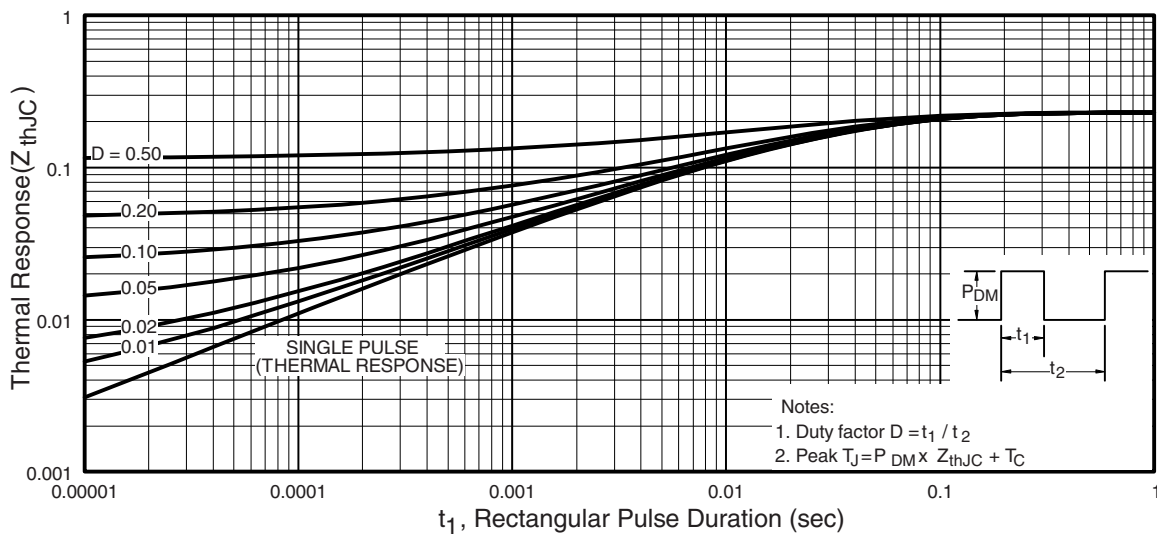


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

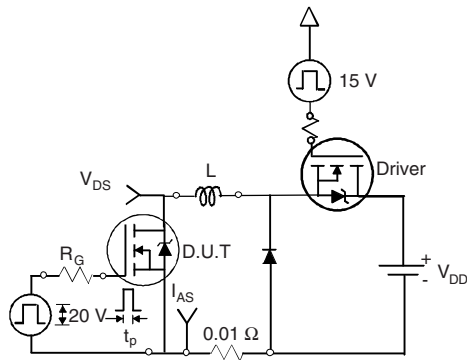


Fig. 12a - Unclamped Inductive Test Circuit

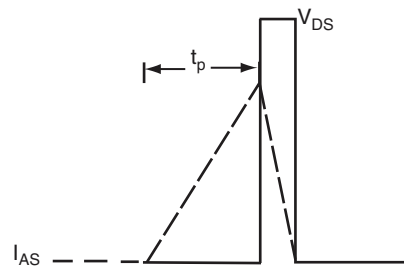


Fig. 12b - Unclamped Inductive Waveforms

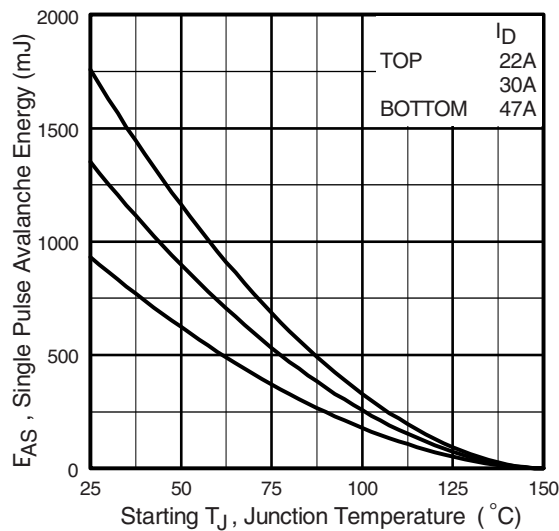


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

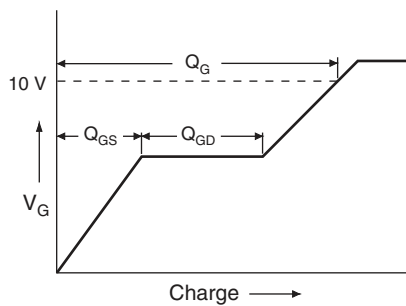


Fig. 13a - Basic Gate Charge Waveform

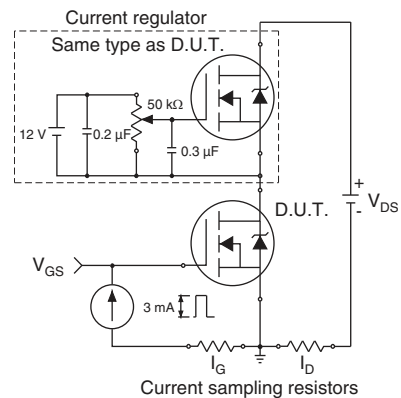
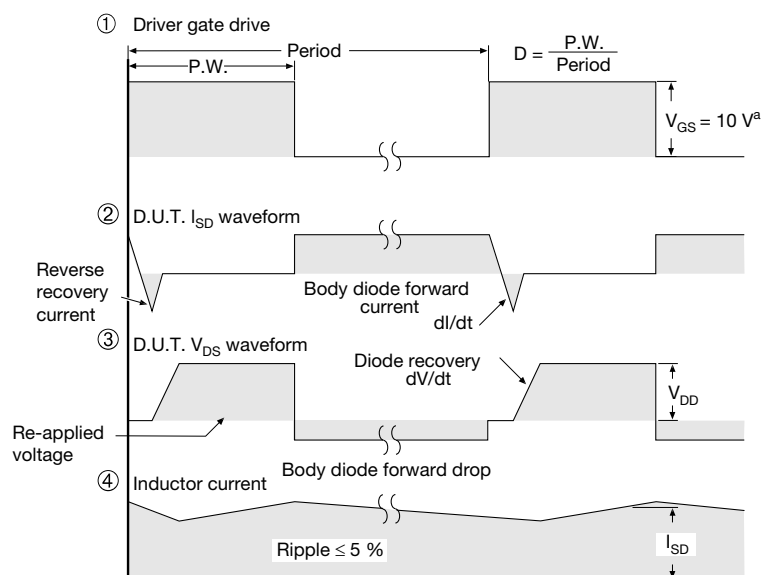
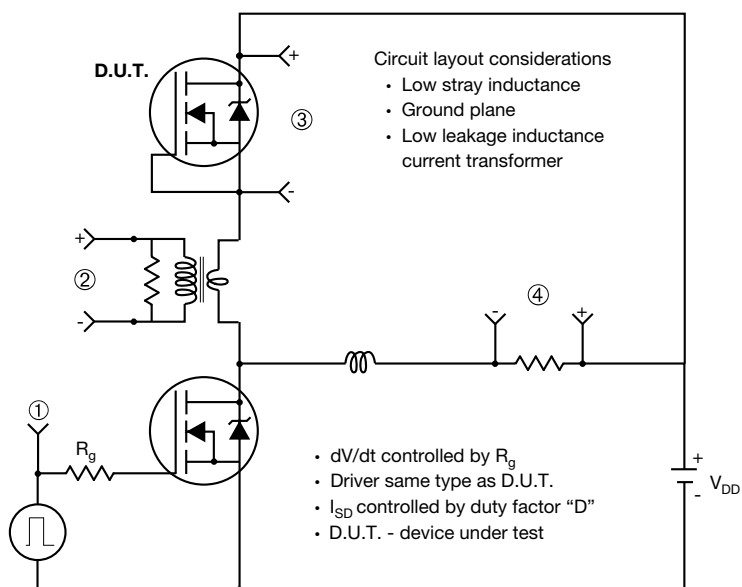


Fig. 13b - Gate Charge Test Circuit

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

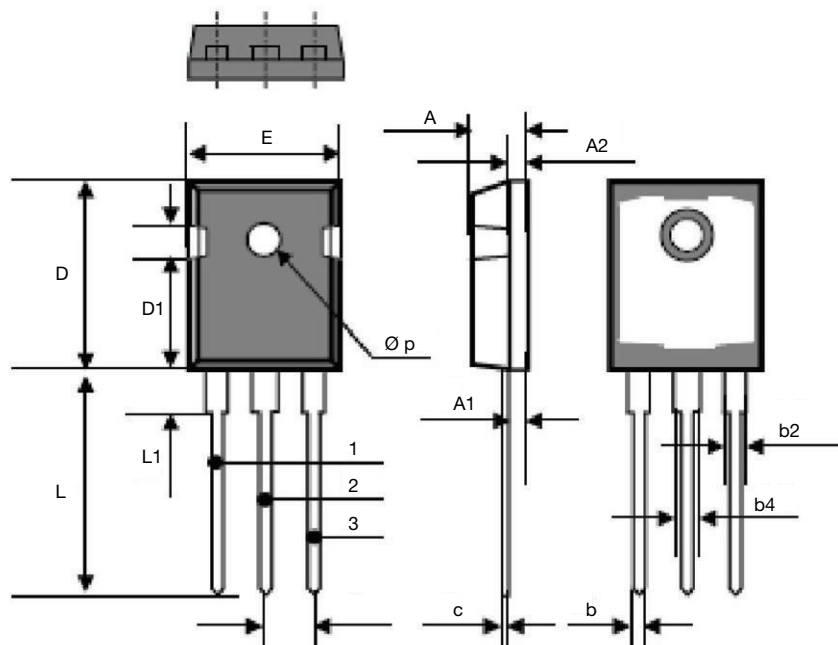


#### Note

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

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

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| 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 |
| $\varnothing p$ | 3.51        | 3.66  | 0.138     | 0.144 |

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