

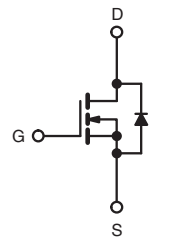
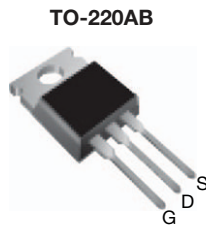
## N-Channel 500V (D-S)Power MOSFET

### PRODUCT SUMMARY

|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 500                    |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.660 |
| $Q_g$ (Max.) (nC)         | 81                     |       |
| $Q_{gs}$ (nC)             | 20                     |       |
| $Q_{gd}$ (nC)             | 36                     |       |
| Configuration             | Single                 |       |

### FEATURES

- Lower Gate Charge  $Q_g$  Results in Simpler Drive Requirements
- Improved Gate, Avalanche and Dynamic  $dV/dt$  Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage
- Compliant to RoHS Directive 2002/95/EC



N-Channel MOSFET

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

| PARAMETER                                        |                                    |                                     | SYMBOL         | LIMIT            | UNIT                  |
|--------------------------------------------------|------------------------------------|-------------------------------------|----------------|------------------|-----------------------|
| Drain-Source Voltage                             |                                    |                                     | $V_{DS}$       | 500              | V                     |
| Gate-Source Voltage                              |                                    |                                     | $V_{GS}$       | $\pm 20$         |                       |
| Continuous Drain Current                         | $V_{GS}$ at 10 V                   | $T_C = 25\text{ }^{\circ}\text{C}$  | $I_D$          | 13               | A                     |
|                                                  |                                    | $T_C = 100\text{ }^{\circ}\text{C}$ |                | 8.1              |                       |
| Pulsed Drain Current <sup>a</sup>                |                                    |                                     | $I_{DM}$       | 50               |                       |
| Linear Derating Factor                           |                                    |                                     |                | 2.0              | W/ $^{\circ}\text{C}$ |
| Single Pulse Avalanche Energy <sup>b</sup>       |                                    |                                     | $E_{AS}$       | 560              | mJ                    |
| Avalanche Current <sup>a</sup>                   |                                    |                                     | $I_{AR}$       | 13               | A                     |
| Repetitive Avalanche Energy <sup>a</sup>         |                                    |                                     | $E_{AR}$       | 25               | mJ                    |
| Maximum Power Dissipation                        | $T_C = 25\text{ }^{\circ}\text{C}$ |                                     | $P_D$          | 250              | W                     |
| Peak Diode Recovery $dV/dt$ <sup>c</sup>         |                                    |                                     | $dV/dt$        | 9.2              | V/ns                  |
| Operating Junction and Storage Temperature Range |                                    |                                     | $T_J, T_{stg}$ | - 55 to + 150    | $^{\circ}\text{C}$    |
| Soldering Recommendations (Peak Temperature)     | for 10 s                           |                                     |                | 300 <sup>d</sup> |                       |
| Mounting Torque                                  | 6-32 or M3 screw                   |                                     |                | 10               | lbf · in              |
|                                                  |                                    |                                     |                | 1.1              | N · m                 |

### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- Starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 5.7\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 14\text{ A}$ ,  $dV/dt = 7.6\text{ V/ns}$  (see fig. 12a).
- $I_{SD} \leq 14\text{ A}$ ,  $dI/dt \leq 250\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

**THERMAL RESISTANCE RATINGS**

| PARAMETER                          | SYMBOL     | TYP. | MAX. | UNIT |
|------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient        | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-Sink, Flat, Greasd Surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum Junction-to-Case (Drain)   | $R_{thJC}$ | -    | 0.50 |      |

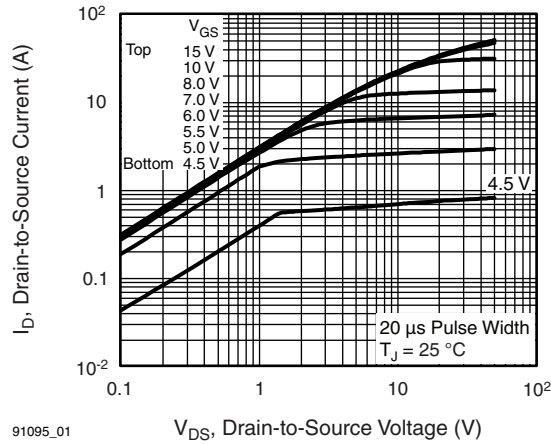
**SPECIFICATIONS** ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

| 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                                                                                                                |                                                                                                        | -    | 0.55  | -    | 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                                                                                              |                                                                                                        | 2.0  | -     | 4.0  | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20V                                                                                                                                  |                                                                                                        | -    | -     | ±100 | nA   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 500 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                                                                        | -    | -     | 25   | 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> = 8.4 A <sup>b</sup>                                                                    | -    | 0.660 | -    | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 8.4 A                                                                                                           |                                                                                                        | 8.1  | -     | -    | 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                                                                             |                                                                                                        | -    | 1910  | -    | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |                                                                                                                                                          |                                                                                                        | -    | 290   | -    |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |                                                                                                                                                          |                                                                                                        | -    | 11    | -    |      |
| Output Capacitance                        | C <sub>oss</sub>                 | V <sub>GS</sub> = 0 V                                                                                                                                    | V <sub>DS</sub> = 1.0 V, f = 1.0 MHz                                                                   | -    | 2730  | -    |      |
|                                           |                                  |                                                                                                                                                          | V <sub>DS</sub> = 400 V, f = 1.0 MHz                                                                   | -    | 82    | -    |      |
| Effective Output Capacitance              | C <sub>oss eff.</sub>            |                                                                                                                                                          | V <sub>DS</sub> = 0 V to 400 V <sup>c</sup>                                                            | -    | 160   | -    |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 14 A, V <sub>DS</sub> = 400 V,<br>see fig. 6 and 13 <sup>b</sup>                      | -    | -     | 81   | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |                                                                                                                                                          |                                                                                                        | -    | -     | 20   |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |                                                                                                                                                          |                                                                                                        | -    | -     | 36   |      |
| 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> = 14 A,<br>R <sub>g</sub> = 7.5 Ω,<br>see fig. 10 <sup>b</sup> | -    | 15    | -    | ns   |
| Rise Time                                 | t <sub>r</sub>                   |                                                                                                                                                          |                                                                                                        | -    | 39    | -    |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |                                                                                                                                                          |                                                                                                        | -    | 39    | -    |      |
| Fall Time                                 | t <sub>f</sub>                   |                                                                                                                                                          |                                                                                                        | -    | 31    | -    |      |
| 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> |                                                                                                        | -    | -     | 13   | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |                                                                                                                                                          |                                                                                                        | -    | -     | 56   |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 14 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> = 14 A,<br>T <sub>J</sub> = 125 °C, dI/dt = 100 A/μs <sup>b</sup>                                                 |                                                                                                        | -    | 370   | 550  | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |                                                                                                                                                          |                                                                                                        | -    | 4.4   | 6.5  | μC   |
| Body Diode Reverse Recovery Current       | I <sub>RRM</sub>                 |                                                                                                                                                          |                                                                                                        | -    | 21    | 31   | 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> )                                                        |                                                                                                        |      |       |      |      |

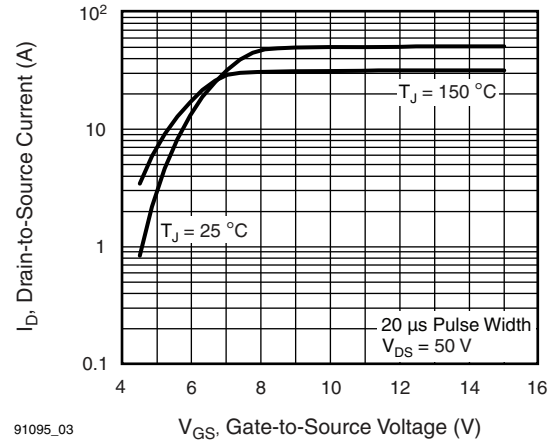
**Notes**

- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; 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 %  $V_{DS}$ .

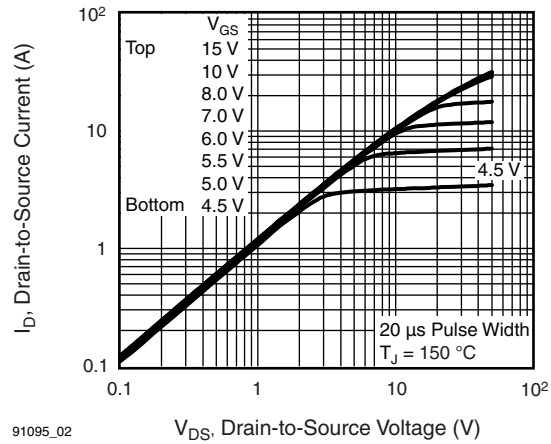
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



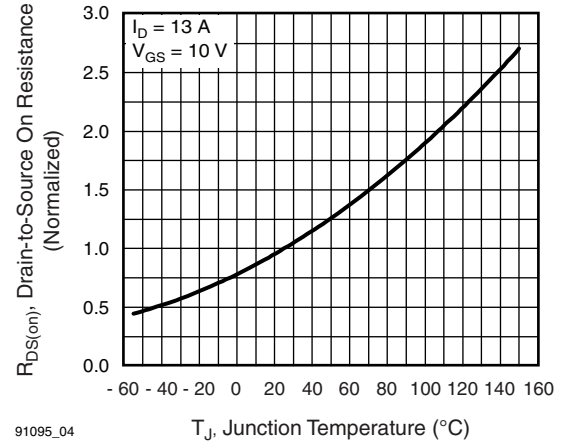
**Fig. 1 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics**



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

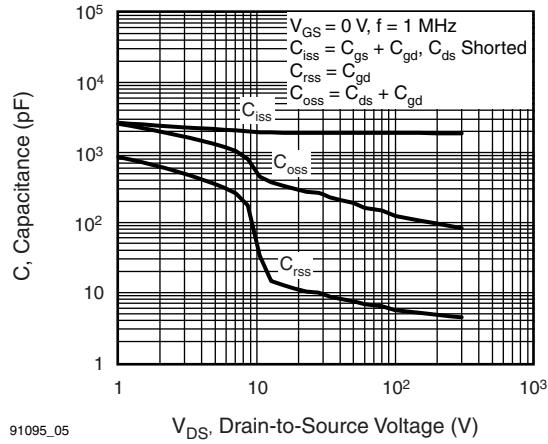


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

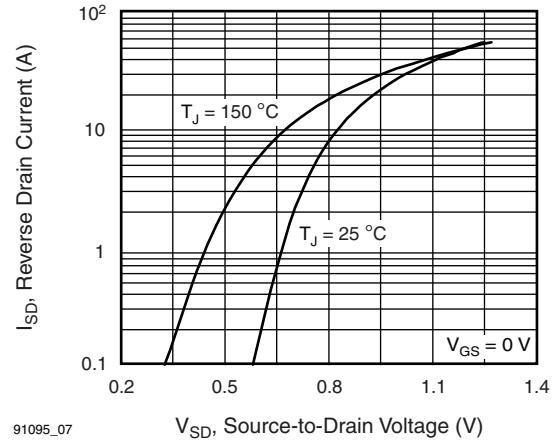


Fig. 7 - Typical Source-Drain Diode Forward Voltage

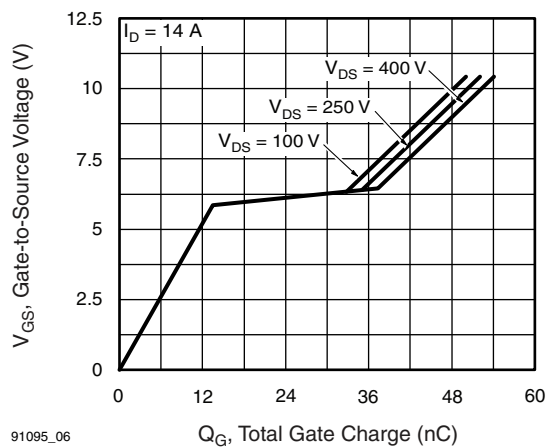


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

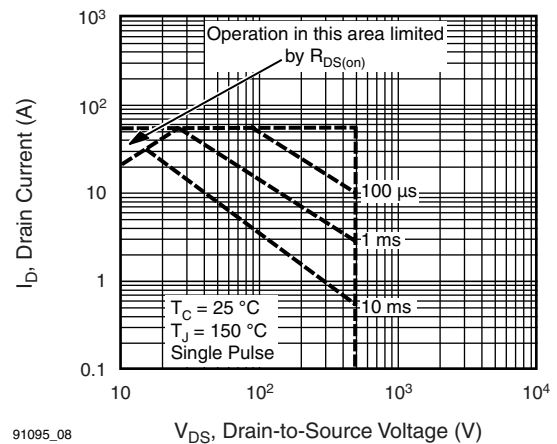
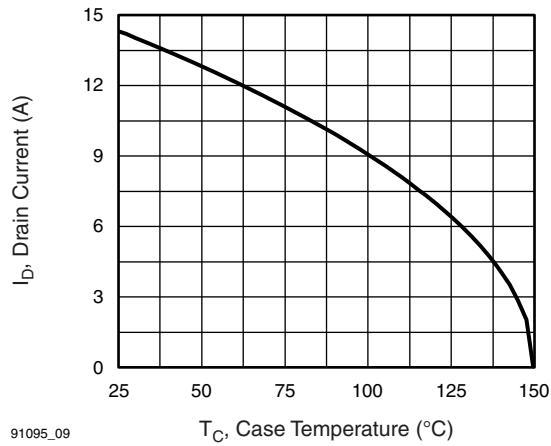


Fig. 8 - Maximum Safe Operating Area



91095\_09

Fig. 9 - Maximum Drain Current vs. Case Temperature

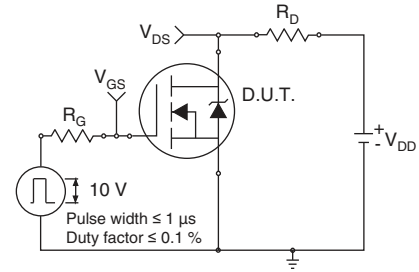


Fig. 10a - Switching Time Test Circuit

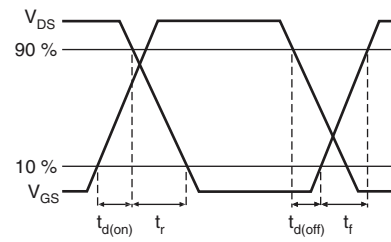
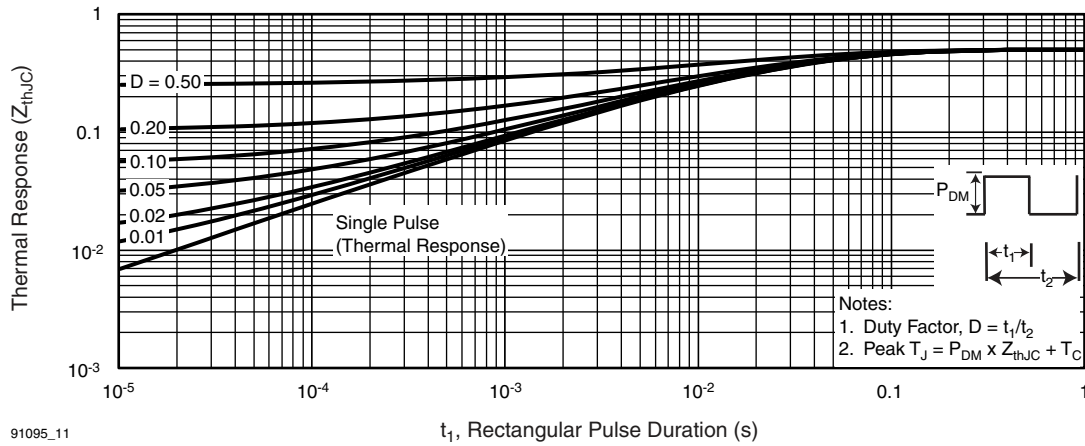


Fig. 10b - Switching Time Waveforms



91095\_11

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

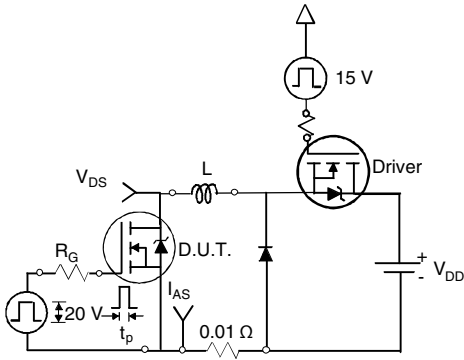


Fig. 12a - Unclamped Inductive Test Circuit

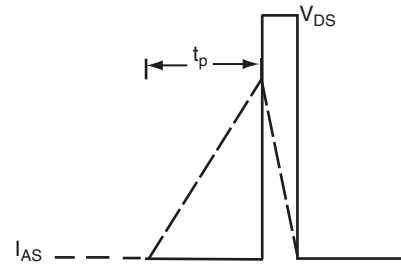


Fig. 12b - Unclamped Inductive Waveforms

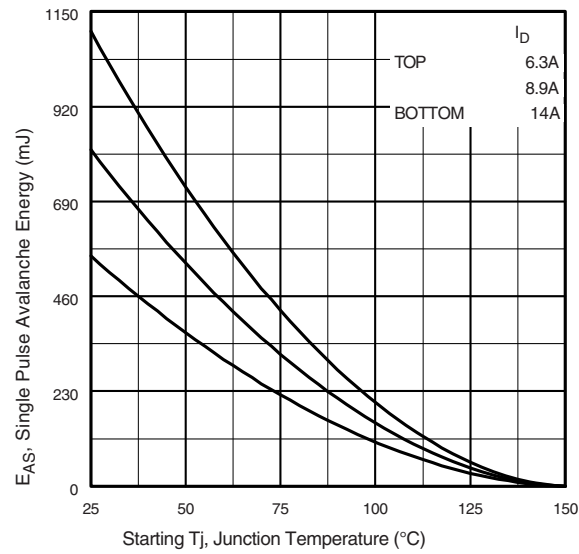


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

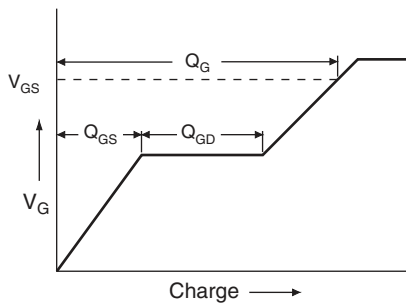


Fig. 13a - Basic Gate Charge Waveform

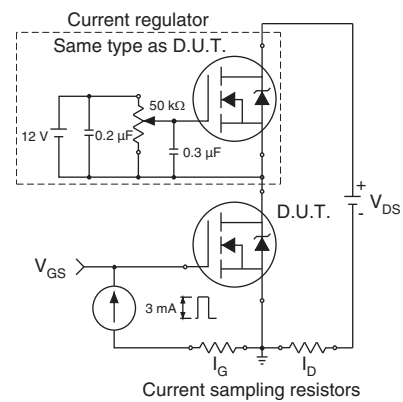
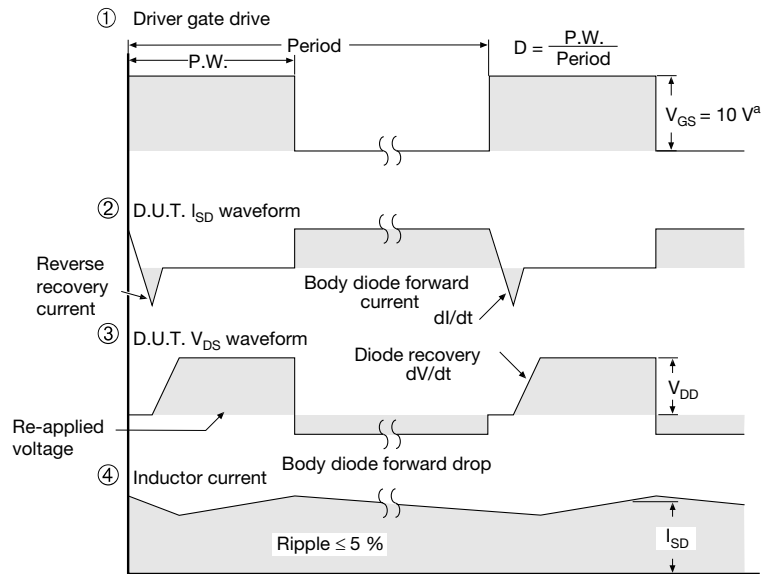
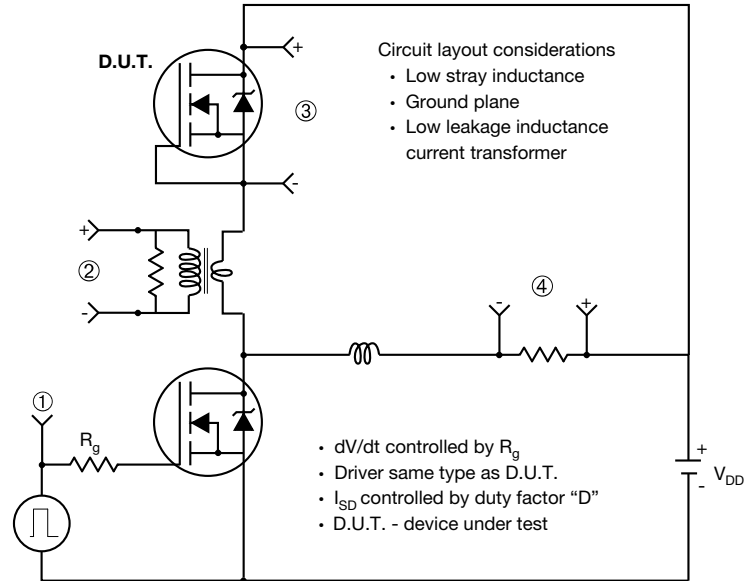


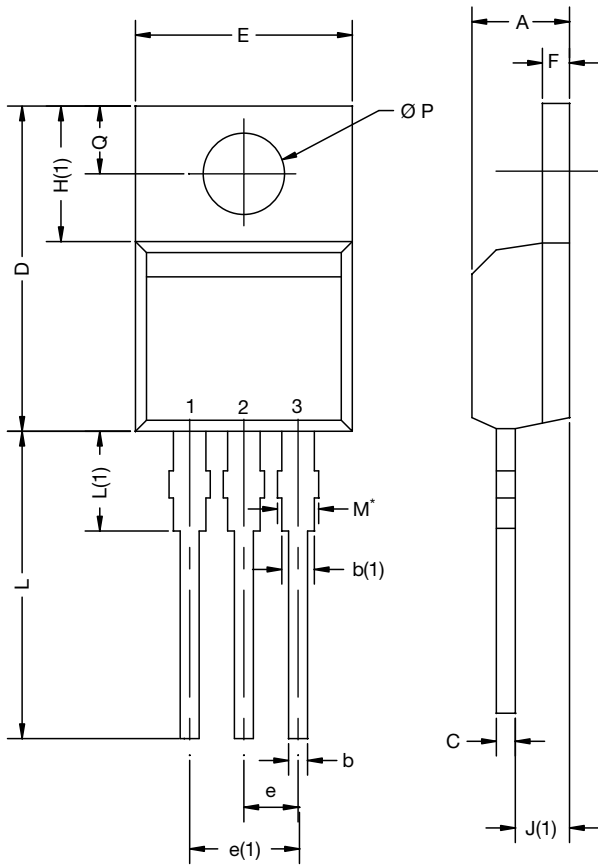
Fig. 13b - Gate Charge Test Circuit

### Peak Diode Recovery dV/dt Test Circuit



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

## TO-220AB



| DIM.            | MILLIMETERS |       | INCHES |       |
|-----------------|-------------|-------|--------|-------|
|                 | MIN.        | MAX.  | MIN.   | MAX.  |
| A               | 4.24        | 4.65  | 0.167  | 0.183 |
| b               | 0.69        | 1.02  | 0.027  | 0.040 |
| b(1)            | 1.14        | 1.78  | 0.045  | 0.070 |
| c               | 0.36        | 0.61  | 0.014  | 0.024 |
| D               | 14.33       | 15.85 | 0.564  | 0.624 |
| E               | 9.96        | 10.52 | 0.392  | 0.414 |
| e               | 2.41        | 2.67  | 0.095  | 0.105 |
| e(1)            | 4.88        | 5.28  | 0.192  | 0.208 |
| F               | 1.14        | 1.40  | 0.045  | 0.055 |
| H(1)            | 6.10        | 6.71  | 0.240  | 0.264 |
| J(1)            | 2.41        | 2.92  | 0.095  | 0.115 |
| L               | 13.36       | 14.40 | 0.526  | 0.567 |
| L(1)            | 3.33        | 4.04  | 0.131  | 0.159 |
| $\varnothing P$ | 3.53        | 3.94  | 0.139  | 0.155 |
| Q               | 2.54        | 3.00  | 0.100  | 0.118 |

ECN: X15-0364-Rev. C, 14-Dec-15  
DWG: 6031

**Note**

- $M^*$  = 0.052 inches to 0.064 inches (dimension including protrusion), heatsink hole for HVM

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