

## 2SK2098-VB Datasheet

### N-Channel 200 V (D-S) MOSFET

#### PRODUCT SUMMARY

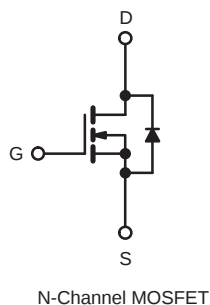
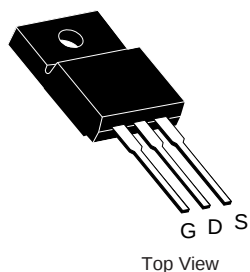
|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 200                    |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.058 |
| $Q_g$ (Max.) (nC)         | 64                     |       |
| $Q_{gs}$ (nC)             | 12                     |       |
| $Q_{gd}$ (nC)             | 30                     |       |
| Configuration             | Single                 |       |

#### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Surface Mount
- Low-Profile Through-Hole
- Available in Tape and Reel
- Dynamic  $dV/dt$  Rating
- 150 °C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Compliant to RoHS Directive 2002/95/EC


**RoHS\***  
 COMPLIANT

TO-220 FULLPAK



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

| PARAMETER                                        |                                    |                                     | SYMBOL         | LIMIT            | UNIT                  |
|--------------------------------------------------|------------------------------------|-------------------------------------|----------------|------------------|-----------------------|
| Drain-Source Voltage                             |                                    |                                     | $V_{DS}$       | 200              | V                     |
| Gate-Source Voltage                              |                                    |                                     | $V_{GS}$       | $\pm 20$         |                       |
| Continuous Drain Current                         | $V_{GS}$ at 10 V                   | $T_C = 25\text{ }^{\circ}\text{C}$  | $I_D$          | 20               | A                     |
|                                                  |                                    | $T_C = 100\text{ }^{\circ}\text{C}$ |                | 14               |                       |
| Pulsed Drain Current <sup>a, e</sup>             |                                    |                                     | $I_{DM}$       | 72               |                       |
| Linear Derating Factor                           |                                    |                                     |                | 1.0              | W/ $^{\circ}\text{C}$ |
| Single Pulse Avalanche Energy <sup>b, e</sup>    |                                    |                                     | $E_{AS}$       | 580              | mJ                    |
| Avalanche Current <sup>a</sup>                   |                                    |                                     | $I_{AR}$       | 20               | A                     |
| Repetitive Avalanche Energy <sup>a</sup>         |                                    |                                     | $E_{AR}$       | 13               | mJ                    |
| Maximum Power Dissipation                        | $T_C = 25\text{ }^{\circ}\text{C}$ |                                     | $P_D$          | 42               | W                     |
|                                                  | $T_A = 25\text{ }^{\circ}\text{C}$ |                                     |                | 13               |                       |
| Peak Diode Recovery $dV/dt$ <sup>c, e</sup>      |                                    |                                     | $dV/dt$        | 5.0              | 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> |                       |

#### Notes

- Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11).
- $V_{DD} = 50\text{ V}$ , starting  $T_J = 25\text{ }^\circ\text{C}$ ,  $L = 2.7\text{ mH}$ ,  $R_g = 25\text{ }\Omega$ ,  $I_{AS} = 18\text{ A}$  (see fig. 12).
- $I_{SD} \leq 20\text{ A}$ ,  $dI/dt \leq 150\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150\text{ }^\circ\text{C}$ .
- 1.6 mm from case.

**THERMAL RESISTANCE RATINGS**

| PARAMETER                                                               | SYMBOL     | TYP. | MAX. | UNIT |
|-------------------------------------------------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient<br>(PCB Mounted, Steady-State) <sup>a</sup> | $R_{thJA}$ | -    | 40   | °C/W |
| Maximum Junction-to-Case (Drain)                                        | $R_{thJC}$ | -    | 1.0  |      |

**Note**

a. When mounted on 1" square PCB (FR-4 or G-10 material).

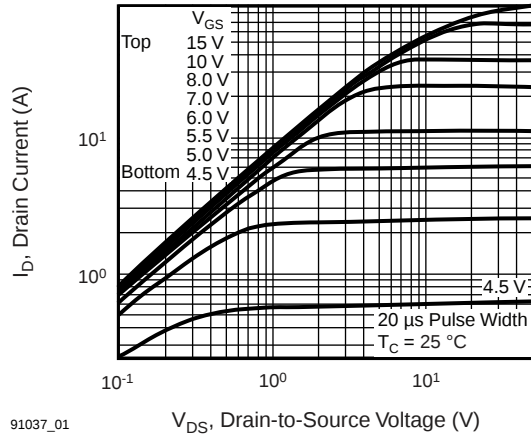
**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

| PARAMETER                                 | SYMBOL              | TEST CONDITIONS                                                                                                                                         |                                                                                      | MIN. | TYP.  | MAX.      | UNIT                |
|-------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|------|-------|-----------|---------------------|
| Static                                    |                     |                                                                                                                                                         |                                                                                      |      |       |           |                     |
| Drain-Source Breakdown Voltage            | $V_{DS}$            | $V_{GS} = 0\text{ V}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                  |                                                                                      | 200  | -     | -         | V                   |
| $V_{DS}$ Temperature Coefficient          | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = 1\text{ mA}^c$                                                                                         |                                                                                      | -    | 0.29  | -         | V/ $^\circ\text{C}$ |
| Gate-Source Threshold Voltage             | $V_{GS(th)}$        | $V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$                                                                                                      |                                                                                      | 2.0  | -     | 4.0       | V                   |
| Gate-Source Leakage                       | $I_{GSS}$           | $V_{GS} = \pm 20\text{ V}$                                                                                                                              |                                                                                      | -    | -     | $\pm 100$ | nA                  |
| Zero Gate Voltage Drain Current           | $I_{DSS}$           | $V_{DS} = 200\text{ V}$ , $V_{GS} = 0\text{ V}$                                                                                                         |                                                                                      | -    | -     | 25        | $\mu\text{A}$       |
|                                           |                     | $V_{DS} = 160\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$                                                                     |                                                                                      | -    | -     | 250       |                     |
| Drain-Source On-State Resistance          | $R_{DS(on)}$        | $V_{GS} = 10\text{ V}$                                                                                                                                  | $I_D = 11\text{ A}^b$                                                                | -    | 0.058 | -         | $\Omega$            |
| Forward Transconductance                  | $g_{fs}$            | $V_{DS} = 50\text{ V}$ , $I_D = 11\text{ A}^d$                                                                                                          |                                                                                      | 6.7  | -     | -         | S                   |
| Dynamic                                   |                     |                                                                                                                                                         |                                                                                      |      |       |           |                     |
| Input Capacitance                         | $C_{iss}$           | $V_{GS} = 0\text{ V}$ ,<br>$V_{DS} = 25\text{ V}$ ,<br>$f = 1.0\text{ MHz}$ , see fig. 5 <sup>d</sup>                                                   |                                                                                      | -    | 1300  | -         | pF                  |
| Output Capacitance                        | $C_{oss}$           |                                                                                                                                                         |                                                                                      | -    | 430   | -         |                     |
| Reverse Transfer Capacitance              | $C_{rss}$           |                                                                                                                                                         |                                                                                      | -    | 130   | -         |                     |
| Total Gate Charge                         | $Q_g$               | $V_{GS} = 10\text{ V}$                                                                                                                                  | $I_D = 20\text{ A}$ , $V_{DS} = 160\text{ V}$ ,<br>see fig. 6 and 13 <sup>b, c</sup> | -    | -     | 70        | nC                  |
| Gate-Source Charge                        | $Q_{gs}$            |                                                                                                                                                         |                                                                                      | -    | -     | 13        |                     |
| Gate-Drain Charge                         | $Q_{gd}$            |                                                                                                                                                         |                                                                                      | -    | -     | 39        |                     |
| Turn-On Delay Time                        | $t_{d(on)}$         | $V_{DD} = 100\text{ V}$ , $I_D = 20\text{ A}$ ,<br>$R_g = 9.1\text{ }\Omega$ , $R_D = 5.4\text{ }\Omega$ , see fig. 10 <sup>b, c</sup>                  |                                                                                      | -    | 14    | -         | ns                  |
| Rise Time                                 | $t_r$               |                                                                                                                                                         |                                                                                      | -    | 51    | -         |                     |
| Turn-Off Delay Time                       | $t_{d(off)}$        |                                                                                                                                                         |                                                                                      | -    | 45    | -         |                     |
| Fall Time                                 | $t_f$               |                                                                                                                                                         |                                                                                      | -    | 36    | -         |                     |
| Drain-Source Body Diode Characteristics   |                     |                                                                                                                                                         |                                                                                      |      |       |           |                     |
| Continuous Source-Drain Diode Current     | $I_S$               | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                                                      | -    | -     | 20        | A                   |
| Pulsed Diode Forward Current <sup>a</sup> | $I_{SM}$            |                                                                                                                                                         |                                                                                      | -    | -     | 72        |                     |
| Body Diode Voltage                        | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_S = 20\text{ A}$ , $V_{GS} = 0\text{ V}^b$                                                                        |                                                                                      | -    | -     | 2.0       | V                   |
| Body Diode Reverse Recovery Time          | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}$ , $I_F = 20\text{ A}$ , $dI/dt = 100\text{ A}/\mu\text{s}^{b, c}$                                                      |                                                                                      | -    | 300   | 610       | ns                  |
| Body Diode Reverse Recovery Charge        | $Q_{rr}$            |                                                                                                                                                         |                                                                                      | -    | 3.4   | 7.1       | $\mu\text{C}$       |
| Forward Turn-On Time                      | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )                                                                         |                                                                                      |      |       |           |                     |

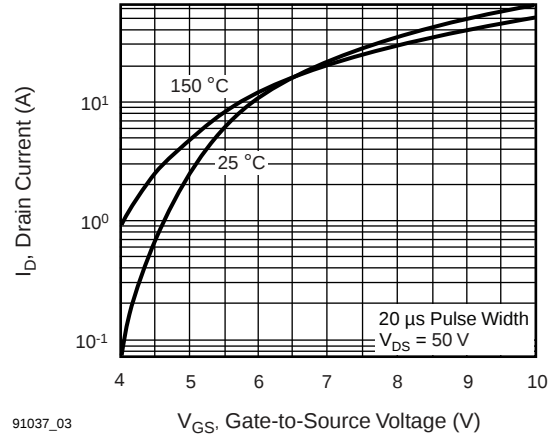
**Notes**

- 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. Uses IRF640/SiHF640 data and test conditions.

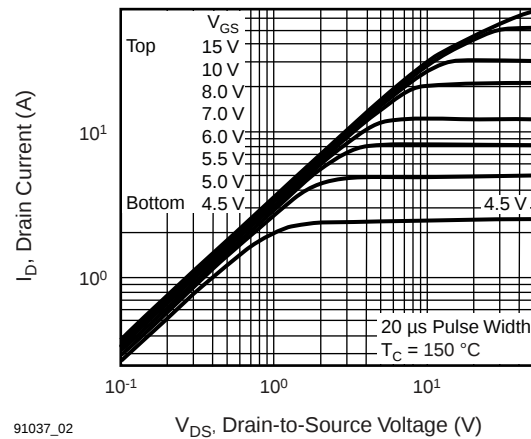
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



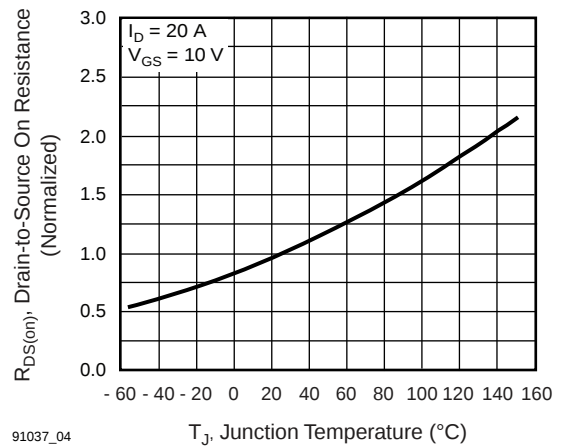
**Fig. 1 - Typical Output Characteristics,  $T_J = 25\text{ °C}$**



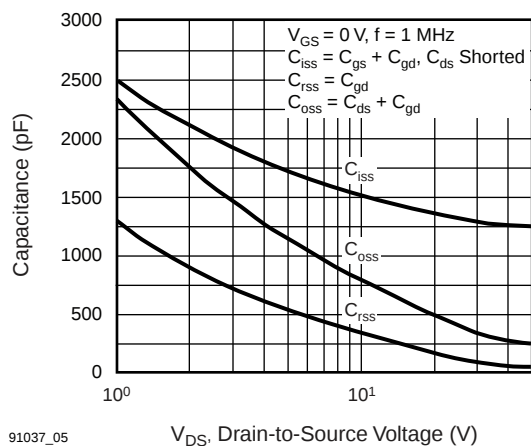
**Fig. 3 - Typical Transfer Characteristics**



**Fig. 2 - Typical Output Characteristics,  $T_J = 175\text{ °C}$**

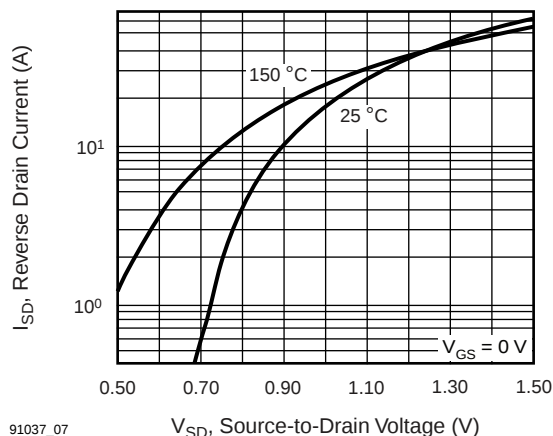


**Fig. 4 - Normalized On-Resistance vs. Temperature**



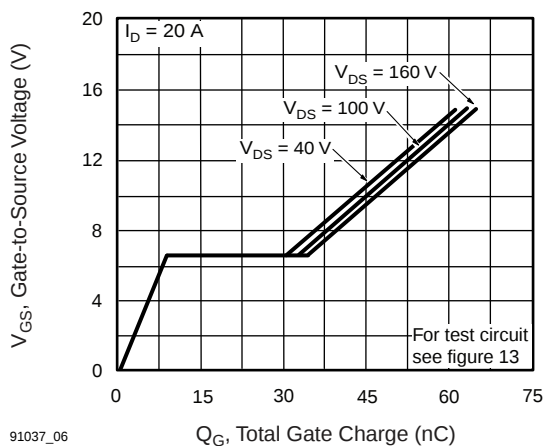
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Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage



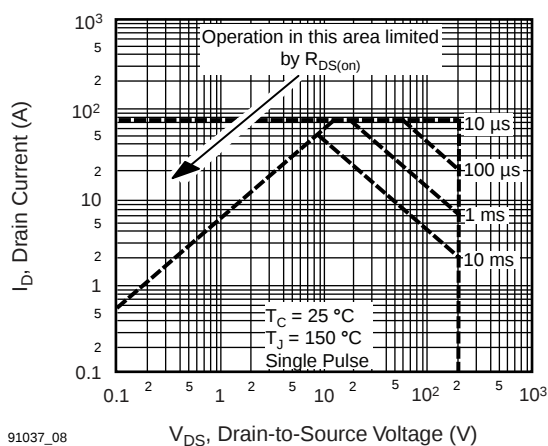
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Fig. 7 - Typical Source-Drain Diode Forward Voltage



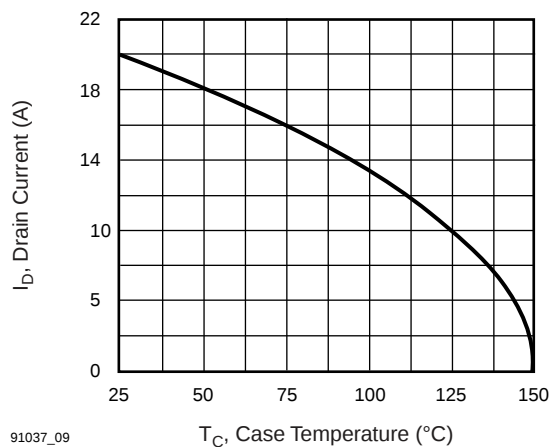
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Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage



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Fig. 8 - Maximum Safe Operating Area



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Fig. 9 - Maximum Drain Current vs. Case Temperature

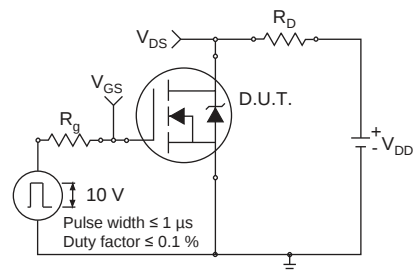


Fig. 10a - Switching Time Test Circuit

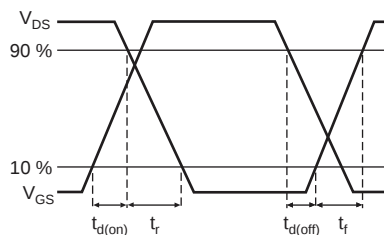
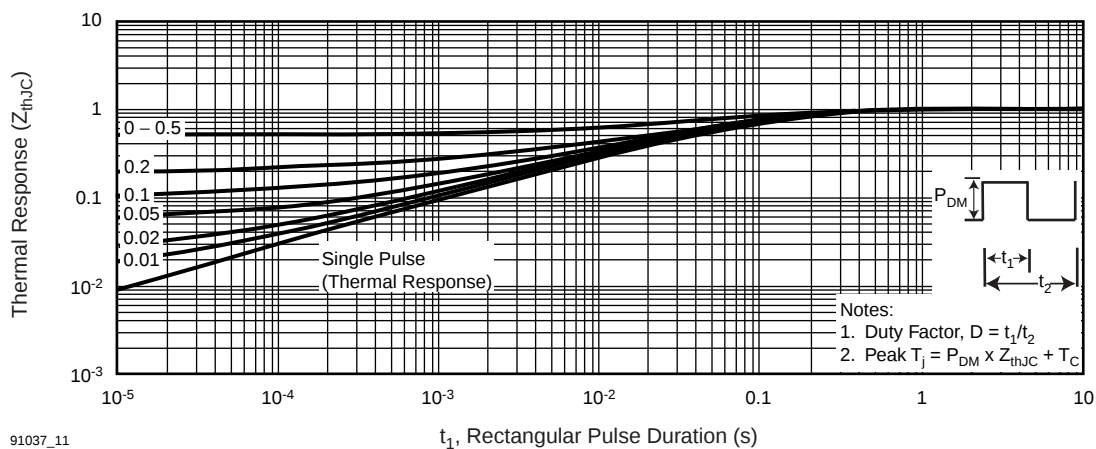


Fig. 10b - Switching Time Waveforms



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

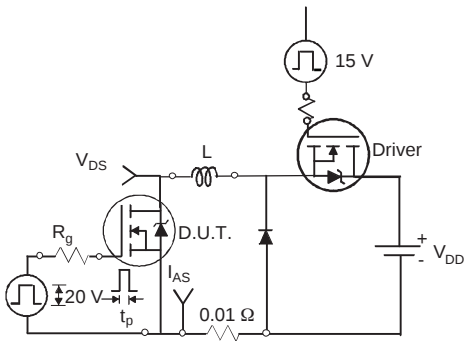


Fig. 12a - Unclamped Inductive Test Circuit

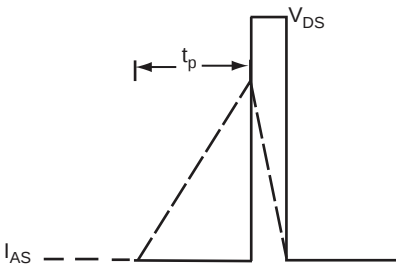


Fig. 12b - Unclamped Inductive Waveforms

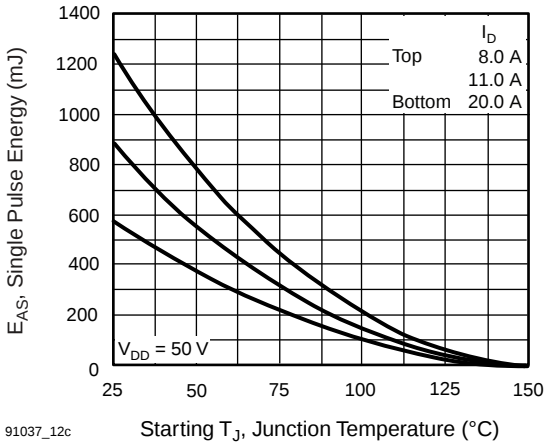


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

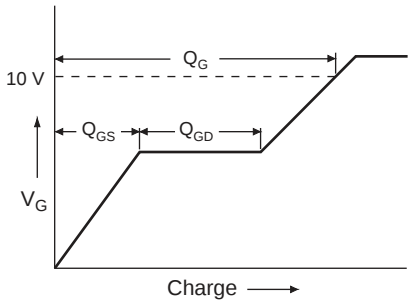


Fig. 13a - Basic Gate Charge Waveform

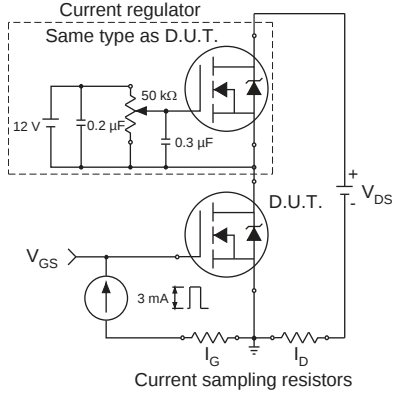
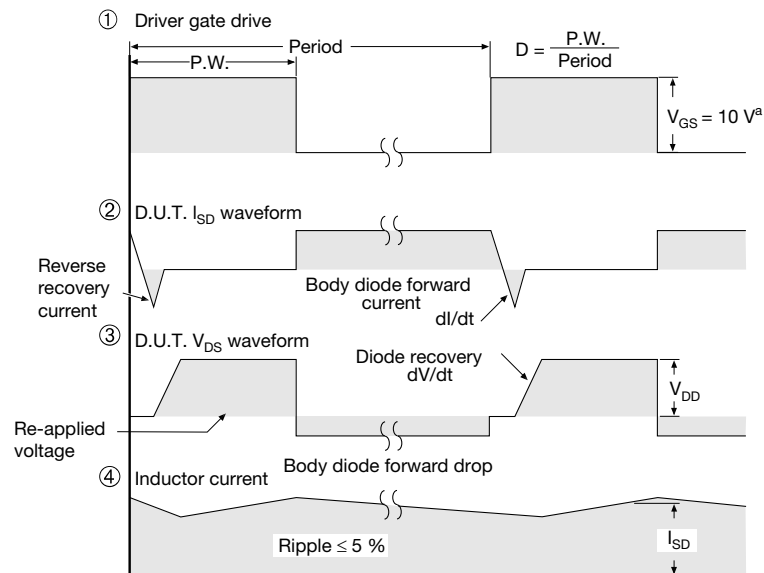
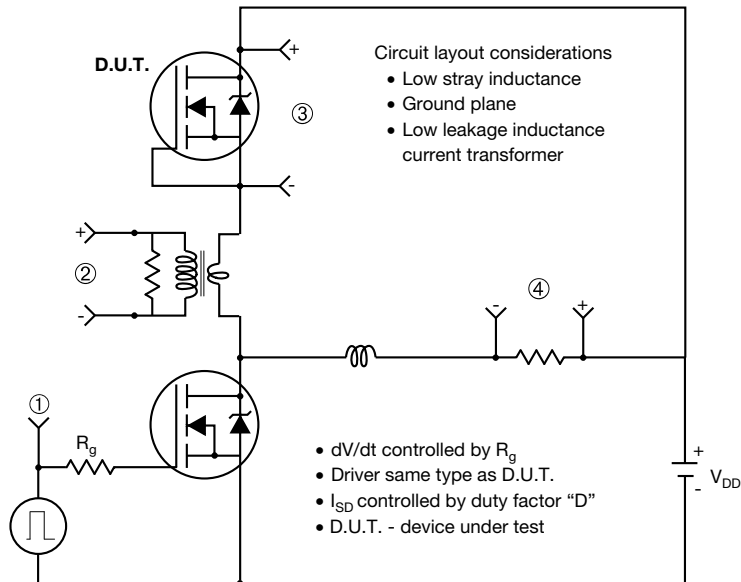


Fig. 13b - Gate Charge Test Circuit

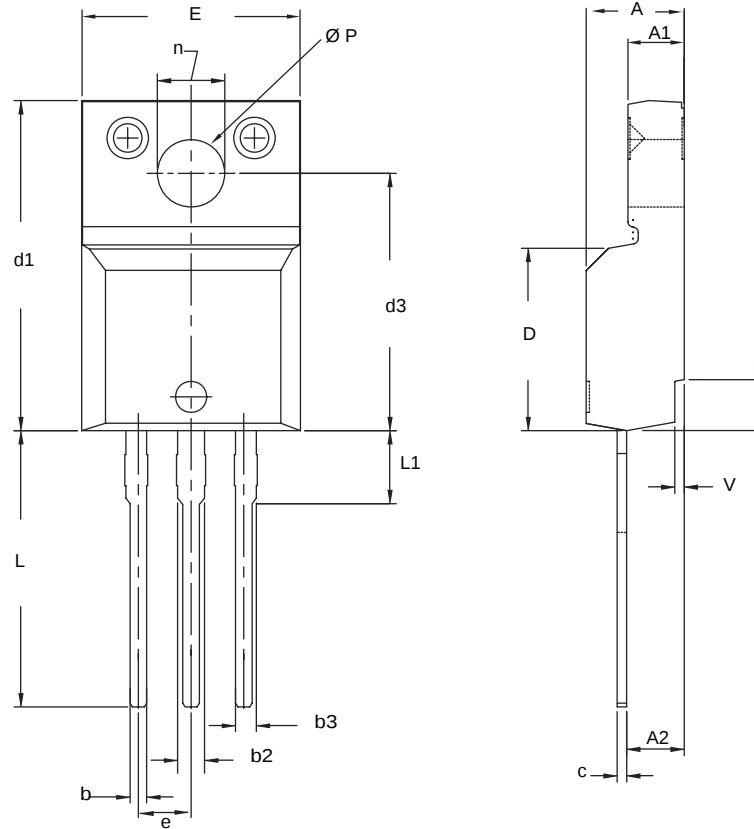
### Peak Diode Recovery dV/dt Test Circuit



#### Note

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

Fig. 14 - For N-Channel

**TO-220 FULLPAK (HIGH VOLTAGE)**

| DIM. | MILLIMETERS |        | INCHES    |       |
|------|-------------|--------|-----------|-------|
|      | MIN.        | MAX.   | MIN.      | MAX.  |
| A    | 4.570       | 4.830  | 0.180     | 0.190 |
| A1   | 2.570       | 2.830  | 0.101     | 0.111 |
| A2   | 2.510       | 2.850  | 0.099     | 0.112 |
| b    | 0.622       | 0.890  | 0.024     | 0.035 |
| b2   | 1.229       | 1.400  | 0.048     | 0.055 |
| b3   | 1.229       | 1.400  | 0.048     | 0.055 |
| c    | 0.440       | 0.629  | 0.017     | 0.025 |
| D    | 8.650       | 9.800  | 0.341     | 0.386 |
| d1   | 15.88       | 16.120 | 0.622     | 0.635 |
| d3   | 12.300      | 12.920 | 0.484     | 0.509 |
| E    | 10.360      | 10.630 | 0.408     | 0.419 |
| e    | 2.54 BSC    |        | 0.100 BSC |       |
| L    | 13.200      | 13.730 | 0.520     | 0.541 |
| L1   | 3.100       | 3.500  | 0.122     | 0.138 |
| n    | 6.050       | 6.150  | 0.238     | 0.242 |
| Ø P  | 3.050       | 3.450  | 0.120     | 0.136 |
| u    | 2.400       | 2.500  | 0.094     | 0.098 |
| v    | 0.400       | 0.500  | 0.016     | 0.020 |

ECN: X09-0126-Rev. B, 26-Oct-09  
DWG: 5972

**Notes**

1. To be used only for process drawing.
2. These dimensions apply to all TO-220, FULLPAK leadframe versions 3 leads.
3. All critical dimensions should C meet  $C_{pk} > 1.33$ .
4. All dimensions include burrs and plating thickness.
5. No chipping or package damage.

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