

## FS531-VB Datasheet

### N-Channel 60 V (D-S) MOSFET

#### PRODUCT SUMMARY

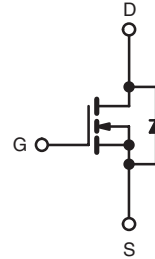
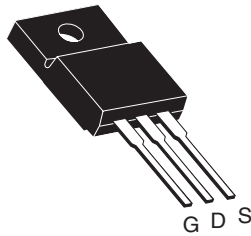
|                           |                        |       |
|---------------------------|------------------------|-------|
| $V_{DS}$ (V)              | 60                     |       |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = 10\text{ V}$ | 0.027 |
| $Q_g$ (Max.) (nC)         | 95                     |       |
| $Q_{gs}$ (nC)             | 27                     |       |
| $Q_{gd}$ (nC)             | 46                     |       |
| Configuration             | Single                 |       |

#### FEATURES

- Isolated Package
- High Voltage Isolation = 2.5 kV<sub>RMS</sub> (t = 60 s; f = 60 Hz)
- Sink to Lead Creepage Distance = 4.8 mm
- 175 °C Operating Temperature
- Dynamic dV/dt Rating
- Low Thermal Resistance
- Lead (Pb)-free Available



TO-220 FULLPAK



N-Channel MOSFET

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

| PARAMETER  |                         |                         | SYMBOL                            | LIMIT            | UNIT     |
|--|-------------------------|-------------------------|-----------------------------------|------------------|----------|
| Drain-Source Voltage                             |                         |                         | V <sub>DS</sub>                   | 60               | V        |
| Gate-Source Voltage                              |                         |                         | V <sub>GS</sub>                   | ± 20             |          |
| Continuous Drain Current                         | V <sub>GS</sub> at 10 V | T <sub>C</sub> = 25 °C  | I <sub>D</sub>                    | 45               | A        |
|  |                         | T <sub>C</sub> = 100 °C |                                   | 30               |          |
| Pulsed Drain Current <sup>a</sup>                |                         |                         | I <sub>DM</sub>                   | 220              |          |
| Linear Derating Factor                           |                         |                         |                                   | 0.32             | W/°C     |
| Single Pulse Avalanche Energy <sup>b</sup>       |                         |                         | E <sub>AS</sub>                   | 100              | mJ       |
| Maximum Power Dissipation                        | T <sub>C</sub> = 25 °C  |                         | P <sub>D</sub>                    | 52               | W        |
| Peak Diode Recovery dV/dt <sup>c</sup>           |                         |                         | dV/dt                             | 4.5              | V/ns     |
| Operating Junction and Storage Temperature Range |                         |                         | T <sub>J</sub> , T <sub>stg</sub> | - 55 to + 175    | °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).
- $V_{DD} = 25\text{ V}$ , starting  $T_J = 25\text{ }^{\circ}\text{C}$ ,  $L = 129\text{ }\mu\text{H}$ ,  $R_G = 25\text{ }\Omega$ ,  $I_{AS} = 30\text{ A}$  (see fig. 12).
- $I_{SD} \leq 52\text{ A}$ ,  $dI/dt \leq 250\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175\text{ }^{\circ}\text{C}$ .
- 1.6 mm from case.

**THERMAL RESISTANCE RATINGS**

| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 65   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 3.1  |      |

**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   |  | 60   | -     | -     | 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  |  | -    | 0.060 | -     | 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  |  | 1.0  | -     | 3.0   | V    |
| Gate-Source Leakage                       | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 20 V   |  | -    | -     | ± 100 | nA   |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>                 | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V  |  | -    | -     | 25    | μA   |
|   |                                  | V <sub>DS</sub> = 48 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 150 °C   |  | -    | -     | 250   |      |
| Drain-Source On-State Resistance          | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V   | I <sub>D</sub> = 18 A <sup>b</sup>   | -    | 0.027 | -     | Ω    |
| Forward Transconductance                  | g <sub>fs</sub>                  | V <sub>DS</sub> = 25 V, I <sub>D</sub> = 18 A <sup>b</sup>   |  | 15   | -     | -     | 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   |  | -    | 1500  | -     | pF   |
| Output Capacitance                        | C <sub>oss</sub>                 |  |  | -    | 720   | -     |      |
| Reverse Transfer Capacitance              | C <sub>rss</sub>                 |  |  | -    | 100   | -     |      |
| Drain to Sink Capacitance                 | C                                | f = 1.0 MHz  |  | -    | 12    | -     |      |
| Total Gate Charge                         | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V   | I <sub>D</sub> = 52 A, V <sub>DS</sub> = 48 V,<br>see fig. 6 and 13 <sup>b</sup> | -    | -     | 95    | nC   |
| Gate-Source Charge                        | Q <sub>gs</sub>                  |  |  | -    | -     | 27    |      |
| Gate-Drain Charge                         | Q <sub>gd</sub>                  |  |  | -    | -     | 46    |      |
| Turn-On Delay Time                        | t <sub>d(on)</sub>               | V <sub>DD</sub> = 30 V, I <sub>D</sub> = 52 A,<br>R <sub>G</sub> = 9.1 Ω, R <sub>D</sub> = 0.54 Ω,<br>see fig. 10 <sup>b</sup> |  | -    | 19    | -     | ns   |
| Rise Time                                 | t <sub>r</sub>                   |  |  | -    | 120   | -     |      |
| Turn-Off Delay Time                       | t <sub>d(off)</sub>              |  |  | -    | 55    | -     |      |
| Fall Time                                 | t <sub>f</sub>                   |  |  | -    | 86    | -     |      |
| Internal Drain Inductance                 | L <sub>D</sub>                   | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact   |  | -    | 4.5   | -     | nH   |
| Internal Source Inductance                | L <sub>S</sub>                   |  |  | -    | 7.5   | -     |      |
| Drain-Source Body Diode Characteristics   |                                  |  |  |      |       |       |      |
| Continuous Source-Drain Diode Current     | I <sub>S</sub>                   | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode   |  | -    | -     | 45    | A    |
| Pulsed Diode Forward Current <sup>a</sup> | I <sub>SM</sub>                  |  |  | -    | -     | 120   |      |
| Body Diode Voltage                        | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 30 A, V <sub>GS</sub> = 0 V <sup>b</sup>  |  | -    | -     | 2.5   | V    |
| Body Diode Reverse Recovery Time          | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = 52 A, dI/dt = 100 A/μs <sup>b</sup>   |  | -    | 140   | 300   | ns   |
| Body Diode Reverse Recovery Charge        | Q <sub>rr</sub>                  |  |  | -    | 1.2   | 2.8   | μC   |
| 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  $\leq 2\%$ .

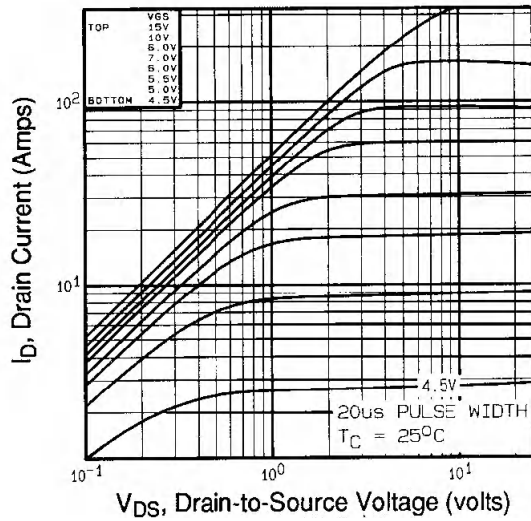
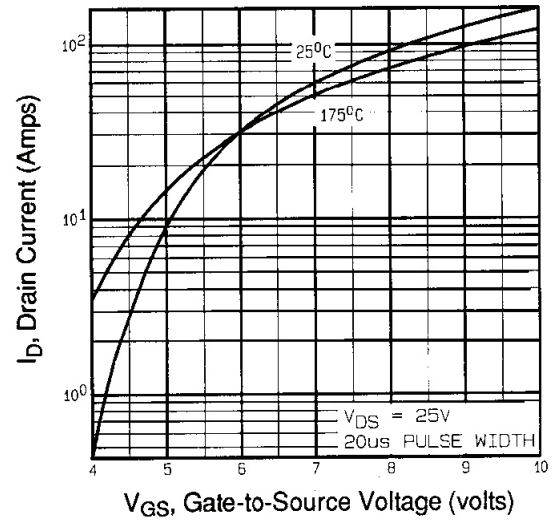
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted
Fig. 1 - Typical Output Characteristics,  $T_C = 25\text{ }^{\circ}\text{C}$ 

Fig. 3 - Typical Transfer Characteristics

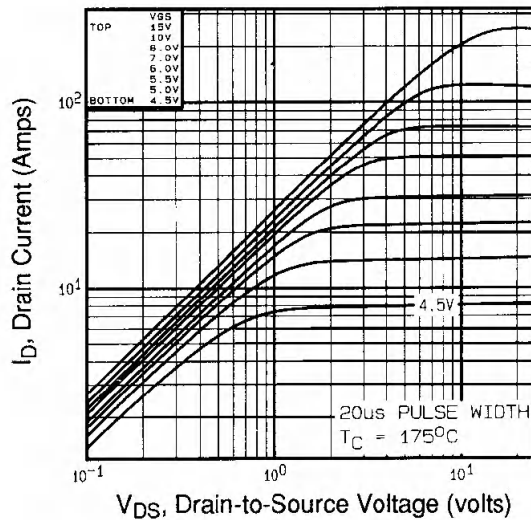
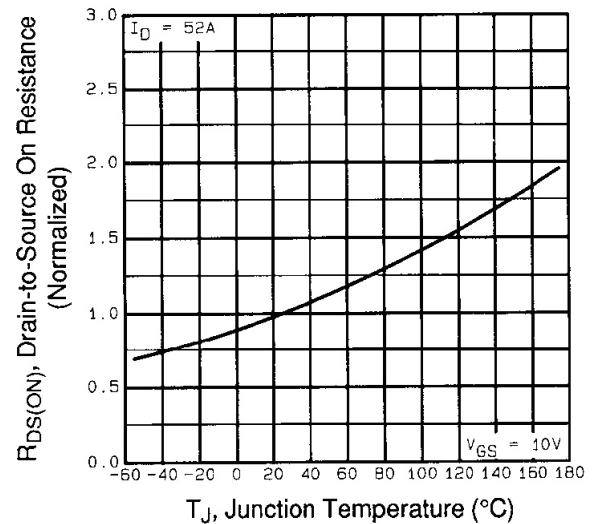
Fig. 2 - Typical Output Characteristics,  $T_C = 175\text{ }^{\circ}\text{C}$ 

Fig. 4 - Normalized On-Resistance vs. Temperature

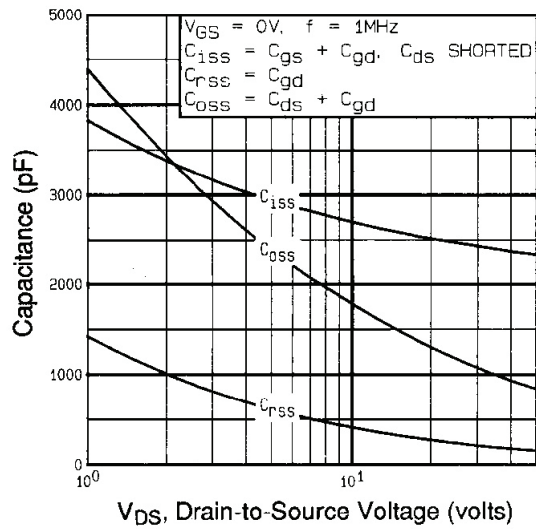


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

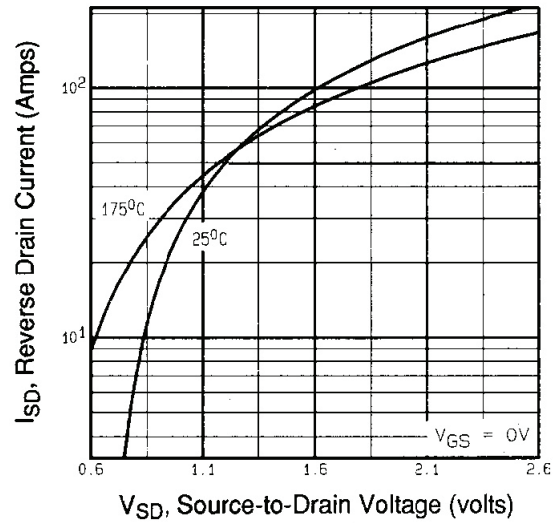


Fig. 7 - Typical Source-Drain Diode Forward Voltage

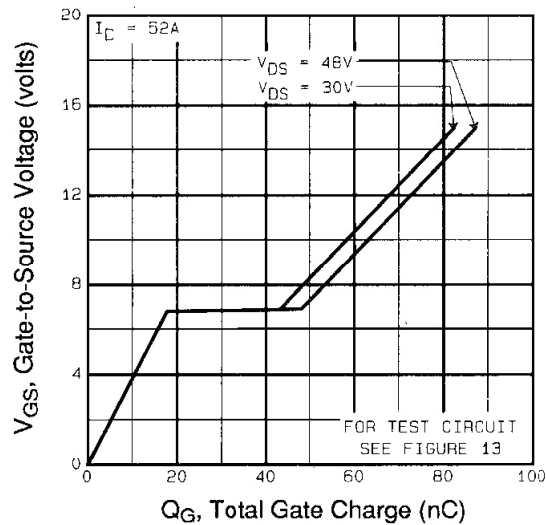


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage

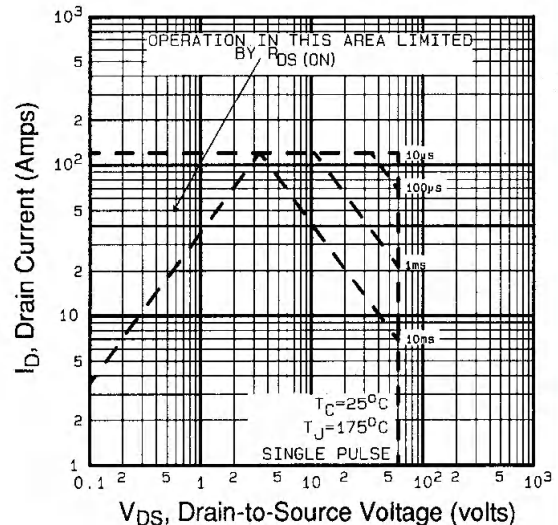


Fig. 8 - Maximum Safe Operating Area

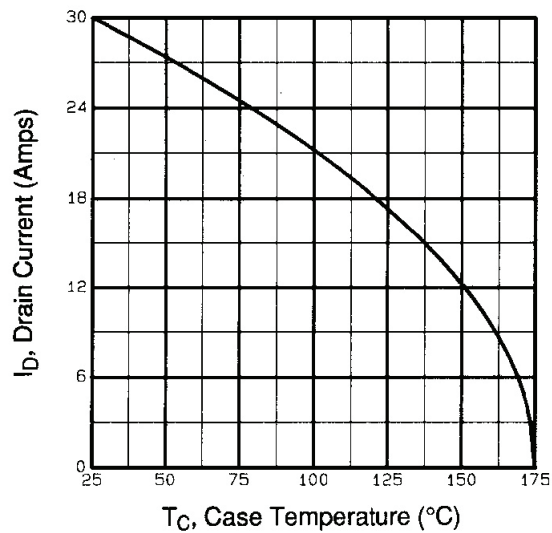


Fig. 9 - Maximum Drain Current vs. Case Temperature

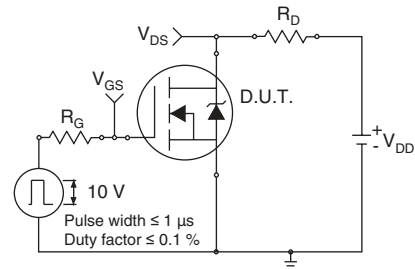


Fig. 10a - Switching Time Test Circuit

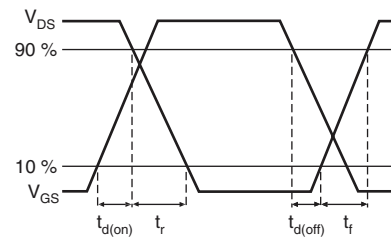


Fig. 10b - Switching Time Waveforms

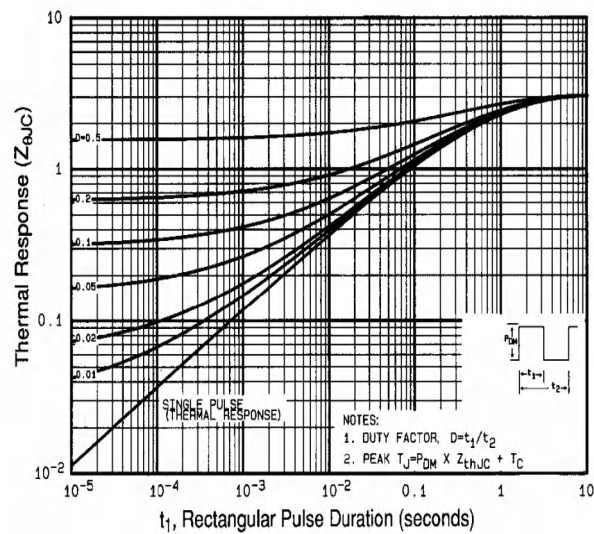


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

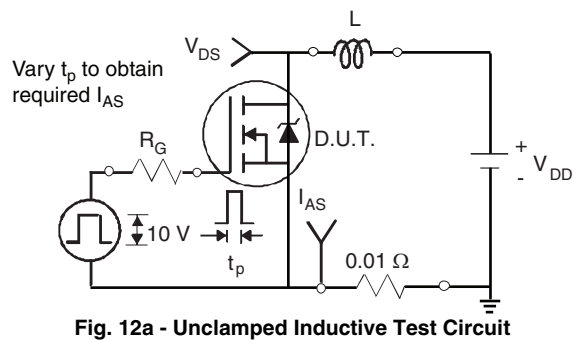


Fig. 12a - Unclamped Inductive Test Circuit

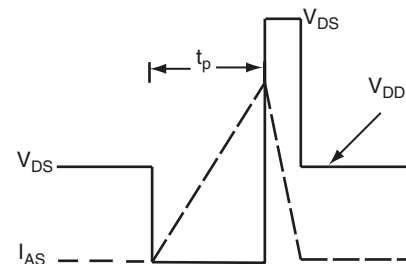


Fig. 12b - Unclamped Inductive Waveforms

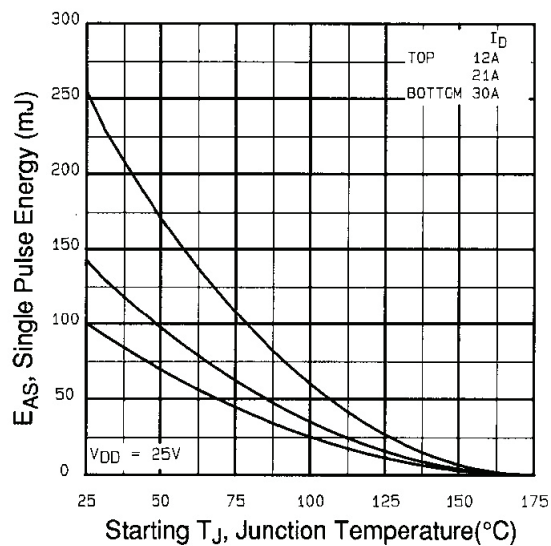


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

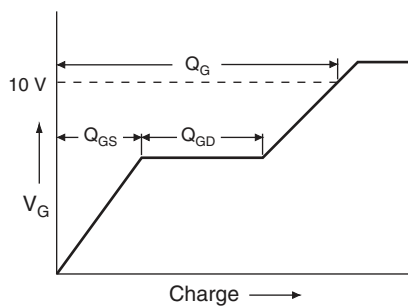


Fig. 13a - Basic Gate Charge Waveform

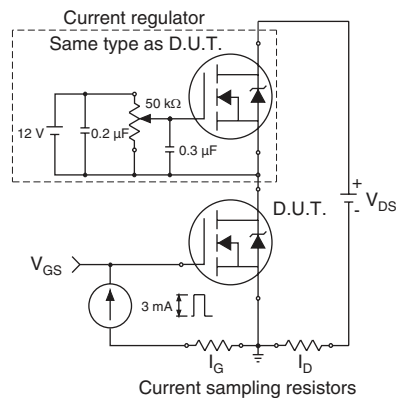
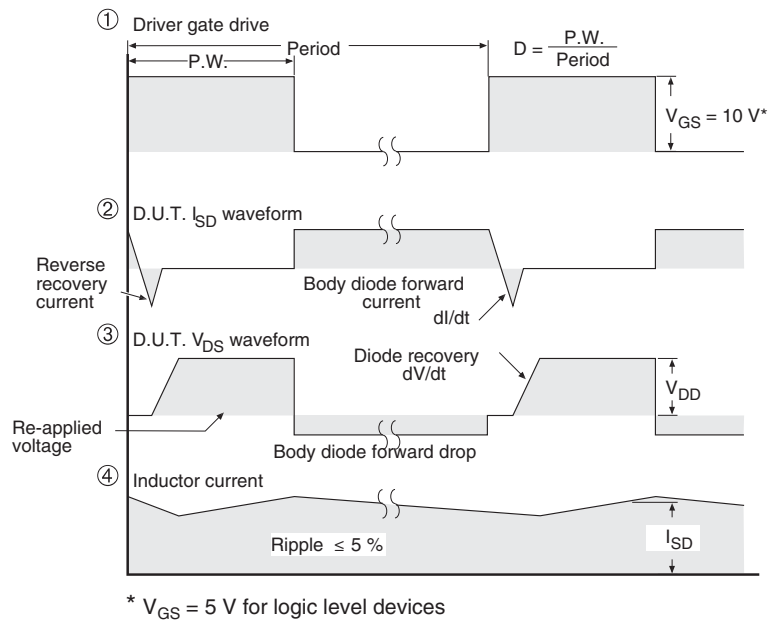
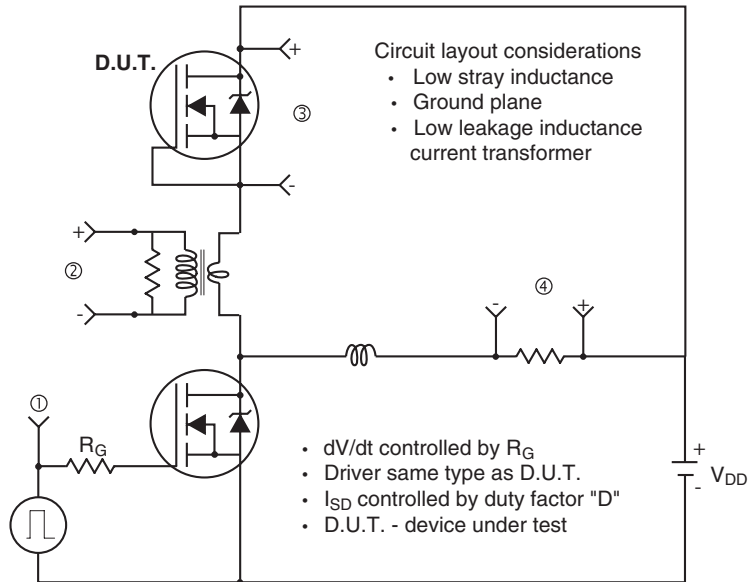


Fig. 13b - Gate Charge Test Circuit

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



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

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