

## Power MOSFET

**TO-220AB**


P-Channel MOSFET

### FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- P-channel
- 175 °C operating temperature
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

### DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

### PRODUCT SUMMARY

|                           |                  |      |
|---------------------------|------------------|------|
| $V_{DS}$ (V)              | -100             |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = -10$ V | 0.30 |
| $Q_g$ max. (nC)           | 38               |      |
| $Q_{gs}$ (nC)             | 6.8              |      |
| $Q_{gd}$ (nC)             | 21               |      |
| Configuration             | Single           |      |

### ORDERING INFORMATION

|                                 |                |
|---------------------------------|----------------|
| Package                         | TO-220AB       |
| Lead (Pb)-free                  | IRF9530PbF     |
| Lead (Pb)-free and halogen-free | IRF9530PbF-BE3 |

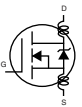

### ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted)

| PARAMETER   | SYMBOL           | LIMIT          | UNIT        |          |
|---|------------------|----------------|-------------|----------|
| Drain-source voltage                                      | $V_{DS}$         | -100           | V           |          |
| Gate-source voltage                                       | $V_{GS}$         | $\pm 20$       |             |          |
| Continuous drain current                                  | $V_{GS}$ at 10 V | $T_C = 25$ °C  | -12         | A        |
|   |                  | $T_C = 100$ °C | -8.2        |          |
| Pulsed drain current <sup>a</sup>                         | $I_{DM}$         | -48            |             |          |
| Linear derating factor                                    |                  | 0.59           | W/°C        |          |
| Single pulse avalanche energy <sup>b</sup>                | $E_{AS}$         | 400            | mJ          |          |
| Repetitive avalanche current <sup>a</sup>                 | $I_{AR}$         | -12            | A           |          |
| Repetitive avalanche energy <sup>a</sup>                  | $E_{AR}$         | 8.8            | mJ          |          |
| Maximum power dissipation                                 | $T_C = 25$ °C    | $P_D$          | 88          | W        |
| Peak diode recovery dV/dt <sup>c</sup>                    |                  | dV/dt          | - 5.5       | V/ns     |
| Operating junction and storage temperature range          | $T_J, T_{stg}$   |                | -55 to +175 | °C       |
| Soldering recommendations (peak temperature) <sup>d</sup> | For 10 s         |                | 300         |          |
| 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)
- $V_{DD} = -25$  V, starting  $T_J = 25$  °C,  $L = 4.2$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = -12$  A (see fig. 12)
- $I_{SD} \leq -12$  A,  $di/dt \leq 140$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 175$  °C
- 1.6 mm from case

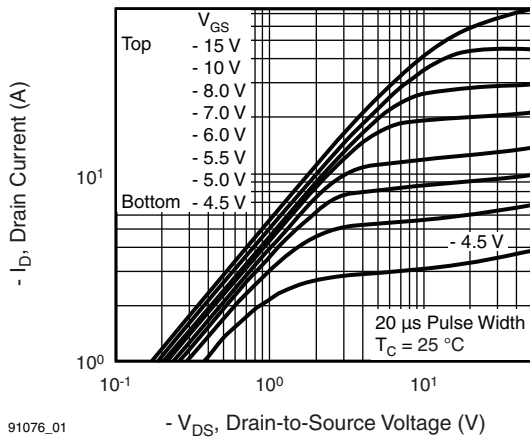
| THERMAL RESISTANCE RATINGS          |            |      |      |      |
|-------------------------------------|------------|------|------|------|
| PARAMETER                           | SYMBOL     | TYP. | MAX. | UNIT |
| Maximum junction-to-ambient         | $R_{thJA}$ | -    | 62   | °C/W |
| Case-to-sink, flat, greased surface | $R_{thCS}$ | 0.50 | -    |      |
| Maximum junction-to-case (drain)    | $R_{thJC}$ | -    | 1.7  |      |

| SPECIFICATIONS ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |                     |   |  |      |       |           |               |
|---|---------------------|---|--|------|-------|-----------|---------------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS   |  | MIN. | TYP.  | MAX.      | UNIT          |
| <b>Static</b>   |                     |   |  |      |       |           |               |
| Drain-source breakdown voltage  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$  |  | -100 | -     | -         | V             |
| $V_{DS}$ temperature coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = -1\text{ mA}$  |  | -    | -0.10 | -         | V/°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   | $I_{DSS}$           | $V_{DS} = -100\text{ V}, V_{GS} = 0\text{ V}$   |  | -    | -     | -100      | $\mu\text{A}$ |
|   |                     | $V_{DS} = -80\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$   |  | -    | -     | -500      |               |
| Drain-source on-state resistance  | $R_{DS(on)}$        | $V_{GS} = -10\text{ V}$   | $I_D = -7.2\text{ A}^b$  | -    | -     | 0.30      | $\Omega$      |
| Forward transconductance  | $g_{fs}$            | $V_{DS} = -50\text{ V}, I_D = -7.2\text{ A}^b$  |  | 3.7  | -     | -         | S             |
| <b>Dynamic</b>  |                     |   |  |      |       |           |               |
| Input capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V}, V_{DS} = -25\text{ V}, f = 1.0\text{ MHz}$ , see fig. 5   |  | -    | 860   | -         | $\mu\text{F}$ |
| Output capacitance  | $C_{oss}$           |   |  | -    | 340   | -         |               |
| Reverse transfer capacitance  | $C_{riss}$          |   |  | -    | 93    | -         |               |
| Total gate charge   | $Q_g$               | $V_{GS} = -10\text{ V}$   | $I_D = -12\text{ A}, V_{DS} = -80\text{ V}$ , see fig. 6 and 13 <sup>b</sup> | -    | -     | 38        | nC            |
| Gate-source charge  | $Q_{gs}$            |   |  | -    | -     | 6.8       |               |
| Gate-drain charge   | $Q_{gd}$            |   |  | -    | -     | 21        |               |
| Turn-on delay time  | $t_{d(on)}$         | $V_{DD} = -50\text{ V}, I_D = -12\text{ A}, R_g = 12\text{ }\Omega, R_D = 3.9\text{ }\Omega$ , see fig. 10 <sup>b</sup>                                 |  | -    | 12    | -         | ns            |
| Rise time   | $t_r$               |   |  | -    | 52    | -         |               |
| Turn-off delay time   | $t_{d(off)}$        |   |  | -    | 31    | -         |               |
| Fall time   | $t_f$               |   |  | -    | 39    | -         |               |
| Gate input resistance   | $L_D$               | Between lead, 6 mm (0.25") from package and center of die contact  |  | -    | 4.5   | -         | nH            |
| Internal drain inductance   | $L_S$               |   |  | -    | 7.5   | -         |               |
| Internal source inductance  | $R_g$               | $f = 1\text{ MHz}$ , open drain   |  | 0.4  | -     | 3.3       | $\Omega$      |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |   |  |      |       |           |               |
| Continuous source-drain diode current                                       | $I_S$               | MOSFET symbol showing the integral reverse p-n junction diode      |  | -    | -     | -12       | A             |
| Pulsed diode forward current <sup>a</sup>                                   | $I_{SM}$            |   |  | -    | -     | -48       |               |
| Body diode voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = -12\text{ A}, V_{GS} = 0\text{ V}^b$   |  | -    | -     | -6.3      | V             |
| Body diode reverse recovery time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = -12\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$  |  | -    | 120   | 240       | ns            |
| Body diode reverse recovery charge  | $Q_{rr}$            |   |  | -    | 0.46  | 0.92      | $\mu\text{C}$ |
| Forward turn-on time  | $t_{on}$            | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$ and $L_D$ )   |  |      |       |           |               |

**Notes**

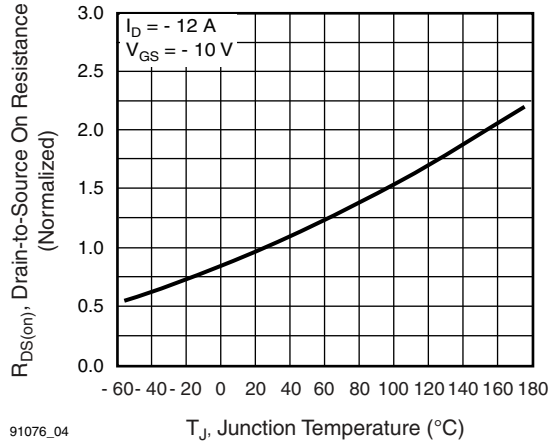
- a. Repetitive rating; pulse width limited by maximum junction temperature (see fig. 11)  
 b. Pulse width  $\leq 300\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$

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



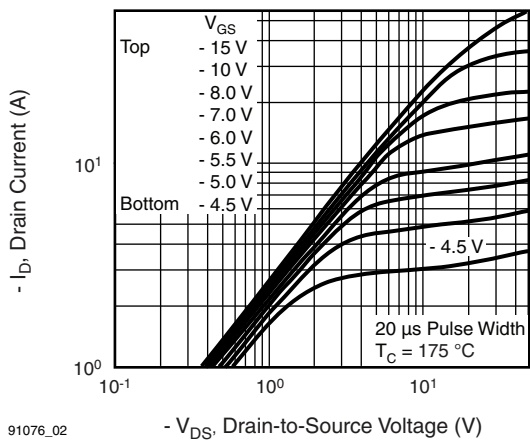
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**Fig. 1 - Typical Output Characteristics, T<sub>C</sub> = 25 °C**



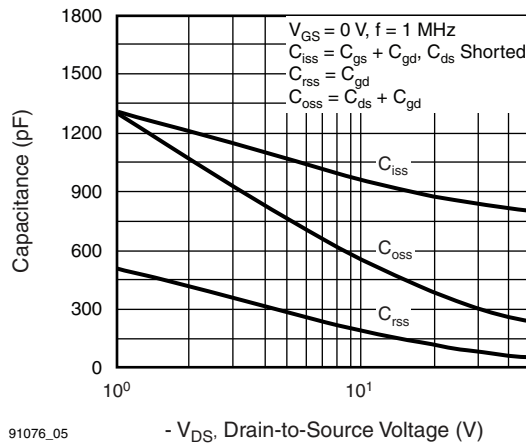
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**Fig. 4 - Normalized On-Resistance vs. Temperature**



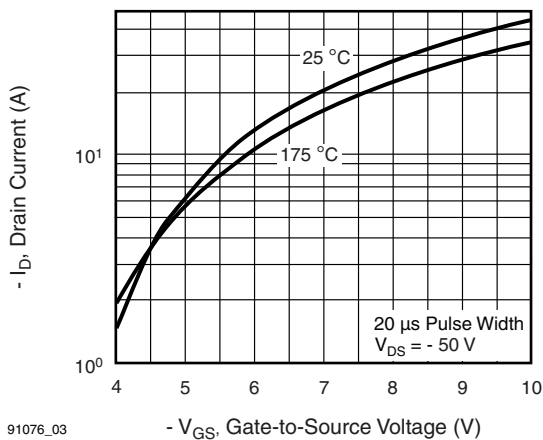
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**Fig. 2 - Typical Output Characteristics, T<sub>C</sub> = 175 °C**



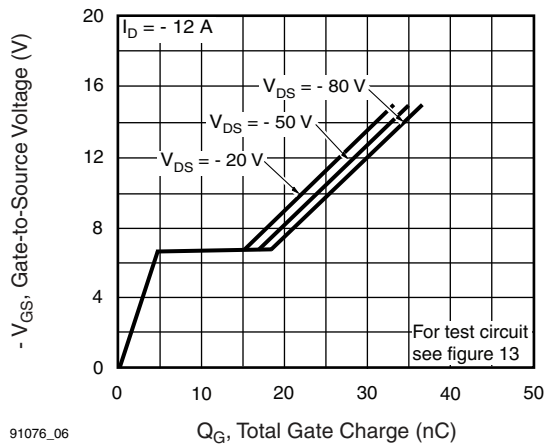
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**Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage**



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**Fig. 3 - Typical Transfer Characteristics**



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

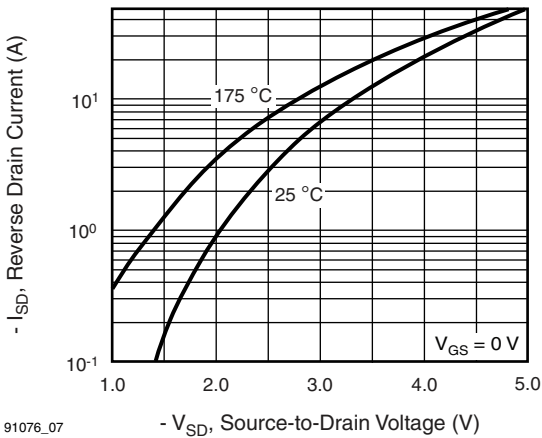


Fig. 7 - Typical Source-Drain Diode Forward Voltage

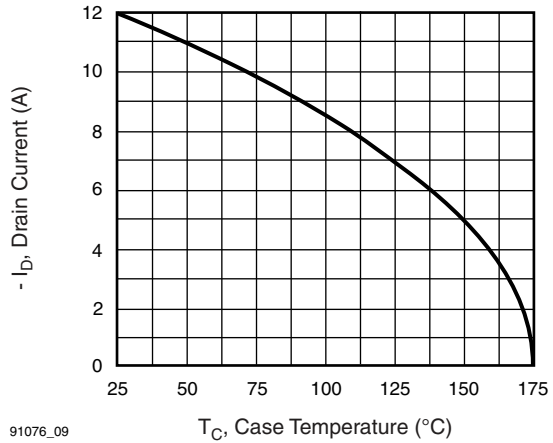


Fig. 9 - Maximum Drain Current vs. Case Temperature

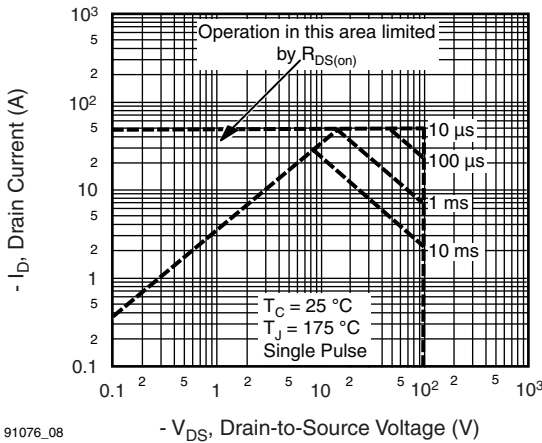


Fig. 8 - Maximum Safe Operating Area

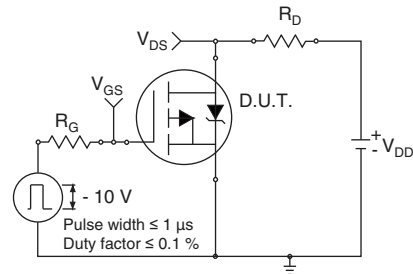


Fig. 10 - Switching Time Test Circuit

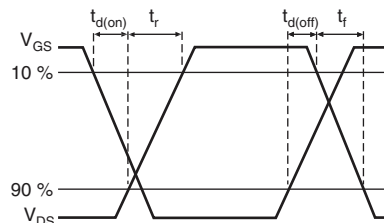


Fig. 11 - Switching Time Waveforms

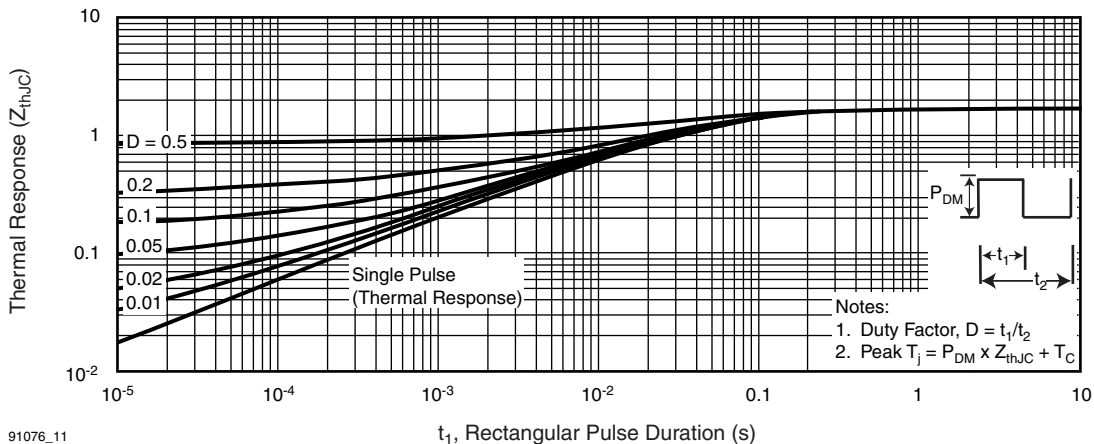


Fig. 12 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

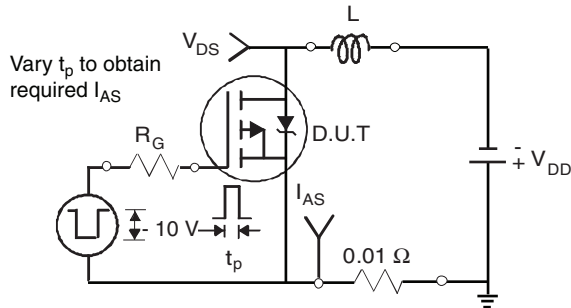


Fig. 13 - Unclamped Inductive Test Circuit

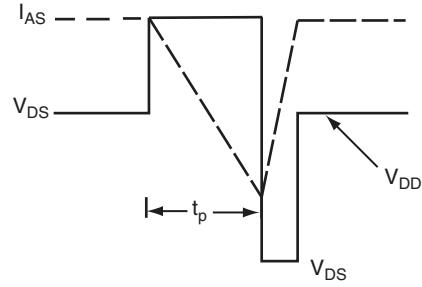


Fig. 14 - Unclamped Inductive Waveforms

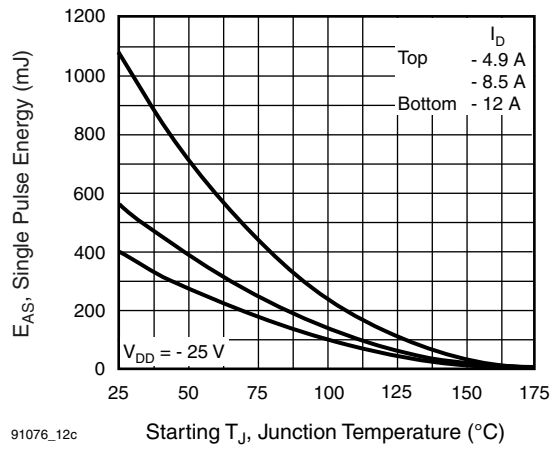


Fig. 15 - Maximum Avalanche Energy vs. Drain Current

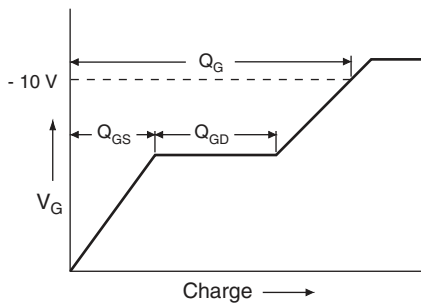


Fig. 16 - Basic Gate Charge Waveform

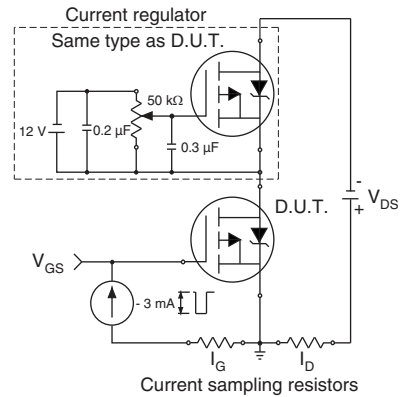
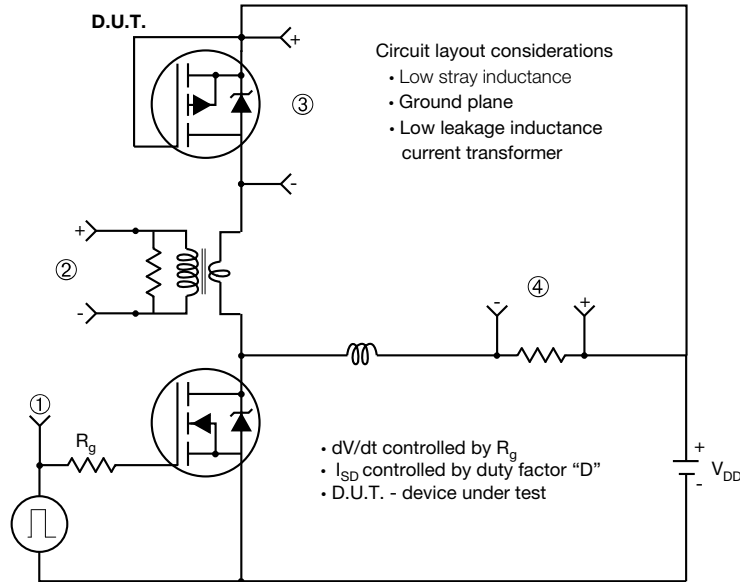


Fig. 17 - Gate Charge Test Circuit

**Peak Diode Recovery dV/dt Test Circuit**



**Note**  
• Compliment N-Channel of D.U.T. for driver



**Note**  
a.  $V_{GS} = -5\text{ V}$  for logic level and  $-3\text{ V}$  drive devices

**Fig. 18 - For P-Channel**

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