

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



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 | |
| $R_{DS(on)}$ (Ω) | $V_{GS} = -10$ V | 1.2 |
| Q_g max. (nC) | 8.7 | |
| Q_{gs} (nC) | 2.2 | |
| Q_{gd} (nC) | 4.1 | |
| Configuration | Single | |

ORDERING INFORMATION

| | |
|---------------------------------|----------------|
| Package | TO-220AB |
| Lead (Pb)-free | IRF9510PbF |
| Lead (Pb)-free and halogen-free | IRF9510PbF-BE3 |

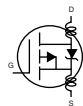

ABSOLUTE MAXIMUM RATINGS ($T_C = 25$ °C, unless otherwise noted)

| PARAMETER | SYMBOL | LIMIT | UNIT | |
|---|------------------|----------------|------|----------|
| Drain-source voltage | V_{DS} | -100 | V | |
| Gate-source voltage | V_{GS} | ± 20 | | |
| Continuous drain current | V_{GS} at 10 V | $T_C = 25$ °C | -4.0 | A |
| | | $T_C = 100$ °C | -2.8 | |
| Pulsed drain current ^a | I_{DM} | -16 | | |
| Linear derating factor | | 0.29 | W/°C | |
| Single pulse avalanche energy ^b | E_{AS} | 200 | mJ | |
| Repetitive avalanche current ^a | I_{AR} | -4.0 | A | |
| Repetitive avalanche energy ^a | E_{AR} | 4.3 | mJ | |
| Maximum power dissipation | $T_C = 25$ °C | P_D | 43 | W |
| Peak diode recovery dV/dt ^c | dV/dt | -5.5 | V/ns | |
| Operating junction and storage temperature range | T_J, T_{stg} | -55 to +175 | °C | |
| Soldering recommendations (peak temperature) ^d | 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, $L = 18$ mH, $R_g = 25$ Ω , $I_{AS} = -4.0$ A (see fig. 12)
- $I_{SD} \leq -4.0$ A, $dI/dt \leq 75$ A/ μ 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} | - | 3.5 | |

| 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_{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 $25\text{ }^\circ\text{C}$, $I_D = -1\text{ mA}$ | - | -0.091 | - | 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} | $V_{GS} = \pm 20\text{ V}$ | - | - | ± 100 | nA |
| Zero gate voltage drain current | I_{DSS} | $V_{DS} = -100\text{ V}, V_{GS} = 0\text{ V}$ | - | - | -100 | μA |
| | | $V_{DS} = -80\text{ V}, V_{GS} = 0\text{ V}, T_J = 150\text{ }^\circ\text{C}$ | - | - | -500 | |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS} = -10\text{ V}, I_D = -2.4\text{ A}^b$ | - | - | 1.2 | Ω |
| Forward transconductance | g_{fs} | $V_{DS} = -50\text{ V}, I_D = -2.4\text{ A}^b$ | 1.0 | - | - | S |
| Dynamic | | | | | | |
| Input capacitance | C_{iss} | $V_{GS} = 0\text{ V}, V_{DS} = -25\text{ V}, f = 1.0\text{ MHz}$, see fig. 5 | - | 200 | - | pF |
| Output capacitance | C_{oss} | | - | 94 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 18 | - | |
| Total gate charge | Q_g | $V_{GS} = -10\text{ V}, I_D = -4.0\text{ A}, V_{DS} = -80\text{ V}$, see fig. 6 and 13 ^b | - | - | 8.7 | nC |
| Gate-source charge | Q_{gs} | | - | - | 2.2 | |
| Gate-drain charge | Q_{gd} | | - | - | 4.1 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD} = -50\text{ V}, I_D = -4.0\text{ A}, R_g = 24\text{ }\Omega, R_D = 11\text{ }\Omega$, see fig. 10 ^b | - | 10 | - | ns |
| Rise time | t_r | | - | 27 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 15 | - | |
| Fall time | t_f | | - | 17 | - | |
| Gate input resistance | R_g | $f = 1\text{ MHz}$, open drain | 1.5 | - | 7.9 | Ω |
| Internal drain inductance | L_D | Between lead, 6 mm (0.25") from package and center of die contact  | - | 4.5 | - | nH |
| Internal source inductance | L_S | | - | 7.5 | - | |
| Drain-Source Body Diode Characteristics | | | | | | |
| Continuous source-drain diode current | I_S | MOSFET symbol showing the integral reverse p - n junction diode  | - | - | -4.0 | A |
| Pulsed diode forward current ^a | I_{SM} | | - | - | -16 | |
| Body diode voltage | V_{SD} | $T_J = 25\text{ }^\circ\text{C}, I_S = -4.0\text{ A}, V_{GS} = 0\text{ V}^b$ | - | - | -5.5 | V |
| Body diode reverse recovery time | t_{rr} | $T_J = 25\text{ }^\circ\text{C}, I_F = -4.0\text{ A}, di/dt = 100\text{ A}/\mu\text{s}^b$ | - | 82 | 160 | ns |
| Body diode reverse recovery charge | Q_{rr} | | - | 0.15 | 0.30 | μC |
| 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)

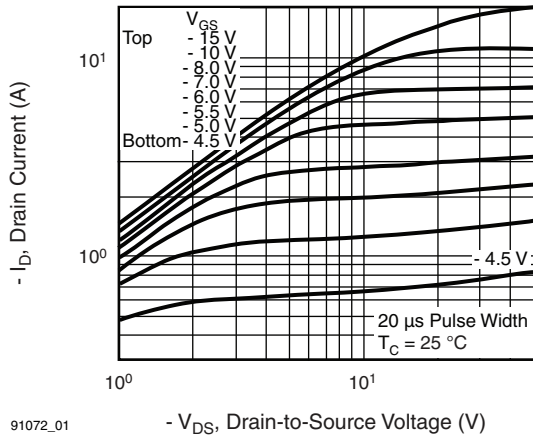


Fig. 1 - Typical Output Characteristics, TC = 25 °C

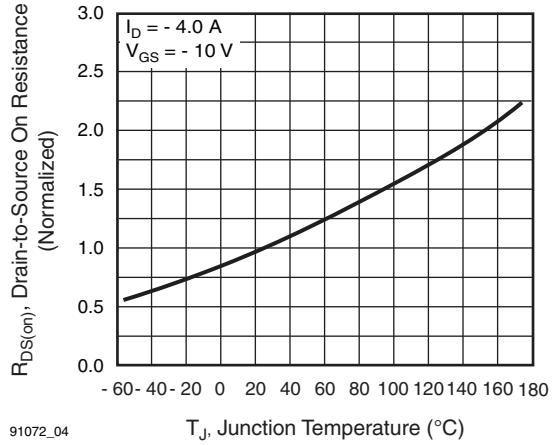


Fig. 4 - Normalized On-Resistance vs. Temperature

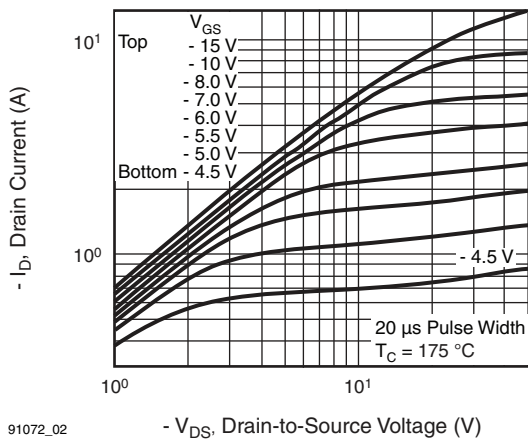


Fig. 2 - Typical Output Characteristics, TC = 175 °C

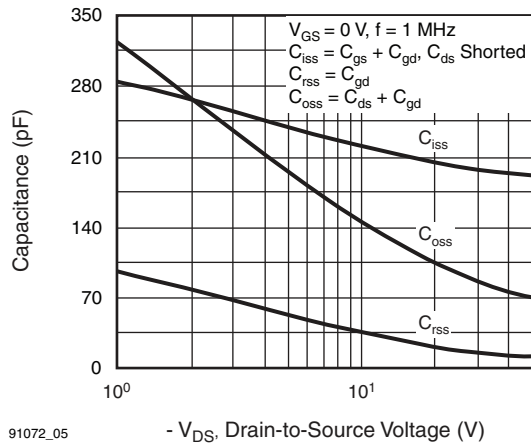


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

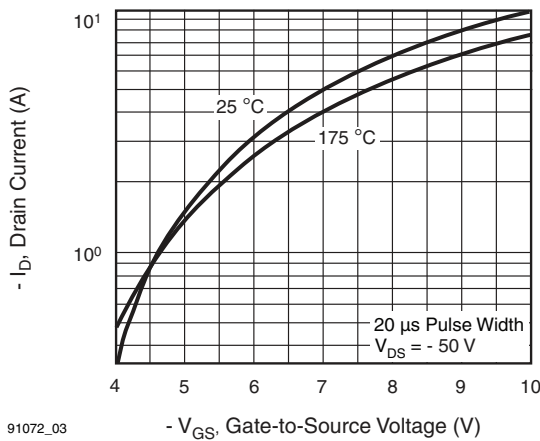


Fig. 3 - Typical Transfer Characteristics

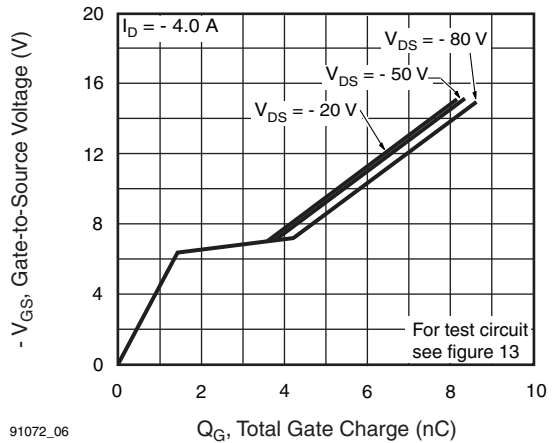
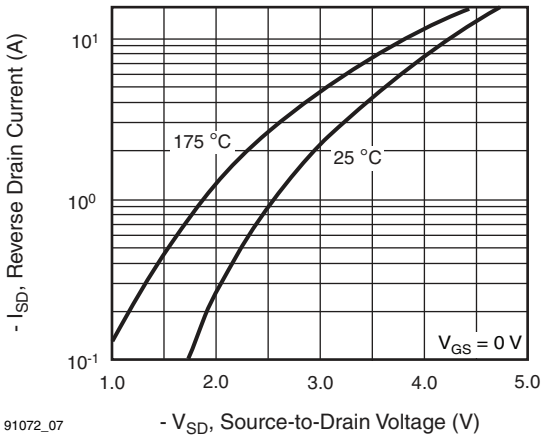
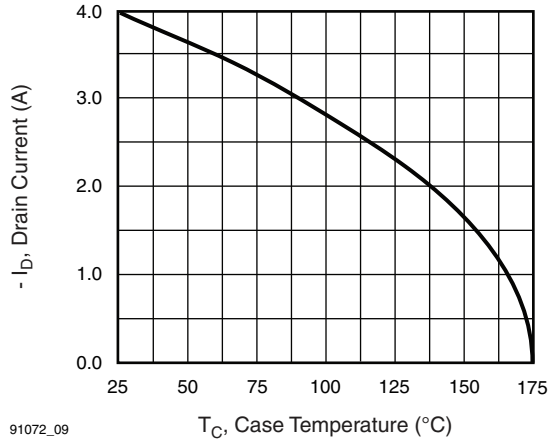


Fig. 6 - Typical Gate Charge vs. Gate-to-Source Voltage



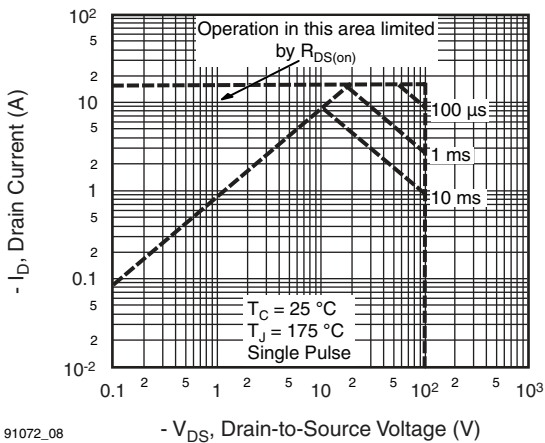
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Fig. 7 - Typical Source-Drain Diode Forward Voltage



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Fig. 9 - Maximum Drain Current vs. Case Temperature



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Fig. 8 - Maximum Safe Operating Area

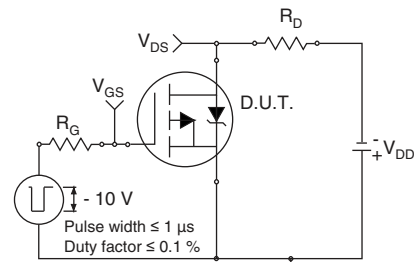


Fig. 10a - Switching Time Test Circuit

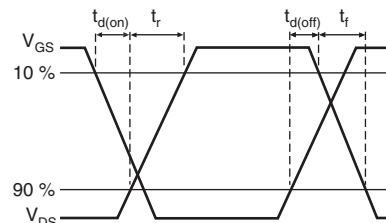
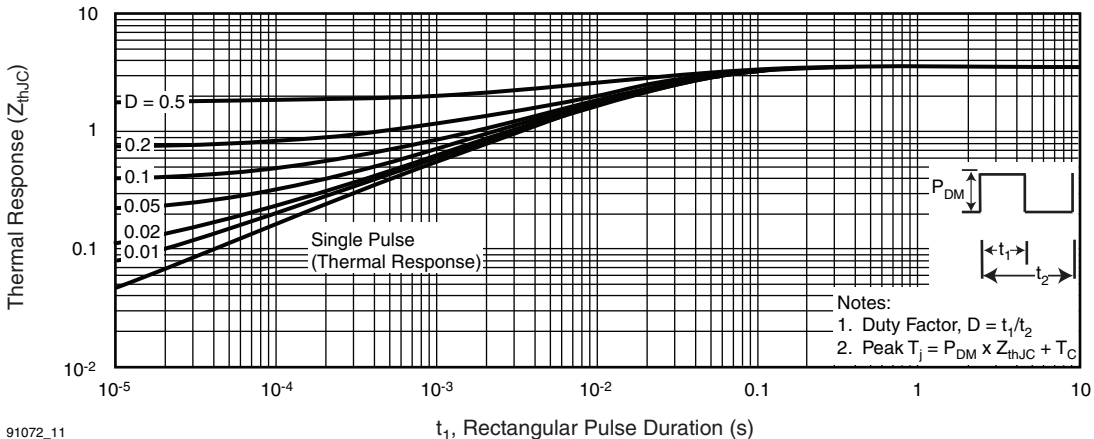


Fig. 10b - Switching Time Waveforms



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

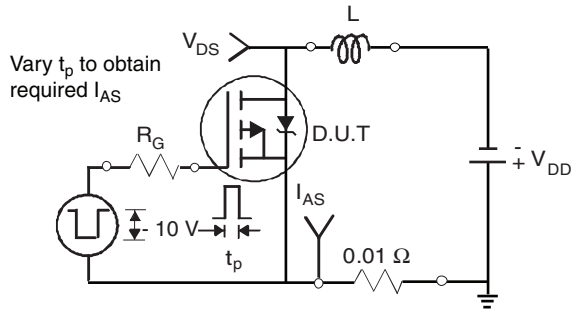


Fig. 12a - Unclamped Inductive Test Circuit

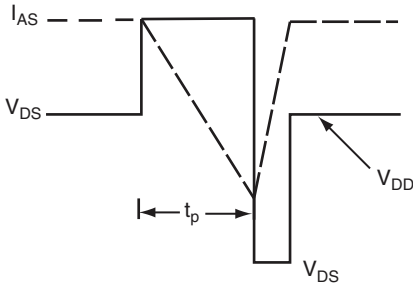
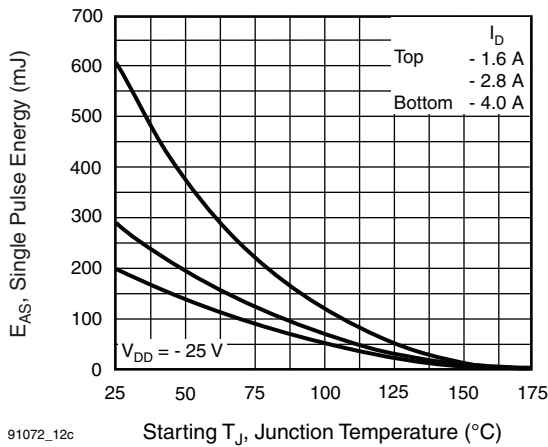


Fig. 12b - Unclamped Inductive Waveforms



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

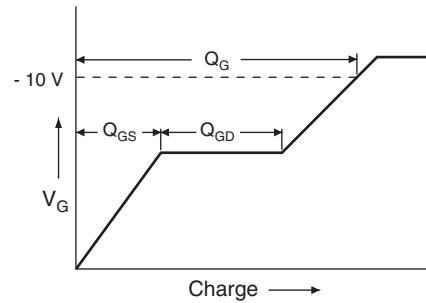


Fig. 13a - Basic Gate Charge Waveform

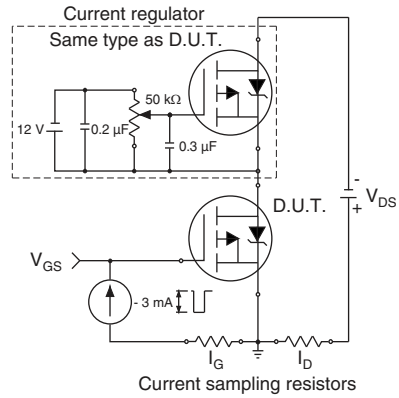
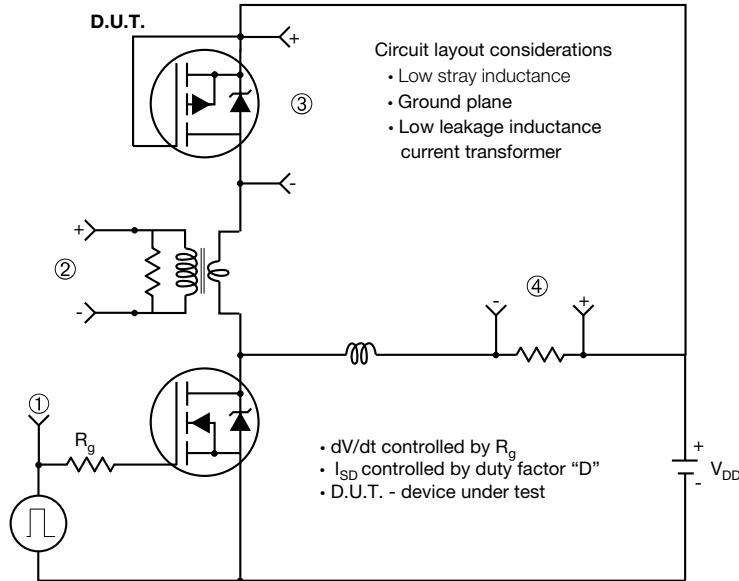


Fig. 13b - Gate Charge Test Circuit

Peak Diode Recovery dV/dt Test Circuit



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



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

Fig. 14 - For P-Channel

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