

## Power MOSFET

| PRODUCT SUMMARY           |                   |      |
|---------------------------|-------------------|------|
| $V_{DS}$ (V)              | - 200             |      |
| $R_{DS(on)}$ ( $\Omega$ ) | $V_{GS} = - 10$ V | 0.50 |
| $Q_g$ (Max.) (nC)         | 44                |      |
| $Q_{gs}$ (nC)             | 7.1               |      |
| $Q_{gd}$ (nC)             | 27                |      |
| Configuration             | Single            |      |

### FEATURES

- Dynamic dV/dt Rating
- Repetitive Avalanche Rated
- P-Channel
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Compliant to RoHS Directive 2002/95/EC

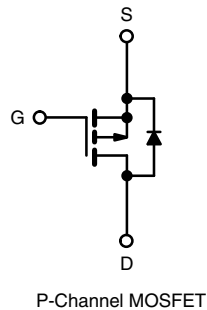
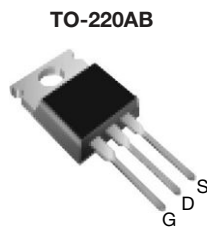


Available  
**RoHS\***  
COMPLIANT

### 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.



| ORDERING INFORMATION |                           |
|----------------------|---------------------------|
| Package              | TO-220AB                  |
| Lead (Pb)-free       | IRF9640PbF<br>SiHF9640-E3 |
| SnPb                 | IRF9640<br>SiHF9640       |

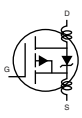

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                    |                |                  |          |   |
|---|--------------------|----------------|------------------|----------|---|
| PARAMETER   |                    | SYMBOL         | LIMIT            | UNIT     |   |
| Drain-Source Voltage  |                    | $V_{DS}$       | - 200            | V        |   |
| Gate-Source Voltage   |                    | $V_{GS}$       | $\pm 20$         | V        |   |
| Continuous Drain Current  | $V_{GS}$ at - 10 V | $I_D$          | $T_C = 25$ °C    | - 11     | A |
|   |                    |                | $T_C = 100$ °C   | - 6.8    |   |
| Pulsed Drain Current <sup>a</sup>                                 |                    | $I_{DM}$       | - 44             |          |   |
| Linear Derating Factor  |                    |                | 1.0              | W/°C     |   |
| Single Pulse Avalanche Energy <sup>b</sup>                        |                    | $E_{AS}$       | 700              | mJ       |   |
| Repetitive Avalanche Current <sup>a</sup>                         |                    | $I_{AR}$       | - 11             | A        |   |
| Repetitive Avalanche Energy <sup>a</sup>                          |                    | $E_{AR}$       | 13               | mJ       |   |
| Maximum Power Dissipation   | $T_C = 25$ °C      | $P_D$          | 125              | W        |   |
| Peak Diode Recovery dV/dt <sup>c</sup>                            |                    | dV/dt          | - 5.0            | V/ns     |   |
| Operating Junction and Storage Temperature Range                  |                    | $T_J, T_{stg}$ | - 55 to + 150    | °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).
- $V_{DD} = - 50$  V, starting  $T_J = 25$  °C,  $L = 8.7$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = - 11$  A (see fig. 12).
- $I_{SD} \leq - 11$  A,  $dI/dt \leq 150$  A/ $\mu$ s,  $V_{DD} \leq V_{DS}$ ,  $T_J \leq 150$  °C.
- 1.6 mm from case.

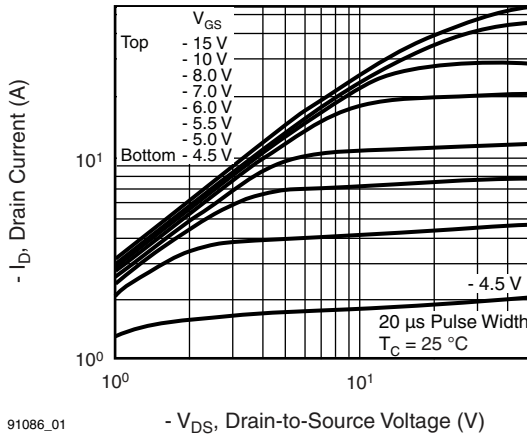
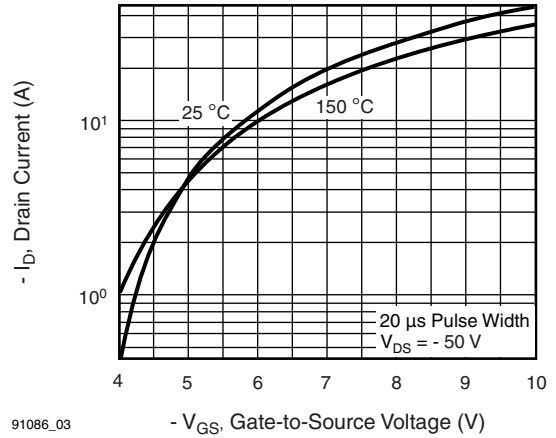
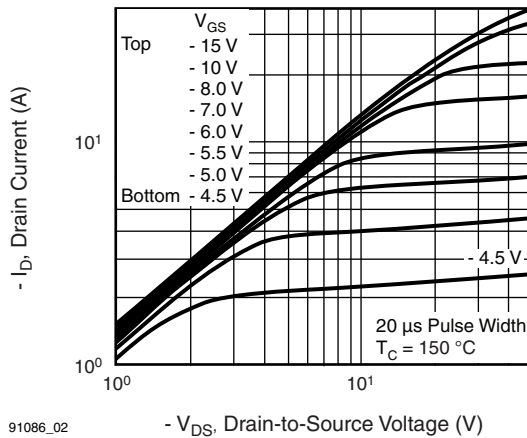
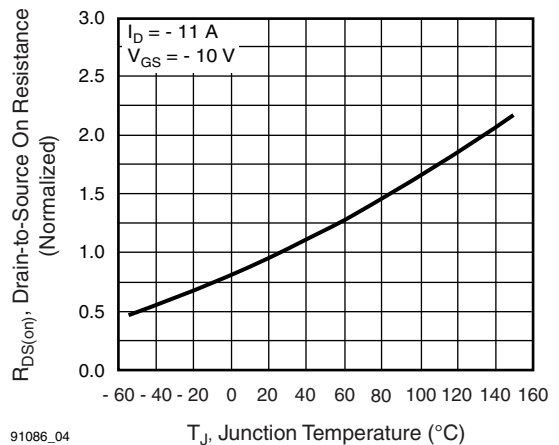
\* Pb containing terminations are not RoHS compliant, exemptions may apply

| 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)    | $R_{thJC}$ | -    | 1.0  |      |

| 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  | $V_{DS}$            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$  | -200 | -    | -         | V             |
| $V_{DS}$ Temperature Coefficient  | $\Delta V_{DS}/T_J$ | Reference to $25\text{ }^\circ\text{C}$ , $I_D = -1\text{ mA}$  | -    | -0.2 | -         | 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   | $I_{DSS}$           | $V_{DS} = -200\text{ V}, V_{GS} = 0\text{ V}$   | -    | -    | -100      | $\mu\text{A}$ |
|   |                     | $V_{DS} = -160\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$  | -    | -    | -500      |               |
| Drain-Source On-State Resistance  | $R_{DS(on)}$        | $V_{GS} = -10\text{ V}, I_D = -6.6\text{ A}^b$  | -    | -    | 0.50      | $\Omega$      |
| Forward Transconductance  | $g_{fs}$            | $V_{DS} = -50\text{ V}, I_D = -6.6\text{ A}^b$  | 4.1  | -    | -         | S             |
| <b>Dynamic</b>  |                     |   |      |      |           |               |
| Input Capacitance   | $C_{iss}$           | $V_{GS} = 0\text{ V},$<br>$V_{DS} = -25\text{ V},$<br>$f = 1.0\text{ MHz},$ see fig. 5  | -    | 1200 | -         | $\mu\text{F}$ |
| Output Capacitance  | $C_{oss}$           |   | -    | 370  | -         |               |
| Reverse Transfer Capacitance  | $C_{rss}$           |   | -    | 81   | -         |               |
| Total Gate Charge   | $Q_g$               | $V_{GS} = -10\text{ V},$<br>$I_D = -11\text{ A}, V_{DS} = -160\text{ V},$<br>see fig. 6 and 13 <sup>b</sup>   | -    | -    | 44        | nC            |
| Gate-Source Charge  | $Q_{gs}$            |   | -    | -    | 7.1       |               |
| Gate-Drain Charge   | $Q_{gd}$            |   | -    | -    | 27        |               |
| Turn-On Delay Time  | $t_{d(on)}$         | $V_{DD} = -100\text{ V}, I_D = -11\text{ A}$<br>$R_g = 9.1\text{ }\Omega, R_D = 8.6\text{ }\Omega,$ see fig. 10 <sup>b</sup>                                    | -    | 14   | -         | ns            |
| Rise Time   | $t_r$               |   | -    | 43   | -         |               |
| Turn-Off Delay Time   | $t_{d(off)}$        |   | -    | 39   | -         |               |
| Fall Time   | $t_f$               |   | -    | 38   | -         |               |
| Internal Drain Inductance   | $L_D$               | Between lead,<br>6 mm (0.25") from<br>package and center of<br>die contact  | -    | 4.5  | -         | nH            |
| Internal Source Inductance  | $L_S$               |   | -    | 7.5  | -         |               |
| <b>Drain-Source Body Diode Characteristics</b>                              |                     |   |      |      |           |               |
| Continuous Source-Drain Diode Current                                       | $I_S$               | MOSFET symbol<br>showing the<br>integral reverse<br>p - n junction diode    | -    | -    | -11       | A             |
| Pulsed Diode Forward Current <sup>a</sup>                                   | $I_{SM}$            |   | -    | -    | -44       |               |
| Body Diode Voltage  | $V_{SD}$            | $T_J = 25\text{ }^\circ\text{C}, I_S = -11\text{ A}, V_{GS} = 0\text{ V}^b$   | -    | -    | -5        | V             |
| Body Diode Reverse Recovery Time  | $t_{rr}$            | $T_J = 25\text{ }^\circ\text{C}, I_F = -11\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}^b$  | -    | 250  | 300       | ns            |
| Body Diode Reverse Recovery Charge  | $Q_{rr}$            |   | -    | 2.9  | 3.6       | $\mu\text{C}$ |
| 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)

**Fig. 1 - Typical Output Characteristics,  $T_C = 25^\circ\text{C}$** 

**Fig. 3 - Typical Transfer Characteristics**

**Fig. 2 - Typical Output Characteristics,  $T_C = 150^\circ\text{C}$** 

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

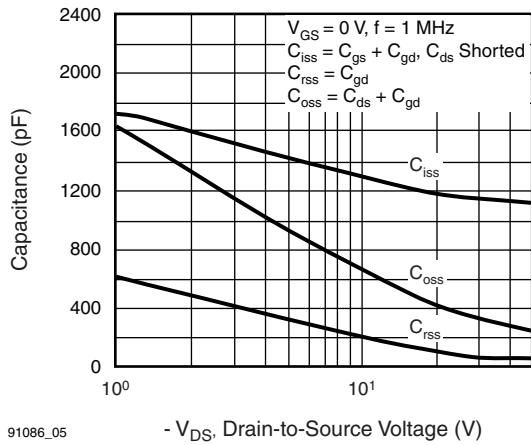


Fig. 5 - Typical Capacitance vs. Drain-to-Source Voltage

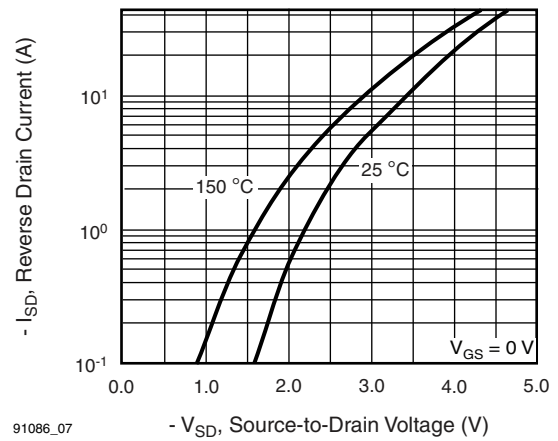


Fig. 7 - Typical Source-Drain Diode Forward Voltage

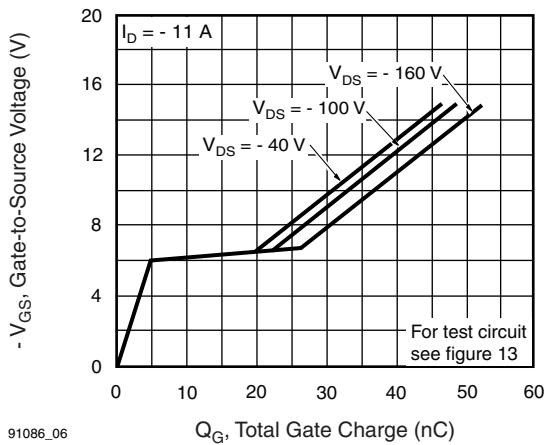


Fig. 6 - Typical Gate Charge vs. Drain-to-Source Voltage

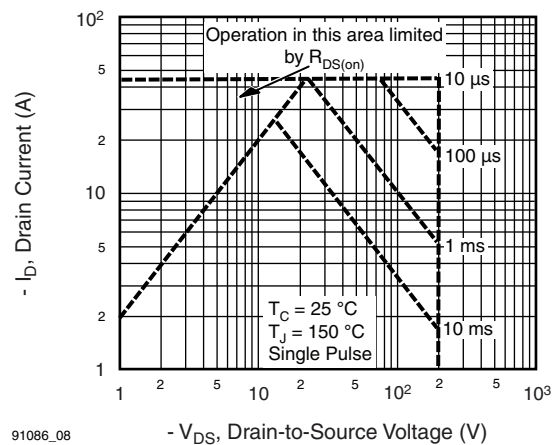


Fig. 8 - Maximum Safe Operating Area

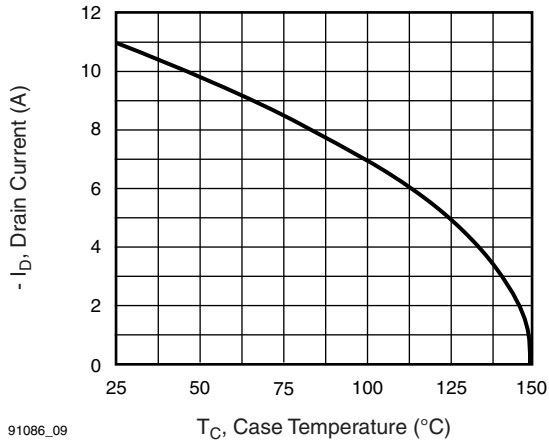


Fig. 9 - Maximum Drain Current vs. Case Temperature

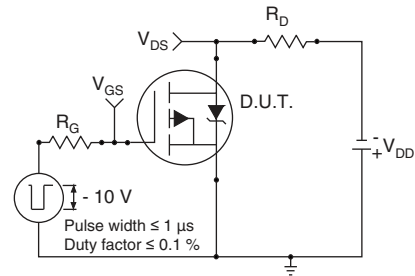


Fig. 10a - Switching Time Test Circuit

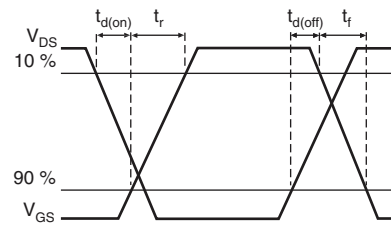


Fig. 10b - Switching Time Waveforms

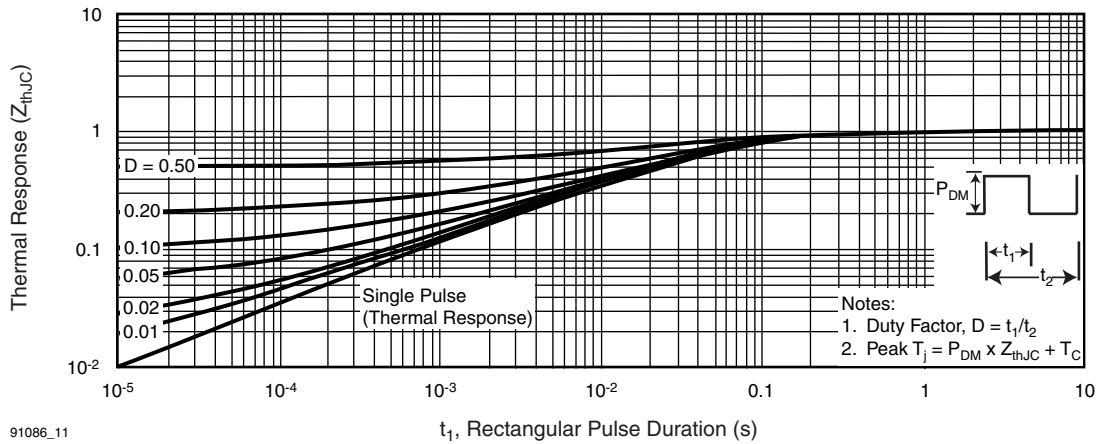


Fig. 11 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

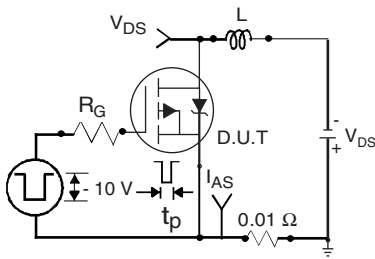


Fig. 12a - Unclamped Inductive Test Circuit

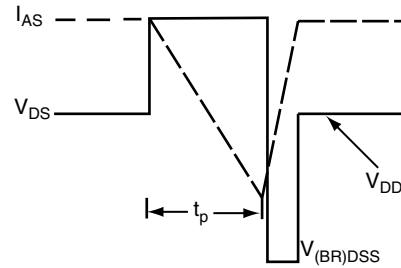


Fig. 12b - Unclamped Inductive Waveforms

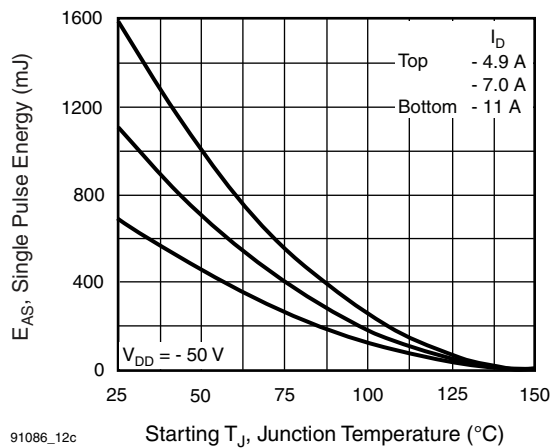


Fig. 12c - Maximum Avalanche Energy vs. Drain Current

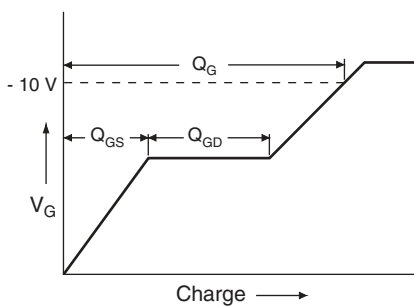


Fig. 13a - Basic Gate Charge Waveform

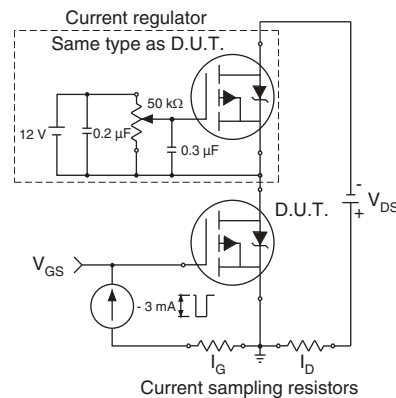


Fig. 13b - Gate Charge Test Circuit

### Peak Diode Recovery dV/dt Test Circuit



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



**Fig. 14 - For P-Channel**

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## TO-220-1



| 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 |
| Ø 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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