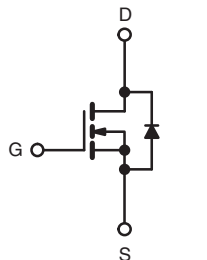
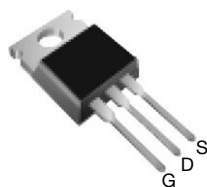


## D Series Power MOSFET

### PRODUCT SUMMARY

|                                         |                 |      |
|-----------------------------------------|-----------------|------|
| $V_{DS}$ (V) at $T_J$ max.              | 450             |      |
| $R_{DS(on)}$ max. at 25 °C ( $\Omega$ ) | $V_{GS} = 10$ V | 0.17 |
| $Q_g$ max. (nC)                         | 88              |      |
| $Q_{gs}$ (nC)                           | 12              |      |
| $Q_{gd}$ (nC)                           | 23              |      |
| Configuration                           | Single          |      |

**TO-220AB**


N-Channel MOSFET

### FEATURES

- Optimal Design
  - Low Area Specific On-Resistance
  - Low Input Capacitance ( $C_{iss}$ )
  - Reduced Capacitive Switching Losses
  - High Body Diode Ruggedness
  - Avalanche Energy Rated (UIS)
- Optimal Efficiency and Operation
  - Low Cost
  - Simple Gate Drive Circuitry
  - Low Figure-of-Merit (FOM):  $R_{on} \times Q_g$
  - Fast Switching
- Compliant to RoHS Directive 2011/65/EU

### Note

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

### APPLICATIONS

- Consumer Electronics
  - Displays (LCD or Plasma TV)
- Lighting
- Industrial
  - Welding
  - Induction Heating
  - Motor Drives
  - Battery Chargers
- SMPS



**RoHS\***  
COMPLIANT  
HALOGEN  
**FREE**  
Available

### ORDERING INFORMATION

|                                 |                |
|---------------------------------|----------------|
| Package                         | TO-220AB       |
| Lead (Pb)-free                  | SiHP25N40D-E3  |
| Lead (Pb)-free and Halogen-free | SiHP25N40D-GE3 |

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

| PARAMETER                                        | SYMBOL           | LIMIT          | UNIT |
|--------------------------------------------------|------------------|----------------|------|
| Drain-Source Voltage                             | $V_{DS}$         | 400            | V    |
| Gate-Source Voltage                              | $V_{GS}$         | $\pm 30$       |      |
| Gate-Source Voltage AC ( $f > 1$ Hz)             |                  | 30             |      |
| Continuous Drain Current ( $T_J = 150$ °C)       | $V_{GS}$ at 10 V | $T_C = 25$ °C  | A    |
|                                                  |                  | $T_C = 100$ °C |      |
| Pulsed Drain Current <sup>a</sup>                | $I_{DM}$         | 78             | W/°C |
| Linear Derating Factor                           |                  | 2.2            |      |
| Single Pulse Avalanche Energy <sup>b</sup>       | $E_{AS}$         | 556            | mJ   |
| Maximum Power Dissipation                        | $P_D$            | 278            | W    |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$   | - 55 to + 150  | °C   |
| Drain-Source Voltage Slope                       | $dV/dt$          | 24             | V/ns |
| Reverse Diode $dV/dt$ <sup>d</sup>               |                  | 0.6            |      |
| Soldering Recommendations (Peak Temperature)     | for 10 s         | 300°           | °C   |

### Notes

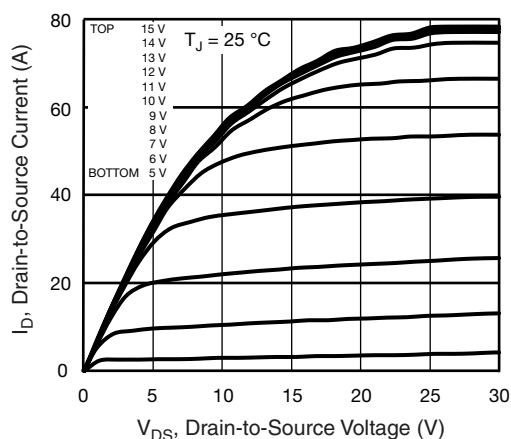
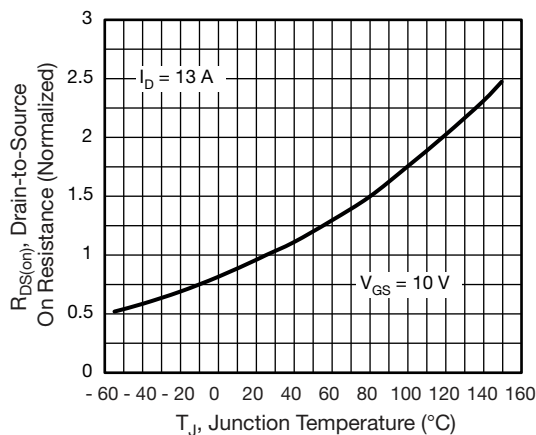
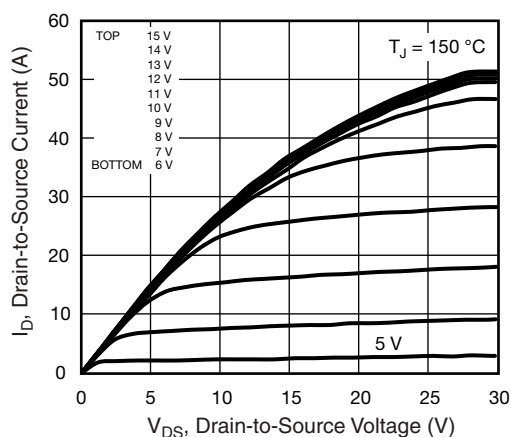
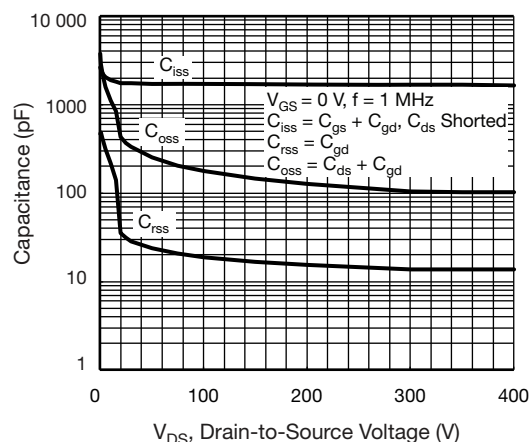
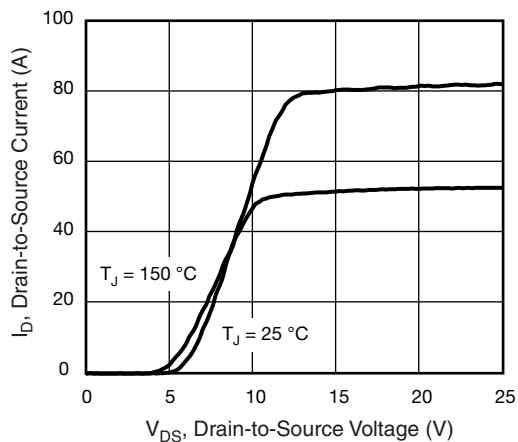
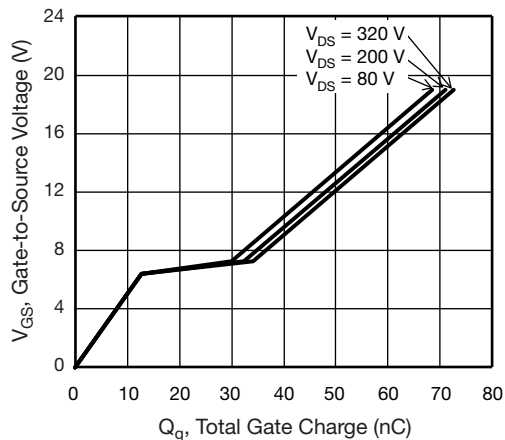
- Repetitive rating; pulse width limited by maximum junction temperature.
- $V_{DD} = 50$  V, starting  $T_J = 25$  °C,  $L = 2.3$  mH,  $R_g = 25$   $\Omega$ ,  $I_{AS} = 17$  A.
- 1.6 mm from case.
- $I_{SD} \leq I_D$ , starting  $T_J = 25$  °C.

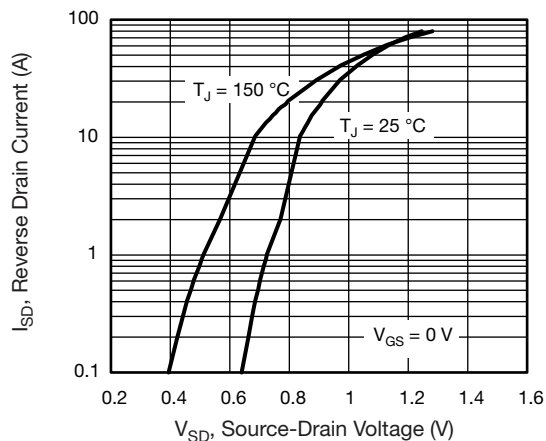
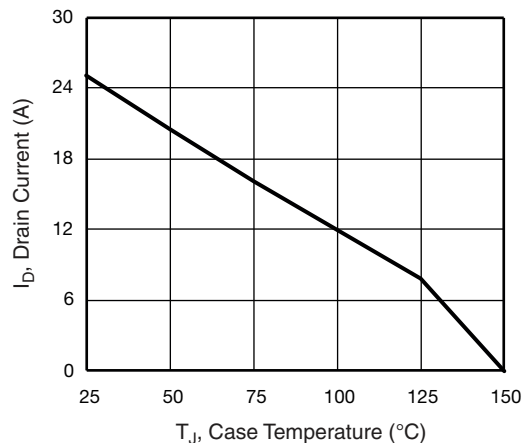
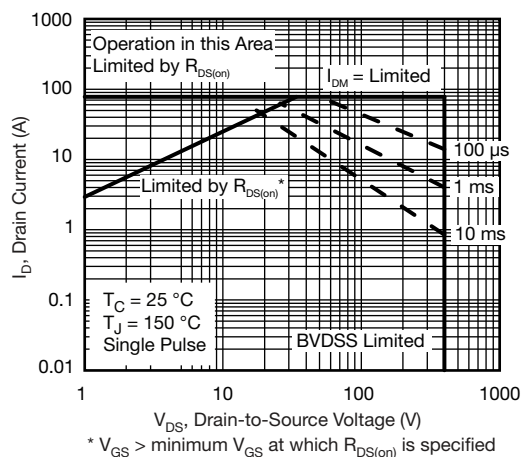
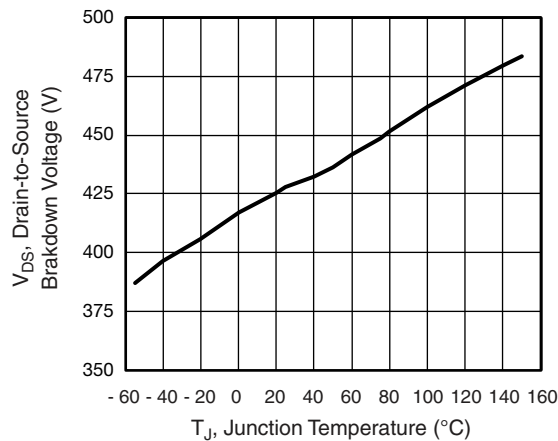
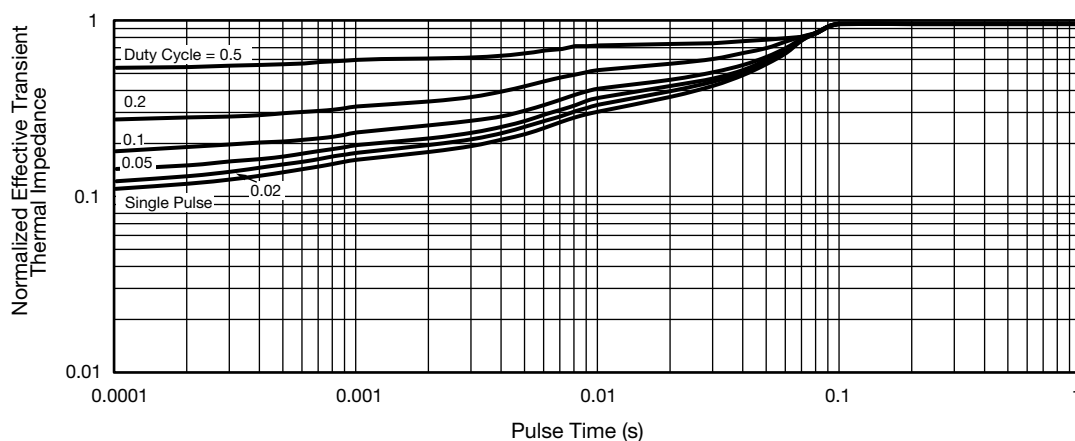
**THERMAL RESISTANCE RATINGS**

| PARAMETER                        | SYMBOL     | TYP. | MAX. | UNIT |
|----------------------------------|------------|------|------|------|
| Maximum Junction-to-Ambient      | $R_{thJA}$ | -    | 62   | °C/W |
| Maximum Junction-to-Case (Drain) | $R_{thJC}$ | -    | 0.45 |      |

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

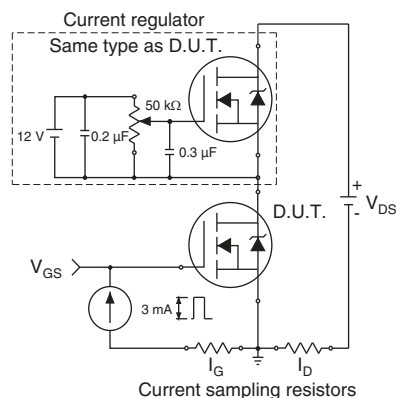
| PARAMETER                               | SYMBOL                           | TEST CONDITIONS                                                                                                                                          |                                                | MIN. | TYP. | MAX.  | UNIT |
|-----------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|------|------|-------|------|
| Static                                  |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Drain-Source Breakdown Voltage          | V <sub>DS</sub>                  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA                                                                                                           |                                                | 400  | -    | -     | V    |
| V <sub>DS</sub> Temperature Coefficient | ΔV <sub>DS</sub> /T <sub>J</sub> | Reference to 25 °C, I <sub>D</sub> = 250 μA                                                                                                              |                                                | -    | 0.5  | -     | V/°C |
| Gate-Source Threshold Voltage (N)       | V <sub>GS(th)</sub>              | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                                              |                                                | 3    | -    | 5     | V    |
| Gate-Source Leakage                     | I <sub>GSS</sub>                 | V <sub>GS</sub> = ± 30 V                                                                                                                                 |                                                | -    | -    | ± 100 | nA   |
| Zero Gate Voltage Drain Current         | I <sub>DSS</sub>                 | V <sub>DS</sub> = 400 V, V <sub>GS</sub> = 0 V                                                                                                           |                                                | -    | -    | 1     | μA   |
|                                         |                                  | V <sub>DS</sub> = 320 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                                                  |                                                | -    | -    | 10    |      |
| Drain-Source On-State Resistance        | R <sub>DS(on)</sub>              | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 13 A                          | -    | 0.14 | 0.17  | Ω    |
| Forward Transconductance                | g <sub>fs</sub>                  | V <sub>DS</sub> = 50 V, I <sub>D</sub> = 13 A                                                                                                            |                                                | -    | 7.4  | -     | S    |
| Dynamic                                 |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Input Capacitance                       | C <sub>iss</sub>                 | V <sub>GS</sub> = 0 V,<br>V <sub>DS</sub> = 100 V,<br>f = 1 MHz                                                                                          |                                                | -    | 1707 | -     | pF   |
| Output Capacitance                      | C <sub>oss</sub>                 |                                                                                                                                                          |                                                | -    | 177  | -     |      |
| Reverse Transfer Capacitance            | C <sub>rss</sub>                 |                                                                                                                                                          |                                                | -    | 19   | -     |      |
| Total Gate Charge                       | Q <sub>g</sub>                   | V <sub>GS</sub> = 10 V                                                                                                                                   | I <sub>D</sub> = 13 A, V <sub>DS</sub> = 320 V | -    | 44   | 88    | nC   |
| Gate-Source Charge                      | Q <sub>gs</sub>                  |                                                                                                                                                          |                                                | -    | 12   | -     |      |
| Gate-Drain Charge                       | Q <sub>gd</sub>                  |                                                                                                                                                          |                                                | -    | 23   | -     |      |
| Turn-On Delay Time                      | t <sub>d(on)</sub>               | V <sub>DD</sub> = 320 V, I <sub>D</sub> = 13 A,<br>V <sub>GS</sub> = 10 V, R <sub>g</sub> = 24.6 Ω                                                       |                                                | -    | 21   | 42    | ns   |
| Rise Time                               | t <sub>r</sub>                   |                                                                                                                                                          |                                                | -    | 57   | 86    |      |
| Turn-Off Delay Time                     | t <sub>d(off)</sub>              |                                                                                                                                                          |                                                | -    | 40   | 80    |      |
| Fall Time                               | t <sub>f</sub>                   |                                                                                                                                                          |                                                | -    | 37   | 74    |      |
| Gate Input Resistance                   | R <sub>g</sub>                   | f = 1 MHz, open drain                                                                                                                                    |                                                | -    | 1.8  | -     | Ω    |
| Drain-Source Body Diode Characteristics |                                  |                                                                                                                                                          |                                                |      |      |       |      |
| Continuous Source-Drain Diode Current   | I <sub>S</sub>                   | MOSFET symbol showing the integral reverse p - n junction diode<br> |                                                | -    | -    | 24    | A    |
| Pulsed Diode Forward Current            | I <sub>SM</sub>                  |                                                                                                                                                          |                                                | -    | -    | 78    |      |
| Diode Forward Voltage                   | V <sub>SD</sub>                  | T <sub>J</sub> = 25 °C, I <sub>S</sub> = 13 A, V <sub>GS</sub> = 0 V                                                                                     |                                                | -    | -    | 1.2   | V    |
| Reverse Recovery Time                   | t <sub>rr</sub>                  | T <sub>J</sub> = 25 °C, I <sub>F</sub> = I <sub>S</sub> = 13 A,<br>dI/dt = 100 A/μs, V <sub>R</sub> = 20 V                                               |                                                | -    | 353  | -     | ns   |
| Reverse Recovery Charge                 | Q <sub>rr</sub>                  |                                                                                                                                                          |                                                | -    | 4.4  | -     | μC   |
| Reverse Recovery Current                | I <sub>RRM</sub>                 |                                                                                                                                                          |                                                | -    | 24   | -     | A    |

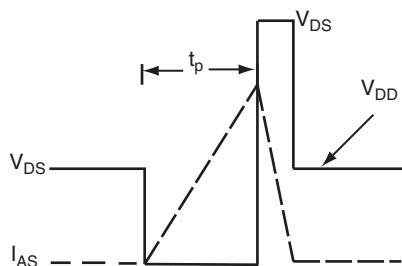
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

**Fig. 1 - Typical Output Characteristics**

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

**Fig. 2 - Typical Output Characteristics**

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

**Fig. 3 - Typical Transfer Characteristics**

**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 - Temperature vs. Drain-to-Source Voltage**

**Fig. 11 - Normalized Thermal Transient Impedance, Junction-to-Case**


**Fig. 12 - Switching Time Test Circuit**

**Fig. 16 - Basic Gate Charge Waveform**

**Fig. 13 - Switching Time Waveforms**

**Fig. 17 - Gate Charge Test Circuit**

**Fig. 14 - Unclamped Inductive Test Circuit**

**Fig. 15 - Unclamped Inductive Waveforms**


**Note**

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

**Fig. 18 - For N-Channel**

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## TO-220AB



| DIM.            | MILLIMETERS |       | INCHES |       |
|-----------------|-------------|-------|--------|-------|
|                 | MIN.        | MAX.  | MIN.   | MAX.  |
| A               | 4.25        | 4.65  | 0.167  | 0.183 |
| b               | 0.69        | 1.01  | 0.027  | 0.040 |
| b(1)            | 1.20        | 1.73  | 0.047  | 0.068 |
| c               | 0.36        | 0.61  | 0.014  | 0.024 |
| D               | 14.85       | 15.49 | 0.585  | 0.610 |
| E               | 10.04       | 10.51 | 0.395  | 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)            | 6.09        | 6.48  | 0.240  | 0.255 |
| J(1)            | 2.41        | 2.92  | 0.095  | 0.115 |
| L               | 13.35       | 14.02 | 0.526  | 0.552 |
| L(1)            | 3.32        | 3.82  | 0.131  | 0.150 |
| $\varnothing P$ | 3.54        | 3.94  | 0.139  | 0.155 |
| Q               | 2.60        | 3.00  | 0.102  | 0.118 |

ECN: X12-0208-Rev. N, 08-Oct-12  
DWG: 5471

### Notes

- \*  $M = 1.32$  mm to  $1.62$  mm (dimension including protrusion)  
Heatsink hole for HVM
- Xi'an and Mingxin actual photo





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