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Vishay Siliconix

## N-Channel 20 V (D-S) MOSFET

| PRODUCT SUMMARY     |                                  |                      |                       |  |  |  |
|---------------------|----------------------------------|----------------------|-----------------------|--|--|--|
| V <sub>DS</sub> (V) | R <sub>DS(on)</sub> (Ω) MAX.     | I <sub>D</sub> (A) a | Q <sub>g</sub> (TYP.) |  |  |  |
| 20                  | 0.037 at V <sub>GS</sub> = 4.5 V | 5.7                  |                       |  |  |  |
|                     | 0.041 at V <sub>GS</sub> = 2.5 V | 5.4                  | 5.9 nC                |  |  |  |
|                     | 0.047 at V <sub>GS</sub> = 1.8 V | 5.0                  | 5.9110                |  |  |  |
|                     | 0.068 at V <sub>GS</sub> = 1.5 V | 4.2                  |                       |  |  |  |

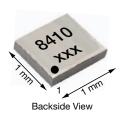
### **FEATURES**

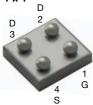
- TrenchFET® power MOSFET
- Ultra small 1 mm x 1 mm maximum outline
- Ultra-thin 0.54 mm maximum height
- Material categorization:
  For definitions of compliance please see
  www.vishav.com/doc?99912



COMPLIANT HALOGEN

#### MICRO FOOT® 1 x 1





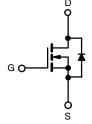
Bump Side View

Marking Code: 8410 Ordering Information:

Si8410DB-T2-E1 (Lead (Pb)-free and Halogen-free)

### **APPLICATIONS**

- · Load switch
- Power management
- · High speed switching



N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS (                    | T <sub>A</sub> = 25 °C, unless    | otherwise note  | ed)               |    |
|---|-----------------------------------|-----------------|-------------------|----|
| PARAMETER                                     | SYMBOL                            | LIMIT           | UNIT              |    |
| Drain-Source Voltage                          |                                   | V <sub>DS</sub> | 20                | V  |
| Gate-Source Voltage                           |                                   | V <sub>GS</sub> | ± 8               |    |
|   | T <sub>A</sub> = 25 °C            |                 | 5.7 <sup>a</sup>  |    |
| Continuous Drain Current (T, = 150 °C)        | T <sub>A</sub> = 70 °C            | 1-              | 4.5 <sup>a</sup>  |    |
| Continuous Drain Current (1) = 130 C)         | T <sub>A</sub> = 25 °C            | I <sub>D</sub>  | 3.8 <sup>c</sup>  |    |
|   | T <sub>A</sub> = 70 °C            |                 | 3.0 °             | Α  |
| Pulsed Drain Current (t = 100 μs)             |                                   | I <sub>DM</sub> | 20                |    |
| Continuous Source-Drain Diode Current         | T <sub>C</sub> = 25 °C            |                 | 1.5 <sup>a</sup>  |    |
| Continuous Source-Drain Diode Current         | T <sub>A</sub> = 25 °C            | I <sub>S</sub>  | 0.65 <sup>c</sup> |    |
|   | T <sub>A</sub> = 25 °C            |                 | 1.8 <sup>a</sup>  |    |
| Manian na Danna Diagia atian                  | T <sub>A</sub> = 70 °C            |                 | 1.1 <sup>a</sup>  | W  |
| Maximum Power Dissipation                     | T <sub>A</sub> = 25 °C            | P <sub>D</sub>  | 0.78 °            | VV |
|   | T <sub>A</sub> = 70 °C            |                 | 0.5 °             |    |
| Operating Junction and Storage Temperature Ra | T <sub>J</sub> , T <sub>stg</sub> | -55 to 150      |                   |    |
| Package Poflow Conditions 6                   | VPR                               |                 | 260               | °C |
| Package Reflow Conditions e                   | IR/Convection                     |                 | 260               |    |

| THERMAL RESISTANCE RATINGS       |          |                   |         |      |      |  |  |
|----------------------------------|----------|-------------------|---------|------|------|--|--|
| PARAMETER                        | SYMBOL   | TYPICAL           | MAXIMUM | UNIT |      |  |  |
| Maximum Junction-to-Ambient a, b | t = 10 s | R <sub>thJA</sub> | 55      | 70   | °C/W |  |  |
| Maximum Junction-to-Ambient c, d | t = 10 s | □thJA             | 125     | 160  | C/VV |  |  |

#### Notes

- a. Surface mounted on 1" x 1" FR4 board with full copper, t = 10 s,  $T_A = 25 \,^{\circ}\text{C}$ .
- b. Maximum under steady state conditions is 100 °C/W.
- c. Surface mounted on 1" x 1" FR4 board with minimum copper, t = 10 s.
- d. Maximum under steady state conditions is 190 °C/W.
- e. Refer to IPC/JEDEC® (J-STD-020), no manual or hand soldering.
- f. In this document, any reference to case represents the body of the MICRO FOOT device and foot is the bump.

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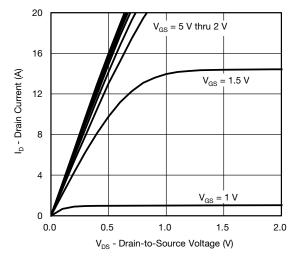
| PARAMETER                                     | SYMBOL                  | TEST CONDITIONS   | MIN.     | TYP.  | MAX.  | UNIT  |  |
|---|-------------------------|---|----------|-------|-------|-------|--|
| Static  |                         |   |          |       | L     |       |  |
| Drain-Source Breakdown Voltage                | V <sub>DS</sub>         | $V_{GS} = 0 \text{ V}, I_D = 250 \mu\text{A}$                           | 20       | -     | _     | V     |  |
| V <sub>DS</sub> Temperature Coefficient       | $\Delta V_{DS}/T_{J}$   |   | -        | 17    | -     | mV/°C |  |
| V <sub>GS(th)</sub> Temperature Coefficient   | $\Delta V_{GS(th)}/T_J$ | I <sub>D</sub> = 250 μA   | -        | -2.6  | -     |       |  |
| Gate-Source Threshold Voltage                 | V <sub>GS(th)</sub>     | $V_{DS} = V_{GS}, I_{D} = 250 \mu\text{A}$                              | 0.4      | -     | 0.85  |       |  |
| Gate-Source Leakage                           | I <sub>GSS</sub>        | $V_{DS} = 0 \text{ V}, V_{GS} = \pm 8 \text{ V}$                        | _        | -     | ± 100 | nA    |  |
| Zero Gate Voltage Drain Current               | _                       | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V                           | -        | -     | 1     |       |  |
|   | I <sub>DSS</sub>        | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 70 °C   | -        | -     | 10 µA |       |  |
| On-State Drain Current <sup>a</sup>           | I <sub>D(on)</sub>      | $V_{DS} \le -5 \text{ V}, V_{GS} = 4.5 \text{ V}$                       | 10       | -     | -     | Α     |  |
|   |                         | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 1.5 A                         | -        | 0.030 | 0.037 |       |  |
|   |                         | V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 1 A                           | -        | 0.033 | 0.041 |       |  |
| Drain-Source On-State Resistance <sup>a</sup> | R <sub>DS(on)</sub>     | V <sub>GS</sub> = 1.8 V, I <sub>D</sub> = 1 A                           | -        | 0.038 | 0.047 | Ω     |  |
|   |                         | V <sub>GS</sub> = 1.5 V, I <sub>D</sub> = 0.5 A                         | -        | 0.044 | 0.068 |       |  |
| Forward Transconductance <sup>a</sup>         | 9 <sub>fs</sub>         | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 1.5 A                          | -        | 17    | -     | S     |  |
| Dynamic <sup>b</sup>                          |                         |   |          |       | L     |       |  |
| Input Capacitance                             | C <sub>iss</sub>        |   | -        | 620   | -     | pF    |  |
| Output Capacitance                            | C <sub>oss</sub>        | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V, f = 1 MHz                | -        | 110   | -     |       |  |
| Reverse Transfer Capacitance                  | C <sub>rss</sub>        | †   | -        | 40    | -     |       |  |
| T. 10 1 01                                    | Q <sub>g</sub>          | $V_{DS} = 10 \text{ V}, V_{GS} = 8 \text{ V}, I_D = 1.5 \text{ A}$      | - 10.4 1 |       | 16    | 1     |  |
| Total Gate Charge                             |                         | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 1.5 A | -        | 5.9   | 9     | nC    |  |
| Gate-Source Charge                            |                         |   | -        | 0.7   | -     |       |  |
| Gate-Drain Charge                             | $Q_{gd}$                | ]   | -        | 0.66  | -     |       |  |
| Gate Resistance                               | $R_g$                   | V <sub>GS</sub> = 0.1 V, f = 1 MHz                                      | -        | 5.3   | -     | Ω     |  |
| Turn-On Delay Time                            | t <sub>d(on)</sub>      |   | -        | 5     | 10    |       |  |
| Rise Time                                     | t <sub>r</sub>          | $V_{DD} = -10 \text{ V}, R_L = 6.7 \Omega$                              | -        | 25    | 50    | -     |  |
| Turn-Off Delay Time                           | t <sub>d(off)</sub>     | $I_D \cong 1.5 \text{ A}, V_{GEN} = -4.5 \text{ V}, R_g = 1 \Omega$     | -        | 26    | 50    |       |  |
| Fall Time                                     | t <sub>f</sub>          | ]   | -        | 10    | 20    |       |  |
| Turn-On Delay Time                            | t <sub>d(on)</sub>      |   | -        | 5     | 10    | ns    |  |
| Rise Time                                     | t <sub>r</sub>          | $V_{DD} = -10 \text{ V}, R_L = 6.7 \Omega$                              | -        | 22    | 45    | 1     |  |
| Turn-Off Delay Time                           | t <sub>d(off)</sub>     | $I_D \cong$ -1.5 A, $V_{GEN}$ = -8 V, $R_g$ = 1 $\Omega$                | -        | 23    | 45    |       |  |
| Fall Time                                     | t <sub>f</sub>          | ]   | -        | 10    | 20    |       |  |
| Drain-Source Body Diode Characteri            | stics                   |   |          |       |       |       |  |
| Continuous Source-Drain Diode<br>Current      | I <sub>S</sub>          | T <sub>A</sub> = 25 °C  | -        | -     | 1.5   | Α     |  |
| Pulse Diode Forward Current                   | I <sub>SM</sub>         |   | -        | -     | 20    |       |  |
| Body Diode Voltage                            | $V_{SD}$                | $I_S = 1.5 \text{ A}, V_{GS} = 0$                                       | -        | 0.7   | 1.2   | V     |  |
| Body Diode Reverse Recovery Time              | t <sub>rr</sub>         |   | -        | 15    | 30    | ns    |  |
| Body Diode Reverse Recovery Charge            | Q <sub>rr</sub>         | Π<br>- I <sub>F</sub> = 1.5 A, dl/dt = 100 A/μs, T <sub>J</sub> = 25 °C | -        | 6     | 15    | nC    |  |
| Reverse Recovery Fall Time                    | t <sub>a</sub>          | 1.5 Λ, αι/αι = 100 Α/μs, 1J = 25 °C                                     | -        | 8.5   | -     | nc    |  |
| Reverse Recovery Rise Time                    | t <sub>b</sub>          |   | -        | 6.5   | -     | ns    |  |

#### Notes

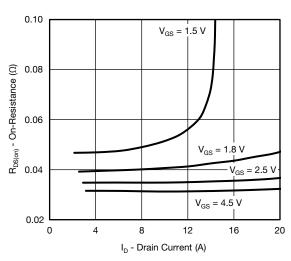
- a. Pulse test; pulse width  $\leq 300~\mu s,$  duty cycle  $\leq 2~\%.$
- b. Guaranteed by design, not subject to production testing.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

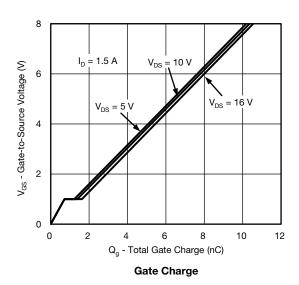


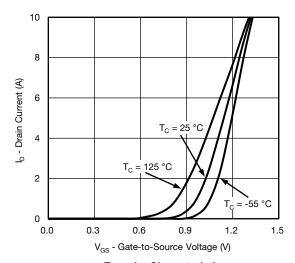


### **Output Characteristics**

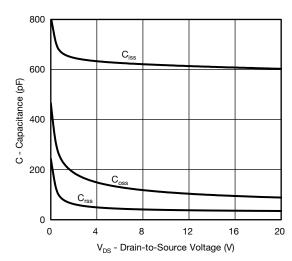


On-Resistance vs. Drain Current and Gate Voltage

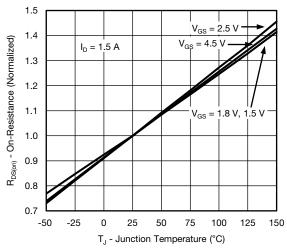




**Transfer Characteristics** 

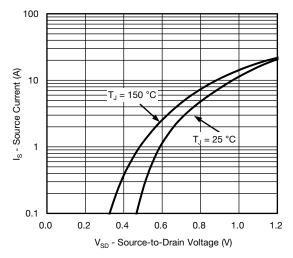


Capacitance

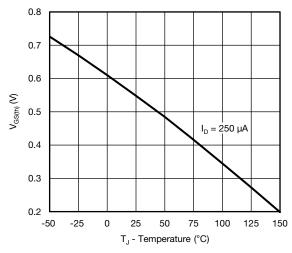


**On-Resistance vs. Junction Temperature** 

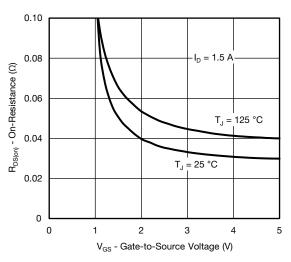




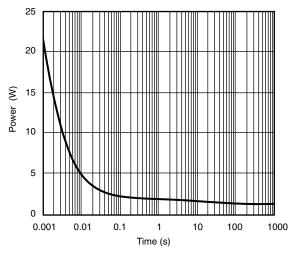
### Source-Drain Diode Forward Voltage



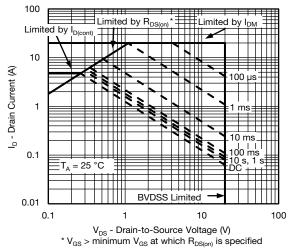
**Threshold Voltage** 



On-Resistance vs. Gate-to-Source Voltage

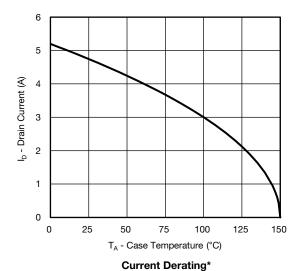


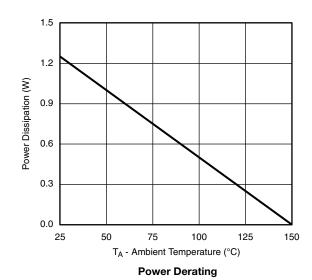
Single Pulse Power, Junction-to-Ambient



Safe Operating Area, Junction-to-Ambient



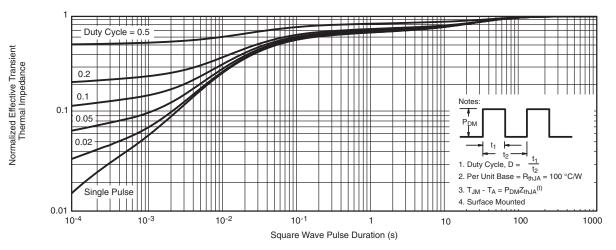




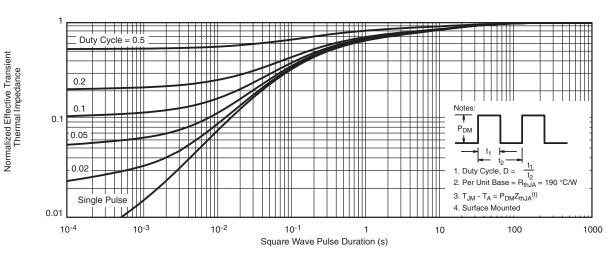
#### Note

- When mounted on 1" x 1" FR4 with full copper.
- \* The power dissipation P<sub>D</sub> is based on T<sub>J (max.)</sub> = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.





Normalized Thermal Transient Impedance, Junction-to-Ambient (1" x 1" FR4 Board with Full Copper)

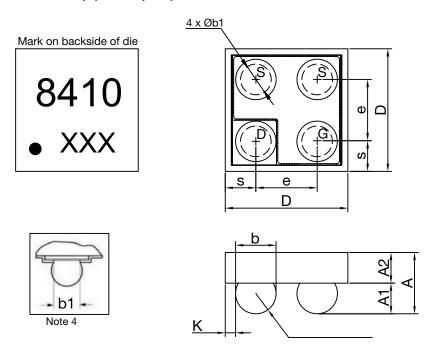


Normalized Thermal Transient Impedance, Junction-to-Ambient (1" x 1" FR4 Board with Minimum Copper)



### **PACKAGE OUTLINE**

### MICRO FOOT 1 mm x 1 mm: 4-Bump (0.5 mm pitch)



#### **Notes**

- (1) Laser mark on the backside surface of die.
- (2) Bumps are 95.5 % Sn, 3.8 % Ag, 0.7 % Cu.
- (3) is location of pin 1.
- (4) "b1" is the diameter of the solderable substrate surface, defined by an opening in the solder resist layer solder mask defined.
- (5) Non-solder mask defined copper landing pad.

| DIMENSION - | MILLIMETERS a |         |         | INCHES  |         |         |  |
|-------------|---------------|---------|---------|---------|---------|---------|--|
|             | MINIMUM       | NOMINAL | MAXIMUM | MINIMUM | NOMINAL | MAXIMUM |  |
| Α           | 0.460         | 0.500   | 0.540   | 0.0181  | 0.0196  | 0.0212  |  |
| A1          | 0.214         | 0.250   | 0.286   | 0.0084  | 0.0098  | 0.0112  |  |
| A2          | 0.244         | 0.254   | 0.264   | 0.0096  | 0.0100  | 0.0104  |  |
| b           | 0.297         | 0.330   | 0.363   | 0.0116  | 0.0129  | 0.0142  |  |
| b1          | 0.250         |         |         | 0.0098  |         |         |  |
| е           | 0.500         |         |         | 0.0197  |         |         |  |
| S           | 0.210         | 0.230   | 0.250   | 0.0008  | 0.0090  | 0.0098  |  |
| D           | 0.920         | 0.960   | 1.000   | 0.0362  | 0.0377  | 0.0393  |  |
| K           | 0.028         | 0.065   | 0.101   | 0.0011  | 0.0025  | 0.0039  |  |

#### Note

a. Use millimeters as the primary measurement.

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Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.

Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.

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Revision: 02-Oct-12 Document Number: 91000

## **ПОСТАВКА** ЭЛЕКТРОННЫХ КОМПОНЕНТОВ

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001 Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

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