

# Automotive N-Channel 40 V (D-S) 175 °C MOSFET



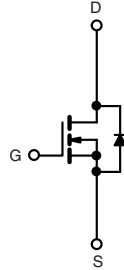
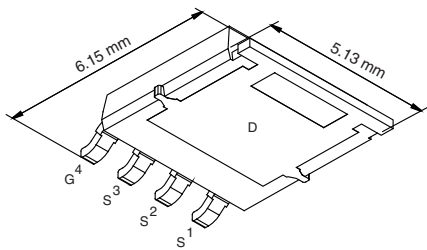
**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

| PRODUCT SUMMARY                               |        |
|---|--------|
| $V_{DS}$ (V)                                  | 40     |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 10$ V  | 0.0041 |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 4.5$ V | 0.0052 |
| $I_D$ (A)                                     | 32     |
| Configuration                                 | Single |

## FEATURES

- TrenchFET® Power MOSFET
- AEC-Q101 Qualified<sup>d</sup>
- 100 %  $R_g$  and UIS Tested
- Material categorization:  
For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

PowerPAK® SO-8L Single



N-Channel MOSFET

| ORDERING INFORMATION            |                 |
|---------------------------------|-----------------|
| Package                         | PowerPAK SO-8L  |
| Lead (Pb)-free and Halogen-free | SQJ412EP-T1-GE3 |

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                |                |      |
|---|----------------|----------------|------|
| PARAMETER   | SYMBOL         | LIMIT          | UNIT |
| Drain-Source Voltage  | $V_{DS}$       | 40             | V    |
| Gate-Source Voltage   | $V_{GS}$       | $\pm 20$       |      |
| Continuous Drain Current <sup>a</sup>                             | $I_D$          | $T_C = 25$ °C  | 32   |
|   |                | $T_C = 125$ °C | 32   |
| Continuous Source Current (Diode Conduction) <sup>a</sup>         | $I_S$          | 32             | A    |
| Pulsed Drain Current <sup>b</sup>                                 | $I_{DM}$       | 128            |      |
| Single Pulse Avalanche Current                                    | $L = 0.1$ mH   | $I_{AS}$       | 53   |
| Single Pulse Avalanche Energy                                     |                | $E_{AS}$       | 140  |
| Maximum Power Dissipation <sup>b</sup>                            | $P_D$          | $T_C = 25$ °C  | 83   |
|   |                | $T_C = 125$ °C | 27   |
| Operating Junction and Storage Temperature Range                  | $T_J, T_{stg}$ | - 55 to + 175  | °C   |
| Soldering Recommendations (Peak Temperature) <sup>e, f</sup>      |                | 260            |      |

| THERMAL RESISTANCE RATINGS |            |       |      |
|----------------------------|------------|-------|------|
| PARAMETER                  | SYMBOL     | LIMIT | UNIT |
| Junction-to-Ambient        | $R_{thJA}$ | 65    | °C/W |
| Junction-to-Case (Drain)   |            |       |      |

## Notes

- Package limited.
- Pulse test; pulse width  $\leq 300$   $\mu$ s, duty cycle  $\leq 2$  %.
- When mounted on 1" square PCB (FR-4 material).
- Parametric verification ongoing.
- See Solder Profile ([www.vishay.com/doc?73257](http://www.vishay.com/doc?73257)). The PowerPAK SO-8L. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper tip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection.
- Rework conditions: manual soldering with a soldering iron is not recommended for leadless components.



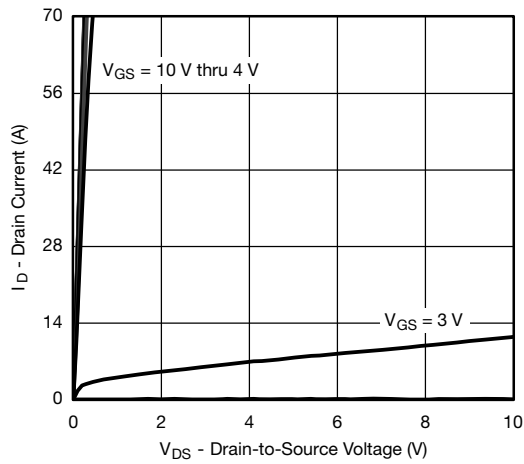
| <b>SPECIFICATIONS</b> ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted) |              |   |   |      |        |           |               |
|--|--------------|---|---|------|--------|-----------|---------------|
| PARAMETER  | SYMBOL       | TEST CONDITIONS   |   | MIN. | TYP.   | MAX.      | UNIT          |
| <b>Static</b>  |              |   |   |      |        |           |               |
| Drain-Source Breakdown Voltage   | $V_{DS}$     | $V_{GS} = 0, I_D = 250\text{ }\mu\text{A}$  |   | 40   | -      | -         | V             |
| Gate-Source Threshold Voltage  | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$   |   | 1.5  | 2.0    | 2.5       |               |
| Gate-Source Leakage  | $I_{GSS}$    | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$   |   | -    | -      | $\pm 100$ | nA            |
| Zero Gate Voltage Drain Current  | $I_{DSS}$    | $V_{GS} = 0\text{ V}$   | $V_{DS} = 40\text{ V}$                                  | -    | -      | 1         | $\mu\text{A}$ |
|  |              | $V_{GS} = 0\text{ V}$   | $V_{DS} = 40\text{ V}, T_J = 125\text{ }^\circ\text{C}$ | -    | -      | 50        |               |
|  |              | $V_{GS} = 0\text{ V}$   | $V_{DS} = 40\text{ V}, T_J = 175\text{ }^\circ\text{C}$ | -    | -      | 150       |               |
| On-State Drain Current <sup>a</sup>  | $I_{D(on)}$  | $V_{GS} = 10\text{ V}$  | $V_{DS} \geq 5\text{ V}$                                | 30   | -      | -         | A             |
| Drain-Source On-State Resistance <sup>a</sup>                                      | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}$  | $I_D = 10.3\text{ A}$                                   | -    | 0.0035 | 0.0041    | $\Omega$      |
|  |              | $V_{GS} = 10\text{ V}$  | $I_D = 10.3\text{ A}, T_J = 125\text{ }^\circ\text{C}$  | -    | 0.0053 | 0.0070    |               |
|  |              | $V_{GS} = 10\text{ V}$  | $I_D = 10.3\text{ A}, T_J = 175\text{ }^\circ\text{C}$  | -    | 0.0065 | 0.0085    |               |
|  |              | $V_{GS} = 4.5\text{ V}$   | $I_D = 8.7\text{ A}$                                    | -    | 0.0042 | 0.0052    |               |
| Forward Transconductance <sup>b</sup>  | $g_{fs}$     | $V_{DS} = 15\text{ V}, I_D = 16\text{ A}$   |   | -    | 85     | -         | S             |
| <b>Dynamic<sup>b</sup></b>   |              |   |   |      |        |           |               |
| Input Capacitance  | $C_{iss}$    | $V_{GS} = 0\text{ V}$   | $V_{DS} = 20\text{ V}, f = 1\text{ MHz}$                | -    | 4950   | 5950      | $\mu\text{F}$ |
| Output Capacitance   | $C_{oss}$    |   |   | -    | 630    | 760       |               |
| Reverse Transfer Capacitance   | $C_{rss}$    |   |   | -    | 270    | 330       |               |
| Total Gate Charge <sup>c</sup>   | $Q_g$        | $V_{GS} = 10\text{ V}$  | $V_{DS} = 20\text{ V}, I_D = 10\text{ A}$               | -    | 80     | 120       | nC            |
| Gate-Source Charge <sup>c</sup>  | $Q_{gs}$     |   |   | -    | 13.1   | -         |               |
| Gate-Drain Charge <sup>c</sup>   | $Q_{gd}$     |   |   | -    | 12.3   | -         |               |
| Gate Resistance  | $R_g$        | f = 1 MHz   |   | 0.36 | 0.72   | 1.08      | $\Omega$      |
| Turn-On Delay Time <sup>c</sup>  | $t_{d(on)}$  | $V_{DD} = 20\text{ V}, R_L = 2\text{ }\Omega$<br>$I_D \cong 10\text{ A}, V_{GEN} = 4.5\text{ V}, R_g = 6\text{ }\Omega$ |   | -    | 45     | 55        | ns            |
| Rise Time <sup>c</sup>   | $t_r$        |   |   | -    | 150    | 180       |               |
| Turn-Off Delay Time <sup>c</sup>   | $t_{d(off)}$ |   |   | -    | 50     | 60        |               |
| Fall Time <sup>c</sup>   | $t_f$        |   |   | -    | 55     | 70        |               |
| <b>Source-Drain Diode Ratings and Characteristics<sup>b</sup></b>                  |              |   |   |      |        |           |               |
| Pulsed Current <sup>a</sup>  | $I_{SM}$     |   |   | -    | -      | 128       | A             |
| Forward Voltage  | $V_{SD}$     | $I_F = 10\text{ A}, V_{GS} = 0$   |   | -    | 0.8    | 1.1       | V             |

**Notes**

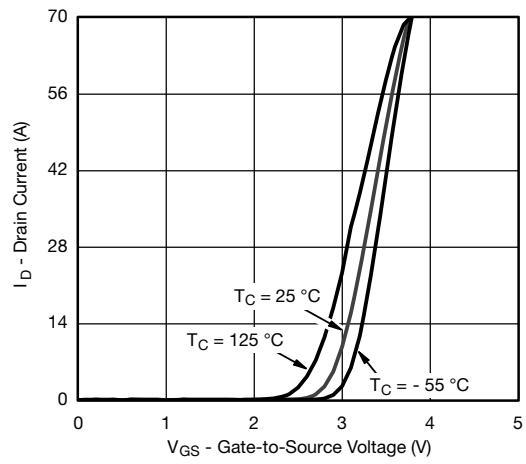
- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- b. Guaranteed by design, not subject to production testing.
- c. Independent of operating temperature.

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.

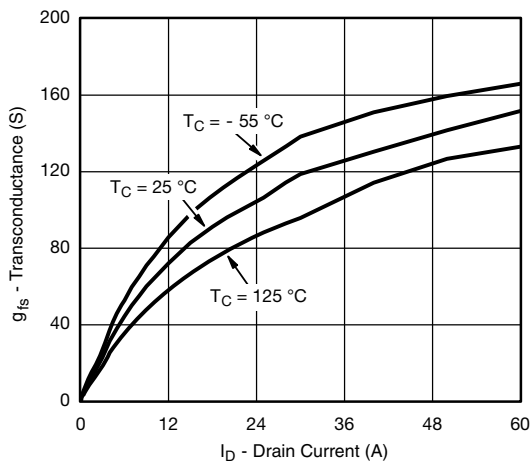
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



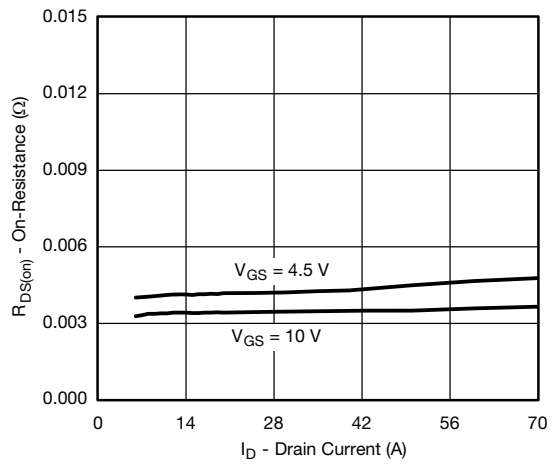
**Output Characteristics**



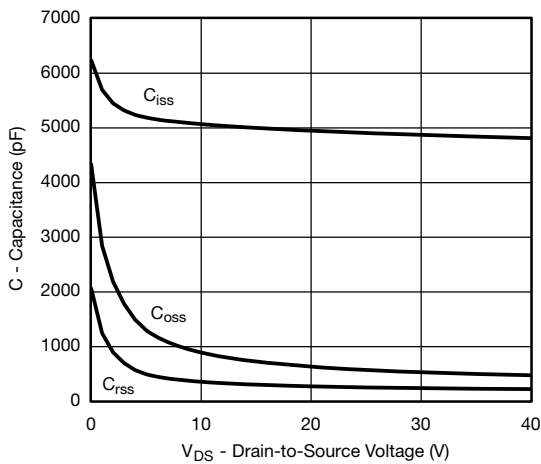
**Transfer Characteristics**



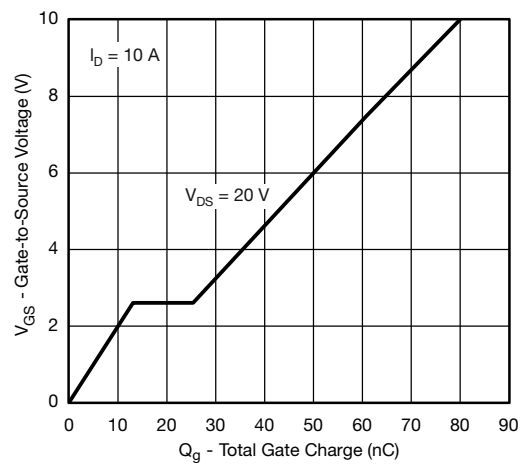
**Transconductance**



**On-Resistance vs. Drain Current**



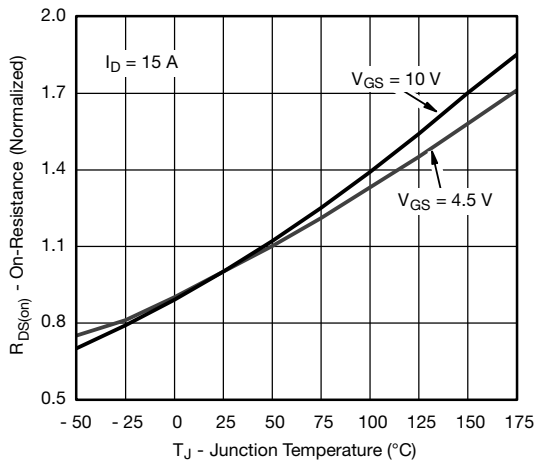
**Capacitance**



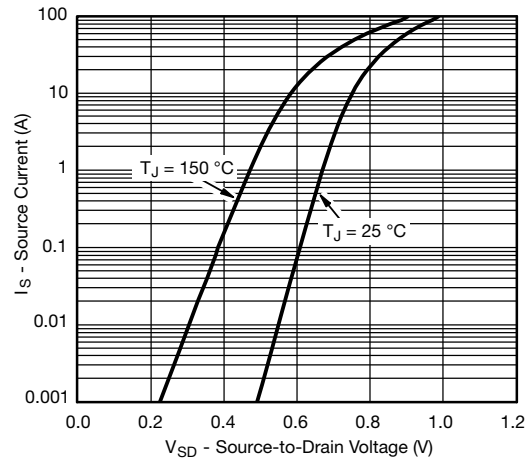
**Gate Charge**



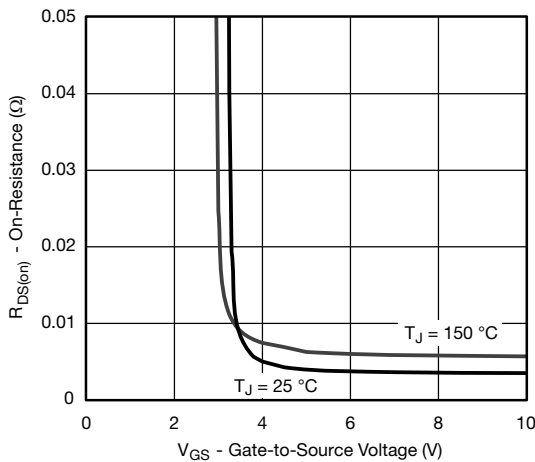
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



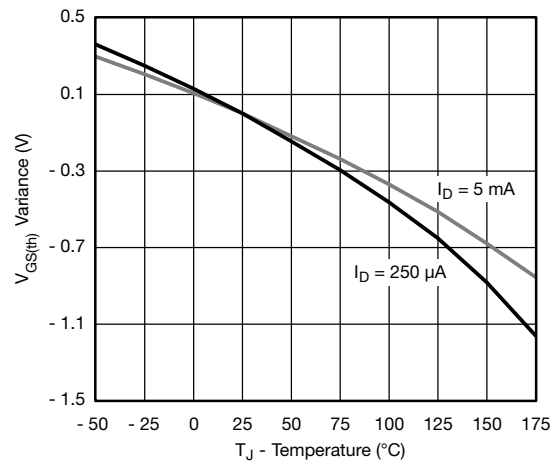
**On-Resistance vs. Junction Temperature**



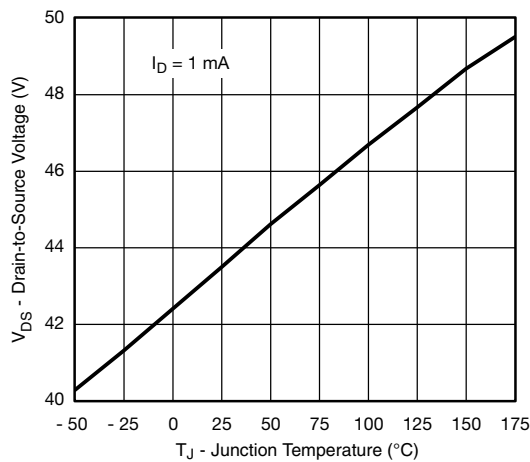
**Source Drain Diode Forward Voltage**



**On-Resistance vs. Gate-to-Source Voltage**



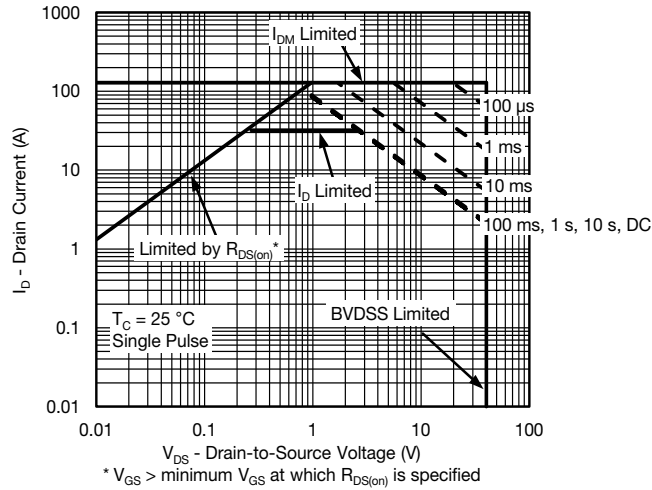
**Threshold Voltage**



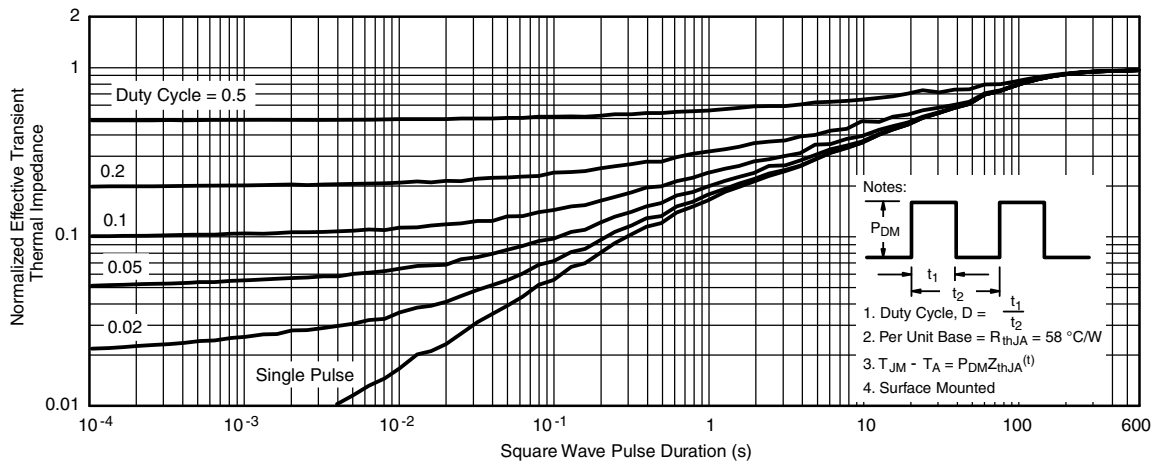
**Drain Source Breakdown vs. Junction Temperature**



**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



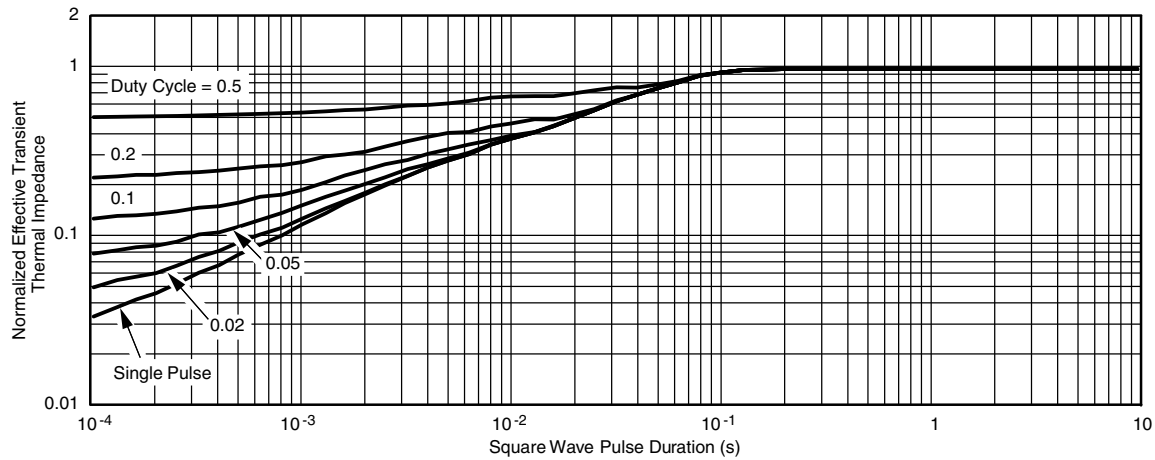
**Safe Operating Area**



**Normalized Thermal Transient Impedance, Junction-to-Ambient**



**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



**Normalized Thermal Transient Impedance, Junction-to-Case**

**Note**

- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient (25 °C)
  - Normalized Transient Thermal Impedance Junction-to-Case (25 °C)
 are given for general guidelines only to enable the user to get a “ball park” indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions.

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?65935](http://www.vishay.com/ppg?65935).



## PowerPAK® SO-8L

Ordering codes for the SQ rugged series power MOSFETs in the PowerPAK SO-8L package:

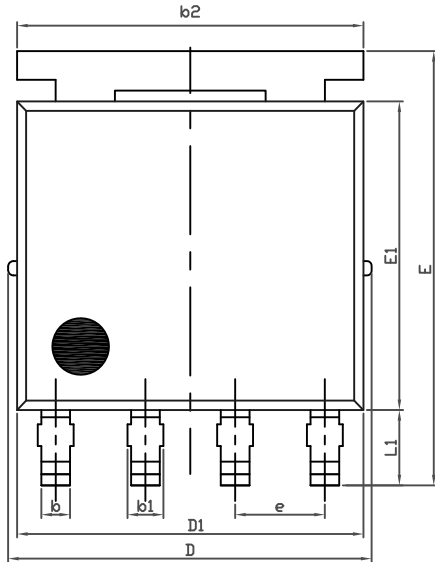
| DATASHEET PART NUMBER | OLD ORDERING CODE <sup>a</sup> | NEW ORDERING CODE |
|-----------------------|--------------------------------|-------------------|
| SQJ200EP              | -                              | SQJ200EP-T1_GE3   |
| SQJ401EP              | SQJ401EP-T1-GE3                | SQJ401EP-T1_GE3   |
| SQJ402EP              | SQJ402EP-T1-GE3                | SQJ402EP-T1_GE3   |
| SQJ403EEP             | SQJ403EEP-T1-GE3               | SQJ403EEP-T1_GE3  |
| SQJ403EP              | -                              | SQJ403EP-T1_GE3   |
| SQJ410EP              | SQJ410EP-T1-GE3                | SQJ410EP-T1_GE3   |
| SQJ412EP              | SQJ412EP-T1-GE3                | SQJ412EP-T1_GE3   |
| SQJ422EP              | SQJ422EP-T1-GE3                | SQJ422EP-T1_GE3   |
| SQJ431EP              | SQJ431EP-T1-GE3                | SQJ431EP-T1_GE3   |
| SQJ443EP              | SQJ443EP-T1-GE3                | SQJ443EP-T1_GE3   |
| SQJ456EP              | SQJ456EP-T1-GE3                | SQJ456EP-T1_GE3   |
| SQJ460AEP             | -                              | SQJ460AEP-T1_GE3  |
| SQJ461EP              | SQJ461EP-T1-GE3                | SQJ461EP-T1_GE3   |
| SQJ463EP              | SQJ463EP-T1-GE3                | SQJ463EP-T1_GE3   |
| SQJ465EP              | SQJ465EP-T1-GE3                | SQJ465EP-T1_GE3   |
| SQJ469EP              | SQJ469EP-T1-GE3                | SQJ469EP-T1_GE3   |
| SQJ486EP              | SQJ486EP-T1-GE3                | SQJ486EP-T1_GE3   |
| SQJ488EP              | SQJ488EP-T1-GE3                | SQJ488EP-T1_GE3   |
| SQJ500AEP             | SQJ500AEP-T1-GE3               | SQJ500AEP-T1_GE3  |
| SQJ840EP              | SQJ840EP-T1-GE3                | SQJ840EP-T1_GE3   |
| SQJ844AEP             | SQJ844AEP-T1-GE3               | SQJ844AEP-T1_GE3  |
| SQJ850EP              | SQJ850EP-T1-GE3                | SQJ850EP-T1_GE3   |
| SQJ858AEP             | SQJ858AEP-T1-GE3               | SQJ858AEP-T1_GE3  |
| SQJ886EP              | SQJ886EP-T1-GE3                | SQJ886EP-T1_GE3   |
| SQJ910AEP             | SQJ910AEP-T1-GE3               | SQJ910AEP-T1_GE3  |
| SQJ912AEP             | SQJ912AEP-T1-GE3               | SQJ912AEP-T1_GE3  |
| SQJ940EP              | SQJ940EP-T1-GE3                | SQJ940EP-T1_GE3   |
| SQJ942EP              | SQJ942EP-T1-GE3                | SQJ942EP-T1_GE3   |
| SQJ951EP              | SQJ951EP-T1-GE3                | SQJ951EP-T1_GE3   |
| SQJ952EP              | -                              | SQJ952EP-T1_GE3   |
| SQJ960EP              | SQJ960EP-T1-GE3                | SQJ960EP-T1_GE3   |
| SQJ963EP              | SQJ963EP-T1-GE3                | SQJ963EP-T1_GE3   |
| SQJ968EP              | SQJ968EP-T1-GE3                | SQJ968EP-T1_GE3   |
| SQJ980AEP             | SQJ980AEP-T1-GE3               | SQJ980AEP-T1_GE3  |
| SQJ992EP              | SQJ992EP-T1-GE3                | SQJ992EP-T1_GE3   |

**Note**

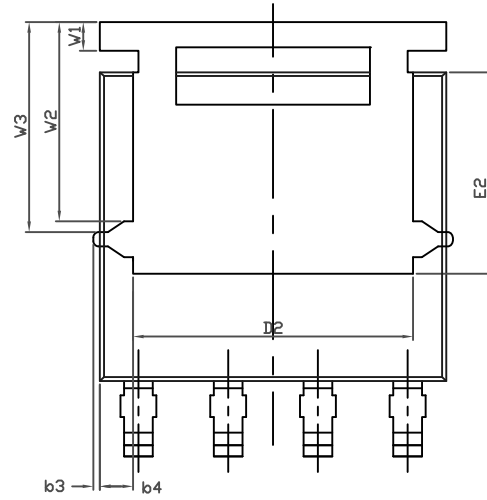
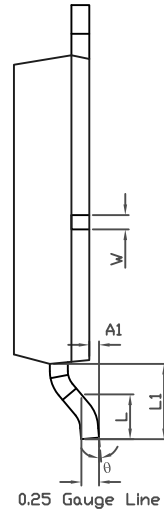
a. Old ordering code is obsolete and no longer valid for new orders



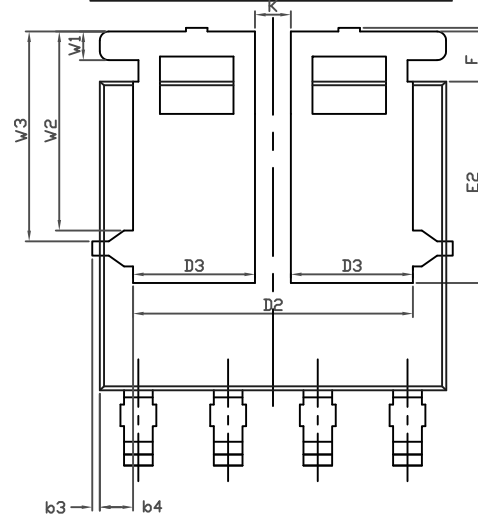
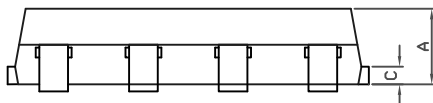
# PowerPAK® SO-8L Case Outline for Non-AI Parts



TOPSIDE VIEW



BACKSIDE VIEW(SINGLE)



BACKSIDE VIEW(DUAL)





| DIM. | MILLIMETERS |      |       | INCHES    |       |       |
|------|-------------|------|-------|-----------|-------|-------|
|      | MIN.        | NOM. | MAX.  | MIN.      | NOM.  | MAX.  |
| A    | 1.00        | 1.07 | 1.14  | 0.039     | 0.042 | 0.045 |
| A1   | 0.00        | -    | 0.127 | 0.00      | -     | 0.005 |
| b    | 0.33        | 0.41 | 0.48  | 0.013     | 0.016 | 0.019 |
| b1   | 0.44        | 0.51 | 0.58  | 0.017     | 0.020 | 0.023 |
| b2   | 4.80        | 4.90 | 5.00  | 0.189     | 0.193 | 0.197 |
| b3   | 0.094       |      |       | 0.004     |       |       |
| b4   | 0.47        |      |       | 0.019     |       |       |
| c    | 0.20        | 0.25 | 0.30  | 0.008     | 0.010 | 0.012 |
| D    | 5.00        | 5.13 | 5.25  | 0.197     | 0.202 | 0.207 |
| D1   | 4.80        | 4.90 | 5.00  | 0.189     | 0.193 | 0.197 |
| D2   | 3.86        | 3.96 | 4.06  | 0.152     | 0.156 | 0.160 |
| D3   | 1.63        | 1.73 | 1.83  | 0.064     | 0.068 | 0.072 |
| e    | 1.27 BSC    |      |       | 0.050 BSC |       |       |
| E    | 6.05        | 6.15 | 6.25  | 0.238     | 0.242 | 0.246 |
| E1   | 4.27        | 4.37 | 4.47  | 0.168     | 0.172 | 0.176 |
| E2   | 3.18        | 3.28 | 3.38  | 0.125     | 0.129 | 0.133 |
| F    | -           | -    | 0.15  | -         | -     | 0.006 |
| L    | 0.62        | 0.72 | 0.82  | 0.024     | 0.028 | 0.032 |
| L1   | 0.92        | 1.07 | 1.22  | 0.036     | 0.042 | 0.048 |
| K    | 0.51        |      |       | 0.020     |       |       |
| W    | 0.23        |      |       | 0.009     |       |       |
| W1   | 0.41        |      |       | 0.016     |       |       |
| W2   | 2.82        |      |       | 0.111     |       |       |
| W3   | 2.96        |      |       | 0.117     |       |       |
| q    | 0°          | -    | 10°   | 0°        | -     | 10°   |

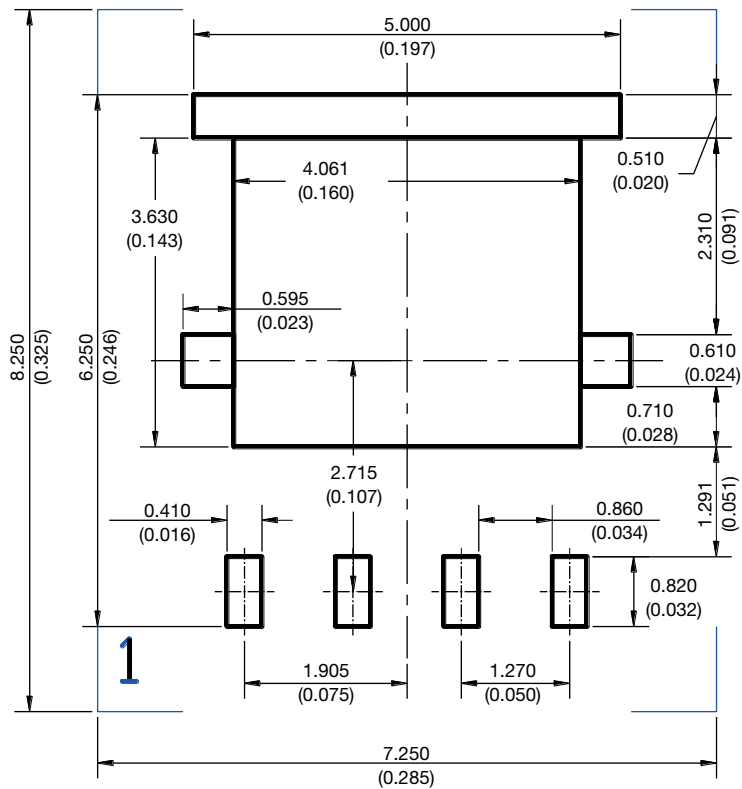
ECN: C15-1122-Rev. C, 07-Sep-15  
 DWG: 5976

**Note**

- Millimeters will govern



## RECOMMENDED MINIMUM PAD FOR PowerPAK® SO-8L SINGLE



Recommended Minimum Pads  
Dimensions in mm (inches)



## Disclaimer

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## Material Category Policy

**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.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**