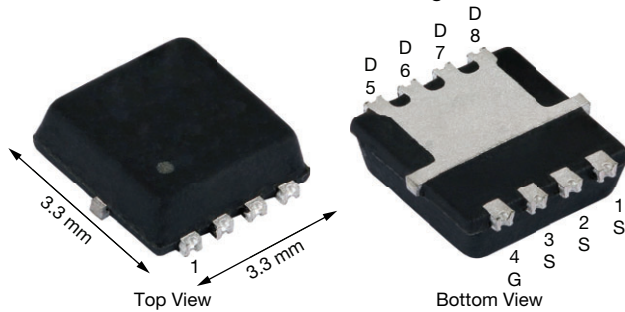


# Automotive N-Channel 60 V (D-S) 175 °C MOSFET

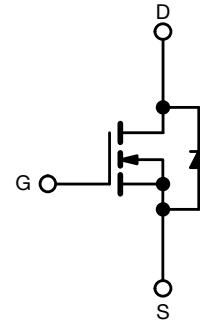
**PowerPAK® 1212-8W Single**

**Marking code: Q056**

| PRODUCT SUMMARY                               |                  |
|---|------------------|
| $V_{DS}$ (V)                                  | 60               |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 10$ V  | 0.0300           |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 4.5$ V | 0.0410           |
| $I_D$ (A)                                     | 8                |
| Configuration                                 | Single           |
| Package                                       | PowerPAK 1212-8W |

**FEATURES**

- TrenchFET® power MOSFET
- AEC-Q101 qualified
- 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)

 AUTOMOTIVE  
GRADE

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


N-Channel MOSFET

| ORDERING INFORMATION            |                  |
|---------------------------------|------------------|
| Package                         | PowerPAK 1212-8W |
| Lead (Pb)-free and halogen-free | SQS460CENW       |

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                |                |          |
|---|----------------|----------------|----------|
| PARAMETER   | SYMBOL         | LIMIT          | UNIT     |
| Drain-source voltage  | $V_{DS}$       | 60             | V        |
| Gate-source voltage   | $V_{GS}$       | $\pm 20$       |          |
| Continuous drain current <sup>a</sup>                             | $I_D$          | $T_C = 25$ °C  | 8        |
|   |                | $T_C = 125$ °C | 8        |
| Continuous source current (diode conduction) <sup>a</sup>         | $I_S$          | 8              | A        |
| Pulsed drain current <sup>b</sup>                                 | $I_{DM}$       | 32             |          |
| Single pulse avalanche current                                    | $I_{AS}$       | L = 0.1 mH     | 13.5     |
| Single pulse avalanche energy                                     |                |                | $E_{AS}$ |
| Maximum power dissipation   | $P_D$          | $T_C = 25$ °C  | 27       |
|   |                | $T_C = 125$ °C | 9        |
| Operating junction and storage temperature range                  | $T_J, T_{stg}$ | -55 to +175    | °C       |
| Soldering recommendations (peak temperature) <sup>d, e</sup>      |                | 260            |          |

| THERMAL RESISTANCE RATINGS |            |       |      |
|----------------------------|------------|-------|------|
| PARAMETER                  | SYMBOL     | LIMIT | UNIT |
| Junction-to-ambient        | $R_{thJA}$ | 81    | °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 (FR4 material)
- See solder profile ([www.vishay.com/doc?73257](http://www.vishay.com/doc?73257)). The PowerPAK1212-8W package may have visible exposed Cu at the end of the lead terminals due to the singulation process. However, the leads also have plated indents on the top and bottom surfaces that promote the formation of a solder fillet compatible with automated optical inspection methods
- Rework conditions: manual soldering with a soldering iron is not recommended



| SPECIFICATIONS (T <sub>C</sub> = 25 °C, unless otherwise noted)   |                      |  |      |        |        |      |
|---|----------------------|--|------|--------|--------|------|
| PARAMETER   | SYMBOL               | TEST CONDITIONS  | MIN. | TYP.   | MAX.   | UNIT |
| <b>Static</b>   |                      |  |      |        |        |      |
| Drain-source breakdown voltage                                    | V <sub>DS</sub>      | V <sub>GS</sub> = 0, I <sub>D</sub> = 250 μA   | 60   | -      | -      | V    |
| Gate-source threshold voltage                                     | V <sub>GS(th)</sub>  | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA  | 1.5  | 2.0    | 2.5    |      |
| Gate-source leakage   | I <sub>GSS</sub>     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V  | -    | -      | ± 100  | nA   |
| Zero gate voltage drain current                                   | I <sub>DSS</sub>     | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 60 V  | -    | -      | 1      | μA   |
|   |                      | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 60 V, T <sub>J</sub> = 125 °C   | -    | -      | 50     |      |
|   |                      | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 60 V, T <sub>J</sub> = 175 °C   | -    | -      | 150    |      |
| On-state drain current <sup>a</sup>                               | I <sub>D(on)</sub>   | V <sub>GS</sub> = 10 V, V <sub>DS</sub> ≥ 5 V  | 20   | -      | -      | A    |
| Drain-source on-state resistance <sup>a</sup>                     | R <sub>DS(on)</sub>  | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 5.3 A   | -    | 0.0240 | 0.0300 | Ω    |
|   |                      | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 5.3 A, T <sub>J</sub> = 125 °C  | -    | -      | 0.0480 |      |
|   |                      | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 5.3 A, T <sub>J</sub> = 175 °C  | -    | -      | 0.0590 |      |
|   |                      | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 4 A  | -    | 0.0330 | 0.0410 |      |
| Forward transconductance <sup>b</sup>                             | g <sub>fs</sub>      | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 5.3 A   | -    | 19     | -      | S    |
| <b>Dynamic <sup>b</sup></b>                                       |                      |  |      |        |        |      |
| Input capacitance   | C <sub>iss</sub>     | V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 25 V, f = 1 MHz   | -    | 493    | 580    | pF   |
| Output capacitance  | C <sub>oss</sub>     |  | -    | 226    | 290    |      |
| Reverse transfer capacitance                                      | C <sub>rss</sub>     |  | -    | 13     | 20     |      |
| Total gate charge <sup>c</sup>                                    | Q <sub>g</sub>       | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 30 V, I <sub>D</sub> = 4.5 A   | -    | 7.2    | 11     | nC   |
| Gate-source charge <sup>c</sup>                                   | Q <sub>gs</sub>      |  | -    | 2.15   | -      |      |
| Gate-drain charge <sup>c</sup>                                    | Q <sub>gd</sub>      |  | -    | 0.55   | -      |      |
| Gate resistance   | R <sub>g</sub>       | f = 1 MHz  | 0.63 | 1.27   | 1.90   | Ω    |
| Turn-on delay time <sup>c</sup>                                   | t <sub>d(on)</sub>   | V <sub>DD</sub> = 30 V, R <sub>L</sub> = 30 Ω<br>I <sub>D</sub> ≅ 1 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω | -    | 9      | 14     | ns   |
| Rise time <sup>c</sup>  | t <sub>r</sub>       |  | -    | 3      | 5      |      |
| Turn-off delay time <sup>c</sup>                                  | t <sub>d(off)</sub>  |  | -    | 16     | 24     |      |
| Fall time <sup>c</sup>  | t <sub>f</sub>       |  | -    | 15     | 23     |      |
| <b>Source-Drain Diode Ratings and Characteristic <sup>b</sup></b> |                      |  |      |        |        |      |
| Pulsed current <sup>a</sup>                                       | I <sub>SM</sub>      |  | -    | -      | 32     | A    |
| Forward voltage   | V <sub>SD</sub>      | I <sub>F</sub> = 6 A, V <sub>GS</sub> = 0 V  | -    | 0.845  | 1.1    | V    |
| Body diode reverse recovery time                                  | t <sub>rr</sub>      | I <sub>F</sub> = 5 A, di/dt = 100 A/μs   | -    | 15     | 30     | ns   |
| Body diode reverse recovery charge                                | Q <sub>rr</sub>      |  | -    | 8      | 16     | nC   |
| Reverse recovery fall time  | t <sub>a</sub>       |  | -    | 9      | -      | ns   |
| Reverse recovery rise time  | t <sub>b</sub>       |  | -    | 6      | -      |      |
| Body diode peak reverse recovery current                          | I <sub>RM(REC)</sub> |  |      | -      | -1     | -    |

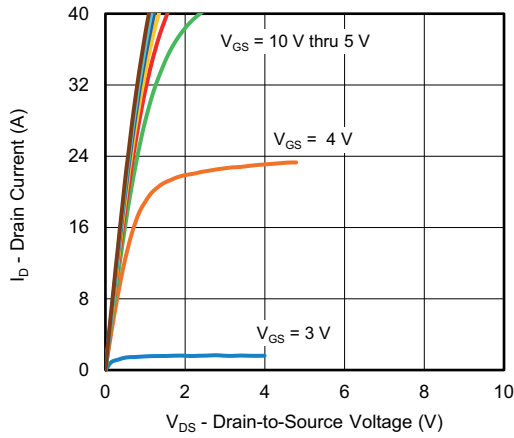
**Notes**

- a. Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %
- b. Guaranteed by design, not subject to production testing
- c. Independent of operating temperature

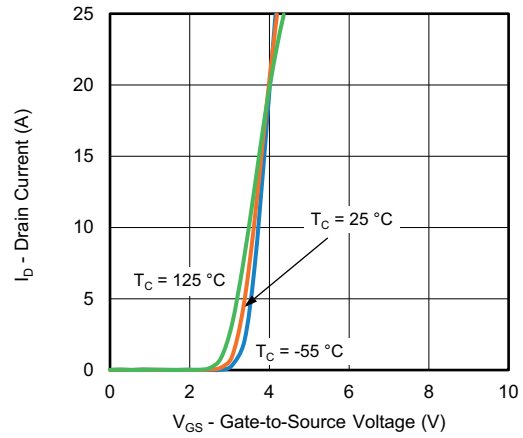
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



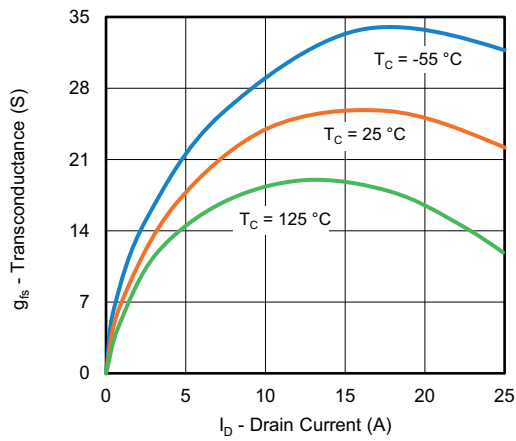
TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



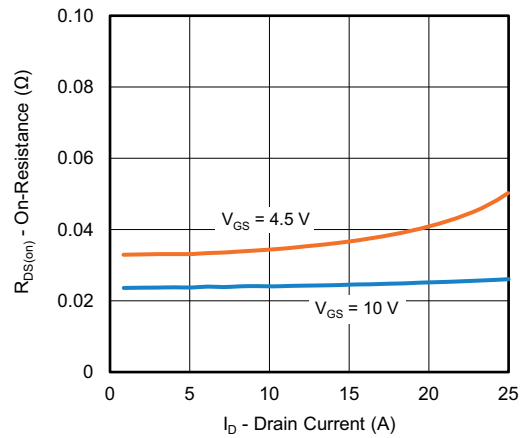
Output Characteristics



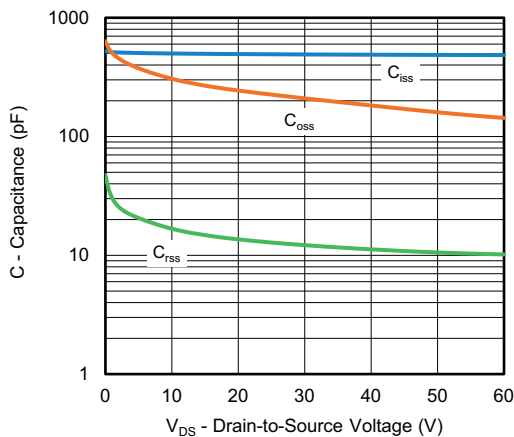
Transfer Characteristics



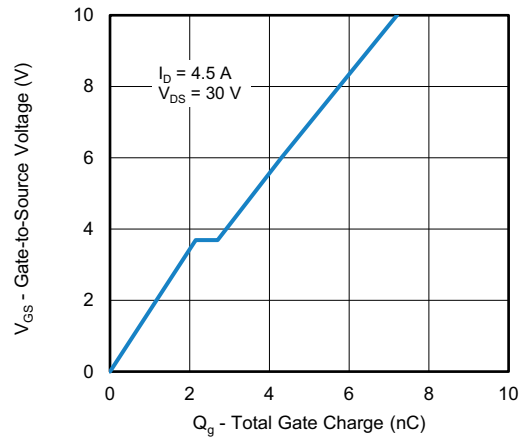
Transconductance



On-Resistance vs. Drain Current



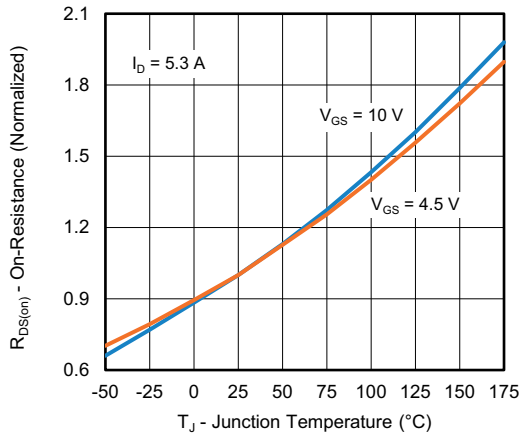
Capacitance



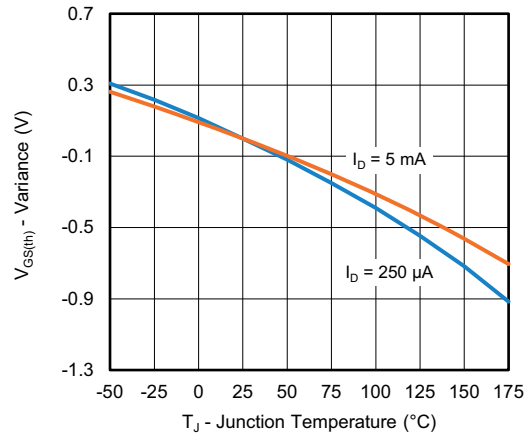
Gate Charge



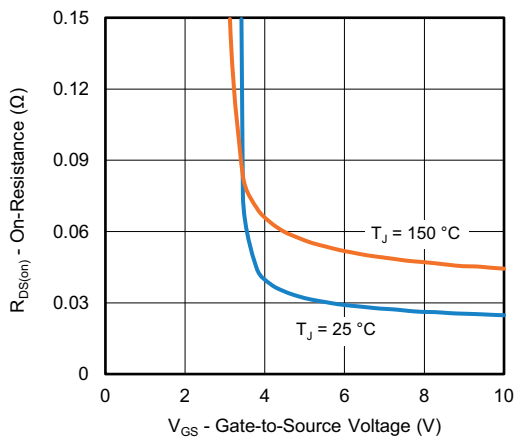
TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



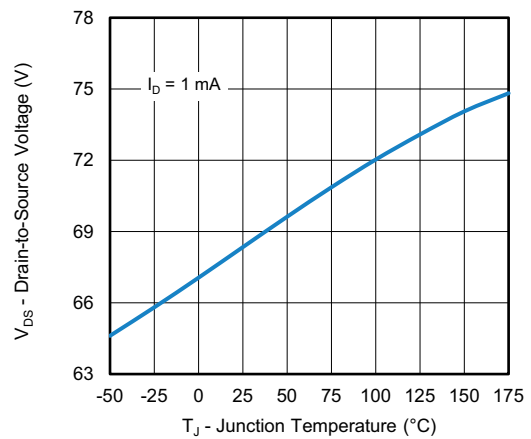
On-Resistance vs. Junction Temperature



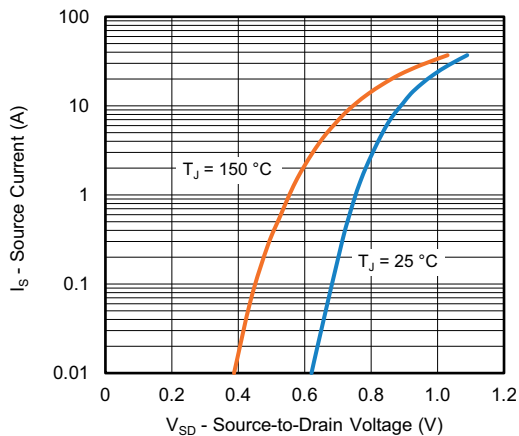
Threshold Voltage



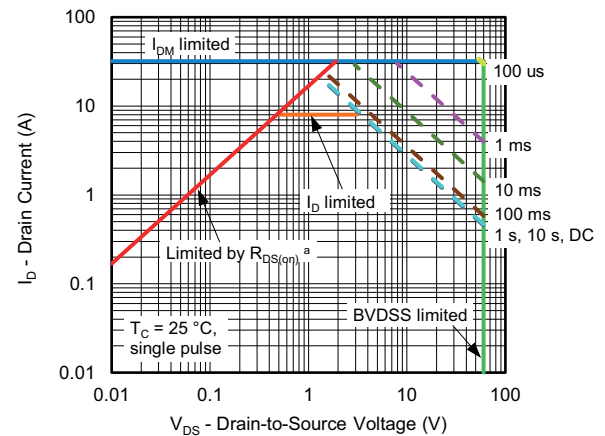
On-Resistance vs. Gate-to-Source Voltage



Drain Source Breakdown vs. Junction Temperature



Source Drain Diode Forward Voltage



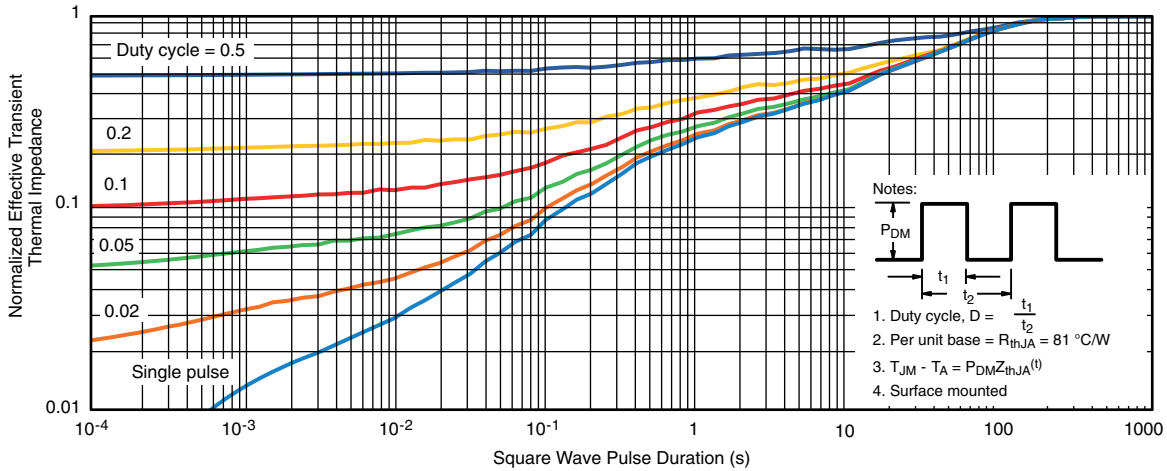
Safe Operating Area

Note

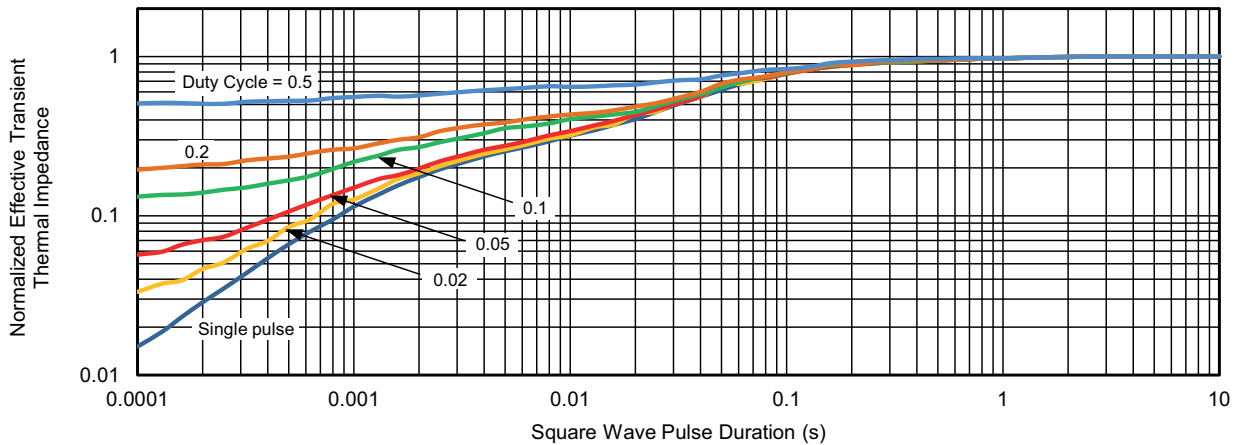
a. V<sub>GS</sub> > minimum V<sub>GS</sub> at which R<sub>DS(on)</sub> is specified



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



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



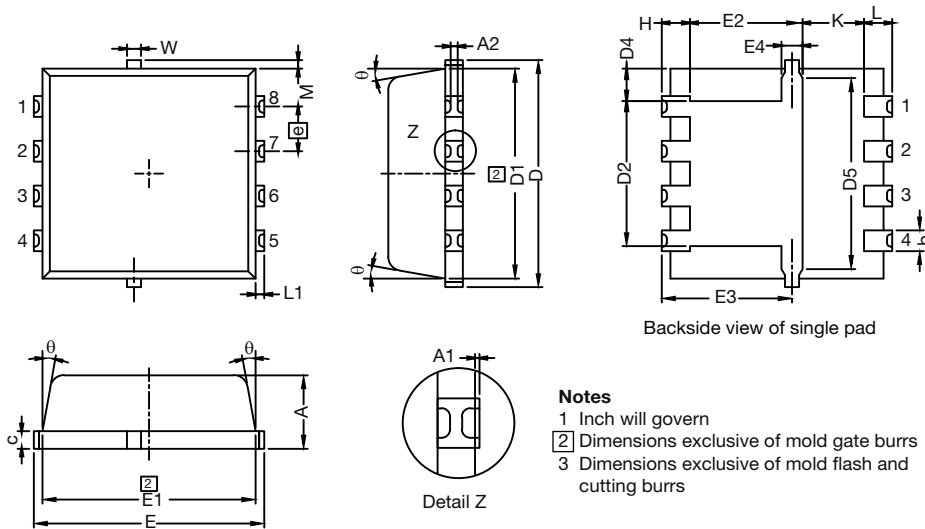
**Normalized Thermal Transient Impedance, Junction-to-Case**

**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

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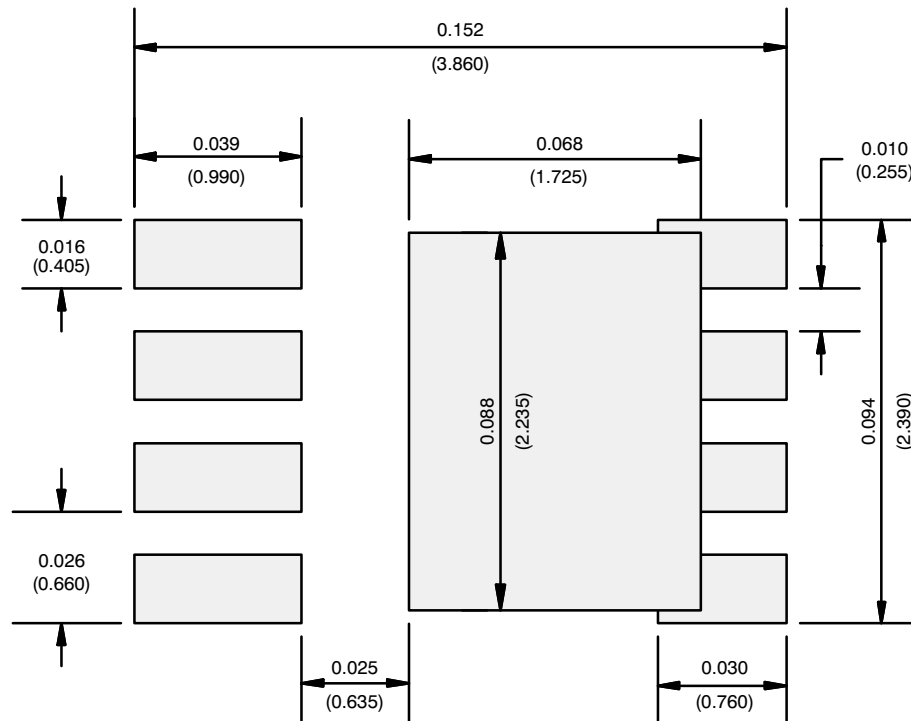
### PowerPAK® 1212-8W Case Outline



| DIM. | MILLIMETERS |      |      | INCHES      |       |       |
|------|-------------|------|------|-------------|-------|-------|
|      | MIN.        | NOM. | MAX. | MIN.        | NOM.  | MAX.  |
| A    | 0.97        | 1.04 | 1.12 | 0.038       | 0.041 | 0.044 |
| A1   | 0           | -    | 0.05 | 0           | -     | 0.002 |
| A2   | 0           | -    | 0.13 | 0           | -     | 0.005 |
| b    | 0.23        | 0.30 | 0.41 | 0.009       | 0.012 | 0.016 |
| c    | 0.23        | 0.28 | 0.33 | 0.009       | 0.011 | 0.013 |
| D    | 3.20        | 3.30 | 3.40 | 0.126       | 0.130 | 0.134 |
| D1   | 2.95        | 3.05 | 3.15 | 0.116       | 0.120 | 0.124 |
| D2   | 1.98        | 2.11 | 2.24 | 0.078       | 0.083 | 0.088 |
| D4   | 0.47 typ.   |      |      | 0.0185 typ. |       |       |
| D5   | 2.3 typ.    |      |      | 0.090 typ.  |       |       |
| E    | 3.20        | 3.30 | 3.40 | 0.126       | 0.130 | 0.134 |
| E1   | 2.95        | 3.05 | 3.15 | 0.116       | 0.120 | 0.124 |
| E2   | 1.47        | 1.60 | 1.73 | 0.058       | 0.063 | 0.068 |
| E3   | 1.75        | 1.85 | 1.98 | 0.069       | 0.073 | 0.078 |
| E4   | 0.34 typ.   |      |      | 0.013 typ.  |       |       |
| e    | 0.65 BSC.   |      |      | 0.026 BSC   |       |       |
| K    | 0.86 typ.   |      |      | 0.034 typ.  |       |       |
| H    | 0.30        | 0.41 | 0.51 | 0.012       | 0.016 | 0.020 |
| L    | 0.30        | 0.43 | 0.56 | 0.012       | 0.017 | 0.022 |
| L1   | 0.06        | 0.13 | 0.20 | 0.002       | 0.005 | 0.008 |
| θ    | 0°          | -    | 12°  | 0°          | -     | 12°   |
| W    | 0.15        | 0.25 | 0.36 | 0.006       | 0.010 | 0.014 |
| M    | 0.125 typ.  |      |      | 0.005 typ.  |       |       |

ECN: C15-1530-Rev. B, 16-Nov-15  
 DWG: 6032

## RECOMMENDED MINIMUM PADS FOR PowerPAK® 1212-8 Single



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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