# 40V +175°C P-CHANNEL ENHANCEMENT MODE MOSFET
## PowerDI5060-8

## Product Summary

| $BV_{DSS}$ | $R_{DS(ON)\ Max}$ | $I_D$ $T_C$ = +25°C |
|---|---|---|
| -40V | 13mΩ @ $V_{GS}$ = -10V | -69A |
| | 23mΩ @ $V_{GS}$ = -4.5V | -52A |

## Features and Benefits

- Rated to +175°C – Ideal for High Ambient Temperature Environments
- 100% Unclamped Inductive Switching (UIS) Test in Production – Ensures More Reliable and Robust End Application
- Low On-Resistance
- Fast Switching Speed
- **Lead-Free Finish; RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **An automotive-compliant part is available under separate datasheet (DMPH4013SPSWQ)**

## Description and Applications

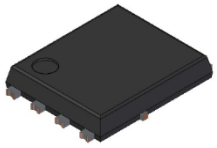
This new generation MOSFET has been designed to minimize the on-state resistance ($R_{DS(ON)}$) yet maintain superior switching performance, making it ideal for high-efficiency power-management applications.

- Reverse polarity protections
- BLDC motor controls
- Power-management functions

## Mechanical Data

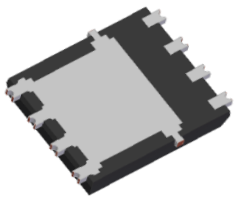
- Package: PowerDI®5060-8
- Package Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminal Connections: See Diagram
- Terminals: Finish – 100% Matte Tin Annealed over Copper Leadframe. Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.097 grams (Approximate)

PowerDI5060-8/SWP (Type UX)

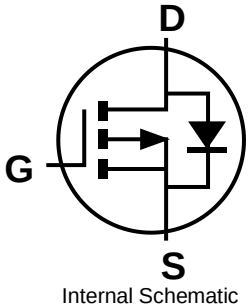


Top View

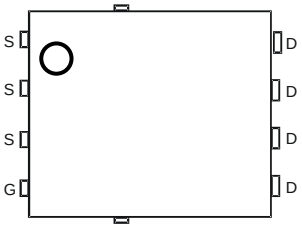
Pin1



Bottom View




Internal Schematic



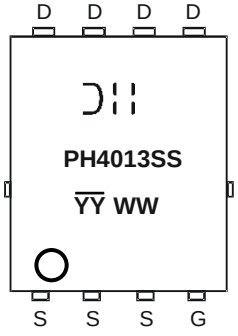

Top View
Pin Configuration

## Ordering Information (Note 4)

| Part Number | Package | Packing | |
|---|---|---|---|
| | | Qty. | Carrier |
| DMPH4013SPSW-13 | PowerDI5060-8/SWP (Type UX) | 2,500 | Tape & Reel |

Notes:
1. EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant. All applicable RoHS exemptions applied.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

## Marking Information




= Manufacturer's Marking
PH4013SS = Product Type Marking Code
YYWW = Date Code Marking
YY = Year (ex: 24 = 2024)
WW = Week (01 to 53)

## Maximum Ratings (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | | | Symbol | Value | Unit |
|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DSS}$ | -40 | V |
| Gate-Source Voltage | | | $V_{GSS}$ | ±20 | V |
| Continuous Drain Current, $V_{GS}$ = -10V (Note 7) | Steady State | $T_C$ = +25°C<br>$T_C$ = +100°C | $I_D$ | -69<br>-49 | A |
| Pulsed Drain Current (10µs Pulse, Duty Cycle = 1%) | | | $I_{DM}$ | -277 | A |
| Maximum Body Diode Continuous Current (Note 7) | | | $I_S$ | -69 | A |
| Pulsed Source Current (10µs Pulse, Duty Cycle = 1%) | | | $I_{SM}$ | -277 | A |
| Avalanche Current (Note 8) L = 1mH | | | $I_{AS}$ | -22 | A |
| Avalanche Energy (Note 8) L = 1mH | | | $E_{AS}$ | 260 | mJ |

## Thermal Characteristics (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | | Symbol | Value | Unit |
|---|---|---|---|---|
| Total Power Dissipation (Note 5) | $T_A$ = +25°C | $P_D$ | 1.5 | W |
| Thermal Resistance, Junction to Ambient (Note 5) | Steady State | $R_{\theta JA}$ | 98 | °C/W |
| Total Power Dissipation (Note 6) | $T_A$ = +25°C | $P_D$ | 3.3 | W |
| Thermal Resistance, Junction to Ambient (Note 6) | Steady State | $R_{\theta JA}$ | 45 | °C/W |
| Thermal Resistance, Junction to Case (Note 7) | | $R_{\theta JC}$ | 1.6 | °C/W |
| Operating and Storage Temperature Range | | $T_J$, $T_{STG}$ | -55 to +175 | °C |

## Electrical Characteristics (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | Symbol | Min | Typ | Max | Unit | Test Condition |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS (Note 9)** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | -40 | — | — | V | $V_{GS}$ = 0V, $I_D$ = -250µA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | — | — | -1 | µA | $V_{DS}$ = -40V, $V_{GS}$ = 0V |
| Gate-Source Leakage | $I_{GSS}$ | — | — | ±100 | nA | $V_{GS}$ = ±20V, $V_{DS}$ = 0V |
| **ON CHARACTERISTICS (Note 9)** | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | -1 | -1.8 | -3 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = -250µA |
| Static Drain-Source On-Resistance | $R_{DS(ON)}$ | — | 9 | 13 | mΩ | $V_{GS}$ = -10V, $I_D$ = -10A |
| | | — | 12.4 | 23 | | $V_{GS}$ = -4.5V, $I_D$ = -8A |
| Diode Forward Voltage | $V_{SD}$ | — | -0.70 | -1.2 | V | $V_{GS}$ = 0V, $I_S$ = -1A |
| **DYNAMIC CHARACTERISTICS (Note 10)** | | | | | | |
| Input Capacitance | $C_{iss}$ | — | 4763 | — | pF | $V_{DS}$ = -20V, $V_{GS}$ = 0V<br>f = 1MHz |
| Output Capacitance | $C_{oss}$ | — | 539 | — | | |
| Reverse Transfer Capacitance | $C_{rss}$ | — | 403 | — | | |
| Gate Resistance | $R_g$ | — | 7.4 | — | Ω | $V_{DS}$ = 0V, $V_{GS}$ = 0V, f = 1MHz |
| Total Gate Charge ($V_{GS}$ = -4.5V) | $Q_g$ | — | 39 | — | nC | $V_{DS}$ = -20V,<br>$I_D$ = -10A |
| Total Gate Charge ($V_{GS}$ = -10V) | $Q_g$ | — | 87 | — | | |
| Gate-Source Charge | $Q_{gs}$ | — | 12.5 | — | | |
| Gate-Drain Charge | $Q_{gd}$ | — | 15 | — | | |
| Turn-On Delay Time | $t_{D(ON)}$ | — | 6.2 | — | ns | $V_{GS}$ = -10V, $V_{DD}$ = -20V,<br>$R_G$ = 3Ω, $I_D$ = -10A |
| Turn-On Rise Time | $t_R$ | — | 4.8 | — | | |
| Turn-Off Delay Time | $t_{D(OFF)}$ | — | 126 | — | | |
| Turn-Off Fall Time | $t_F$ | — | 57 | — | | |
| Reverse Recovery Time | $t_{RR}$ | — | 27 | — | ns | $I_F$ = -10A, di/dt = -100A/µs |
| Reverse Recovery Charge | $Q_{RR}$ | — | 21 | — | nC | $I_F$ = -10A, di/dt = -100A/µs |

Notes:
5. Device mounted on FR-4 PC board, with minimum recommended pad layout, single sided.
6. Device mounted on FR-4 substrate PC board, 2oz copper, with thermal bias to bottom layer 1inch square copper plate.
7. Thermal resistance from junction to soldering point (on the exposed drain pad).
8. $I_{AS}$ and $E_{AS}$ ratings are based on low frequency and duty cycles to keep $T_J$ = +25°C.
9. Short duration pulse test used to minimize self-heating effect.
10. Guaranteed by design. Not subject to product testing.

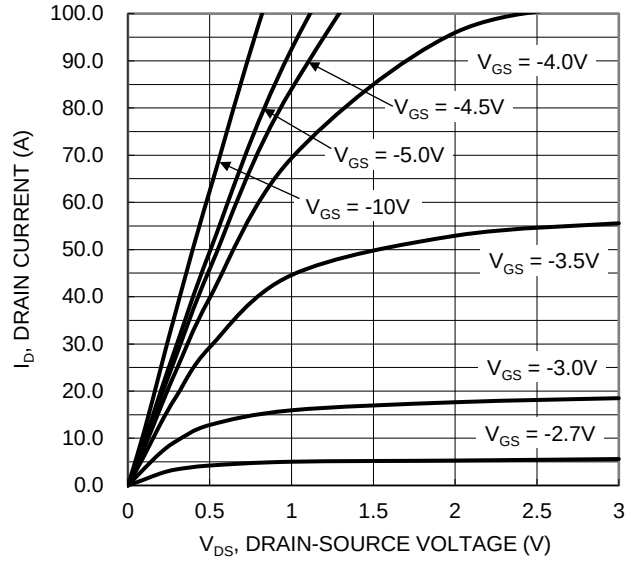



Figure 1. Typical Output Characteristic

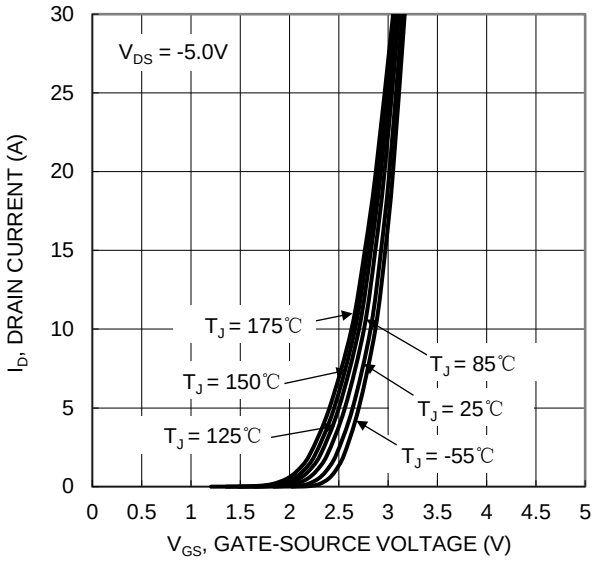



Figure 2. Typical Transfer Characteristic

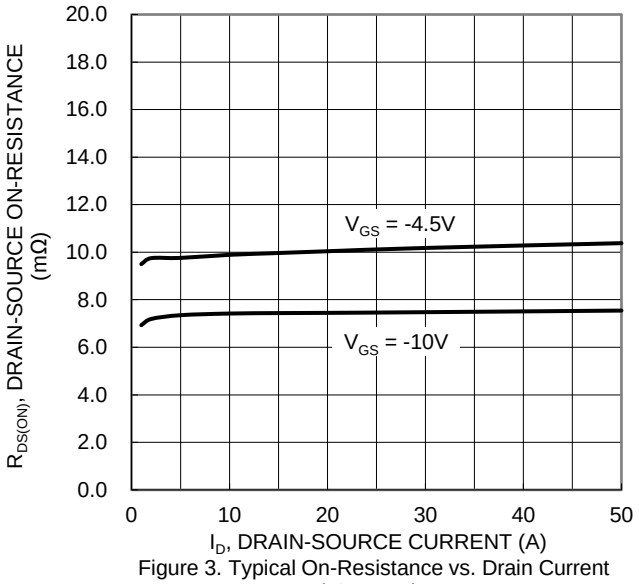



Figure 3. Typical On-Resistance vs. Drain Current and Gate Voltage

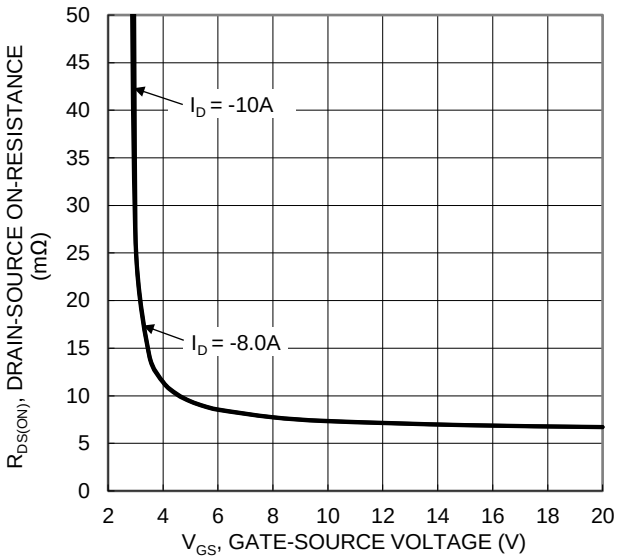



Figure 4. Typical Transfer Characteristic

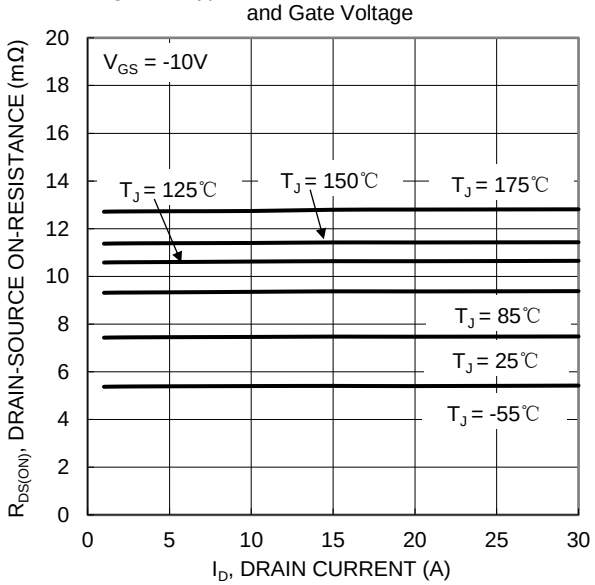



Figure 5. Typical On-Resistance vs. Drain Current and Temperature

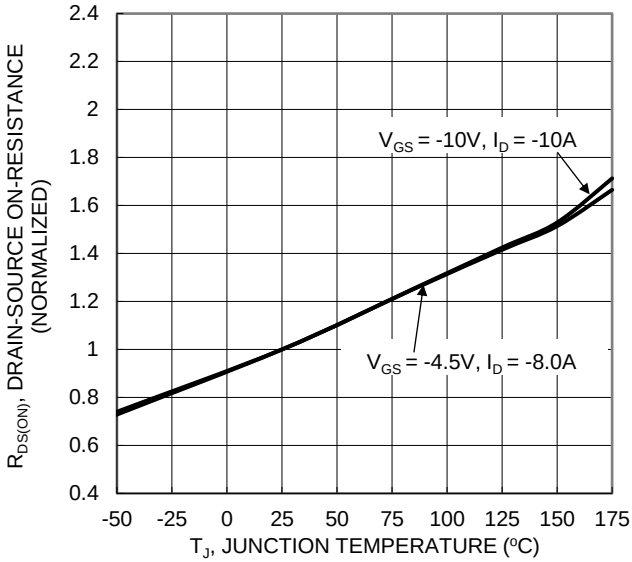



Figure 6. On-Resistance Variation with Temperature

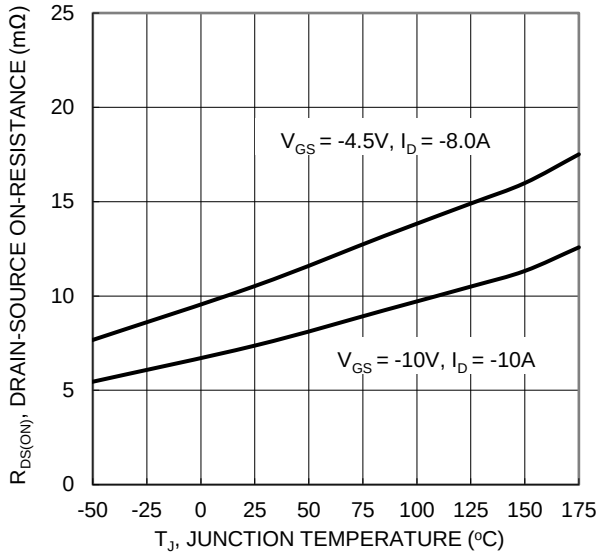



Figure 7. On-Resistance Variation with Temperature

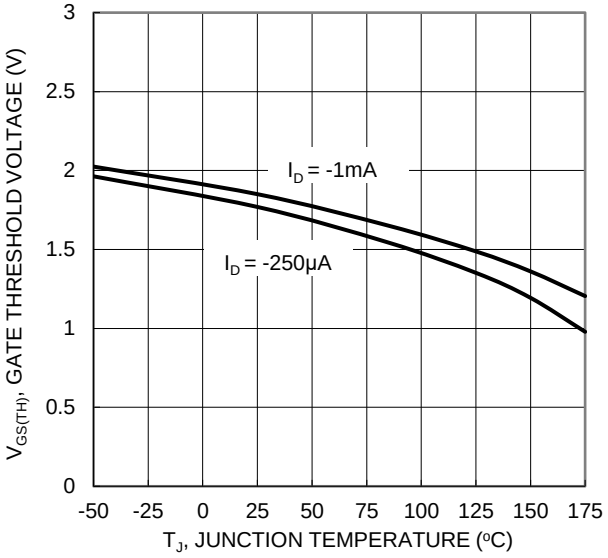



Figure 8. Gate Threshold Variation vs. Junction Temperature

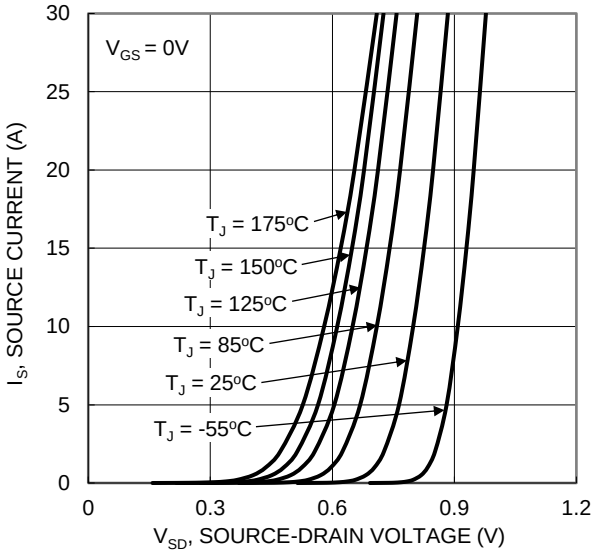



Figure 9. Diode Forward Voltage vs. Current

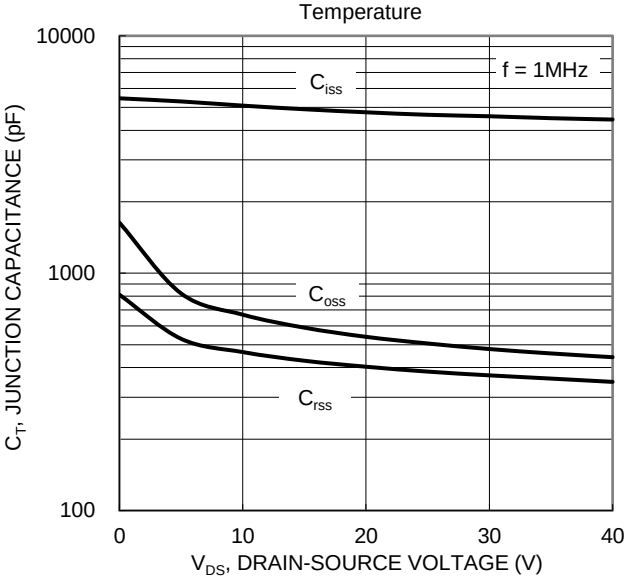



Figure 10. Typical Junction Capacitance

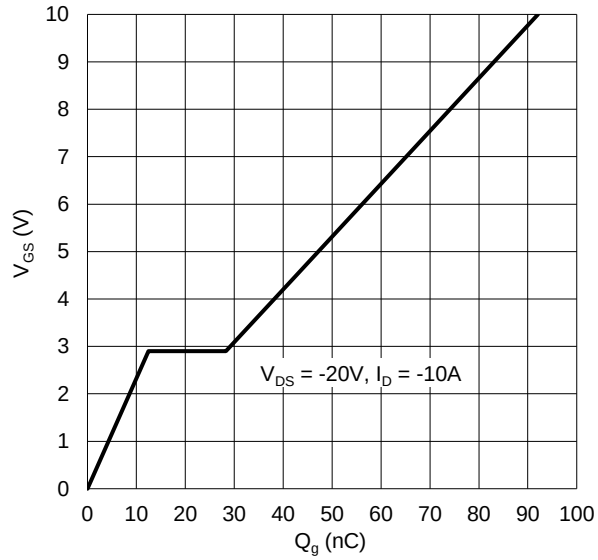



Figure 11. Gate Charge

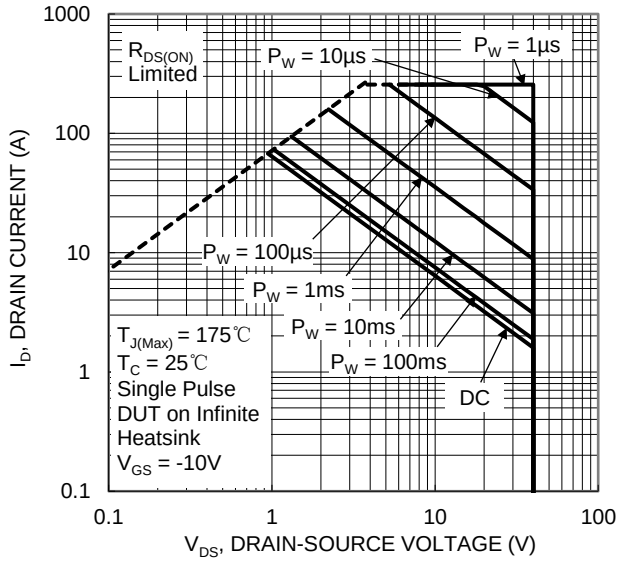



Figure 12. SOA, Safe Operation Area

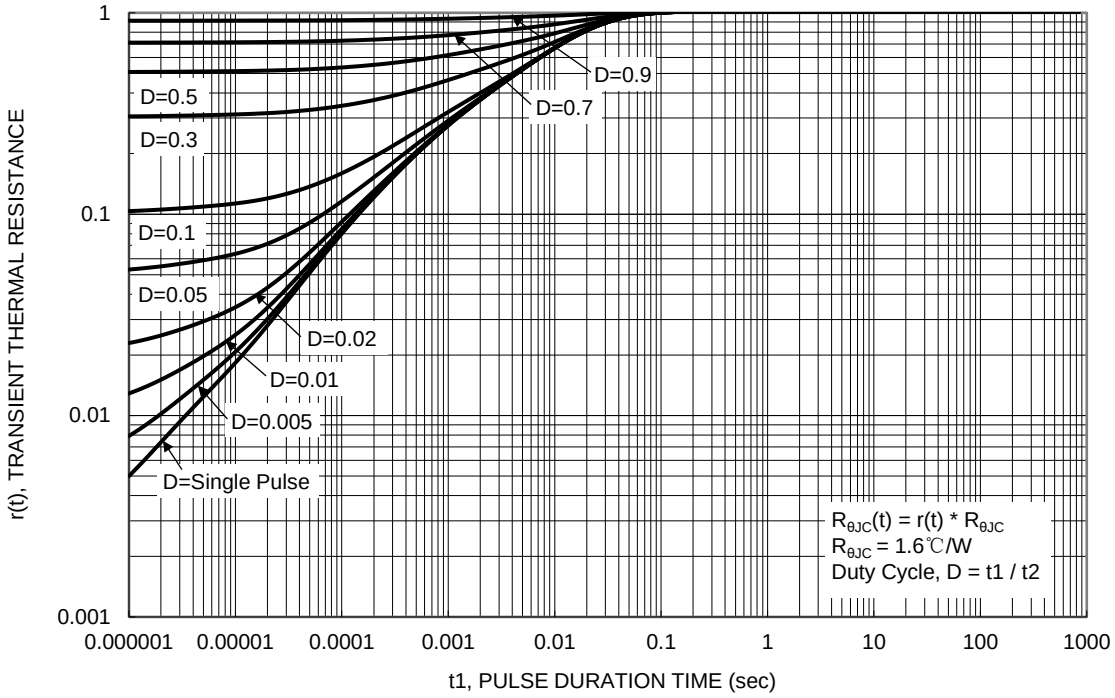
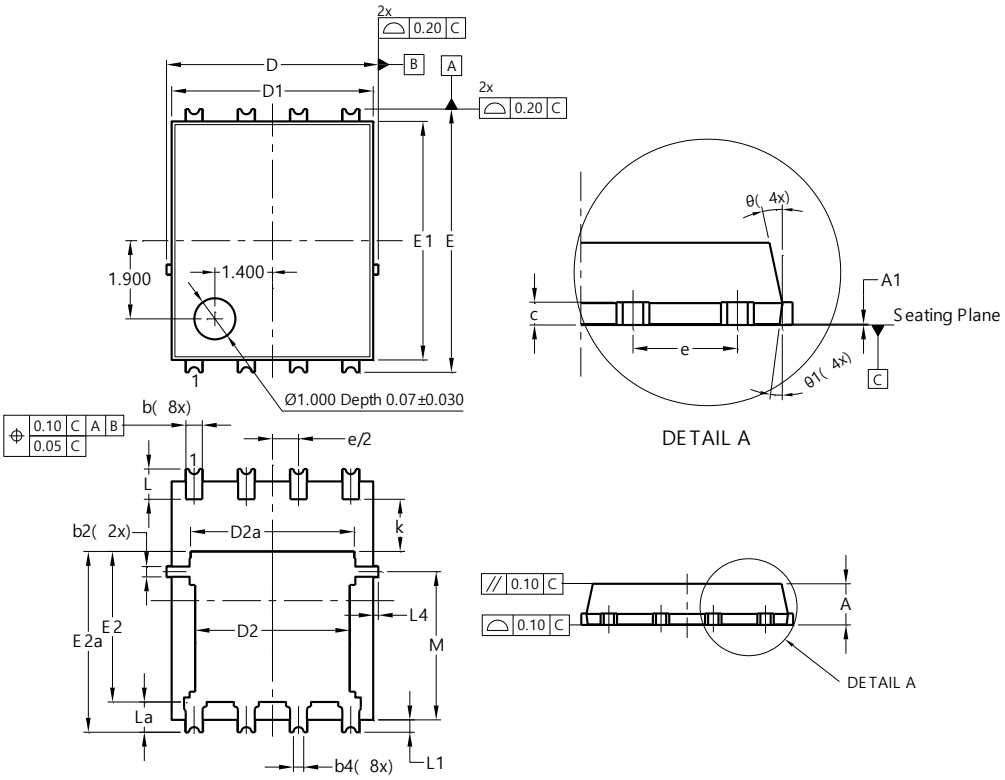



Figure 13. Transient Thermal Resistance

## Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

**PowerDI5060-8/SWP (Type UX)**

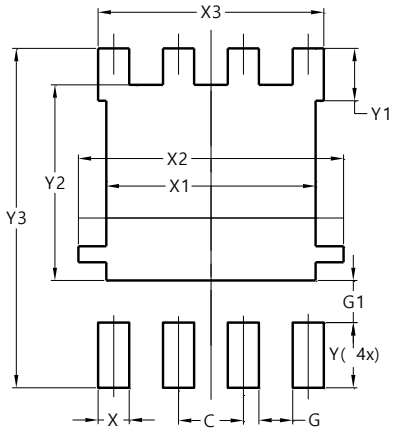



| PowerDI5060-8/SWP (Type UX) | | | |
|---|---|---|---|
| **Dim** | **Min** | **Max** | **Typ** |
| **A** | 0.90 | 1.10 | 1.00 |
| **A1** | 0 | 0.05 | -- |
| **b** | 0.30 | 0.50 | 0.41 |
| **b2** | 0.20 | 0.35 | 0.25 |
| **b4** | 0.25REF | | |
| **c** | 0.230 | 0.330 | 0.277 |
| **D** | 5.15 BSC | | |
| **D1** | 4.70 | 5.10 | 4.90 |
| **D2** | 3.56 | 3.96 | 3.76 |
| **D2a** | 3.78 | 4.18 | 3.98 |
| **E** | 6.40 BSC | | |
| **E1** | 5.60 | 6.00 | 5.80 |
| **E2** | 3.46 | 3.86 | 3.66 |
| **E2a** | 4.195 | 4.595 | 4.395 |
| **e** | 1.27BSC | | |
| **k** | 1.05 | -- | -- |
| **L** | 0.635 | 0.835 | 0.735 |
| **La** | 0.635 | 0.835 | 0.735 |
| **L1** | 0.200 | 0.400 | 0.300 |
| **L4** | 0.025 | 0.225 | 0.125 |
| **M** | 3.205 | 4.005 | 3.605 |
| **θ** | 10° | 12° | 11° |
| **θ1** | 6° | 8° | 7° |
| **All Dimensions in mm** | | | |

## Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

**PowerDI5060-8/SWP (Type UX)**




| Dimensions | Value (in mm) |
|---|---|
| **C** | 1.270 |
| **G** | 0.660 |
| **G1** | 0.820 |
| **X** | 0.610 |
| **X1** | 4.100 |
| **X2** | 5.190 |
| **X3** | 4.420 |
| **Y** | 1.270 |
| **Y1** | 1.020 |
| **Y2** | 3.810 |
| **Y3** | 6.610 |

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