# COMPLEMENTARY PAIR ENHANCEMENT MODE MOSFET
## PowerDI5060-8

## Product Summary

| Device | $V_{(BR)DSS}$ | $R_{DS(ON)}$ | $I_D$ $T_A$ = +25°C |
|---|---|---|---|
| Q1 | 12V | 17mΩ @ $V_{GS}$ = 4.5V | 9.5A |
| | | 25mΩ @ $V_{GS}$ = 2.5V | 7.8A |
| Q2 | -20V | 20mΩ @ $V_{GS}$ = -4.5V | -8.7A |
| | | 25mΩ @ $V_{GS}$ = -2.5V | -7.8A |

## Description and Applications

This new generation Complementary Pair Enhancement Mode MOSFET has been designed to minimize $R_{DS(ON)}$ and yet maintain superior switching performance. This device is ideal for use in Notebook battery power management and Loadswitch.

- Notebook Battery Power Management
- DC-DC Converters
- Loadswitch

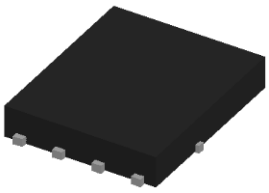
## Features and Benefits

- Thermally Efficient Package-Cooler Running Applications
- High Conversion Efficiency
- Low $R_{DS(ON)}$ – Minimizes On State Losses
- Low Input Capacitance
- Fast Switching Speed
- **ESD Protected Gate for Q2 P-Channel**
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e.: parts qualified to AEC-Q101, PPAP capable, and manufactured in IATF 16949 certified facilities), please refer to the related automotive grade (Q-suffix) part. A listing can be found at https://www.diodes.com/products/automotive/automotive-products/.**
- **This part is qualified to JEDEC standards (as references in AEC-Q101) for High Reliability. https://www.diodes.com/quality/product-definitions/**

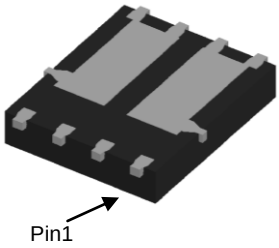
## Mechanical Data

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

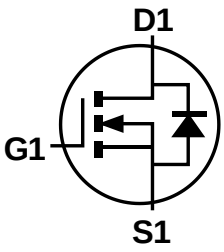
PowerDI5060-8 (Type C)



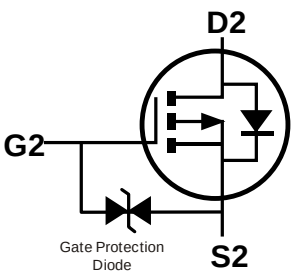
Top View



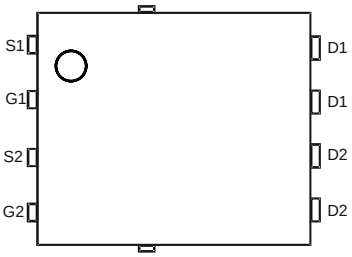

Bottom View




Q1 N-Channel MOSFET




Q2 P-Channel MOSFET



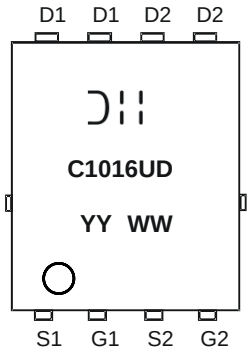

Top View
Pin Configuration

## Ordering Information (Note 4)

| Part Number | Case | Packaging |
|---|---|---|
| DMC1016UPD-13 | PowerDI5060-8 (Type C) | 2500 / Tape & Reel |

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
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
C1016UD = Product Type Marking Code
YYWW = Date Code Marking
YY = Year (ex: 16 = 2016)
WW = Week (01 to 53)

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

| Characteristic | | | Symbol | Q1 Value | Q2 Value | Units |
|---|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DSS}$ | 12 | -20 | V |
| Gate-Source Voltage | | | $V_{GSS}$ | ±8 | ±8 | V |
| Continuous Drain Current (Note 5) $V_{GS}$ = 4.5V | Steady State | $T_A$ = +25°C<br>$T_A$ = +70°C | $I_D$ | 9.5<br>7.6 | -8.7<br>-7.0 | A |
| | t<10s | $T_A$ = +25°C<br>$T_A$ = +70°C | $I_D$ | 13.0<br>10.4 | -12.0<br>-9.6 | A |
| Maximum Body Diode Forward Current (Note 5) | | | $I_S$ | 2.6 | -2.6 | A |
| Pulsed Drain Current (10µs pulse, duty cycle = 1%) | | | $I_{DM}$ | 65 | -60 | A |
| Avalanche Current (Note 6) L = 0.1mH | | | $I_{AS}$ | 20 | -27 | A |
| Avalanche Energy (Note 6) L = 0.1mH | | | $E_{AS}$ | 25 | 38 | mJ |

## Thermal Characteristics

| Characteristic | | Symbol | Value | Units |
|---|---|---|---|---|
| Total Power Dissipation (Note 5) | $T_A$ = +25°C | $P_D$ | 2.3 | W |
| | $T_A$ = +70°C | | 1.5 | |
| Thermal Resistance, Junction to Ambient (Note 5) | Steady state | $R_{\theta JA}$ | 55 | °C/W |
| | t<10s | | 29 | |
| Thermal Resistance, Junction to Case | | $R_{\theta JC}$ | 6.2 | |
| Operating and Storage Temperature Range | | $T_J$, $T_{STG}$ | -55 to +150 | °C |

Notes: 5. Device mounted on FR-4 substrate PC board, 2oz copper, with 1inch square copper plate.
6. $I_{AS}$ and $E_{AS}$ rating are based on low frequency and duty cycles to keep $T_J$ = +25°C.

## Electrical Characteristics Q1 N-Channel (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | Symbol | Min | Typ | Max | Unit | Test Condition |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS (Note 7)** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | 12 | — | — | V | $V_{GS}$ = 0V, $I_D$ = 250µA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | — | — | 1 | µA | $V_{DS}$ = 12V, $V_{GS}$ = 0V |
| Gate-Source Leakage | $I_{GSS}$ | — | — | ±100 | nA | $V_{GS}$ = ±8V, $V_{DS}$ = 0V |
| **ON CHARACTERISTICS (Note 7)** | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | 0.6 | 0.8 | 1.5 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 250µA |
| Static Drain-Source On-Resistance | $R_{DS(ON)}$ | — | 9.0 | 17 | mΩ | $V_{GS}$ = 4.5V, $I_D$ = 11.8A |
| | | — | 11 | 25 | | $V_{GS}$ = 2.5V, $I_D$ = 9.8A |
| Diode Forward Voltage | $V_{SD}$ | — | 0.7 | 1.2 | V | $V_{GS}$ = 0V, $I_S$ = 2.9A |
| **DYNAMIC CHARACTERISTICS (Note 8)** | | | | | | |
| Input Capacitance | $C_{iss}$ | — | 1454 | — | pF | $V_{DS}$ = 6V, $V_{GS}$ = 0V, f = 1.0MHz |
| Output Capacitance | $C_{oss}$ | — | 336 | — | | |
| Reverse Transfer Capacitance | $C_{rss}$ | — | 311 | — | | |
| Gate Resistance | $R_G$ | — | 1.6 | — | Ω | $V_{DS}$ = 0V, $V_{GS}$ = 0V, f = 1.0MHz |
| Total Gate Charge ($V_{GS}$ = 4.5V) | $Q_g$ | — | 18 | — | nC | $V_{DS}$ = 6V, $I_D$ = 11.8A |
| Total Gate Charge ($V_{GS}$ = 8V) | $Q_g$ | — | 32 | — | | |
| Gate-Source Charge | $Q_{gs}$ | — | 3.1 | — | | |
| Gate-Drain Charge | $Q_{gd}$ | — | 4.3 | — | | |
| Turn-On Delay Time | $t_{D(ON)}$ | — | 6.6 | — | ns | $V_{DD}$ = 6V, $R_L$ = 6Ω, $V_{GS}$ = 4.5V, $R_G$ = 6Ω, $I_D$ = 1A |
| Turn-On Rise Time | $t_R$ | — | 9.6 | — | | |
| Turn-Off Delay Time | $t_{D(OFF)}$ | — | 42.5 | — | | |
| Turn-Off Fall Time | $t_F$ | — | 22.5 | — | | |
| Body Diode Reverse Recovery Time | $t_{RR}$ | — | 16.6 | — | ns | $I_F$ = 11.8A, di/dt = 100A/µs |
| Body Diode Reverse Recovery Charge | $Q_{RR}$ | — | 2.8 | — | nC | $I_F$ = 11.8A, di/dt = 100A/µs |

Notes: 7. Short duration pulse test used to minimize self-heating effect.
8. Guaranteed by design. Not subject to product testing.

## Electrical Characteristics Q2 P-Channel (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | Symbol | Min | Typ | Max | Unit | Test Condition |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS (Note 7)** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | -20 | — | — | V | $V_{GS}$ = 0V, $I_D$ = -250μA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | — | — | -1 | μA | $V_{DS}$ = -20V, $V_{GS}$ = 0V |
| Gate-Source Leakage | $I_{GSS}$ | — | — | ±10 | μA | $V_{GS}$ = ±8V, $V_{DS}$ = 0V |
| **ON CHARACTERISTICS (Note 7)** | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | -0.35 | -0.6 | -1.0 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = -250μA |
| Static Drain-Source On-Resistance | $R_{DS(ON)}$ | — | 14 | 20 | mΩ | $V_{GS}$ = -4.5V, $I_D$ = -7.0A |
| | | — | 17 | 25 | | $V_{GS}$ = -2.5V, $I_D$ = -5.0A |
| | | — | 22 | 40 | | $V_{GS}$ = -1.8V, $I_D$ = -3.0A |
| | | — | 26 | 80 | | $V_{GS}$ = -1.5V, $I_D$ = -1.0A |
| Diode Forward Voltage | $V_{SD}$ | — | -0.8 | -1.2 | V | $V_{GS}$ = 0V, $I_S$ = -1.0A |
| **DYNAMIC CHARACTERISTICS (Note 8)** | | | | | | |
| Input Capacitance | $C_{iss}$ | — | 3103 | — | pF | $V_{DS}$ = -15V, $V_{GS}$ = 0V, f = 1.0MHz |
| Output Capacitance | $C_{oss}$ | — | 351 | — | | |
| Reverse Transfer Capacitance | $C_{rss}$ | — | 239 | — | | |
| Gate Resistance | $R_G$ | — | 12 | — | Ω | $V_{DS}$ = 0V, $V_{GS}$ = 0V, f = 1.0MHz |
| Total Gate Charge ($V_{GS}$ = -4.5V) | $Q_g$ | — | 32 | — | nC | $V_{DS}$ = -6V, $I_D$ = -8.9A |
| Total Gate Charge ($V_{GS}$ = -8V) | $Q_g$ | — | 56 | — | | |
| Gate-Source Charge | $Q_{gs}$ | — | 4.5 | — | | |
| Gate-Drain Charge | $Q_{gd}$ | — | 6.1 | — | | |
| Turn-On Delay Time | $t_{D(ON)}$ | — | 8.1 | — | ns | $V_{DD}$ = -6V, $R_L$ = 6Ω<br>$V_{GS}$ = -4.5V, $R_G$ = 6Ω, $I_D$ = -1A |
| Turn-On Rise Time | $t_R$ | — | 16.0 | — | | |
| Turn-Off Delay Time | $t_{D(OFF)}$ | — | 150 | — | | |
| Turn-Off Fall Time | $t_F$ | — | 82 | — | | |
| Body Diode Reverse Recovery Time | $t_{RR}$ | — | 20.6 | — | ns | $I_F$ = -8.9A, di/dt = -100A/μs |
| Body Diode Reverse Recovery Charge | $Q_{RR}$ | — | 8.3 | — | nC | $I_F$ = -8.9A, di/dt = -100A/μs |

Notes: 7. Short duration pulse test used to minimize self-heating effect.
8. Guaranteed by design. Not subject to product testing.

## Typical Characteristics - N-CHANNEL

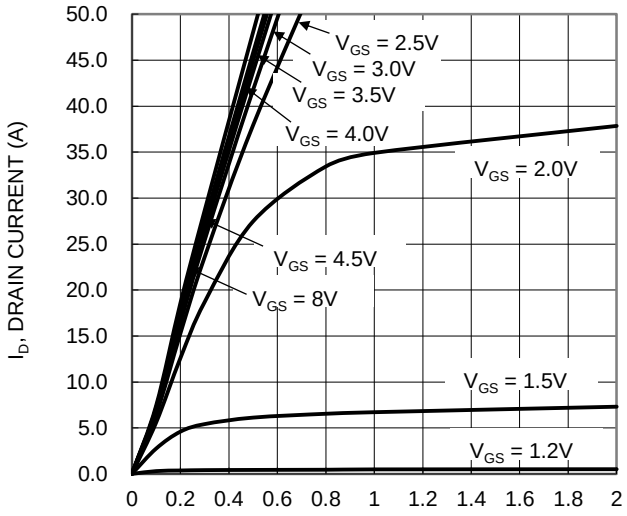



Figure 1. Typical Output Characteristic

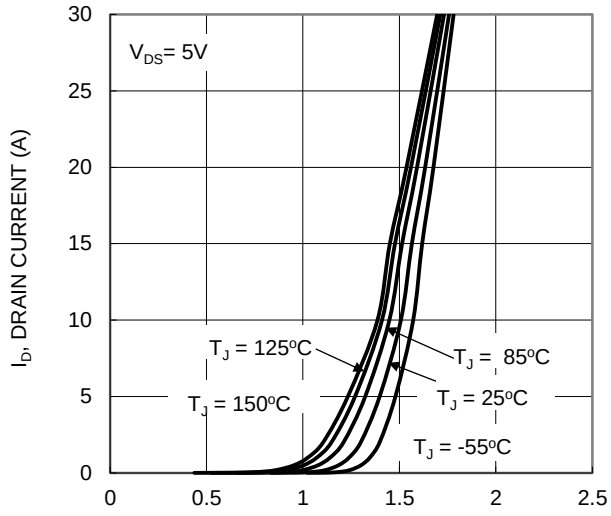



Figure 2. Typical Transfer Characteristic

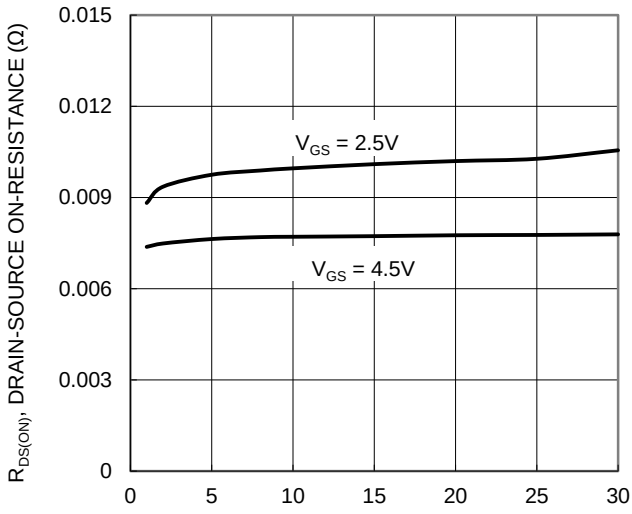



Figure 3. Typical On-Resistance vs Drain Current and Gate Voltage

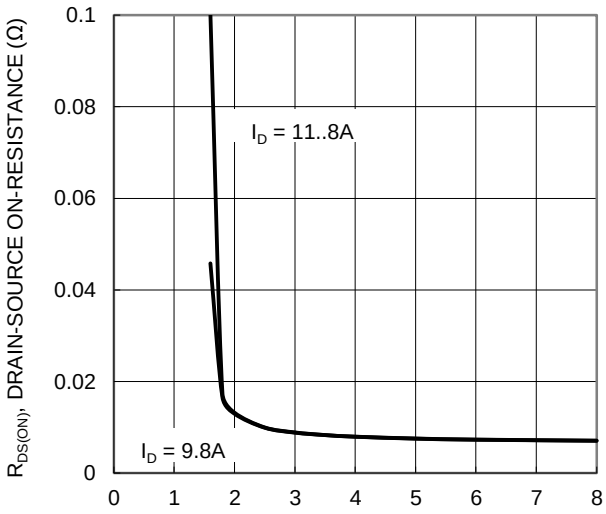



Figure 4. Typical Transfer Characteristic

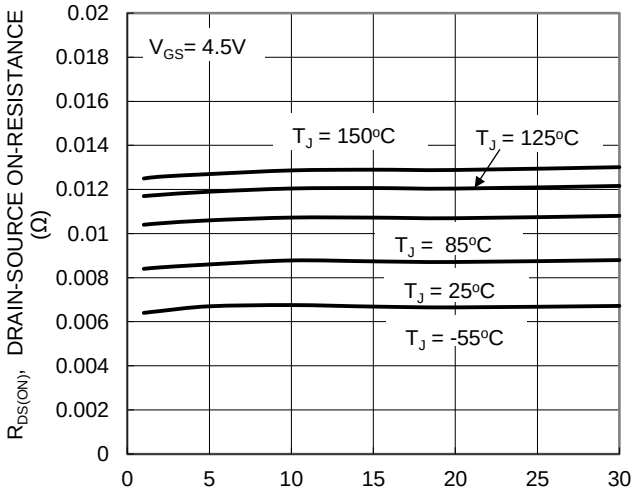



Figure 5. Typical On-Resistance vs Drain Current and Temperature

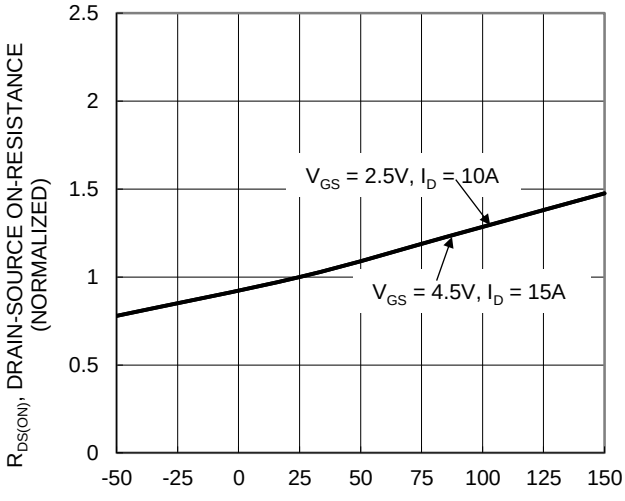



Figure 6. On-Resistance Variation with Junction Temperature

## Typical Characteristics - N-CHANNEL (Cont.)

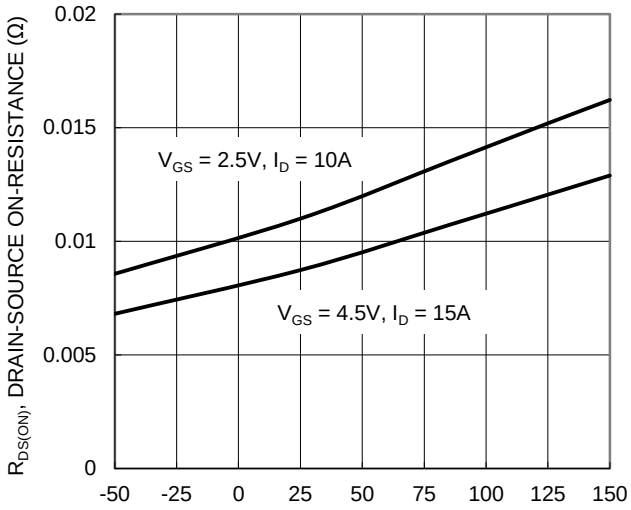



Figure 7. On-Resistance Variation with Junction Temperature

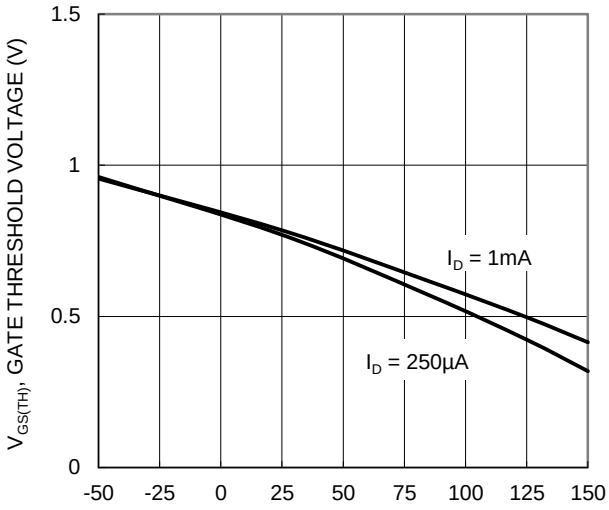



Figure 8. Gate Threshold Variation vs Junction Temperature

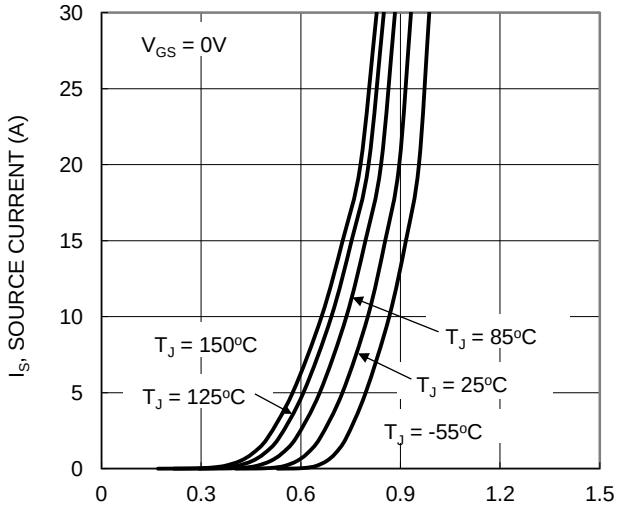



Figure 9. Diode Forward Voltage vs. Current

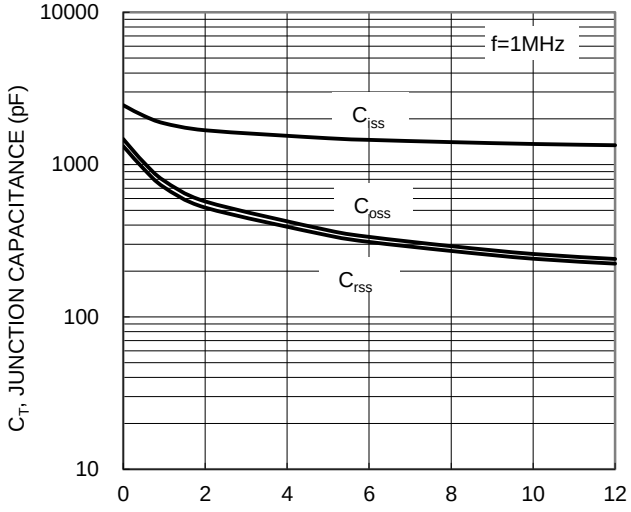



Figure 10. Typical Junction Capacitance

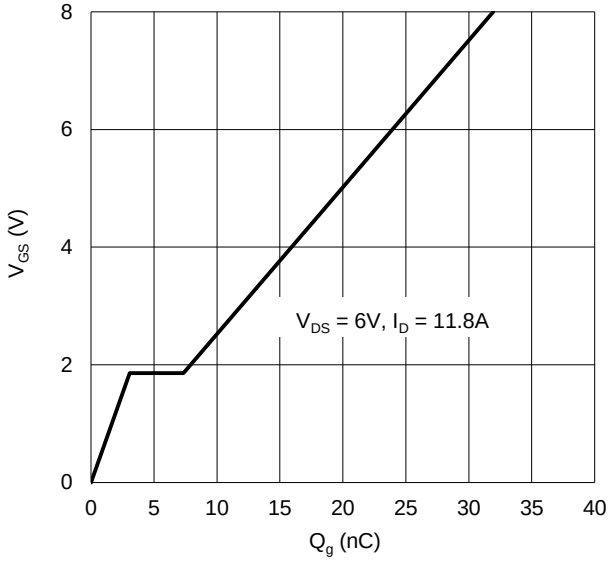



Figure 11. Gate Charge

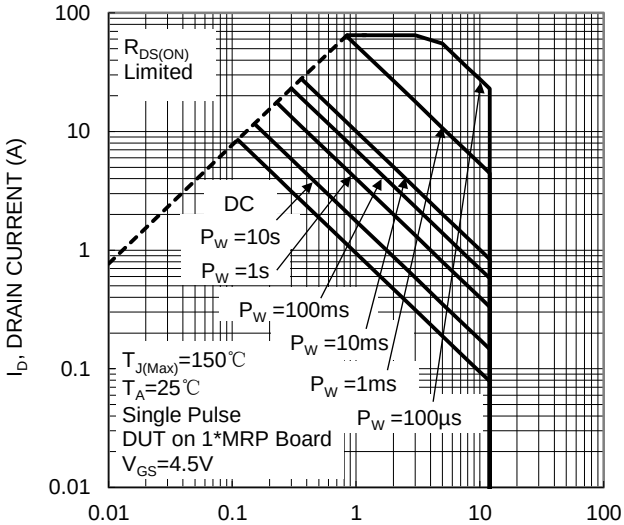



Figure 12. SOA, Safe Operation Area

## Typical Characteristics - P-CHANNEL

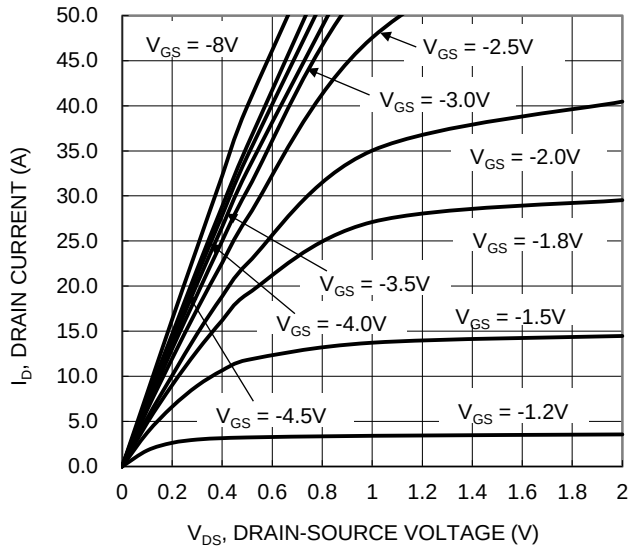



Figure 13. Typical Output Characteristic

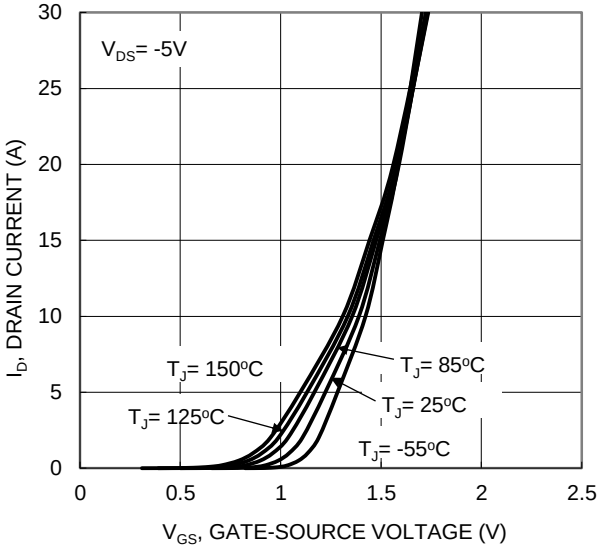



Figure 14. Typical Transfer Characteristic

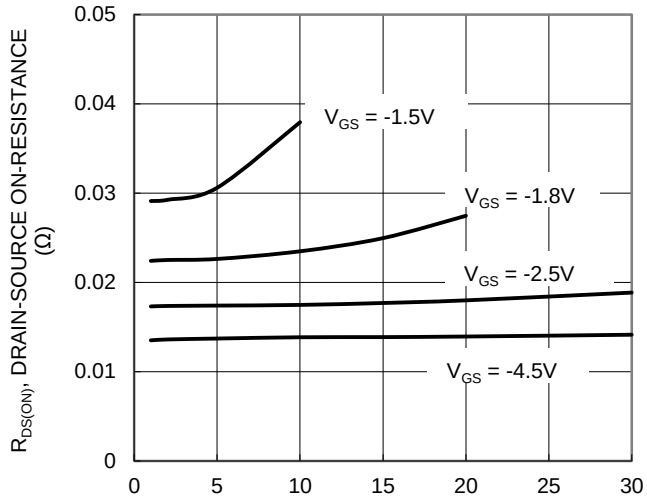



Figure 15. Typical On-Resistance vs Drain Current and Gate Voltage

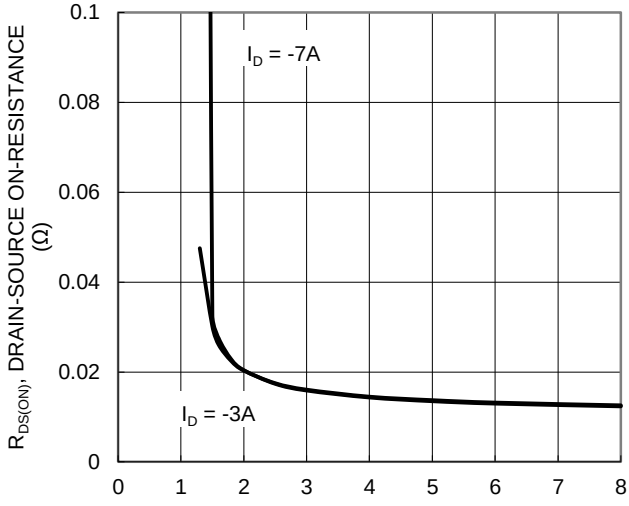



Figure 16. Typical Transfer Characteristic

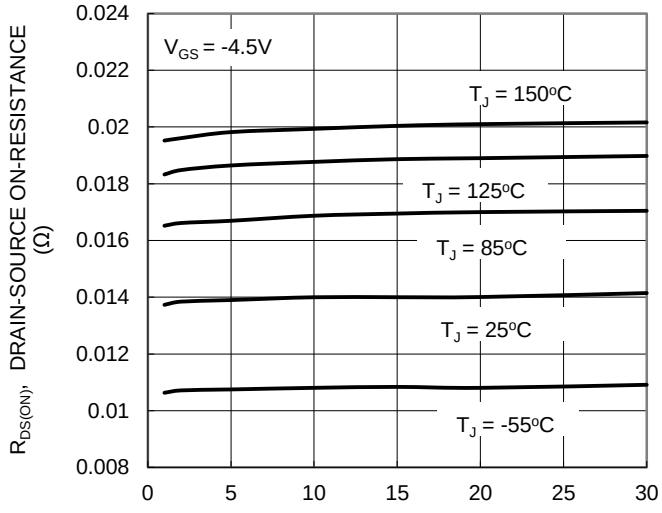



Figure 17. Typical On-Resistance vs Drain Current and Temperature

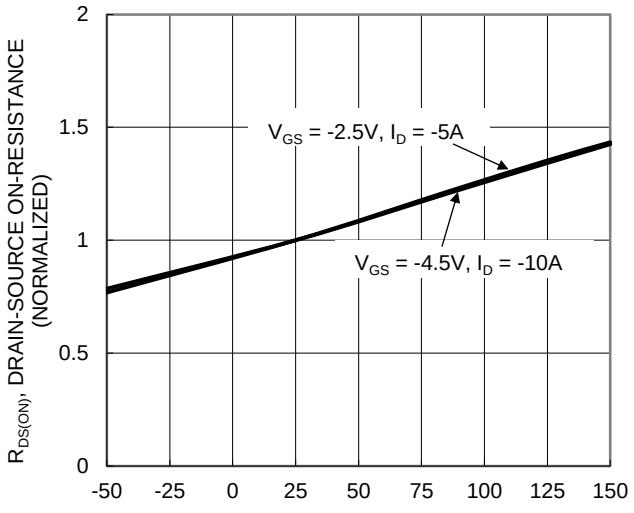



Figure 18. On-Resistance Variation with junction Temperature

## Typical Characteristics - P-CHANNEL (Cont.)

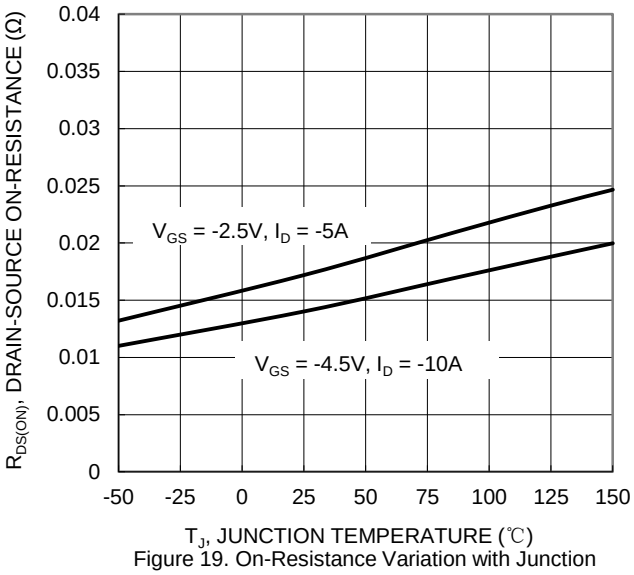



Figure 19. On-Resistance Variation with Junction Temperature

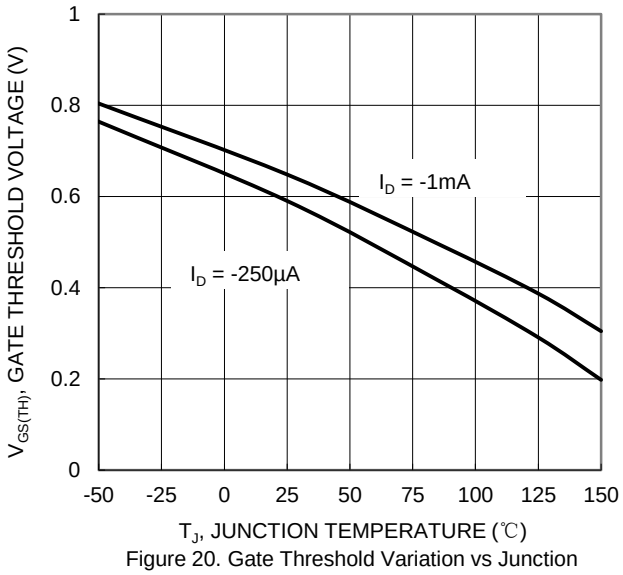



Figure 20. Gate Threshold Variation vs Junction Temperature

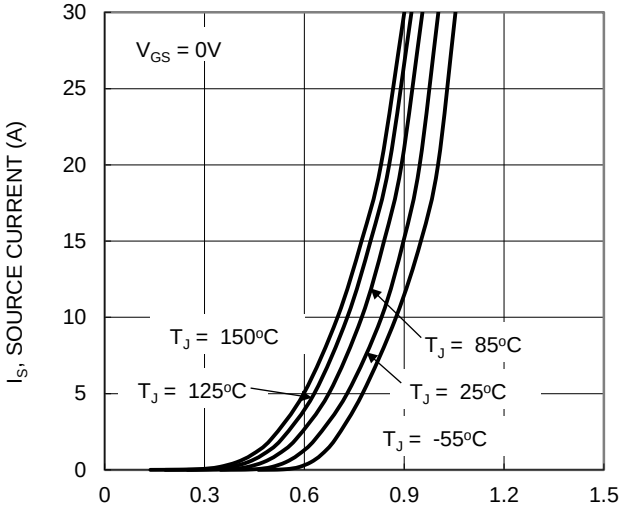



Figure 21. Diode Forward Voltage vs. Current

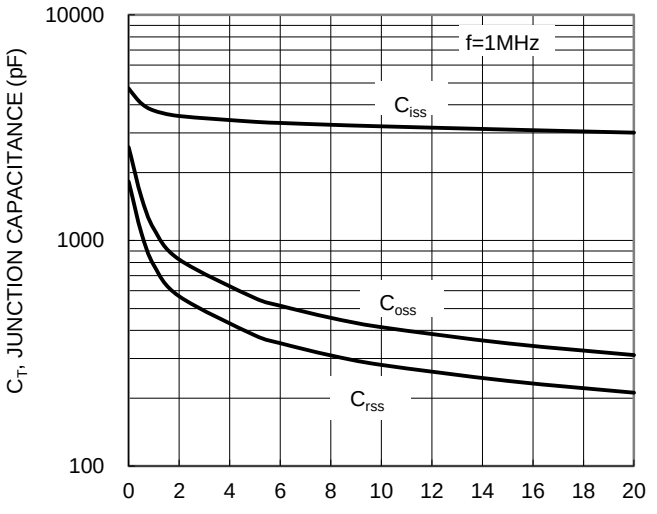



Figure 22. Typical Junction Capacitance

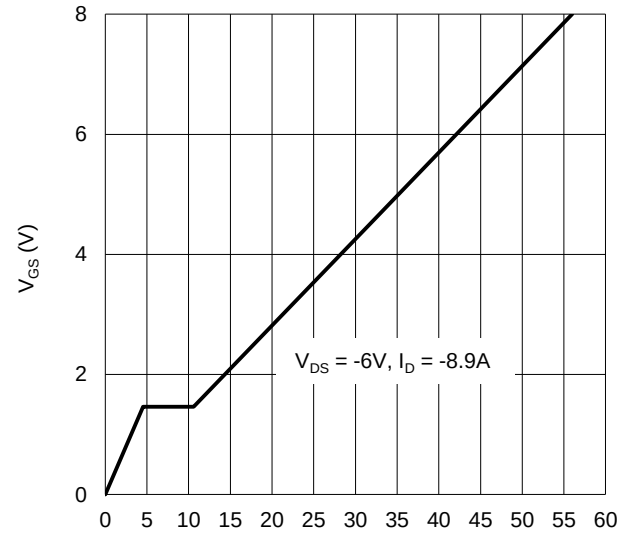



Figure 23. Gate Charge

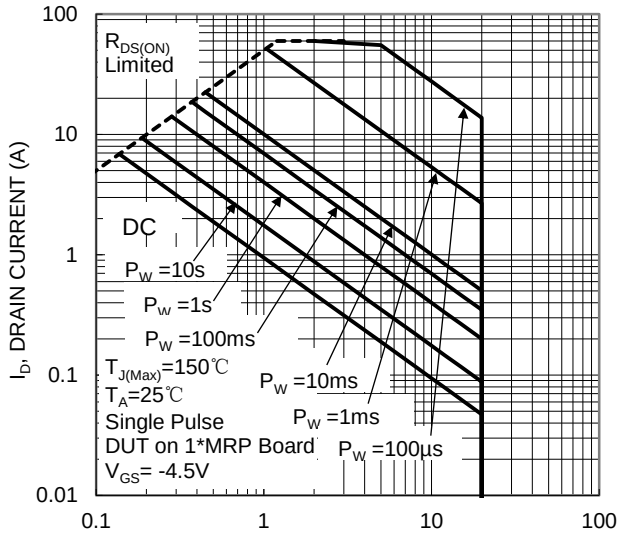



Figure 24. SOA, Safe Operation Area

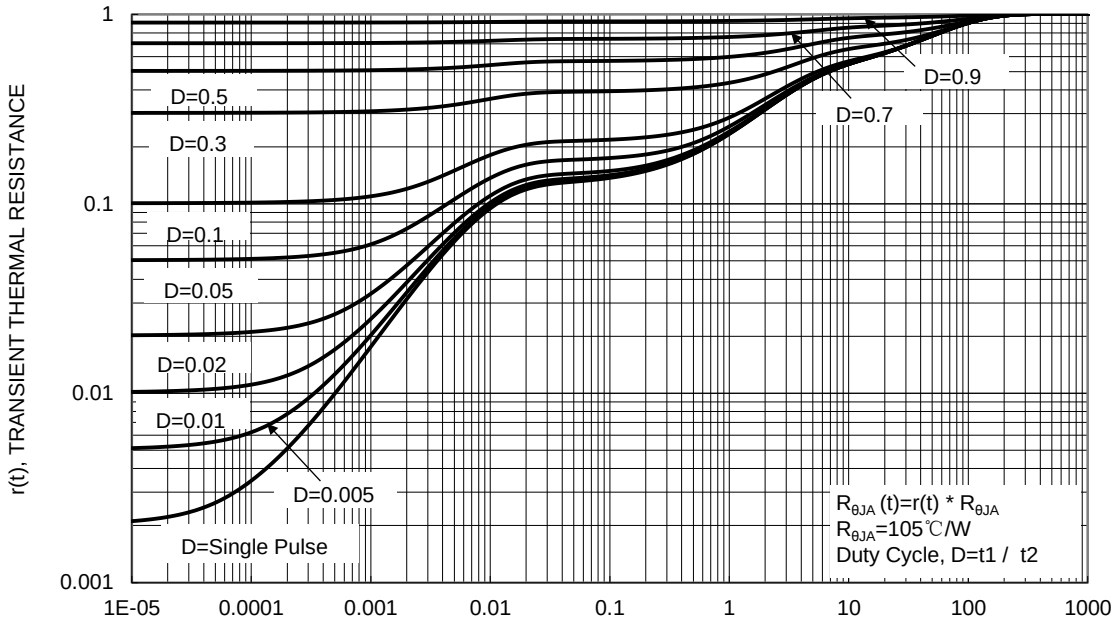
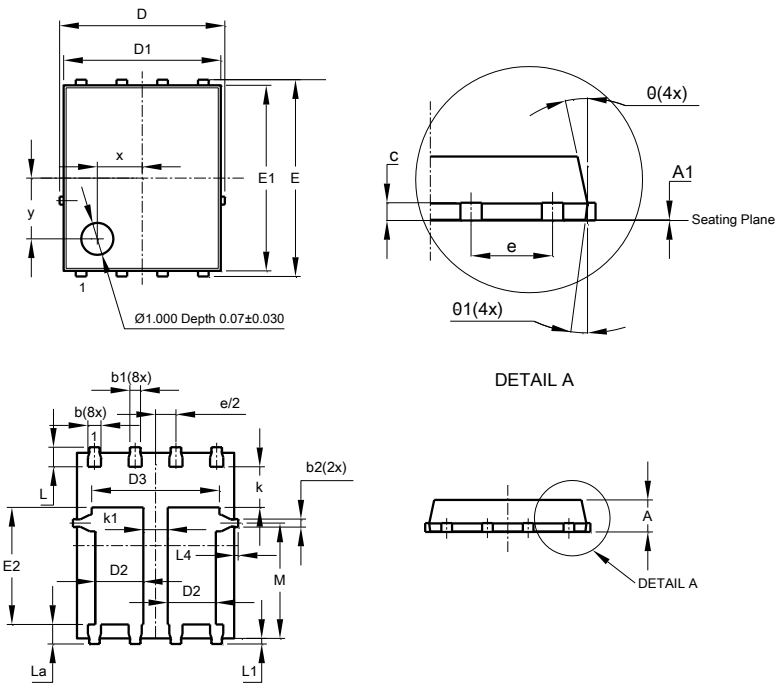



Figure 25. Transient Thermal Resistance

## Package Outline Dimensions

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

**PowerDI5060-8 (Type C)**




| PowerDI5060-8 (Type C) | | | |
|---|---|---|---|
| **Dim** | **Min** | **Max** | **Typ** |
| **A** | 0.90 | 1.10 | 1.00 |
| **A1** | 0 | 0.05 | 0.02 |
| **b** | 0.33 | 0.51 | 0.41 |
| **b1** | 0.300 | 0.366 | 0.333 |
| **b2** | 0.20 | 0.35 | 0.25 |
| **c** | 0.23 | 0.33 | 0.277 |
| **D** | 5.15 BSC | | |
| **D1** | 4.85 | 4.95 | 4.90 |
| **D2** | 1.40 | 1.60 | 1.50 |
| **D3** | - | - | 3.98 |
| **E** | 6.15 BSC | | |
| **E1** | 5.75 | 5.85 | 5.80 |
| **E2** | 3.56 | 3.76 | 3.66 |
| **e** | 1.27BSC | | |
| **k** | - | - | 1.27 |
| **k1** | 0.56 | - | - |
| **L** | 0.51 | 0.71 | 0.61 |
| **La** | 0.51 | 0.71 | 0.61 |
| **L1** | 0.05 | 0.20 | 0.175 |
| **L4** | - | - | 0.125 |
| **M** | 3.50 | 3.71 | 3.605 |
| **x** | - | - | 1.400 |
| **y** | - | - | 1.900 |
| **θ** | 10° | 12° | 11° |
| **θ1** | 6° | 8° | 7° |
| **All Dimensions in mm** | | | |

## Suggested Pad Layout

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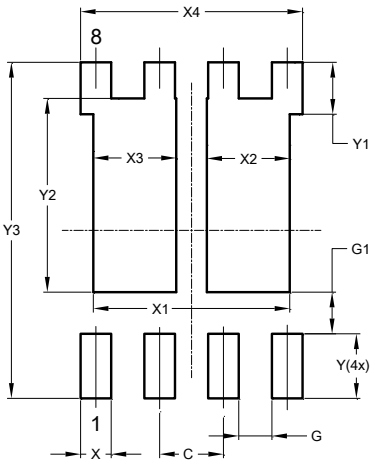
**PowerDI5060-8 (Type C)**




| Dimensions | Value (in mm) |
|---|---|
| **C** | 1.270 |
| **G** | 0.660 |
| **G1** | 0.820 |
| **X** | 0.610 |
| **X1** | 3.910 |
| **X2** | 1.650 |
| **X3** | 1.650 |
| **X4** | 4.420 |
| **Y** | 1.270 |
| **Y1** | 1.020 |
| **Y2** | 3.810 |
| **Y3** | 6.610 |

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