

COMPLEMENTARY PAIR ENHANCEMENT MODE MOSFET

Product Summary

| Device | BV _{DSS} | R _{DS(ON)} max | I _D max T _A = +25°C |
|-----------------|-------------------|---------------------------------|--|
| Q1 N-Channel | 12V | 25mΩ @ V _{GS} = 4.5V | 6.0A |
| | | 30mΩ @ V _{GS} = 3.3V | 5.5A |
| | | 32mΩ @ V _{GS} = 2.5V | 5.3A |
| Q2 P-Channel | -20V | 80mΩ @ V _{GS} = -4.5V | -3.4A |
| | | 90mΩ @ V _{GS} = -3.3V | -3.2A |
| | | 100mΩ @ V _{GS} = -2.5V | -3.0A |

Features

- Low On-Resistance
- Low Input Capacitance
- Low Profile, 0.6mm Max Height
- **ESD HBM Protected up to 1.5KV, MM Protected up to 150V.**
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Description

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

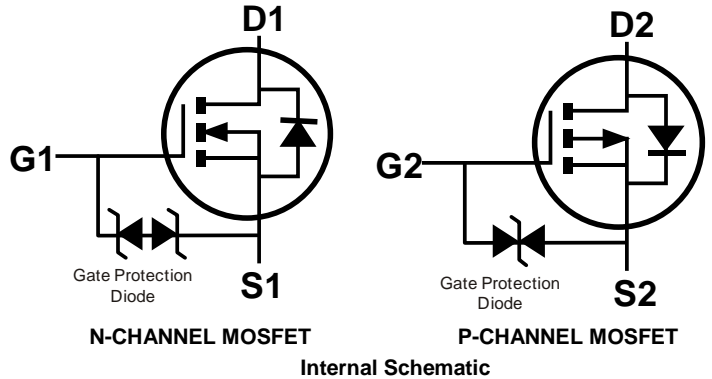
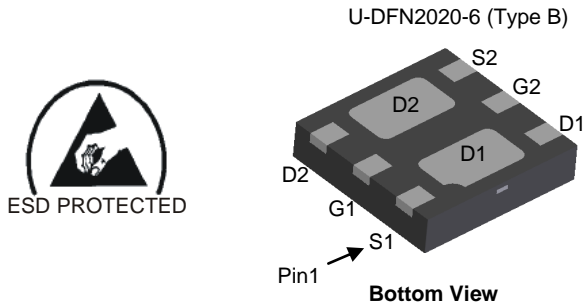
Applications

Optimized for Point of Load (POL) Synchronous Buck Converter that steps down from 3.3V to 1V for core voltage supply to ASICs. Target applications are Ethernet Network Controllers used in:

- Routers, Switchers, Network Interface Controllers (NICs)
- Digital Subscriber Line (DSL)
- Set-Top Boxes (STBs)

Mechanical Data

- Case: U-DFN2020-6 (Type B)
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish NiPdAu over Copper Leadframe. Solderable per MIL-STD-202, Method 208 (e4)
- Terminals Connections: See Diagram Below
- Weight: 0.0065 grams (Approximate)

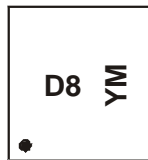


Ordering Information (Note 4)

| Part Number | Case | Packaging |
|----------------|----------------------|--------------------|
| DMC1028UFDB-7 | U-DFN2020-6 (Type B) | 3,000/Tape & Reel |
| DMC1028UFDB-13 | U-DFN2020-6 (Type B) | 10,000/Tape & Reel |

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
 2. See http://www.diodes.com/quality/lead_free.html 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 <http://www.diodes.com>.

Marking Information



D8 = Product Type Marking Code
 YM = Date Code Marking
 Y = Year (ex: C = 2015)
 M = Month (ex: 9 = September)

Date Code Key

| Year | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|------|------|------|------|------|------|------|------|
| Code | C | D | E | F | G | H | I |

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Code | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | O | N | D |

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

| Characteristic | | | Symbol | Q1 N-CHANNEL | Q2 P-CHANNEL | 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 T _A = +70°C | I _D | 6.0 4.8 | -3.4 -2.7 | A |
| | t < 5s | T _A = +25°C T _A = +70°C | I _D | 7.1 5.7 | -4.0 -3.2 | A |
| Maximum Continuous Body Diode Forward Current (Note 5) | | | I _S | 1.4 | -1.4 | A |
| Pulsed Drain Current (10μs Pulse, Duty Cycle = 1%) | | | I _{DM} | 40 | -20 | A |
| Avalanche Current L = 0.1mH | | | I _{AS} | 12 | -12 | A |
| Avalanche Energy L = 0.1mH | | | E _{AS} | 8.4 | 7.5 | mJ |

Thermal Characteristics

| Characteristic | | Symbol | Value | Units |
|--|--------------|-----------------------------------|-------------|-------|
| Total Power Dissipation (Note 5) | Steady State | P _D | 1.36 | W |
| | t < 5s | | 1.89 | |
| Thermal Resistance, Junction to Ambient (Note 5) | Steady State | R _{θJA} | 92 | °C/W |
| | t < 5s | | 66 | |
| Thermal Resistance, Junction to Case (Note 5) | | R _{θJC} | 19 | |
| Operating and Storage Temperature Range | | T _J , T _{STG} | -55 to +150 | °C |

Note: 5. Device mounted on 1" x 1" FR-4 PCB with high coverage 2oz. Copper, single sided.

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

| Characteristic | Symbol | Min | Typ | Max | Unit | Test Condition |
|--|---------------------|-----|------|-----|------|---|
| OFF CHARACTERISTICS (Note 6) | | | | | | |
| Drain-Source Breakdown Voltage | BV _{DSS} | 12 | - | - | V | V _{GS} = 0V, I _D = 250μA |
| Zero Gate Voltage Drain Current T _J = +25°C | I _{DSS} | - | - | 1.0 | μA | V _{DS} = 12V, V _{GS} = 0V |
| Gate-Source Leakage | I _{GSS} | - | - | ±10 | μA | V _{GS} = ±8V, V _{DS} = 0V |
| ON CHARACTERISTICS (Note 6) | | | | | | |
| Gate Threshold Voltage | V _{GS(TH)} | 0.4 | - | 1 | V | V _{DS} = V _{GS} , I _D = 250μA |
| Static Drain-Source On-Resistance | R _{DS(ON)} | - | 17 | 25 | mΩ | V _{GS} = 4.5V, I _D = 5.2A |
| | | - | 19 | 30 | | V _{GS} = 3.3V, I _D = 5.0A |
| | | - | 21 | 32 | | V _{GS} = 2.5V, I _D = 4.8A |
| | | - | 30 | 40 | | V _{GS} = 1.8V, I _D = 2.5A |
| Diode Forward Voltage | V _{SD} | - | 0.7 | 1.2 | V | V _{GS} = 0V, I _S = 1A |
| DYNAMIC CHARACTERISTICS (Note 7) | | | | | | |
| Input Capacitance | C _{ISS} | - | 787 | - | pF | V _{DS} = 6V, V _{GS} = 0V, f = 1.0MHz |
| Output Capacitance | C _{OSS} | - | 203 | - | pF | |
| Reverse Transfer Capacitance | C _{RSS} | - | 177 | - | pF | |
| Gate Resistance | R _g | - | 4.8 | - | Ω | V _{DS} = 0V, V _{GS} = 0V, f = 1MHz |
| Total Gate Charge (V _{GS} = 3.3V) | Q _g | - | 7.9 | - | nC | V _{DS} = 6V, I _D = 6.8A |
| Total Gate Charge (V _{GS} = 4.5V) | | - | 10.5 | - | nC | |
| Total Gate Charge (V _{GS} = 8V) | | - | 18.5 | - | nC | |
| Gate-Source Charge | Q _{gs} | - | 1.2 | - | nC | |
| Gate-Drain Charge | Q _{gd} | - | 2.9 | - | nC | |
| Turn-On Delay Time | t _{D(ON)} | - | 4.6 | - | ns | |
| Turn-On Rise Time | t _r | - | 9.4 | - | ns | V _{DD} = 6V, V _{GS} = 4.5V, R _L = 1.1Ω, R _G = 1Ω |
| Turn-Off Delay Time | t _{D(OFF)} | - | 15.7 | - | ns | |
| Turn-Off Fall Time | t _f | - | 3.7 | - | ns | |
| Body Diode Reverse Recovery Time | t _{RR} | - | 12.0 | - | ns | I _S = 5.4A, dI/dt = 100A/μs |
| Body Diode Reverse Recovery Charge | Q _{RR} | - | 1.8 | - | nC | I _S = 5.4A, dI/dt = 100A/μs |

Electrical Characteristics Q2 P-CHANNEL (@ $T_A = +25^\circ\text{C}$, unless otherwise specified.)

| Characteristic | Symbol | Min | Typ | Max | Unit | Test Condition |
|---|--------------|------|------|----------|------------|--|
| OFF CHARACTERISTICS (Note 6) | | | | | | |
| Drain-Source Breakdown Voltage | BV_{DSS} | -20 | - | - | V | $V_{GS} = 0V, I_D = -250\mu A$ |
| Zero Gate Voltage Drain Current $T_J = +25^\circ\text{C}$ | I_{DSS} | - | - | -1.0 | μA | $V_{DS} = -20V, V_{GS} = 0V$ |
| Gate-Source Leakage | I_{GSS} | - | - | ± 10 | μA | $V_{GS} = \pm 8V, V_{DS} = 0V$ |
| ON CHARACTERISTICS (Note 6) | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | -0.4 | - | -1 | V | $V_{DS} = V_{GS}, I_D = -250\mu A$ |
| Static Drain-Source On-Resistance | $R_{DS(ON)}$ | - | 55 | 80 | m Ω | $V_{GS} = -4.5V, I_D = -3.8A$ |
| | | - | 63 | 90 | | $V_{GS} = -3.3V, I_D = -3.5A$ |
| | | - | 70 | 100 | | $V_{GS} = -2.5V, I_D = -3.3A$ |
| | | - | 88 | 140 | | $V_{GS} = -1.8V, I_D = -1.0A$ |
| | | - | 110 | 210 | | $V_{GS} = -1.5V, I_D = -0.5A$ |
| | | - | - | - | | - |
| Diode Forward Voltage | V_{SD} | - | -0.7 | -1.2 | V | $V_{GS} = 0V, I_S = -1A$ |
| DYNAMIC CHARACTERISTICS (Note 7) | | | | | | |
| Input Capacitance | C_{ISS} | - | 576 | - | pF | $V_{DS} = -10V, V_{GS} = 0V, f = 1.0MHz$ |
| Output Capacitance | C_{OSS} | - | 87 | - | pF | |
| Reverse Transfer Capacitance | C_{RSS} | - | 71 | - | pF | |
| Gate Resistance | R_g | - | 15 | - | Ω | $V_{DS} = 0V, V_{GS} = 0V, f = 1MHz$ |
| Total Gate Charge ($V_{GS} = -3.3V$) | Q_g | - | 5.2 | - | nC | $V_{DS} = -10V, I_D = -4.9A$ |
| Total Gate Charge ($V_{GS} = -4.5V$) | | - | 6.7 | - | nC | |
| Total Gate Charge ($V_{GS} = -8V$) | | - | 11.5 | - | nC | |
| Gate-Source Charge | Q_{GS} | - | 1.0 | - | nC | |
| Gate-Drain Charge | Q_{GD} | - | 2.0 | - | nC | |
| Turn-On Delay Time | $t_{D(ON)}$ | - | 3.5 | - | ns | |
| Turn-On Rise Time | t_R | - | 3.6 | - | ns | |
| Turn-Off Delay Time | $t_{D(OFF)}$ | - | 20.8 | - | ns | |
| Turn-Off Fall Time | t_F | - | 12.7 | - | ns | |
| Body Diode Reverse Recovery Time | t_{RR} | - | 13.1 | - | ns | |
| Body Diode Reverse Recovery Charge | Q_{RR} | - | 3.9 | - | nC | $I_S = -3.9A, dI/dt = 100A/\mu s$ |

Notes: 6. Short duration pulse test used to minimize self-heating effect.
7. Guaranteed by design. Not subject to product testing.

Typical Characteristics - N-CHANNEL

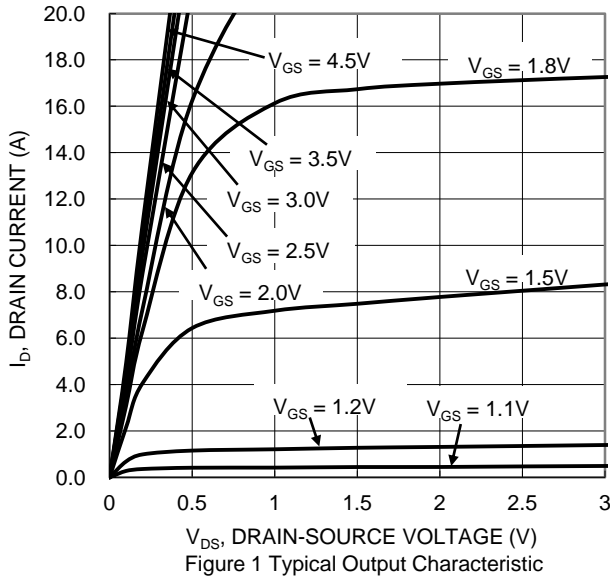


Figure 1 Typical Output Characteristic

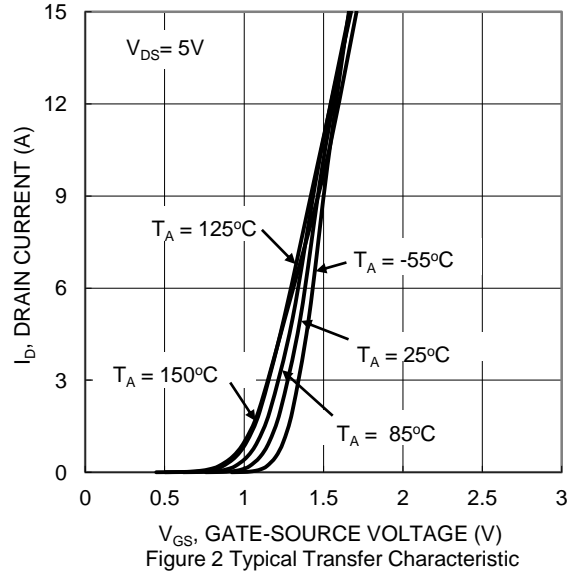


Figure 2 Typical Transfer Characteristic

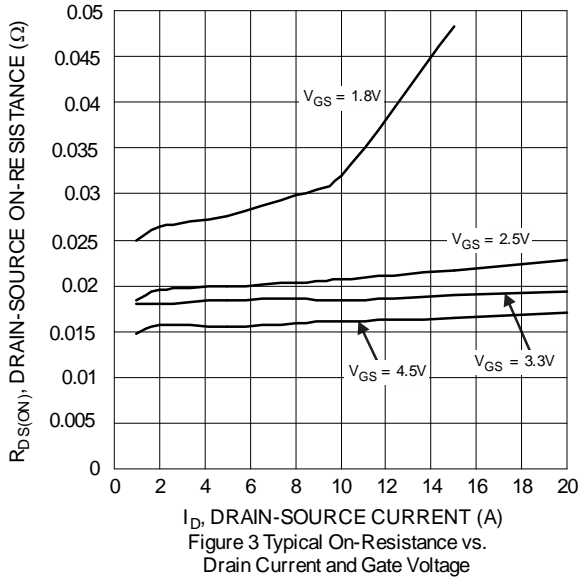


Figure 3 Typical On-Resistance vs. Drain Current and Gate Voltage

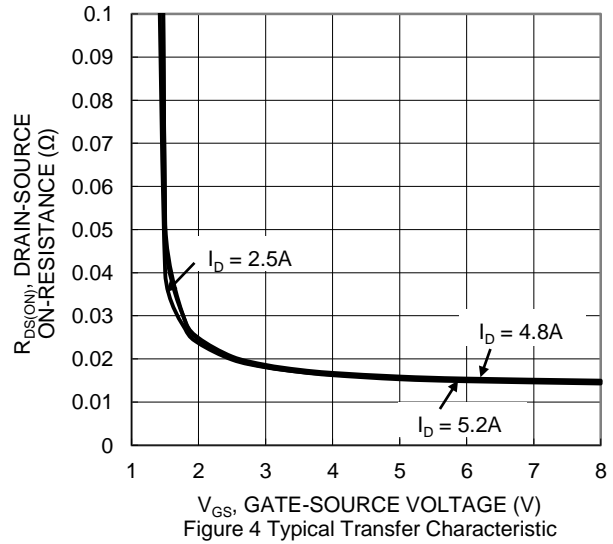


Figure 4 Typical Transfer Characteristic

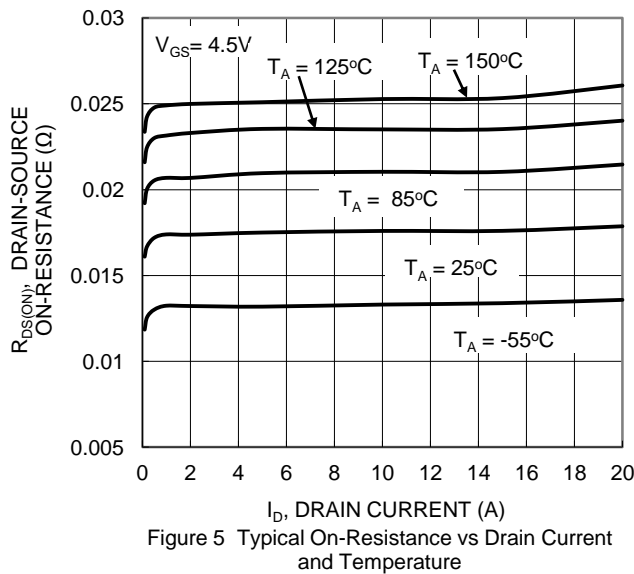


Figure 5 Typical On-Resistance vs Drain Current and Temperature

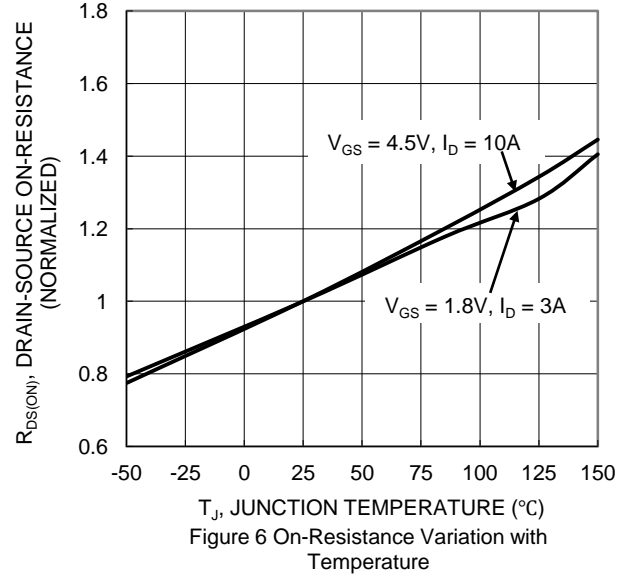


Figure 6 On-Resistance Variation with Temperature

Typical Characteristics - N-CHANNEL (continued)

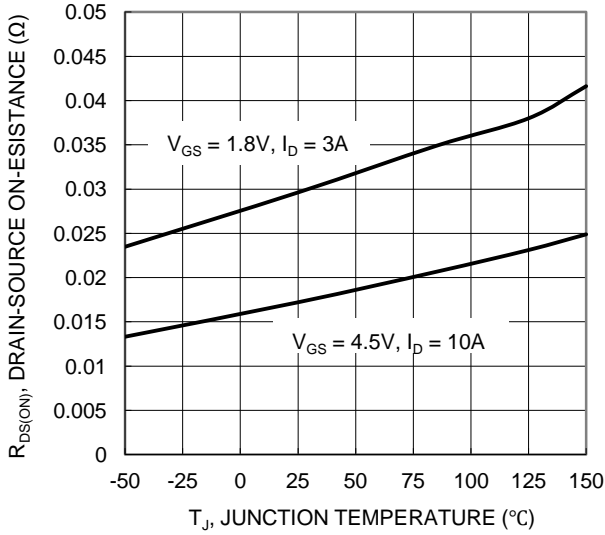


Figure 7 On-Resistance Variation with Temperature

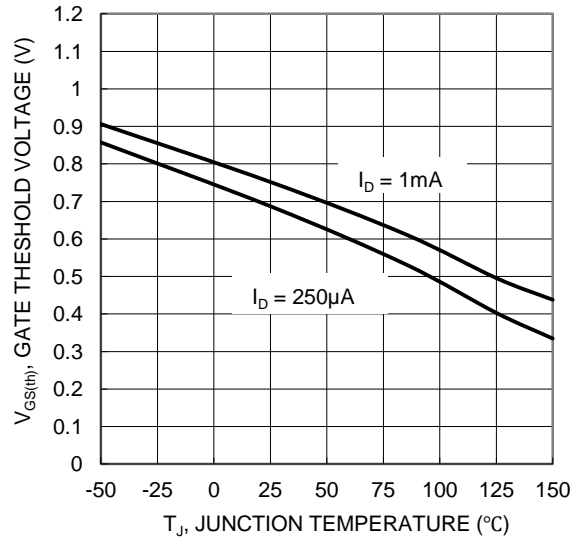


Figure 8 Gate Threshold Variation vs Junction Temperature

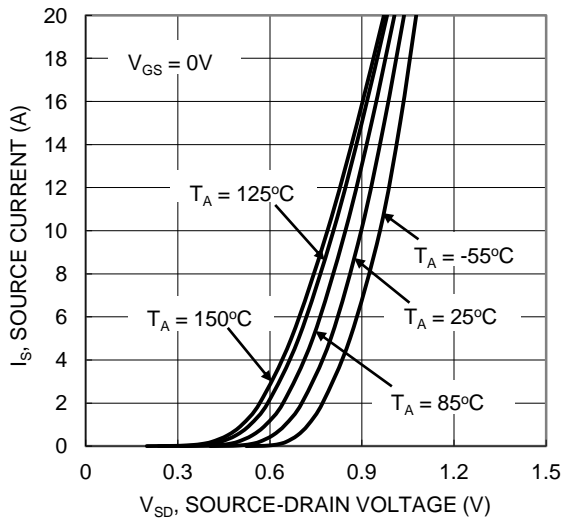


Figure 9 Diode Forward Voltage vs. Current

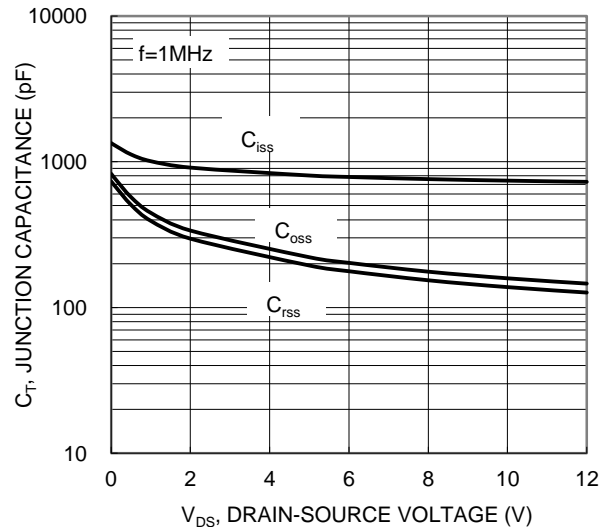


Figure 10 Typical Junction Capacitance

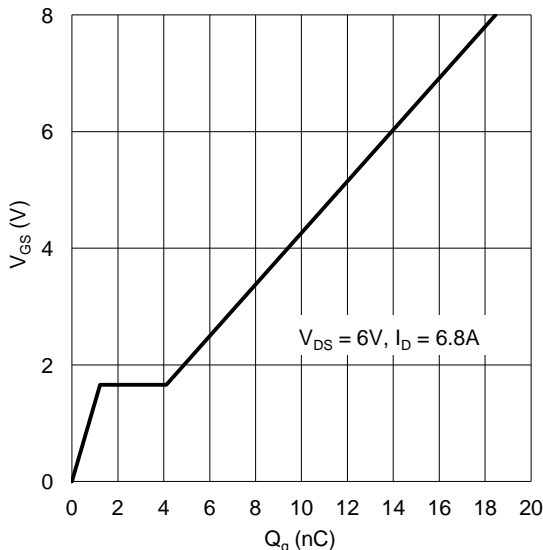


Figure 11 Gate Charge

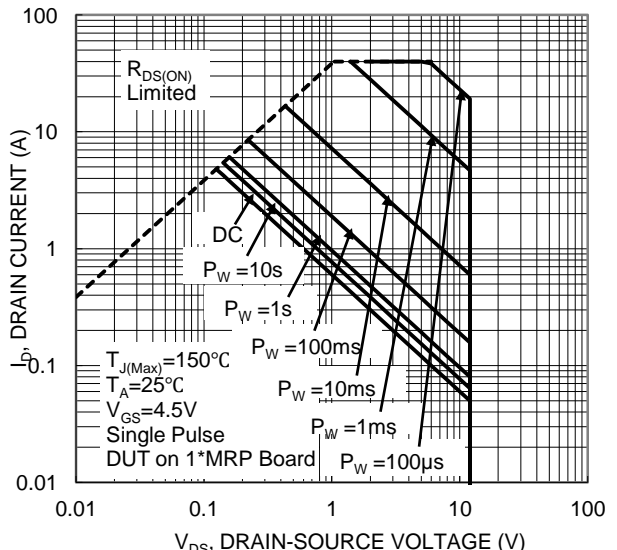


Figure 12 SOA, Safe Operation Area

Typical Characteristics - P-CHANNEL

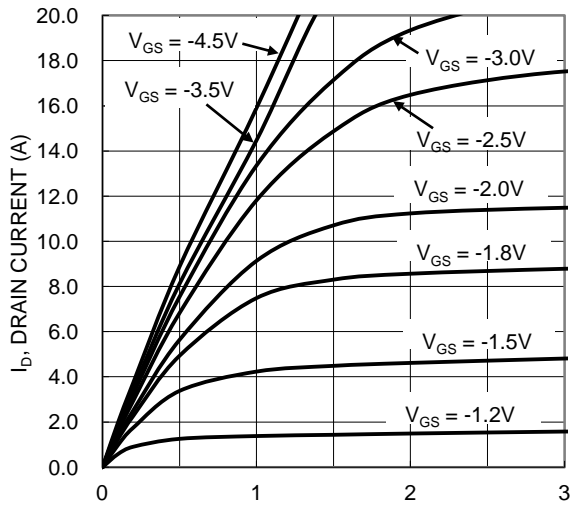


Figure 13 Typical Output Characteristic

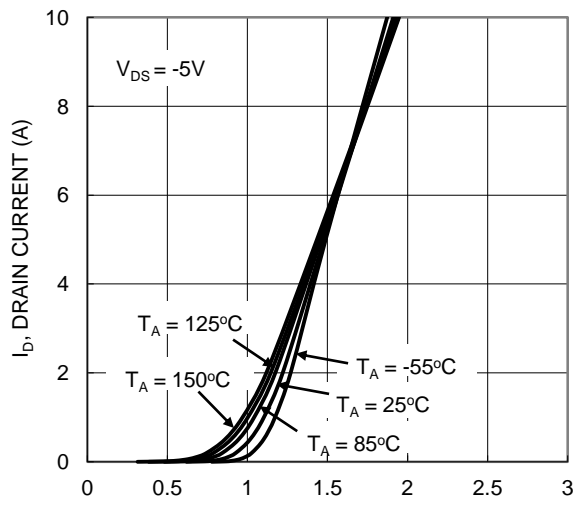


Figure 14 Typical Transfer Characteristic

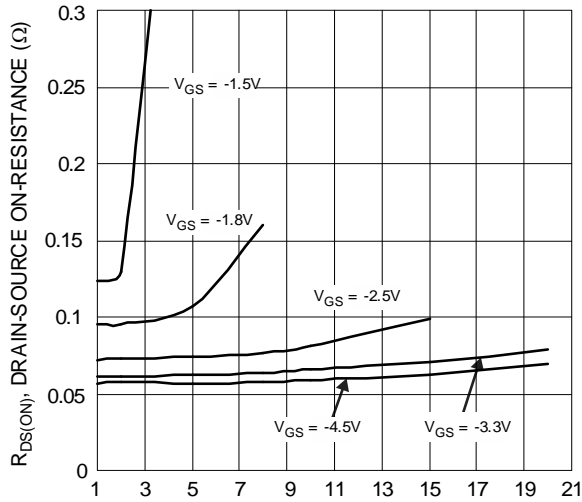


Figure 15 Typical On-Resistance vs. Drain Current and Gate Voltage

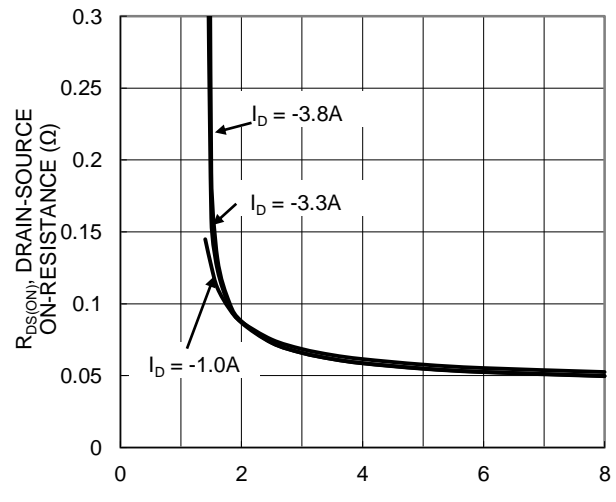


Figure 16 Typical Transfer Characteristic

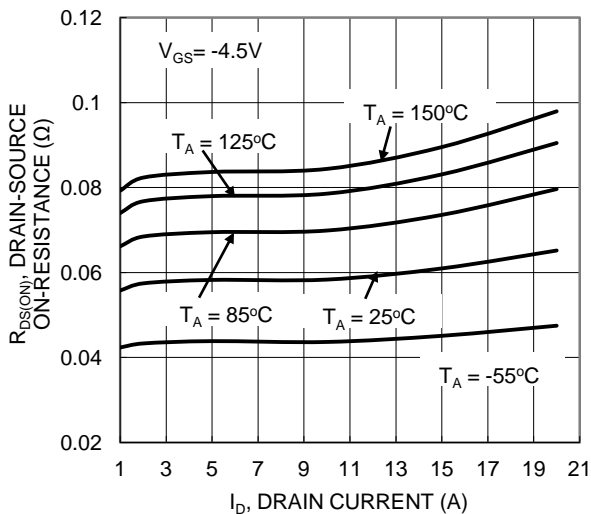


Figure 17 Typical On-Resistance vs Drain Current and Temperature

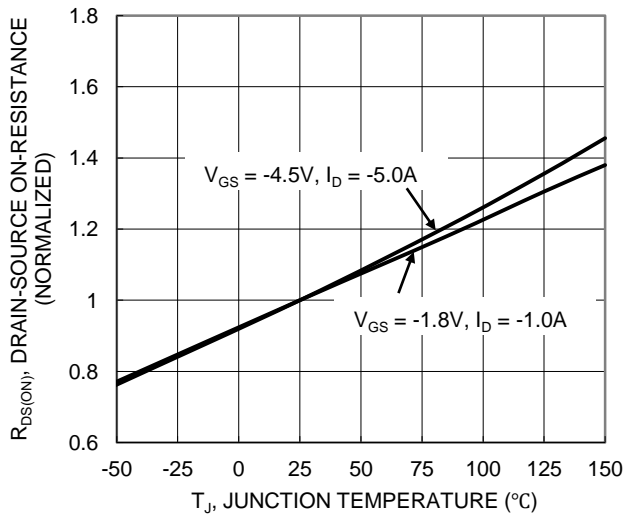


Figure 18 On-Resistance Variation with Temperature

Typical Characteristics - P-CHANNEL (continued)

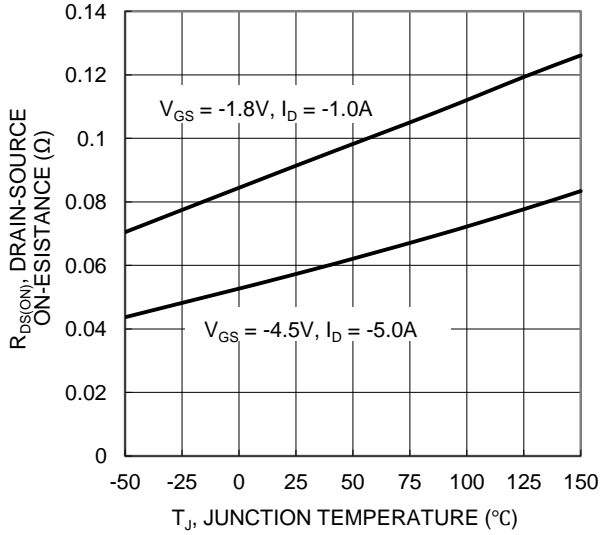


Figure 19 On-Resistance Variation with Temperature

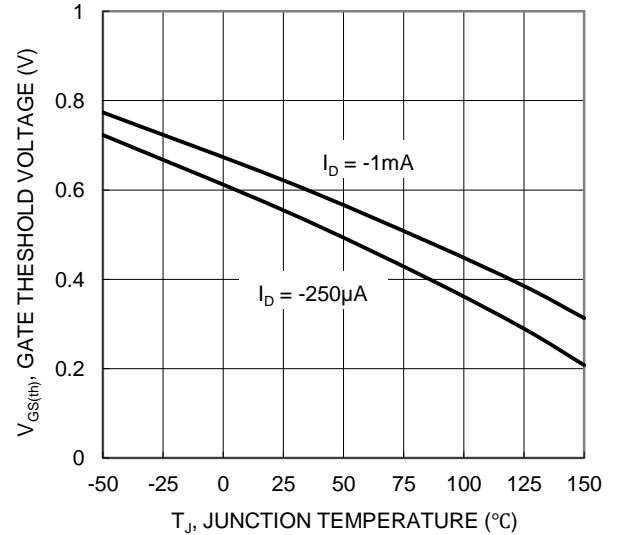


Figure 20 Gate Threshold Variation vs Junction Temperature

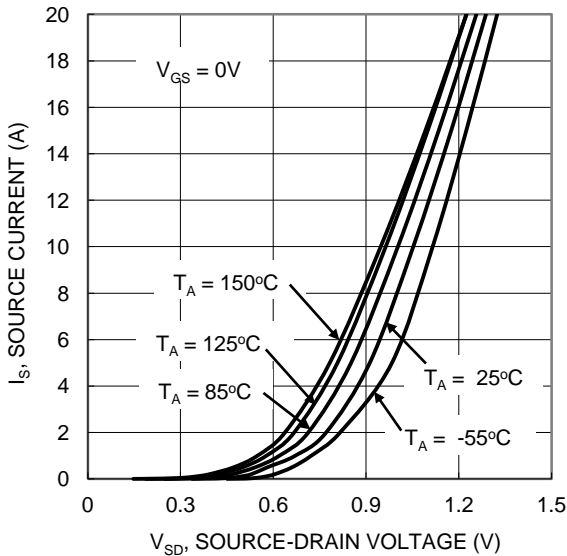


Figure 21 Diode Forward Voltage vs. Current

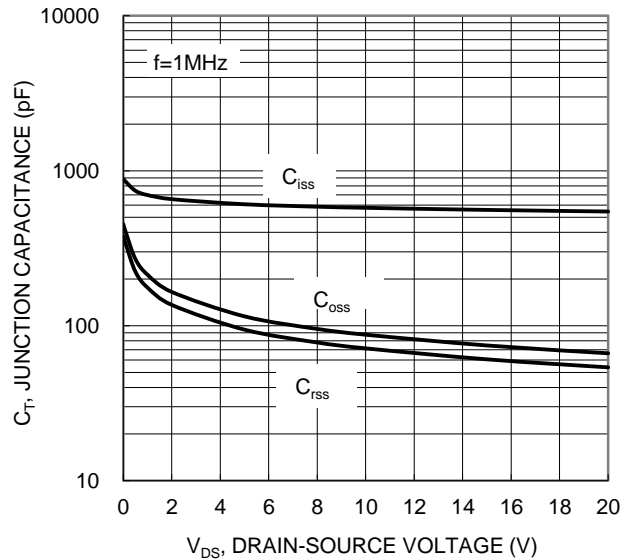
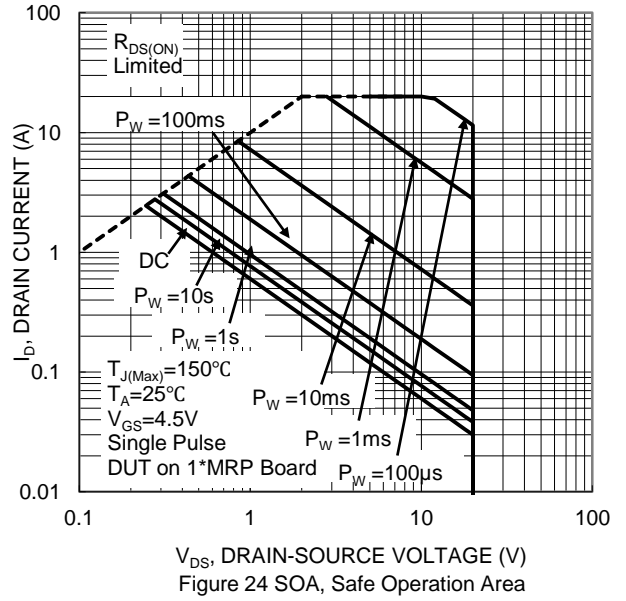
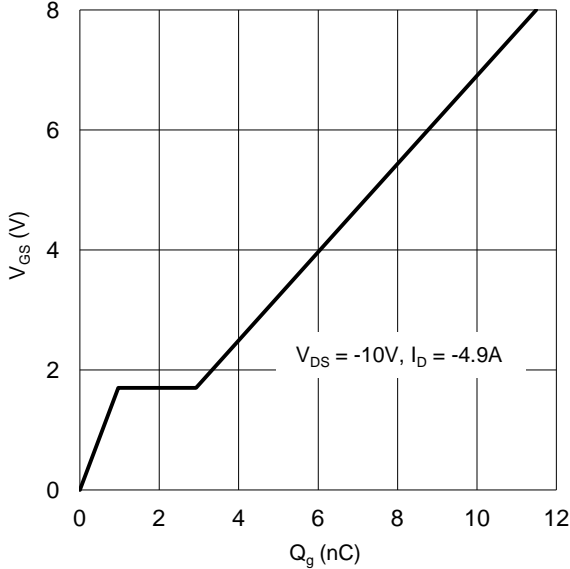
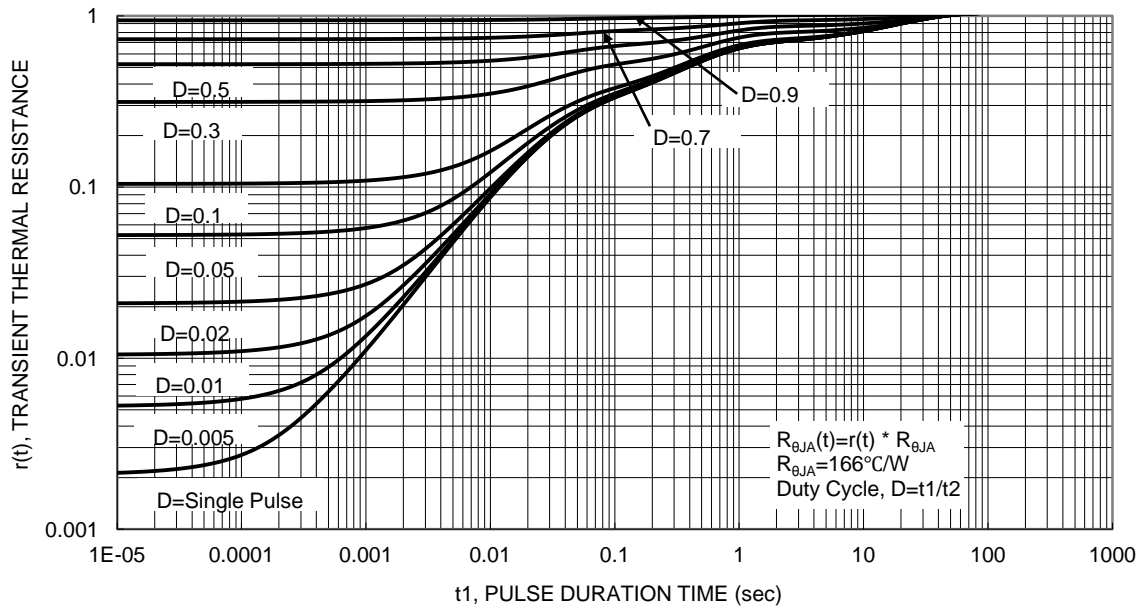


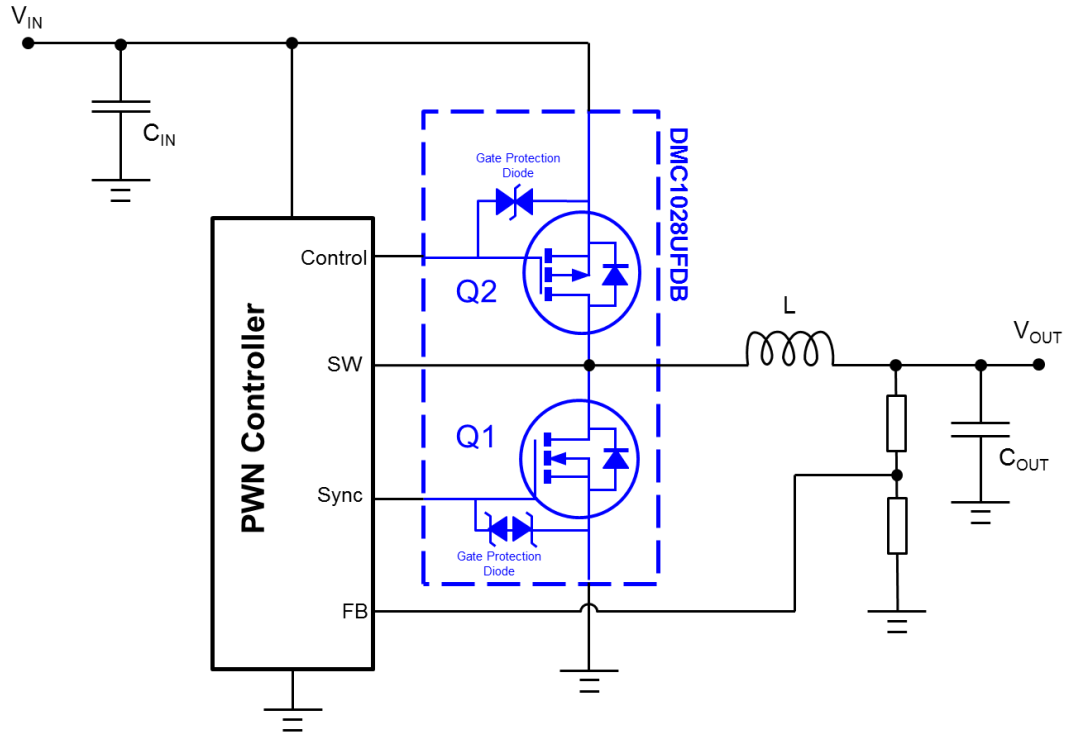
Figure 22 Typical Junction Capacitance



Typical Characteristics - P-CHANNEL (cont.)



Typical Application Circuit

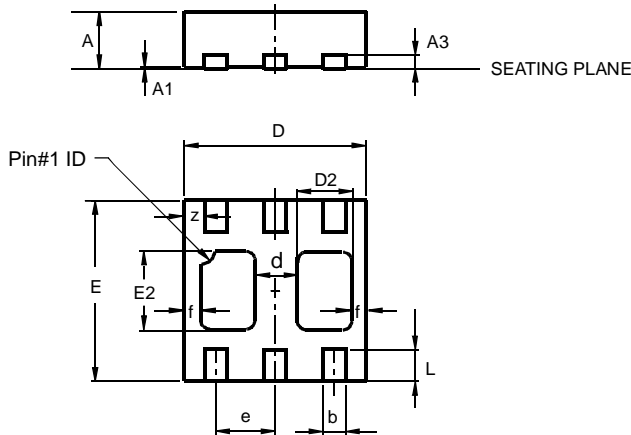


Example of a 3.3V to 1V POL Buck Converter using the DMC1028UFDB

DMC1028UFDB is designed for Point-of-Load (POL) converter that is stepping down from a nominal 3.3V to 1V with a load current up to 3A. This is implemented with a separate ASIC that is PWM signaling the complementary MOSFETs to act as a synchronous buck converter. The control switch (Q2) is implemented with P-channel MOSFETs to avoid needing a charge pump and with the 3.3V to 1V step down, which has a duty cycle of 33%. This means that for 67% of the cycle, the synchronous switch (Q1) is on and efficiency is dominated by the conduction losses; hence, the need for low $R_{DS(on)}$ N-channel MOSFETs. Whereas for the control switch (Q2), the gate charge needs to be minimized as the switching losses become significant.

Package Outline Dimensions

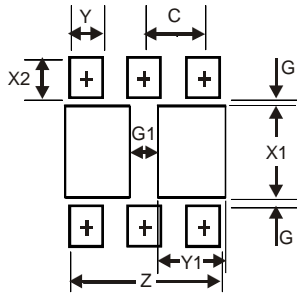
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.



| U-DFN2020-6 Type B | | | |
|-----------------------|-------|-------|-------|
| Dim | Min | Max | Typ |
| A | 0.545 | 0.605 | 0.575 |
| A1 | 0 | 0.05 | 0.02 |
| A3 | — | — | 0.13 |
| b | 0.20 | 0.30 | 0.25 |
| D | 1.95 | 2.075 | 2.00 |
| d | — | — | 0.45 |
| D2 | 0.50 | 0.70 | 0.60 |
| e | — | — | 0.65 |
| E | 1.95 | 2.075 | 2.00 |
| E2 | 0.90 | 1.10 | 1.00 |
| f | — | — | 0.15 |
| L | 0.25 | 0.35 | 0.30 |
| z | — | — | 0.225 |
| All Dimensions in mm | | | |

Suggested Pad Layout

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.



| Dimensions | Value (in mm) |
|------------|---------------|
| Z | 1.67 |
| G | 0.20 |
| G1 | 0.40 |
| X1 | 1.0 |
| X2 | 0.45 |
| Y | 0.37 |
| Y1 | 0.70 |
| C | 0.65 |

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