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.

Mechanical Data

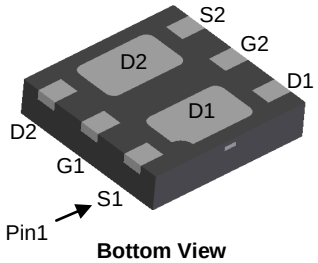
- Case: U-DFN2020-6 (Type B)
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish NiPdAu over Copper Leadframe. Solderable per MIL-STD-202, Method 208 e4
- Terminals Connections: See Diagram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

Applications

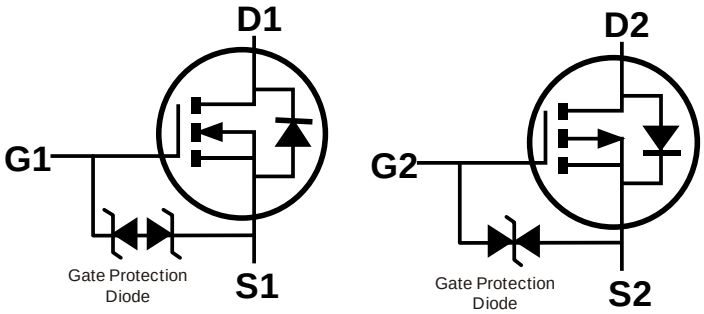
Optimized for Point of Load (POL) Synchronous Buck Converter that steps down from 3.3V to 1V for core voltage supply to ASICs. Target applications are Ethernet Network Controllers used in:

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

U-DFN2020-6 (Type B)



Bottom View



Internal Schematic

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	$R_{\theta JA}$	92	°C/W
	t < 5s		66	
Thermal Resistance, Junction to Case (Note 5)		$R_{\theta JC}$	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	V_{DD} = 6V, V_{GS} = 4.5V, R_L = 1.1Ω, R_G = 1Ω
Turn-On Rise Time	t_R	-	9.4	-	ns	
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°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 = -250µA
Zero Gate Voltage Drain Current T_J = +25°C	I_{DSS}	-	-	-1.0	µA	V_{DS} = -20V, 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	$R_{DS(ON)}$	-	55	80	mΩ	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	V_{DD} = -10V, V_{GS} = -4.5V, R_L = 2.6Ω, R_G = 1Ω
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	I_S = -3.9A, dI/dt = 100A/µs
Body Diode Reverse Recovery Charge	Q_{RR}	-	3.9	-	nC	I_S = -3.9A, dI/dt = 100A/µs

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

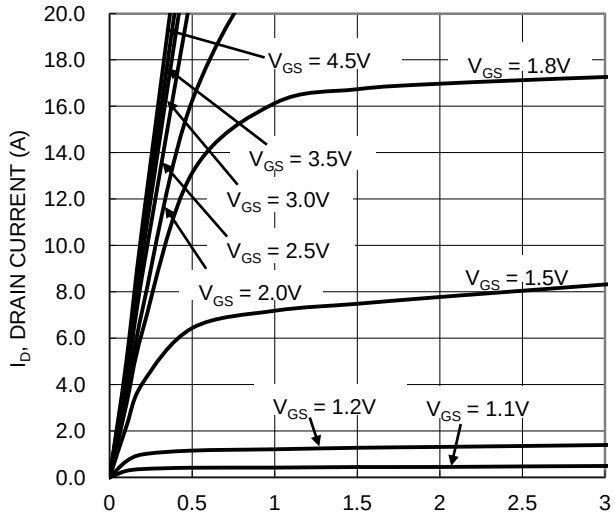


Figure 1 Typical Output Characteristic

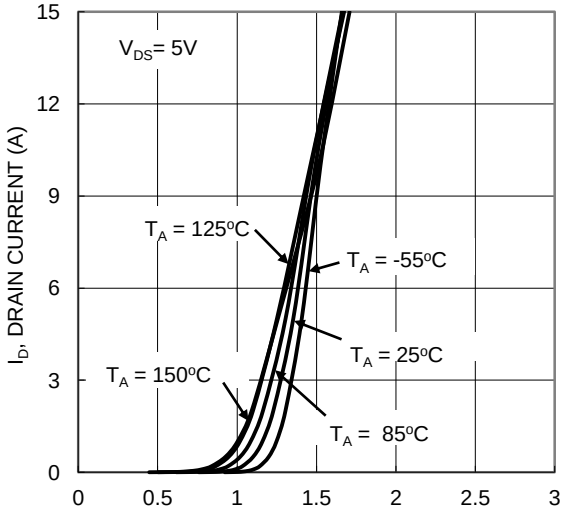


Figure 2 Typical Transfer Characteristic

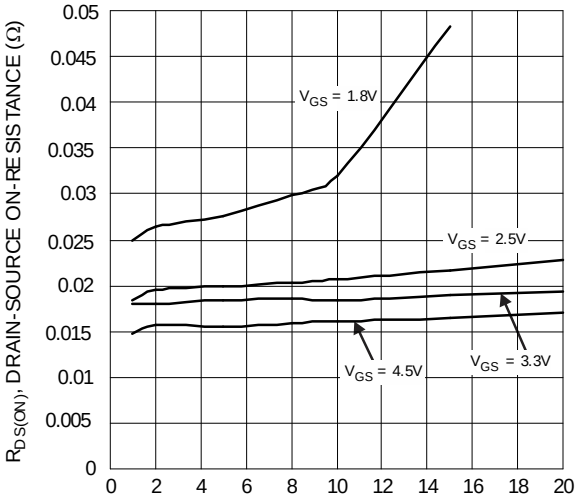


Figure 3 Typical On-Resistance vs. Drain Current and Gate Voltage

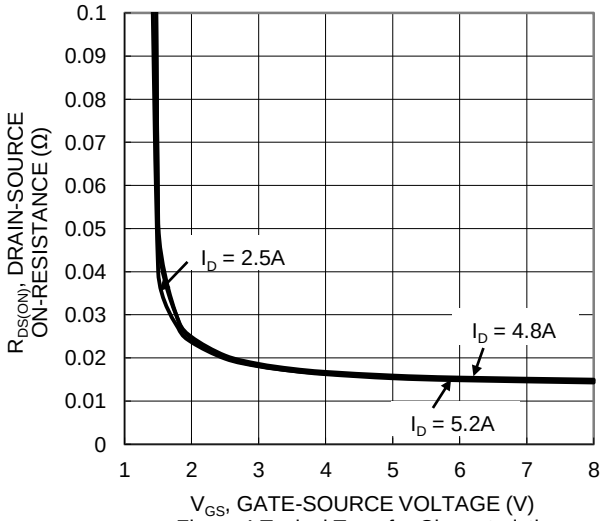


Figure 4 Typical Transfer Characteristic

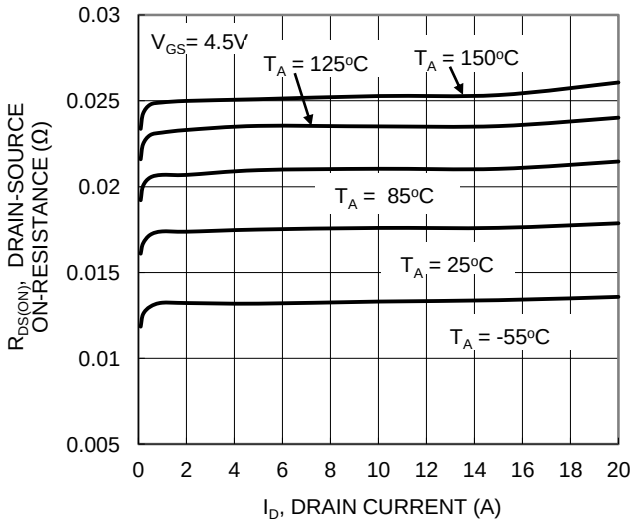


Figure 5 Typical On-Resistance vs Drain Current and Temperature

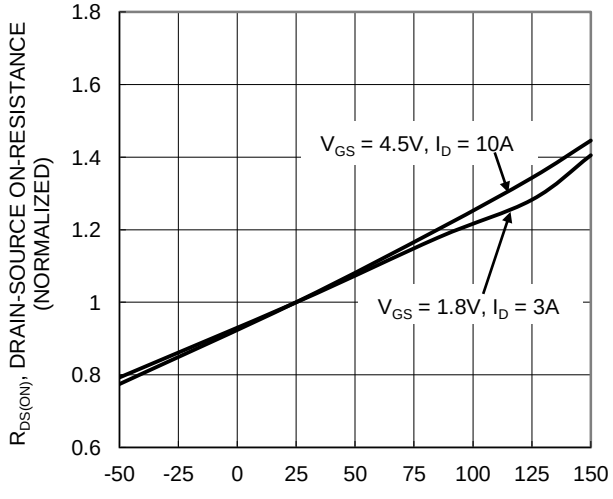


Figure 6 On-Resistance Variation with Temperature

Typical Characteristics - N-CHANNEL (continued)

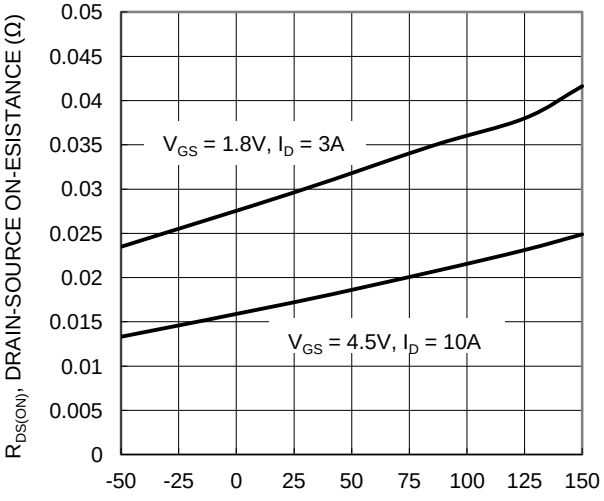


Figure 7 On-Resistance Variation with Temperature

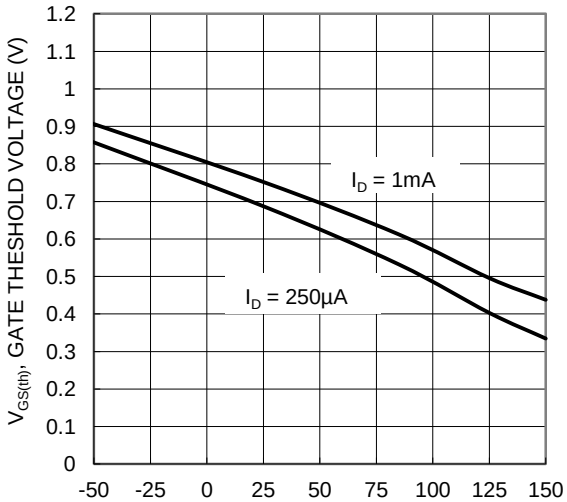


Figure 8 Gate Theshold Variation vs Junction Temperature

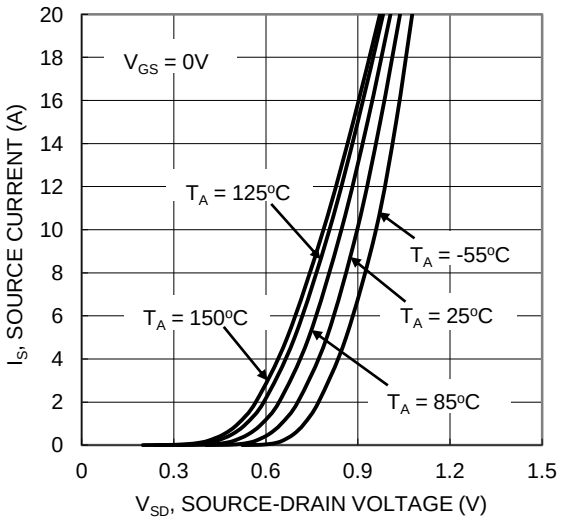


Figure 9 Diode Forward Voltage vs. Current

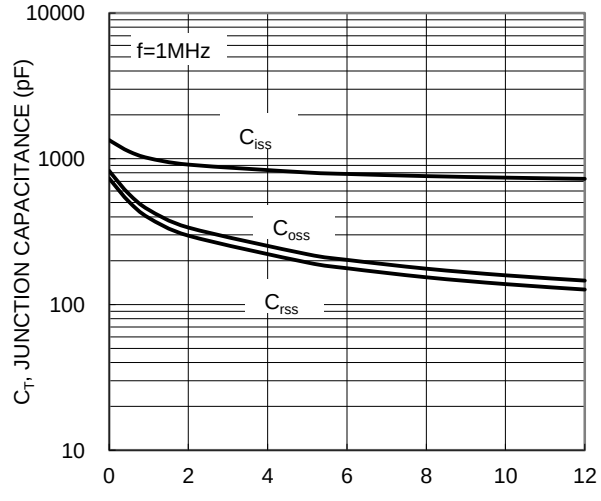
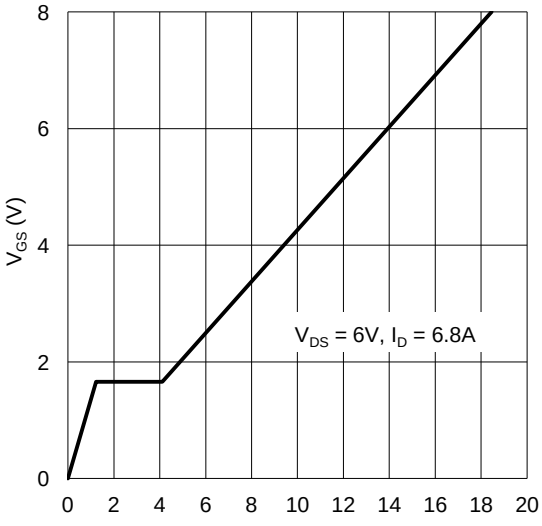


Figure 10 Typical Junction Capacitance



Fiure 11 Gate Charge

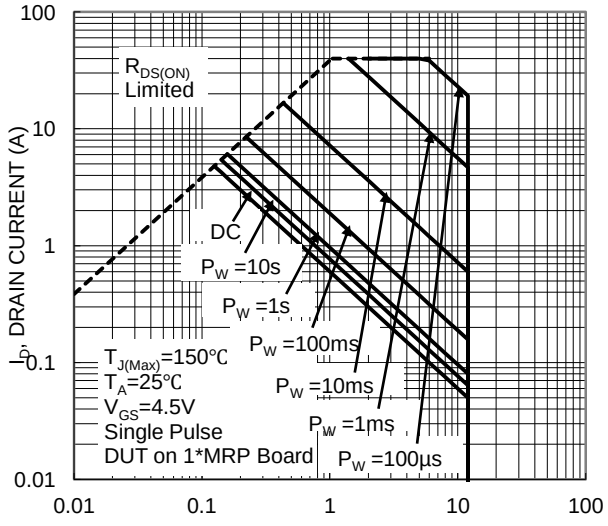


Figure 12 SOA, Safe Operation Area

Typical Characteristics - P-CHANNEL

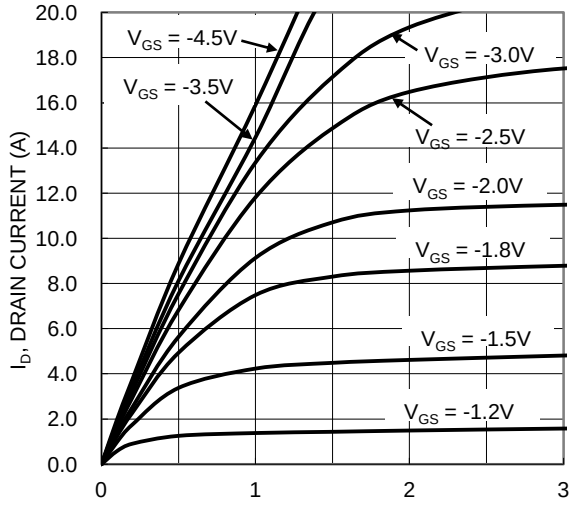


Figure 13 Typical Output Characteristic

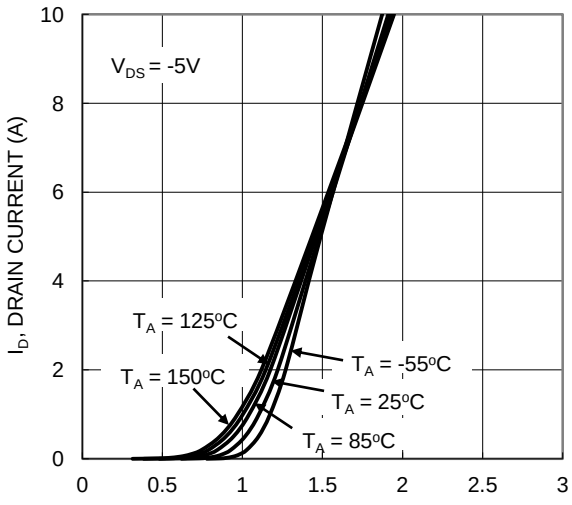


Figure 14 Typical Transfer Characteristic

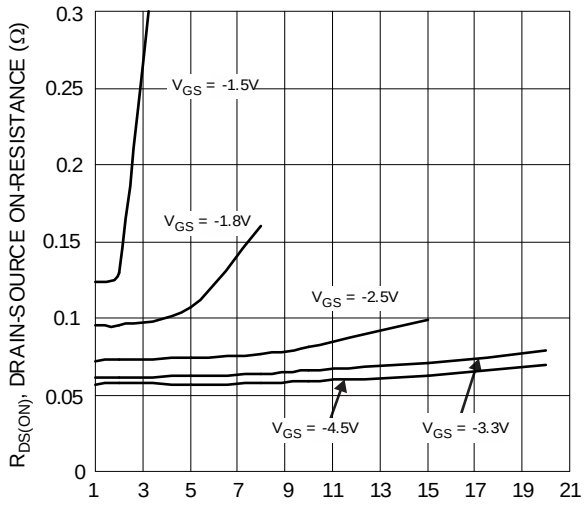


Figure 15 Typical On-Resistance vs. Drain Current and Gate Voltage

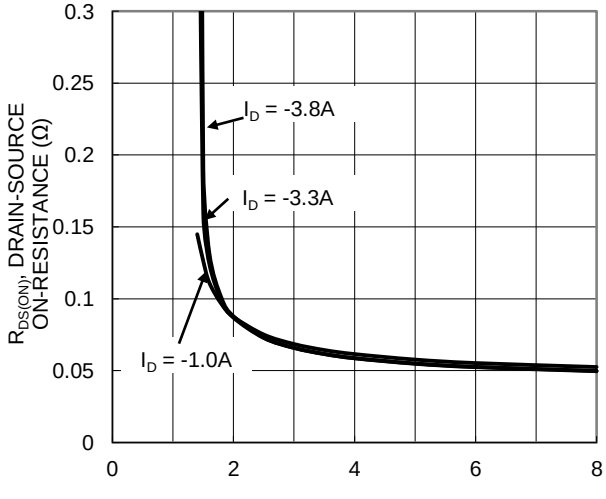


Figure 16 Typical Transfer Characteristic

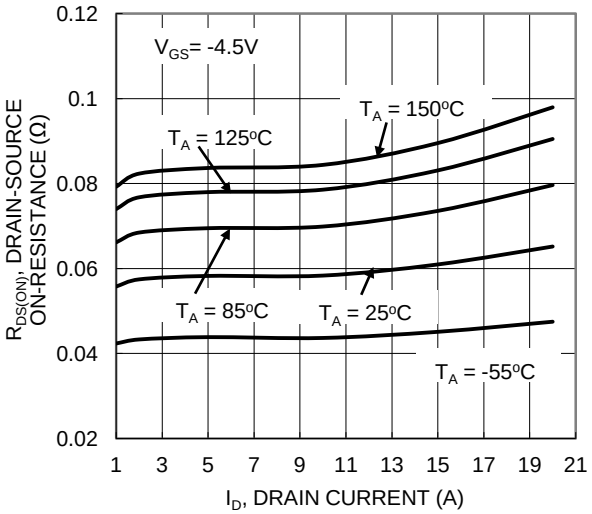


Figure 17 Typical On-Resistance vs Drain Current and Temperature

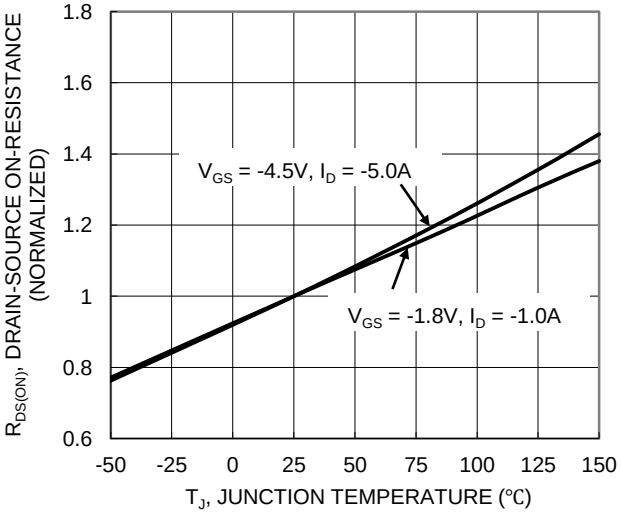


Figure 18 On-Resistance Variation with Temperature

Typical Characteristics - P-CHANNEL (continued)

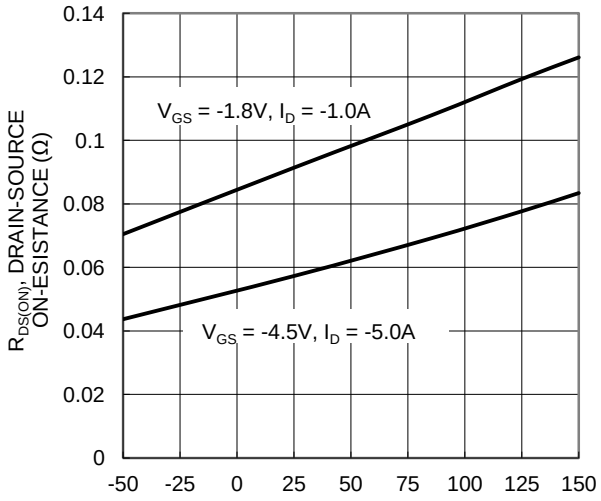


Figure 19 On-Resistance Variation with Temperature

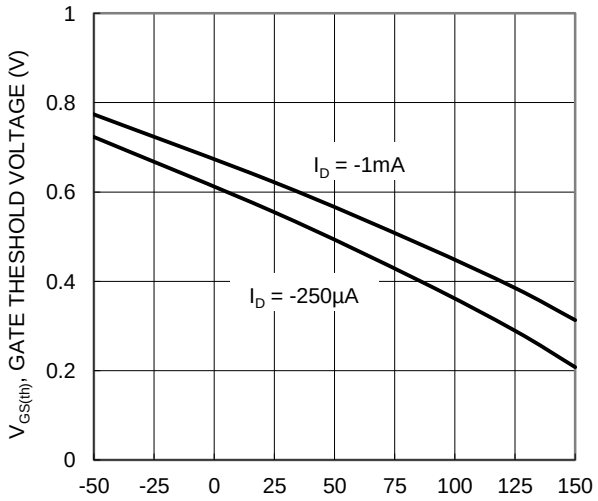


Figure 20 Gate Theshold Variation vs Junction Temperature

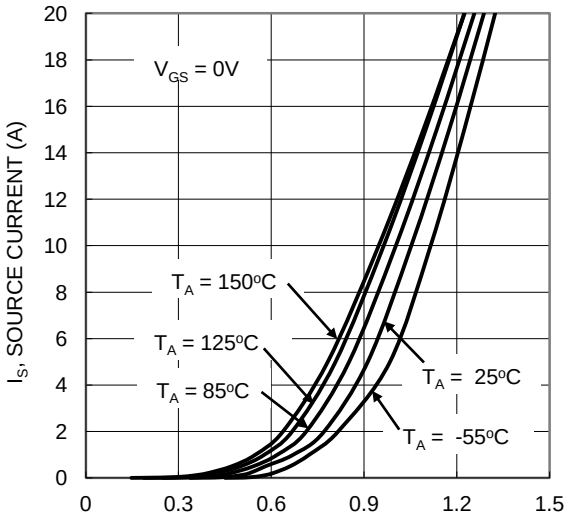


Figure 21 Diode Forward Voltage vs. Current

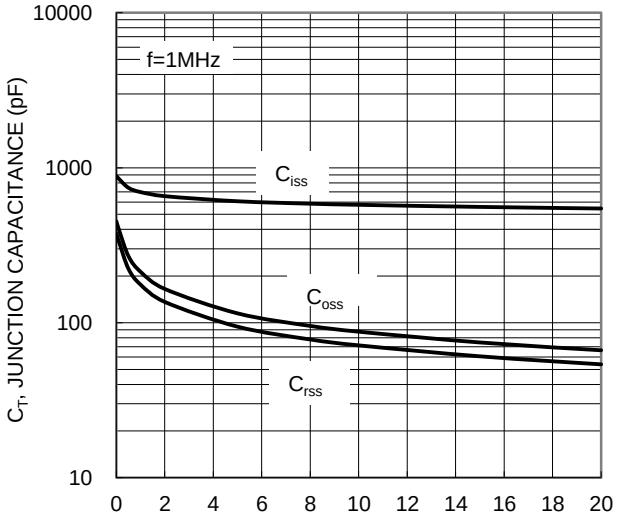


Figure 22 Typical Junction Capacitance

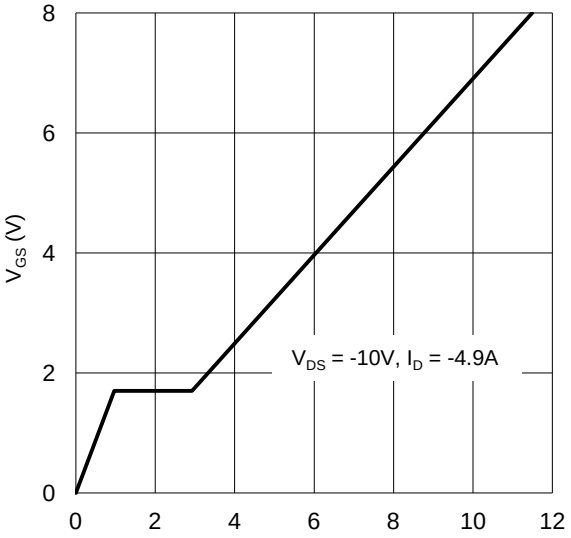


Figure 23 Gate Charge

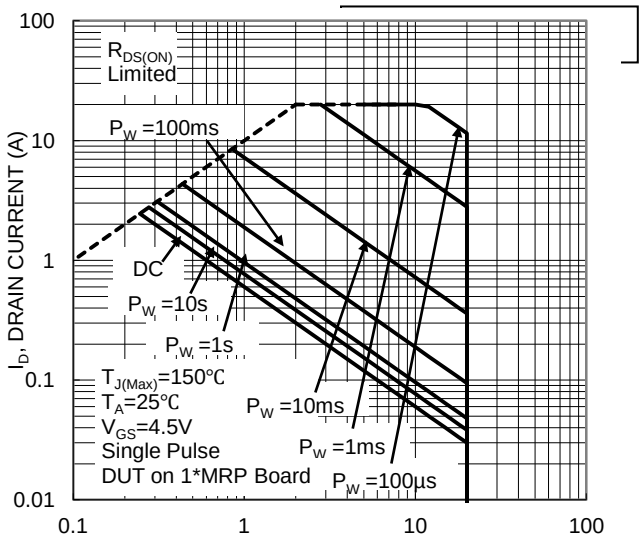


Figure 24 SOA, Safe Operation Area

Typical Characteristics - P-CHANNEL (cont.)

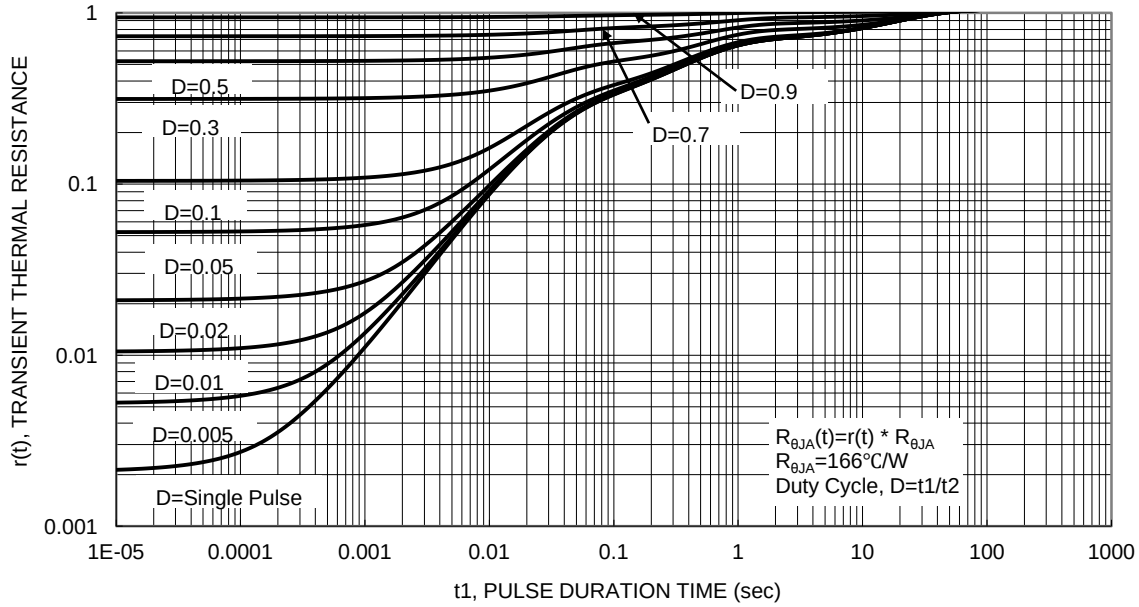
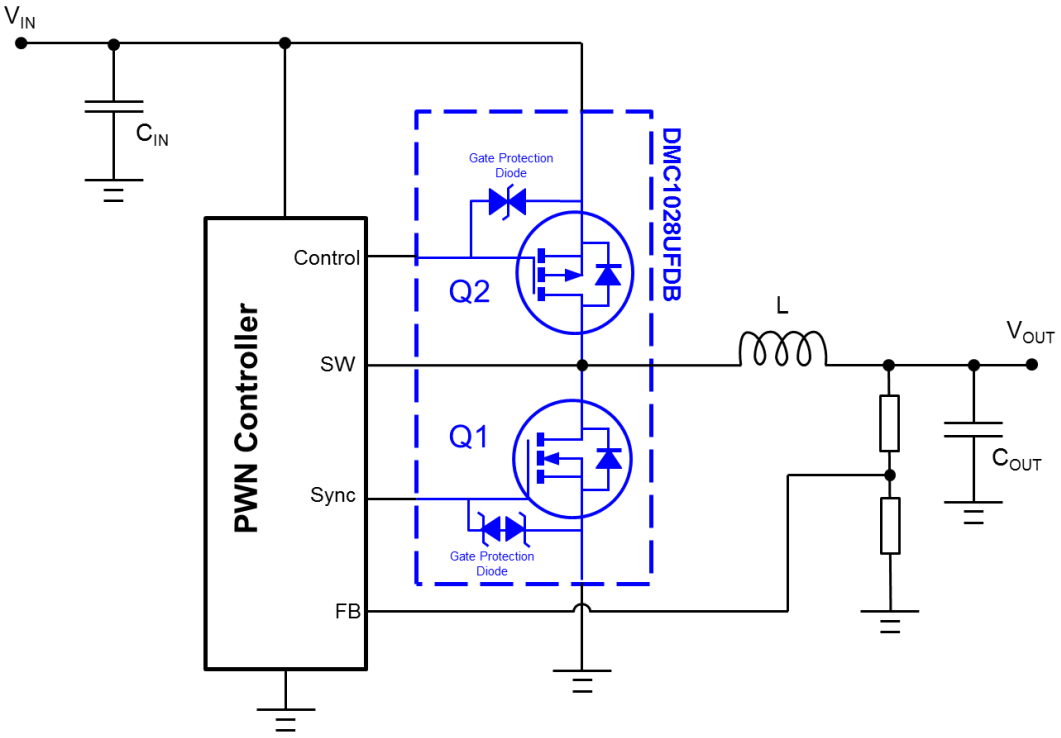


Figure 25 Transient Thermal Resistance

Typical Application Circuit

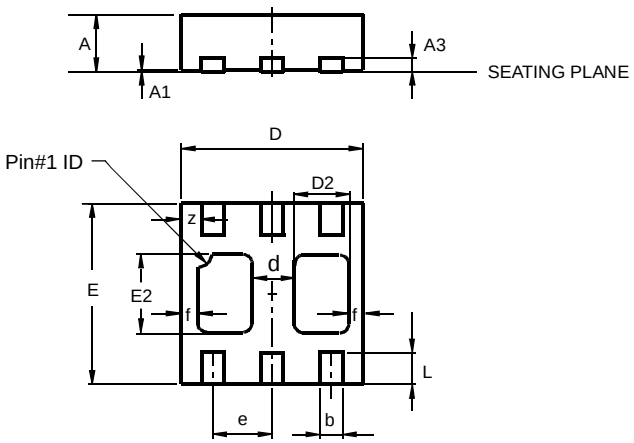


Example of a 3.3V to 1V POL Buck Converter using the DMC1028UFDB

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

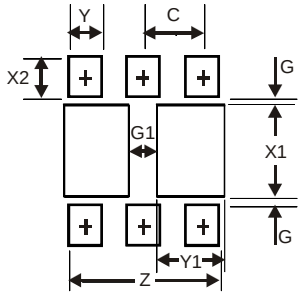
Please see AP02002 at http://www.diodes.com/datasheets/ap02002.pdf for the latest version.



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