

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.

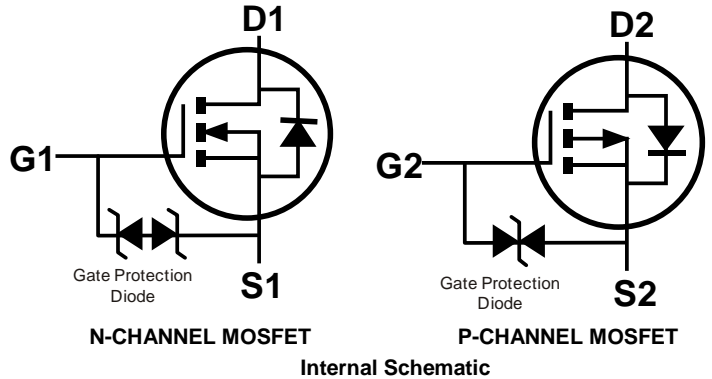
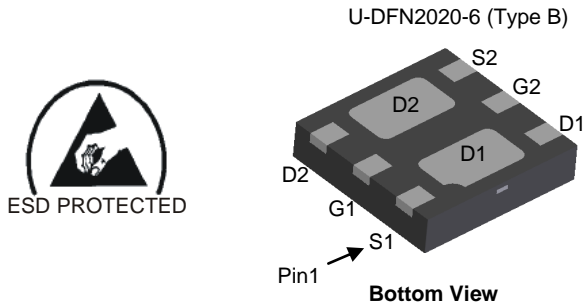
Applications

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)

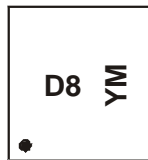


Ordering Information (Note 4)

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	$V_{DS} = -10V, V_{GS} = 0V, f = 1.0\text{MHz}$
Output Capacitance	C_{OSS}	-	87	-	pF	
Reverse Transfer Capacitance	C_{RSS}	-	71	-	pF	
Gate Resistance	R_g	-	15	-	Ω	$V_{DS} = 0V, V_{GS} = 0V, f = 1\text{MHz}$
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

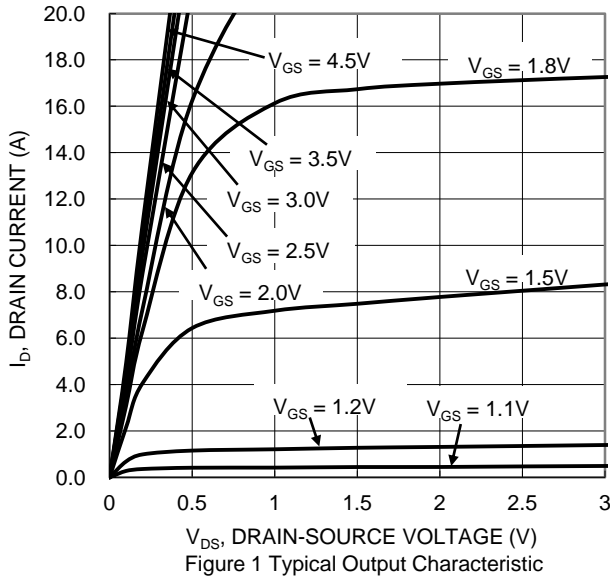


Figure 1 Typical Output Characteristic

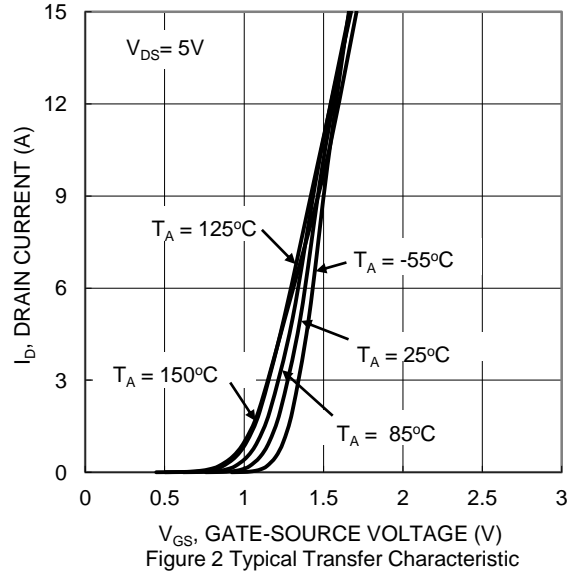


Figure 2 Typical Transfer Characteristic

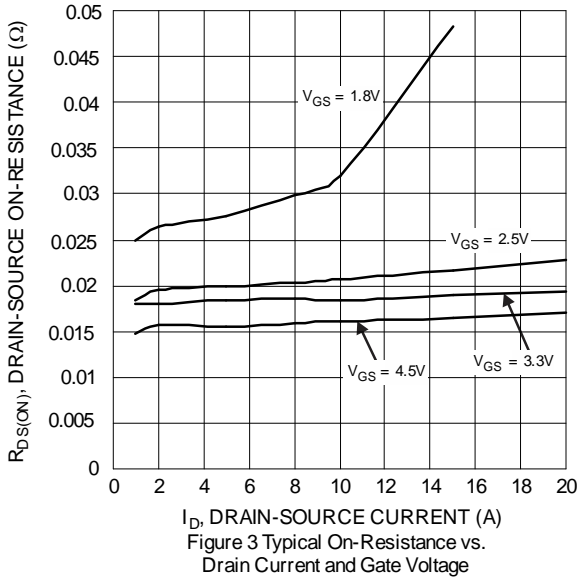


Figure 3 Typical On-Resistance vs. Drain Current and Gate Voltage

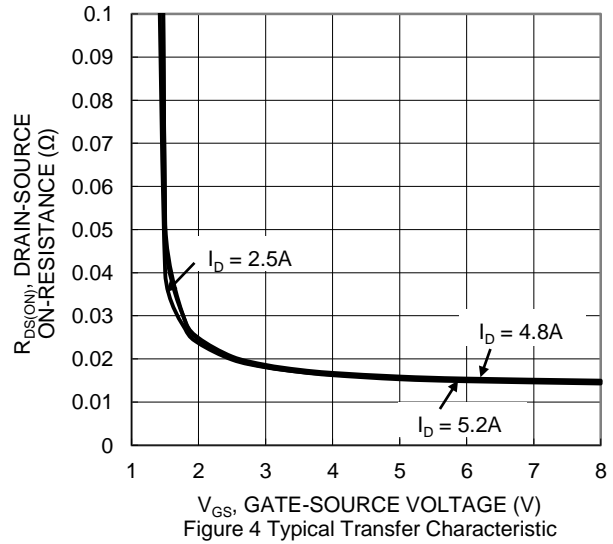


Figure 4 Typical Transfer Characteristic

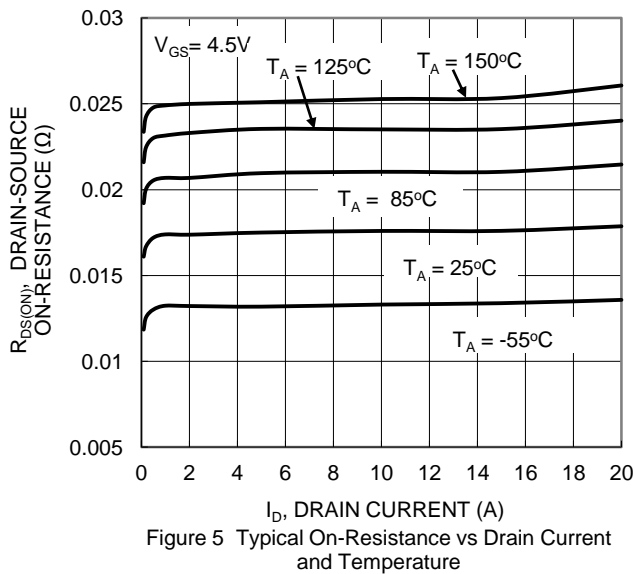


Figure 5 Typical On-Resistance vs Drain Current and Temperature

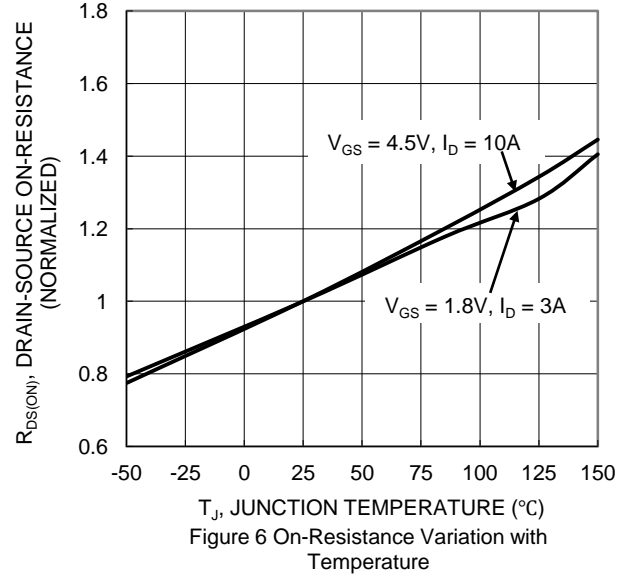


Figure 6 On-Resistance Variation with Temperature

Typical Characteristics - N-CHANNEL (continued)

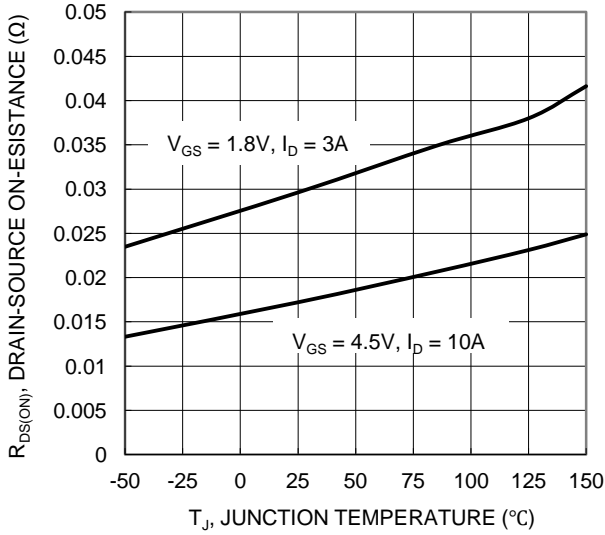


Figure 7 On-Resistance Variation with Temperature

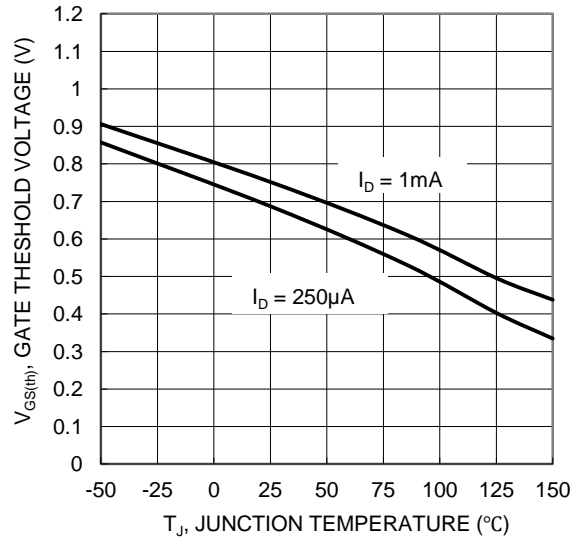


Figure 8 Gate Threshold Variation vs Junction Temperature

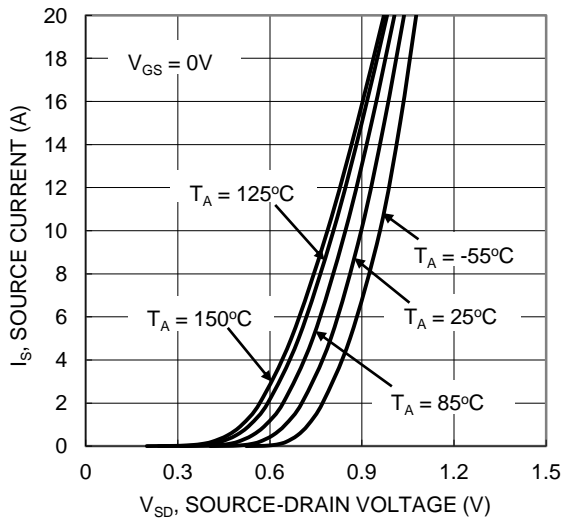


Figure 9 Diode Forward Voltage vs. Current

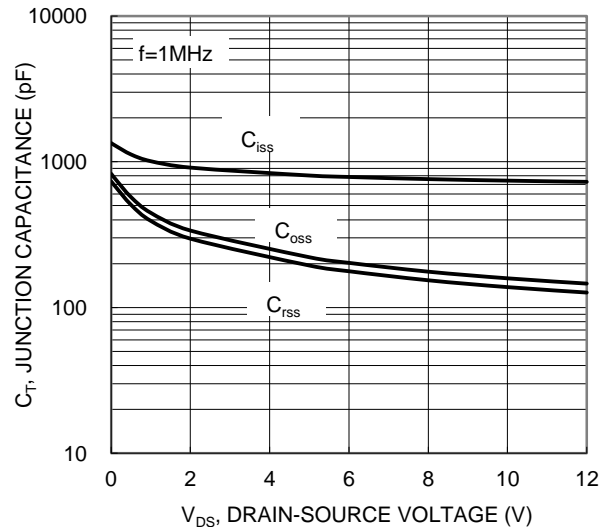


Figure 10 Typical Junction Capacitance

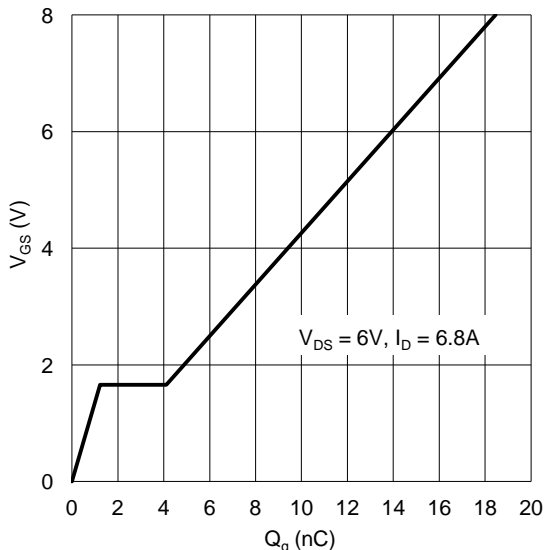


Figure 11 Gate Charge

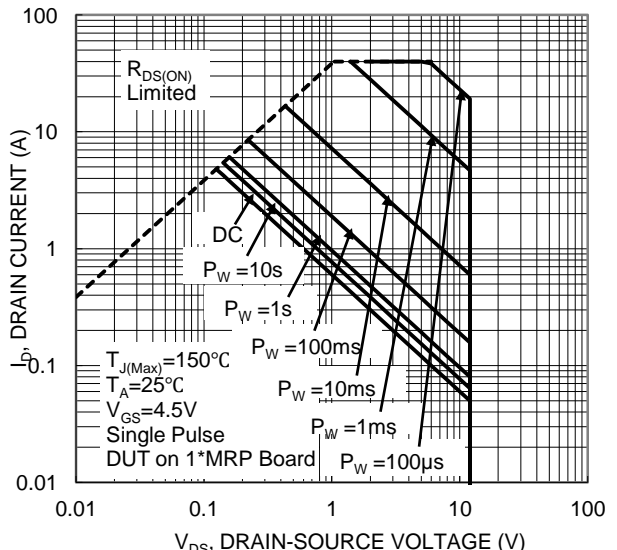


Figure 12 SOA, Safe Operation Area

Typical Characteristics - P-CHANNEL

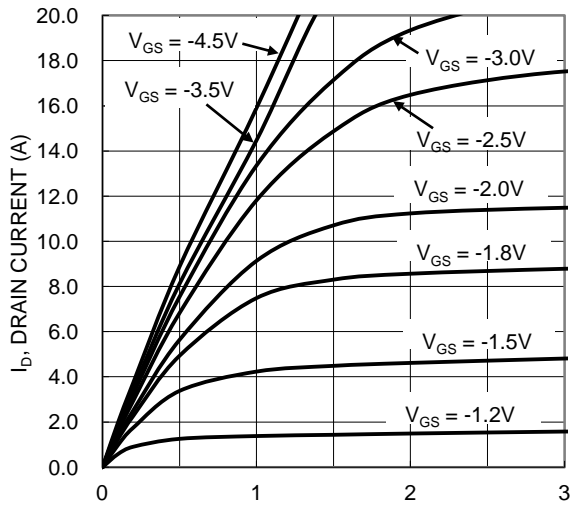


Figure 13 Typical Output Characteristic

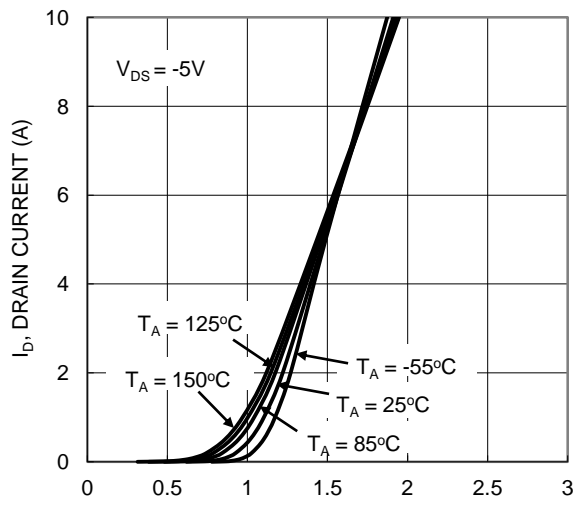


Figure 14 Typical Transfer Characteristic

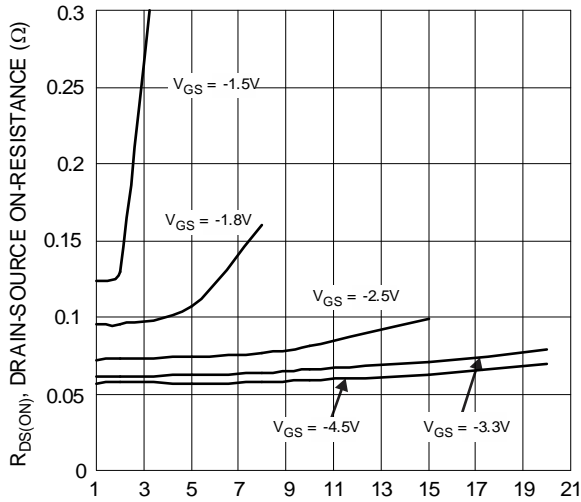


Figure 15 Typical On-Resistance vs. Drain Current and Gate Voltage

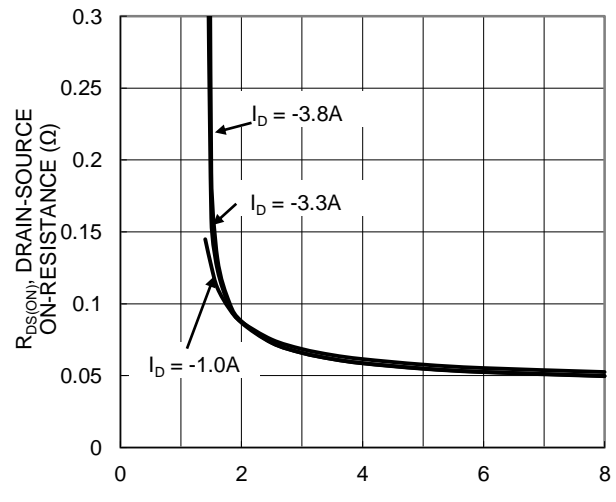


Figure 16 Typical Transfer Characteristic

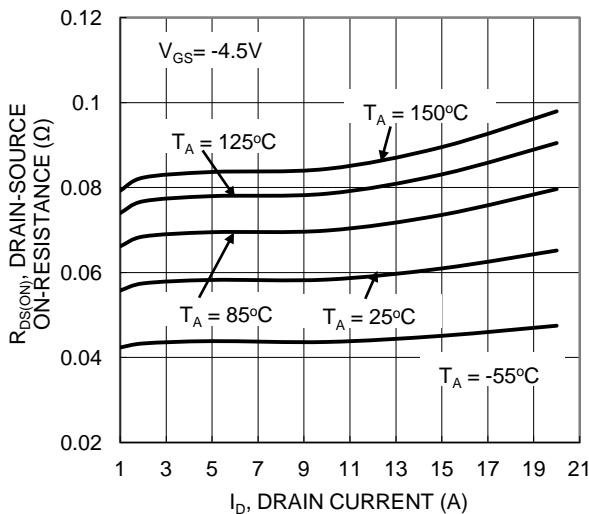


Figure 17 Typical On-Resistance vs Drain Current and Temperature

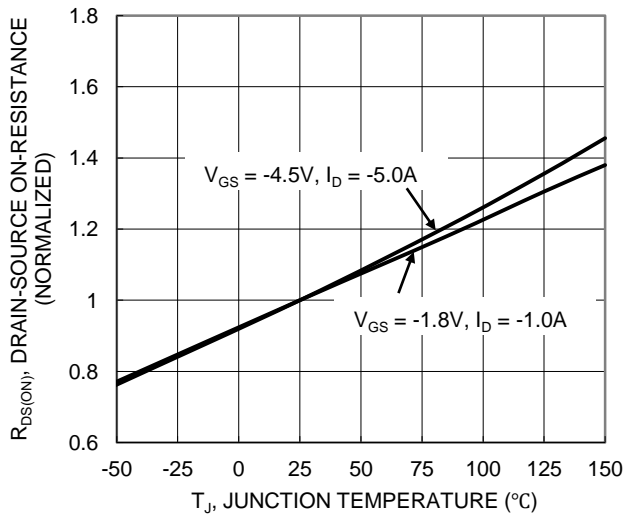


Figure 18 On-Resistance Variation with Temperature

Typical Characteristics - P-CHANNEL (continued)

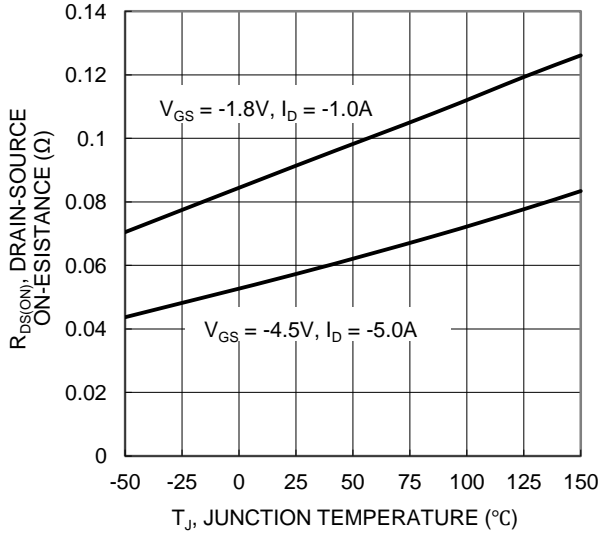


Figure 19 On-Resistance Variation with Temperature

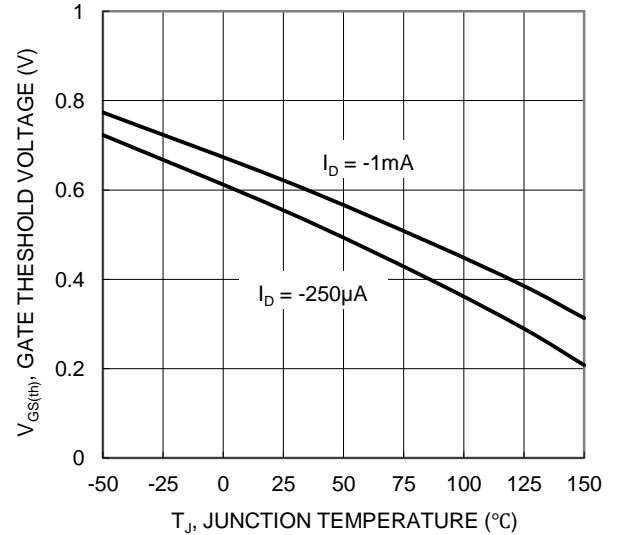


Figure 20 Gate Threshold Variation vs Junction Temperature

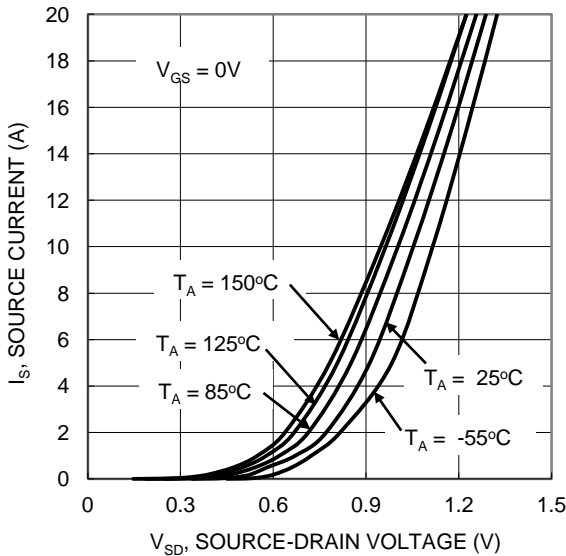


Figure 21 Diode Forward Voltage vs. Current

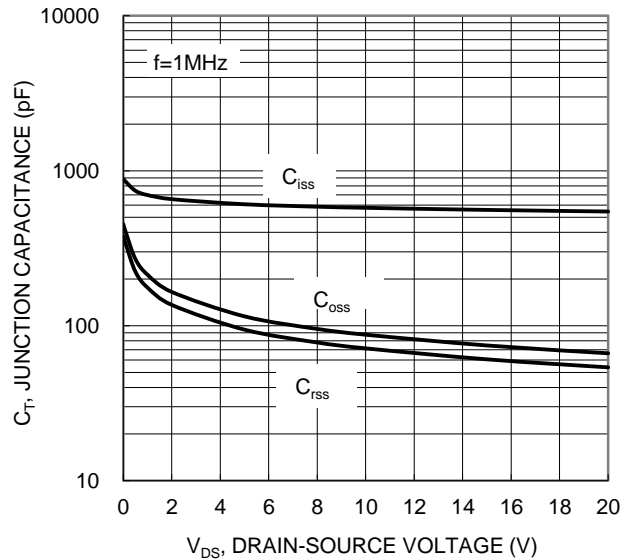
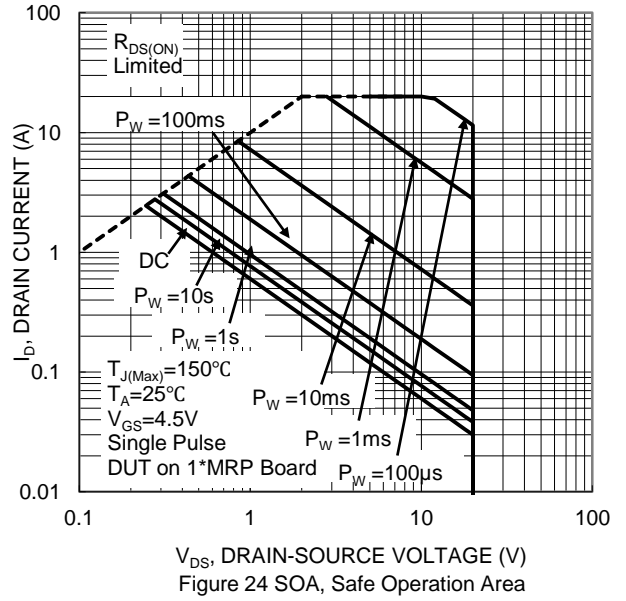
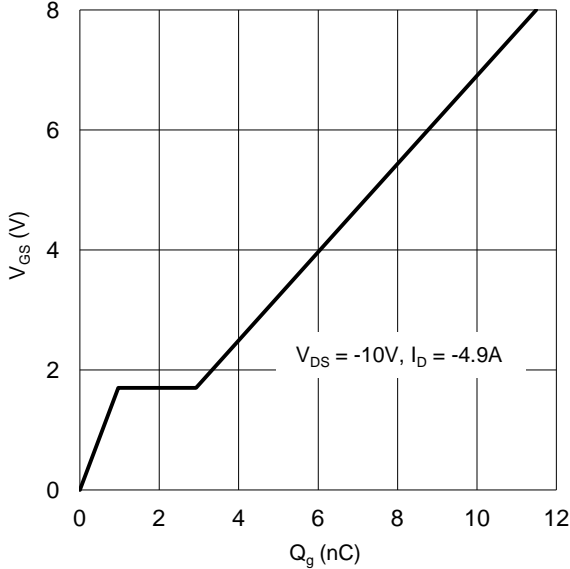
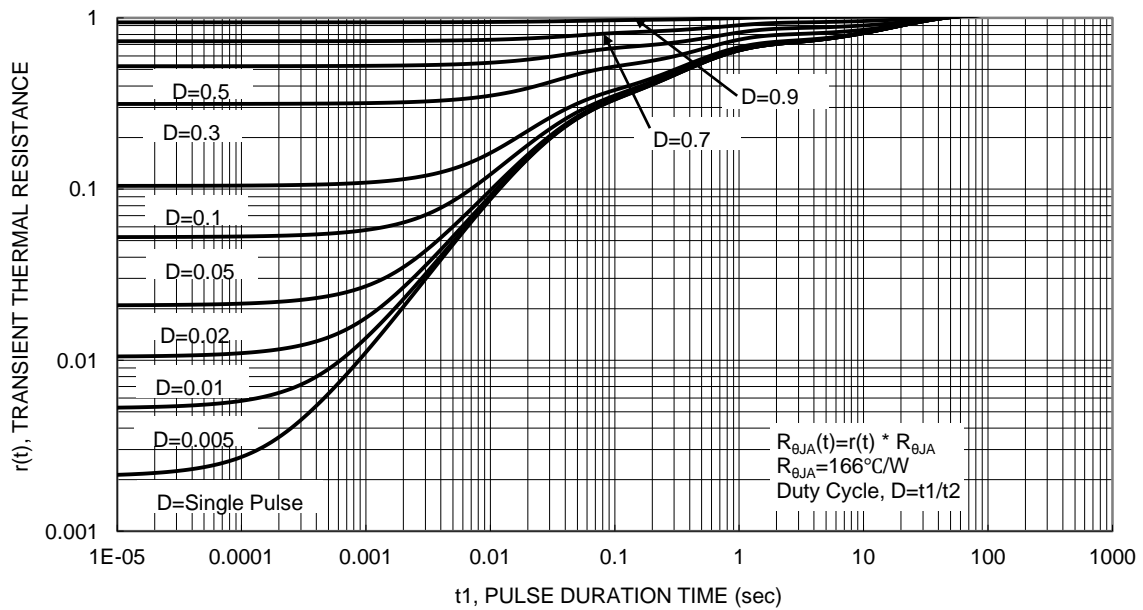


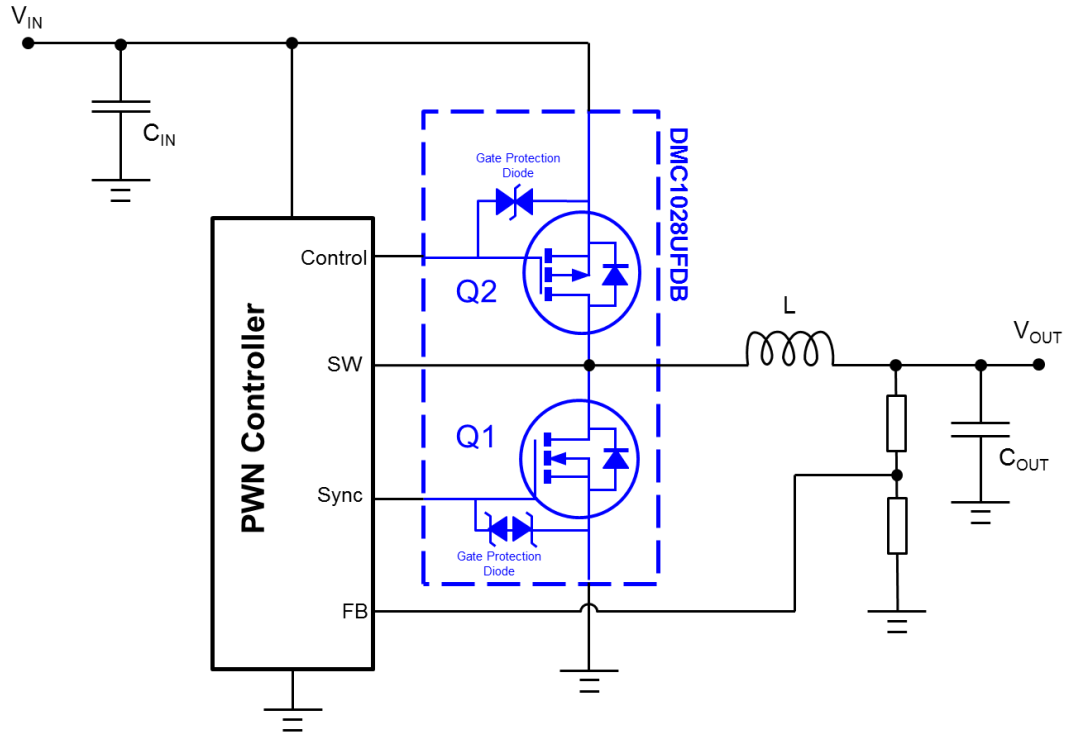
Figure 22 Typical Junction Capacitance



Typical Characteristics - P-CHANNEL (cont.)



Typical Application Circuit

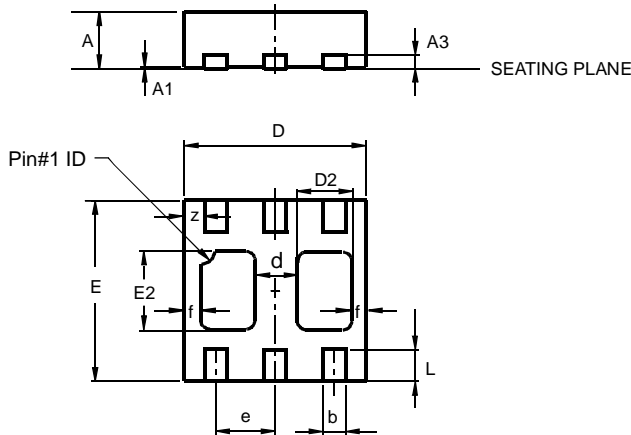


Example of a 3.3V to 1V POL Buck Converter using the DMC1028UFDB

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.

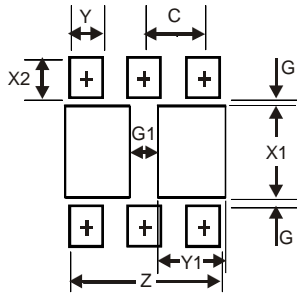


U-DFN2020-6 Type B			
Dim	Min	Max	Typ
A	0.545	0.605	0.575
A1	0	0.05	0.02
A3	—	—	0.13
b	0.20	0.30	0.25
D	1.95	2.075	2.00
d	—	—	0.45
D2	0.50	0.70	0.60
e	—	—	0.65
E	1.95	2.075	2.00
E2	0.90	1.10	1.00
f	—	—	0.15
L	0.25	0.35	0.30
z	—	—	0.225

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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