Lead-free Green

Description

The DML2010LFDS load switch provides a component and area-reducing solution for efficient power domain switching. In addition to integrated control functionality with ultra-low on-resistance, this device offers system safeguards and monitoring via fault protection and power good signaling. This cost-effective solution is ideal for power-management and hot-swap applications requiring low power consumption in a small footprint.

Features and Benefits

- Advanced Controller with Charge Pump
- Integrated N-Channel MOSFET with Ultra-Low R_{ON}
- Input Voltage Range 0.5V to 13.5V
- Power-Good Signal
- Thermal Shutdown
- V_{CC} Undervoltage Lockout
- Short-Circuit Protection
- Extremely Low Standby Current
- Load Bleed (Quick Discharge)
- **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-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**

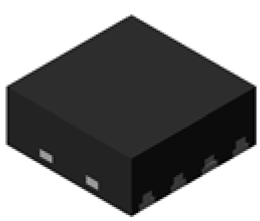
Applications

- Portable electronics and systems
- Notebook and tablet computers
- Telecom, networking, medical, and industrial equipment
- Set-top boxes, servers, and gateways
- Hot-swap devices and peripheral ports

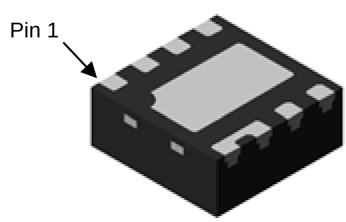
Mechanical Data

- Package: V-DFN2020-8
- Package 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)
- Weight: 0.011 grams (Approximate)

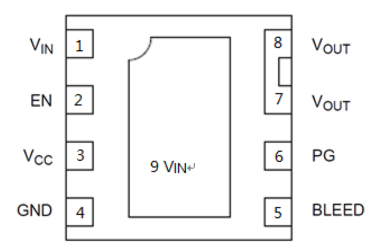
V-DFN2020-8 (Type N)



Top View



Bottom View



Top View

Ordering Information (Note 4)

Orderable Part Number	Package	Packing	
		Qty.	Carrier
DML2010LFDS-7	V-DFN2020-8 (Type N)	3,000	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/.

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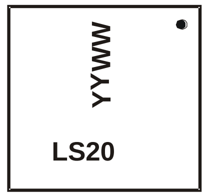
Marking Information

Site 1

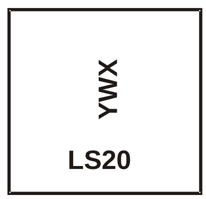
V-DFN2020-8 (Type N)



LS20 = Product Type Marking Code
YYWW = Date Code Marking
YY = Last Two Digits of Year (ex: 24 = 2024)
WW = Week Code (01 to 53)

Site 2

V-DFN2020-8 (Type N)



LS20 = Product Type Marking Code
YWX = Date Code Marking
Y = Year (ex: 4 = 2024)
W = Week (ex: a = Week 27; z Represents Week 52 and 53)
X = Internal Code (ex: U = Monday)

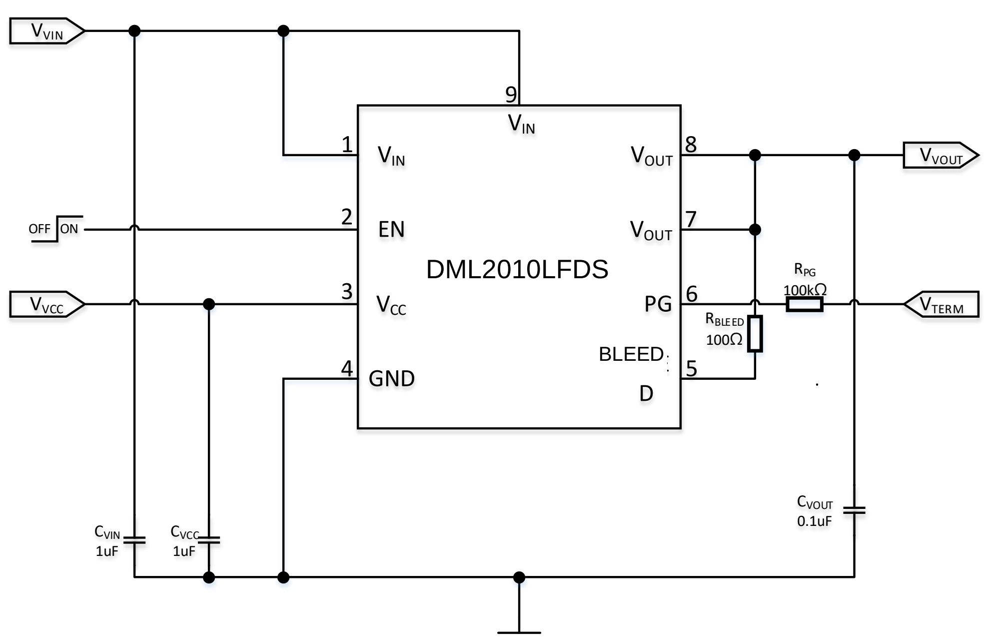
Date Code Key

Year	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Code	4	5	6	7	8	9	0	1	2	3	4	5

Week	**1-26**	**27-52**	**53**
Code	A-Z	a-z	z

Internal Code	**Sun**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
Code	T	U	V	W	X	Y	Z

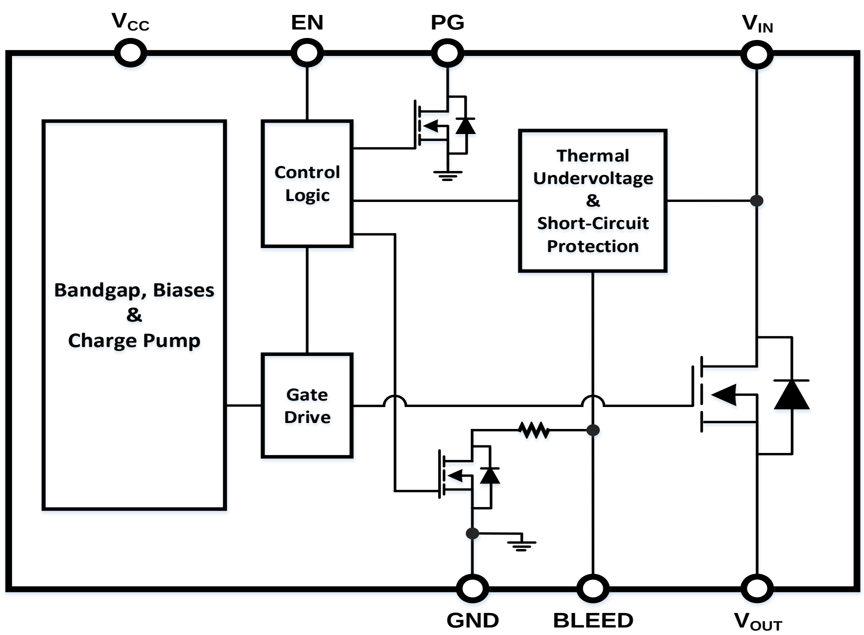
Typical Application Circuit



Pin Description

Pin Number	Pin Name	Pin Function
1, 9	V_{IN}	Drain of internal MOSFET (0.5V to 13.5V), pin 1 must connect to pin 9.
2	EN	Active-high digital input used to turn on the MOSFET, pin has an internal pulldown resistor to GND.
3	V_{CC}	Supply voltage to controller (3.0V to 5.5V)
4	GND	Controller ground
5	BLEED	Load bleed connection, must be tied to V_{OUT} through a resistor ≤ 1kΩ
6	PG	Active-high, open-drain output that indicates when the gate of the MOSFET is fully charged, external pullup resistor ≥ 1kΩ to an external voltage source required; tie to GND if not used.
7, 8	V_{OUT}	Source of internal MOSFET connected to load

Function Block Diagram



Absolute Maximum Rating

Parameter	Rating
V_{IN}, BLEED, V_{OUT} to GND	-0.3V to 18V
EN, V_{CC}, PG to GND	-0.3V to 6V
I_{MAX_DC} (Note 5)	10.5A
Storage Temperature (T_S)	-65°C to +150°C

Note: 5. I_{MAX_DC} defined as the maximum steady state current the load switch can pass at room ambient temperature without entering thermal lockout.

Recommended Operating Ranges

Parameter	Rating
Supply Voltage (V_{CC})	3V to 5.5V
Input Voltage (V_{IN})	0.5V to 13.5V
Ambient Temperature (T_A)	-40°C to +85°C
Junction Temperature (T_J)	-40°C to +125°C
Package Thermal Resistance (θ_{JC})	5.3°C/W
Package Thermal Resistance (θ_{JA})	40°C/W

Electrical Characteristics (T_A = +25°C, V_{VCC} = 3.3V, V_{VIN} = 5V = V_{TERM}, C_{VIN} = 1µF, C_{VOUT} = 0.1µF, C_{VCC} = 1µF, C_{SR} = 1nF, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage	—	0.5	—	13.5	V
V_{CC}	Supply Voltage	—	3.0	—	5.5	V
I_{DYN}	V_{CC} Dynamic Supply Current	V_{EN} = V_{CC} = 3V, V_{IN} = 12V	—	150	290	µA
		V_{EN} = V_{CC} = 5.5V, V_{IN} = 1.8V	—	200	390	µA
I_{STBY}	V_{CC} Shutdown Supply Current	V_{CC} = 3V, V_{EN} = 0V	—	0.1	1	µA
		V_{CC} = 5.5V, V_{EN} = 0V	—	0.1	2	µA
V_{ENH}	EN High-Level Voltage	V_{CC} = 3V to 5.5V	2.0	—	—	V
V_{ENL}	EN Low-Level Voltage	V_{CC} = 3V to 5.5V	—	—	0.8	V
R_{BLEED}	Bleed Resistance	V_{CC} = 3V, V_{EN} = 0V	90	120	180	Ω
		V_{CC} = 5.5V, V_{EN} = 0V	70	100	150	Ω
I_{BLEED}	Bleed Pin Leakage Current	V_{CC} = V_{EN} = 3V, V_{IN} = 1.8V	—	3	—	µA
		V_{CC} = V_{EN} = 3V, V_{IN} = 12V	—	32	—	µA
V_{PGL}	PG Output Low Voltage	V_{CC} = 3V, I_{SINK} = 5mA	—	—	0.2	V
I_{PG}	PG Output Leakage Current	V_{CC} = 3V, V_{TERM} = 3.3V	—	—	100	nA
Switching Device						
R_{ON}	Switch On-State Resistance	V_{CC} = 3.3V, V_{IN} = 1.8V	—	7	10	mΩ
		V_{CC} = 3.3V, V_{IN} = 5V	—	7	10	mΩ
		V_{CC} = 3.3V, V_{IN} = 12V	—	7	10	mΩ
		V_{CC} = 5V, V_{IN} = 1.8V	—	6	9.5	mΩ
		V_{CC} = 5V, V_{IN} = 5V	—	6	9.5	mΩ
		V_{CC} = 5V, V_{IN} = 12V	—	6	9.5	mΩ
I_{LEAK}	Input Shutdown Supply Current	V_{EN} = 0V, V_{IN} = 12V	—	—	10	µA
R_{PDEN}	EN Pulldown Resistance	—	50	100	150	kΩ
Fault Protection						
T_{OTP}	Thermal Shutdown Threshold	V_{CC} = 3V to 5.5V	—	+145	—	°C
T_{OTPHYS}	Thermal Shutdown Hysteresis	V_{CC} = 3V to 5.5V	—	+20	—	°C
V_{UVLO}	V_{CC} Lockout Threshold	—	2.3	2.55	2.8	V
$V_{UVLOHYS}$	V_{CC} Lockout Hysteresis	—	—	200	—	mV
V_{SCP}	Short-Circuit Protection Threshold	V_{CC} = 3.3V, V_{IN} = 0.5V to 5V	120	240	450	mV
		V_{CC} = 3.3V, V_{IN} =12V	100	240	500	mV

Switching Characteristics (T_A = +25°C, V_{TERM} = V_{VCC} = 5V, R_{PG} = 100kΩ, R_{VOUT} = 10Ω, C_{VIN} = 1µF, C_{VOUT} = 0.1µF, C_{VCC} = 1µF, unless otherwise specified.)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{IN} = 1.8V						
t_{ON}	Output Turn-On Delay time	V_{CC} = 3.3V	—	250	—	µs
		V_{CC} = 5V	—	150	—	
t_{OFF}	Output Turn-Off Delay time	V_{CC} = 3.3V	—	3	—	
		V_{CC} = 5V	—	3	—	
t_{PGON}	Power-Good Turn-On Time	V_{CC} = 3.3V	—	0.95	—	ms
		V_{CC} = 5V	—	0.6	—	
t_{PGOFF}	Power-Good Turn-Off Time	V_{CC} = 3.3V	—	20	—	ns
		V_{CC} = 5V	—	15	—	
SR	Output Slew Rate	V_{CC} = 3.3V	—	5	—	kV/s
		V_{CC} = 5V	—	12	—	
V_{IN} = 12V						
t_{ON}	Output Turn-On Delay time	V_{CC} = 3.3V	—	250	—	µs
		V_{CC} = 5V	—	150	—	
t_{OFF}	Output Turn-Off Delay time	V_{CC} = 3.3V	—	3	—	
		V_{CC} = 5V	—	3	—	
t_{PGON}	Power-Good Turn-On Time	V_{CC} = 3.3V	—	2	—	ms
		V_{CC} = 5V	—	1	—	
t_{PGOFF}	Power-Good Turn-Off Time	V_{CC} = 3.3V	—	20	—	ns
		V_{CC} = 5V	—	15	—	
SR	Output Slew Rate	V_{CC} = 3.3V	—	7.5	—	kV/s
		V_{CC} = 5V	—	20	—	

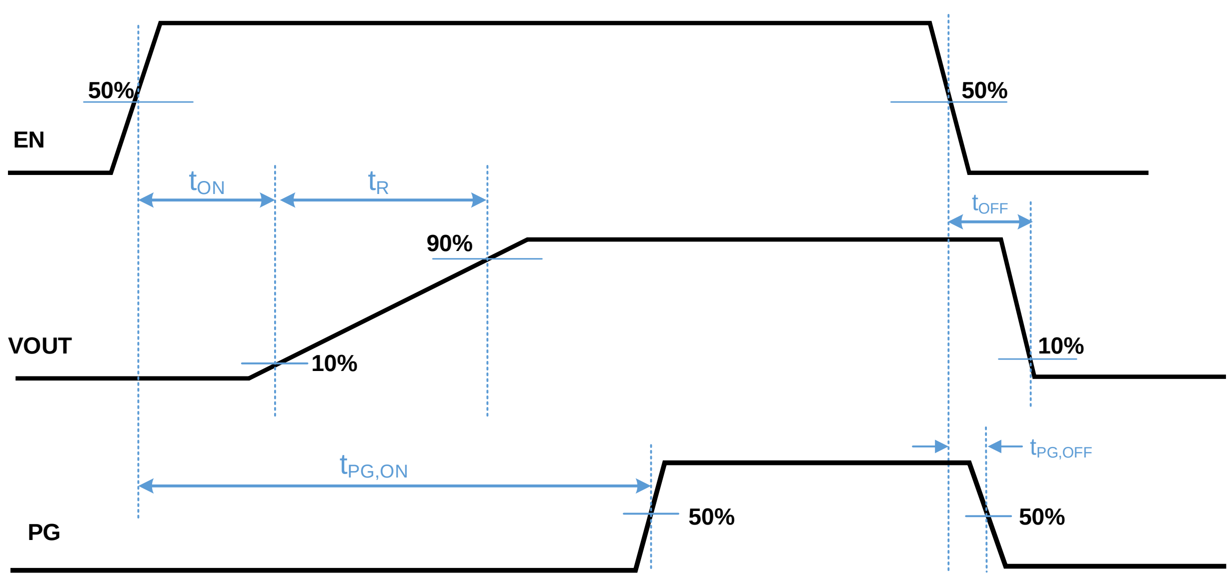
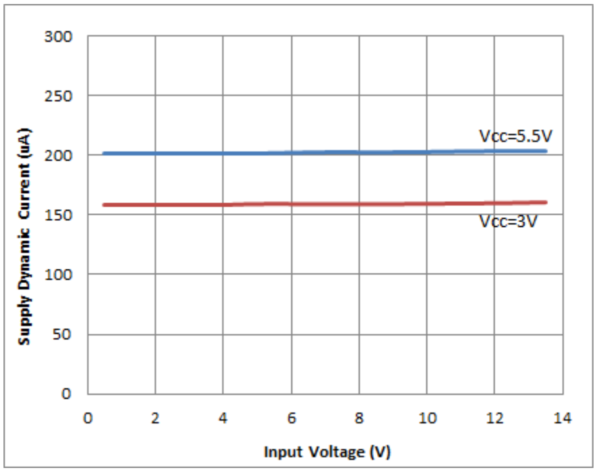


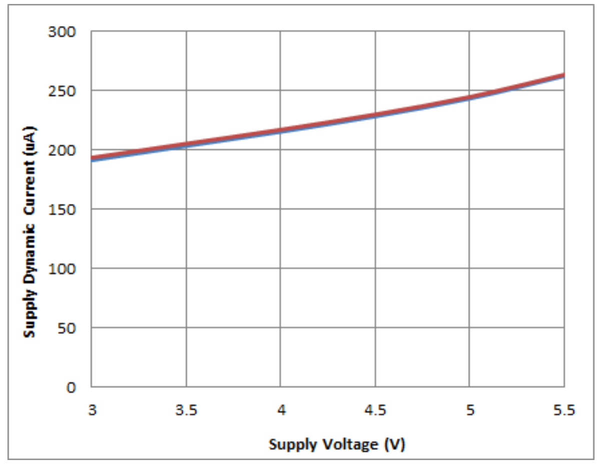
Figure 1. Timing Diagram

Performance Characteristics (@T_A = +25°C, unless otherwise specified.)

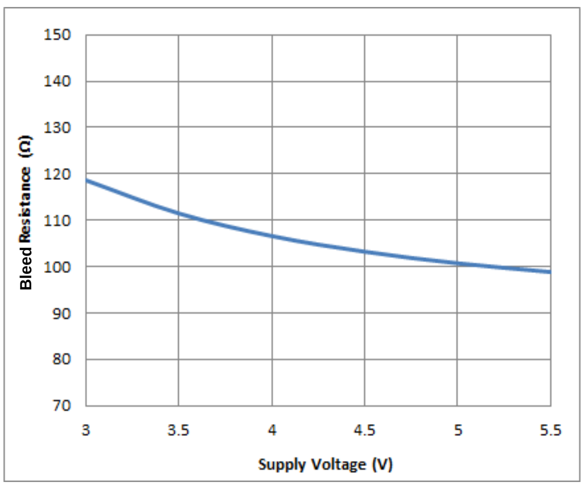
Supply Dynamic Current vs. Input Voltage



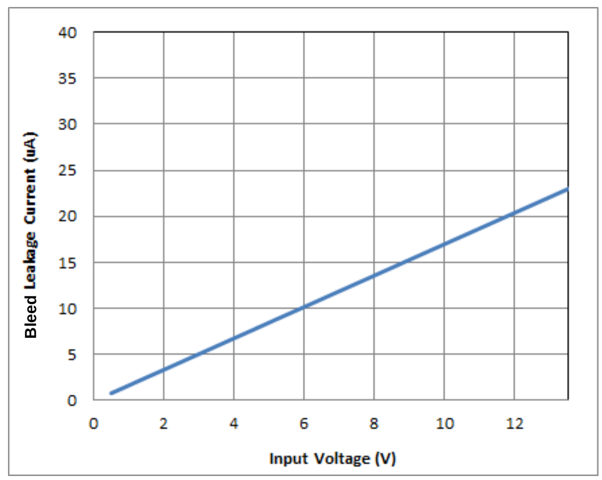
Supply Dynamic Current vs. Supply Voltage



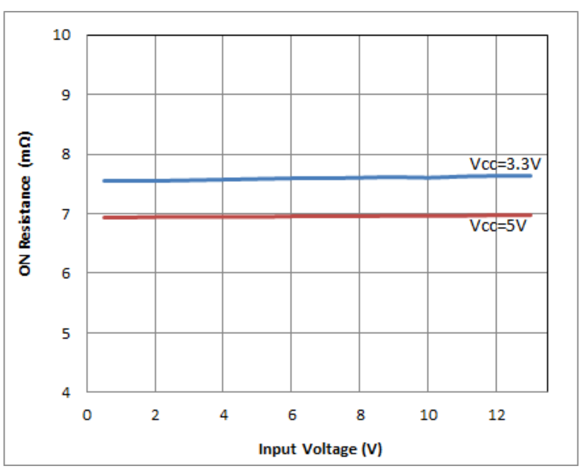
Bleed Resistance vs. Supply Voltage



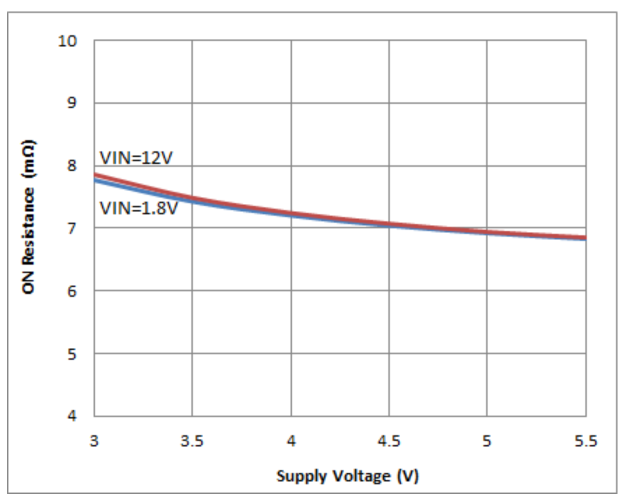
Bleed Leakage Current vs. Input Voltage



ON Resistance vs. Input Voltage



ON Resistance vs. Supply Voltage



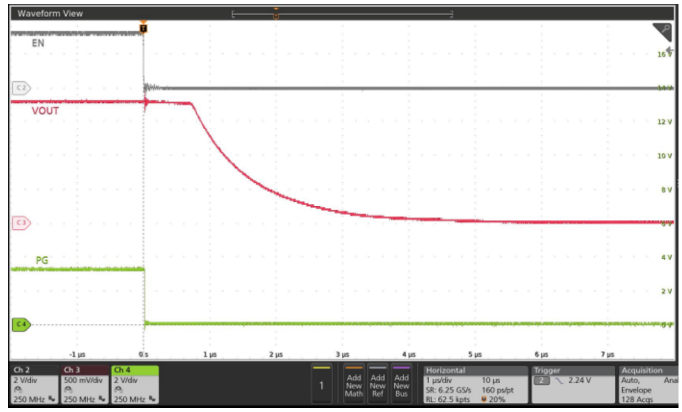
Performance Characteristics (@T_A = +25°C, unless otherwise specified.) (continued)

Turn ON Response

V_{VIN}=1.8V, V_{VCC}=3.3V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn OFF Response

V_{VIN}=1.8V, V_{VCC}=3.3V, V_{EN}=0V to 3.3V, R_L=10Ω



Turn ON Response

V_{VIN}=5V, V_{VCC}=3.3V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn OFF Response

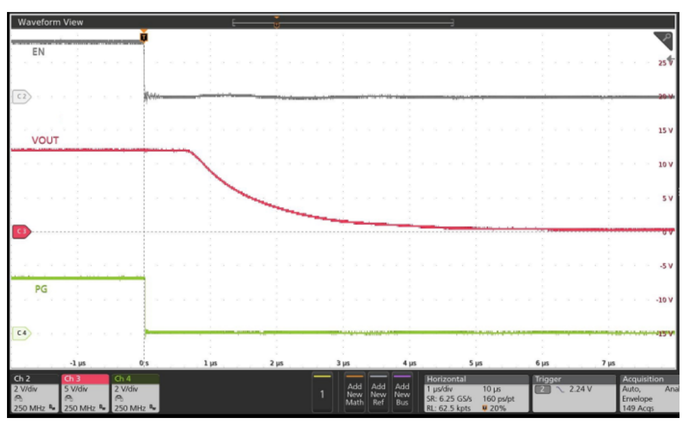
V_{VIN}=5V, V_{VCC}=3.3V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn ON Response

V_{VIN}=12V, V_{VCC}=3.3V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn OFF Response

V_{VIN}=12V, V_{VCC}=3.3V, V_{EN}=0V to 3.3V, R_L=10Ω



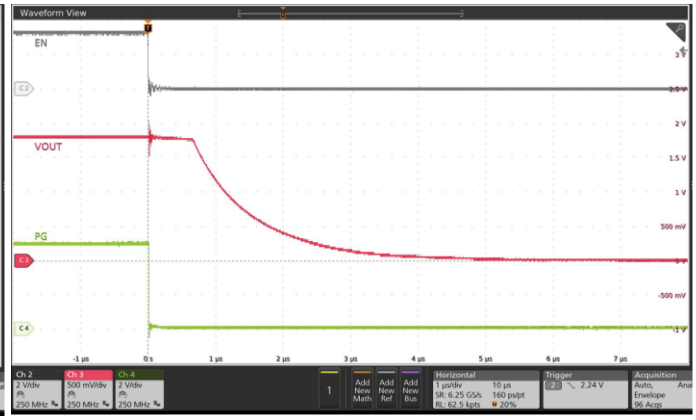
Performance Characteristics (@T_A = +25°C, unless otherwise specified.) (continued)

Turn ON Response

V_{VIN}=1.8V, V_{VCC}=5V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn OFF Response

V_{VIN}=1.8V, V_{VCC}=5V, V_{EN}=0V to 3.3V, R_L=10Ω



Turn ON Response

V_{VIN}=5V, V_{VCC}=5V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn OFF Response

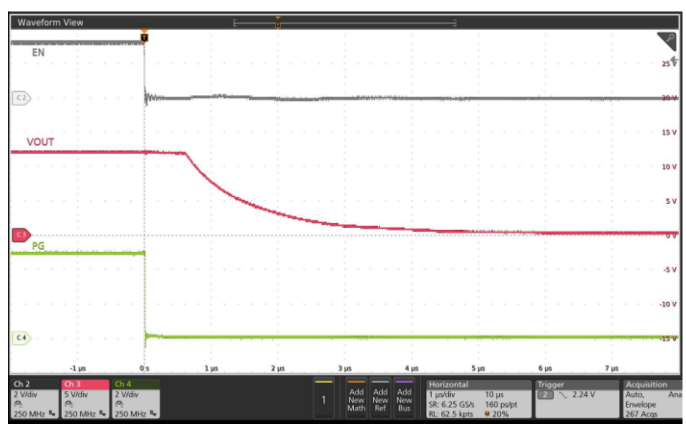
V_{VIN}=5V, V_{VCC}=5V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn ON Response

V_{VIN}=5V, V_{VCC}=5V, V_{EN}=0V to 3.3V, R_L=10Ω

Turn OFF Response

V_{VIN}=5V, V_{VCC}=5V, V_{EN}=0V to 3.3V, R_L=10Ω



Application Information

General Description

The DML2010LFDS is a single-channel load switch which integrates PG indicator in an 8-pin V-DFN2020-8 (Type N) package. The device contains an n-channel MOSFET that can operate over an input voltage range of 0.5V to 13.5V and can support a maximum continuous current of 10.5A. The wide input voltage range and high current capability enable the device to be used across multiple designs and end equipment. 10mΩ on-resistance minimizes the voltage drop across the load switch and power loss from the load switch.

Integrated PG indicator notifies the system of the status of the load switch to facilitate seamless power sequencing. During shutdown, the device has very low leakage current, thereby reducing unnecessary leakages for downstream modules during standby. The DML2010LFDS also has a 100Ω on-chip resistor embedded on BLEED pin for quick discharge of the output when switch is disabled.

Enable Control

The DML2010LFDS device allows for enabling the MOSFET in an active-high configuration. When the V_{CC} supply pin has an adequate voltage applied and the EN pin is at logic-high level, the MOSFET will be enabled. Similarly, when the EN pin is at logic-low level, the MOSFET will be disabled. An internal pulldown resistor to ground on the EN pin ensures that the MOSFET will be disabled when not being driven.

Power Sequencing

The DML2010LFDS device functions with fixed power sequence. The performance of output turn-on delay may vary from what is specified. To achieve the specified performance, recommended power sequences are:

1.) $V_{CC} \rightarrow V_{IN} \rightarrow V_{EN}$
2.) $V_{IN} \rightarrow V_{CC} \rightarrow V_{EN}$

Load Bleed (Quick Discharge)

The DML2010LFDS device has an internal bleed discharge device, which is used to bleed the charge off from the load to ground after the MOSFET is disabled. The bleed discharge device is enabled whenever the MOSFET is disabled. The MOSFET and the bleed device are never concurrently active.

The BLEED pin must be connected to V_{OUT} either directly or through an external resistor, R_{EXT}. R_{EXT} should not exceed 1kΩ and can be used to increase the total bleed resistance.

To ensure that the power dissipated across R_{BLEED} is kept at safe level, dissipated power of R_{BLEED} needs to be detailedly calculated. The maximum continuous power that can be dissipated across R_{BLEED} is 0.4W. R_{EXT} can be used to decrease the amount of power dissipated across R_{BLEED}.

Power-Good

The DML2010LFDS device has a power-good output (PG) that can be used to indicate when the gate of the MOSFET is driven high and the switch is on with the on-resistance close to its final value (full load ready). The PG pin is an active-high, open-drain output that requires an external pullup resistor, R_{PG}, greater than or equal to 1kΩ to an external voltage source, V_{TERM}, compatible with input levels of those devices connected to this pin.

Table 1 contains PG turn-on time values measured on a typical device. PG turn-on times shown below are valid for the power-up sequence 1.

Table 1. PG Turn-On Time

	V_{CC} = 5V, C_L = 0.1µF, R_L = 10Ω, R_{PG} = 10kΩ, +25°C			
	V_{VIN} = 12V	V_{VIN} = 5V	V_{VIN} = 3.3V	V_{VIN} = 1.8V
t_{PG_ON} (ms)	1.02	0.77	0.68	0.61

The power-good output can be used as the enable signal for other active-high devices in the system. This allows for guaranteed by design power sequencing and reduces the number of enable signals needed from the system controller. If the power-good feature is not used in the application, the PG pin should be tied to GND.

Application Information (continued)

Short-Circuit Protection

The DML2010LFDS device is equipped with short-circuit protection that is used to help protect the part and the system from a sudden high-current event, such as the output, V_{OUT}, being shorted to ground. This circuitry is only active when the gate of MOSFET is fully charged.

Once active, the circuitry monitors the difference in the voltage on the V_{IN} pin and the voltage on the BLEED pin. In order for the V_{OUT} voltage to be monitored through the BLEED pin, it is required that the BLEED pin be connected to V_{OUT} either directly or through a resistor, R_{EXT}, which should not exceed 1kΩ. With the BLEED pin connected to V_{OUT}, the short-circuit protection is able to monitor the voltage drop across the MOSFET.

If the voltage drop across the MOSFET is greater than or equal to the short-circuit protection threshold voltage, the MOSFET is turned off immediately and the load bleed is activated. The part remains latched in this off state until EN is toggled or V_{CC} supply voltage is cycled, at which point the MOSFET will be turn-on delay and slew rate. The current through the MOSFET that will cause a short-circuit event can be calculated by dividing the short-circuit protection threshold by expected on-resistance of the MOSFET.

Thermal Shutdown

The DML2010LFDS device is equipped with thermal shutdown protection for internally or externally generated excessive temperatures. This circuitry is disabled when EN is not active to reduce standby current. When an overtemperature condition is detected, the MOSFET is turned off immediately and the load bleed is active.

The part comes out of thermal shutdown when the junction temperature decreases to a safe operating temperature as dictated by the thermal hysteresis. Upon exiting a thermal shutdown state, and if EN remains active, the MOSFET will be turned on in a controlled fashion with the normal output turn-on delay and slew rate.

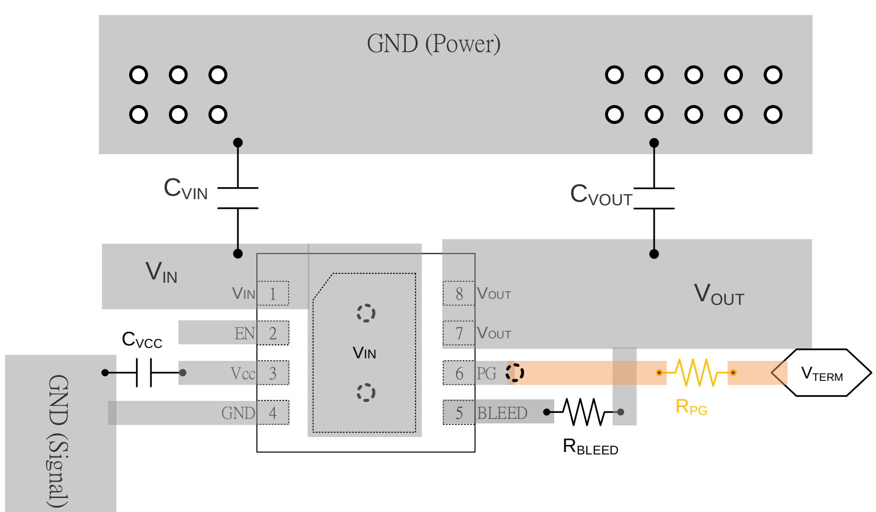
Undervoltage Lockout

The DML2010LFDS device is equipped with undervoltage lockout protection. DML2010LFDS turns the MOSFET off and activates the load bleed when the input voltage V_{CC} is less than or equal to the undervoltage lockout threshold. This circuitry is disabled when EN is not active to reduce standby current.

If the V_{CC} voltage rises above the undervoltage lockout threshold and EN remains active, the MOSFET will be turned on in a controlled fashion with the normal output turn-on delay and slew rate.

PCB Layout Consideration

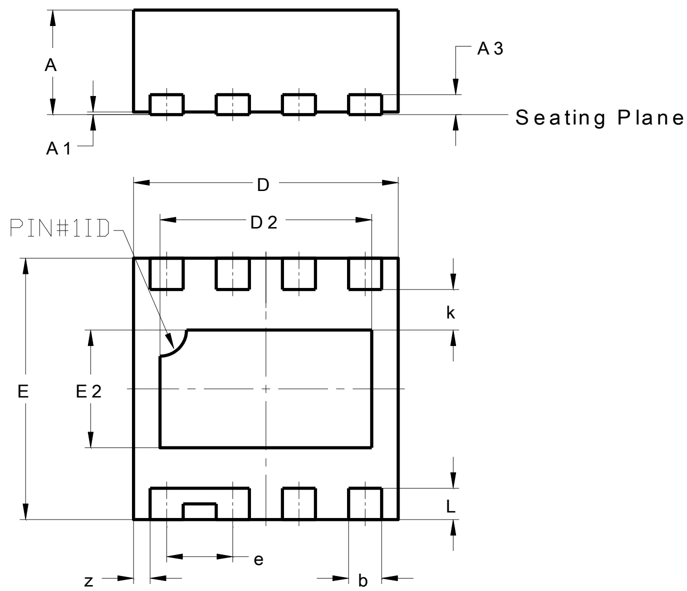
1. Place the input/output capacitors C_{VIN} and C_{VOUT} as close as possible to the V_{IN} and V_{OUT} pins.
2. The power traces which are V_{IN} trace, V_{OUT} trace and GND trace should be short, wide and directly for minimizing parasitic inductance.
3. Place feedback resistance R_{BLEED} as close as possible to BLEED pin.
4. Place C_{VCC} capacitor near the device pin.
5. Connect the signal ground to the GND pin and keep a single connection from GND pin to the power ground behind the input or output capacitors.
6. For better power dissipation, via holes are recommended to connect the exposed pad's landing area to a large copper polygon on the other side of the printed circuit board. The copper polygons and exposed pad shall be connected to V_{IN} pin on the printed circuit board.



Package Outline Dimensions

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

V-DFN2020-8 (Type N)

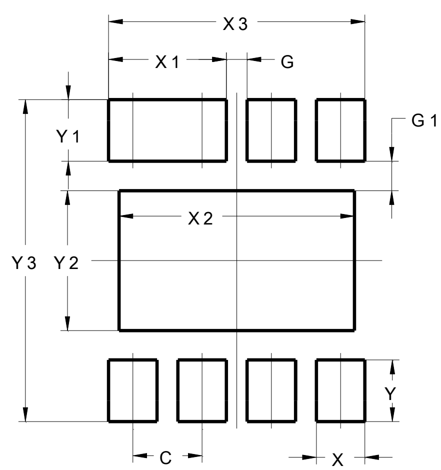


V-DFN2020-8 (Type N)			
Dim	**Min**	**Max**	**Typ**
A	0.75	0.85	0.80
A1	0.00	0.05	0.02
A3	--	--	0.152
b	0.20	0.30	0.25
D	1.95	2.05	2.00
D2	1.50	1.70	1.60
E	1.95	2.05	2.00
E2	0.80	1.00	0.90
e	--	--	0.50
k	--	--	0.31
L	0.19	0.29	0.24
z	--	--	0.125
All Dimensions in mm			

Suggested Pad Layout

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

V-DFN2020-8 (Type N)



Dimensions	Value (in mm)
C	0.500
G	0.150
G1	0.210
X	0.350
X1	0.850
X2	1.700
X3	1.850
Y	0.440
Y1	0.440
Y2	1.000
Y3	2.300

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