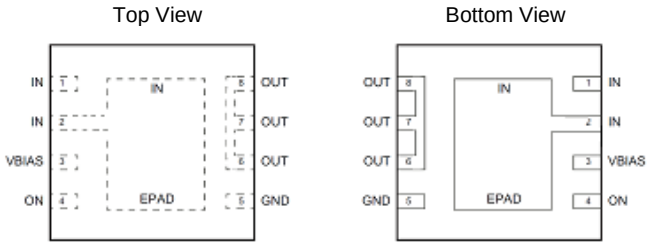
## Description

The DIODES™ DML1010FDK is a single channel load switch with very low on-resistance in a small package. It contains an N-channel MOSFET for up to $V_{VBIAS}$-1.5V input voltage operation and 6A current channel with 3.2V to 5.5V bias supply. The load switch is controlled by a low voltage control signal through ON pin.

## Features and Benefits

- Low $R_{DS(ON)}$—Ensures On-State Losses are Minimized
- 0.8V to $V_{VBIAS}$-1.5V Input Voltage Range
- 6A Continuous Current
- Low $R_{DS(ON)}$ Internal NFETs
  8mΩ at $V_{BIAS}$ = 5V, $V_{IN}$ = 1.05V, $T_A$ = +85°C
- 35µA Low Quiescent Current
- 10µs Turn on Rise Time
- 3.2V to 5.5V Bias Voltage
- Integrated Quick Output Discharge Resistor
- Moisture Sensitivity: Level 1 per J-STD-020
- **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/**

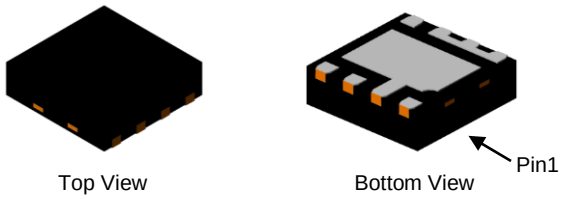
## Pin Assignments




## Applications

- Portable electronics and systems
- Notebooks and tablet computers
- Telecom, networking, medical, and industrial equipment
- Set-top boxes, servers, and gateways
- SSD

U-DFN2020-8 (Type K)




Top View Bottom View

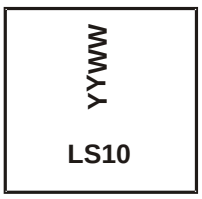
## Ordering Information (Note 4)

| Part Number | Package | Packing | |
|---|---|---|---|
| | | Qty. | Carrier |
| DML1010FDK-7 | U-DFN2020-8 (Type K) | 3000 | 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/.

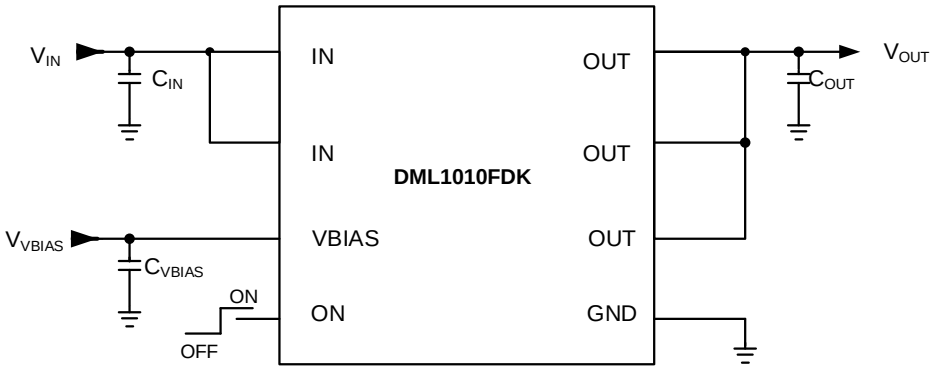
## Marking Information

U-DFN2020-8 (Type K)




LS10 = Product Type Marking Code
YYWW = Date Code Marking
YY = Last Two Digits of Year (ex: 22 = 2022)
WW = Week Code (01 to 53)

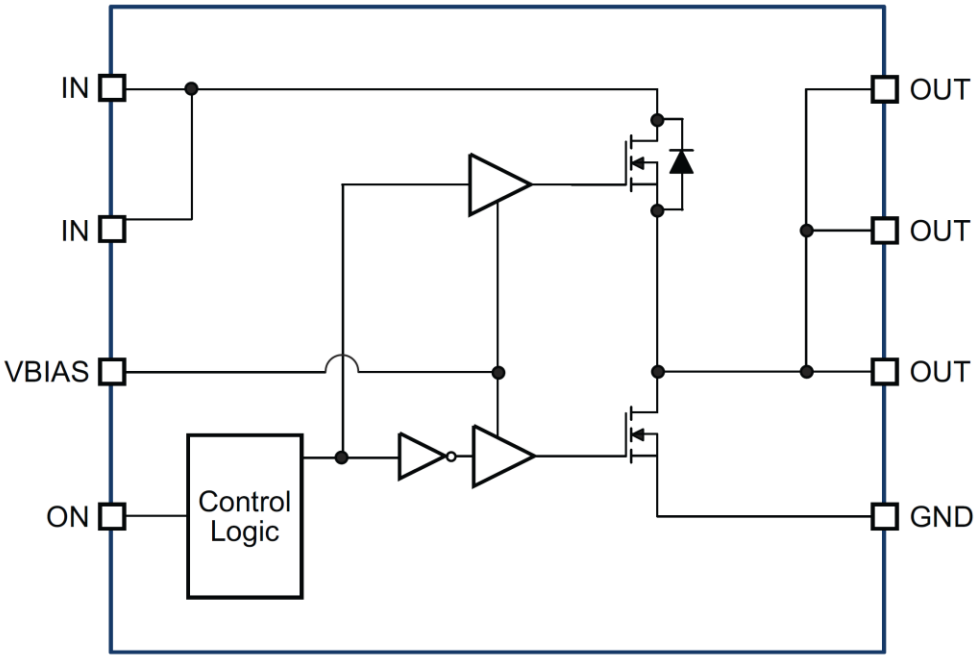
## Typical Application Circuit




## Pin Description

| Pin Number | Pin Name | Pin Function |
|---|---|---|
| 1, 2, EPAD | IN | Load Switch Input. Bypass capacitor is recommended to minimize input voltage dip. |
| 3 | VBIAS | Bias Voltage. Power supply input for the device. |
| 4 | ON | Enable Input. Load switch is on when ON is pulled high. Load switch is off when ON is pulled low. Do not leave floating. |
| 5 | GND | Ground. |
| 6, 7, 8 | OUT | Load Switch Output. |

## Function Block Diagram



## Absolute Maximum Rating

| Parameter | Rating |
|---|---|
| IN, ON, VBIAS, OUT to GND | -0.3V to 6V |
| Junction Temperature ($T_J$) | +150°C |
| $I_{MAX}$ | 12A |
| Storage Temperature ($T_S$) | -65°C to +150°C |
| ESD Rating HBM/CDM | 2kV/1kV |

## Recommended Operating Ranges

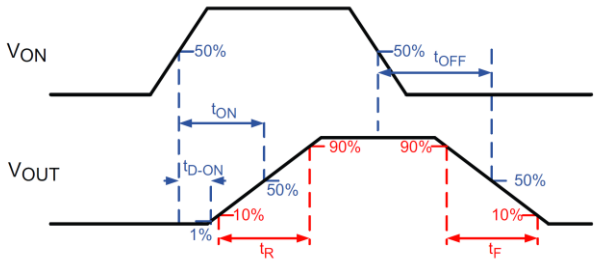
| Parameter | Rating |
|---|---|
| Supply Voltage ($V_{VBIAS}$) | 3.2V to 5.5V |
| Input Voltage ($V_{IN}$) | 0.8V to $V_{BIAS}$-1.5V |
| Ambient Temperature ($T_A$) | -40°C to +85°C |
| Package Thermal Resistance ($\theta_{JC}$) | 8°C/W |
| Package Thermal Resistance ($\theta_{JA}$) | 60°C/W |

## Electrical Characteristics ($T_A$ = +25°C, $V_{VBIAS}$ = 5V, $V_{IN}$ = 1.05V, unless otherwise specified.)

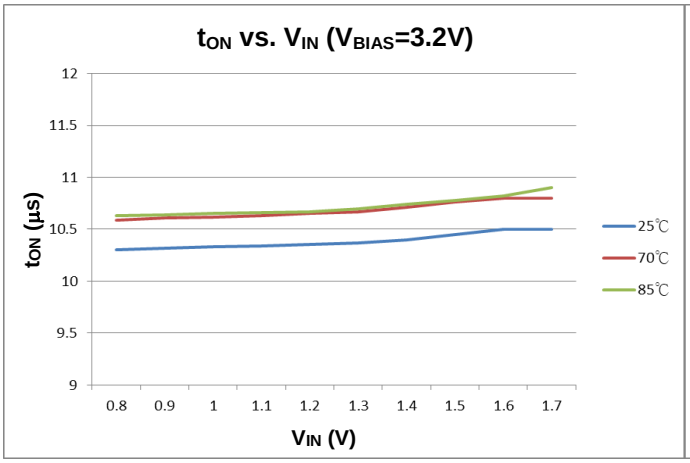
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{IN}$ | IN Supply Voltage | $V_{ON}$ = 5V | 0.8 | 1.05 | $V_{VBIAS}$-1.5 | V |
| $V_{VBIAS}$ | VBIAS Supply Voltage | — | 3.2 | 5 | 5.5 | V |
| $I_D$ | Maximum Continuous Current | $V_{ON}$ = 5V | — | 6 | — | A |
| $I_{PLS}$ | Maximum Pulsed Switch Current | $V_{IN}$ = $V_{ON}$ = 5V<br>Pulse < 300µs, 2% Duty Cycle | — | 9 | — | A |
| $I_Q$ | Quiescent Supply Current of VBIAS | $I_{OUT}$ = 0V, $V_{ON}$ = 5V | — | 35 | — | µA |
| $I_{OFF}$ | VBIAS Shutdown Supply Current | $V_{ON}$ = 0V, $V_{OUT}$ = 0V | — | — | 2 | µA |
| $I_{INOFF}$ | IN Shutdown Supply Current | $V_{ON}$ = 0V, $V_{OUT}$ = 0V | — | — | 2 | µA |
| $I_{ON}$ | ON Leakage Current | $V_{ON}$ = 5V | — | — | 1 | µA |
| $V_{ONH}$ | ON High Level Voltage | — | 1.2 | — | — | V |
| $V_{ONL}$ | ON Low Level Voltage | — | — | — | 0.5 | V |
| **Switching On Resistance** | | | | | | |
| $R_{ON}$ | Switch On-State Resistance | $I_{OUT}$ = -200mA, $V_{ON}$ = 5V, $V_{VBIAS}$ = 5V | — | — | 8 | mΩ |
| | | $I_{OUT}$ = -200mA, $V_{ON}$ = 5V<br>$V_{VBIAS}$ = 3.3V | — | — | 10 | mΩ |
| $R_{PD}$ | Output Pull-Down Resistance | $I_{OUT}$ = 15mA, $V_{ON}$ = 0V | — | — | 200 | Ω |

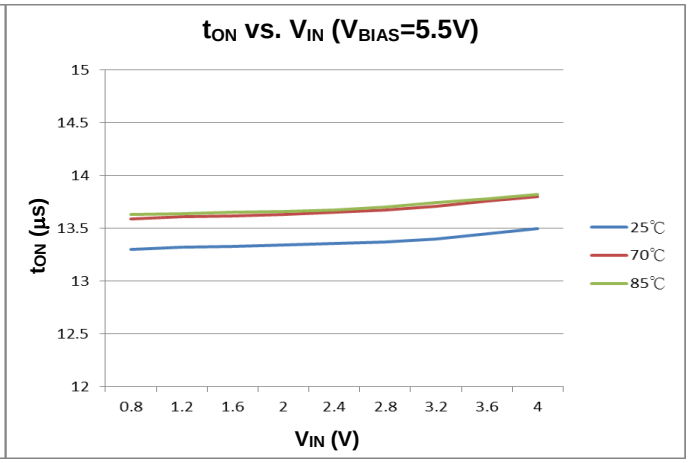
## Switching Electrical Characteristics ($T_A$ = +25°C, $V_{VBIAS}$ = $V_{ON}$ = 5V, $V_{IN}$ = 1.05V, $C_{IN}$ = 1µF, $C_{OUT}$ = 0.1µF, unless otherwise specified.)

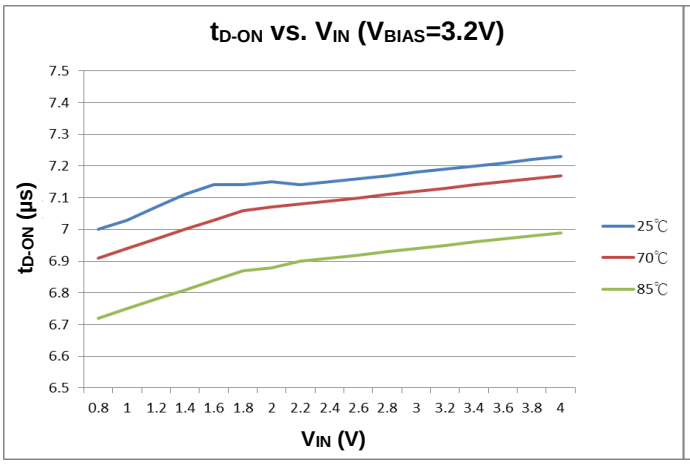
| Symbol | Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **$V_{IN}$ = 1.5V, $V_{VBIAS}$ = $V_{ON}$ = 5V** | | | | | |
| $t_{ON}$ | Turn-ON Time | 10 | — | 65 | µs |
| $t_{D-ON}$ | Turn-ON Delay Time | 7.5 | — | 45 | |
| $t_R$ | Turn-ON Rise Time | 5 | — | 33 | |
| $t_{OFF}$ | Turn-OFF Time | — | 0.2 | — | |
| $t_F$ | Turn-OFF Fall Time | — | 0.7 | — | |
| **$V_{IN}$ = 1.05V, $V_{VBIAS}$ = $V_{ON}$ = 5V** | | | | | |
| $t_{ON}$ | Turn-ON Time | 10 | — | 65 | µs |
| $t_{D-ON}$ | Turn-ON Delay Time | 7.5 | — | 45 | |
| $t_R$ | Turn-ON Rise Time | 5 | — | 33 | |
| $t_{OFF}$ | Turn-OFF Time | — | 0.2 | — | |
| $t_F$ | Turn-OFF Fall Time | — | 0.7 | — | |

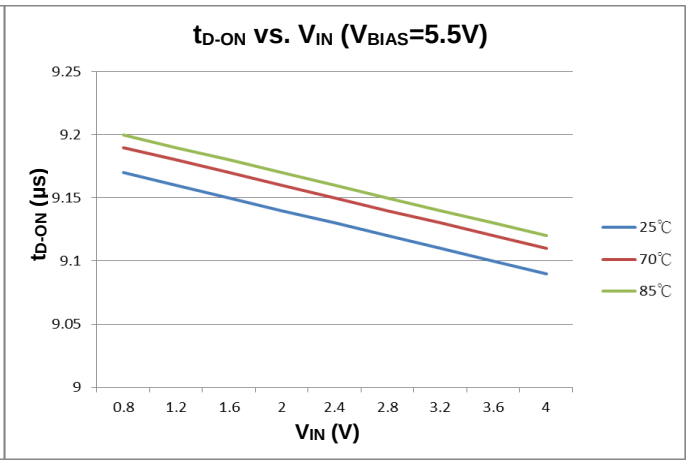


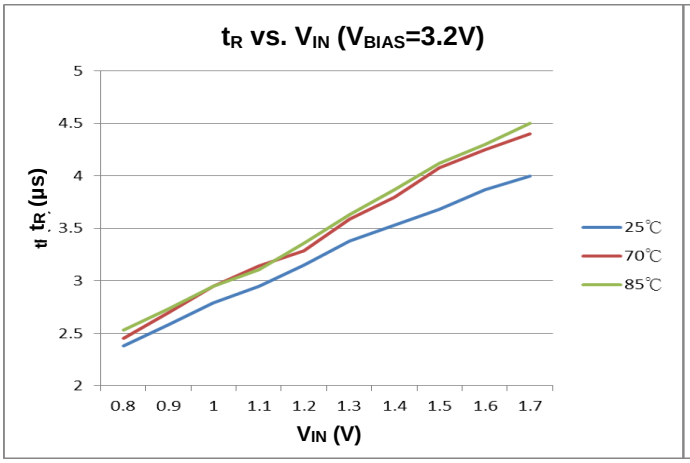
## Performance Characteristics (@ $T_A$ = +25°C, unless otherwise specified.)

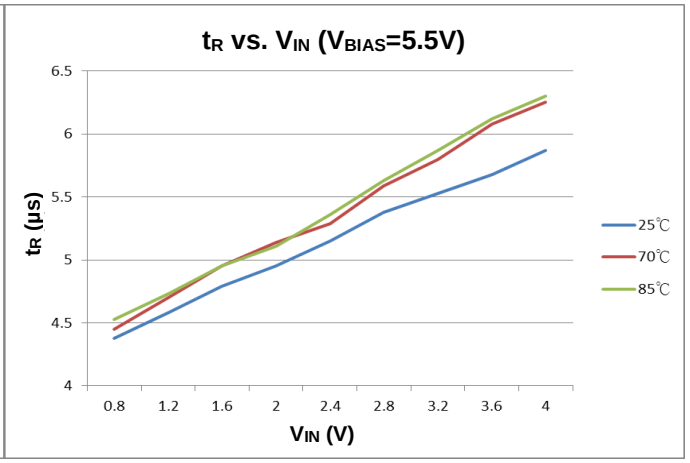


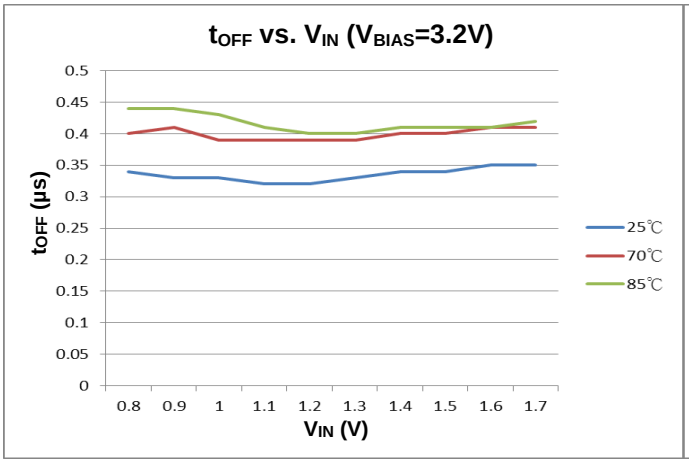



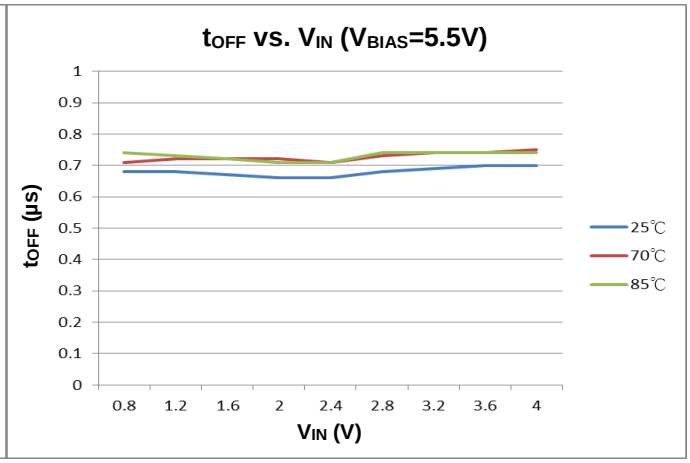



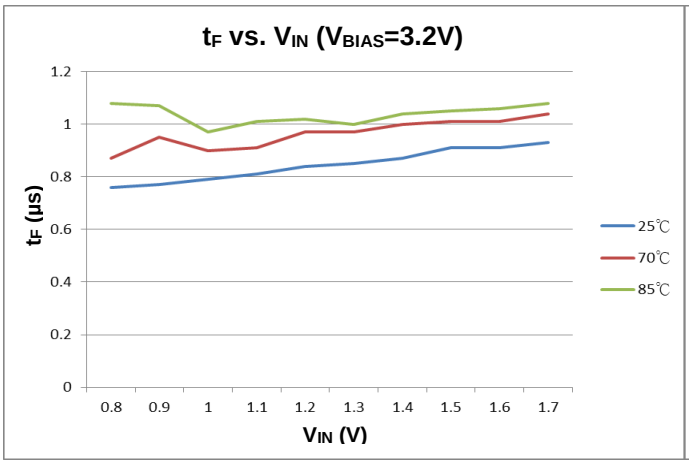



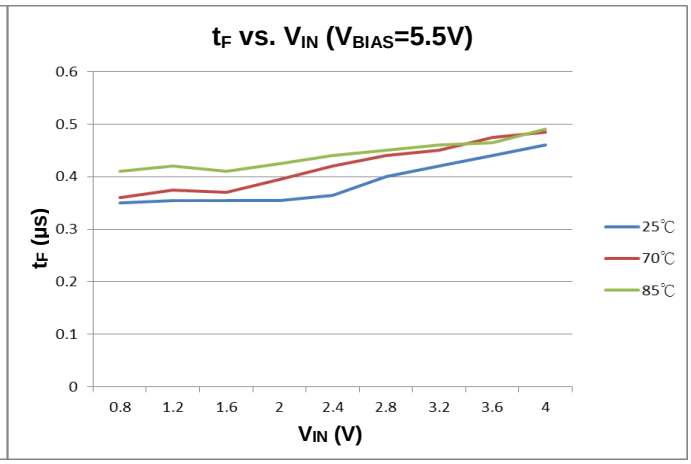



## Performance Characteristics (@ $T_A$ = +25°C, unless otherwise specified.) (continued)



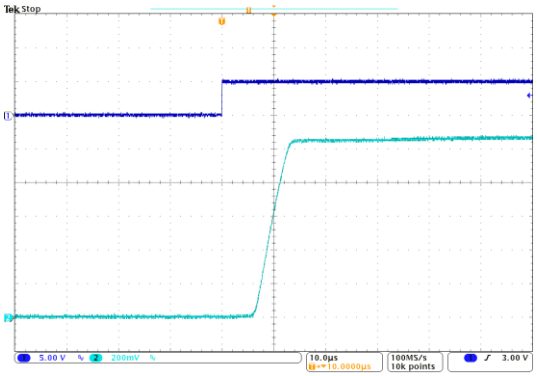



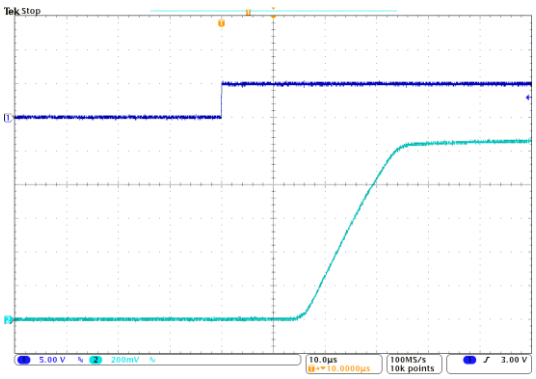
## Performance Characteristics (@ $T_A$ = +25°C, unless otherwise specified) (continued)

**Turn-ON & Turn-ON Rise Times**
$V_{IN}$=1.05V, $V_{VBIAS}$=5V, $C_{IN}$=1µF, $C_{OUT}$=0.1µF, $R_{OUT}$=10Ω



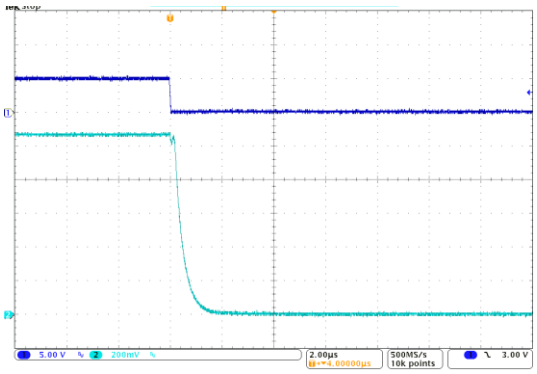

$V_{ON}$ (5V/div)
$V_{OUT}$ (200mV/div)

**Turn-ON & Turn-ON Rise Times**
$V_{IN}$=1.05V, $V_{VBIAS}$=3.2V, $C_{IN}$=1µF, $C_{OUT}$=0.1µF, $R_{OUT}$=10Ω



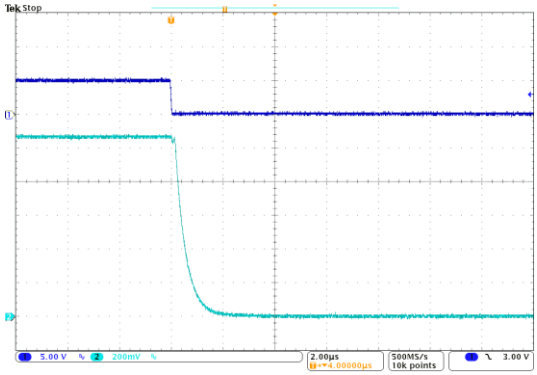

$V_{ON}$ (5V/div)
$V_{OUT}$ (200mV/div)

**Turn-OFF & Turn-OFF Fall Times**
$V_{IN}$=1.05V, $V_{VBIAS}$=5V, $C_{IN}$=1µF, $C_{OUT}$=0.1µF, $R_{OUT}$=10Ω



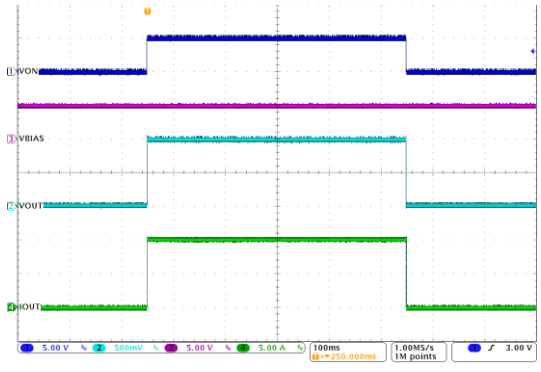

$V_{ON}$ (5V/div)
$V_{OUT}$ (200mV/div)

**Turn-OFF & Turn-OFF Fall Times**
$V_{IN}$=1.05V, $V_{VBIAS}$=3.2V, $C_{IN}$=1µF, $C_{OUT}$=0.1µF, $R_{OUT}$=10Ω



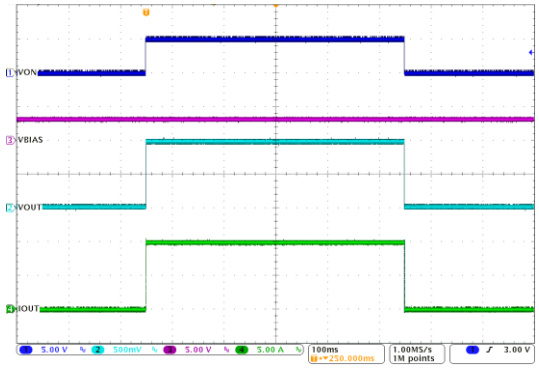

$V_{ON}$ (5V/div)
$V_{OUT}$ (200mV/div)

**Turn-ON & Turn-OFF at $I_{OUT}$= -10A**
$V_{IN}$=1.05V, $V_{VBIAS}$=5V, $C_{IN}$=1µF, $C_{OUT}$=0.1µF, $R_{OUT}$=0.1Ω




$V_{ON}$ (5V/div)
$V_{BIAS}$ (5V/div)
$V_{OUT}$ (500mV/div)
$I_{OUT}$ (5A/div)

**Turn-ON & Turn-OFF at $I_{OUT}$= -10A**
$V_{IN}$=1.05V, $V_{VBIAS}$=3.2V, $C_{IN}$=1µF, $C_{OUT}$=0.1µF, $R_{OUT}$=0.1Ω




$V_{ON}$ (5V/div)
$V_{BIAS}$ (5V/div)
$V_{OUT}$ (500mV/div)
$I_{OUT}$ (5A/div)

## Application Information

**General Description**

The DML1010FDK is a single-channel, 6A load switch in an 8-pin U-DFN2020-8 (Type K) package. To reduce the voltage drop in high current rails, the device implements an ultra-low resistance N-channel MOSFET, which can be operated over an input voltage range from 0.8V to 3.5V.

The device has very low leakage current during off state. This prevents downstream circuits from pulling high standby current from the supply. Integrated control logic, driver, power supply and discharge FET eliminate the requirement for any external components, which reduce solution size and bill of materials (BOM) count.

**Enable Control**

The DML1010FDK device allows for enabling the MOSFET in an active-high configuration. When the VBIAS supply pin has an adequate voltage applied and the ON pin is at logic high level, the MOSFET is enabled. Similarly, when the ON pin is at logic low level, the MOSFET is disabled.

**Power Sequencing**

The DML1010FDK device functions with fixed power sequence, the performance of output turn-on delay may vary from what is specified. To achieve the specified performance, there are two recommended power sequences:

1.) $V_{VBIAS} \rightarrow V_{IN} \rightarrow V_{ON}$
2.) $V_{IN} \rightarrow V_{VBIAS} \rightarrow V_{ON}$

**Input Capacitor**

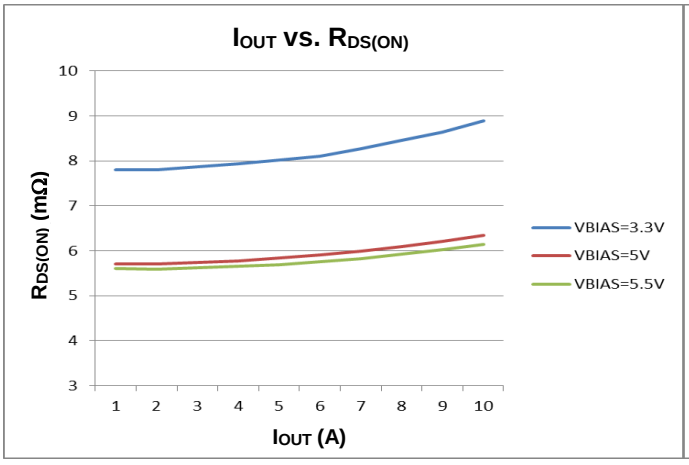
A capacitor of 10µF or higher value is recommended to be placed close to the IN pins of DML1010FDK. This capacitor can reduce the voltage drop caused by the in-rush current during the turn-on transient of the load switch. A higher value capacitor can be used to further reduce the voltage drop during high-current application.

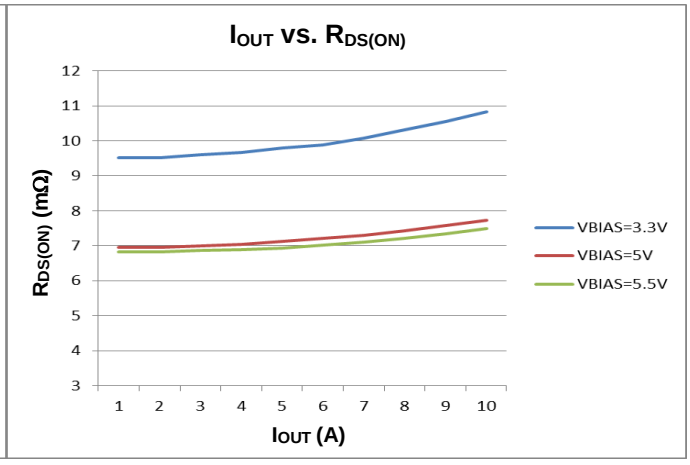
**Output Capacitor**

A capacitor of 0.1µF or higher value is recommended to be placed between the OUT pins and GND. The switching times are affected by the capacitance. A larger capacitor makes the initial turn-on transient smoother. This capacitor must be large enough to supply a fast transient load in order to prevent the output from dropping.

**VIN and VBIAS Voltage Range**

For optimal on-resistance of load switch, make sure $V_{IN} \leq 1.5V + V_{VBIAS}$ and $V_{VBIAS}$ is within the voltage range from 3.2V to 5.5V. On-resistance of load switch is higher if $V_{IN} + 1.5V > V_{VBIAS}$. Resistance curves of a typical sample device at different $V_{VBIAS} = V_{IN}$ at $I_{OUT}$ = -200mA are shown as below.



## Application Information (continued)

**Thermal Considerations**

To ensure proper operation, the maximum junction temperature of the DML1010FDK should not exceed +150°C. Several factors attribute to the junction temperate rise: load current, MOSFET on-resistance, junction-to-ambient thermal resistance, and ambient temperature. The maximum load current can be determined by:

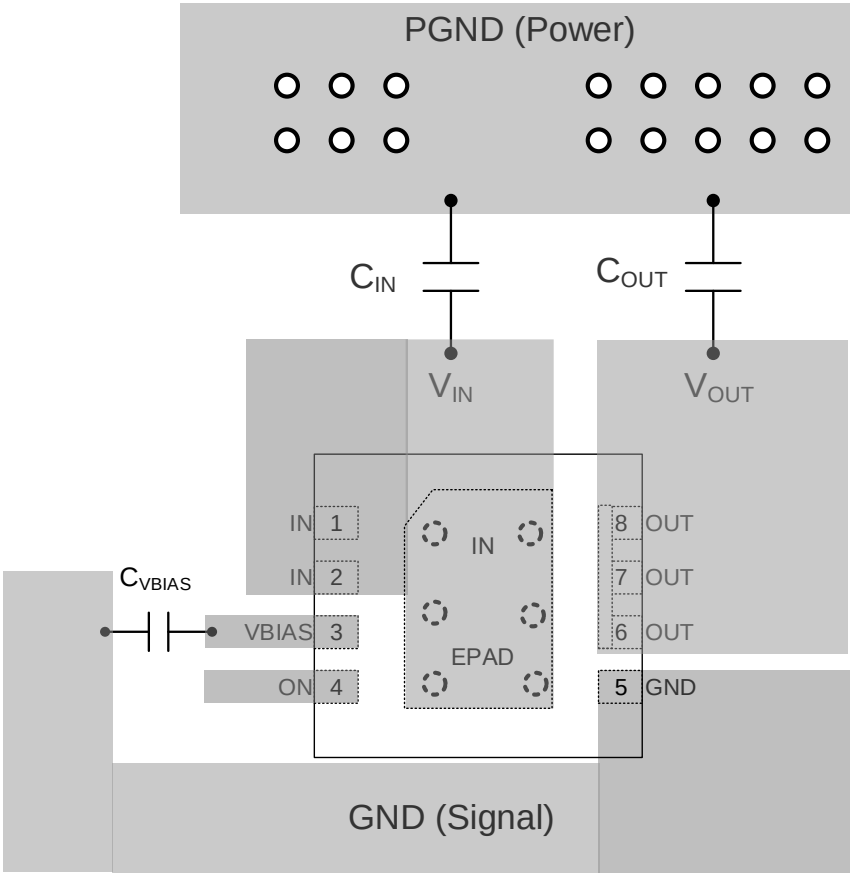
$$I_{LOAD(MAX)} = \sqrt{\frac{T_{J(MAX)} - T_C}{\Theta_{JC} \times R_{DS(ON)}}}$$

Where

- $I_{LOAD(MAX)}$ is the maximum allowable current on load (A). (6A for DML1010FDK)
- $T_{J(MAX)}$ is the maximum allowable junction temperature.
- $T_C$ is the case temperature of the device.
- $\theta_{JC}$ = Junction to case thermal impedance. This parameter is highly dependent upon PCB layout.

**PCB Layout Consideration**

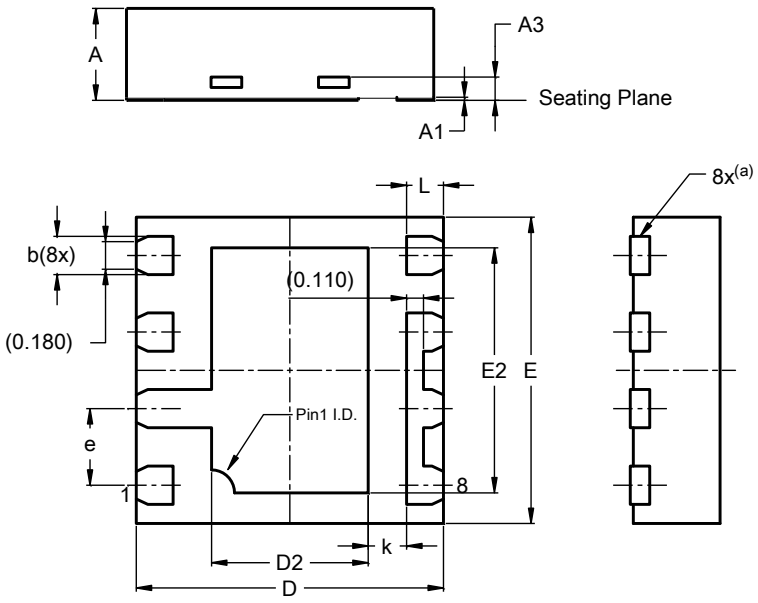
1. Place the input/output capacitors $C_{IN}$ and $C_{OUT}$ as close as possible to the IN and OUT pins.
2. The power traces which are IN trace, OUT trace, and GND trace should be short, wide, and direct for minimizing parasitic inductance.
3. Place $C_{VBIAS}$ capacitor near the device pin.
4. Connect 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.
5. 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 connect to IN pin on the printed circuit board.



## Package Outline Dimensions

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

**U-DFN2020-8 (Type K)**



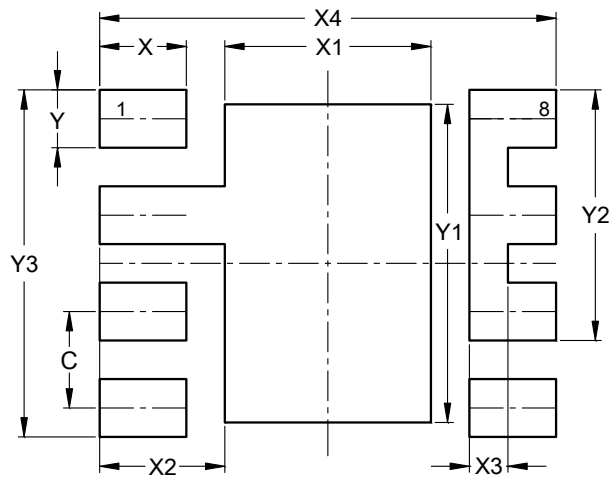

a) Actual shape depending upon manufacturing technology used.

| U-DFN2020-8 (Type K) | | | |
|---|---|---|---|
| **Dim** | **Min** | **Max** | **Typ** |
| **A** | 0.55 | 0.65 | 0.60 |
| **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** | 0.92 | 1.12 | 1.02 |
| **E** | 1.95 | 2.05 | 2.00 |
| **E2** | 1.50 | 1.70 | 1.60 |
| **e** | 0.50 BSC | | |
| **k** | — | — | 0.25 |
| **L** | 0.19 | 0.29 | 0.24 |
| **All Dimensions in mm** | | | |

## Suggested Pad Layout

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

**U-DFN2020-8 (Type K)**




| Dimensions | Value (in mm) |
|---|---|
| **C** | 0.500 |
| **X** | 0.450 |
| **X1** | 1.070 |
| **X2** | 0.650 |
| **X3** | 0.200 |
| **X4** | 2.370 |
| **Y** | 0.300 |
| **Y1** | 1.650 |
| **Y2** | 1.300 |
| **Y3** | 1.800 |

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