FAIRCHILD SEMICONDUCTOR®

August 2008

FPF2174
IntelliMAX™ Advanced Load Management Products

Features

- 1.8 to 5.5V Input Voltage Range
- Controlled Turn-On
- 200mA Current Limit Option
- Undervoltage Lockout
- Thermal Shutdown
- <1μA Shutdown Current
- Fast Current limit Response Time
  - 3μs to Moderate Over Currents
  - 20ns to Hard Shorts
- Integrated very low V_F Schottky Diode for Reverse Current Blocking
- Integrated Zener Diode for Output Clamp
- RoHS Compliant

Applications

- PDAs
- Cell Phones
- GPS Devices
- MP3 Players
- Digital Cameras
- Peripheral Ports
- Hot Swap Supplies

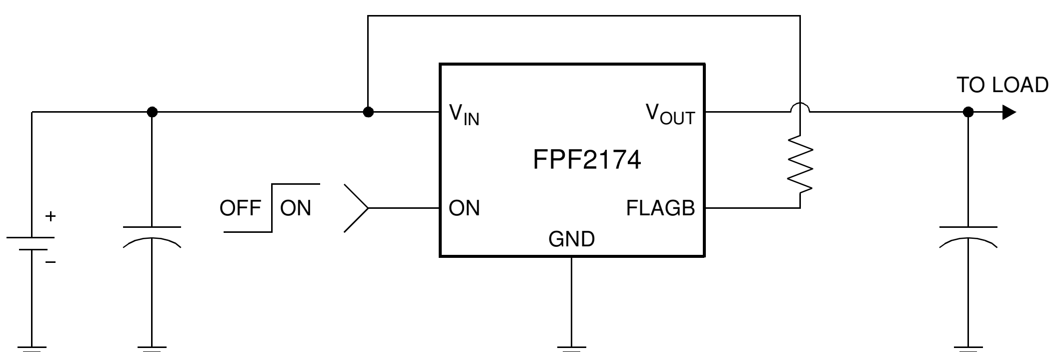
General Description

The FPF2174 is a load switch which combines the functionality of the IntelliMAX™ series load switch with a very low forward voltage drop Schottky barrier rectifier and a zener clamp at the output. The integrated solution provides full protection to systems and loads which may encounter large current conditions in a very compact MLP 3x3 package. This device contain a 0.125Ω current-limited P-channel MOSFET which can operate over an input voltage range of 1.8-5.5V. The Schottky diode acts as a barrier so that no reverse current can flow when the MOSFET is off and the output voltage is higher than the input voltage. Switch control is by a logic input (ON) capable of interfacing directly with low voltage control signals. Each part contains thermal shutdown protection which shuts off the switch to prevent damage to the part when a continuous over-current condition causes excessive heating.

When the switch current reaches the current limit, the part operates in a constant-current mode to prohibit excessive currents from causing damage. If the constant current condition still persists after 10ms, these parts will shut off the switch and pull the fault signal pin (FLAGB) low. The switch will remain off until the ON pin is cycled. The minimum current limit is 200mA.

These parts are available in a space-saving 6L MLP 3x3 package.

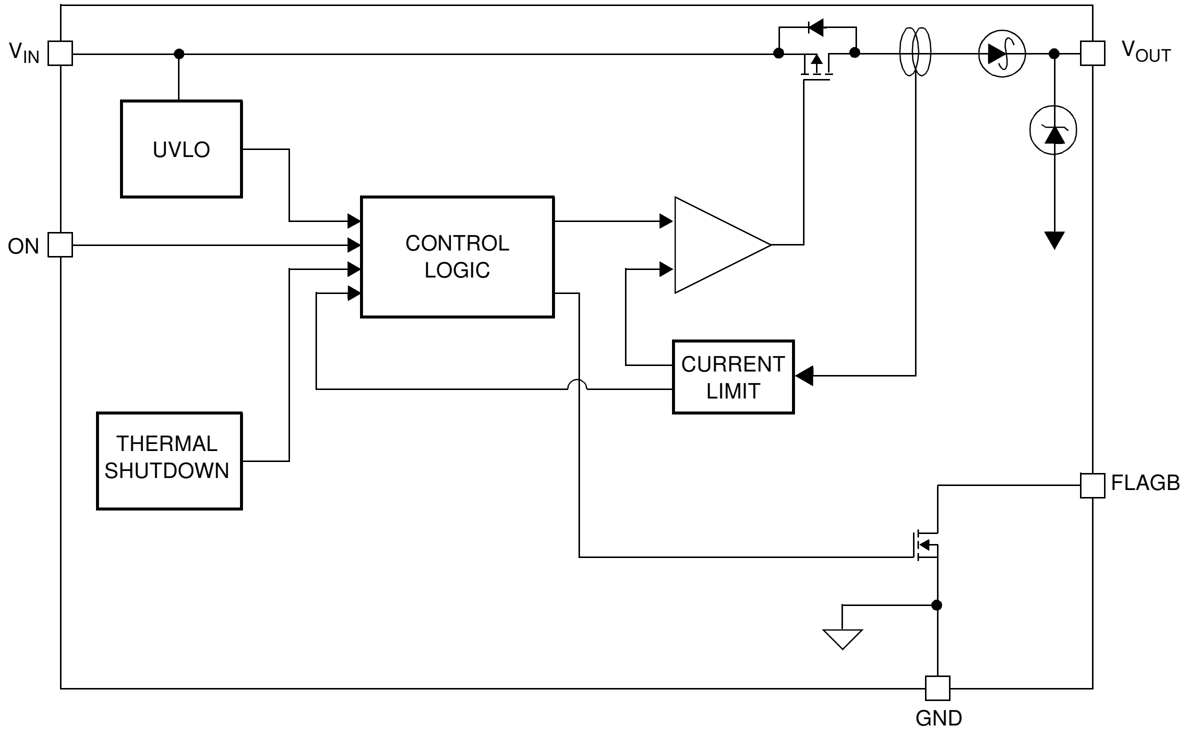
Typical Application Circuit



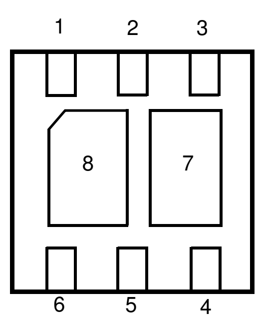
Ordering Information

Part	Current Limit [mA]	Current Limit Blanking Time [ms]	Auto-Restart Time [ms]	ON Pin Activity	Top Mark
FPF2174	200	10	NA	Active HI	2174

Functional Block Diagram



Pin Configuration



3x3 MLP BOTTOM VIEW

Pin Description

Pin	Name	Function
1	V_{IN}	Supply Input: Input to the power switch and the supply voltage for the IC
2	NC	No Connect
3, 7	V_{OUT}	Switch Output: Output of the power switch
4	GND	Ground
5	FLAGB	Fault Output: Active LO, open drain output which indicates an over current supply, under voltage or over temperature state.
6	ON	ON Control Input
8	PAD1	IC substrate. Can be connected to GND. Do not connect to other pins.

Absolute Maximum Ratings

Parameter		Min	Max	Unit
V_{IN}, ON, FLAGB to GND		-0.3	6	V
V_{OUT} to GND		-0.3	20	V
Power Dissipation @ T_A = 25℃ (note 1)		-	1.4	W
Operating Temperature Range		-40	85	℃
Storage Temperature		-65	150	℃
Thermal Resistance, Junction to Ambient		-	70	℃/W
Electrostatic Discharge Protection	HBM	4000	-	V
	MM	400	-	V

Recommended Operating Range

Parameter	Min	Max	Unit
V_{IN}	1.8	5.5	V
Ambient Operating Temperature, T_A	-40	85	℃

Electrical Characteristics

V_{IN} = 1.8 to 5.5V, T_A = -40 to +85℃ unless otherwise noted. Typical values are at V_{IN} = 3.3V and T_A = 25℃.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Basic Operation						
Operating Voltage	V_{IN}		1.8	-	5.5	V
Quiescent Current	I_Q	I_{OUT} = 0mA, V_{ON} ACTIVE; V_{IN} = 1.8 to 3.3V	-	95	-	μA
		I_{OUT} = 0mA, V_{ON} ACTIVE; V_{IN} = 3.3 to 5.5V	-	110	200	μA
Shutdown Current	I_{SHDN}	V_{ON} = 0V, I_{OUT} = 0mA	-	-	1	μA
Latch-off Current	$I_{LATCHOFF}$	V_{ON} =V_{IN}, after an overcurrent fault	-	50	-	μA
Reverse Block Leakage Current	I_R	V_{OUT} = 12V, V_{IN} = V_{ON} = 0V, T_A = 25℃	-	-	10	μA
Reverse Breakdown Voltage		I_{OUT} = 1mA	-	15	-	V
Dropout Voltage	V_{DROP}	T_A = 25℃, I_{OUT} = 150mA	-	0.3	0.4	V
		T_A = 85℃, I_{OUT} = 150mA		0.23	-	V
		T_A = -40℃, I_{OUT} = 150mA	-	0.36	-	V
ON Input Logic High Voltage (ON)	V_{IH}	V_{IN} = 1.8V	0.75	-	-	V
		V_{IN} = 5.5V	1.3	-	-	V
ON Input Logic Low Voltage	V_{IL}	V_{IN} = 1.8V	-	-	0.5	V
		V_{IN} = 5.5V	-	-	1.0	V
ON Input Leakage		V_{ON} = V_{IN} or GND	-	-	1	μA
Off Switch Leakage	I_{SWOFF}	V_{ON} = 0V, V_{OUT} = 0V @ V_{IN} = 5.5V, T_A = 85℃			1	μA
		V_{ON} = 0V, V_{OUT} = 0V @ V_{IN} = 3.3V, T_A = 25℃		10	100	nA
FLAGB Output Logic Low Voltage		V_{IN} = 5V, I_{SINK} = 10mA	-	-	0.2	V
		V_{IN} = 1.8V, I_{SINK} = 10mA	-	-	0.3	V
FLAGB Output High Leakage Current		V_{IN} = 5V, Switch on	-	-	1	μA

Electrical Characteristics Cont.

V_{IN} = 1.8 to 5.5V, T_A = -40 to +85℃ unless otherwise noted. Typical values are at V_{IN} = 3.3V and T_A = 25℃.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Protections						
Current Limit	I_{LIM}	V_{IN} = 3.3V, V_{OUT} = 2.0V	200	300	400	mA
Thermal Shutdown		Shutdown Threshold	-	140	-	℃
		Return from Shutdown	-	130	-	
		Hysteresis	-	10	-	
Under Voltage Shutdown	UVLO	V_{IN} Increasing	1.5	1.6	1.7	V
Under Voltage Shutdown Hysteresis			-	47	-	mV
Zener Clamp Voltage	V_Z	I_Z = 1mA	-	15	-	V
Zener Leakage	I_Z	V_Z = 12V	-	-	10	µA
Dynamic						
Turn on time	t_{ON}	R_L = 500Ω, C_L = 0.1µF	-	25	50	µs
Turn off time	t_{OFF}	R_L = 500Ω, C_L = 0.1µF	-	20	40	µs
V_{OUT} Rise Time	t_R	R_L = 500Ω, C_L = 0.1µF	-	14	30	µs
V_{OUT} Fall Time	t_F	R_L = 500Ω, C_L = 0.1µF	-	126	250	µs
Over Current Blanking Time	t_{BLANK}		5	10	20	ms
Short Circuit Response Time		V_{IN} = V_{ON} = 3.3V. Moderate Over-Current Condition.	-	3	-	µs
		V_{IN} = V_{ON} = 3.3V. Hard Short.	-	20	-	ns

Note 1: Package power dissipation on 1 square inch pad, 2 oz. copper board.

Typical Characteristics

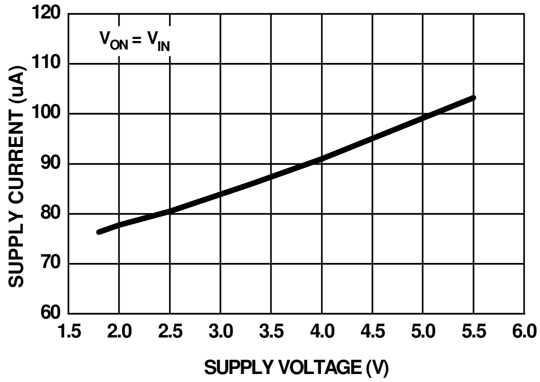


Figure 1. Quiescent Current vs. Input Voltage

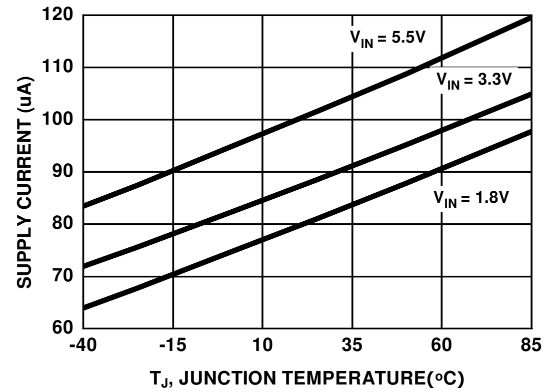


Figure 2. Quiescent Current vs. Temperature

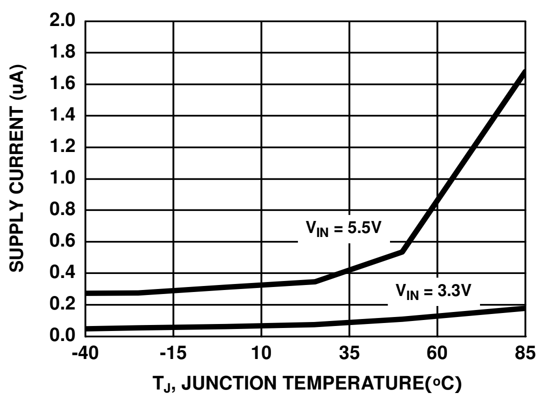


Figure 3. $I_{SHUTDOWN}$ Current vs. Temperature

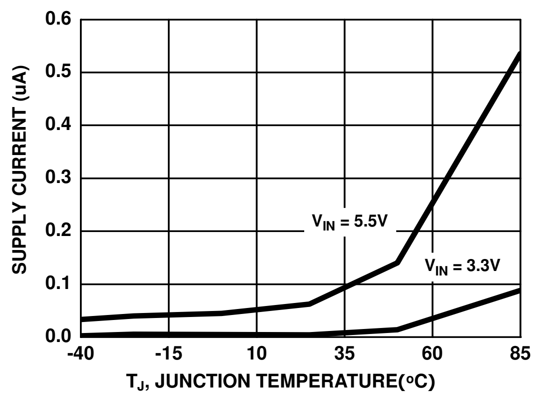


Figure 4. $I_{SWITCH-OFF}$ Current vs. Temperature

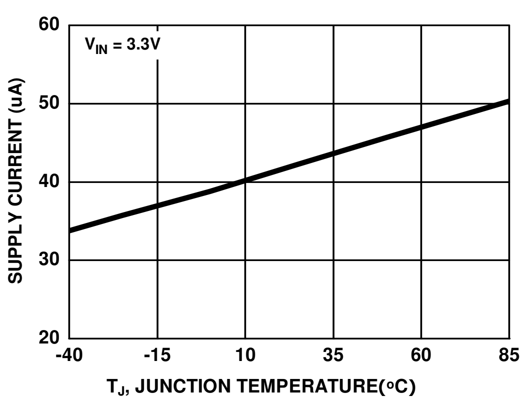


Figure 5. Latchoff current vs. Temperature

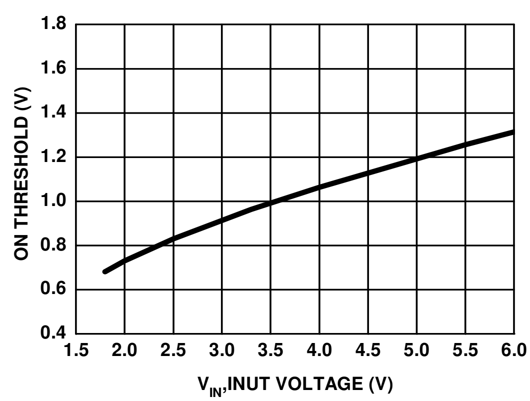


Figure 6. Input Voltage vs. On Threshold Voltage

Typical Characteristics

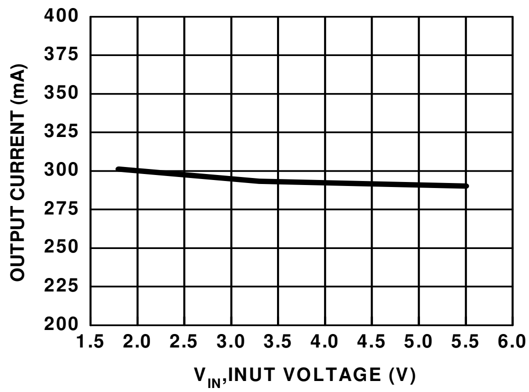


Figure 7. Current Limit vs. Output Voltage

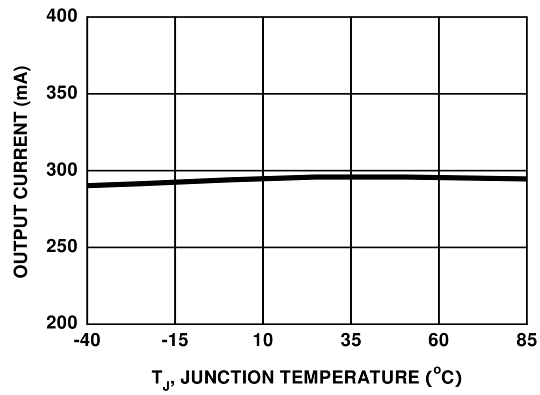


Figure 8. Current Limit vs. Temperature

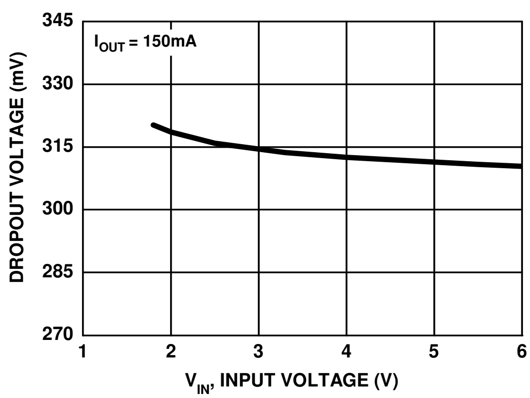


Figure 9. Drop Voltage vs. Input Voltage

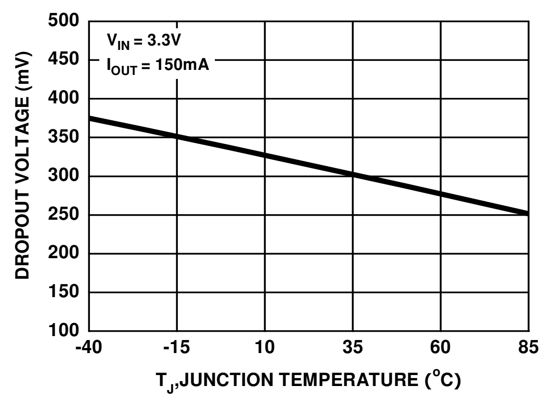


Figure 10. Drop Voltage vs. Temperature

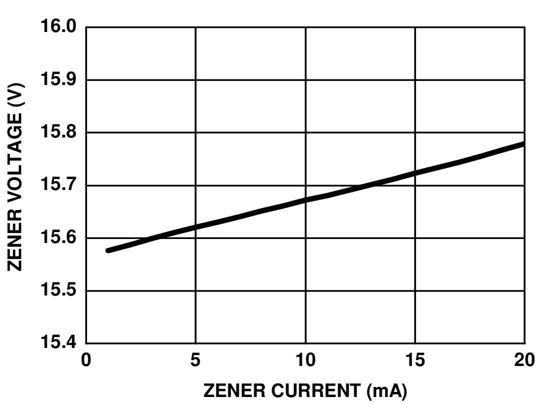


Figure 11. Zener Voltage vs. Zener Current

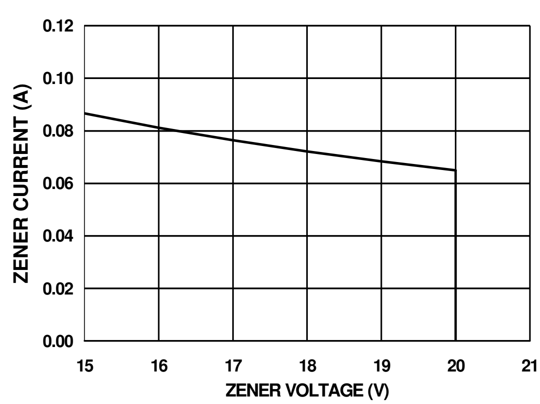


Figure 12. Zener Diode Safe Operating Area

Typical Characteristics

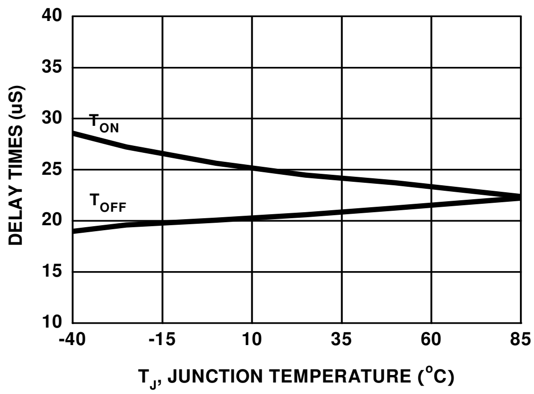


Figure 13. T_{ON}/T_{Off} vs. Temperature

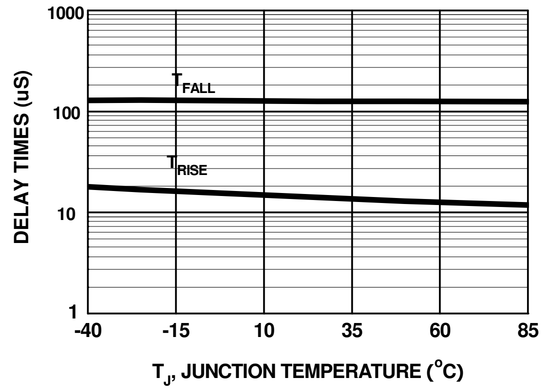


Figure 14. T_{Rise}/T_{Fall} vs. Temperature

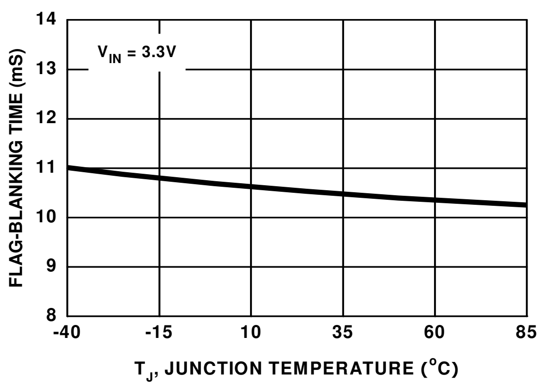


Figure 15. T_{BLANK} vs. Temperature

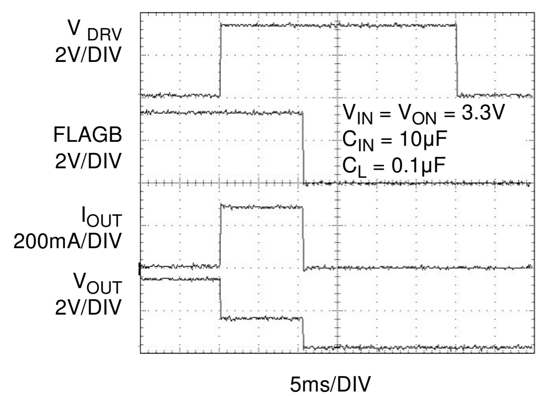


Figure 16. T_{BLANK} Response

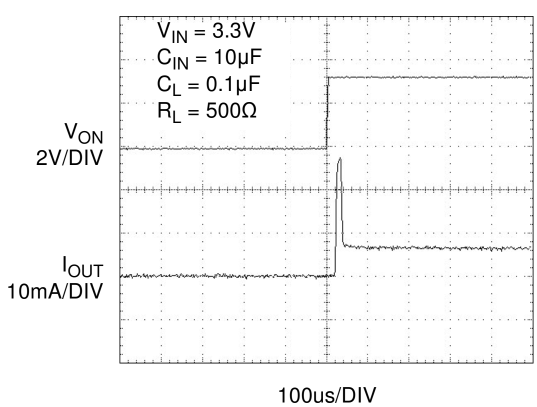


Figure 17. T_{ON} Response

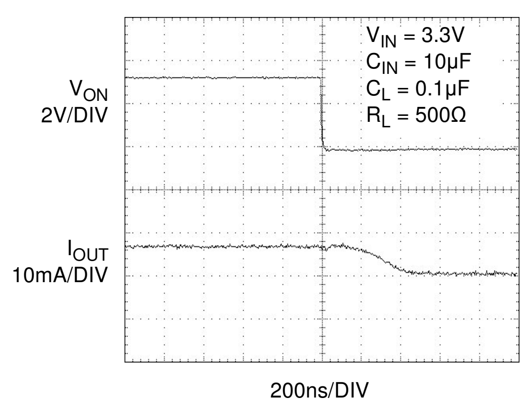


Figure 18. T_{OFF} Response

Typical Characteristics

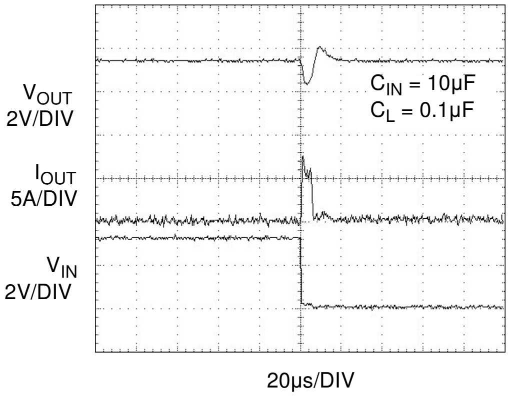


Figure 19. Short Circuit Response Time
(Output Shorted to GND)

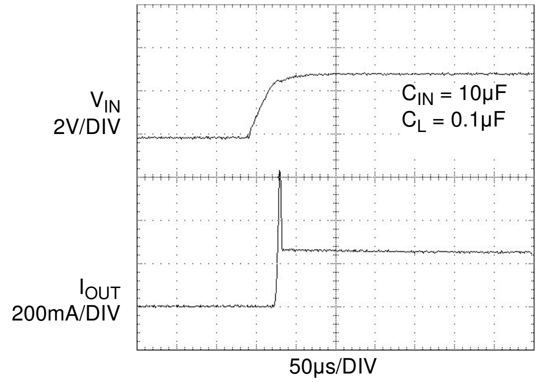


Figure 20. Current Limit Response Time
(Switch power up to hard short)

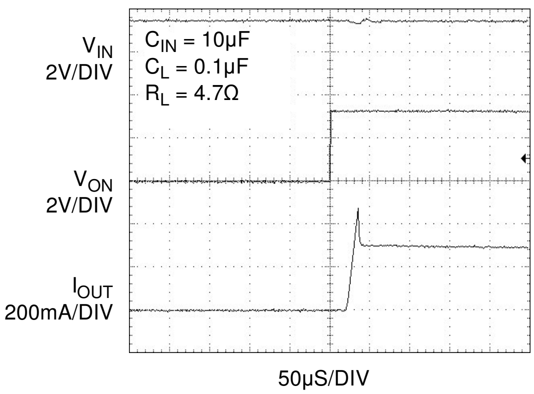


Figure 21. Current Limit Response Time
(Output has a 4.7Ω load)

Description of Operation

The FPF2174 is a current limited switch that protects systems and loads which can be damaged or disrupted by the application of high currents. The core of the device is a 0.125Ω P-channel MOSFET and a controller capable of functioning over a wide input operating range of 1.8-5.5V paired with a low forward voltage drop Schottky diode for reverse blocking and a 16V zener diode for output clamp. The controller protects against system malfunctions through current limiting, under-voltage lockout and thermal shutdown. The current limit is preset for 200mA.

On/Off Control

The ON pin controls the state of the switch. Activating ON continuously holds the switch in the on state so long as there is no under-voltage on V_{IN} or a junction temperature in excess of 150°C. ON is active HI and has a low threshold making it capable of interfacing with low voltage signals. When the MOSFET is off, the Schottky diode acts as a barrier so that no reverse current can flow when V_{OUT} is greater than V_{IN}.

Fault Reporting

Upon the detection of an over-current, an input under-voltage, or an over-temperature condition, the FLAGB signals the fault mode by activating LO. The FLAGB goes LO at the end of the blanking time and is latched LO and ON must be toggled to release it. FLAGB is an open-drain MOSFET which requires a pull-up resistor between V_{IN} and FLAGB. During shutdown, the pull-down on FLAGB is disabled to reduce current draw from the supply.

Current Limiting

The current limit guarantees that the current through the switch doesn't exceed a maximum value while not limiting at less than a minimum value. The minimum current is 200mA and the maximum current is 400mA. The device has a blanking time of 10ms, nominally, during which the switch will act as a constant current source. At the end of the blanking time, the switch will be turned-off and the FLAGB pin will activate to indicate that current limiting has occurred.

Under-Voltage Lockout

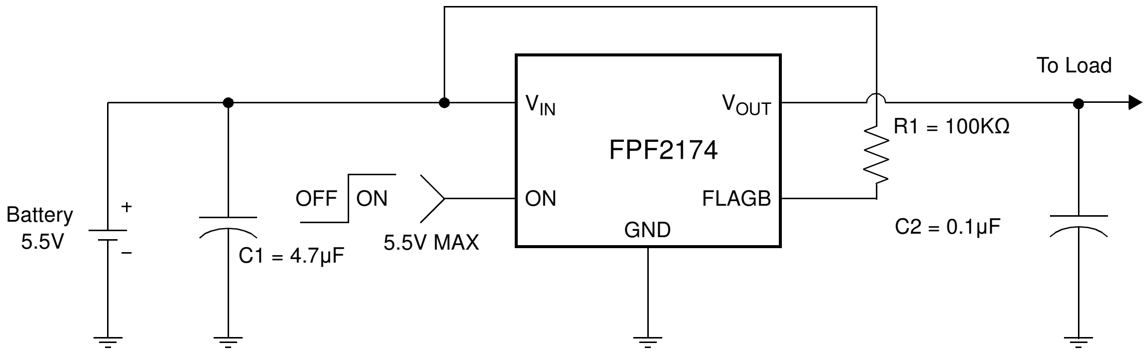
The under-voltage lockout turns-off the switch if the input voltage drops below the under-voltage lockout threshold. With the ON pin active the input voltage rising above the under-voltage lockout threshold will cause a controlled turn-on of the switch which limits current over-shoots.

Thermal Shutdown

The thermal shutdown protects the die from internally or externally generated excessive temperatures. During an over-temperature condition the FLAGB is activated and the switch is turned-off. The switch automatically turns-on again if temperature of the die drops below the threshold temperature.

Application Information

Typical Application



Input Capacitor

To limit the voltage drop on the input supply caused by transient in-rush currents when the switch turns-on into a discharged load capacitor or a short-circuit, a capacitor needs to be placed between V_{IN} and GND. A 4.7μF ceramic capacitor, C_{IN}, placed close to the pins is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop.

Output Capacitor

A 0.1uF capacitor C_{OUT}, should be placed between V_{OUT} and GND. This capacitor will prevent parasitic board inductances from forcing V_{OUT} below GND when the switch turns-off.

Power Dissipation

During normal operation as a switch, the power dissipation is small and has little effect on the operating temperature of the part. The parts with the higher current limits will dissipate the most power and that will only be typically,

$$P = I_{LIM} \times V_{DROP} = 0.4 \times 0.4 = 160\text{mW} \quad (2)$$

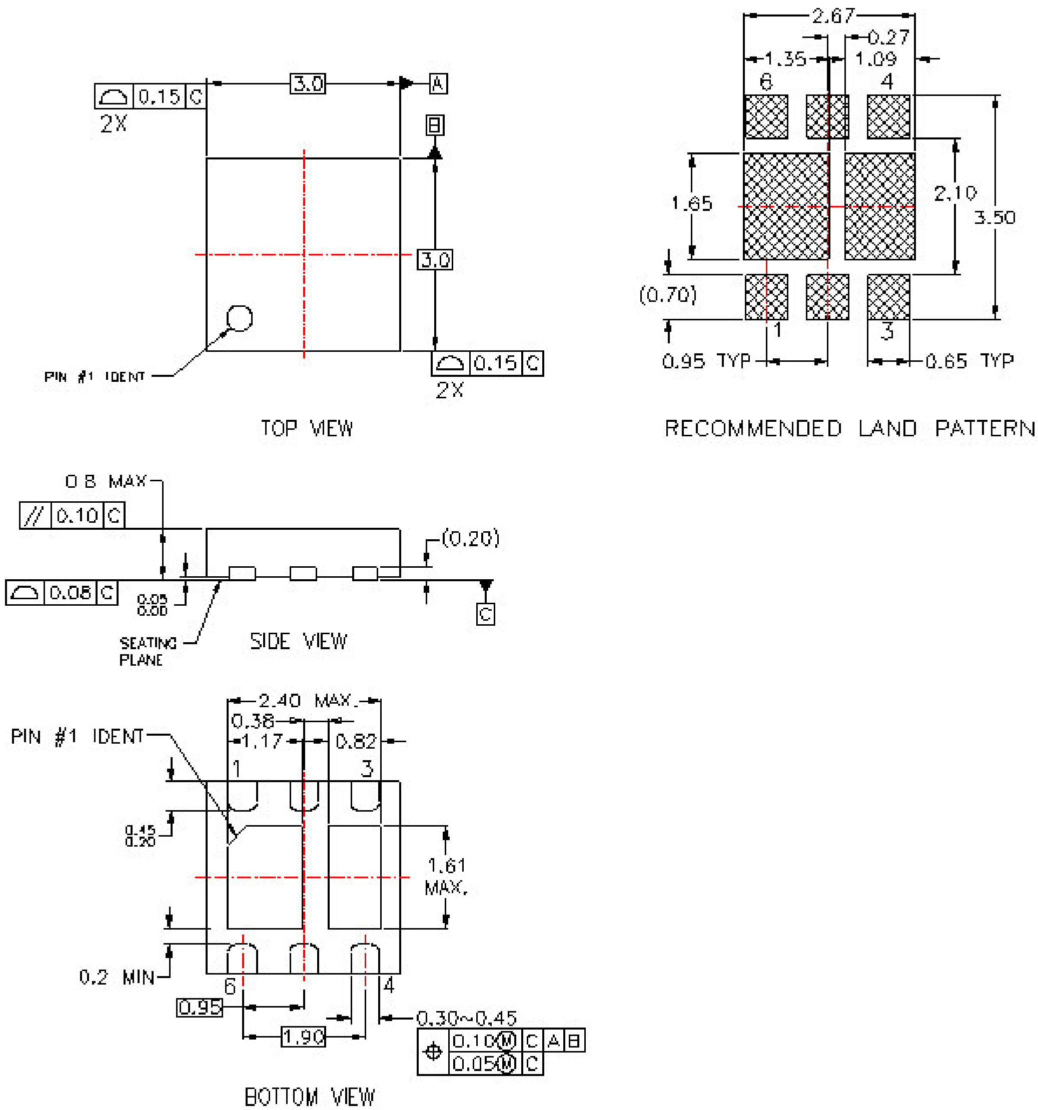
When using the part, attention must be given to the manual resetting of the part. Continuously resetting the part at a high duty cycle when a short on the output is present can cause the temperature of the part to increase. The junction temperature will only be allowed to increase to the thermal shutdown threshold. Once this temperature has been reached, toggling ON will not turn-on the switch until the junction temperature drops.

Board Layout

For best performance, all traces should be as short as possible. To be most effective, the input and output capacitors should be placed close to the device to minimize the effects that parasitic trace inductances may have on normal and short-circuit operation. Using wide traces for V_{IN}, V_{OUT} and GND will help minimize parasitic electrical effects along with minimizing the case to ambient thermal impedance.

Dimensional Outline and Pad Layout

Package MLP06H



NOTES:

A. CONFORMS TO JEDEC REGISTRATION MO-229, VARIATION WEEA, DATED 11/2001

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994

MLP06HrevA

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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I35