IntelliMAX™ Advanced Load Management Product

FPF2123-FPF2125

Description

The FPF2123, FPF2124, and FPF2125 are a series of load switches which provide full protection to systems and loads which may encounter large current conditions. These devices contain a 0.125 Ω current−limited P−channel MOSFET which can operate over an input voltage range of 1.8−5.5 V. The current limit is settable using an external resistor. Internally, current is prevented from flowing 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 parts operate in a constant−current mode to prohibit excessive currents from causing damage. For the FPF2123 and FPF2124 if the constant current condition still persists after 10 ms, these parts will shut off the switch. The FPF2123 has an auto−restart feature which will turn the switch on again after 160 ms if the ON pin is still active. The FPF2124 does not have this auto−restart feature so the switch will remain off after a current limit fault until the ON pin is cycled. The FPF2125 will not turn off after a current limit fault, but will rather remain in the constant current mode indefinitely. The minimum current limit is 150 mA.

These parts are available in a space−saving 5 pin SOT23 package.

Features

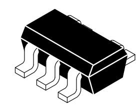
- 1.8 to 5.5 V Input Voltage Range
- Controlled Turn−On
- 0.15−1.5 A Adjustable Current Limit
- Under−Voltage Lockout
- Thermal Shutdown
- < 2 μA Shutdown Current
- Auto Restart
- Fast Current Limit Response Time
  - 3 μs to Moderate Over Currents
- Fault Blanking
- Reverse Current Blocking
- These Devices are Pb−Free and are RoHS Compliant

Applications

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

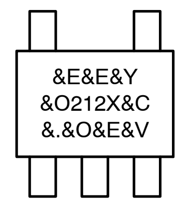
ON Semiconductor®

www.onsemi.com



SOT23−5
CASE 527AH

MARKING DIAGRAM



&E	= Designates Space
&Y	= Binary Calendar Year Coding Scheme
&O	= Plant Code identifier
212X	= Device Specific Code X = 3. 4 or 5
&C	= Single digit Die Run Code
&.	= Pin One Dot
&V	= Eight−Week Binary Datecoding Scheme

ORDERING INFORMATION

See detailed ordering and shipping information on page 11 of this data sheet.

Typical Application Circuit

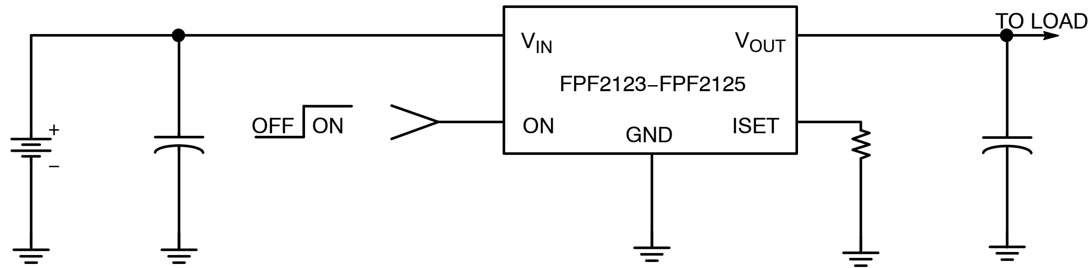


Figure 1. Typical Application

Functional Block Diagram

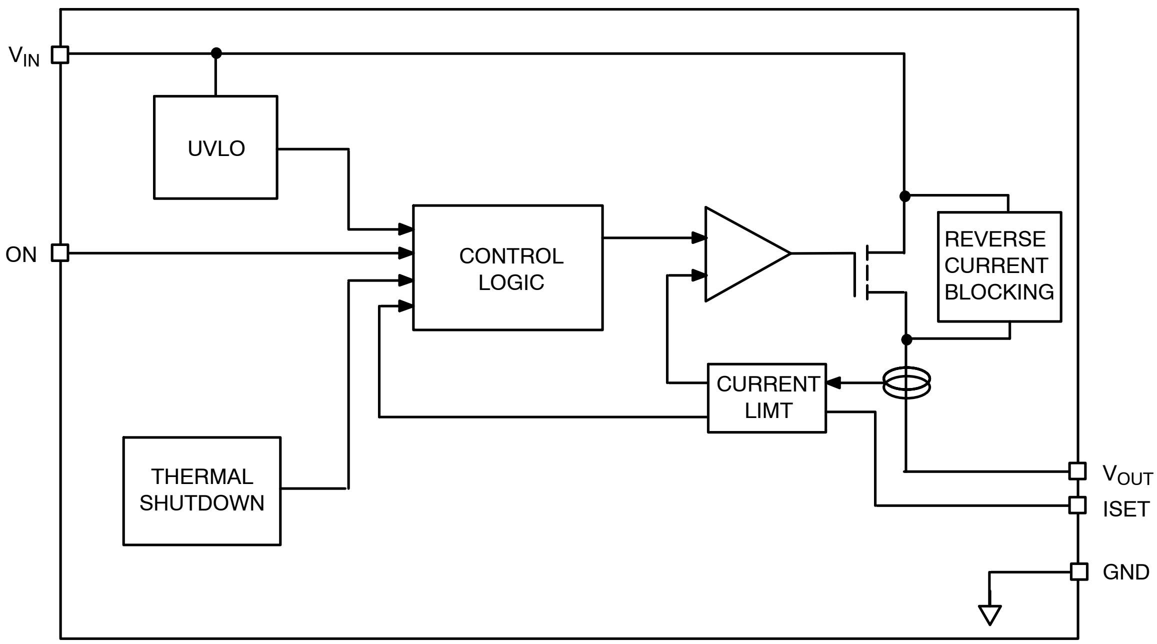


Figure 2. Block Diagram

Pin Configuration

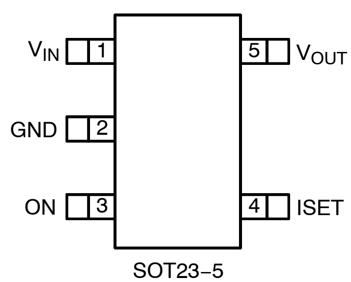


Figure 3. Pin Assignment

PIN DESCRIPTIONS

Pin	Name	Function
1	V_{IN}	Supply Input: Input to the power switch and the supply voltage for the IC
2	GND	Ground
3	ON	ON Control Input
4	ISET	Current Limit Set Input: A resistor from ISET to ground sets the current limit for the switch.
5	V_{OUT}	Switch Output: Output of the power switch

ABSOLUTE MAXIMUM RATINGS

Parameter		Min	Max	Unit
V_{IN}, V_{OUT}, ON, ISET to GND		−0.3	6.0	V
Power Dissipation @ T_A = 25°C (Note 1)			667	mW
Operating Temperature Range		−40	125	°C
Storage Temperature		−65	150	°C
Thermal Resistance, Junction to Ambient			150	°C/W
Electrostatic Discharge Protection	HBM	4000		V
	MM	400		

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	1.8	5.5	V
T_A	Ambient Operating Temperature	−40	85	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Test Condition		Min	Typ	Max	Unit
BASIC OPERATION							
V_{IN}	Operating Voltage			1.8		5.5	V
I_Q	Quiescent Current	I_{OUT} = 0 mA	V_{IN} = 1.8 to 3.3 V		75		µA
			V_{IN} = 3.3 to 5.5 V		80	120	
I_{SHDN}	Shutdown Current					2	µA
I_{BLOCK}	Reverse Block Leakage Current					1	µA
$I_{LATCHOFF}$	Latch−Off Current	FPF2124			50		µA
R_{ON}	ON−Resistance	V_{IN} = 3.3 V, I_{OUT} = 50 mA, T_A = 25°C			125	160	mΩ
		V_{IN} = 3.3 V, I_{OUT} = 50 mA, T_A = 85°C			150	200	
		V_{IN} = 3.3 V, I_{OUT} = 50 mA, T_A = −40°C to + 85°C		65		200	
V_{IH}	ON Input Logic High Voltage (ON)	V_{IN} = 1.8 V		0.75			V
		V_{IN} = 5.5 V		1.30			
V_{IL}	ON Input Logic Low Voltage (ON)	V_{IN} = 1.8 V				0.5	V
		V_{IN} = 5.5 V				1.0	

ELECTRICAL CHARACTERISTICS (continued)

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

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
BASIC OPERATION						
	ON Input Leakage	V_{ON} = V_{IN} or GND			1	μA
I_{SWOFF}	Off Switch Leakage	V_{ON} = 0 V, V_{OUT} = 0 V			1	μA
PROTECTIONS						
I_{LIM}	Current Limit	V_{IN} = 3.3 V, V_{OUT} = 3.0 V, RSET = 576 Ω	600	800	1000	mA
$I_{LIM(min.)}$	Min. Current Limit	V_{IN} = 3.3 V, V_{OUT} = 3.0 V		150		mA
	Thermal Shutdown	Shutdown Threshold		140		°C
		Return from Shutdown		130		
		Hysteresis		10		
UVLO	Under Voltage Shutdown	V_{IN} Increasing	1.5	1.6	1.7	V
	Under Voltage Shutdown Hysteresis			50		mV
DYNAMIC						
t_{ON}	Turn On Time	R_L = 500 Ω, C_L = 0.1 μF		25		μs
t_{OFF}	Turn Off Time	R_L = 500 Ω, C_L = 0.1 μF		70		μs
t_R	V_{OUT} Rise Time	R_L = 500 Ω, C_L = 0.1 μF		12		μs
t_F	V_{OUT} Fall Time	R_L = 500 Ω, C_L = 0.1 μF		200		μs
t_{BLANK}	Over Current Blanking Time	FPF2123, FPF2124	5	10	20	ms
$t_{RESTART}$	Auto−Restart Time	FPF2123	80	160	320	ms
		FPF2124, FPF2125		NA		
	Short Circuit Response Time	V_{IN} = V_{ON} = 3.3 V Moderate Over−Current Conditions		3		μs
		V_{IN} = V_{ON} = 3.3 V Hard Short		20		μs

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

TYPICAL CHARACTERISTICS

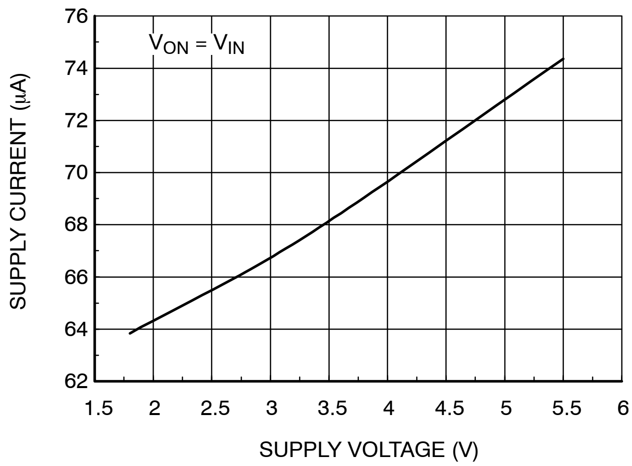


Figure 4. Quiescent Current vs. Input Voltage

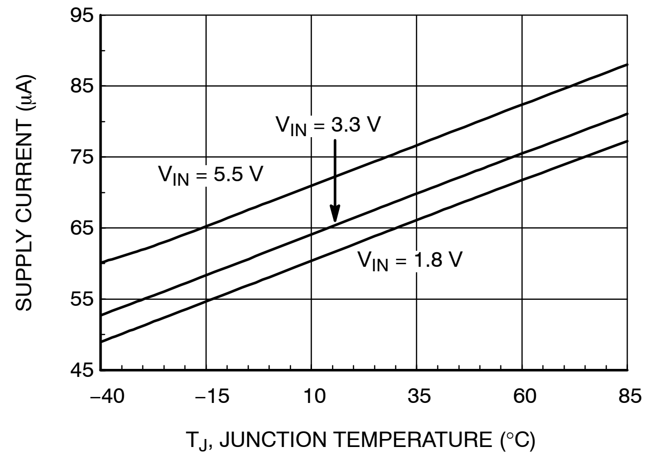


Figure 5. Quiescent Current vs. Temperature

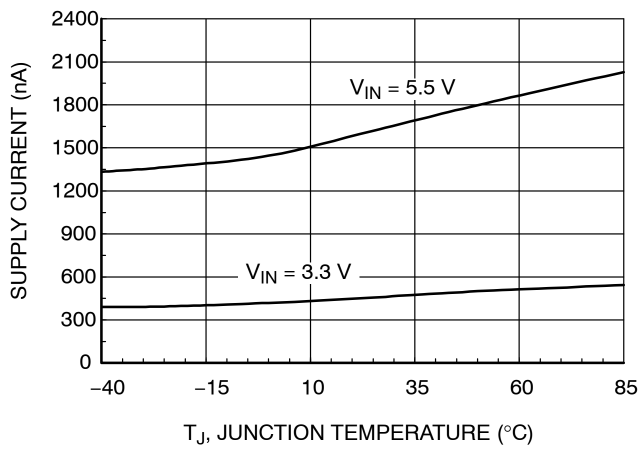


Figure 6. $I_{SHUTDOWN}$ Current vs. Temperature

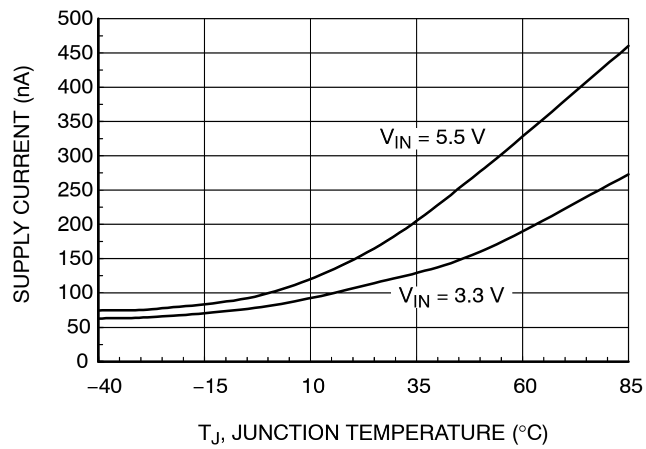


Figure 7. $I_{SWITCH-OFF}$ Current vs. Temperature

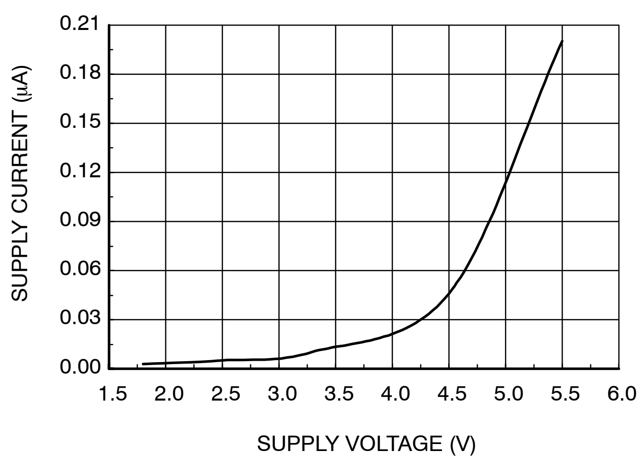


Figure 8. Reverse Current vs. V_{OUT}

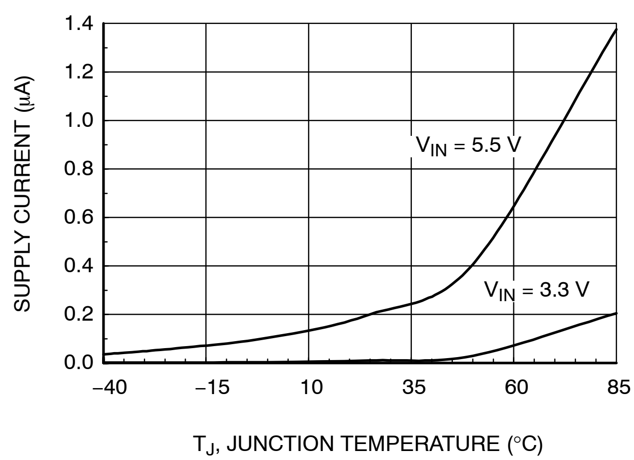


Figure 9. Reverse Current vs. Temperature

TYPICAL CHARACTERISTICS (Continued)

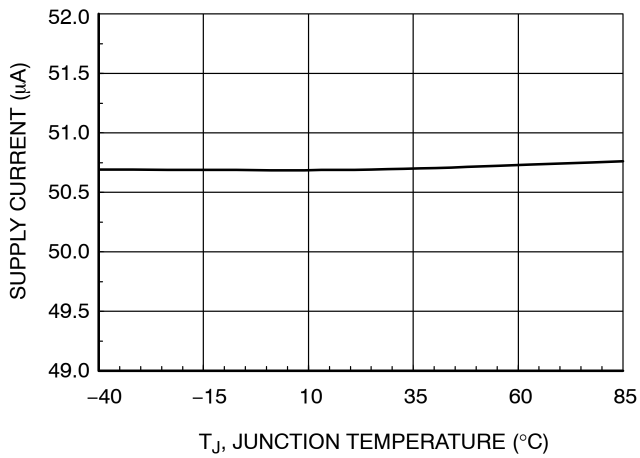


Figure 10. $I_{LATCH-OFF}$ Current vs. Temperature

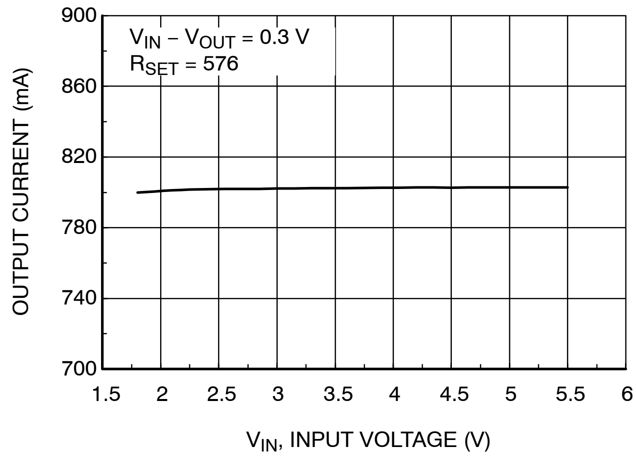


Figure 11. Current Limit vs. Input Voltage

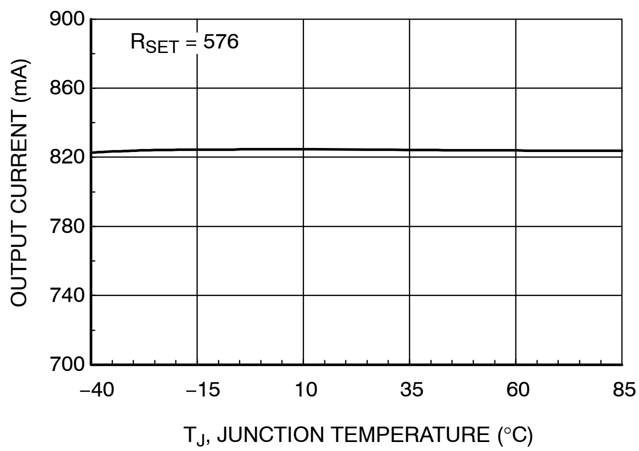


Figure 12. Current Limit vs. Temperature

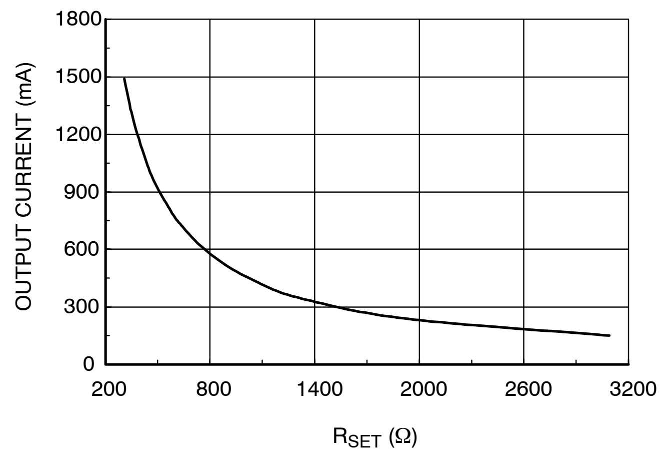


Figure 13. Current Limit vs. Rest

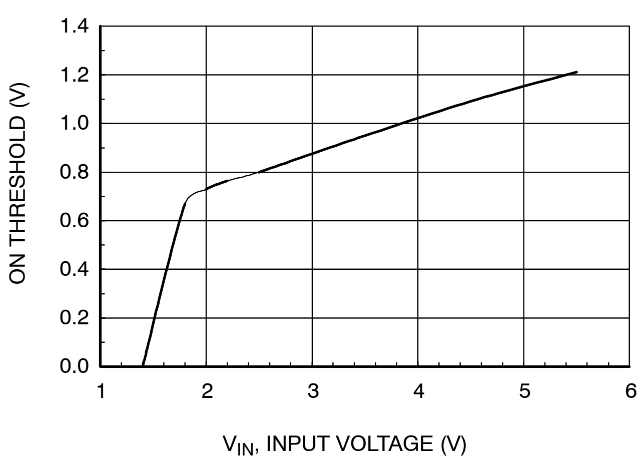


Figure 14. V_{IH} vs. V_{IN}

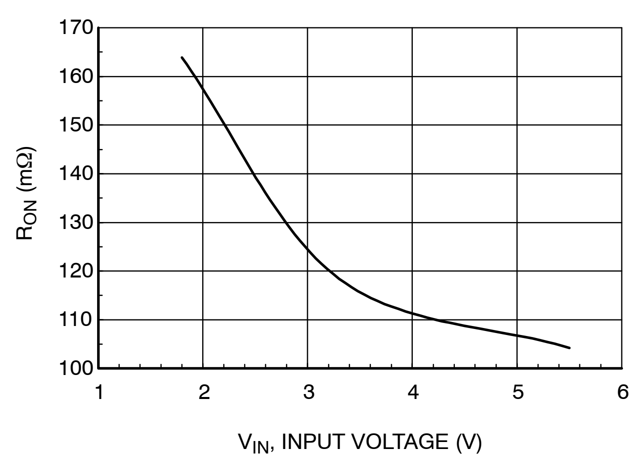


Figure 15. R_{ON} vs. V_{IN}

TYPICAL CHARACTERISTICS (Continued)

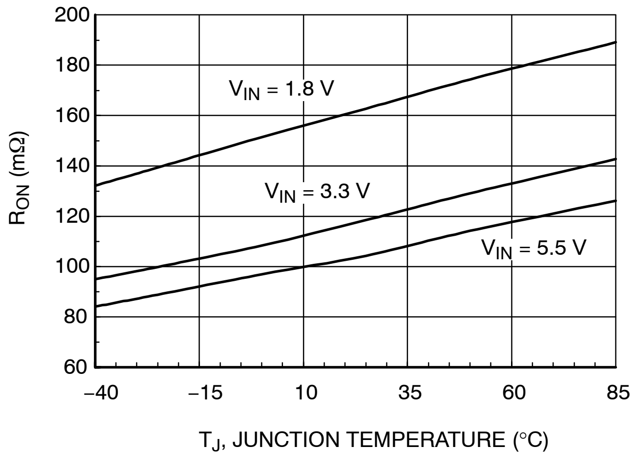


Figure 16. $R_{(ON)}$ vs. Temperature

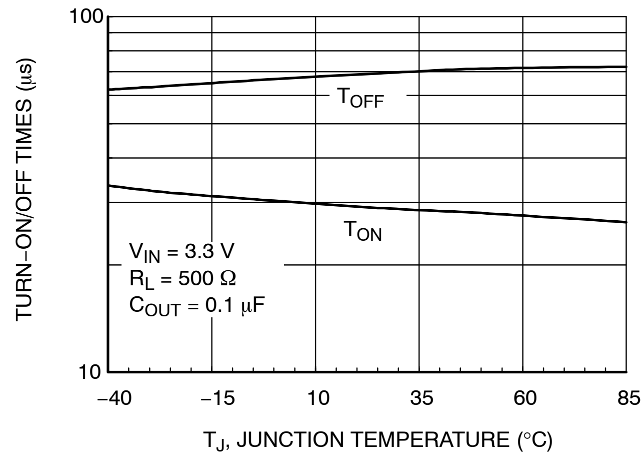


Figure 17. T_{ON}/T_{OFF} vs Temperature

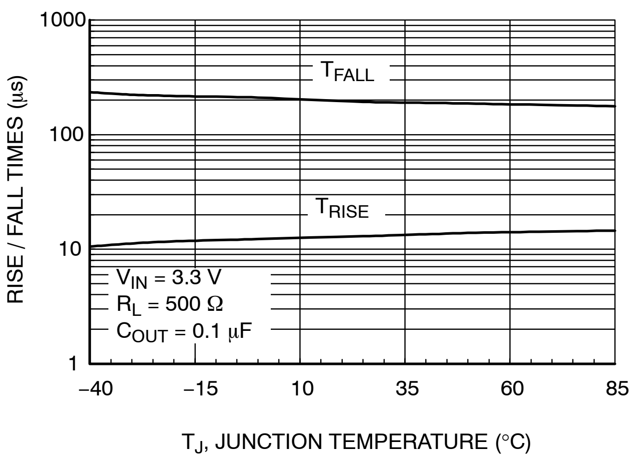


Figure 18. T_{RISE}/T_{FALL} vs. Temperature

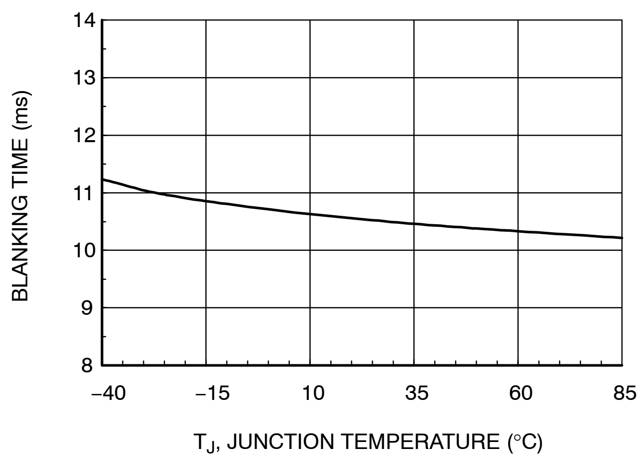


Figure 19. T_{BLANK} vs. Temperature

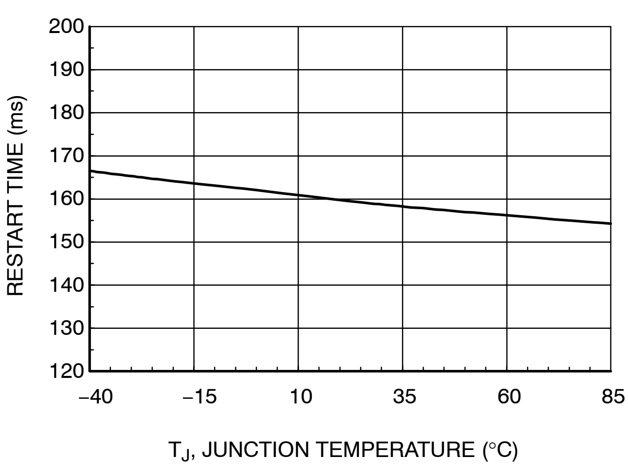


Figure 20. $T_{RESTAR}T$ vs. Temperature

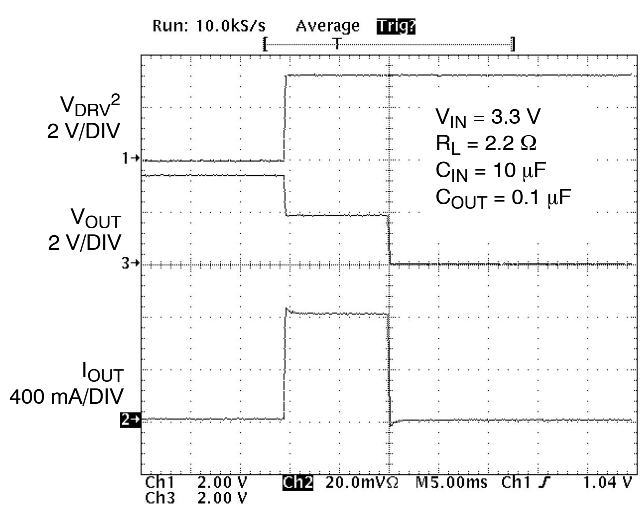


Figure 21. T_{BLANK} Response

TYPICAL CHARACTERISTICS (Continued)

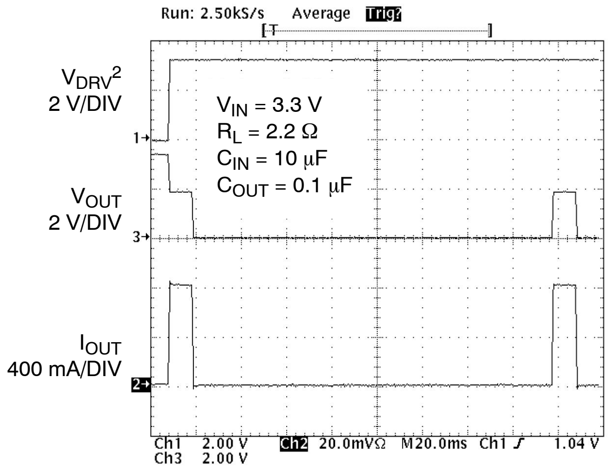


Figure 22. $T_{RESTART}$ Response

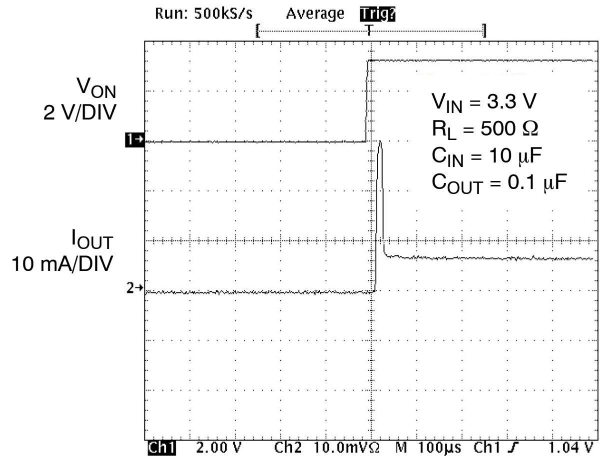


Figure 23. T_{ON} Response

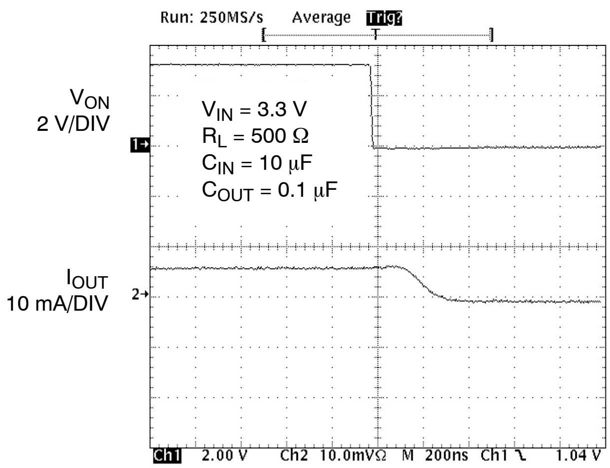


Figure 24. T_{OFF} Response

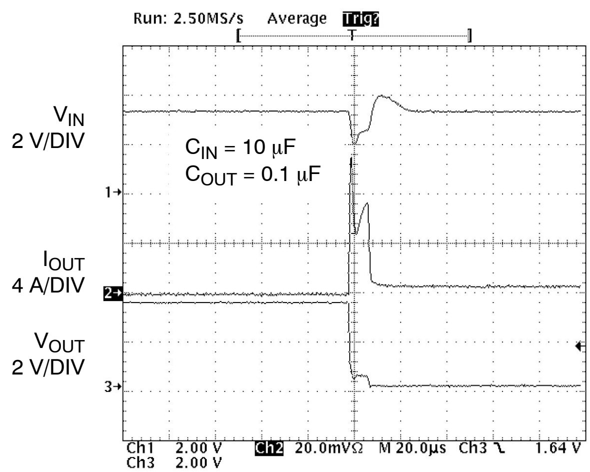


Figure 25. Short Circuit Response (Output Shorted to GND)

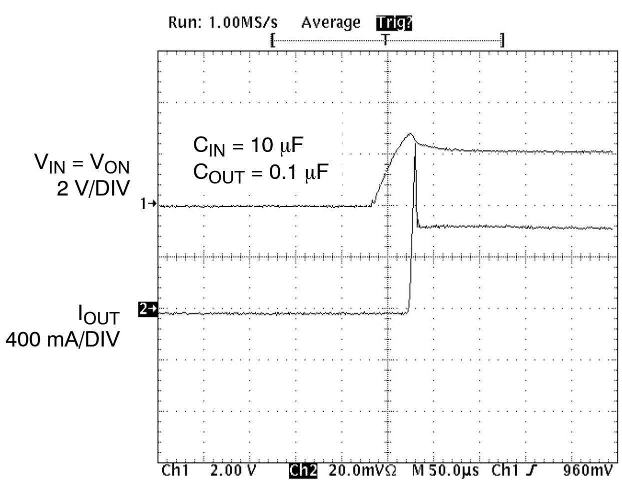


Figure 26. Current Limit Response (Switch Power Up to Hard Short)

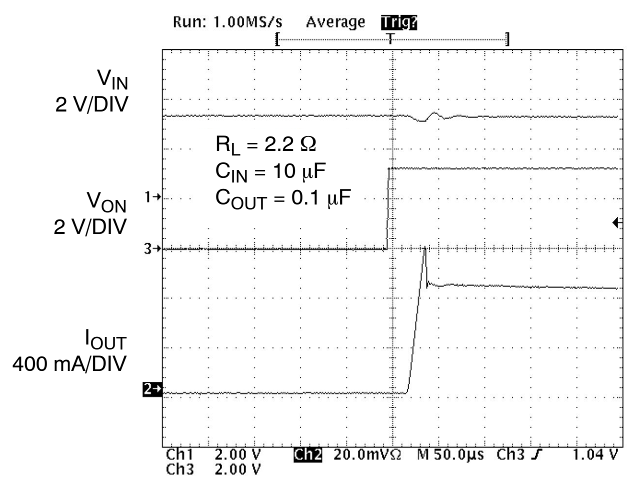


Figure 27. Current Limit Response (Output Shorted to GND by 2.2 Ω, Moderate Short)

NOTE: V_{DRV} signal forces the device to go into overcurrent condition by loading a 2.2 Ω resistor.

Description of Operation

The FPF2123, FPF2124, and FPF2125 are current limited switches that protect systems and loads which can be damaged or disrupted by the application of high currents. The core of each device is a 0.125 Ω P−channel MOSFET and a controller capable of functioning over a wide input operating range of 1.8−5.5 V. The controller protects against system malfunctions through current limiting under−voltage lockout and thermal shutdown. The current limit is adjustable from 150 mA to 1.5 A through the selection of an external resistor.

On/Off Control

The ON pin controls the state of the switch. When ON is high, the switch is in the on state. Activating ON continuously holds the switch in the on state so long as there is no fault. For all versions, an under−voltage on V_{IN} or a junction temperature in excess of 140°C overrides the ON control to turn off the switch. In addition, excessive currents will cause the switch to turn off in the FPF2123 and FPF2124. The FPF2123 has an Auto−Restart feature which will automatically turn the switch on again after 160 ms. For the FPF2124, the ON pin must be toggled to turn−on the switch again. The FPF2125 does not turn off in response to an over current condition but instead remains operating in a constant current mode so long as ON is active and the thermal shutdown or under−voltage lockout have not activated.

The ON pin control voltage and V_{IN} pin have independent recommended operating ranges. The ON pin voltage can be driven by a voltage level higher than the input voltage.

Current Limiting

The current limit ensures that the current through the switch doesn't exceed a maximum value while not limiting at less than a minimum value. The current at which the parts will limit is adjustable through the selection of an external resistor connected to ISET. Information for selecting the resistor is found in the Application Info section. The FPF2123 and FPF2124 have a blanking time of 10 ms, 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. The FPF2125 has no current limit blanking period so it will remain in a constant current state until the ON pin is deactivated or the thermal shutdown turns−off the switch.

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 switch is turned−off. The switch automatically turns−on again if the temperature of the die drops below the threshold temperature.

APPLICATIONS INFORMATION

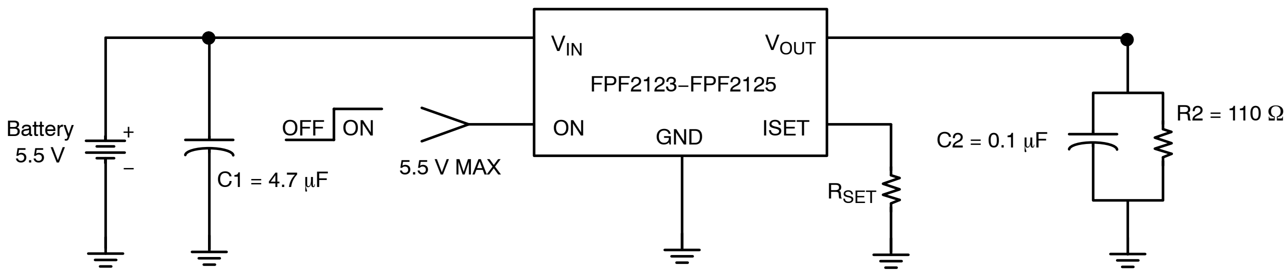


Figure 28. Typical Application

Setting Current Limit

The FPF2123, FPF2124, and FPF2125 have a current limit which is set with an external resistor connected between ISET and GND. This resistor is selected by using the following equation (1),

$$R_{SET} = \frac{460}{I_{LIM}} \qquad \text{(eq. 1)}$$

R_{SET} is in Ohms and that of I_{LIM} is Amps.

The table below can also be used to select R_{SET}. A typical application would be the 500 mA current that is required by a single USB port. Using the table below an appropriate selection for the R_{SET} resistor would be 604 Ω. This will ensure that the port load could draw 570 mA, but not more than 950 mA. Likewise for a dual port system, an R_{SET} of 340 Ω would always deliver at least 1120 mA and never more than 1860 mA.

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 capacitance or a short−circuit, a capacitor needs to be placed between V_{IN} and GND. A 4.7 μF ceramic capacitor, C_{IN}, must be placed close to the V_{IN} pin. A higher value of C_{IN} can be used to further reduce the voltage drop experienced as the switch is turned on into a large capacitive load.

Output Capacitor

A 0.1 μF 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. For the FPF2123 and FPF2124, the total output capacitance needs to be kept below a maximum value, $C_{OUT(max)}$, to prevent the part from registering an over−current condition and turning−off the switch. The maximum output capacitance can be determined from the following formula,

$$C_{OUT}(max) = \frac{I_{LIM}(min) \times t_{BLANK}(min)}{V_{IN}} \qquad \text{(eq. 2)}$$

Table 1. Current Limit Various R_{SET} Values

R_{SET} [Ω]	Min. Current Limit [mA]	Typ. Current Limit [mA]	Max. Current Limit [mA]
309	1120	1490	1860
340	1010	1350	1690
374	920	1230	1540
412	840	1120	1400
453	760	1010	1270
499	690	920	1150
549	630	840	1050
576	600	800	1000
604	570	760	950
732	470	630	790
887	390	520	650
1070	320	430	540
1300	260	350	440
1910	180	240	300
3090	110	150	190

Power Dissipation

During normal operation as a switch, the power dissipated in the part will depend upon the level at which the current limit is set. The maximum allowed setting for the current limit is 1.5 A and this will result in a typical power dissipation of,

$$P = (I_{LIM})^2 \times R_{ON} = (1.5)^2 \times 0.125 = 281\ \text{mW} \qquad \text{(eq. 3)}$$

If the part goes into current limit the maximum power dissipation will occur when the output is shorted to ground. For the FPF2123 the power dissipation will scale by the Auto−Restart Time, $t_{RESTART}$, and the Over Current Blanking Time, t_{BLANK}, so that the maximum power dissipated is,

$$P(\max) = \frac{t_{BLANK}(\max)}{t_{RESTART}(\min) + t_{BLANK}(\max)} \times$$

$$\times V_{IN}(\max) \times I_{LIM}(\max) = \frac{20}{80 + 20} \times 5.5 \times 1.5 = 1.65\ \text{W} \qquad \text{(eq. 4)}$$

This is more power than the package can dissipate, but the thermal shutdown of the part will activate to protect the part from damage due to excessive heating. When using the FPF2124, attention must be given to the manual resetting of the part. Continuously resetting the part when a short on the output is present will cause the temperature of the part to increase. The junction temperature will only be able 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. For the FPF2125, a short on the output will cause the part to operate in a constant current state dissipating a worst case power of,

$$P(\max) = V_{IN}(\max) \times I_{LIM}(\max) = 5.5 \times 1.5 = 8.25\ \text{W} \qquad \text{(eq. 5)}$$

This large amount of power will activate the thermal shutdown and the part will cycle in and out of thermal shutdown so long as the ON pin is active and the short is present.

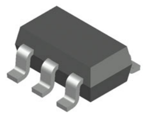
Board Layout

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.

ORDERING INFORMATION

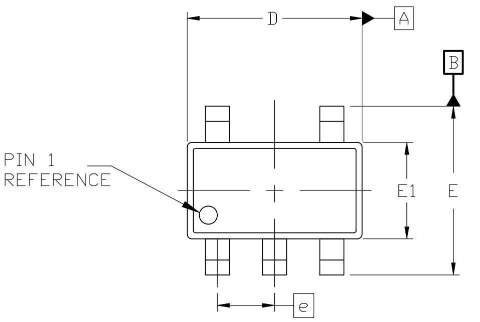
Part Number	Current Limit [A]	Current Limit Blanking Time [ms]	Auto Restart Time [ms]	On Pin Activity	Top Mark	Shipping†
FPF2123	0.15 − 1.5	5/10/20	80/160/320	Active HI	2123	3000 / Tape & Reel
FPF2124	0.15 − 1.5	5/10/20	NA	Active HI	2124	3000 / Tape & Reel
FPF2125	0.15 − 1.5	Infinite	NA	Active HI	2425	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D



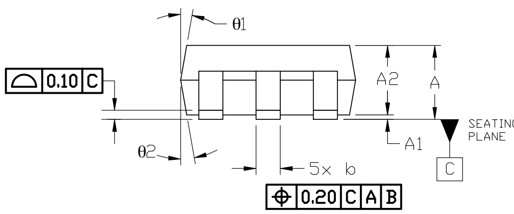
SOT−23, 5 Lead
CASE 527AH
ISSUE A

DATE 09 JUN 2021

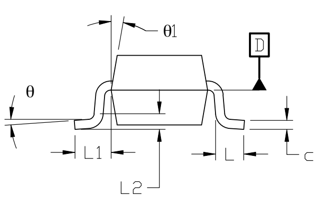


TOP VIEW

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 19894
2. CONTROLLING DIMENSION: MILLIMETERS
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E1 DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.25 PER SIDE. D AND E1 DIMENSIONS ARE DETERMINED AT DATUM D.
5. DIMENSION 'b' DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08mm TOTAL IN EXCESS OF THE 'b' DIMENSION AT MAXIMUM MATERIAL CONDITION. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD SHALL NOT BE LESS THAN 0.07mm.

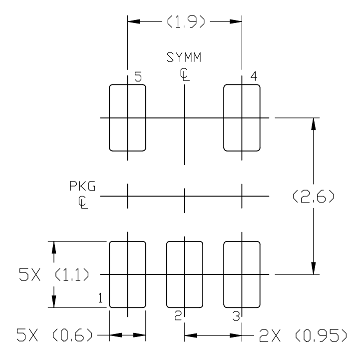


SIDE VIEW



END VIEW

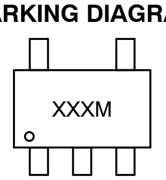
DIM	MILLIMETERS MIN.	NOM.	MAX.
A	0.90	—	1.45
A1	0.00	—	0.15
A2	0.90	1.15	1.30
b	0.30	—	0.50
c	0.08	—	0.22
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 BSC		
L	0.30	0.45	0.60
L1	0.60 REF		
L2	0.25 REF		
θ	0°	4°	8°
θ1	0°	10°	15°
θ2	0°	10°	15°



RECOMMENDED MOUNTING FOOTPRINT

For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC MARKING DIAGRAM*



XXX = Specific Device Code
M = Date Code

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

DOCUMENT NUMBER:	**98AON34320E**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	**SOT−23, 5 LEAD**	**PAGE 1 OF 1**

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Email Requests to: orderlit@onsemi.com

onsemi Website: www.onsemi.com

TECHNICAL SUPPORT
North American Technical Support:
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative