

# FPF1013/4 IntelliMAX™ 1V Rated Advanced Load Management Products

## Features

- 0.8V to 1.8V Input Voltage Range
- Typical  $R_{DS(ON)} = 17m\Omega @ V_{ON} - V_{IN} = 2.0V$
- Output Discharge Function
- Internal Pull-down at ON Pin
- Accurate Slew Rate Controlled Turn-on time
- Low  $< 1\mu A$  Quiescent Current
- ESD Protected, above 8000V HBM, 2000V CDM
- RoHS Compliant
- Free from Halogenated Compounds and Antimony Oxides

## Applications

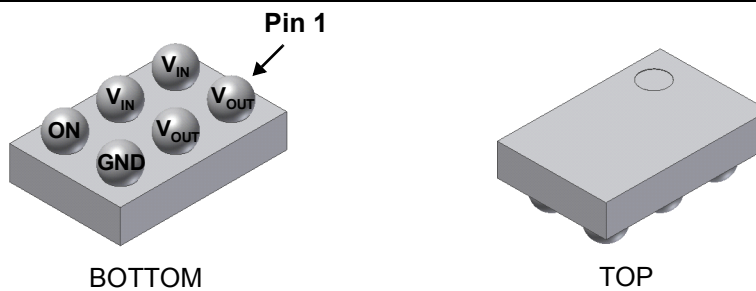
- PDAs
- Cell Phones
- GPS Devices
- MP3 Players
- Digital Cameras
- Notebook Computer



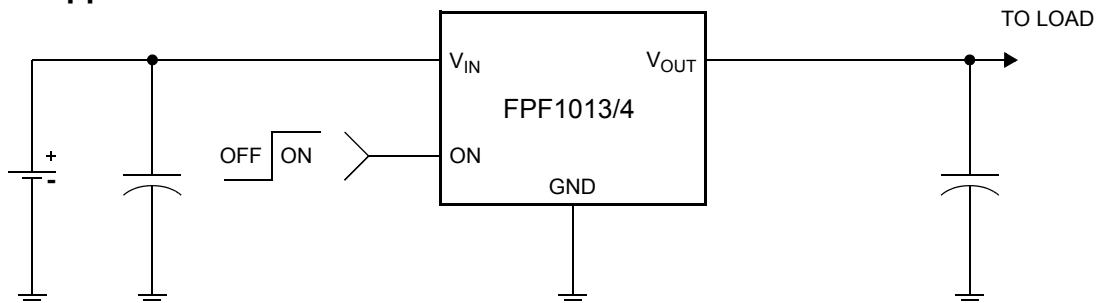
## General Description

The FPF1013/4 series is an IntelliMAX advanced slew rate loadswitch offering a very low operating voltage. These devices consist of a 17mΩ N-channel MOSFET that supports an input voltage up to 2.0V. These slew rate devices control the switch turn-on and prevent excessive in-rush current from the supply rails. The input voltage range operates from 0.8V to 1.8V to fulfill today's lowest Ultraportable Device's supply requirements. Switch control is via a logic input (ON) capable of interfacing directly with low voltage control signals.

The FPF1014 has an On-Chip pull down allowing for quick and controlled output discharge when switch is turned off. The FPF1013/4 series is available in a space-saving 1X1.5 CSP-6L package.



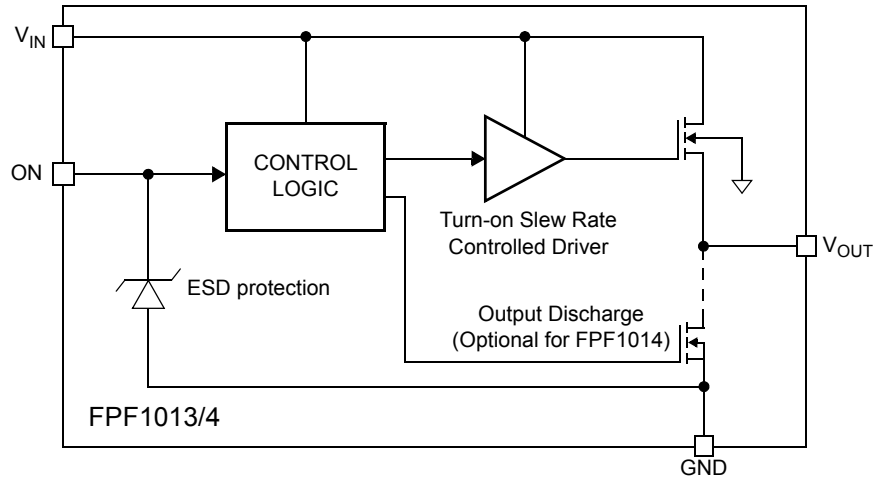
## Typical Application Circuit



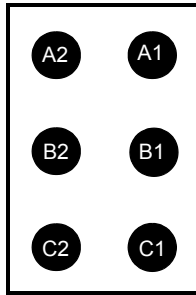
## Ordering Information

Part	Switch	Turn-on Time	Output Discharge	ON Pin Activity	Package
FPF1013	17mΩ, NMOS	43μs	N/A	Active HI	CSP1X1.5
FPF1014	17mΩ, NMOS	43μs	60Ω	Active HI	CSP1X1.5

## Functional Block Diagram



## Pin Configuration



1.0 x 1.5 CSP Bottom View

## Pin Description

Pin	Name	Function
A2, B2	$V_{IN}$	Supply Input: Input to the power switch and the supply voltage for the IC
C2	ON	ON Control Input
A1, B1	$V_{OUT}$	Switch Output: Output of the power switch
C1	GND	Ground

## Absolute Maximum Ratings

Parameter	Min	Max	Unit
$V_{IN}, V_{OUT}$ to GND	-0.3	2	V
$V_{ON}$ to GND	-0.3	4.2	V
Maximum Continuous Switch Current		1.5	A
Power Dissipation @ $T_A = 25^\circ\text{C}$ (Note 1)		1.2	W
Operating Temperature Range	-40	85	$^\circ\text{C}$
Storage Temperature	-65	150	$^\circ\text{C}$
Thermal Resistance, Junction to Ambient		85	$^\circ\text{C}/\text{W}$
Electrostatic Discharge Protection	HBM	8000	V
	CDM	2000	V

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

## Recommended Operating Range

Parameter	Min	Max	Unit
$V_{IN}$	0.8	1.8	V
Ambient Operating Temperature, $T_A$	-40	85	°C

## Electrical Characteristics

$V_{IN} = 0.8$  to  $1.8$ V,  $T_A = -40$  to  $+85$ °C unless otherwise noted. Typical values are at  $V_{IN} = 1.8$ V and  $T_A = 25$ °C.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>Basic Operation</b>						
Operating Voltage	$V_{IN}$		0.8		1.8	V
ON Input Voltage	$V_{ON(MIN)}$	$V_{IN} = 0.8$ V	1.8	2.8	4.0	V
	$V_{ON(MAX)}$	$V_{IN} = 1.8$ V (Note 2)	2.8	3.8	4.0	V
Operating Current	$I_{CC}$	$V_{IN} = 1$ V, $V_{ON} = 3.3$ V, $V_{OUT} = \text{Open}$			1	μA
Quiescent Current	$I_Q$	$V_{IN} = 1$ V, $V_{ON} = \text{GND}$ , $V_{OUT} = \text{Open}$			2	μA
Off Switch Current	$I_{SWOFF}$	$V_{IN} = 1.8$ V, $V_{ON} = \text{GND}$ , $V_{OUT} = \text{GND}$			2	μA
On-Resistance	$R_{ON}$	$V_{IN} = 1$ V, $V_{ON} = 3$ V, $I_{OUT} = 1$ A, $T_A = 25$ C		17	27	mΩ
		$V_{IN} = 1$ V, $V_{ON} = 2.3$ V, $I_{OUT} = 1$ A, $T_A = 25$ °C		25	38	
Output Pull Down Resistance	$R_{PD}$	$V_{IN} = 1$ V, $V_{ON} = 0$ V, $I_{OUT} = 1$ mA, $T_A = 25$ °C, FPF1014		60	120	Ω
ON Input Logic Low Voltage	$V_{IL}$	$V_{IN} = 0.8$ V, $R_L = 1$ KΩ			0.3	V
		$V_{IN} = 1.8$ V, $R_L = 1$ KΩ			0.8	
ON Input Leakage		$V_{ON} = V_{IN}$ or GND	-1		1	μA
<b>Dynamic</b> ( $V_{IN} = 1.0$ V, $V_{ON} = 3.0$ V, $T_A = 25$ °C)						
$V_{OUT}$ Rise Time	$T_R$	$R_L = 500$ Ω, $C_L = 0.1$ μF		28		μs
		$R_L = 3.3$ Ω, $C_L = 10$ μF		38		
Turn On Time	$T_{ON}$	$R_L = 500$ Ω, $C_L = 0.1$ μF		43		μs
		$R_L = 3.3$ Ω, $C_L = 10$ μF		58		
$V_{OUT}$ Fall Time	$T_F$	FPF1014, $R_L = 500$ Ω, $C_L = 0.1$ μF		14		μs
		FPF1014, $R_L = 3.3$ Ω, $C_L = 10$ μF		76		
Turn Off Time	$T_{OFF}$	FPF1014, $R_L = 500$ Ω, $C_L = 0.1$ μF		50		μs
		FPF1014, $R_L = 3.3$ Ω, $C_L = 10$ μF		96		

**Note 2:**  $V_{ON(MAX)}$  is limited by the absolute rating.

## Typical Characteristics

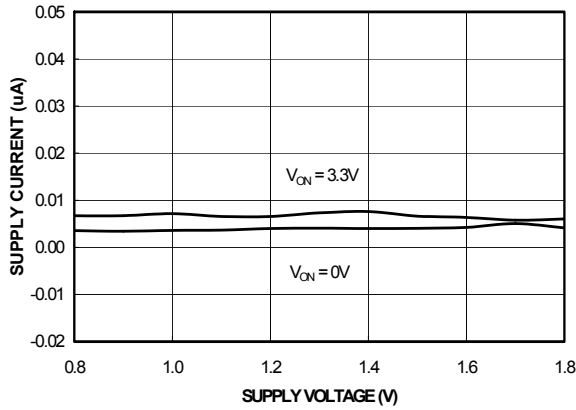


Figure 1. Supply Current vs.  $V_{IN}$

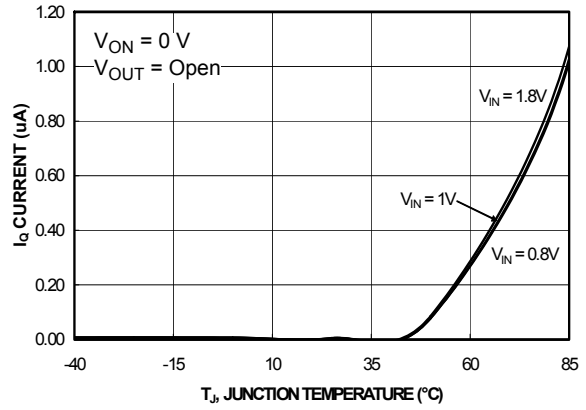


Figure 2. Off Quiescent Current vs. Temperature

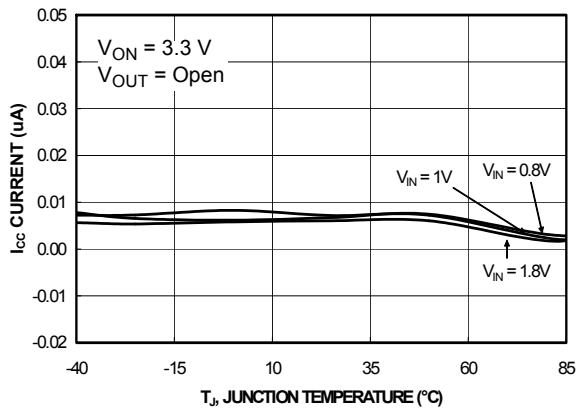


Figure 3. Operating Current vs. Temperature

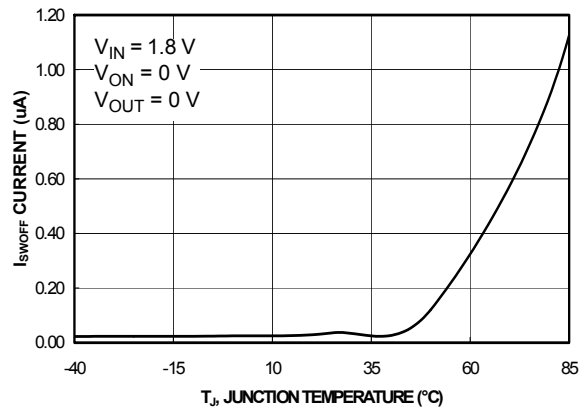


Figure 4. Off Switch Current vs. Temperature

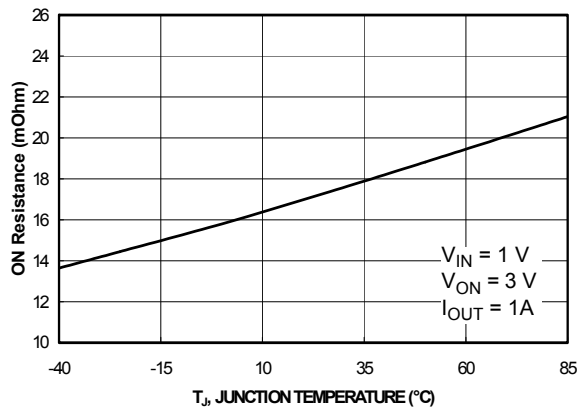


Figure 5.  $R_{ON}$  vs. Temperature

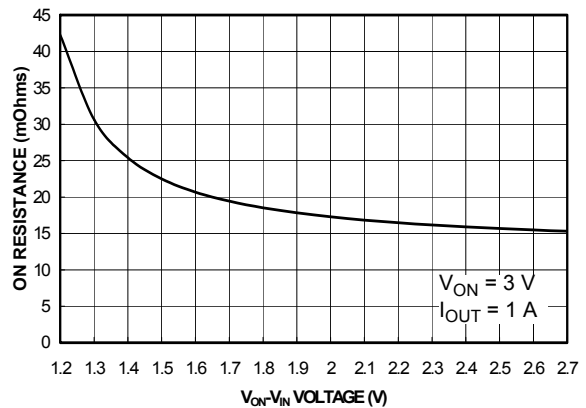


Figure 6.  $R_{ON}$  vs.  $V_{ON}-V_{IN}$

## Typical Characteristics

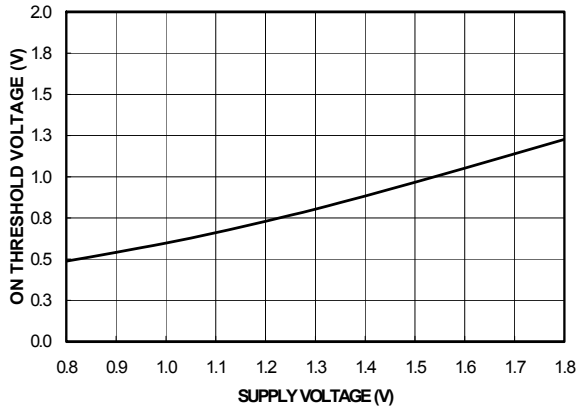


Figure 7.  $V_{IL}$  vs.  $V_{IN}$

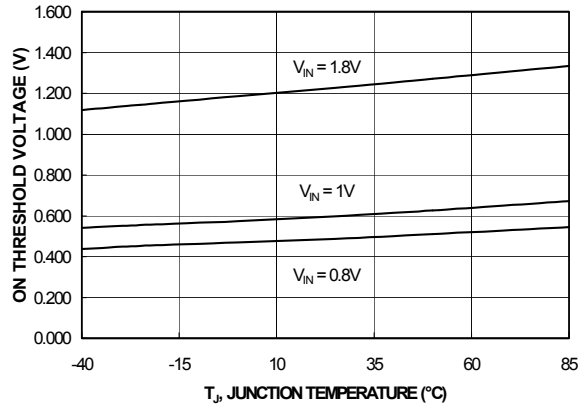


Figure 8.  $V_{IL}$  vs. Temperature

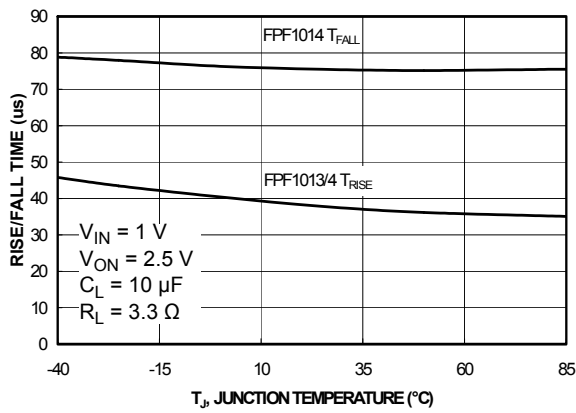


Figure 9.  $T_{RISE}/T_{FALL}$  vs. Temperature

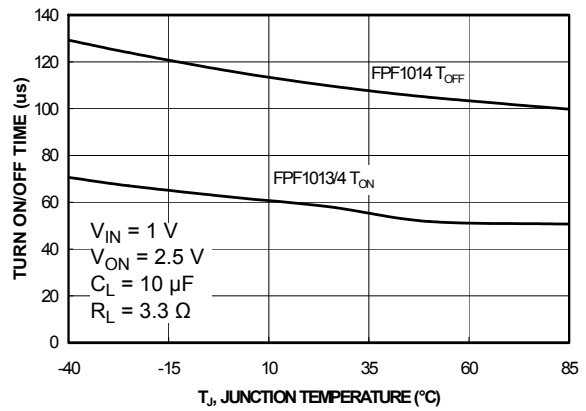


Figure 10.  $T_{ON}/T_{OFF}$  vs. Temperature

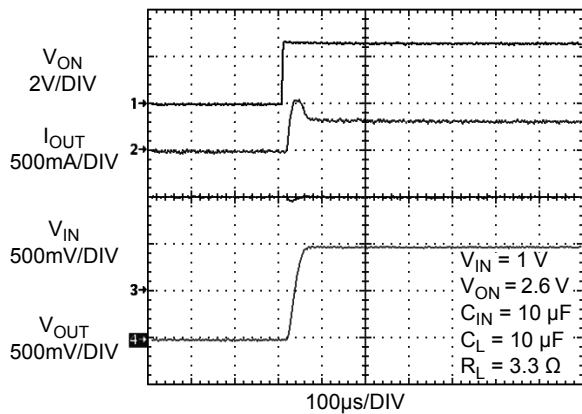


Figure 11. FPF1013/4 Turn ON Response

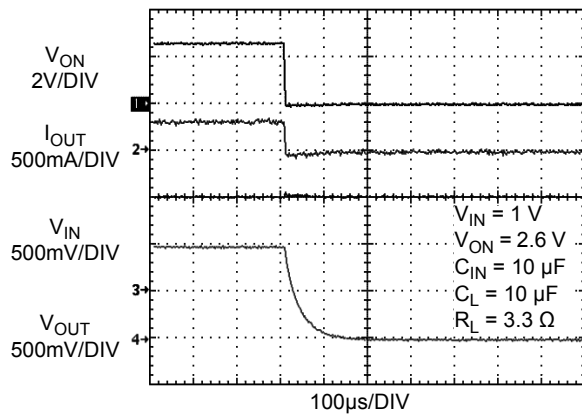


Figure 12. FPF1014 Turn OFF Response

## Typical Characteristics

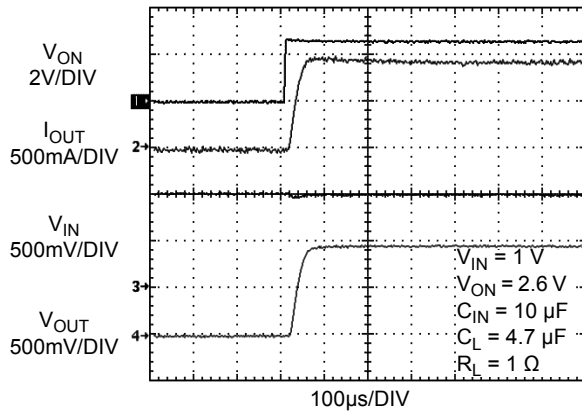


Figure 13. FPF1013/4 Turn ON Response

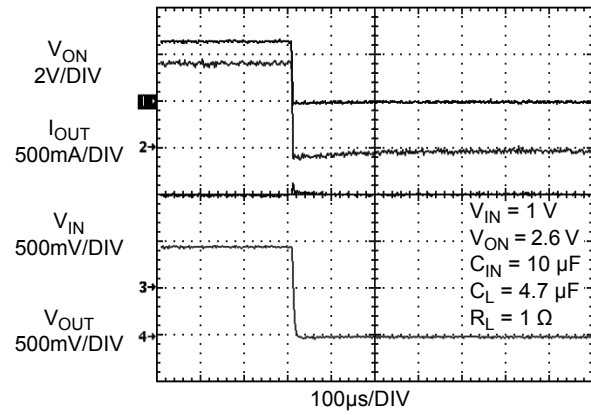


Figure 14. FPF1014 Turn OFF Response

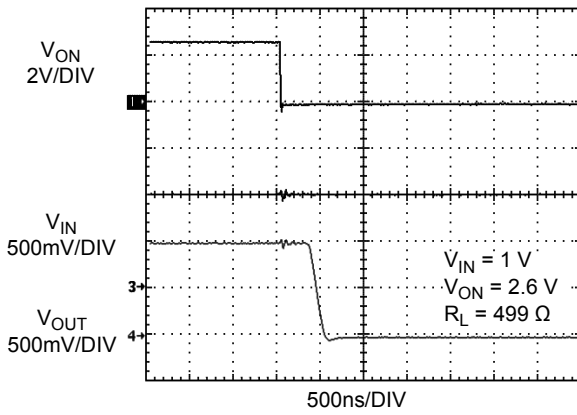


Figure 15. FPF1014 Output Pull-down Response

## Description of Operation

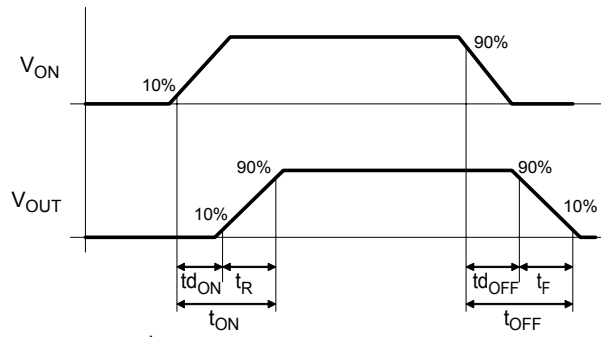
The FPF1013/4 are low  $R_{DS(ON)}$  N-Channel load switches with controlled turn-on. The core of each device is a  $17m\Omega$  ( $V_{IN} = 1V$ ,  $V_{ON} = 3V$ ) N-Channel MOSFET and is customized for a low input operating range of 0.8 to 1.8V. The ON pin controls the state of the switch.

The FPF1014 contains a  $60\Omega$ (typ) on-chip resistor which is connected internally from  $V_{OUT}$  to GND for quick output discharge when the switch is turned off.

## On/Off Control

The ON pin is active high and it controls the state of the switch. Applying a continuous high signal will hold the switch in the ON state. In order to minimize the switch on resistance, the ON pin voltage should exceed the input voltage by 2V. This device is compatible with a GPIO (General Purpose Input/Output) port, where the logic voltage level can be configured to  $4V \geq V_{ON} \geq V_{IN} + 2V$  and power consumed is less than  $1\mu A$  in steady state.

## Timing Diagram

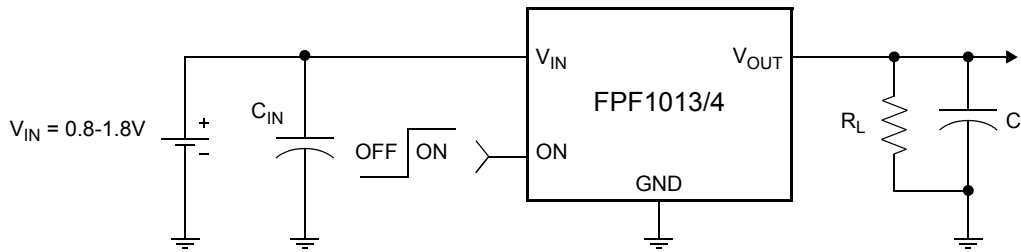


where:

- $t_{d_{ON}}$  = Delay On Time
- $t_R$  =  $V_{OUT}$  Rise Time
- $t_{ON}$  = Turn On Time
- $t_{d_{OFF}}$  = Delay Off Time
- $t_F$  =  $V_{OUT}$  Fall Time
- $t_{OFF}$  = Turn Off Time

## 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, a capacitor must be placed between  $V_{IN}$  and GND. For minimized voltage drop, especially when the operating voltage approaches 1V a  $10\mu F$  ceramic capacitor should be placed close to the  $V_{IN}$  pins. Higher values of  $C_{IN}$  can be used to further reduce the voltage drop during higher current modes of operation.

### Output Capacitor

A  $0.1\mu F$  capacitor,  $C_L$ , should be placed between  $V_{OUT}$  and GND. This capacitor will prevent parasitic board inductance from forcing  $V_{OUT}$  below GND when the switch turns-off. If the application has a capacitive load, the FPF1014 can be used to discharged that load through an on-chip output discharge path.

### 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 or large copper planes for all pins ( $V_{IN}$ ,  $V_{OUT}$ , ON and GND) will help minimize the parasitic electrical effects along with minimizing the case to ambient thermal impedance.

### Improving Thermal Performance

An improper layout could result in higher junction temperature. This concern applies when continuous operation current is set to maximum allowed current and switch turns into a large capacitive load that introduce high inrush current in the transient. Since FPF1013/4 does not have thermal shutdown feature a proper layout can essentially reduce power dissipation of the switch in transient and prevents switch to exceed the maximum absolute power dissipation of 1.2W.

The  $V_{IN}$ ,  $V_{OUT}$  and GND pins will dissipate most of the heat generated during a high load current condition. The layout suggested in Figure 16 provides each pin with adequate copper so that heat may be transferred as efficiently as possible out of the device. The ON pin trace may be laid-out diagonally from the device to maximize the area available to the ground pad. Placing the input and output capacitors as close to the device as possible also contributes to heat dissipation, particularly during high load currents.

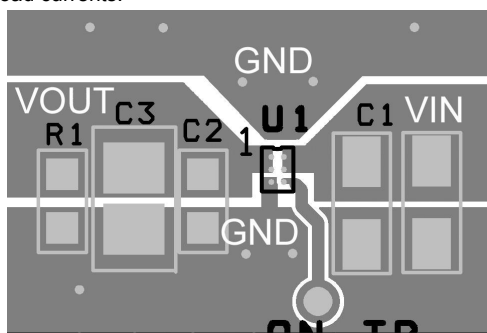


Figure 16: Proper layout of output, input and ground copper area

### Demo Board Layout

FPF1013/4 Demo board has the components and circuitry to demonstrate FPF1013/4 load switches functions. Thermal performance of the board is improved using a few techniques recommended in the layout recommendations section of datasheet.

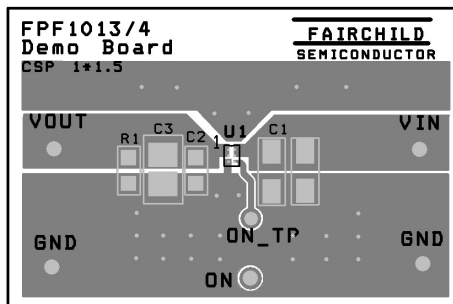
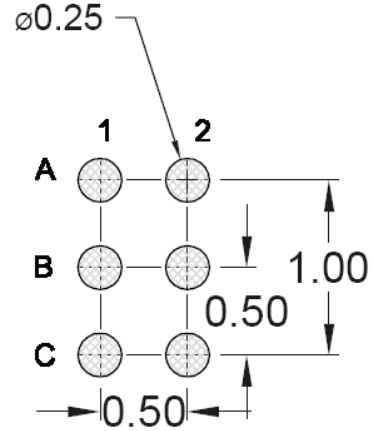
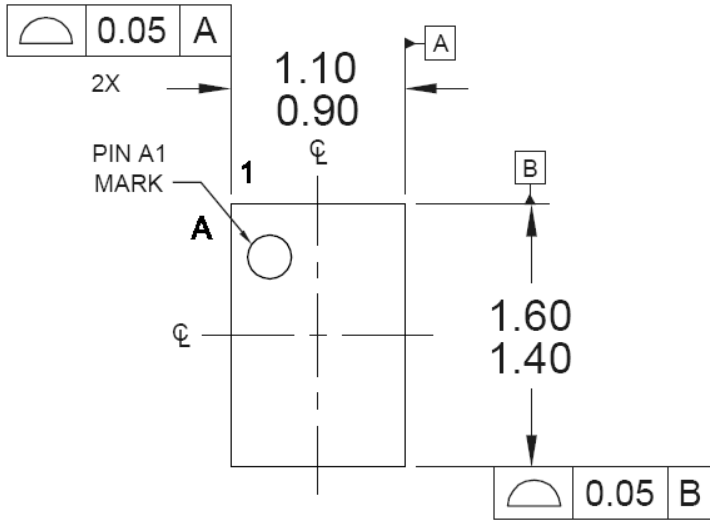


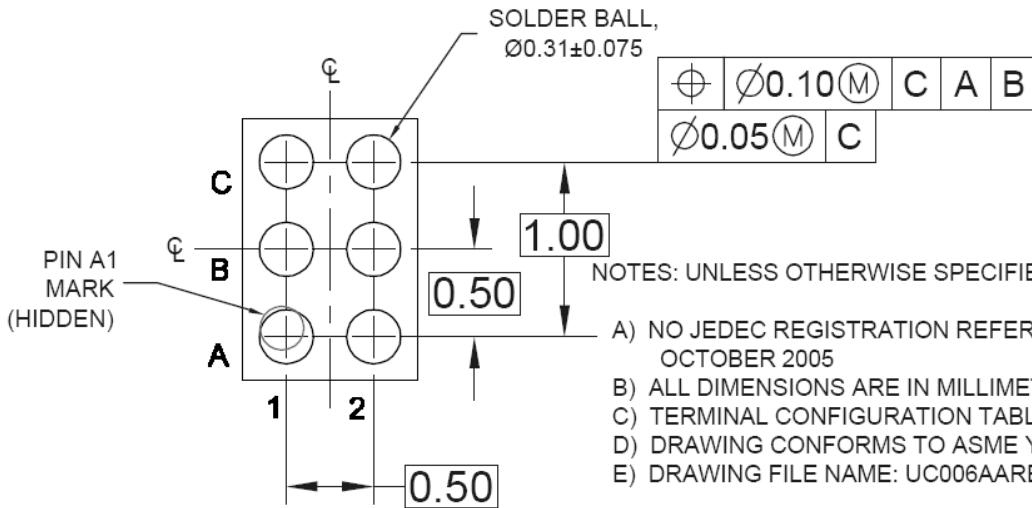
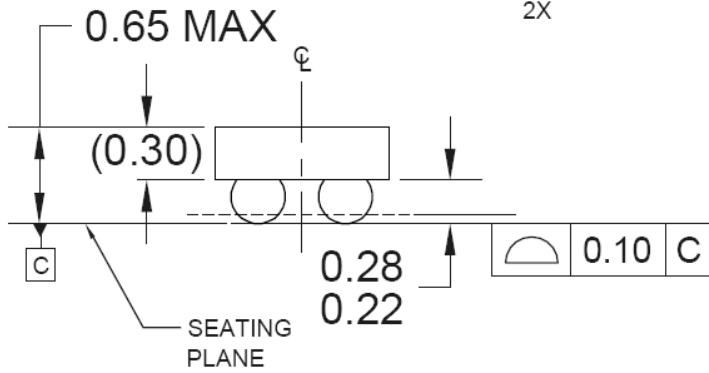
Figure 17. FPF1013/4 Demo Board Layout



### Dimensional Outline and Pad Layout



LAND PATTERN RECOMMENDATION








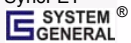
NOTES: UNLESS OTHERWISE SPECIFIED

- A) NO JEDEC REGISTRATION REFERENCE AS OF OCTOBER 2005
- B) ALL DIMENSIONS ARE IN MILLIMETERS
- C) TERMINAL CONFIGURATION TABLE.
- D) DRAWING CONFORMS TO ASME Y14.5M-1994
- E) DRAWING FILE NAME: UC006AAREV4.



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**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.
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