FAIRCHILD SEMICONDUCTOR®

September 2010

FPF1013 / FPF1014
IntelliMAX™ 1V-Rated Advanced Load Management Products

Features

- 0.8V to 1.8V Input Voltage Range
- Typical $R_{DS(ON)}$ = 17mΩ @ V_{ON} - V_{IN} = 2.0V
- Output Discharge Function
- Internal Pull-Down at ON Pin
- Accurate Slew Rate Controlled Turn-on Time
- Low < 1μA Quiescent Current
- ESD Protected, above 8000V HBM, 2000V CDM

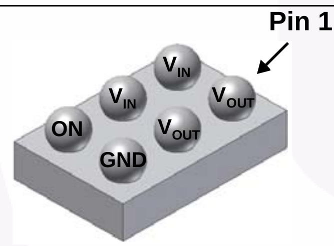
Applications

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

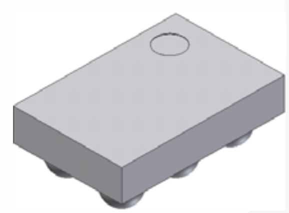
General Description

The FPF1013/4 series is an IntelliMAX™ advanced slew rate load switch offering 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 inrush current from supply rails. The input voltage range operates from 0.8V to 1.8V to fulfill today's lowest ultra-portable device 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 the switch is turned off. The FPF1013/4 series is available in a space-saving six-lead 1mm x 1.5mm Wafer-Level Chip-Scale Package (WLCSP).

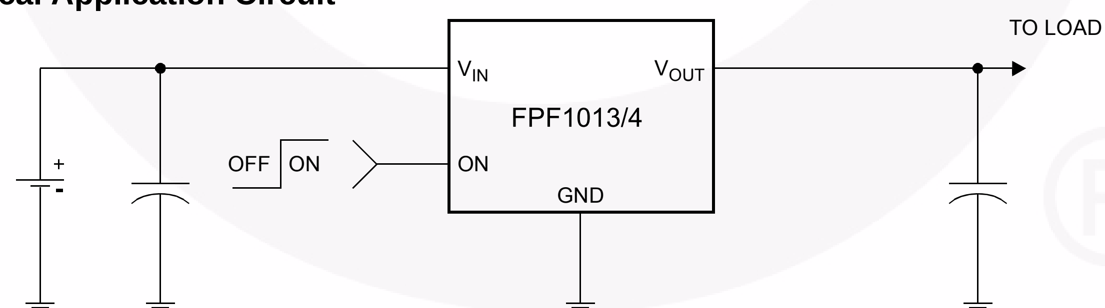


BOTTOM



TOP

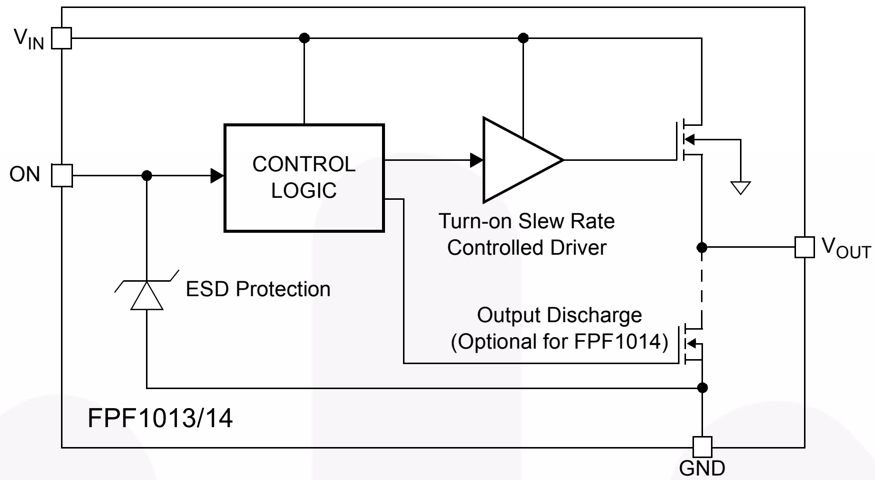
Typical Application Circuit



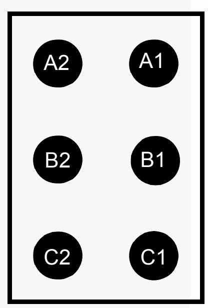
Ordering Information

Part	Switch	Turn-on Time	Output Discharge	ON Pin Activity	Package
FPF1013	17mΩ, NMOS	43μs	N/A	Active HIGH	WLCSP1X1.5
FPF1014	17mΩ, NMOS	43μs	60Ω	Active HIGH	WLCSP1X1.5

Functional Block Diagram



Pin Configuration



1.0mm x 1.5mm WLCSP 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

Symbol	Parameter	Min.	Max.	Units
	V_{IN}, V_{OUT}, to GND	-0.3	2.0	V
	V_{ON} to GND	-0.3	4.2	V
I_{SW}	Maximum Continuous Switch Current		1.5	A
P_D	Power Dissipation at T_A = 25°C[1]		1.2	W
T_A	Operating Temperature Range	-40	+85	°C
T_{STG}	Storage Temperature	-65	+150	°C
J_A	Thermal Resistance, Junction to Ambient		85	°C/W
ESD	Electrostatic Discharge Protection: Human Body Model	8000		V
	Electrostatic Discharge Protection: Charged Device Model	2000		V

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

Recommended Operating Range

Symbol	Parameter	Min.	Max.	Units
V_{IN}	Supply Voltage	0.8	1.8	V
T_A	Ambient Operating Temperature	-40	+85	°C

Electrical Characteristics

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

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

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

Typical Characteristics

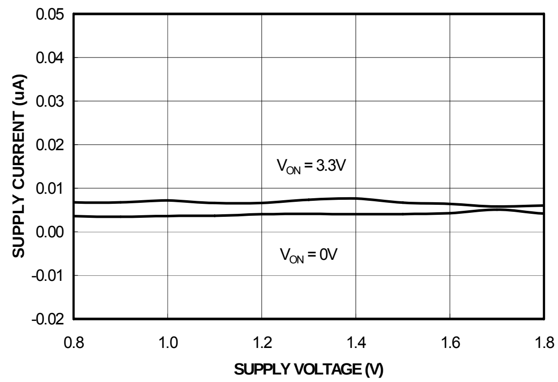


Figure 1. Supply Current vs. V_{IN}

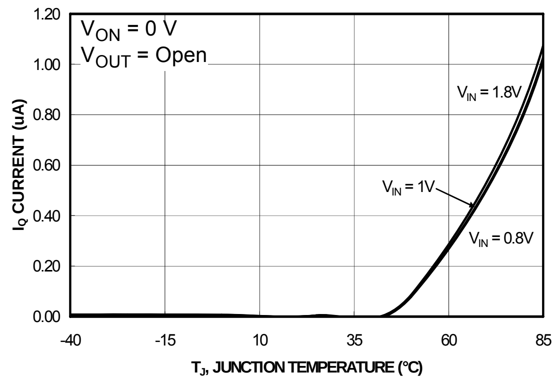


Figure 2. Off Quiescent Current vs. Temperature

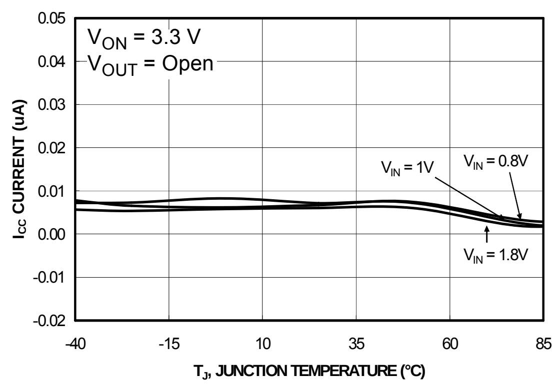


Figure 3. Operating Current vs. Temperature

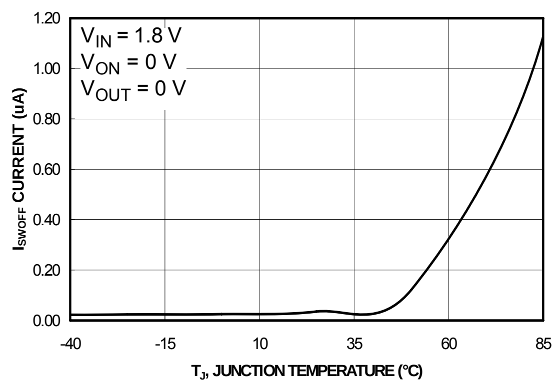


Figure 4. Off Switch Current vs. Temperature

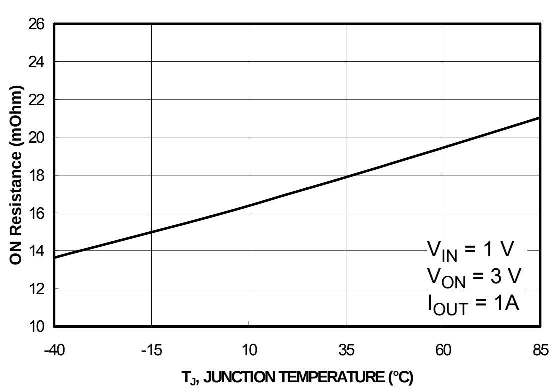


Figure 5. R_{ON} vs. Temperature

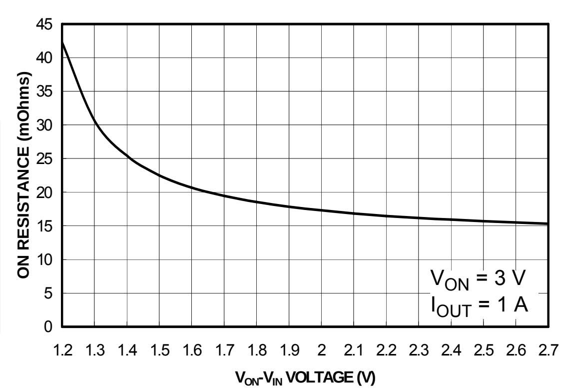


Figure 6. R_{ON} vs. V_{ON}-V_{IN}

Typical Characteristics

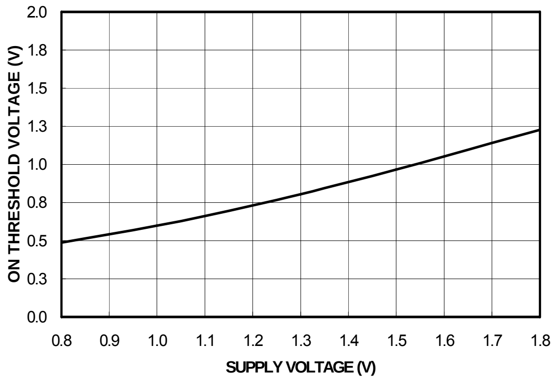


Figure 7. V_{IL} vs. V_{IN}

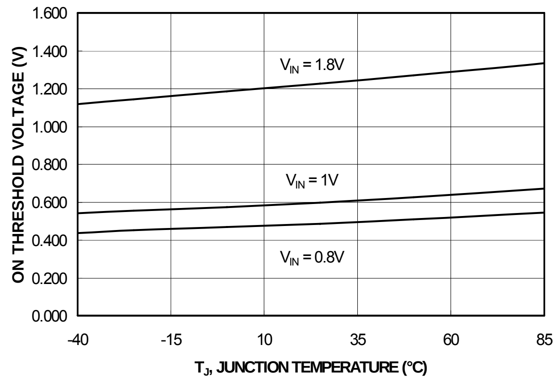


Figure 8. V_{IL} vs. Temperature

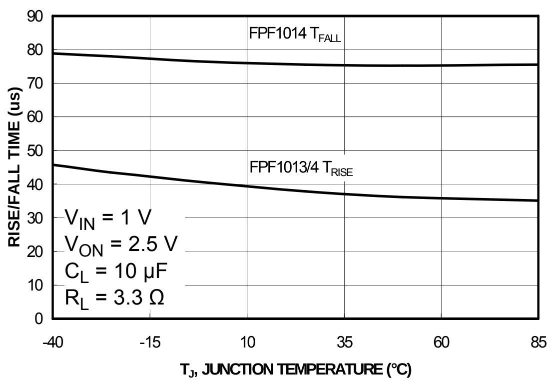


Figure 9. T_{RISE}/T_{FALL} vs. Temperature

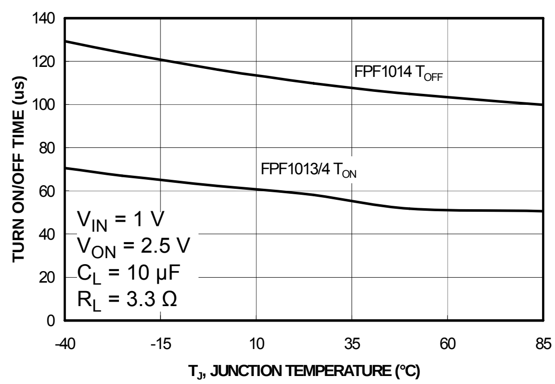


Figure 10. T_{ON}/T_{OFF} vs. Temperature

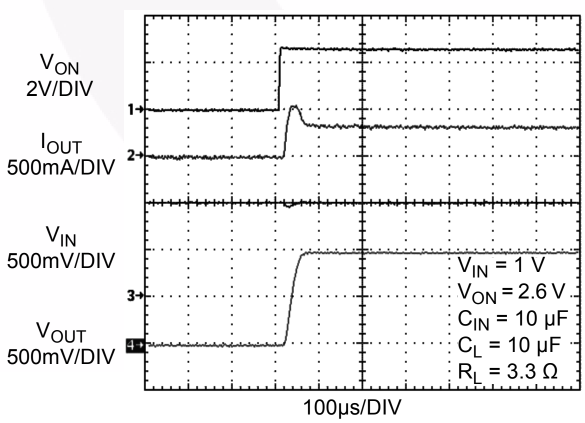


Figure 11. FPF1013/4 Turn ON Response

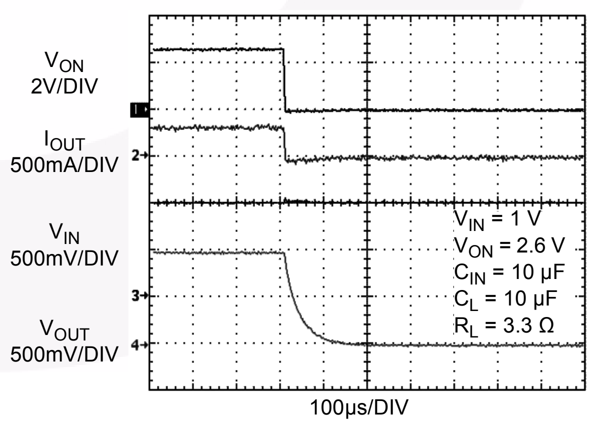


Figure 12. FPF1014 Turn OFF Response

Typical Characteristics

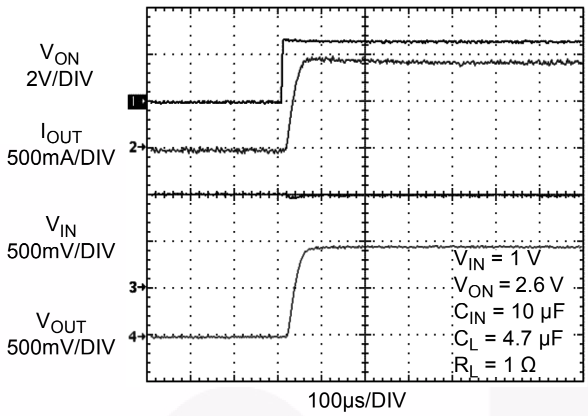


Figure 13. FPF1013/4 Turn ON Response

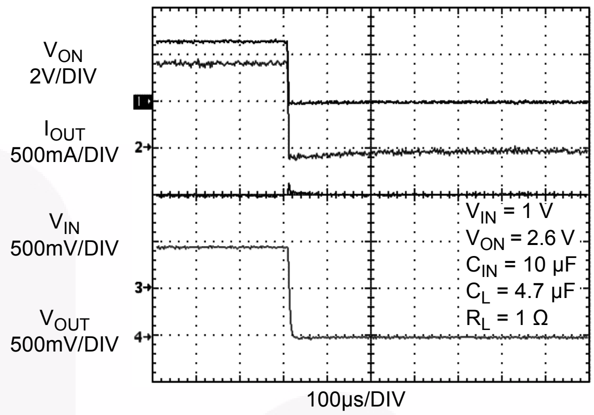


Figure 14. FPF1014 Turn OFF Response

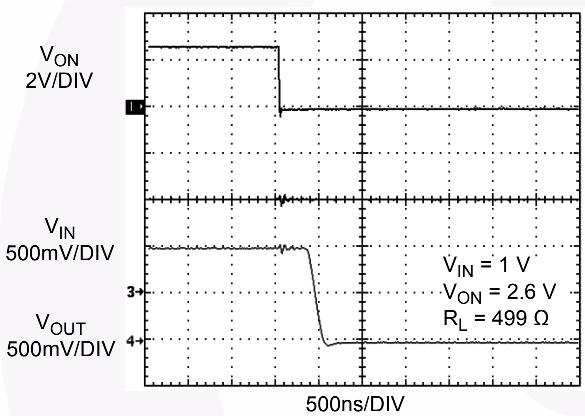


Figure 15. FPF1014 Output Pull-down Response

Description of Operation

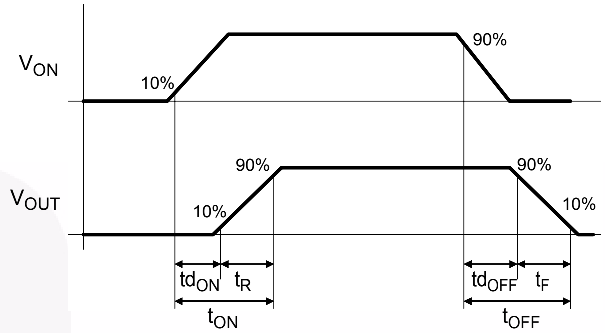
The FPF1013/4 are low $R_{DS(ON)}$ N-Channel load switches with controlled turn-on. The core of each device is a 17mΩ (V_{IN} = 1V, V_{ON} = 3V) N-Channel MOSFET and is customized for a low input operating range of 0.8 to 1.8V. The ON pin controls the state of the switch.

The FPF1014 contains a 60Ω(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 ≥ V_{ON} ≥ V_{IN}+2V and power consumed is less than 1µA in steady state.

Timing Diagram

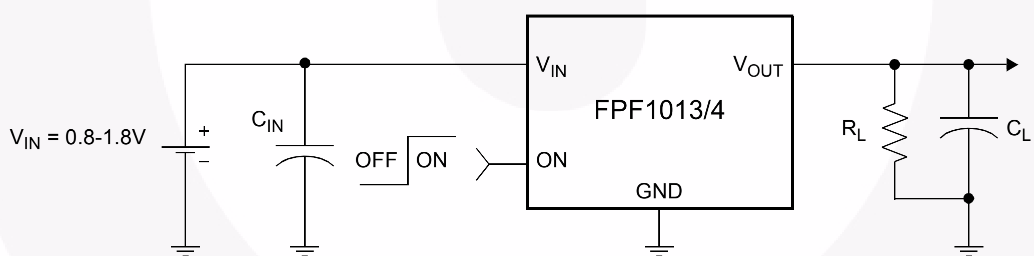


where:

- td_{ON} = Delay On Time
- t_R = V_{OUT} Rise Time
- t_{ON} = Turn On Time
- td_{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 10µF 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 0.1µF 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.

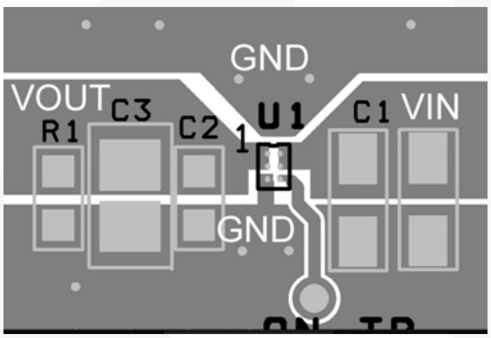


Figure 16: Proper Layout of Output, Input, |and Ground Copper Area

Demonstration Board Layout

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

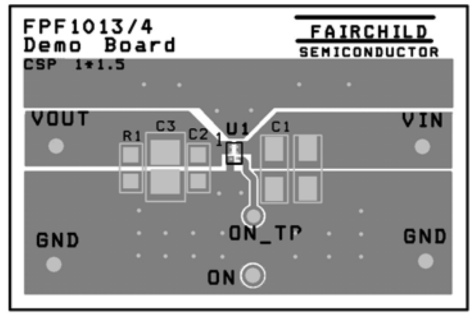
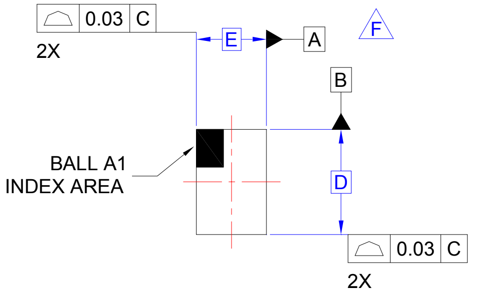
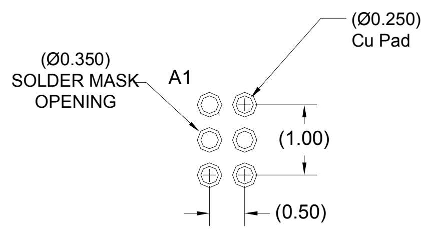


Figure 17. FPF1013/4 Demonstration Board Layout

Dimensional Outline and Pad Layout

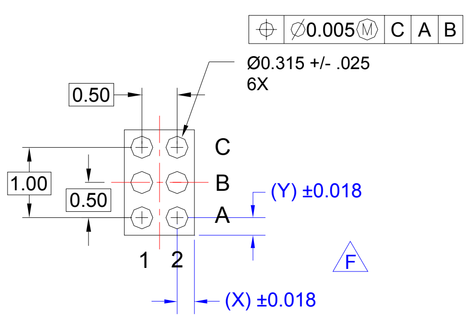


TOP VIEW



RECOMMENDED LAND PATTERN
(NSMD PAD TYPE)

SIDE VIEWS



BOTTOM VIEW

NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCE PER ASMEY14.5M, 1994.

D. DATUM C IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.

E. PACKAGE NOMINAL HEIGHT IS 582 MICRONS ±43 MICRONS (539-625 MICRONS).

F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.

G. DRAWING FILNAME: MKT-UC006AFrev2.

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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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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.

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