FAIRCHILD SEMICONDUCTOR®

November 2012

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

Features

- 0.8 V to 1.8 V Input Voltage Range
- Typical $R_{DS(ON)}$ = 17 mΩ at V_{ON} - V_{IN} = 2.0 V
- Output Discharge Function
- Internal Pull-Down at ON Pin
- Accurate Slew Rate Controlled Turn-on Time
- Low < 1 µA Quiescent Current
- ESD Protected, above 8 kV HBM, 2 kV CDM

Applications

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

Description

The FPF1013/14 IntelliMAX™ advanced slew rate load switch offers very low operating voltage and a 17 mΩ N-channel MOSFET that supports an input voltage up to 2.0 V. This slew-rate device control the switch turn-on and prevent excessive inrush current from supply rails. The input voltage range operates from 0.8 V to 1.8 V to fulfill today's lowest mobile 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 FPF10131/4 is available in a space-saving six-lead 1 mm x 1.5 mm Wafer-Level Chip-Scale Package (WLCSP).

Figure 1. WLCSP Bump Configuration (Top & Bottom)

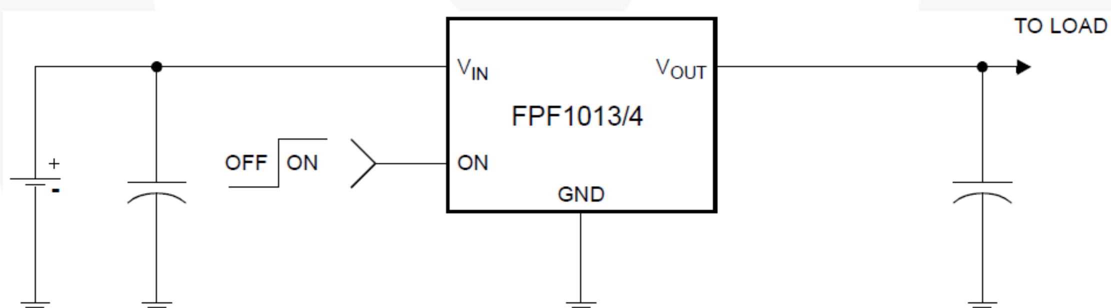


Figure 2. Typical Application

Ordering Information

Part Number	Switch	Turn-On Time	Output Discharge	ON Pin Activity	Package
FPF1013	17 mΩ, NMOS	43 µs	N/A	Active HIGH	WLCSP 950 µm x 1450 µm, (*see Figure 24*)
FPF1014	17 mΩ, NMOS	43 µs	60 Ω	Active HIGH	

Functional Block Diagram

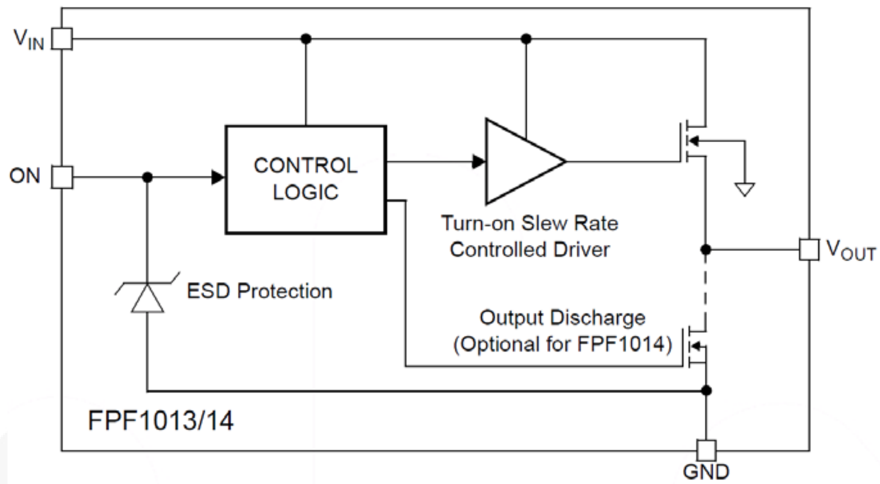


Figure 3. Functional Block Diagram

Pin Configuration

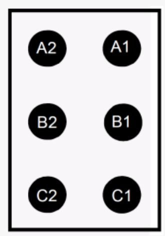


Figure 4. Pin Configuration

Pin Definitions

Pin	Name	Description
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

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

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
Θ_{JA}	Thermal Resistance, Junction to Ambient			85	°C/W
ESD	Electrostatic Discharge Protection	Human Body Model	8000		V
		Charged Device Model	2000		V

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

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

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

Typical Performance Characteristics

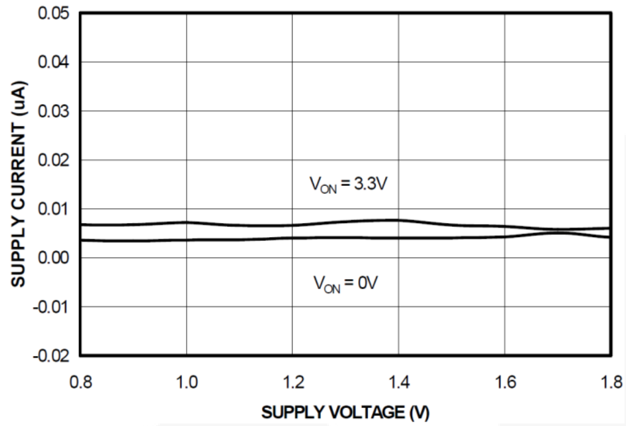


Figure 5. Supply Current vs. V_{IN}

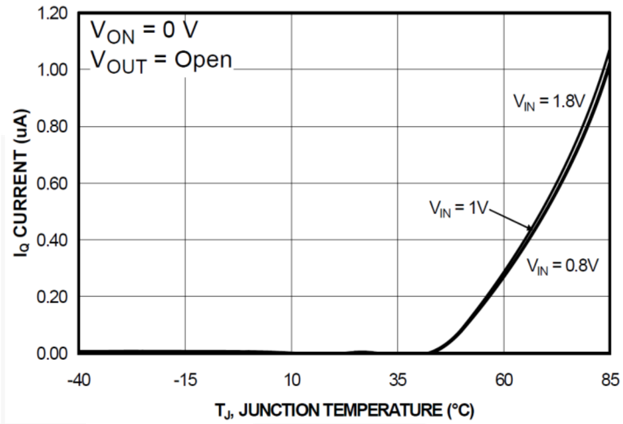


Figure 6. Off Quiescent Current vs. Temperature

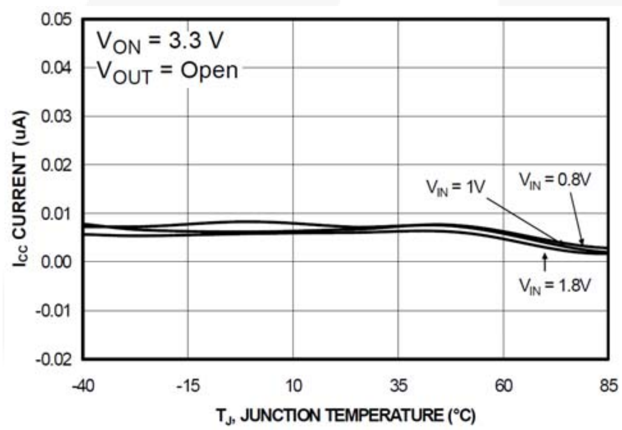


Figure 7. Operating Current vs. Temperature

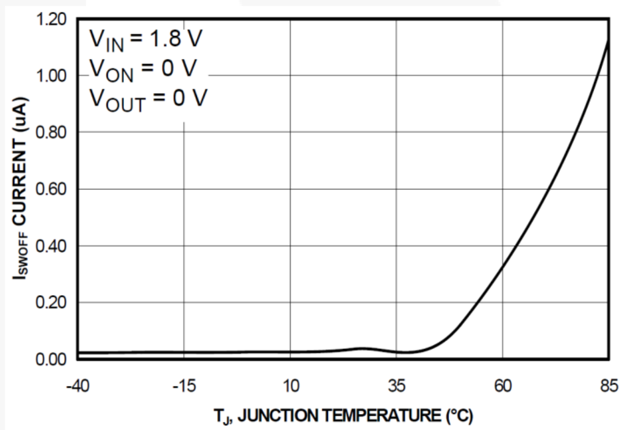


Figure 8. Off Switch Current vs. Temperature

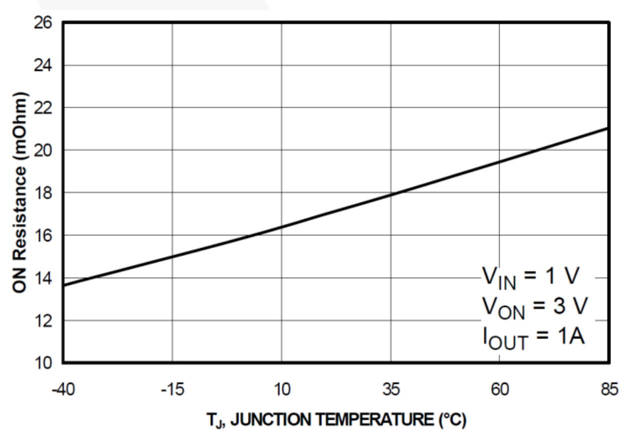


Figure 9. R_{ON} vs. Temperature

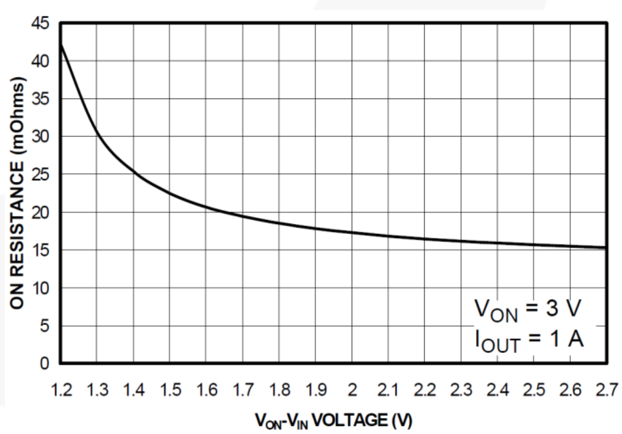


Figure 10. R_{ON} vs. V_{ON}-V_{IN}

Typical Performance Characteristics

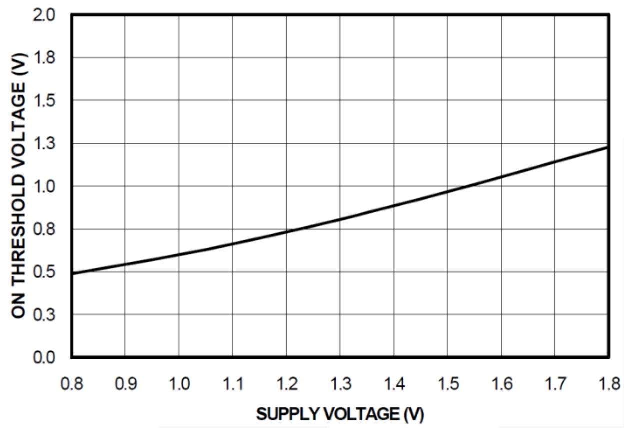


Figure 11. V_{IL} vs. V_{IN}

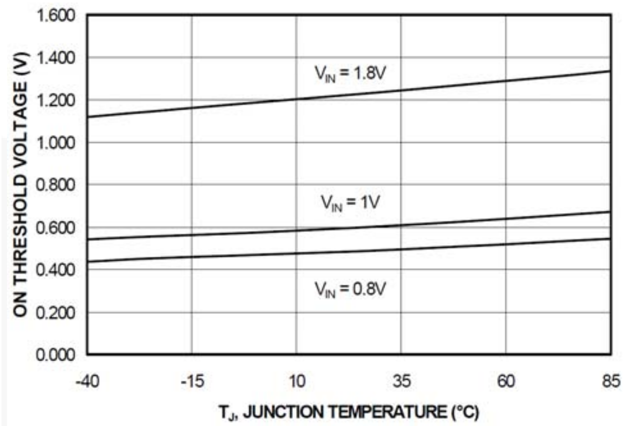


Figure 12. V_{IL} vs. Temperature

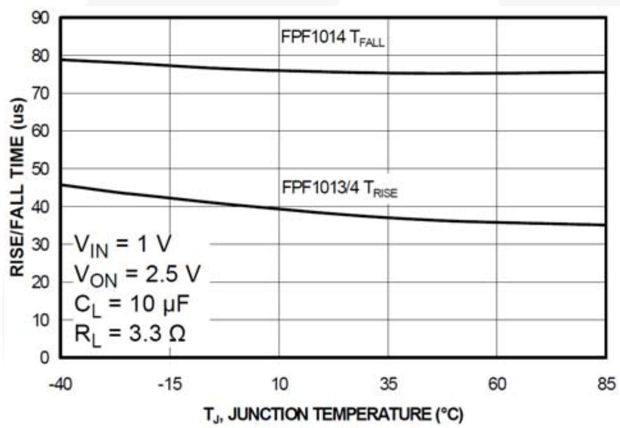


Figure 13. t_{RISE} / t_{FALL} vs. Temperature

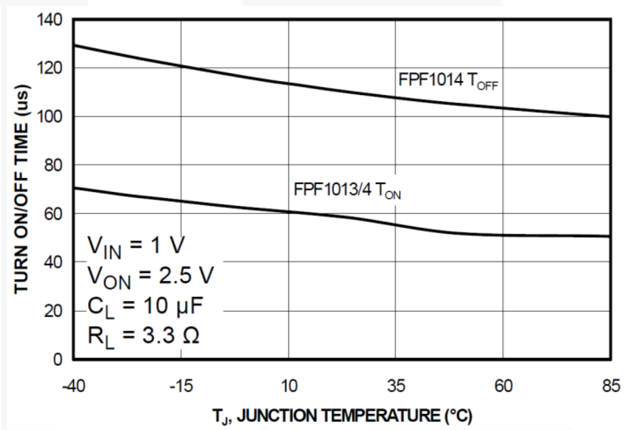


Figure 14. t_{ON} / t_{OFF} vs. Temperature

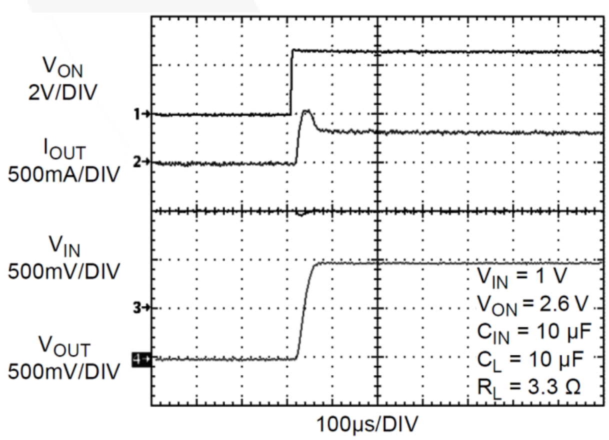


Figure 15. Turn-On Response

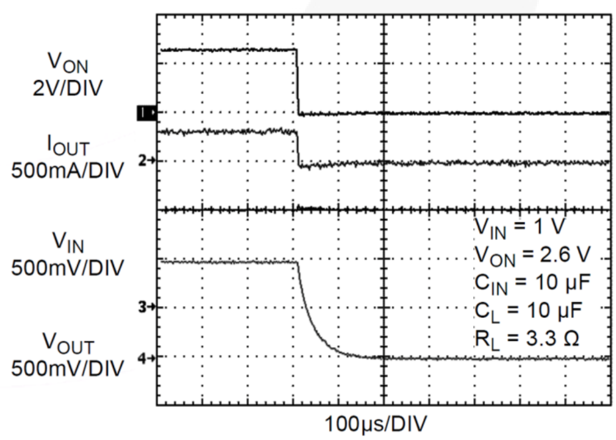


Figure 16. FPF1014 Turn-Off Response

Typical Performance Characteristics

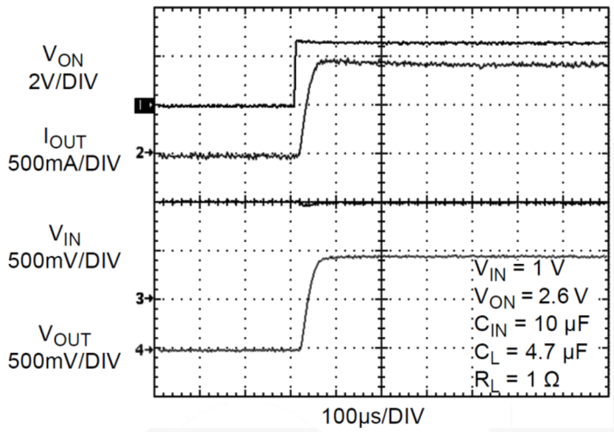


Figure 17. Turn On Response

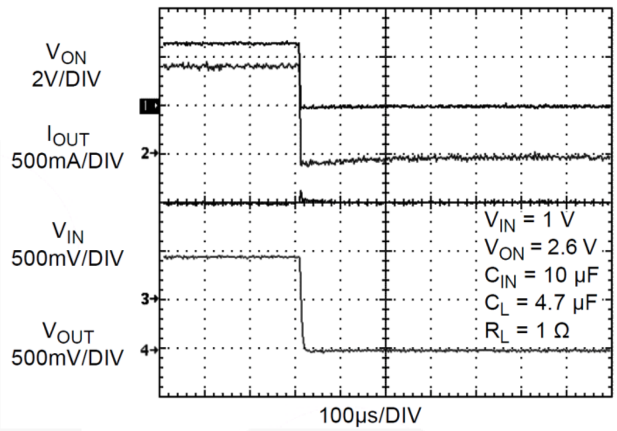


Figure 18. FPF1014 Turn-Off Response

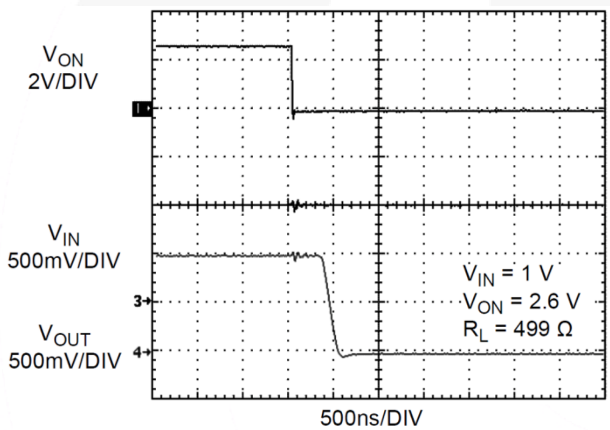


Figure 19. FPF1014 Output Pull-Down Response

Operational Description

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

The FPF1014 contains a 60 Ω (typical) on-chip resistor, which is connected internally from VOUT to GND for quick output discharge when the switch is turned off.

On / Off Control

The ON pin is active HIGH and controls the state of the switch. Applying a continuous HIGH signal holds the switch in the ON state. To minimize the switch on resistance, the ON pin voltage should exceed the input voltage by 2 V. This device is compatible with a GPIO (General-Purpose Input / Output) port, where the logic voltage level can be configured to 4 V ≥ V_{ON} ≥ V_{IN} + 2 V and power consumed is less than 1 µA in steady state.

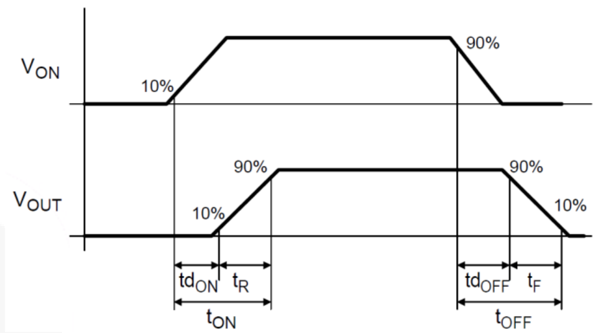


Figure 20. Timing Diagram

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

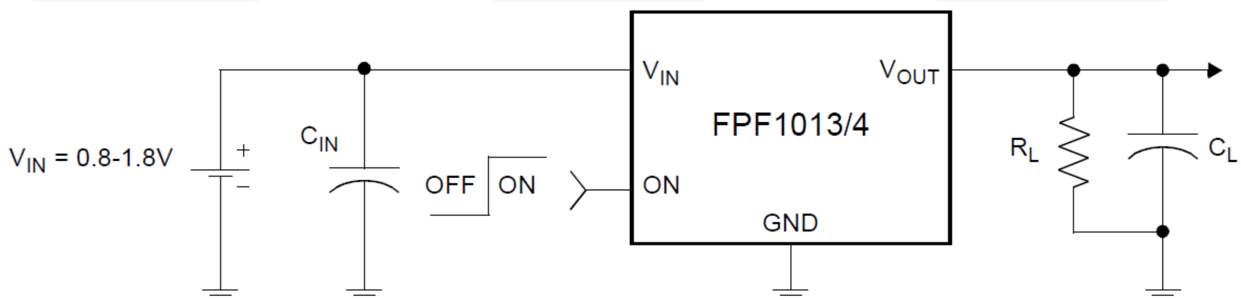


Figure 21. Typical Application

Application Information

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 VIN and GND. For minimized voltage drop, especially when the operating voltage approaches 1 V a 10 µF ceramic capacitor should be placed close to the VIN 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 µF capacitor, C_L, should be placed between VOUT and GND. This capacitor prevents 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 discharge 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 (VIN, VOUT, ON, and GND) helps minimize the parasitic electrical effects along with minimizing the case-to-ambient thermal impedance.

Improving Thermal Performance

Improper layout can result in higher junction temperature. This applies when continuous operation current is set to maximum allowed current and switch turns into a large capacitive load that introduces high inrush current in the transient. Since FPF1013/14 does not have thermal shutdown feature, proper layout can essentially reduce power dissipation of the switch in transient and prevents the switch exceeding the maximum absolute power dissipation of 1.2 W.

The VIN, VOUT, and GND pins dissipate most of the heat generated during a high load current condition. The layout suggested in Figure 22 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.

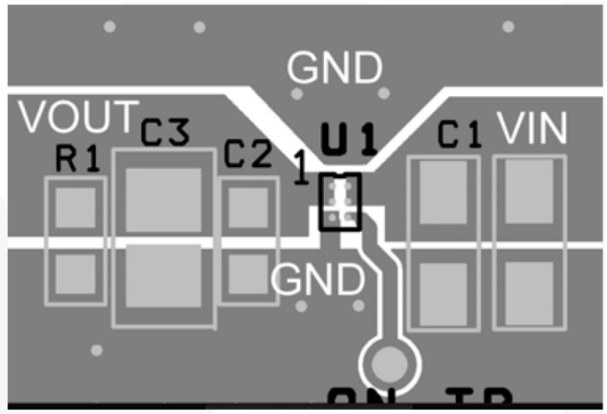


Figure 22. Proper Layout of Output, Input, and Ground Copper Area

Demonstration Board Layout

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

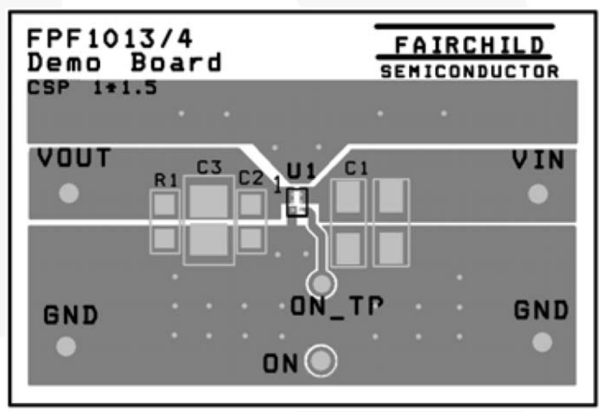
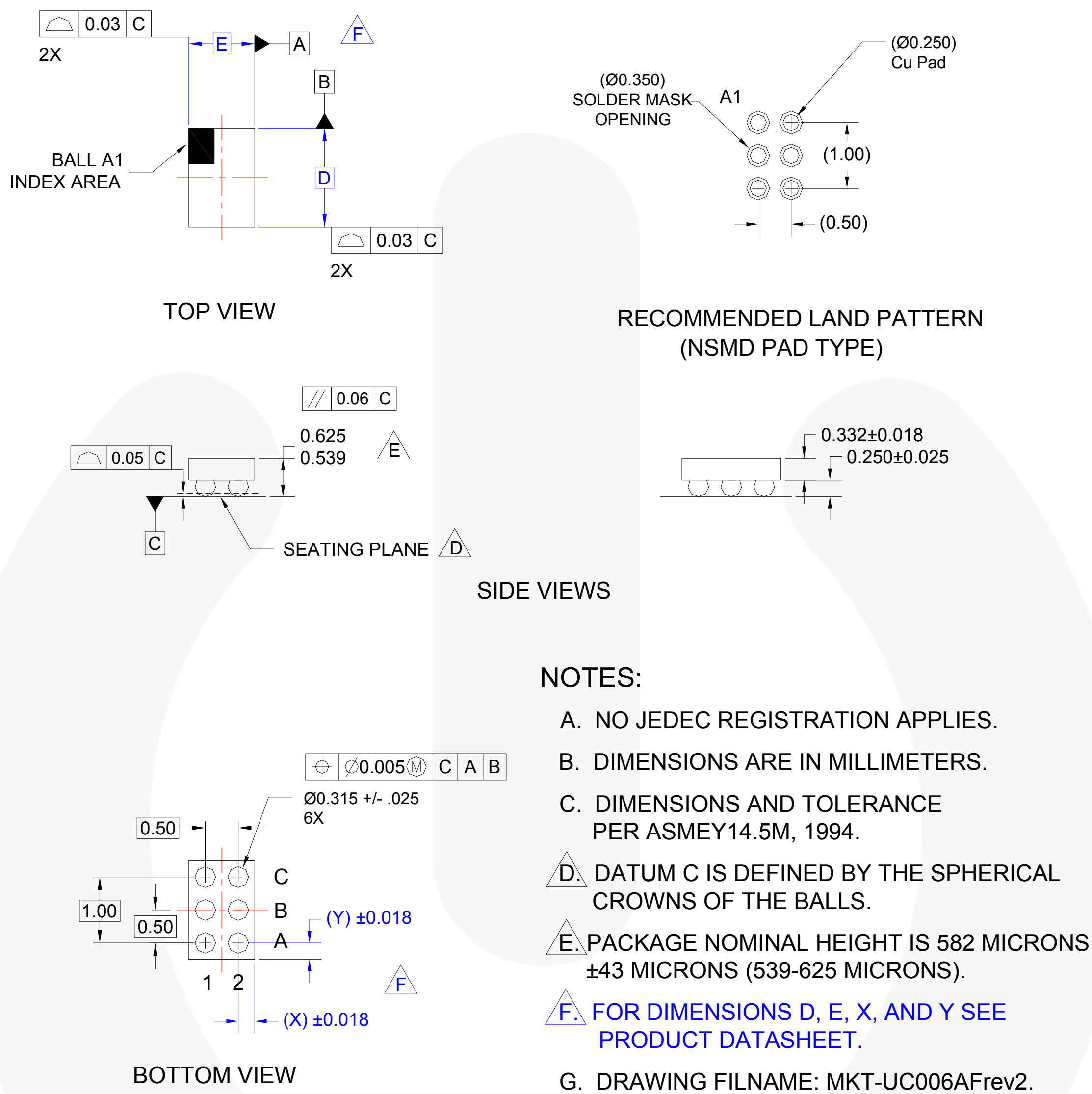


Figure 23. Demonstration Board Layout

Physical Dimensions



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.

Figure 24. 6- Ball Wafer-Level Chip-Scale Package (WLCSP) 2X3 ARRAY, 0.5 mm Pitch, 300 µm Ball

E	D	X	Y
950 µm ±30 µm	1450 µm ±30 µm	225 µm	225 µm

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TinyBoost™
TinyBuck™
TinyCalc™
TinyLogic®
TINYOPTO™
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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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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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