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# FPF1003A / FPF1004 IntelliMAX™ Advanced Load Management Products

## Features

- 1.2 V to 5.5 V Input Voltage Operating Range
- Typical  $R_{DS(ON)}$ :
  - 30 m $\Omega$  at  $V_{IN}=5.5$  V
  - 35 m $\Omega$  at  $V_{IN}=3.3$  V
- ESD Protected: Above 8000 V HBM
- ROHS Compliant

## Applications

- PDA's
- Cell Phones
- GPS Devices
- MP3 Players
- Digital Cameras
- Peripheral Ports
- Hot Swap Supplies

## Description

The FPF1003A and FPF1004 are low  $R_{DS}$  P-channel MOSFET load switches with controlled turn-on. The input voltage range operates from 1.2 V to 5.5 V to fulfill today's ultra-portable device supply requirements. Switch control is accomplished with a logic input (ON) capable of interfacing directly with low-voltage control signal. In FPF1004, a 120  $\Omega$  on-chip load resistor is added for output quick discharge when the switch is turned off.

Both FPF1003A and FPF1004 are available in a space-saving 1.0x1.5 mm<sup>2</sup> wafer-level chip-scale package.

## Ordering Information

Part Number	Top Mark	Switch	Input Buffer	Output Discharge	ON Pin Activity	Package
FPF1003A	Q2	30 m $\Omega$ , PMOS	Schmitt	NA	Active HIGH	1.0 x 1.5 mm <sup>2</sup> Wafer-Level Chip-Scale Package (WLCSP),
FPF1004	Q3			120 $\Omega$	Active HIGH	

### Application Diagram

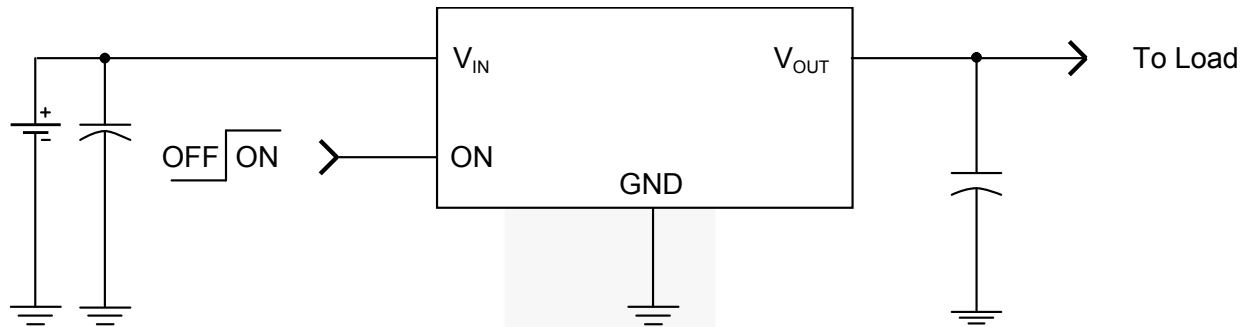


Figure 1. Typical Application

### Block Diagram

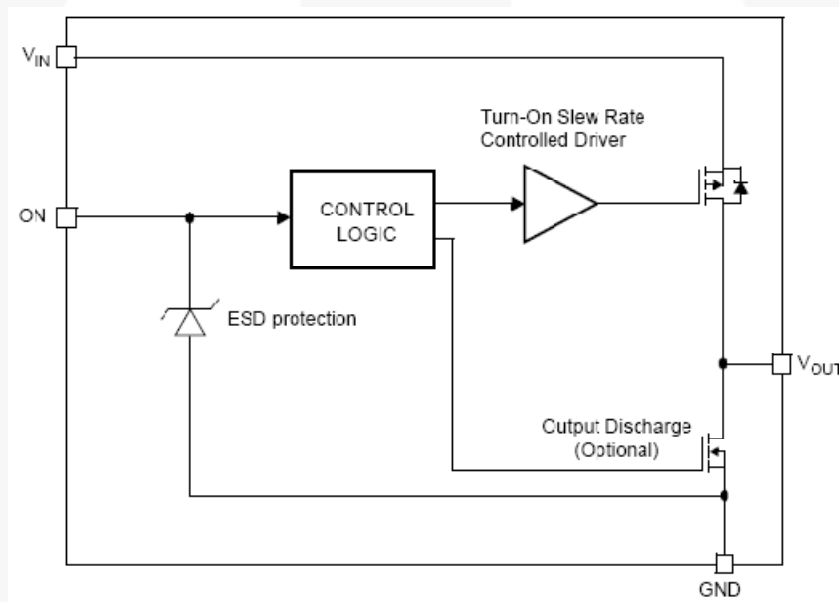


Figure 2. Functional Block Diagram

## Pin Configurations

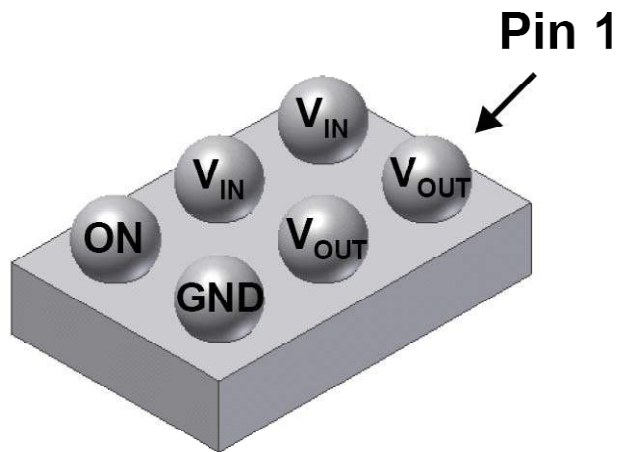


Figure 3. WLCSP Bumps Facing UP

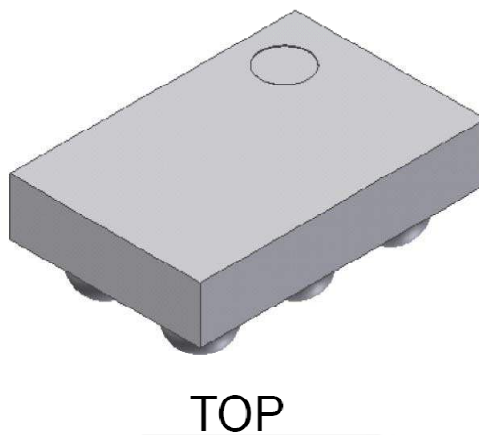


Figure 4. WLCSP Bumps Facing Down

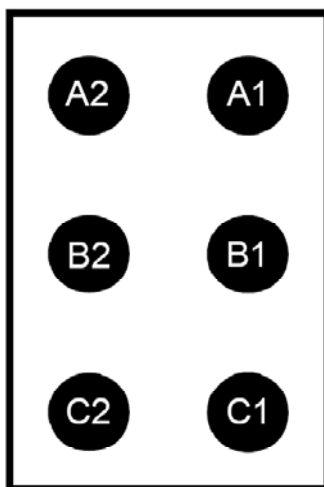


Figure 5. 1.0mm x 1.5mm WLCSP Pin Assignments (Bottom View)

## Pin Definitions

Pin #	Name	Description
A2, B2	$V_{IN}$	Input to the power switch and the supply voltage for the IC
C2	ON	ON Control Input
A1, B1	$V_{OUT}$	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.	Unit
$V_{IN}$	$V_{IN}$ , $V_{OUT}$ , ON to GND	-0.3	6.0	V
$I_{SW}$	Maximum Continuous Switch Current		2.0	A
$P_D$	Power Dissipation at $T_A=25^{\circ}\text{C}^{(1)}$		1.2	W
$T_{STG}$	Storage Junction Temperature	-65	+150	$^{\circ}\text{C}$
$T_A$	Operating Temperature Range	-40	+125	$^{\circ}\text{C}$
$\Theta_{JA}$	Thermal Resistance, Junction-to-Ambient		85	$^{\circ}\text{C}/\text{W}$
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	5500	V
		Charged Device Model, JESD22-C101	1500	

### Note:

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

## 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.	Unit
$V_{IN}$	Supply Voltage	1.2	5.5	V
$T_A$	Ambient Operating Temperature	-40	+85	$^{\circ}\text{C}$

## Electrical Characteristics

Unless otherwise noted,  $V_{IN}=1.2$  to  $5.0V$ ,  $T_A=-40$  to  $+85^{\circ}C$ ; typical values are at  $V_{IN}=3.3V$  and  $T_A=25^{\circ}C$ .

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
<b>Basic Operation</b>						
$V_{IN}$	Supply Voltage		1.2		5.5	V
$I_{Q(OFF)}$	Off Supply Current	$V_{ON}=GND$ , $OUT=Open$			1	$\mu A$
$I_{SD}$	Shutdown Current	$V_{ON}=GND$ , $V_{OUT}=0$ at $V_{IN}=5.5$ , $T_A=85^{\circ}C$			1	$\mu A$
		$V_{ON}=GND$ , $V_{OUT}=0$ at $V_{IN}=3.3$ , $T_A=85^{\circ}C$		10	100	nA
$I_Q$	Quiescent Current	$I_{OUT}=0$ mA, $V_{IN}=V_{ON}$			1	$\mu A$
$R_{ON}$	On-Resistance	$V_{IN}=5.5$ V, $I_{OUT}=1$ A, $T_A=25^{\circ}C$		20	30	m $\Omega$
		$V_{IN}=3.3$ V, $I_{OUT}=1$ A, $T_A=25^{\circ}C$		25	35	
		$V_{IN}=1.5$ V, $I_{OUT}=1$ A, $T_A=25^{\circ}C$		50	75	
		$V_{IN}=1.2$ V, $I_{OUT}=1$ A, $T_A=25^{\circ}C$		95	150	
		$V_{IN}=3.3$ V, $I_{OUT}=1$ A, $T_A=85^{\circ}C$		30	42	
		$V_{IN}=3.3$ V, $I_{OUT}=1$ A, $T_A=40^{\circ}C$ to $85^{\circ}C$	12		42	
$R_{PD}$	Output Pull-Down Resistance	$V_{IN}=3.3$ V, $V_{ON}=0$ V, $T_A=25^{\circ}C$ , FPF1004		75	120	$\Omega$
$V_{IH}$	ON Input Logic High Voltage	$V_{IN}=1.2$ V to $5.5$ V	2			V
		$V_{IN}=1.2$ V	0.8			
$V_{IL}$	ON Input Logic Low Voltage	$V_{IN}=2.7$ V to $5.5$ V			0.8	V
		$V_{IN}=1.2$ V			0.35	
$I_{ON}$	ON Input Leakage	$V_{ON}=V_{IN}$ or GND			1	$\mu A$
<b>Dynamic Characteristics</b>						
$t_{ON}$	Turn-On Time	$V_{IN}=3.3$ V, $R_L=500$ $\Omega$ , $C_L=0.1$ $\mu F$ , $T_A=25^{\circ}C$		13		$\mu s$
$t_{OFF}$	Turn-Off Time	$V_{IN}=3.3$ V, $R_L=500$ $\Omega$ , $C_L=0.1$ $\mu F$ , $T_A=25^{\circ}C$ , FPF1003A		45		$\mu s$
		$V_{IN}=3.3$ V, $R_L=500$ $\Omega$ , $C_L=0.1$ $\mu F$ , $R_{L\_CHIP}=120$ $\Omega$ , $T_A=25^{\circ}C$ , FPF1004		15		
$t_R$	$V_{OUT}$ Rise Time	$V_{IN}=3.3$ V, $R_L=500$ $\Omega$ , $C_L=0.1$ $\mu F$ , $T_A=25^{\circ}C$		13		$\mu s$
$t_F$	$V_{OUT}$ Fall Time	$V_{IN}=3.3$ V, $R_L=500$ $\Omega$ , $C_L=0.1$ $\mu F$ , $T_A=25^{\circ}C$ , FPF1003A		113		$\mu s$
		$V_{IN}=3.3$ V, $R_L=500$ $\Omega$ , $C_L=0.1$ $\mu F$ , $R_{L\_CHIP}=120$ $\Omega$ , $T_A=25^{\circ}C$ , FPF1004		10		

## Typical Performance Characteristics

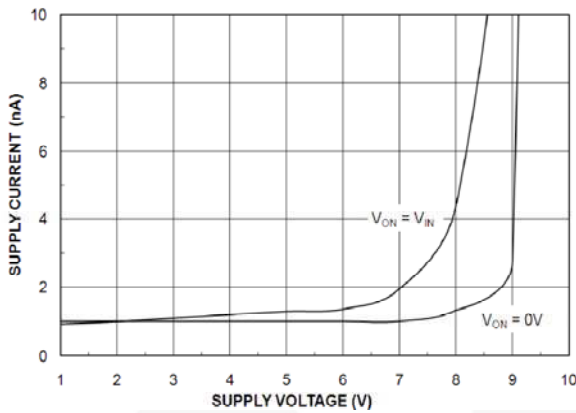


Figure 6. Quiescent Current vs.  $V_{IN}$

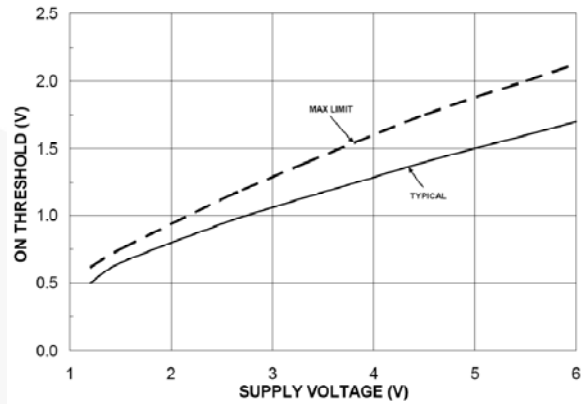


Figure 7. ON Threshold vs.  $V_{IN}$

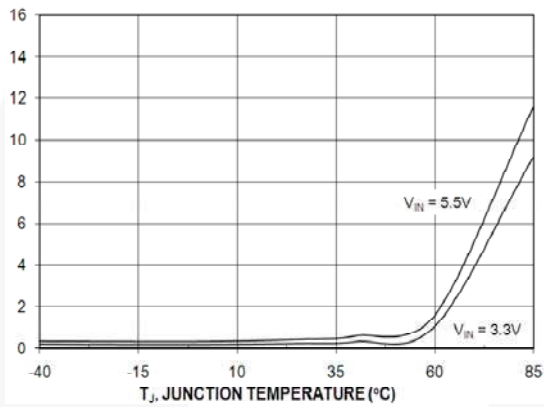


Figure 8. Quiescent Current vs. Temperature

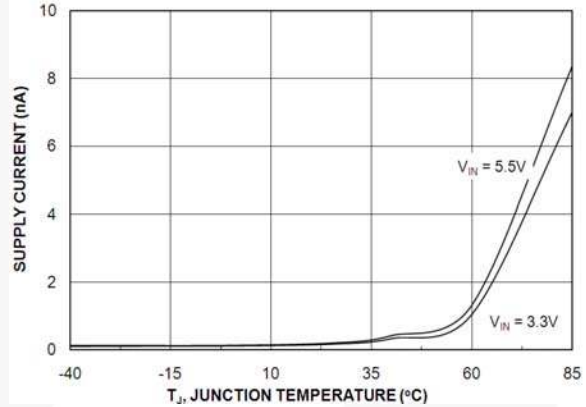


Figure 9. Quiescent Current (OFF) vs. Temperature

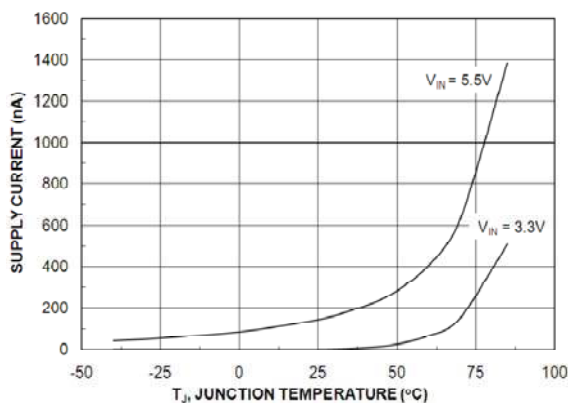


Figure 10.  $I_{\text{SWITCH-OFF}}$  Current vs. Temperature

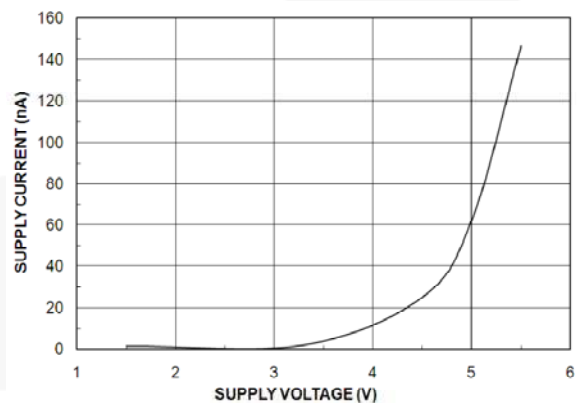


Figure 11.  $I_{\text{SWITCH-OFF}}$  Current vs.  $V_{IN}$

## Typical Performance Characteristics

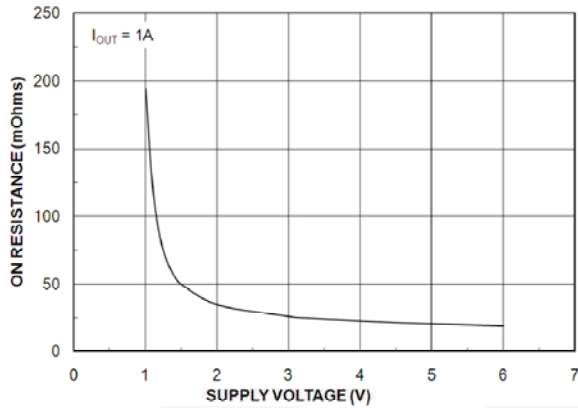


Figure 12.  $R_{ON}$  vs.  $V_{IN}$

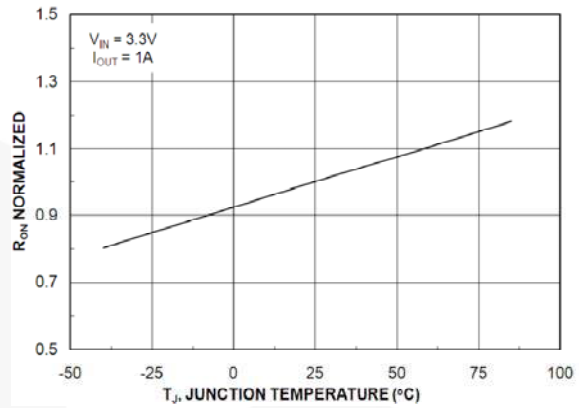


Figure 13.  $R_{ON}$  vs. Temperature

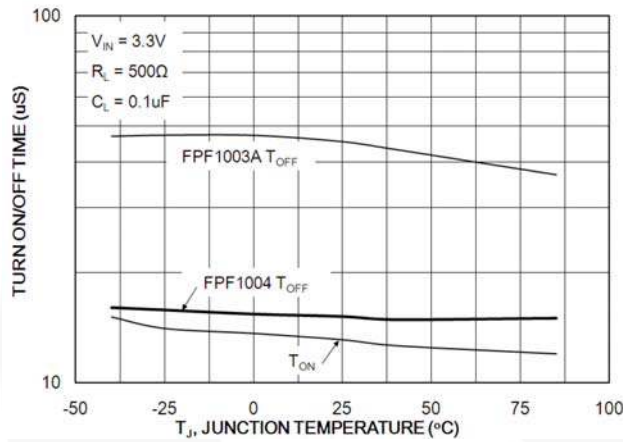


Figure 14.  $t_{ON}/t_{OFF}$  vs. Temperature

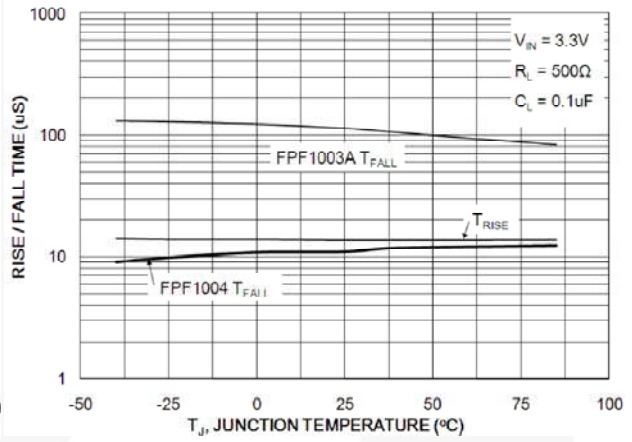


Figure 15.  $t_R/t_F$  vs. Temperature

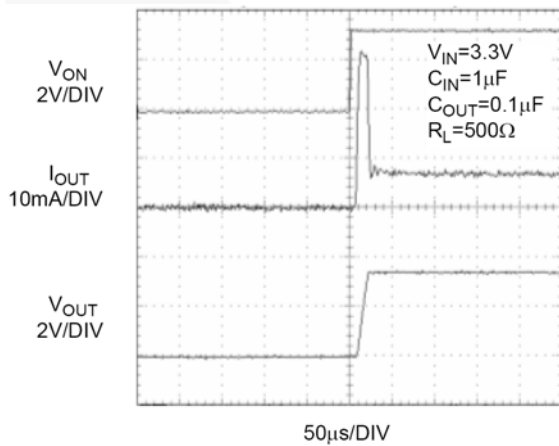


Figure 16. FPF1003A  $t_{ON}$  Response

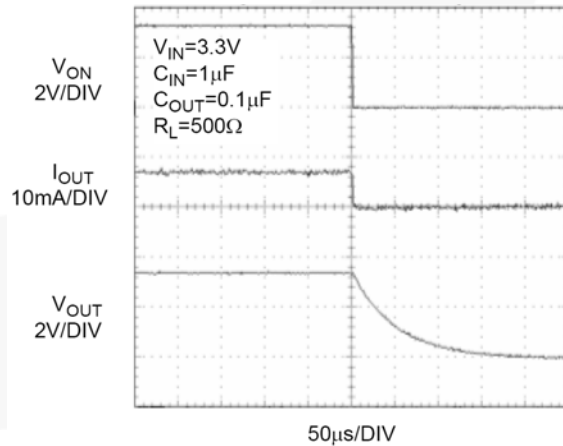


Figure 17. FPF1003A  $t_{OFF}$  Response



### Typical Performance Characteristics

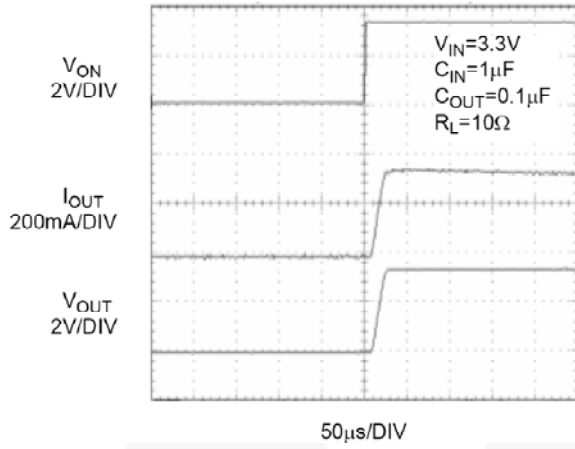


Figure 18. FPF1003A  $t_{ON}$  Response

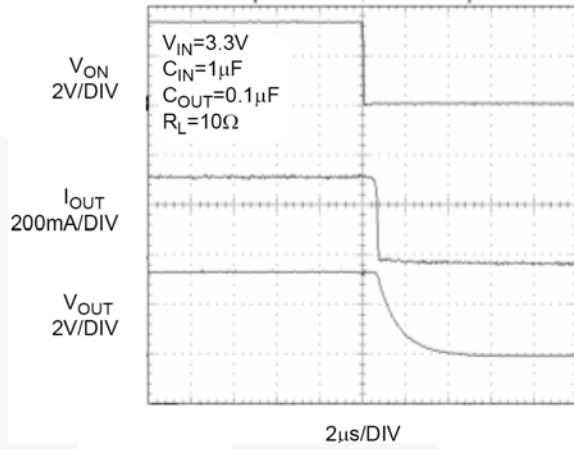


Figure 19. FPF1003A  $t_{OFF}$  Response

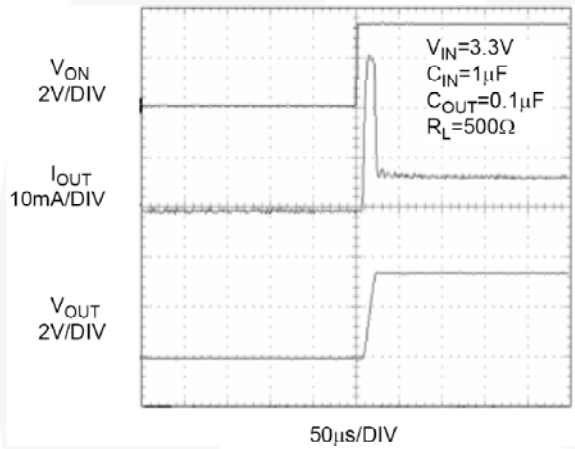


Figure 20. FPF1004  $t_{ON}$  Response

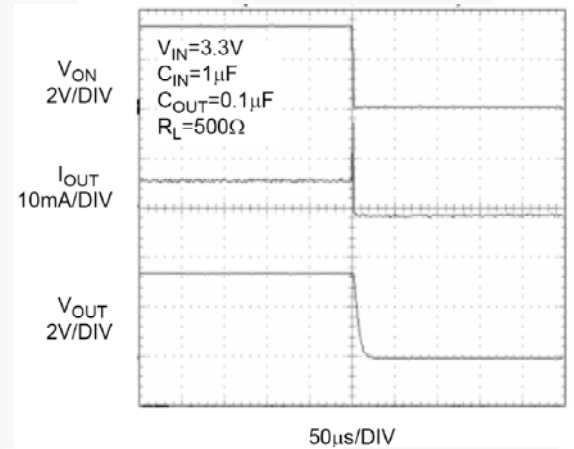


Figure 21. FPF1004  $t_{OFF}$  Response

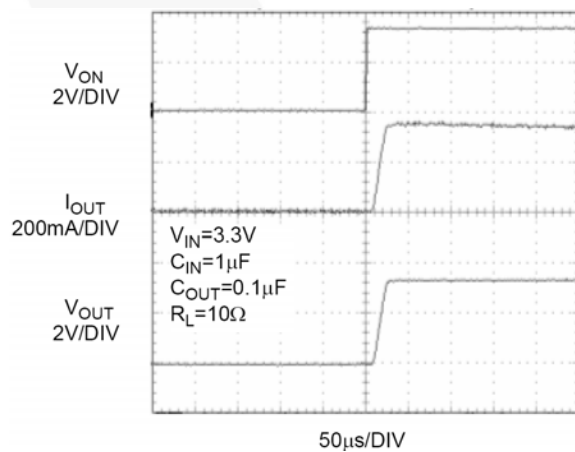


Figure 22. FPF1004  $t_{ON}$  Response

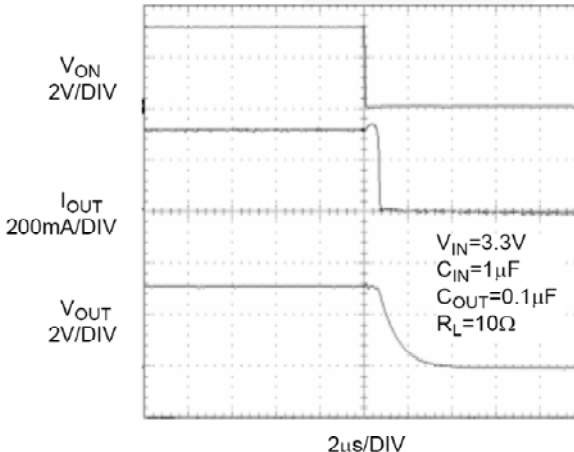


Figure 23. FPF1004  $t_{OFF}$  Response

## Description of Operation

### Input Capacitor

FPF1003A and FPF1004 are low- $R_{DS(ON)}$  P-channel load switches with controlled turn-on. The core of each device is a 30 m $\Omega$  P-Channel MOSFET and a controller capable of functioning over an input operating range of

1.2 to 5.5 V. Switch control is accomplished with a logic input (ON) capable of interfacing directly with low-voltage control signal. In FPF1004, a 120  $\Omega$  on-chip load resistor is added for output quick discharge when the switch is turned off.

### Application Information

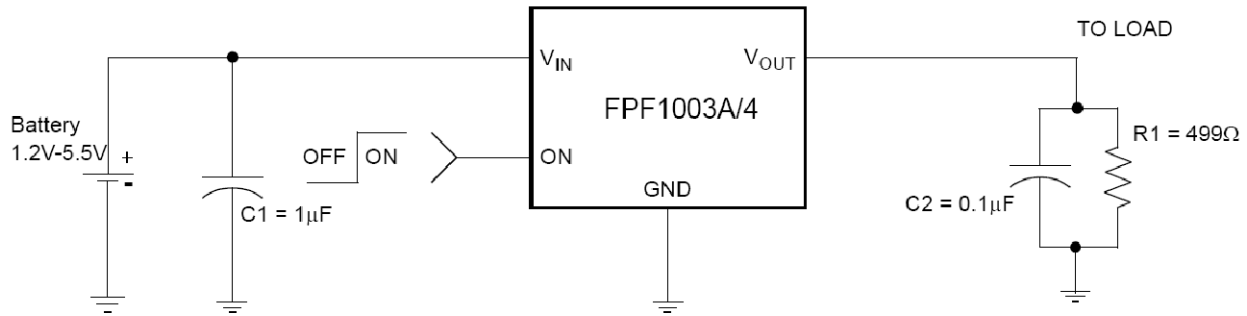


Figure 24. Typical Application

### Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush currents when the switch turns on into a discharged load capacitor or short-circuit, a capacitor needs to be placed between  $V_{IN}$  and GND. A 0.1  $\mu\text{F}$  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  $\mu\text{F}$  capacitor,  $C_{OUT}$ , should be placed between  $V_{OUT}$  and GND. This capacitor prevents parasitic board inductance from forcing  $V_{OUT}$  below GND when the switch turns off. Due to the integral body diode in the

PMOS switch, a  $C_{IN}$  greater than  $C_{OUT}$  is recommended. A  $C_{OUT}$  greater than  $C_{IN}$  can cause  $V_{OUT}$  to exceed  $V_{IN}$  when the system supply is removed. This could result in current flow through the body diode from  $V_{OUT}$  to  $V_{IN}$ .

### 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 minimizes the parasitic electrical effects and case-to-ambient thermal impedance.

## Physical Dimensions

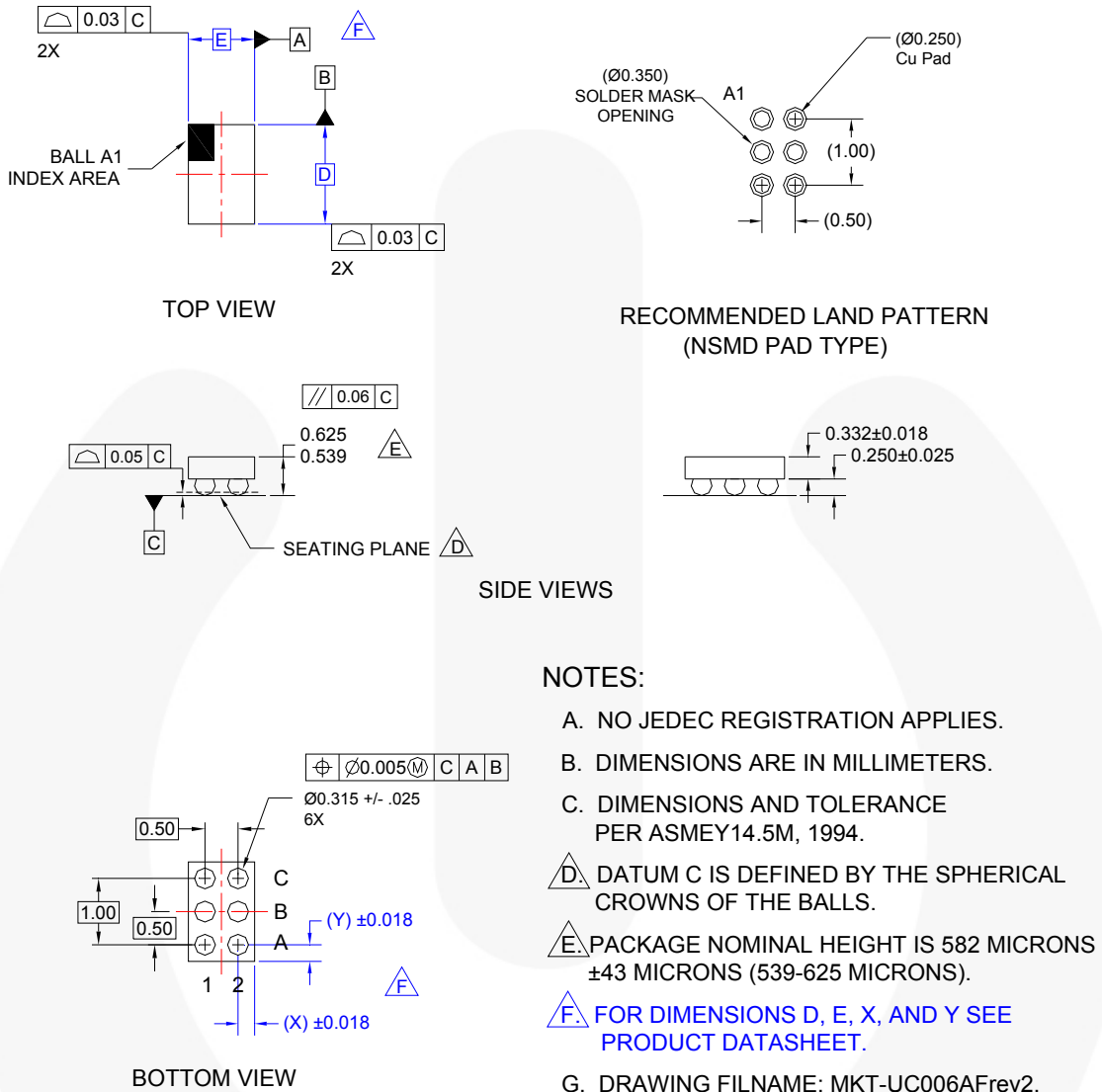


Figure 25. 1.0 x 1.5 mm<sup>2</sup> Wafer-Level Chip-Scale Package (WLCSP)

## Product-Specific Dimensions

Product	D	E	X	Y
FPF1003A	1480 $\mu\text{m} \pm 30 \mu\text{m}$	980 $\mu\text{m} \pm 30 \mu\text{m}$	240 $\mu\text{m}$	240 $\mu\text{m}$
FPF1004	1480 $\mu\text{m} \pm 30 \mu\text{m}$	980 $\mu\text{m} \pm 30 \mu\text{m}$	240 $\mu\text{m}$	240 $\mu\text{m}$

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| BitSiC™                                                                                      | GreenBridge™                                   | QFET®                                                                                              | TinyBuck™                                                                           |
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| FAST®                                                                                        | OptoHiT™                                       | SupreMOS®                                                                                          | VisualMax™                                                                          |
| FastvCore™                                                                                   | OPTOLOGIC®                                     | SyncFET™                                                                                           | VoltagePlus™                                                                        |
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**Definition of Terms**

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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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Rev. 162

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