

# FPF1203 / FPF1204

## IntelliMAX™ Ultra-Small, Slew-Rate-Controlled Load Switch

### Features

- 1.2V to 5.5V Input Voltage Operating Range
- Typical  $R_{ON}$ :
  - 45m $\Omega$  at  $V_{IN}=5.5V$
  - 55m $\Omega$  at  $V_{IN}=3.3V$
  - 90m $\Omega$  at  $V_{IN}=1.8V$
  - 185m $\Omega$  at  $V_{IN}=1.2V$
- Slew Rate Control with  $t_R$ : 100 $\mu s$
- Output Discharge Function on FPF1204
- Low <1.5 $\mu A$  Quiescent Current
- ESD Protected: Above 7kV HBM, 2kV CDM
- GPIO/CMOS-Compatible Enable Circuitry
- 4-Bump, WLCSP 0.76mm x 0.76mm, 0.4mm Pitch

### Applications

- Mobile Devices and Smart Phones
- Portable Media Devices
- Tablet PCs
- Advanced Notebook, UMPC, MID
- Portable Medical Devices
- GPS and Navigation Equipment

### Description

The FPF1203/FPF1204 is ultra-small integrated IntelliMAX™ load switch with integrated P-channel switch and analog control features. Integrated slew-rate control prevents inrush current and the resulting excessive voltage drop on the power rail. The input voltage range operates from 1.2V to 5.5V to provide power-disconnect capability for post-regulated power rails in portable and consumer products. The low shut-off current of 1 $\mu A$  (maximum) allows power designs to meet standby and off-power drain specifications.

The FPF1203/FPF1204 is controlled by an active-HIGH logic input (ON pin) compatible with standard CMOS GPIO circuitry found on Field Programmable Gate Array (FPGA) embedded processors. The FPF1203/FPF1204 is available in 0.76mm x 0.76mm 4-bump WLCSP.

### Ordering Information

Part Number	Top Mark	Switch (Typical) at 3.3V <sub>IN</sub>	Output Discharge	ON Pin Activity	t <sub>R</sub>	Package
FPF1203UCX	QL	55m $\Omega$	NA	Active HIGH	100 $\mu s$	4-BUMP, Wafer-Level Chip-Scale Package (WLCSP) 0.76mm x 0.76mm, 0.4mm Pitch
FPF1204UCX	QM	55m $\Omega$	65 $\Omega$	Active HIGH	100 $\mu s$	

### Application Diagram

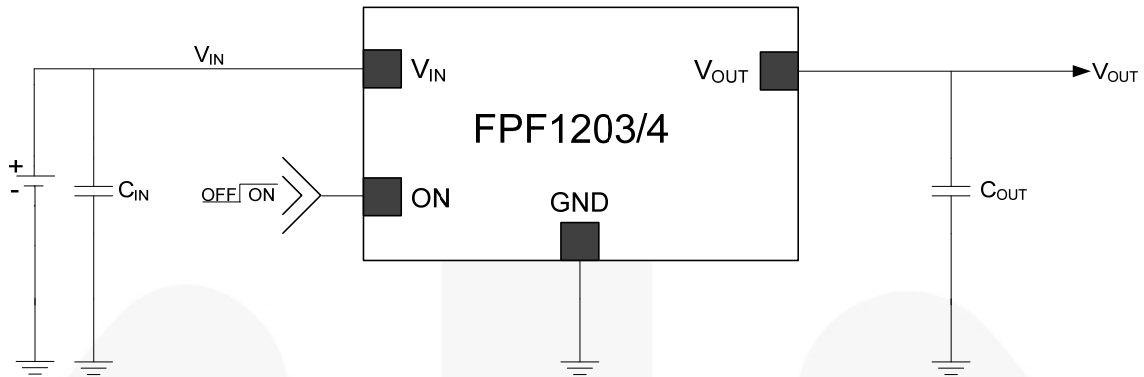


Figure 1. Typical Application

### Functional Block Diagram

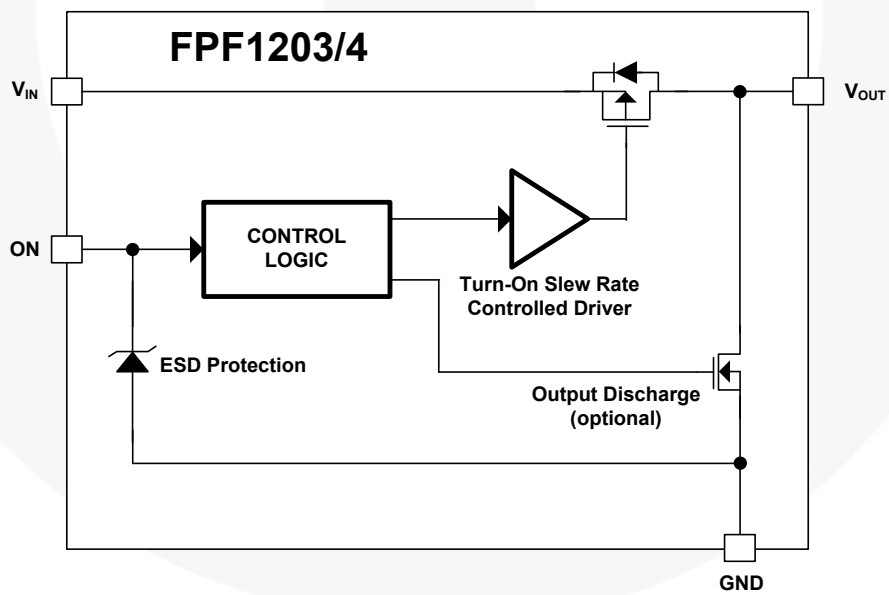


Figure 2. Functional Block Diagram (Output Discharge for FPF1204 Only)

## Pin Configurations

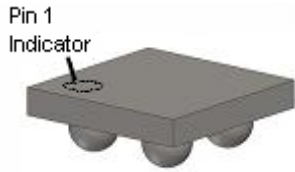


Figure 3. WLCSP Bumps Facing Down (Top View)

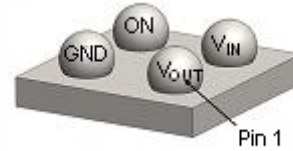


Figure 4. WLCSP Bumps Facing Up (Bottom View)

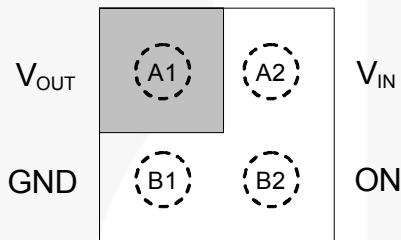


Figure 5. Pin Assignments (Top View)

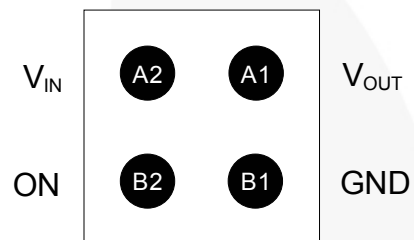


Figure 6. Pin Assignments (Bottom View)

## Pin Definitions

Pin #	Name	Description
A1	$V_{OUT}$	Switch Output
A2	$V_{IN}$	Supply Input: Input to the power switch
B1	GND	Ground
B2	ON	ON/OFF Control, active HIGH

## 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	
$V_{IN}$	$V_{IN}$ , $V_{OUT}$ , $V_{ON}$ to GND	-0.3	6.0	V	
$I_{SW}$	Maximum Continuous Switch Current		1.5	A	
$P_D$	Power Dissipation at $T_A=25^\circ\text{C}$		1.0	W	
$T_{STG}$	Storage and Operating Temperature Range	-65	+150	$^\circ\text{C}$	
$\Theta_{JA}$	Thermal Resistance, Junction-to-Ambient	1S2P with One Thermal Via <sup>(1)</sup>		110	$^\circ\text{C}/\text{W}$
		1S2P without Thermal Via <sup>(2)</sup>		95	
ESD	Electrostatic Discharge Capability <sup>(1,2)</sup>	Human Body Model, JESD22-A114	7		kV
		Charged Device Model, JESD22-C101	2		

### Notes:

1. Measured using 2S2P JEDEC std. PCB.
2. Measured using 2S2P JEDEC PCB COLD PLATE Method.

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

## Electrical Characteristics

Unless otherwise noted,  $V_{IN}=1.2V$  to  $5.5V$  and  $T_A=-40$  to  $+85^{\circ}C$ . Typical values are at  $V_{IN}=3.3V$  and  $T_A=25^{\circ}C$ .

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Basic Operation</b>						
$V_{IN}$	Supply Voltage		1.2		5.5	V
$I_{Q(OFF)}$	Off Supply Current	$V_{ON}=OFF$ , $V_{OUT}=Open$ , $V_{IN}=5.5V$		0.1	1.0	$\mu A$
$I_{SD}$	Shutdown Current	$V_{ON}=GND$ , $V_{OUT}=GND$			1.0	$\mu A$
$I_Q$	Quiescent Current	$I_{OUT}=0mA$			1.5	$\mu A$
$R_{ON}$	On Resistance	$V_{IN}=5.5V$ , $I_{OUT}=200mA$ , $T_A=25^{\circ}C$		45		m $\Omega$
		$V_{IN}=3.3V$ , $I_{OUT}=200mA$ , $T_A=25^{\circ}C$		55		
		$V_{IN}=1.8V$ , $I_{OUT}=200mA$ , $T_A=25^{\circ}C$		90		
		$V_{IN}=1.2V$ , $I_{OUT}=200mA$ , $T_A=25^{\circ}C$		185		
		$V_{IN}=1.8V$ , $I_{OUT}=200mA$ , $T_A=85^{\circ}C^{(3)}$			105	
$R_{PD}$	Output Discharge $R_{PULL\ DOWN}$	$V_{IN}=3.3V$ , $V_{ON}=OFF$ , $I_{FORCE}=20mA$ , $T_A=25^{\circ}C$ , FPF1204		65	75	$\Omega$
$V_{IH}$	On Input Logic HIGH Voltage	$V_{IN}=1.2V$ to $5.5V$	1.15			V
$V_{IL}$	On Input Logic LOW Voltage	$V_{IN}=1.2V$ to $5.5V$			0.65	V
		$V_{IN}=1.2V$ to $1.8V$			0.60	V
$R_{ON\_PD}$	Pulldown Resistance at ON Pin			8.3		M $\Omega$
$I_{ON}$	On Input Leakage	$V_{ON}=V_{IN}$ or GND			1	$\mu A$
<b>Dynamic Characteristics</b>						
$t_{DON}$	Turn-On Delay <sup>(4)</sup>	$V_{IN}=3.3V$ , $R_L=10\Omega$ , $C_L=0.1\mu F$ , $T_A=25^{\circ}C$		70		$\mu s$
$t_R$	$V_{OUT}$ Rise Time <sup>(4)</sup>			100		
$t_{ON}$	Turn-On Time <sup>(6)</sup>			170		
$t_{DOFF}$	Turn-Off Delay <sup>(4,5)</sup>	$V_{IN}=3.3V$ , $R_L=10\Omega$ , $C_L=0.1\mu F$ , $T_A=25^{\circ}C$ , FPF1203		4.0		$\mu s$
$t_F$	$V_{OUT}$ Fall Time <sup>(4,5)</sup>			2.9		
$t_{OFF}$	Turn-Off Time <sup>(5,7)</sup>			7.3		
$t_{DOFF}$	Turn-Off Delay <sup>(4,5)</sup>	$V_{IN}=3.3V$ , $R_L=500\Omega$ , $C_L=0.1\mu F$ , $T_A=25^{\circ}C$ , FPF1203		6		$\mu s$
$t_F$	$V_{OUT}$ Fall Time <sup>(4,5)</sup>			115		
$t_{OFF}$	Turn-Off Time <sup>(5,7)</sup>			121		
$t_{DOFF}$	Turn-Off Delay <sup>(4,5)</sup>	$V_{IN}=3.3V$ , $R_L=10\Omega$ , $C_L=0.1\mu F$ , $T_A=25^{\circ}C$ , FPF1204 <sup>(5)</sup>		4.0		$\mu s$
$t_F$	$V_{OUT}$ Fall Time <sup>(4,5)</sup>			2.5		
$t_{OFF}$	Turn-Off Time <sup>(5,7)</sup>			6.5		
$t_{DOFF}$	Turn-Off Delay <sup>(4,5)</sup>	$V_{IN}=3.3V$ , $R_L=500\Omega$ , $C_L=0.1\mu F$ , $T_A=25^{\circ}C$ , FPF1204 <sup>(5)</sup>		6		$\mu s$
$t_F$	$V_{OUT}$ Fall Time <sup>(4,5)</sup>			11		
$t_{OFF}$	Turn-Off Time <sup>(5,7)</sup>			17		

### Notes:

- This parameter is guaranteed by design and characterization; not production tested.
- $t_{DON}/t_{DOFF}/t_R/t_F$  are defined in Figure 22.
- Output discharge enabled during off-state.
- $t_{ON}=t_R + t_{DON}$ .
- $t_{OFF}=t_F + t_{DOFF}$ .

## Typical Performance Characteristics

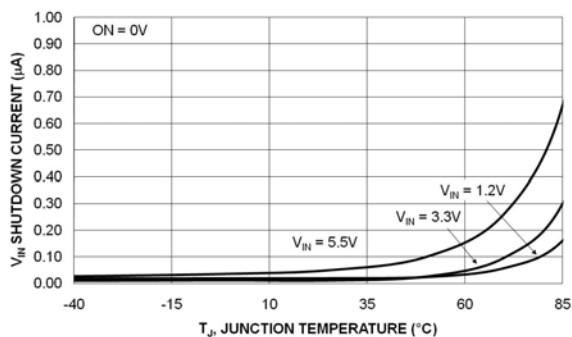


Figure 7. Shutdown Current vs. Temperature

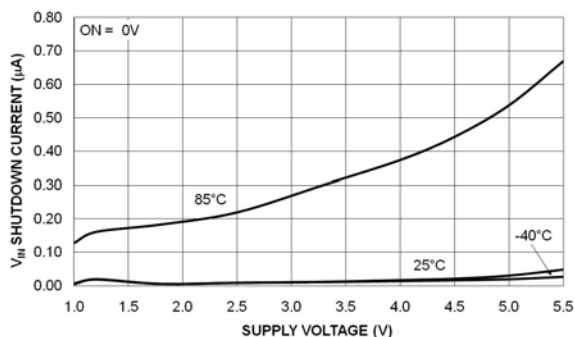


Figure 8. Shutdown Current vs. Supply Voltage

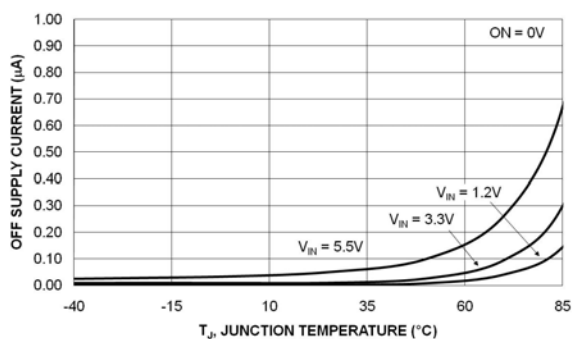


Figure 9. Off Supply Current vs. Temperature (V<sub>OUT</sub> Floating)

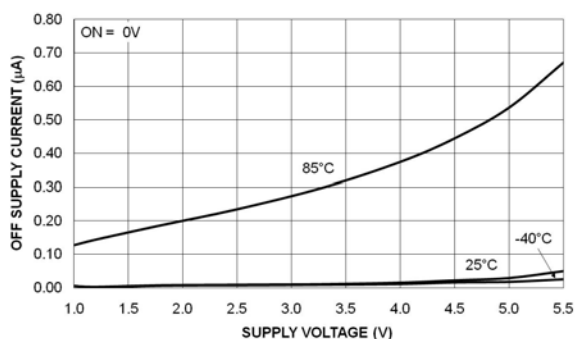


Figure 10. Off Supply Current vs. Supply Voltage (V<sub>OUT</sub> Floating)

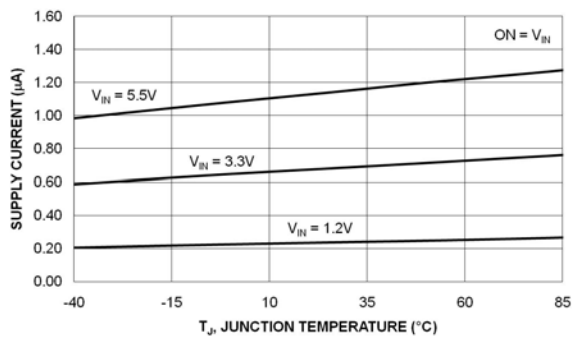


Figure 11. Quiescent Current vs. Temperature

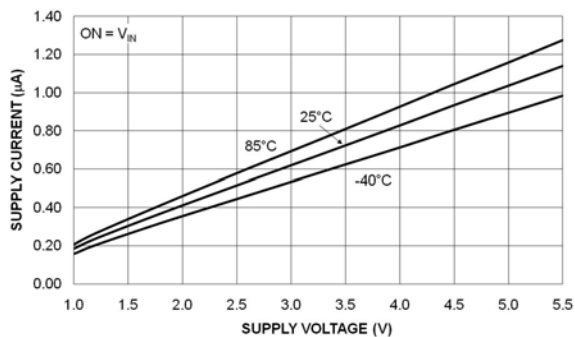


Figure 12. Quiescent Current vs. Supply Voltage

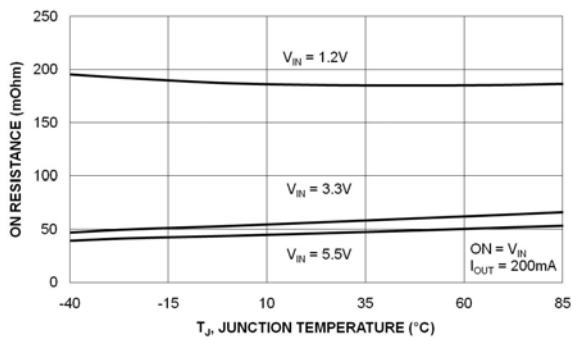


Figure 13. R<sub>ON</sub> vs. Temperature

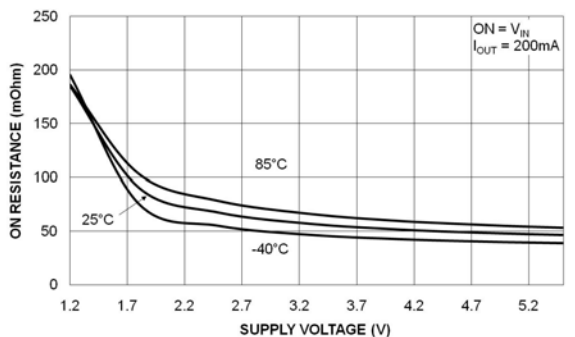


Figure 14. R<sub>ON</sub> vs. Supply Voltage

## Typical Performance Characteristics (Continued)

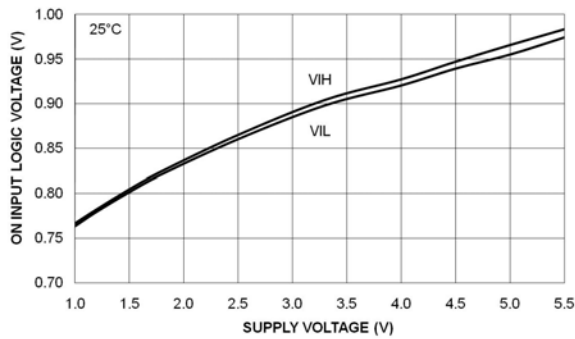


Figure 15. ON Pin Threshold vs.  $V_{IN}$

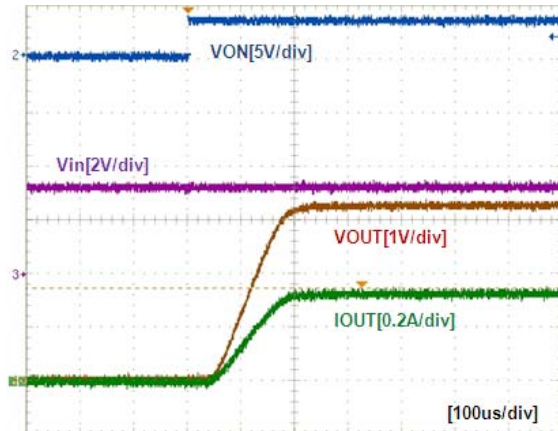


Figure 16. Turn-On Response ( $V_{IN}=3.3V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT}=0.1\mu F$ ,  $R_L=10\Omega$ )

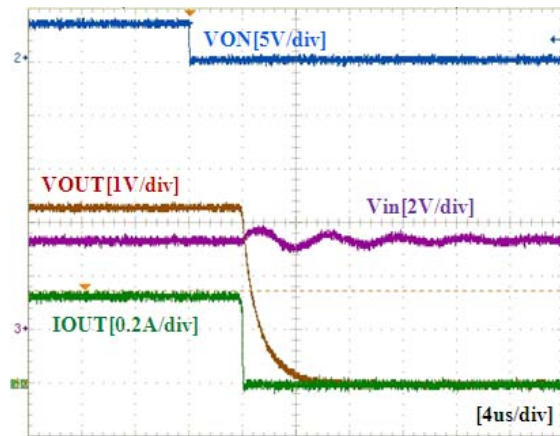


Figure 17. Turn-Off Response ( $V_{IN}=3.3V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT}=0.1\mu F$ ,  $R_L=10\Omega$ , FPF1203)

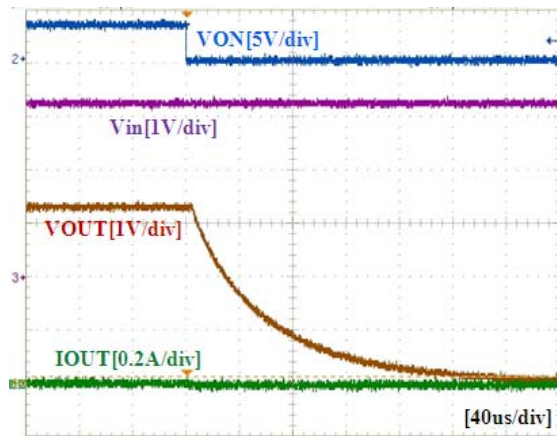


Figure 18. Turn-Off Response ( $V_{IN}=3.3V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT}=0.1\mu F$ ,  $R_L=500\Omega$ , FPF1203)

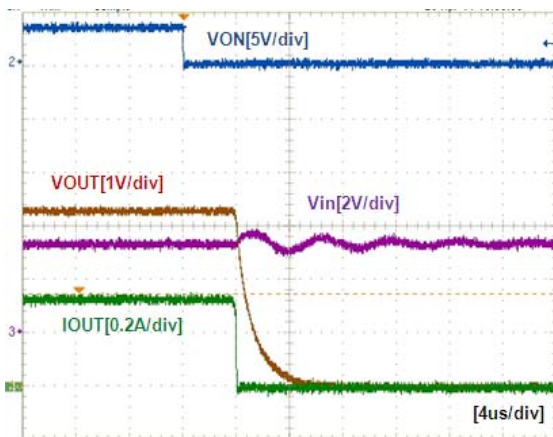


Figure 19. Turn-Off Response ( $V_{IN}=3.3V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT}=0.1\mu F$ ,  $R_L=10\Omega$ , FPF1204)

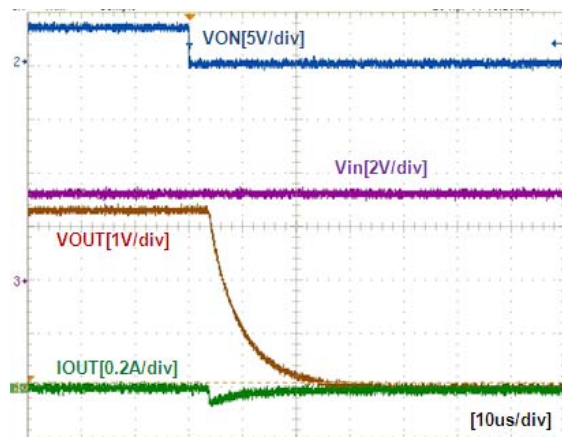


Figure 20. Turn-Off Response ( $V_{IN}=3.3V$ ,  $C_{IN}=1\mu F$ ,  $C_{OUT}=0.1\mu F$ ,  $R_L=500\Omega$ , FPF1204)

## Operation and Application Description

The FPF1203/FPF1204 is low- $R_{ON}$  P-channel load switch with controlled turn-on. The core of each device is a  $55m\Omega$  P-channel MOSFET and controller capable of functioning over a wide input operating range of 1.2 to 5.5V. The ON pin, an active-HIGH GIOP / CMOS-compatible input, controls the state of the switch.

The FPF1204 contains a  $65\Omega$  on-chip load resistor for quick output discharge when the switch is turned off.

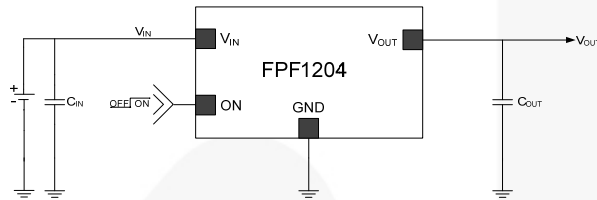


Figure 21. Typical Application

### Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current when the switch turns on into a discharged load capacitor or short-circuit, a capacitor must be placed between the  $V_{IN}$  and GND pins. A  $1\mu F$  ceramic capacitor,  $C_{IN}$ , placed close to the pins is usually sufficient. Higher-value  $C_{IN}$  can be used to reduce the voltage drop in higher-current applications.

### Output Capacitor

A  $0.1\mu F$  capacitor,  $C_{OUT}$ , should be placed between the  $V_{OUT}$  and GND pins. This capacitor prevents parasitic board inductance from forcing  $V_{OUT}$  below GND when

the switch is on.  $C_{IN}$  greater than  $C_{OUT}$  is highly recommended.  $C_{OUT}$  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  $V_{IN}$ .

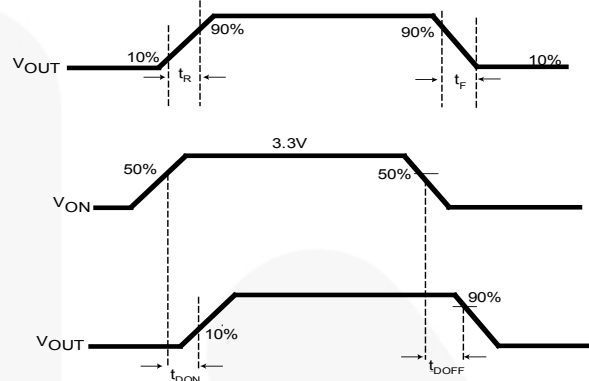


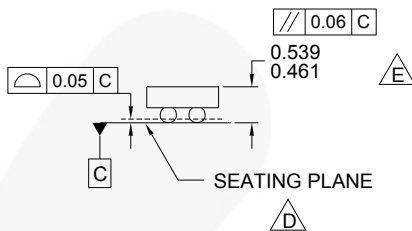
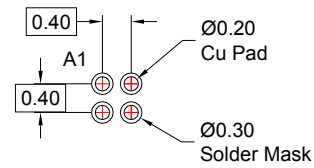
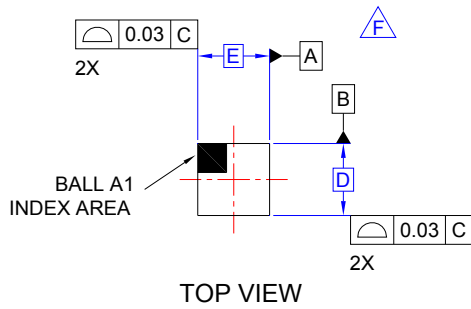
Figure 22. Timing Diagram

### Board Layout

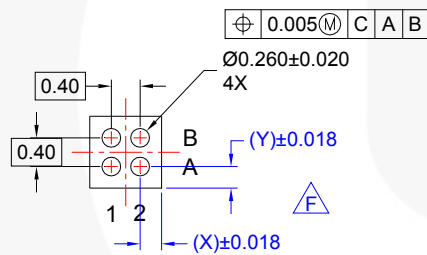
For best performance, traces should be as short as possible. To be most effective, input and output capacitors should be placed close to the device to minimize the effect of parasitic trace inductance on normal and short-circuit operation. Using wide traces or large copper planes for all pins ( $V_{IN}$ ,  $V_{OUT}$ , ON, and GND) minimizes the parasitic electrical effects and the case-ambient thermal impedance. However, the  $V_{OUT}$  pin should not connect directly to the battery source due to the discharge mechanism of the load switch.



## Physical Dimensions



SIDE VIEWS



BOTTOM VIEW

### NOTES:

- A. NO JEDEC REGISTRATION APPLIES.
- B. DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS AND TOLERANCE PER ASME Y14.5M, 1994.
- D. DATUM C IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.
- E. PACKAGE NOMINAL HEIGHT IS 500 MICRONS ±39 MICRONS (461-539 MICRONS).
- F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.
- G. DRAWING FILNAME: MKT-UC004AFrev1.

Figure 23. 4-Bump, 0.76 x 0.76mm, Wafer-Level Chip-Scale Packaging

## Product-Specific Dimensions

Product	D	E	X	Y
FPF1203UCX	760µm ± 30µm	760µm ± 30µm	0.180mm± 0.018µm	0.180mm± 0.018µm
FPF1204UCX	760µm ± 30µm	760µm ± 30µm	0.180mm± 0.018µm	0.180mm± 0.018µm





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| BitSiC®   | Global Power Resource™  | Programmable Active Droop™  | TinyBoost™  |
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|  | MillerDrive™  | SuperFET®   |  |
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| Fairchild Semiconductor®  | Motion-SPM™   | SuperSOT™.6   | Ultra FRFET™  |
| FACT Quiet Series™  | mWSaver™  | SuperSOT™.8   | UniFET™   |
| FACT®   | OptoHiT™  | SupreMOS®   | VCX™  |
| FAST®   | OPTOLOGIC®  | SyncFET™  | VisualMax™  |
| FastyCore™  | OPTOPLANAR®   | SyncLock™   | XS™   |
| FETBench™   |  |   |   |
| FlashWriter®  | PDP SPM™  |   |   |

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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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**PRODUCT STATUS DEFINITIONS**

**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.

Rev. 154