FAIRCHILD SEMICONDUCTOR®

October 2013

FPF1504 / FPF1504L
Advanced Load Management Switch

Features

- 1.0 V to 3.6 V Input Voltage Operating Range
- Typical $R_{DS(ON)}$:
  - 15 mΩ at V_{IN}=3.3 V
  - 20 mΩ at V_{IN}=1.8 V
  - 55 mΩ at V_{IN}=1.0 V
- Slew Rate Control
- Output Discharge Function
- Low <1 µA Quiescent Current at V_{ON}=V_{IN}
- ESD Protected: 4000 V HBM, 2000 V CDM
- GPIO/CMOS-Compatible Enable Circuitry
- Active HIGH and active LOW versions

Applications

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

Description

The FPF1504/FPF1504L are low-R_{DS} P-channel MOSFET load switches of the IntelliMAX™ family. Integrated slew-rate control prevents excessive inrush current from the supply rails with capacitive loads common in power applications. In addition, the FPF1504/FPF1504L feature output discharge capability.

The input voltage range operates from 1.0 V to 3.6 V to fulfill today's mobile device supply requirements. Switch control is by a logic input (ON pin) capable of interfacing directly with low-voltage CMOS control signals and GPIOs in embedded processors.

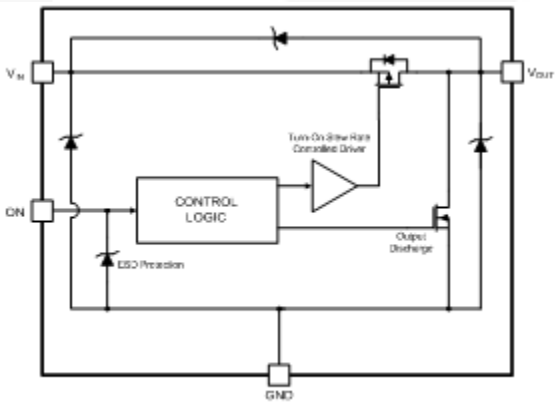


Figure 1. Block Diagram

Ordering Information

Part Number	Top Mark	Switch (Typical) At 1.8 V_{IN}	Input Buffer	Output Discharge	ON Pin Activity	Package
FPF1504UCX	G4	20 mΩ	CMOS	YES	Active HIGH	4-Ball, WLCSP, 0.5 mm Pitch
FPF1504BUCX	G4	20 mΩ	CMOS	YES	Active HIGH	4-Ball, WLCSP with Backside Laminate, 0.5 mm Pitch
FPF1504LUCX	GZ	20 mΩ	CMOS	YES	Active LOW	4-Ball, WLCSP, 0.5 mm Pitch

Application Diagram

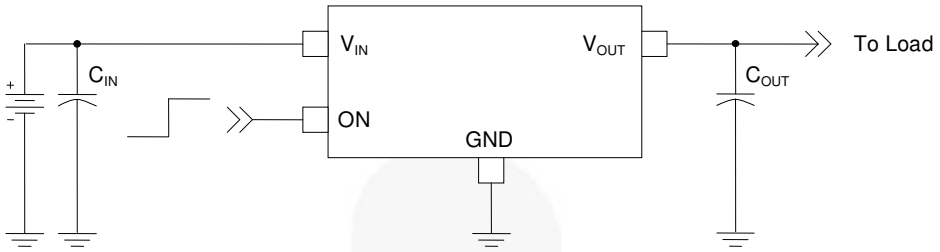


Figure 2. Typical Application

Notes:
1. C_{IN}=1 μF, X5R, 0603, for example Murata GRM185R60J105KE26.
2. C_{OUT}=1 μF, X5R, 0805, for example Murata GRM216R61A105KA01.

Pin Configurations

Figure 3. 1 x 1 mm WLCSP Bumps Facing Down

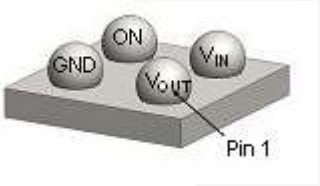


Figure 4. 1 x 1 mm WLCSP Bumps Facing Up

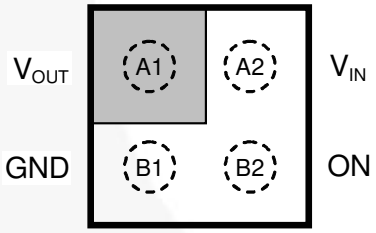


Figure 5. Pin Assignments (Top View)

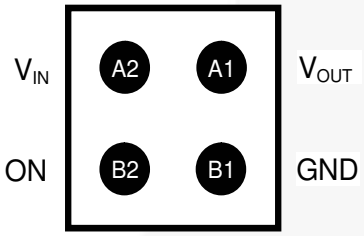


Figure 6. Pin Assignments (Bottom View)

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

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	4.0	V
I_{SW}	Maximum Continuous Switch Current			1.5	A
P_D	Power Dissipation at T_A=25°C			1.0	W
T_{STG}	Storage Junction Temperature		-65	+150	°C
T_A	Operating Temperature Range		-40	+85	°C
Θ_{JA}	Thermal Resistance, Junction-to-Ambient	1S2P with 1 Thermal Via		95	°C/W
		1S2P without Thermal Via		187	
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	4		kV
		Charged Device Model, JESD22-C101	2		

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	1.0	3.6	V
T_A	Ambient Operating Temperature	-40	+85	°C

Electrical Characteristics

Unless otherwise noted, V_{IN}=1.0 to 3.6 V, T_A=-40 to +85°C; typical values are at V_{IN}=3.3 V and T_A=25°C.

Symbol	Parameter		Conditions	Min.	Typ.	Max.	Units
Basic Operation							
V_{IN}	Supply Voltage			1.0		3.6	V
$I_{Q(OFF)}$	Off Supply Current	FPF1504	V_{ON}=GND, V_{OUT}=Open		0.25		µA
		FPF1504L	V_{ON}= V_{IN}, V_{OUT}=Open		0.3		
$I_{SD(OFF)}$	Off Switch Current	FPF1504	V_{ON}=GND, V_{OUT}=GND		0.25		
		FPF1504L	V_{ON}= V_{IN}, V_{OUT}=GND		0.3		
I_Q	Quiescent Current	FPF1504	I_{OUT}=0 mA, V_{IN}=3.6 V, V_{ON}=V_{IN}		0.08		
			I_{OUT}=0 mA, V_{ON}=$V_{IH(MIN)}$		0.75		
		FPF1504L	I_{OUT}=0 mA, V_{IN}=3.6 V, V_{ON}=GND		0.08		
			I_{OUT}=0 mA, V_{ON}=$V_{IL(MAX)}$		0.95		
R_{ON}	On Resistance		V_{IN}=3.3 V, I_{OUT}=200 mA, T_A=25°C		15	30	mΩ
			V_{IN}=1.8 V, I_{OUT}=200 mA, T_A=25°C		20	40	
			V_{IN}=1.5 V, I_{OUT}=200 mA, T_A=25°C		30		
			V_{IN}=1.0 V, I_{OUT}=200 mA, T_A=25°C		40	80	
			V_{IN}=1.8 V, I_{OUT}=200 mA, T_A=85°C[3]		35	50	
R_{PD}	Output Discharge Pull-Down Resistance		V_{ON}=0 V or V_{IN}, I_{OUT}=-20 mA		65	95	Ω
V_{IH}	On Input Logic High Voltage	FPF1504		0.8			V
V_{IL}	On Input Logic Low Voltage	FPF1504				0.3	
I_{ON}	On Input Leakage		V_{ON}=V_{IN} or GND			1	µA
Dynamic Characteristics							
t_{DON}	Turn-On Delay[4]	FPF1504	R_L=10 Ω, C_L=0.1 µF, V_{IN}=3.3 V, T_A=25°C		80		µs
t_R	V_{OUT} Rise Time[4]	FPF1504			130		
t_{ON}	Turn-On Time[4]	FPF1504			210		
t_{DON}	Turn-On Delay[4]	FPF1504	R_L=500 Ω, C_L=0.1 µF, V_{IN}=3.3 V, T_A=25°C		70	100	µs
		FPF1504L			95		
t_R	V_{OUT} Rise Time[4]	FPF1504			110	150	
		FPF1504L			115		
t_{ON}	Turn-On Time[4]	FPF1504			180	250	
		FPF1504L			210		

Continued on the following page…

Electrical Characteristics (Continued)

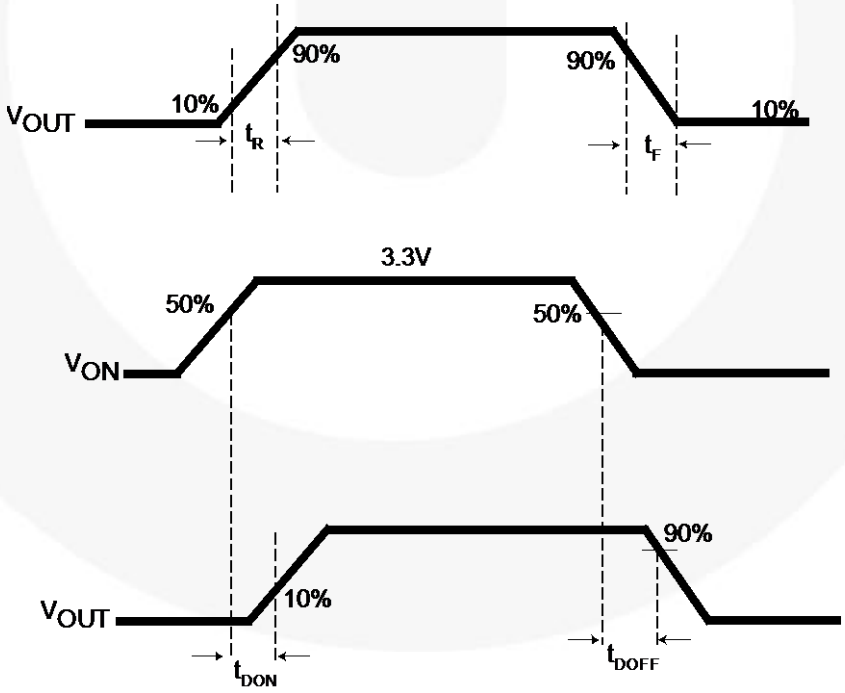
Unless otherwise noted, V_{IN}=1.0 to 3.6 V, T_A=-40 to +85°C; typical values are at V_{IN}=3.3 V and T_A=25°C.

Symbol	Parameter		Conditions	Min.	Typ.	Max.	Units
Dynamic Characteristics (Continued)							
t_{DOFF}	Turn-Off Delay[4]	FPF1504	R_L=10 Ω, C_L=0.1 µF, V_{IN}=3.3 V, T_A=25°C		25	30	µs
t_F	V_{OUT} Fall Time[4]	FPF1504			2		
t_{OFF}	Turn-Off Time[4]	FPF1504			27		
t_{DOFF}	Turn-Off Delay[4]	FPF1504	R_L=500 Ω, C_L=0.1 µF, V_{IN}=3.3 V, T_A=25°C		25		µs
		FPF1504L			2		
t_F	V_{OUT} Fall Time[4]	FPF1504			12		
		FPF1504L			14		
t_{OFF}	Turn-Off Time[4]	FPF1504			37		
		FPF1504L			16		

Notes:

3. This parameter is guaranteed by design and characterization; not production tested.
4. t_{DON}/t_{DOFF}/t_R/t_F are defined in Figure 7.
5. Output discharge path is enabled during off.

Timing Diagram – FPF1504



Notes:

6. t_{ON}=t_R + t_{DON}.
7. t_{OFF}=t_F + t_{DOFF}.

Figure 7. Timing Diagram for FPF1504

Typical Performance Characteristics for FPF1504

Applicable to active high version only.

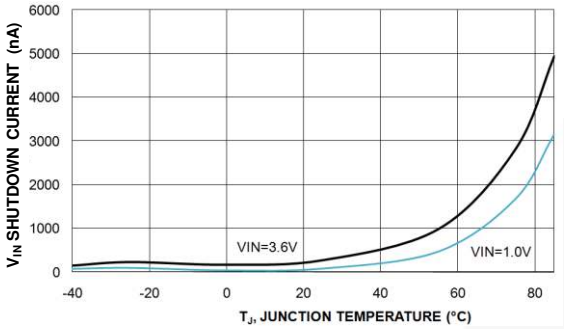


Figure 8. Shutdown Current vs. Temperature

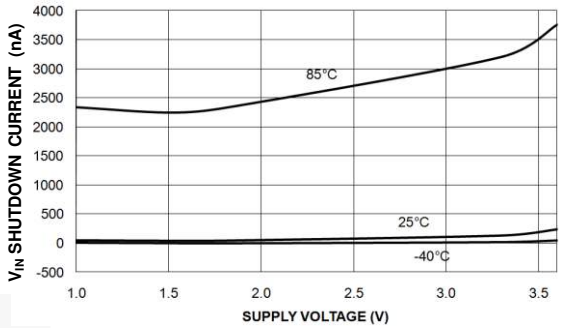


Figure 9. Shutdown Current vs. Supply Voltage

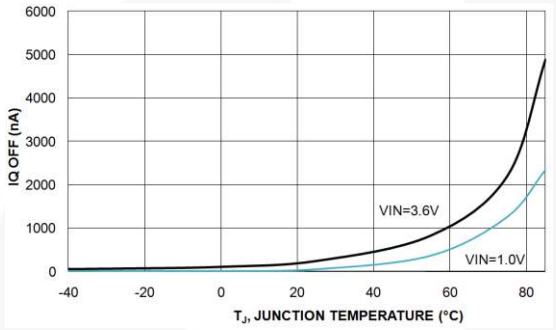


Figure 10. Off Supply Current vs. Temperature

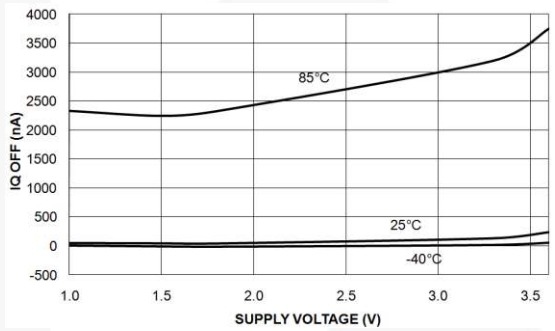


Figure 11. Off Supply Current vs. Supply Voltage

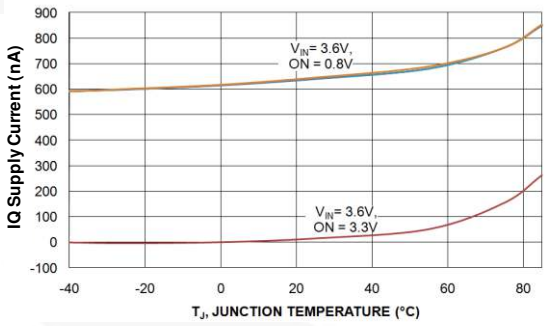


Figure 12. Quiescent Current vs. Temperature

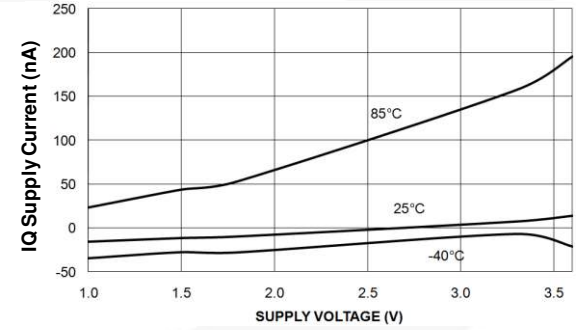


Figure 13. Quiescent Current vs. Supply Voltage (V_{ON}=V_{IN})

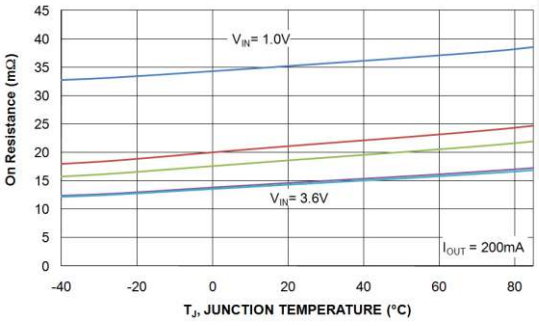


Figure 14. R_{ON} vs. Temperature

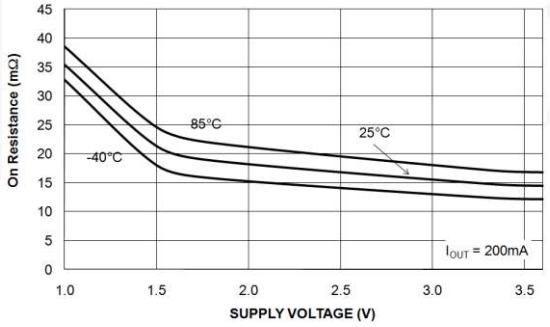


Figure 15. R_{ON} vs. Supply Voltage

Typical Performance Characteristics for FPF1504

Applicable to active high version only.

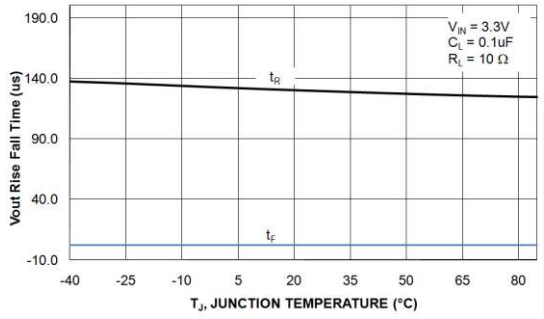


Figure 16. V_{OUT} Rise/Fall Times vs. Temperature (R_L=10 Ω)

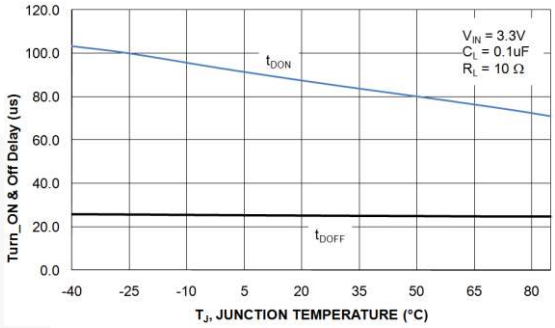


Figure 17. V_{OUT} Turn-On/Turn-Off Delays vs. Temperature (R_L=10 Ω)

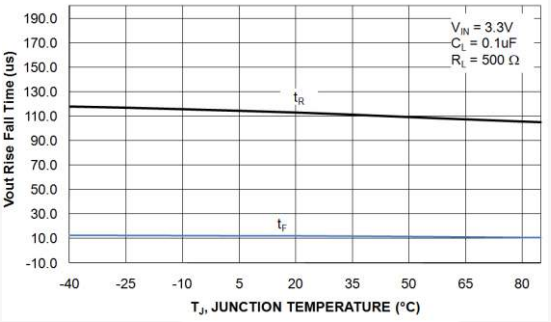


Figure 18. V_{OUT} Rise/Fall Time vs. Temperature (R_L=500 Ω)

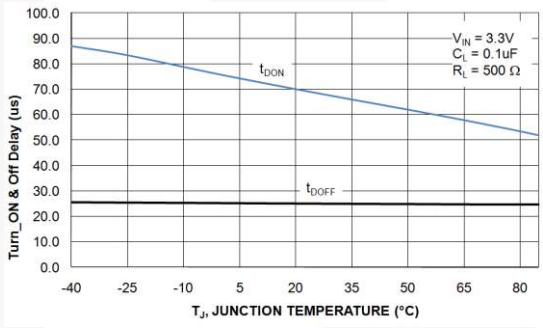


Figure 19. V_{OUT} Turn-On/Turn-Off Delays vs. Temperature (R_L=500 Ω)

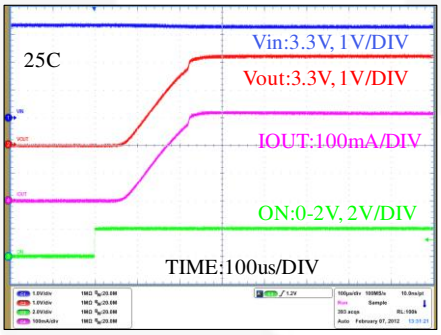


Figure 20. Turn-On Response (V_{IN}=3.3 V, C_{OUT}=0.1 µF, R_L=10 Ω)

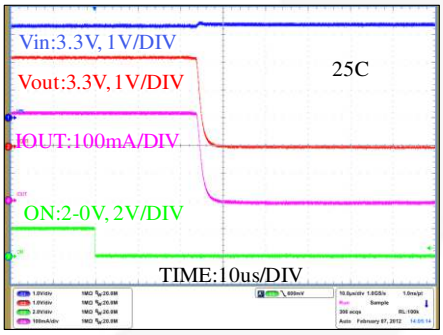


Figure 21. Turn-Off Response (V_{IN}=3.3 V, C_{OUT}=0.1 µF, R_L=10 Ω)

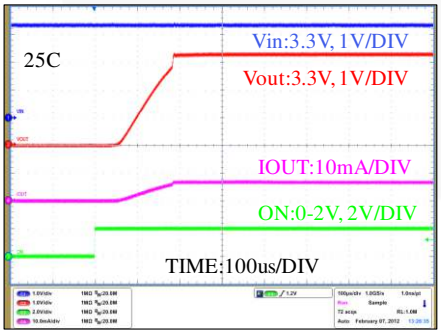


Figure 22. Turn-On Response (V_{IN}=3.3 V, C_{OUT}=0.1 µF, R_L=500 Ω)

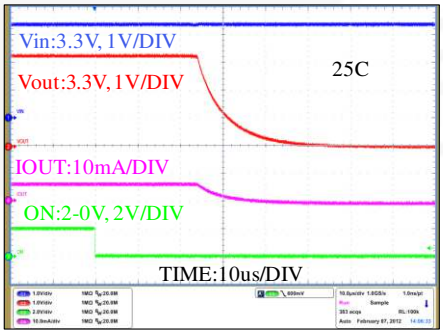


Figure 23. Turn-Off Response (V_{IN}=3.3 V, C_{OUT}=0.1 µF, R_L=500 Ω)

Application Information

Input Capacitor

IntelliMAX™ switches don't require an input capacitor. To reduce device inrush current, a 0.1 µF ceramic capacitor, C_{IN}, is recommended close to the VIN 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

IntelliMAX™ switches work without an output capacitor. If the applications parasitic board inductance forces V_{OUT} below GND when switching off, a 0.1 µF capacitor, C_{OUT}, should be placed between V_{OUT} and GND.

Fall Time

Device output fall time can be calculated based on RC constant of external components as follows:

$$t_F = R_L \times C_L \times 2.2 \quad (1)$$

where t_F is 90% to 10% fall time, R_L is output, load and C_L is output capacitor.

The same equation works for a device with a pull-down output resistor, then R_L is replaced by a parallel connected pull-down and external output resistor combination, as follows:

$$t_F = \frac{R_L \times R_{PD}}{R_L + R_{PD}} \times C_L \times 2.2 \quad (2)$$

where t_F is 90% to 10% fall time, R_L is output load, R_{PD} is output pull-down resistor (65 Ω typical), and C_L is the output capacitor.

Recommended Land Pattern and Layout

For best thermal performance and minimal inductance and parasitic effects, it is recommended to keep input and output traces short and the capacitors as close to the device as possible. Below is a recommended layout for this device to achieve optimum performance.

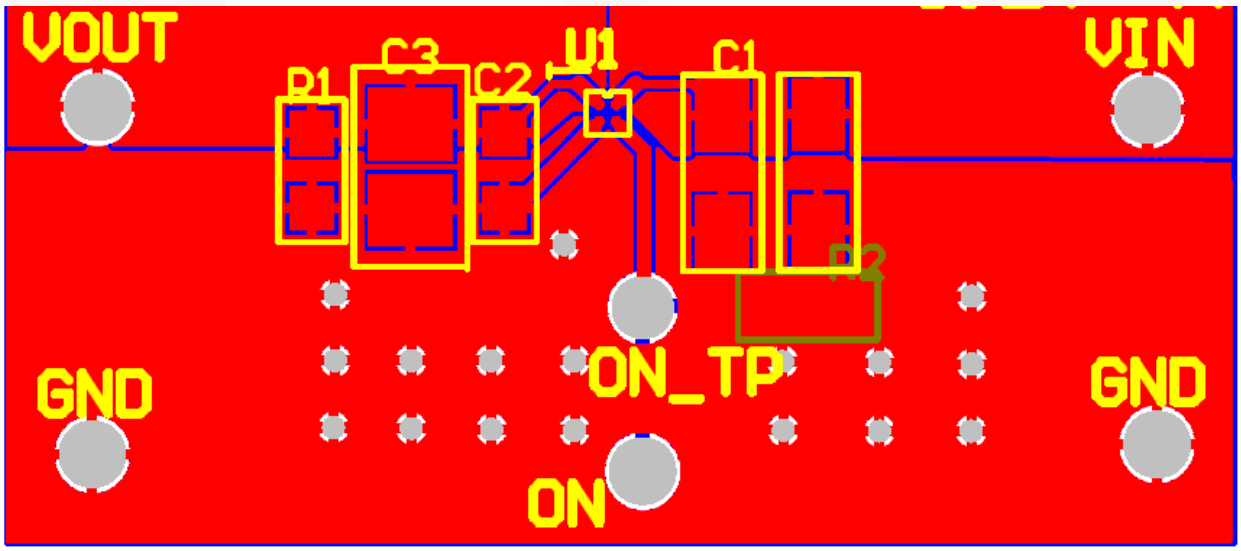
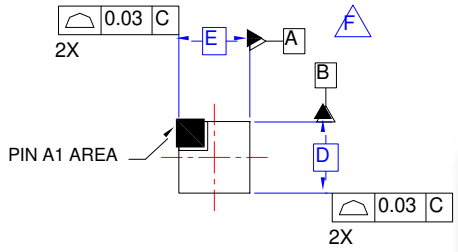
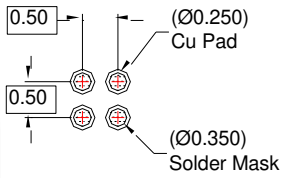


Figure 24. Recommended Land Pattern and Layout

Physical Dimensions

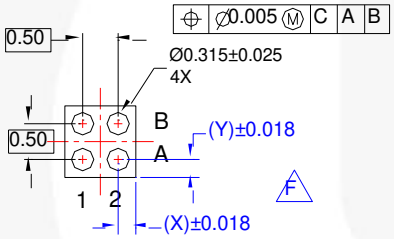


TOP VIEW



RECOMMENDED LAND PATTERN
(NSMD PAD TYPE)

SIDE VIEWS



BOTTOM VIEW

NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 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 FILENAME: MKT-UC004ABrev2.

Figure 25. 4-Ball, 1.0 x 1.0 mm Wafer-Level Chip Scale (WLCSP) Packaging

Product-Specific Dimensions

Product	D	E	X	Y
FPF1504UCX	960 µm ±30 µm	960 µm ±30 µm	0.230 mm	0.230 mm
FPF1504BUCX				
FPF1504LUCX				

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

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FACT®
FAST®
FastvCore™
FETBench™
FPS™
F-PFS™
FRFET®
Global Power Resource℠
GreenBridge™
Green FPS™
Green FPS™ e-Series™
Gmax™
GTO™
IntelliMAX™
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MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
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OPTOLOGIC®
OPTOPLANAR®
®
PowerTrench®
PowerXS™
Programmable Active Droop™
QFET®
QS™
Quiet Series™
RapidConfigure™
™
Saving our world, 1mW/W/kW at a time™
SignalWise™
SmartMax™
SMART START™
Solutions for Your Success™
SPM®
STEALTH™
SuperFET®
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
SupreMOS®
SyncFET™
Sync-Lock™
SYSTEM GENERAL®*
TinyBoost®
TinyBuck®
TinyCalc™
TinyLogic®
TINYOPTO™
TinyPower™
TinyPWM™
TinyWire™
TranSiC™
TriFault Detect™
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VoltagePlus™
XS™

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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
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.

ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors.

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.

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