

ON Semiconductor

Is Now

onsemi™

To learn more about onsemi™, please visit our website at
www.onsemi.com

onsemi and **onsemi** and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi** product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner. Other names and brands may be claimed as the property of others.



Is Now Part of



ON Semiconductor®

To learn more about ON Semiconductor, please visit our website at
www.onsemi.com

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

AN-9748

The Smallest Integrated Slew Rate Switch for Peripheral Load Management in Smart Phones and Tablet PCs

Introduction

Smart phones and tablet PCs are popular today and widely used — anywhere and anytime. Those smart devices are adding more powerful functions (such as Wi-Fi, GPS, high-pixel camera, and so on), as well as getting thinner and lighter. One of the challenges in system design is to reduce leakage current from peripherals to extend operating time under limited battery capacitance. To save leakage power, integrated load switches are usually adopted.

This note introduces IntelliMAX™ FPF1203 and FPF1204, ultra-small, slew-rate-controlled load switches. They offer optimized peripheral load management meeting key electrical requirements, such as low on resistance, wide operating input voltage range, small package size, and low inrush current.

Design Challenge

Figure 1 shows general power architecture in a smart phone or tablet PC, focusing on peripherals. There are many peripherals requiring different voltage input, from below 1V for AP (Application Processor) core to 4.2V battery, or even 5V TA (Travel Adapter) for LED driver.

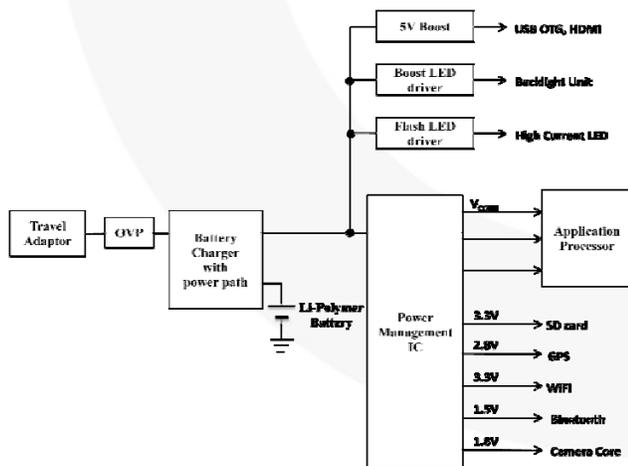


Figure 1. Simplified Power Architecture of Smart Phone and Tablet PC

One case using a load switch to reduce leakage current is an LED backlight application, as shown in Figure 2.

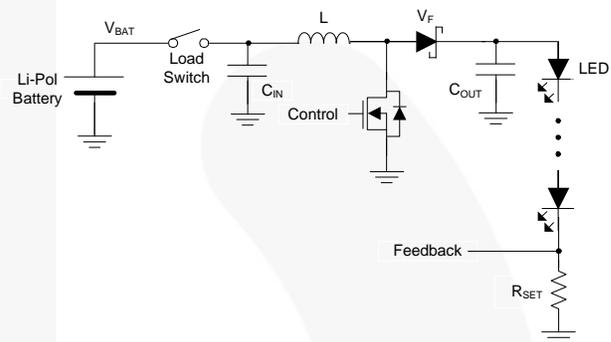


Figure 2. Simplified LED Backlight Drive Application with Load Switch

A simplified-asynchronous-boost-topology-based LED driver power circuit with load switch is shown in Figure 2. A problem often starts when the LED driver is turned off without the load switch. Leakage current flows from the battery to C_{OUT} via Schottky diode and C_{OUT} is being charged and maintained $V_{BAT} - V_F$ during OFF state. The unwanted leakage path can be disconnected when the LED driver is not in use by adding a load switch between the battery and the LED driver input.

In addition, lower inrush current, lower on resistance, smaller size, and simpler design are criteria required for the load switch.

Figure 3 is a functional block diagram of the FPF1203 and FPF1204 IntelliMAX™ ultra-small, slew-rate-controlled load switch. It has 100µs of slew rate control and 45mΩ at 5.5V of on resistance.

FPF1204 has 65Ω output discharge path to turn off the output load quickly. It is also housed in 0.76mm x 0.76mm WLCSP (Wafer-Level Chip-Scale Package) with four bumps, the smallest form factor currently in industry.

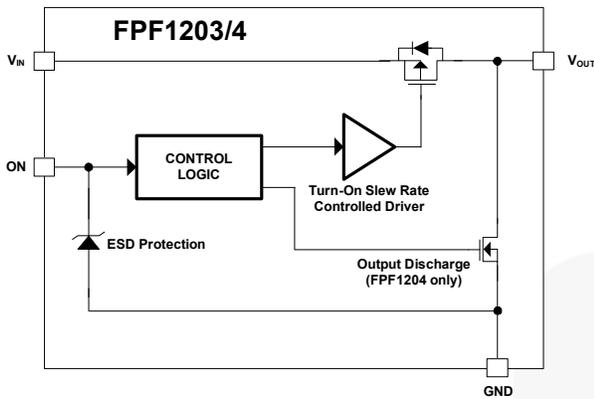


Figure 3. FPF1203/4 Functional Block Diagram

Reliable ON/OFF Operation

One key performance of the load switch is reliable turn-on and turn-off operation. Slew rate control is essential to reduce inrush current when the switch is about to be ON.

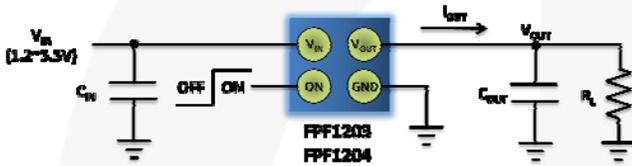


Figure 4. Typical Application

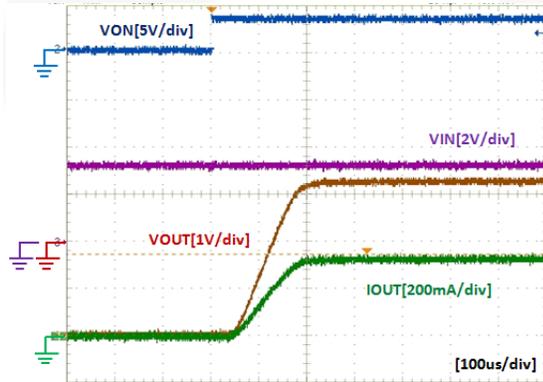


Figure 5. ON Behavior ($V_{IN}=3.3V$, $C_{OUT}=0.1\mu F$, $R_L=10\Omega$)

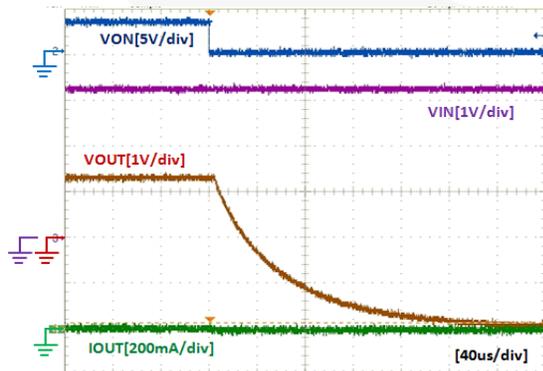


Figure 6. OFF Behavior without Output Discharge (PPF1203, $V_{IN}=3.3V$, $C_{OUT}=0.1\mu F$, $R_L=500\Omega$)

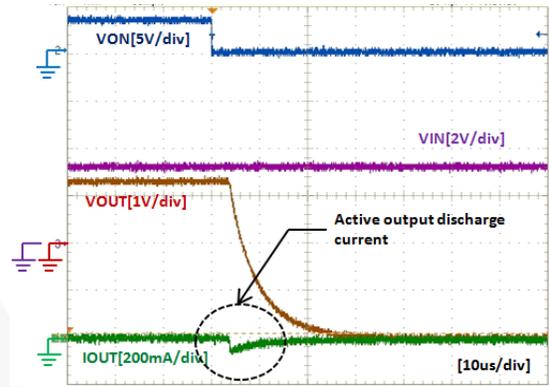


Figure 7. OFF Behavior with Output Discharge (PPF1204, $V_{IN}=3.3V$, $C_{OUT}=0.1\mu F$, $R_L=500\Omega$)

Figure 4 through Figure 7 show actual turn-on and off behaviors with FPF1203 and FPF1204. Figure 4 is a typical application circuit requiring only C_{IN} and C_{OUT} . It makes the circuit design simple.

There is no inrush current nor input voltage drop during turn-on due to the $100\mu s$ slew-rate-control feature shown in Figure 5.

Figure 6 and Figure 7 show the difference between FPF1203 and FPF1204. Falling time of FPF1203 is $115\mu s$, while FPF1204 is $11\mu s$. FPF1204 turns off output load faster by about ten times due to 65Ω of active output discharge path during OFF state. Negative current can be seen with FPF1204 in Figure 7.

Low On Resistance

PPF1203/4 support input voltage from 1.2V to 5.5V. This wide input operating voltage range provides design flexibility for a variety of voltage rails for peripherals.

On resistance is a critical factor during ON state to reduce power loss and input voltage drop.

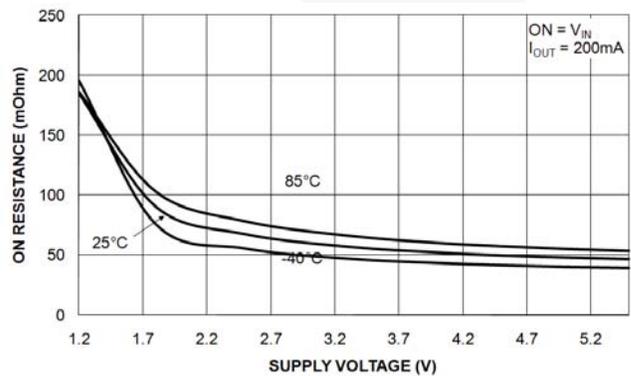


Figure 8. On Resistance vs. V_{IN}

Table 1. R_{ON} at Main V_{IN}

V_{IN}	Typical On Resistance [mΩ]
5.5V	45
3.3V	55
1.8V	90
1.2V	185

Table 1 shows on resistance by V_{IN} . Basically, R_{ON} is highly proportional to die size or package size. FPF1203/4 achieves lower on resistance in a small package size of 0.76mm x 0.76mm with advanced PMOS technology.

Small Form Factor

Load switches in 2mm x 2mm MLP-6L have been widely used to date. In the last two to three years, a 1mm x 1.5mm WLCSP with six bumps has been part of the miniaturized system trend.

Today, the smallest form factor package in the industry is being introduced with FPF1203 and FPF1204. FPF1203/4 is in a 0.76mm x 0.76mm WLCSP with four bumps.

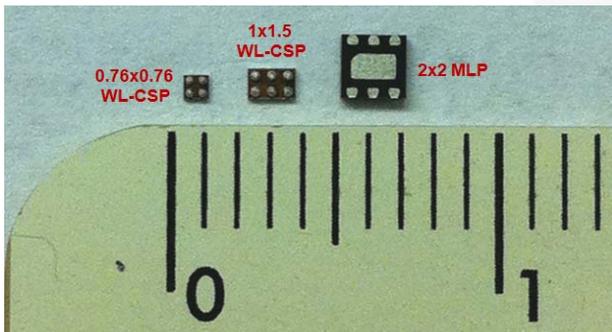


Figure 9. Actual Package Picture

Table 2. Package Size Comparison

Package	0.76x0.76 WLCSP	1.0x1.5 WLCSP	2.0x2.0 MLP
Solution Area [mm ²]	0.580	1.500	4.000
Ratio	0.145	0.375	1.000
	0.387	1.000	

Figure 9 is an actual package photograph. Table 2 shows how small a solution area FPF1203/4 can offer compared to existing package solutions. About 85% of the solution size can be reduced with FPF1203/4 compared with a load switch in a 2x2mm MLP package.

Load Management

FPF1203/4 is optimized as peripheral load management switch in terms of smaller size, low on-resistance, wide operating input voltage, and design simplicity.

An example of peripheral load management with FPF1203/4 is shown in Figure 10.

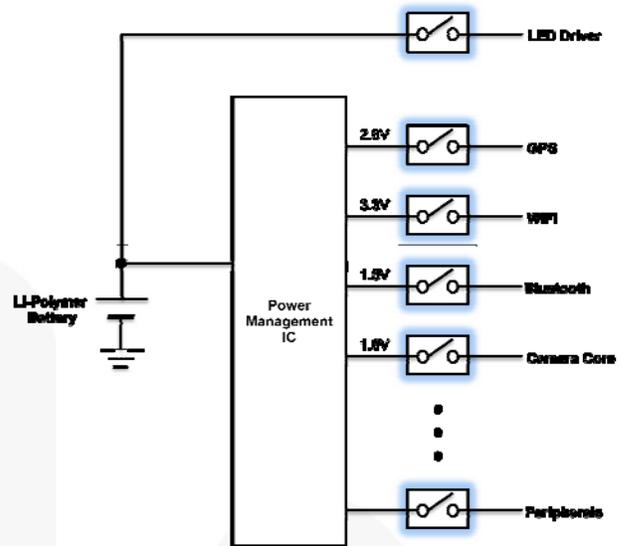


Figure 10. Peripherals with FPF1203/4

Evaluation Board

FPF1203/4 performance can be tested with an evaluation boards. Figure 11 shows an actual board in 30mm x 25mm with the schematic provided in Figure 12.



Figure 11. FPF1203/4 Evaluation Board

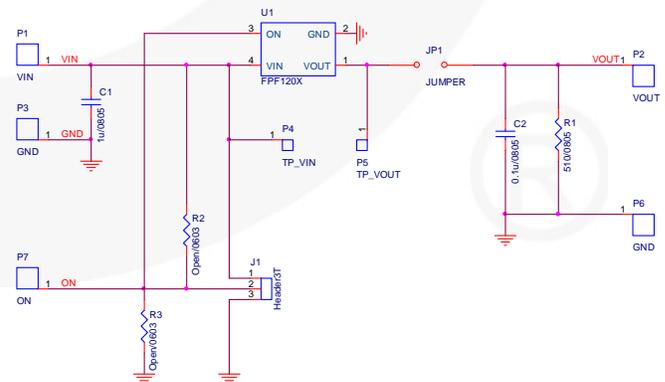


Figure 12. FPF1203/4 Evaluation Board Schematic

Conclusion

IntelliMAX™ FPF1203 and FPF1204 ultra-small, slew rate controlled load switch is optimized for peripheral load management in smart phones and tablet PCs in term of small size, stable ON/OFF operation, wide operating input voltage range, design simplicity, and active output discharge for easy power sequence.

Author

Jeongil Lee, Sr. Applications Engineer with Fairchild Semiconductor Mobile Solutions

Related Datasheets

[FPF1203 / FPF1204 – IntelliMAX™ Ultra-Small, Slew-Rate-Controlled Load Switch](#)

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION.

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, or (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 significant injury to the user.
2. A critical component is 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.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com
Order Literature: <http://www.onsemi.com/orderlit>
For additional information, please contact your local
Sales Representative