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FAIRCHILD SEMICONDUCTOR®

July 2012

FPF3003
IntelliMAX™ Full Functional Input Power Path Management Switch for Dual-Battery Portable System

Features

- 2.3V to 5.5V Input Voltage Operating Range
- Low R_{ON} between Battery and Load
  Maximum 50mΩ at V_{IN} = 4.2V
- Low R_{ON} between Charger and Battery
  Maximum 125mΩ at V_{IN} = 4.2V
- Maximum DC Current for Load Switch: 2.5A
- Maximum DC Current for Charge Switch: 1.5A
- Slew Rate Controlled to 30µs Nominal Rise Time
- Seamless Break-Before-Make Transition
- Quiescent Current: 30µA Typical
- Thermal Shutdown
- Reverse Current Blocking (RCB) between Battery A and Battery B
- RESET Timer Delay: 7s Typical
- ESD Protected:
  - Human Body Model: >2.5kV
  - Charged Device Model: >1.5kV
  - IEC 61000-4-2 Air Discharge: >15kV
  - IEC 61000-4-2 Contact Discharge: >8kV
- 1.6mm X 1.6mm, 16-Bump, 0.4mm Pitch, WLCSP

Applications

- Dual-Battery Cell phone
- Dual-Battery Portable Equipment

Description

The FPF3003 is a single-chip solution for dual-battery power-path switching, including integrated P-channel switches and analog control features. The input voltage range operates from 2.3V to 5.5V. The device selects one of two batteries to provide power to the system, enabling one battery to be charged by the external battery charger.

The FPF3003 has battery voltage monitoring to determine if the battery is under voltage. Special driver and digital circuitry allows the device to switch quickly between battery A and battery B, which allows hot swapping of battery packs. Maximum current from battery to load per channel is limited to a constant 2.5A and internal thermal shutdown circuits protect the part during fault conditions.

The FPF3003 is available in a 1.6mm x 1.6mm, 16-bump, Wafer-Level Chip-Scale Package (WLCSP).

Ordering Information

Part Number	Top Mark	(Charger-Battery) Max. R_{ON} at 4.2V_{IN}	(Battery-Load) Max. R_{ON} at 4.2V_{IN}	Typical t_R	Package
FPF3003UCX	QW	125mΩ	50mΩ	30µs	16-Bump, 0.4mm Pitch, 1.6mm x 1.6mm WLCSP

Typical Application Diagram

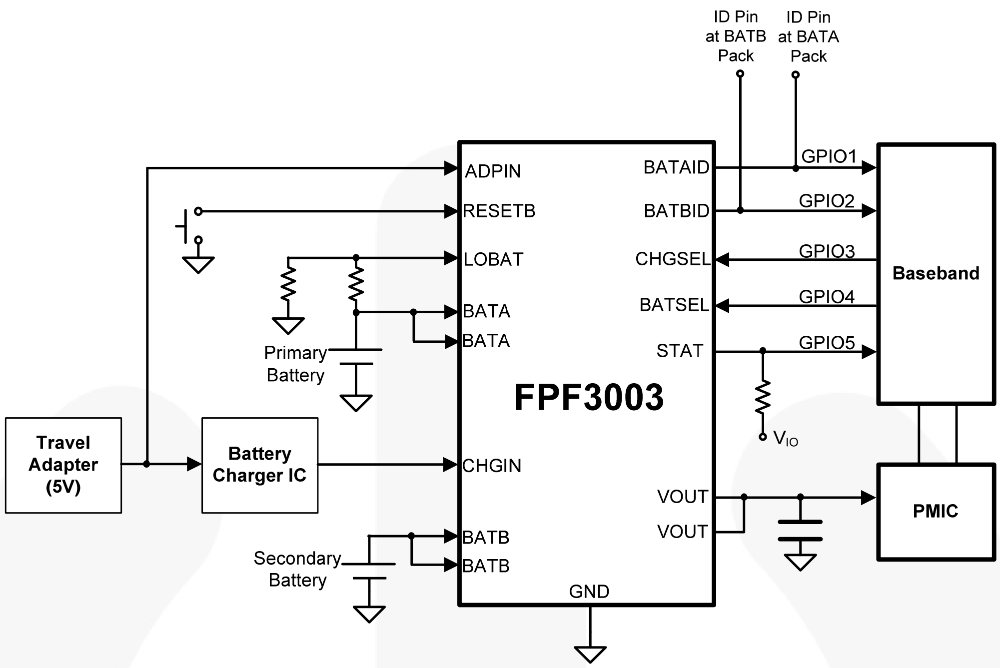

Figure 1. Typical Application

Functional Block Diagram

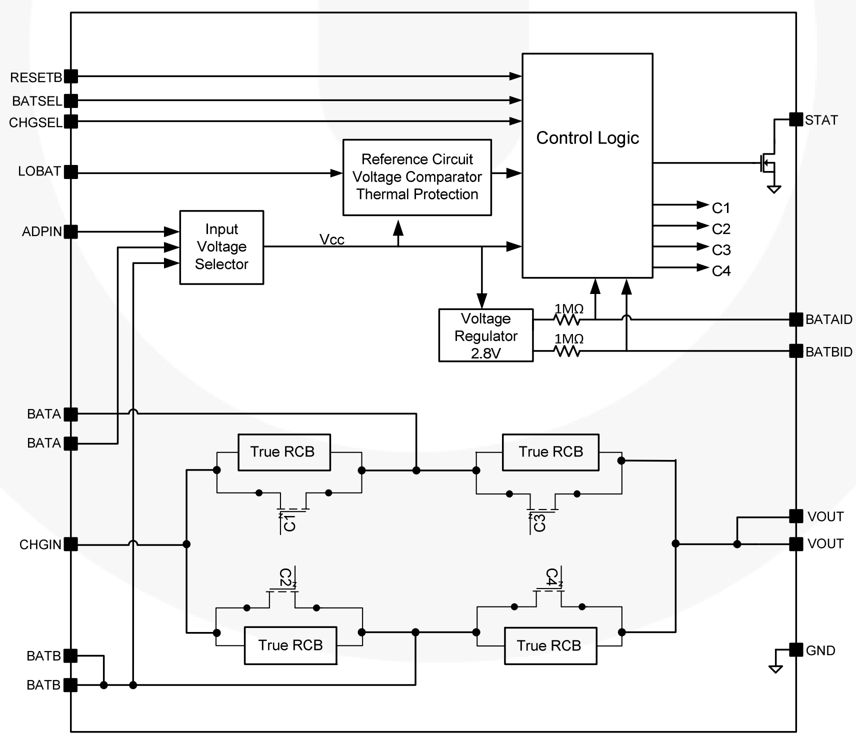

Figure 2. Functional Block Diagram

Pin Configuration

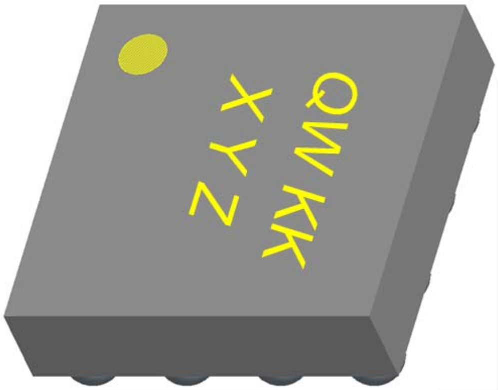

Figure 3. Pin Assignments (Top View)

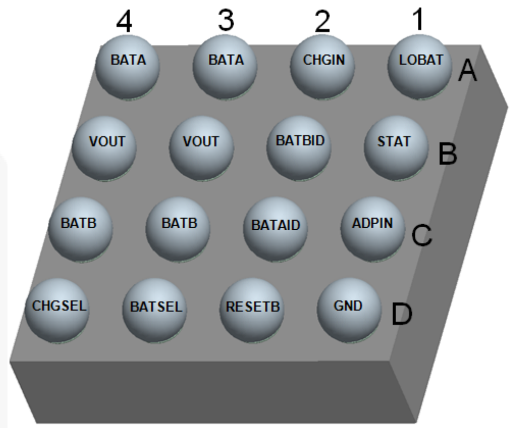

Figure 4. Pin Assignments (Bottom View)

Pin Description

Pin #	Name	Description
A1	LOBAT	**Low Battery A Voltage Input**. Connect to the resistive divider to set the trip level for chip-on moment. If LOBAT is less than 0.8V, V_{OUT} is connected to BATB.
A2	CHGIN	**Charging Input**. Charging path input.
A3, A4	BATA	**Supply Input**. Battery A voltage input.
B1	STAT	**Battery Selector Status**. Open-drain output. HIGH (Hi-Z) means battery A connects to VOUT. LOW means battery B connects to VOUT.
B2	BATBID	**Battery B Indicator**. Connect this pin with the ID pin at the battery pack of BATB. HIGH means battery B absent; LOW means battery B present.
B3,B4	VOUT	**Switch Output**. Connect to system load.
C1	ADPIN	**Adapter Input**. 5V input for battery charger.
C2	BATAID	**Battery A Indicator**. Connect this pin with the ID pin at the battery pack of BATA. HIGH means battery A absent; LOW means battery A present.
C3,C4	BATB	**Supply Input**. Battery B voltage input.
D1	GND	**Ground**
D2	RESETB	**Reset Input**. Active LOW. Both system path switches are disconnected from system load.
D3	BATSEL	**Battery Selection Input**. HIGH means to switch battery B to VOUT; LOW means to switch battery A to VOUT.
D4	CHGSEL	**Charge Selection Input**. HIGH means to charge battery B: LOW means to charge battery A.

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.

<table>
<tr><th>Symbol</th><th colspan="2">Parameters</th><th>Min.</th><th>Max.</th><th>Unit</th></tr>
<tr><td>V_{IN}</td><td colspan="2">All Pins To GND</td><td>-0.3</td><td>6.0</td><td>V</td></tr>
<tr><td rowspan="2">I_{SW}</td><td colspan="2">Maximum Continuous Switch Current to Load</td><td></td><td>2.5</td><td>A</td></tr>
<tr><td colspan="2">Maximum Continuous Switch Current to Charger</td><td></td><td>1.5</td><td>A</td></tr>
<tr><td>P_D</td><td colspan="2">Power Dissipation at T_A = 25°C</td><td></td><td>1.7</td><td>W</td></tr>
<tr><td>T_{STG}</td><td colspan="2">Operating and Storage Junction Temperature</td><td>-65</td><td>150</td><td>°C</td></tr>
<tr><td>Θ_{JA}</td><td colspan="2">Thermal Resistance, Junction to Ambient
(1in. Square Pad of 2oz. Copper)</td><td></td><td>72(1)</td><td>°C/W</td></tr>
<tr><td rowspan="4">ESD</td><td rowspan="4">Electrostatic Discharge Capability</td><td>Human Body Model, JESD22-A114</td><td>2.5</td><td></td><td rowspan="4">kV</td></tr>
<tr><td>Charged Device Model, JESD22-C101</td><td>1.5</td><td></td></tr>
<tr><td>Air Discharge (BATA, BATB, ADPIN to GND), IEC61000-4-2 System Level</td><td>15.0</td><td></td></tr>
<tr><td>Contact Discharge (BATA, BATB, ADPIN to GND), IEC61000-4-2 System Level</td><td>8.0</td><td></td></tr>
</table>

Note:
1. Measured using 2S2P JEDEC std. PCB.

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	Parameters	Min.	Max.	Unit
V_{IN}	ADPIN	4.6	5.5	V
	BATA, BATB	2.3	5.5	V
T_A	Ambient Operating Temperature	-40	85	°C

Electrical Characteristics

ADPIN=4.6 to 5.5V, V_{BATA}=V_{BATB}=2.3 to 5.5V, T_A=-40 to 85°C unless otherwise noted. Typical values are at ADPIN=5V, CHGIN=V_{BATA}=V_{BATB}=4.2V, RESETB=HIGH, and T_A=25°C.

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
Static Characteristics						
V_{ADPIN}	Adapter Input Voltage		4.6		5.5	V
V_{ADPIN_TH}	ADPIN Threshold	ADPIN Rising		4.5		V
		ADPIN Falling		4.2		
V_{BATA}, V_{BATB}	Battery Input Voltage		2.3		5.5	V
I_Q	Quiescent Current	I_{OUT}=0mA		30		µA
R_{ON}	On Resistance to Load Switch, BATA or BATB to VOUT	V_{BATA}=V_{BATB}=5.5V, I_{OUT}=300mA,T_A=25°C(2)		34		mΩ
		V_{BATA}=V_{BATB}=4.2V, I_{OUT}=300mA, T_A=25°C		38	50	
		V_{BATA}=V_{BATB}=3.7V, I_{OUT}=300mA,T_A=25°C		43	55	
		V_{BATA}=V_{BATB}=2.3V, I_{OUT}=300mA, T_A=25°C(2)		62		
	On Resistance to Charger Switch, CHGIN to BATA	V_{BATA}=V_{BATB}=5.5V, I_{CHG}=200mA, T_A=25°C(2)		66		
		V_{BATA}=V_{BATB}=4.2V, I_{CHG}=200mA, T_A=25°C		73	90	
		V_{BATA}=V_{BATB}=3.7V, I_{CHG}=200mA, T_A=25°C		80	95	
		V_{BATA}=V_{BATB}=2.3V, I_{CHG}=200mA, T_A=25°C(2)		101		
	On Resistance to Charger Switch, CHGIN to BATB	V_{BATA}=V_{BATB}=5.5V, I_{CHG}=200mA, T_A=25°C(2)		92		
		V_{BATA}=V_{BATB}=4.2V, I_{CHG}=200mA, T_A=25°C		99	125	
		V_{BATA}=V_{BATB}=3.7V, I_{CHG}=200mA, T_A=25°C		105	130	
		V_{BATA}=V_{BATB}=2.3V, I_{CHG}=200mA, T_A=25°C(2)		128		
V_{IH}	Input Logic HIGH Voltage	V_{BATA}=V_{BATB}=2.3V – 5.5V, CHGSEL, BATSEL	0.90			V
		V_{BATA}=V_{BATB}=2.3V – 5.5V, RESETB	1.15			
		V_{BATA}=V_{BATB}=2.3V – 5.5V, BATAID, BATBID	1.70			
V_{IL}	Input Logic LOW Voltage	V_{BATA}=V_{BATB}=2.3V – 5.5V, CHGSEL, BATSEL			0.6	V
		V_{BATA}=V_{BATB}=2.3V – 5.5V, RESETB			0.8	
		V_{BATA}=V_{BATB}=2.3V – 5.5V, BATAID, BATBID			0.9	
V_{STAT_LO}	STAT Logic LOW Voltage	I_{SINK}=1mA			0.3	V
V_{LOBAT}	LOBAT Threshold	V_{BATA}=V_{BATB}=2.3V – 5.5V		0.8		V
t_{LOBAT}	LOBAT De-Glitch Time	V_{BATA}=V_{BATB}=2.3V – 5.5V		1.3		ms
T_{SD}	Thermal Shutdown	Shutdown Threshold		150		°C
		Return from Shutdown		140		
		Hysteresis		10		
V_{DROOP_OUT}	Output Voltage Droop while Battery Switching	V_{BATA}=4.2V, V_{BATB}=4.2V, Switching from V_{BATA} → V_{BATB}, R_L=100Ω, C_{OUT}=10µF			100	mV

Continued on the following page…

Electrical Characteristics

ADPIN=4.6 to 5.5V, V_{BATA}=V_{BATB}=2.3 to 5.5V, T_A=-40 to 85°C unless otherwise noted. Typical values are at ADPIN=5V, CHGIN=V_{BATA}=V_{BATB}=4.2V, RESETB=HIGH, and T_A=25°C.

Symbol	Parameters	Condition	Min.	Typ.	Max.	Unit
Reverse Current Blocking between V_{BATA} and V_{BATB}						
V_{T_RCB}	RCB Protection Trip Point	V_{OUT} – V_{BATA} or V_{BATB}		20		mV
V_{R_RCB}	RCB Protection Release Trip Point	V_{BATA} or V_{BATB} -V_{OUT}		30		mV
	Hysteresis			50		mV
Dynamic Characteristics: *See Definitions Below*						
t_R	V_{OUT} Rise Time(2,3,4)	V_{BATA}=V_{BATB}=4.2V, R_L=100Ω, T_A=25°C, C_L=10µF, BATAID=HIGH to LOW, BATBID=HIGH		30		µs
t_{DON}	Turn-On Delay(2,3,4)			5		µs
t_{ON}	Turn-On Time(2,3,4)			35		
t_F	V_{OUT} Fall Time(2,3,5)	V_{BATA}=V_{BATB}=4.2V, R_L=100Ω, T_A=25°C, C_L=10µf, BATAID=LOW to HIGH, BATBID=HIGH		2.5		ms
t_{DOFF}	Turn-Off Delay(2,3,5)			0.1		ms
t_{OFF}	Turn-Off Time(2,3,5)			2.6		ms
t_{DSEL}	Selection Delay(2,3)	V_{BATA}=V_{BATB}=4.2V, R_L=100Ω, T_A=25°C, C_L=10µF, CHGSEL or BATSEL=LOW to HIGH		1		ms
t_{DRST}	RESET Timer Delay(2,3)	V_{BATA}=V_{BATB}=4.2V, R_L=100Ω,T_A=25°C, C_L=10µF, RESETB=Floating to LOW		7		s

Notes:

2. This parameter is guaranteed by design and characterization; not production tested.
3. t_{DON}/t_{DOFF}/t_R/t_F is defined in Figure 5.
4. t_{ON}=t_R + t_{DON}.
5. t_{OFF}=t_F + t_{DOFF}.

Timing Diagram

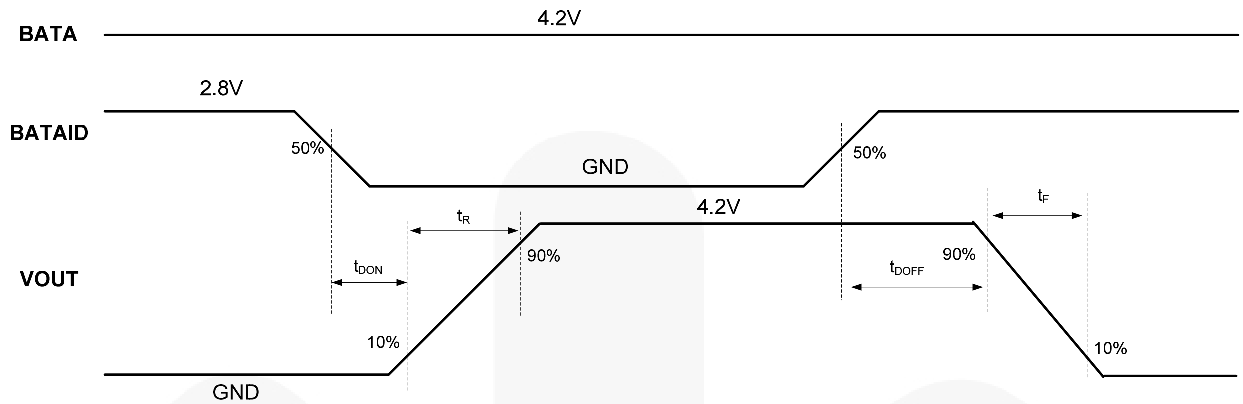

Figure 5. ON/OFF Behavior (V_{BATA}=4.2V)

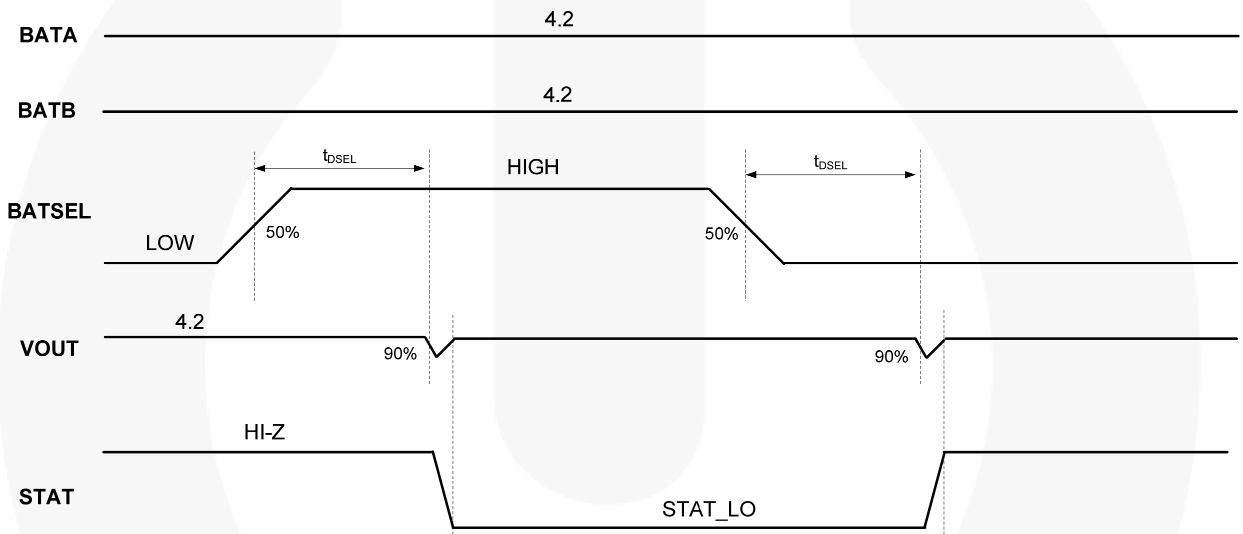

Figure 6. Battery-to-System Path Selection Behavior by BATSEL (V_{BATA}=V_{BATB}=4.2V)

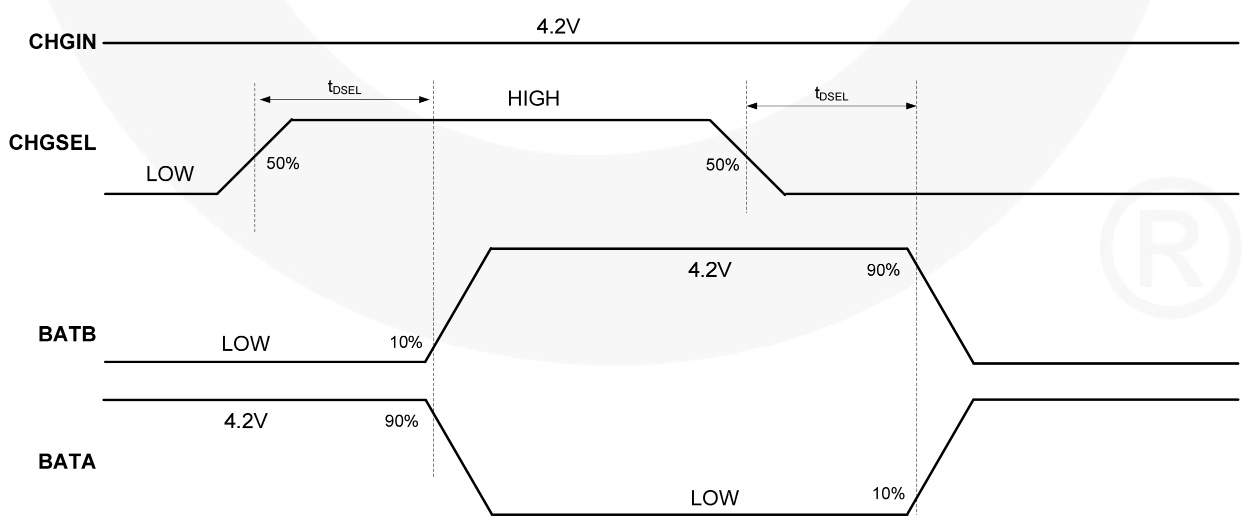

Figure 7. Charging Path Selection Behavior by CHGSEL
(ADPIN=5V, CHGIN=4.2V, V_{BATA}=V_{BATB}=Floating with 1µF)

Timing Diagrams (Continued)

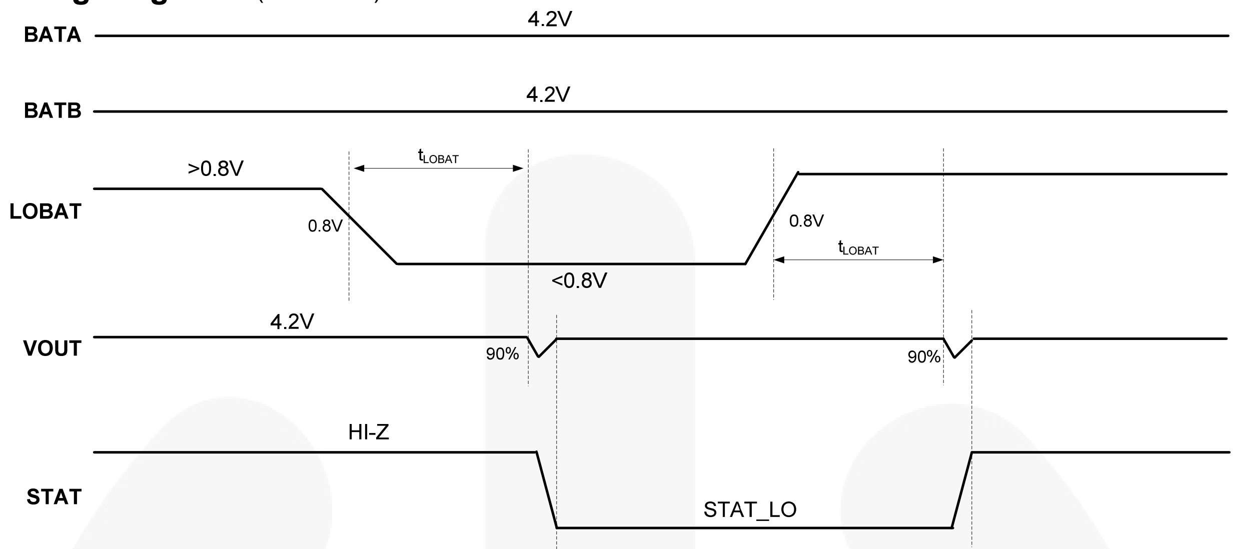

Figure 8. Transition from V_{BATA} to V_{BATB} Behavior by LOBAT (V_{BATA}=V_{BATB}=4.2V)

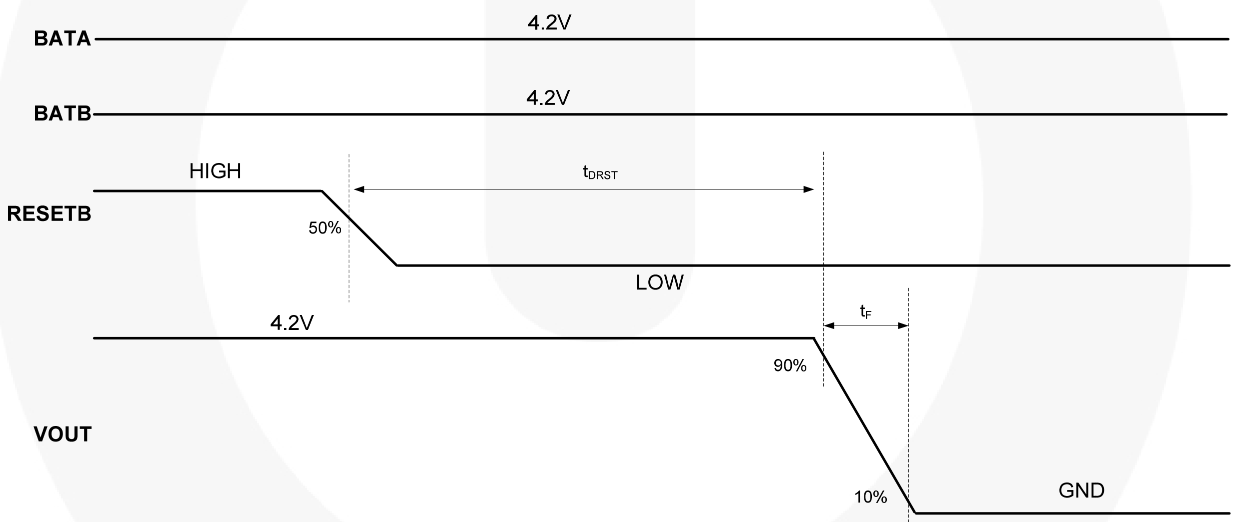

Figure 9. System Reset Behavior by RESETB (V_{BATA}=V_{BATB}=4.2V)

Typical Characteristics

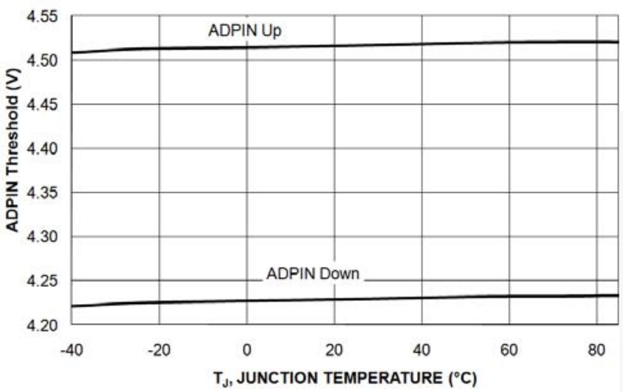

Figure 10. ADPIN vs. Temperature

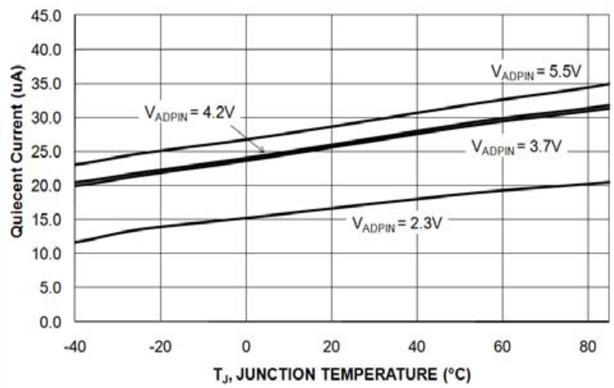

Figure 11. Supply Current vs. Temperature

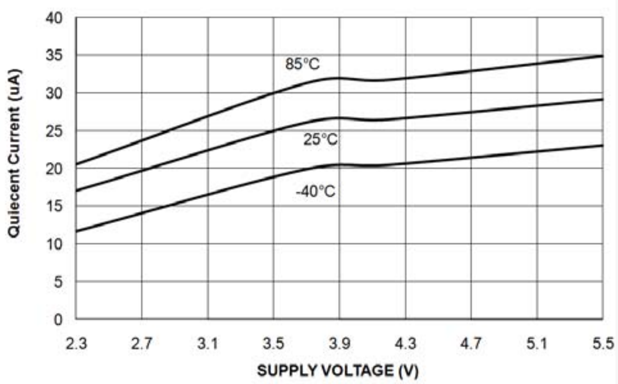

Figure 12. Supply Current vs. Supply Voltage

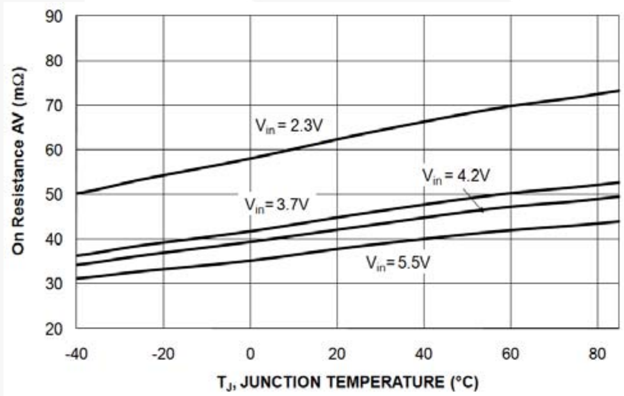

Figure 13. R_{ON} (V_{BATA} or V_{BATB} to V_{OUT}) vs. Temperature

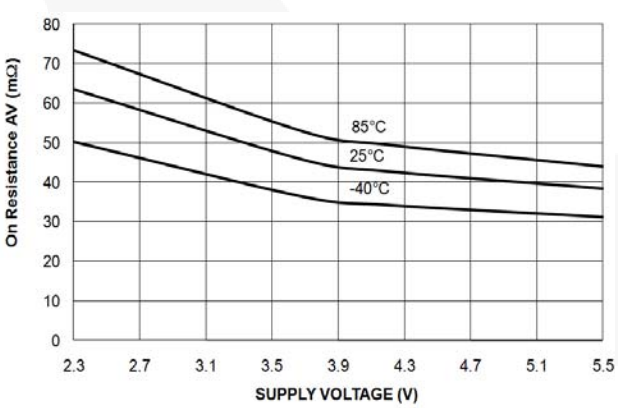

Figure 14. R_{ON} (V_{BATA} or V_{BATB} to V_{OUT}) vs. Supply Voltage

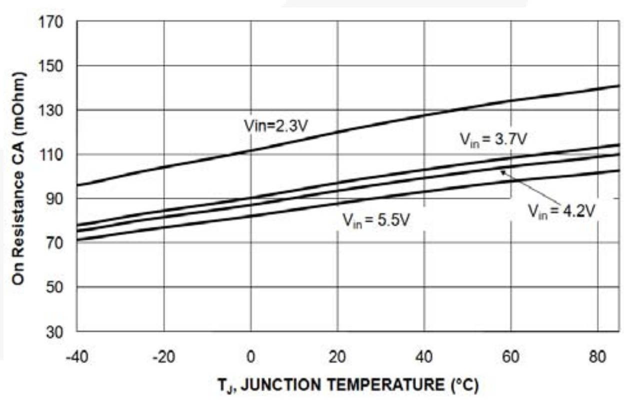

Figure 15. R_{ON} (CHGIN to V_{BATA}) vs. Temperature

Typical Characteristics

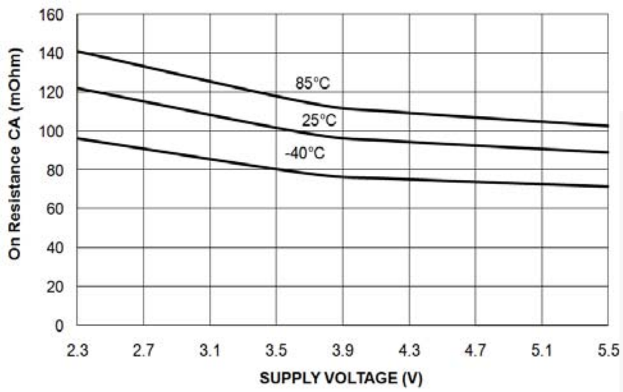

Figure 16. R_{ON} (CHGIN to V_{BATA}) vs. Supply Voltage

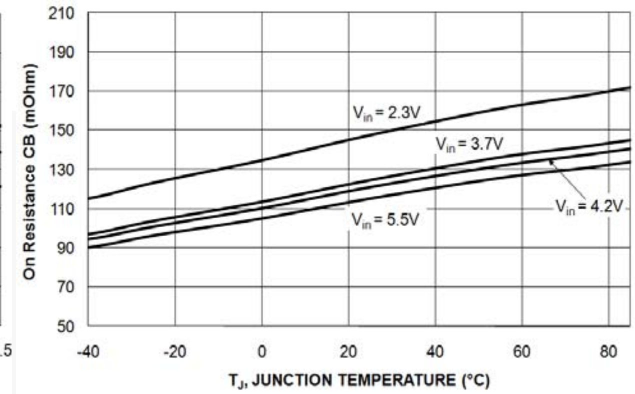

Figure 17. R_{ON} (CHGIN to V_{BATB}) vs. Temperature

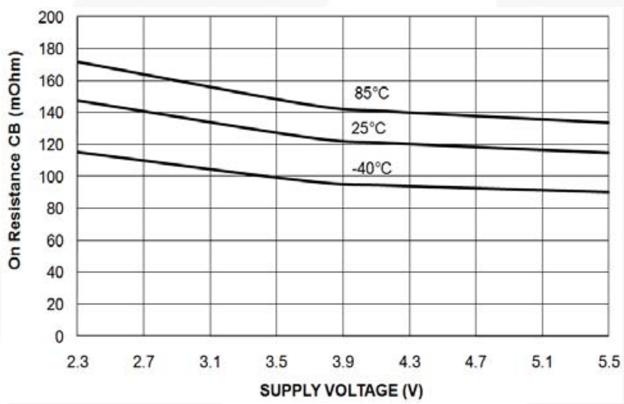

Figure 18. R_{ON} (CHGIN to V_{BATB}) vs. Supply Voltage

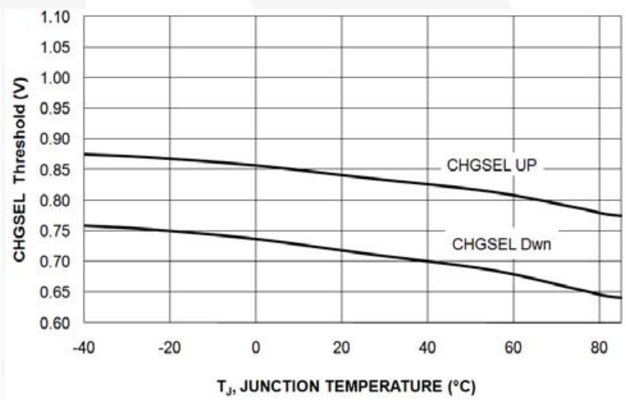

Figure 19. CHGSEL vs. Temperature

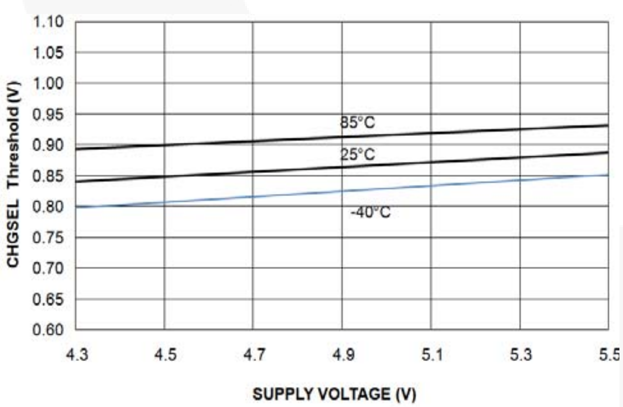

Figure 20. CHGSEL vs. ADPIN Voltage

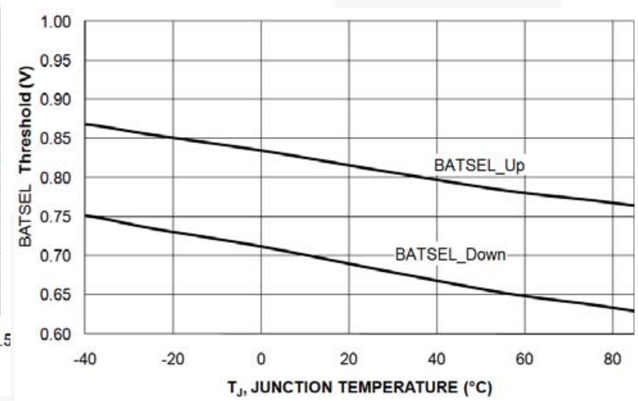

Figure 21. BATSEL vs. Temperature

Typical Characteristics

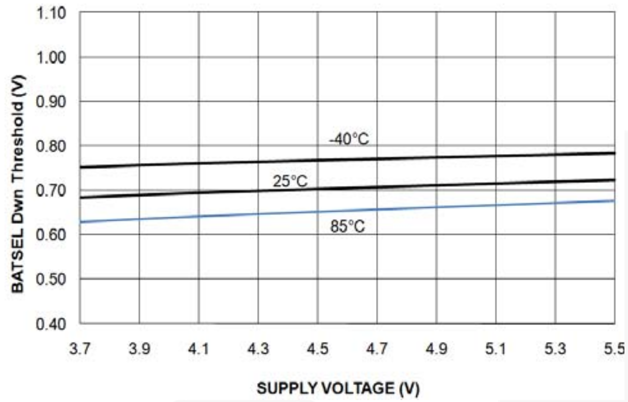

Figure 22. BATSEL vs. Supply Voltage

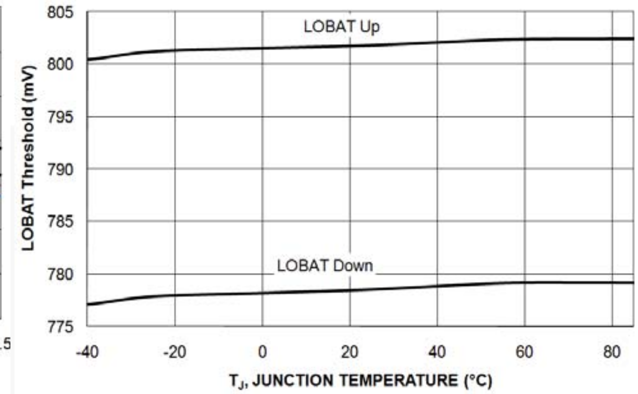

Figure 23. LOBAT vs. Temperature

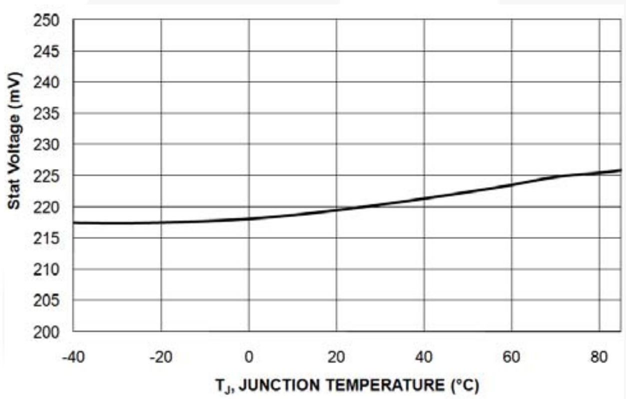

Figure 24. STAT LOW vs. Temperature

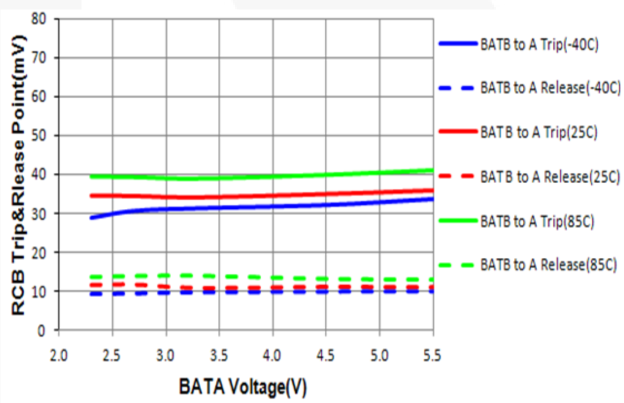

Figure 25. RCB (V_{BATA} and V_{OUT}) vs. Temperature

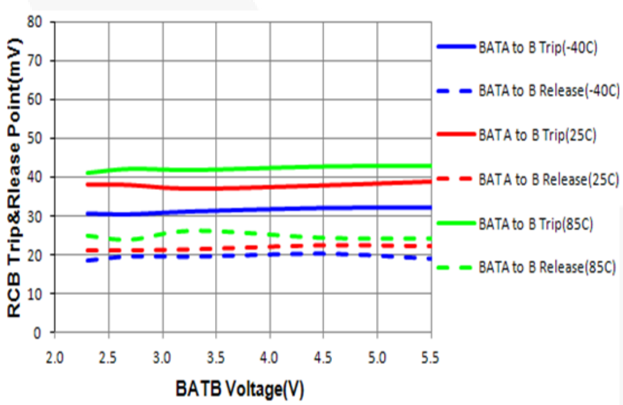

Figure 26. RCB (V_{BATB} and V_{OUT}) vs. Temperature

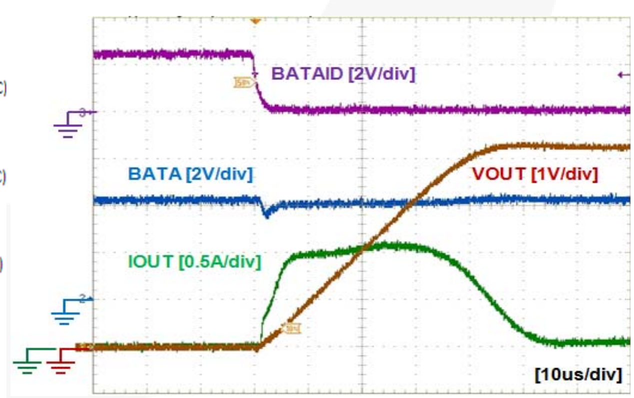

Figure 27. Turn-On Response (V_{BATA}=4.2V, C_{OUT}=10µF, R_L=100Ω)

Typical Characteristics

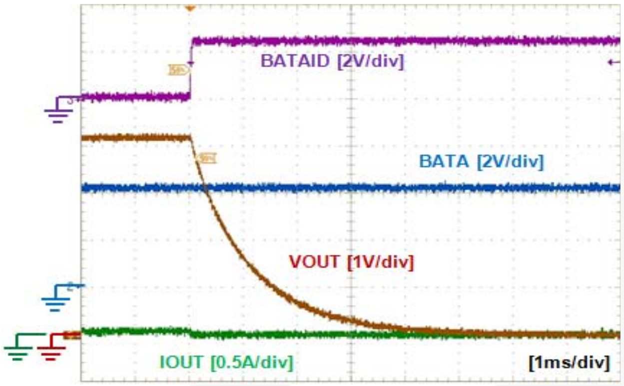

Figure 28. Turn-Off Response (V_{BATA}=4.2V, C_{OUT}=10µF, R_L=100Ω)

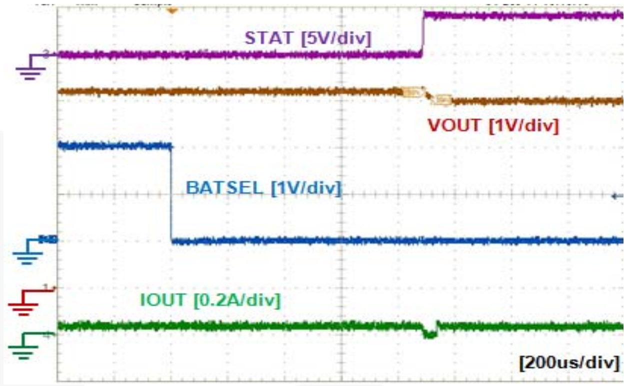

Figure 29. Battery Selection by BATSEL = HIGH → LOW (V_{BATA}=4V, VB_{ATB}=4.2V, C_{OUT}=100µF, R_L=100Ω)

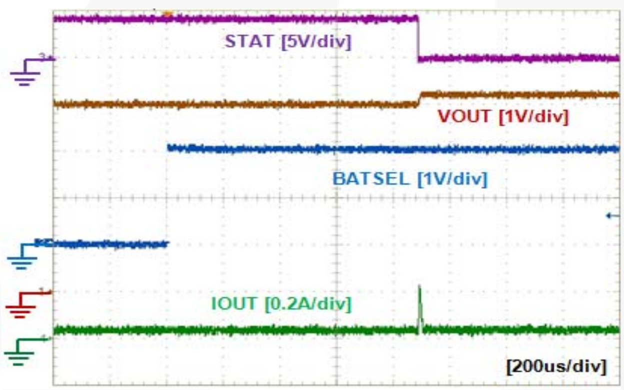

Figure 30. Battery Selection by BATSEL = LOW → HIGH (V_{BATA}=4V, V_{BATB}=4.2V, C_{OUT}=10µF, R_L=100Ω)

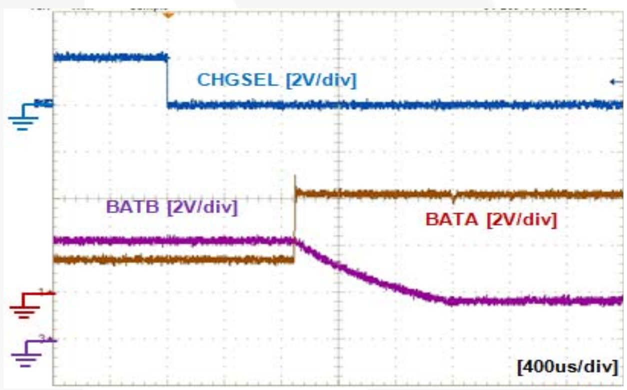

Figure 31. Charge Path Selection by CHGSEL = HIGH → LOW (V_{CHGIN}=4V, V_{BATA}=V_{BATB}=Floating with 1µF)

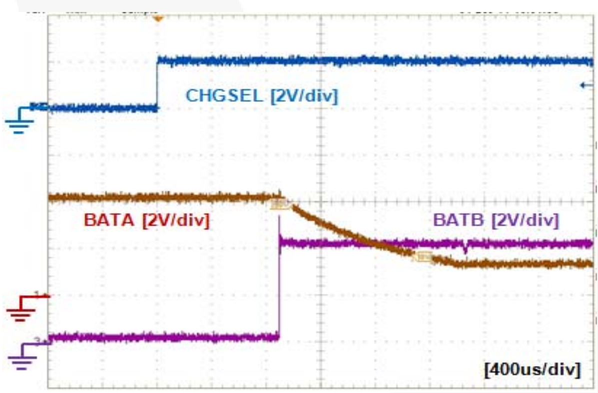

Figure 32. Charge Path Selection by CHGSEL = HIGH → LOW (V_{CHGIN}=4V, BATA=BATB=Floating with 1µF)

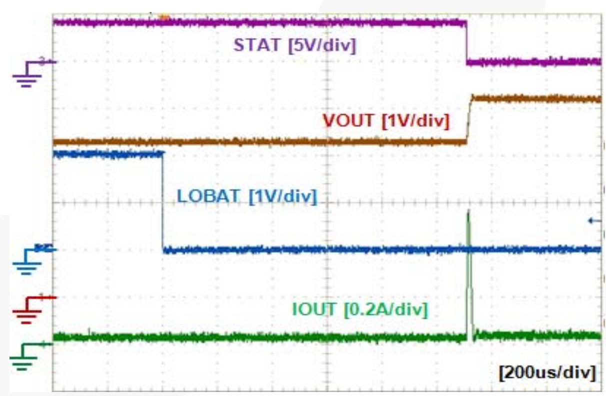

Figure 33. Battery Selection by LOBAT=HIGH → LOW (V_{BATA}=3.8V, V_{BATB}=4.2V, C_{OUT}=100µF, R_L=100Ω)

Typical Characteristics

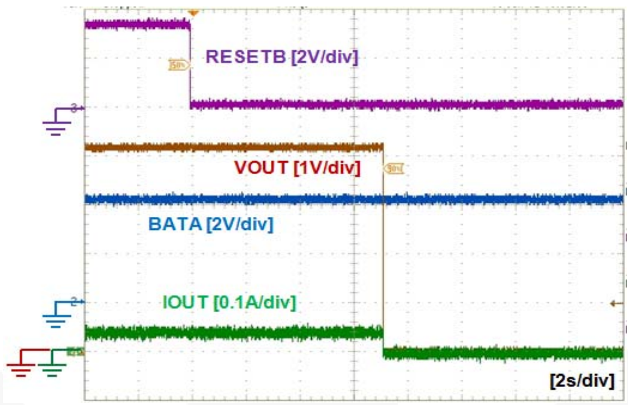

Figure 34. System Reset by RESETB: HIGH → LOW (V_{BATA}=V_{BATB}=4.2V, C_{OUT}=100µF, R_L=100Ω)

Operation and Application Information

The FPF3003 is a low-R_{ON}, P-channel-based, input-source-selection power management switch for dual-battery systems. The FPF3003 input operating range is from 2.3V to 5.5V on BATA and BATB, while ADPIN has a range of 4.6V to 5.5V.

The FPF3003 controls the charging path from the charger to the battery with up to 1.5A and the discharging path from the battery to system load with up to 2.5A. The system or PMIC selects one of two batteries to provide power and enables one of the batteries to be charged by the external battery charger.

The FPF3003 has 30µs slew-rate control to reduce inrush current when engaged and thermal shutdown protection for reliable system operation.

The internal circuit is powered from the highest voltage source among BATA, BATB, and ADPIN.

Battery Presence Detection

The FPF3003 monitors whether or not a battery is present via the BATAID and BATBID pins. If any of these pins are LOW; FPF3003 recognizes the battery is present. Each pin is connected with an internal LDO output, so no pull-up resistor is required.

Output Capacitor

During battery source transition, voltage droop depends on output capacitance and load current condition. Advanced break-before-make operation minimizes the droop with minimum capacitance. At least 10µF is a good starting value in design.

Primary Battery Under-Voltage Set

FPF3003 monitors the primary battery of BATA for under-voltage condition. Once under-voltage condition is confirmed, the system power source changes from BATA to valid BATB automatically.

The under-voltage threshold level can be programmed with 0.8V of LOBAT and R divider (R1 and R2) as:

$$\frac{R1}{R2} = \frac{BATA\_LO}{0.8} - 1 \quad (1)$$

where BATA_LO = Low BATA threshold to set.

If 3.4V of BATA is desired, R1/R2=3.25. If R2 is chosen 1MΩ, R1 is 3.25MΩ. Higher R2 is recommended to reduce leakage current from BATA.

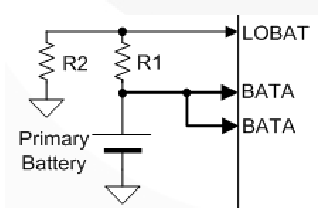

Figure 35. BATA Under-Voltage Level Setting

LOBAT has a 1.3ms of deglitch time to ensure BATA is in true under-voltage rather than transient battery voltage drop during GSM transmission operation.

Battery Selection

The load path can be controlled by the BATSEL pin. When BATSEL is LOW, the system is powered from BATA. When BATSEL is HIGH, BATB powers the system.

Figure 36 is state diagram showing how the power path from battery to system is determined.

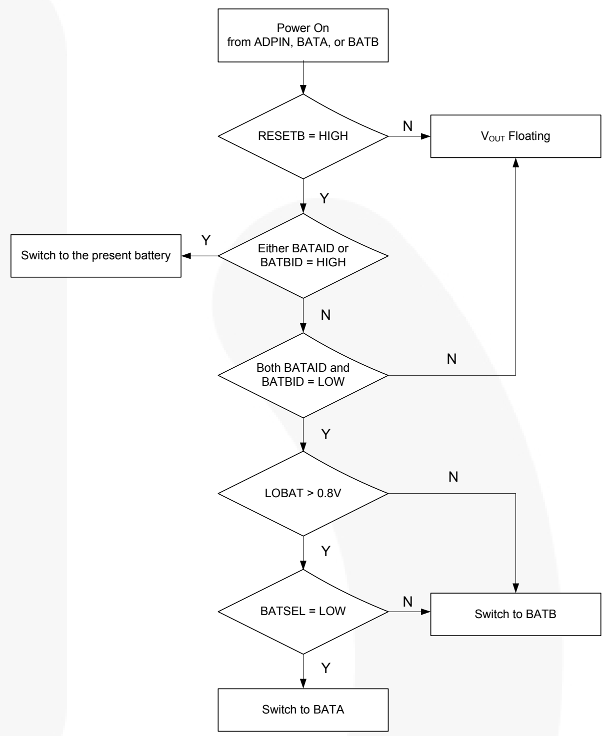

Figure 36. Power Path from Battery to System

The open-drain STAT pin is used to determine which battery powers the system. STAT becomes LOW if BATB is connected to the system. STAT is HIGH (HI-Z) if BATA is connected.

Battery Charging Path Selection

The charging path can be controlled by the CHGSEL pin. When CHGSEL is LOW, BATA can be charged from the charger. When CHGSEL is HIGH, BATB can be charged from the charger.

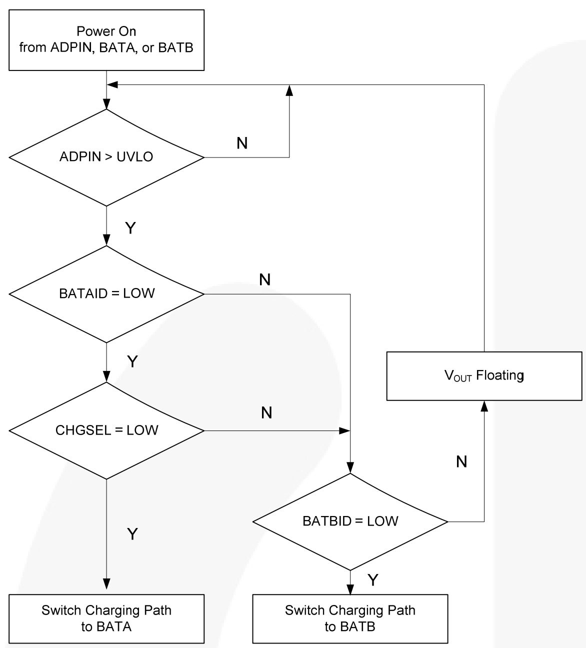

Figure 37. Battery Charging Path

System RESET

The RESETB pin allows the system to be turned off without detaching the battery pack. It has typical 7s delay to avoid transient abnormal signal.

Board Layout

For best performance, all power traces (BATA, BATB, CHGIN, ADPIN, and VOUT) should be as short as possible to minimize the parasitic electrical effects and the case-to-ambient thermal impedance. The output capacitor should be placed close to the device to minimize parasitic trace inductance.

Packaging Information

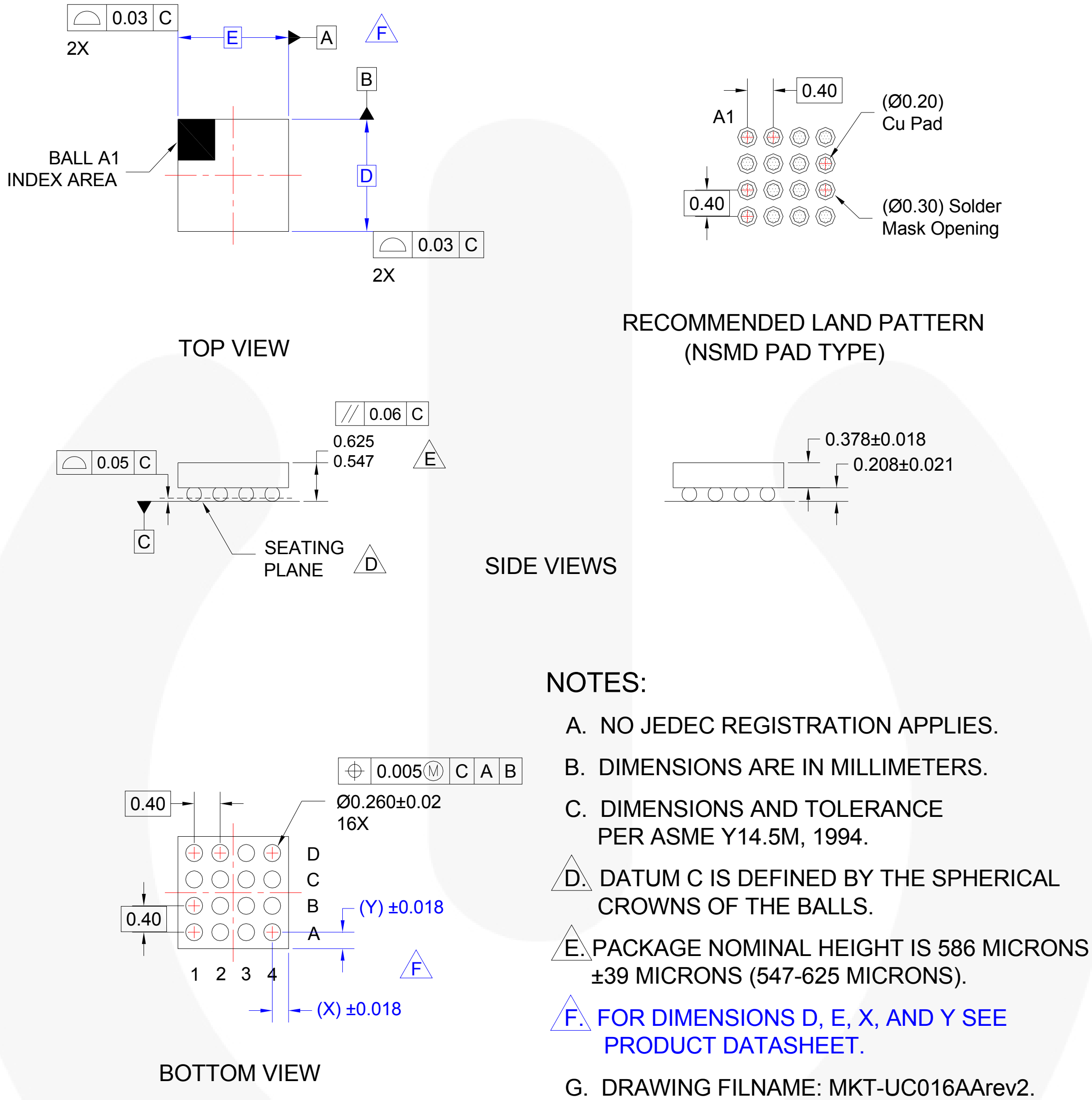

Figure 38. 1.6mmx1.6mm WLCSP, 16-Bumps 0.4mm Pitch

Product-Specific Dimensions

Product	D	E	X	Y
FPF3003UCX	1560μm ±30μm	1560μm ±30μm	180μm	180μm

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