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FPF34891 / FPF34892 SIDO Over-Voltage Protection Load Switch

Features

- Single Input Dual Output (SIDO) Switch
 - V_{BUS} to V_{OUT} Path
 - V_{BUS} to BAT Path
- Surge Protection under IEC 61000-4-5
 - V_{BUS} : ± 100 V
- Input Voltage Range
 - V_{BUS} : 2.7 V ~ 13.5 V
- Max. Continuous Current Capability
 - V_{OUT} Path: 3.5 A
 - BAT Path: 6 A
- Ultra Low On-Resistance
 - V_{OUT} Path: Typ. 28 m Ω
 - BAT Path: Typ. 33 m Ω
- Selectable OVLO for V_{OUT} Path
- Programmable OVLO for V_{BAT}
- Over-Voltage Protection (OVP)
 - V_{OUT} Path: 13.9 V \pm 400 mV (FPF34891)
 - V_{OUT} Path: 10.4 V \pm 300 mV (FPF34892)
 - V_{OUT} Path: 5.8 V \pm 200 mV (OVSEL = GND)
 - BAT Path: 5.8 V \pm 200 mV
- Active LOW Control for V_{BUS} to V_{OUT} Path
- Active HIGH Control for V_{BUS} to BAT Path
- CMOS Output PowerGOOD for V_{BUS} to BAT Path
- RCB for V_{BUS} to BAT Path
- Over-Temperature Protection (OTP)

Description

The FPF3489x features a Single Input Dual Output (SIDO) power switch, which offers surge protection and Over-Voltage Protection (OVP), to protect downstream components and enhancing overall system robustness.

Channel one (V_{BUS} to V_{OUT}) is an active-low, 28 V/3.5 A rated, power MOSFET switch with an internal clamp supporting ± 100 V surge protection, fixed OVP at 5.8V when OVSEL is tied to GND or 13.9V (FPF34891) / 10.4V (FPF34892) when OVSEL is floating.

Channel two (V_{BUS} to BAT) is an active-high, 5 V/6 A rated, power MOSFET, fixed OVP at V_{BUS} is 5.8 V (± 200 mV) and Reverse Current Blocking (RCB) during its OFF State. OVLO at BAT can be programmed by external resistors. The Over-Voltage status will be latched and FLAG will signal the fault by pulling low. To re-start this channel from OVLO, EN2 need to be toggled from LOW to HIGH.

The FPF3489x is available in a 28-bump, 1.67 mm x 2.96 mm Wafer-Level Chip-Scale Package (WL-CSP) with 0.4 mm pitch.

Applications

- Mobile Handsets and Tablets
- Wearable Devices

Ordering Information

| Part Number | Operating Temperature Range | Top Mark | Package | Packing Method |
|-------------|-----------------------------|----------|-----------------------------|----------------|
| FPF34891UCX | -40°C to +85°C | VF | 28-Ball, 0.4 mm Pitch WLCSP | Tape & Reel |
| FPF34892UCX | | VG | | |

Application Diagram

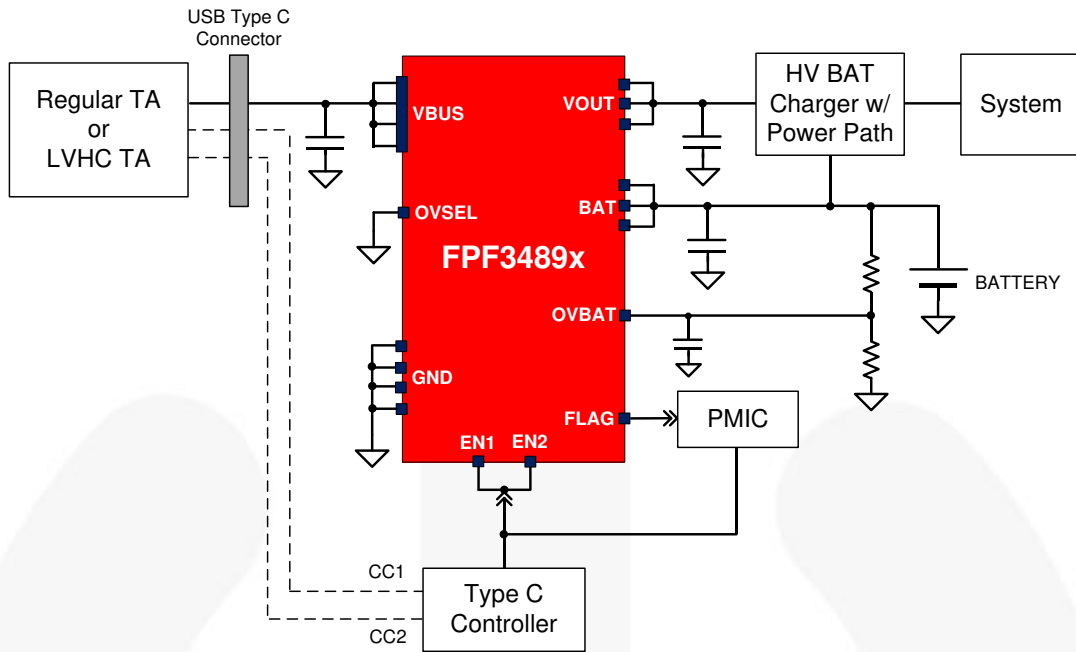


Figure 1. Typical Application

Block Diagram

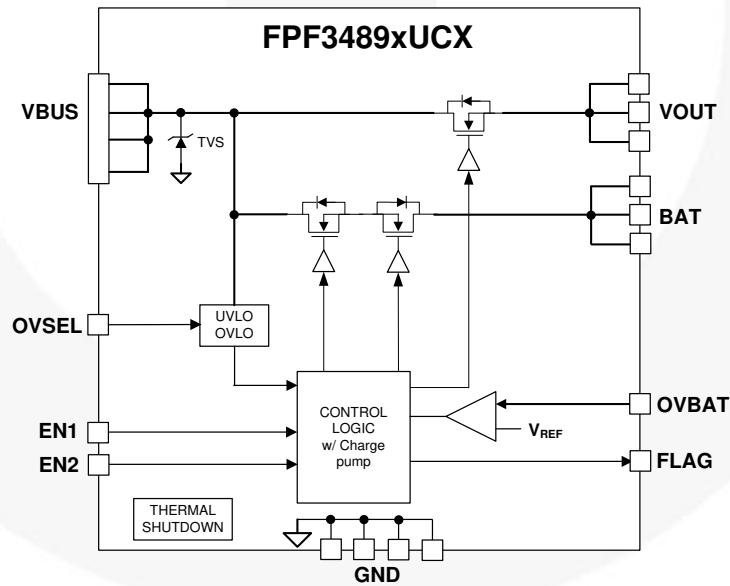


Figure 2. Functional Block Diagram

Pin Configuration

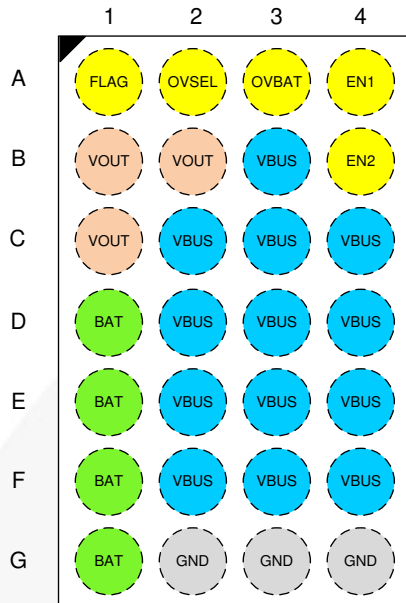


Figure 3. Pin Configuration (Top View)

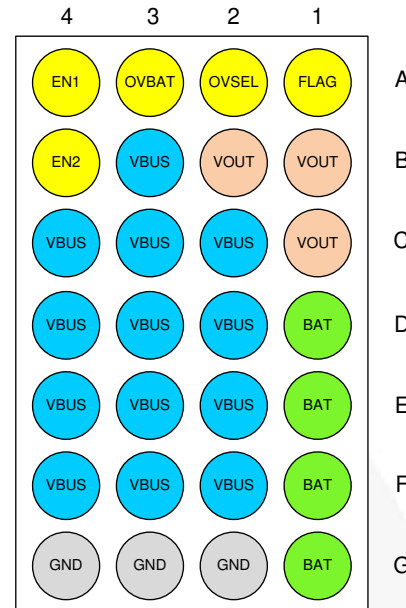


Figure 4. Pin Configuration (Bottom View)

Pin Definitions

| Name | Bump | Type | Description |
|-------|--|--------------|---|
| VBUS | B3, C2, C3, C4, D2, D3, D4, E2, E3, E4, F2, F3, F4 | Input/Supply | Power Switch Input and Device Supply |
| VOUT | B1, B2, C1 | Output | Power Switch Output to Load |
| BAT | D1, E1, F1, G1 | Output | Power Switch Output to Battery |
| OVBAT | A3 | Input | Over-Voltage Lockout on BAT Adjustment Pin |
| EN2 | B4 | Input | Active HIGH. Channel 2, VBUS to BAT path only. Internal pull-down resistor of 1 M Ω is included. |
| EN1 | A4 | Input | Active LOW. Channel 1, VBUS to VOUT path only. Internal pull-down resistor of 1 M Ω is included. |
| OVSEL | A2 | Input | OVSEL Floating, OVP 13.9 V (PPF34891) or 10.4 V (PPF34892); OVSEL = GND, OVP 5.8V. |
| FLAG | A1 | Output | Active HIGH PowerGOOD output for VBUS to BAT path. CMOS output requiring no external bias. HIGH: VBUS to BAT path is ON and in normal state. LOW: VBUS to BAT path is OFF due to EN2=LOW, UVLO, OVLO, thermal shutdown or device shutdown |
| GND | G2, G3, G4 | 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 | Parameters | | Min. | Max. | Unit |
|-------------------------------|---|--|-------------------|-----------------------|------|
| V _{BUS} | VBUS to GND & VBUS to VOUT = GND or Float | | -2 ⁽¹⁾ | 28 | V |
| V _{OUT} | VOUT to GND | | -0.3 | V _{BUS} +0.3 | V |
| BAT | BAT to GND | | -0.3 | 6.0 | V |
| OVBAT | OVBAT to GND | | | 6 | V |
| V _{EN(n)_OVSEL_FLAG} | EN(n), OVSEL or FLAG to GND | | | 6 | V |
| I _{IN_VBUS_VOUT} | Continuous VBUS to VOUT Current | | | 3.5 | A |
| | Peak VBUS to VOUT Current (5 ms) | | | 7 | A |
| I _{IN_VBUS_BAT} | Continuous VBUS to BAT Current | | | 6 | A |
| | Peak VBUS to BAT Current (5 ms) | | | 12 | A |
| t _{PD} | Total Power Dissipation at T _A =25°C | | | 2.27 | W |
| T _{STG} | Storage Junction Temperature | | -65 | +150 | °C |
| T _J | Operating Junction Temperature | | | +150 | °C |
| T _L | Lead Temperature (Soldering, 10 Seconds) | | | +260 | °C |
| θ _{JA} | Thermal Resistance, Junction-to-Ambient (1in. ² pad of 2 oz. copper) | | | 55 ⁽²⁾ | °C/W |
| ESD | Electrostatic Discharge Capability | Human Body Model, ANSI/ESDA/JEDEC JS-001 | 2 | | kV |
| | | Charged Device Model, JESD22-C101 | 1 | | |
| | IEC61000-4-2 System Level | Air Discharge | 15 | | |
| | | Contact Discharge | 8 | | |
| Surge | IEC 61000-4-5 | V _{BUS} | ±100 | | V |

Notes:

1. Pulsed, 50 ms maximum non-repetitive.
2. 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 | Parameter | Min. | Max. | Unit |
|------------------------------------|------------------------------|------|------|------|
| V _{BUS} | Supply Voltage | 2.7 | 13.5 | V |
| C _{IN} / C _{OUT} | Input and Output Capacitance | 0.1 | | μF |
| C _{BAT} | BAT Capacitance | 47 | | μF |
| T _A | Operating Temperature | -40 | +85 | °C |

Electrical Characteristics

Unless otherwise noted, $V_{BUS} = 2.7$ to 13.5 V, $T_A = -40$ to 85°C ; Typical values are at $V_{BUS} = 5$ V, $I_{IN} \leq 2$ A, $C_{IN} = 0.1\ \mu\text{F}$ and $T_A = 25^\circ\text{C}$.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|--|--|---|-------|-------|-------|------------------|
| Basic Operation | | | | | | |
| I_Q | Input Quiescent Current | $V_{BUS} = 5$ V, $EN1=EN2=LOW$ | | 145 | 215 | μA |
| I_{IN_Q} | OVLO Supply Current | $V_{BUS} = 15$ V, $V_{OUT} = 0$ V, $EN1=EN2=LOW$ | | 190 | 290 | μA |
| | | $V_{BUS} = 5.5$ V, $BAT = 0$ V, $EN1=EN2=HIGH$ | | 150 | 210 | μA |
| V_{BUS_CLAMP} | Input Clamping Voltage | $I_{IN}=10$ mA | | 35 | | V |
| V_{BUS_UVLO} | Under-Voltage Trip Level | VBUS Rising, $T_A = -40$ to 85°C | 2.35 | 2.5 | 2.65 | V |
| | | VBUS Falling, $T_A = -40$ to 85°C | 2.20 | 2.35 | 2.50 | V |
| T_{SDN} | Thermal Shutdown ⁽³⁾ | | | 150 | | $^\circ\text{C}$ |
| T_{SDN_HYS} | Thermal Shutdown Hysteresis ⁽³⁾ | | | 20 | | $^\circ\text{C}$ |
| VBUS to VOUT Switch (Channel 1) | | | | | | |
| V_{CH1_OVP} | Over-Voltage Trip Level (OVSEL Floating) | VBUS Rising (PPF34891) | 13.5 | 13.9 | 14.3 | V |
| | | VBUS Falling (PPF34891) | | 13.6 | | |
| | | VBUS Rising (PPF34892) | 10.0 | 10.4 | 10.8 | |
| | | VBUS Falling (PPF34892) | | 10.1 | | |
| | Over-Voltage Trip Level (OVSEL = GND) | VBUS Rising | 5.6 | 5.8 | 6.0 | |
| | | VBUS Falling | | 5.65 | | |
| R_{ON_VOUT} | On-Resistance | $V_{BUS} = 5$ V, $I_{OUT} = 1$ A, $T_A = 25^\circ\text{C}$ | | 28 | 39 | m Ω |
| | | $V_{BUS} = 12$ V, $I_{OUT} = 1$ A, $T_A = 25^\circ\text{C}$ | | 28 | 39 | m Ω |
| t_{DEB_VOUT} | Debounce Time | Time from $V_{BUS_UVLO} < V_{BUS} < V_{BUS_OVLO}$ to $V_{OUT} = 0.1 \times V_{BUS}$ | | 15 | | ms |
| t_{ON_VOUT} | Switch Turn-On Time | $R_L = 100\ \Omega$, $C_L = 10\ \mu\text{F}$, V_{OUT} from $0.1 \times V_{BUS}$ to $0.9 \times V_{BUS}$ | | 2 | | ms |
| t_{OFF_VOUT} | Switch Turn-Off Time ⁽³⁾ | $R_L = 100\ \Omega$, No C_L , $V_{BUS} > V_{OUT_OVLO}$ to $V_{OUT} = 0.9 \times V_{BUS}$ | | | 150 | ns |
| VBUS to BAT Switch (Channel 2) | | | | | | |
| V_{CH2_OVP} | Over-Voltage Trip Level for VBUS monitor | VBUS Rising, $T_A = -40$ to 85°C | 5.6 | 5.8 | 6.0 | V |
| | | VBUS Falling, $T_A = -40$ to 85°C | | 5.65 | | V |
| V_{OVLO_TH} | BAT OVP set Threshold | $OVBAT = 0$ V to V_{OVLO} , $T_A = 0$ to 85°C | 1.145 | 1.155 | 1.165 | V |
| | | $OVBAT = 0$ V to V_{OVLO} , $T_A = -40$ to 85°C | 1.140 | 1.155 | 1.165 | |
| R_{ON_BAT} | On-Resistance | $V_{BUS} = 3$ V, $I_{OUT} = 1$ A, $T_A = 25^\circ\text{C}$ | | 33 | 40 | m Ω |
| I_{RCB} | Reverse Current | $V_{BUS} = 0$ V, $BAT = 4.4$ V | | | 1 | μA |
| t_{DEB_BAT} | Debounce Time | Time from $V_{BUS_UVLO} < V_{BUS} < V_{BUS_OVLO}$ to $BAT = 0.1 \times V_{BUS}$ | | 15 | | ms |
| t_{BAT_START} | Soft-Start Time | Time from $V_{BUS} = V_{BUS_UVLO}$ to $0.1 \times FLAG$ | | 30 | | ms |
| t_{ON_BAT} | Switch Turn-On Time | $R_L = 100\ \Omega$, $C_L = 10\ \mu\text{F}$, V_{OUT} from $0.1 \times V_{BUS}$ to $0.9 \times V_{BUS}$ | | 2.5 | | ms |

Electrical Characteristics

Unless otherwise noted, $V_{BUS} = 2.7$ to 13.5 V, $T_A = -40$ to 85°C ; Typical values are at $V_{BUS} = 5$ V, $I_{IN} \leq 2$ A, $C_{IN} = 0.1 \mu\text{F}$ and $T_A = 25^\circ\text{C}$.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---------------------------------|--|---|------|------|------|------------------|
| $t_{\text{OFF_BAT}}$ | Switch Turn-Off Time ⁽³⁾ | $R_L = 100 \Omega$, No C_L , $V_{BUS} > V_{\text{BAT_OVBAT}}$ to $\text{BAT} = 0.9 \times V_{BUS}$ | | | 150 | ns |
| Digital Signals | | | | | | |
| V_{OH} | FLAG Output HIGH Voltage | $V_{BUS} = 5$ V, $\text{EN2} = \text{LOW}$ | 1.6 | 1.8 | 2.0 | V |
| V_{OL} | FLAG Output LOW Voltage | $V_{BUS} = 5$ V, $\text{EN2} = \text{HIGH}$ | | | 0.5 | V |
| $R_{\text{PD_EN}(n)}$ | Internal Pull-Down Resistor at EN1 and EN2 | | | 1 | | $\text{M}\Omega$ |
| $R_{\text{PU_OVSEL}}$ | Internal Pull-Up Resistor at OVSEL | | | 1 | | $\text{M}\Omega$ |
| $V_{\text{IH_EN}(n)_OVSEL}$ | Logic Enable HIGH Voltage | V_{BUS} Operating Range | 1.2 | | | V |
| $V_{\text{IL_EN}(n)_OVSEL}$ | Logic Enable LOW Voltage | V_{BUS} Operating Range | | | 0.5 | V |
| $I_{\text{OVSEL_EN}(n)_LEAK}$ | OVSEL and EN(n) Leakage Current | $V_{BUS} = 5$ V, V_{OUT} , $\text{BAT} = \text{Floating}$ | | 5 | 7 | μA |

Note:

- Guaranteed by characterization and design.

Timing Diagrams

VBUS to VOUT Path

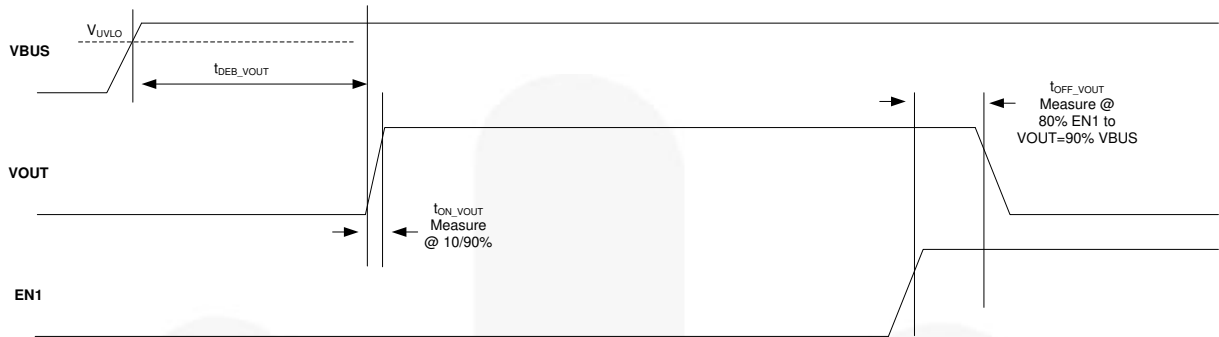


Figure 5. Timing for VBUS to VOUT Power Up/Down and Normal Operation

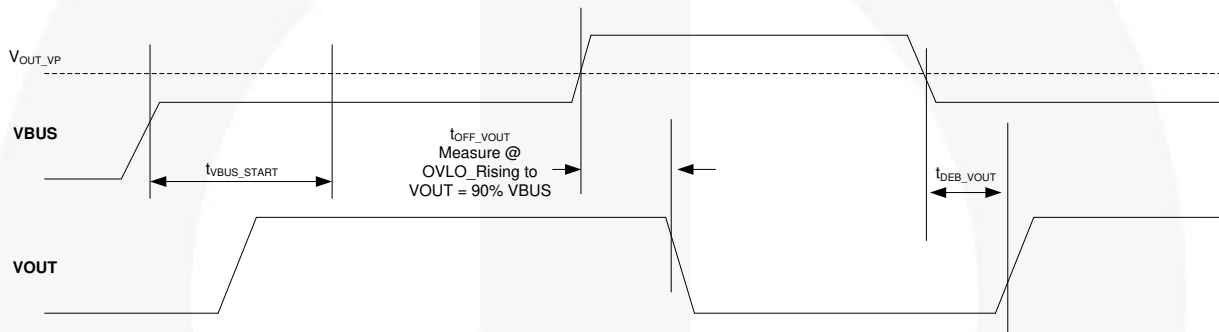


Figure 6. Timing for VBUS to VOUT OVLO Operation (EN1=LOW)

VBUS to BAT Path

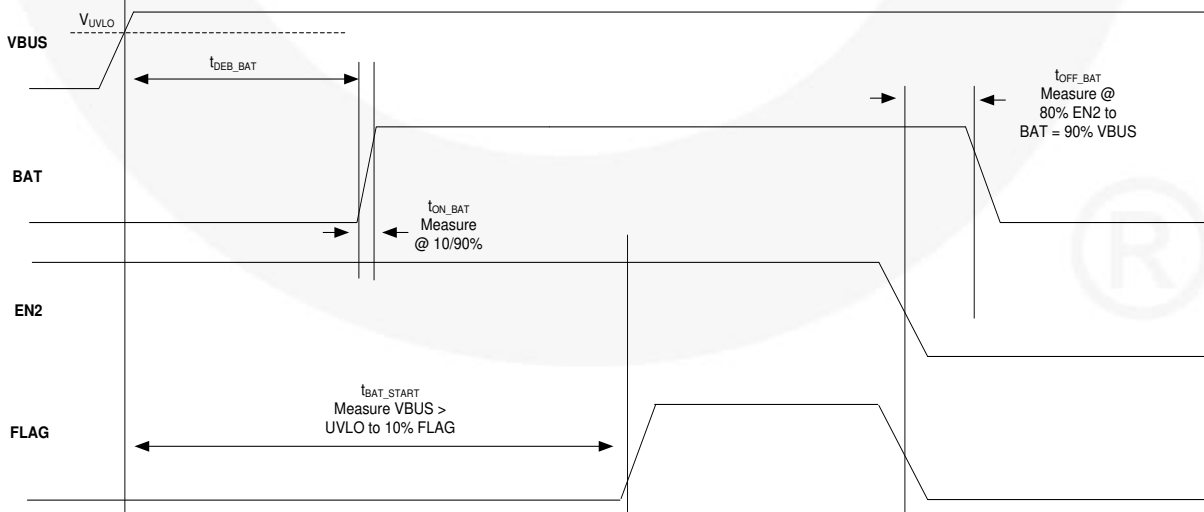


Figure 7. Timing for VBUS to BAT Power Up/Down and Normal Operation

Timing Diagrams (Continued)

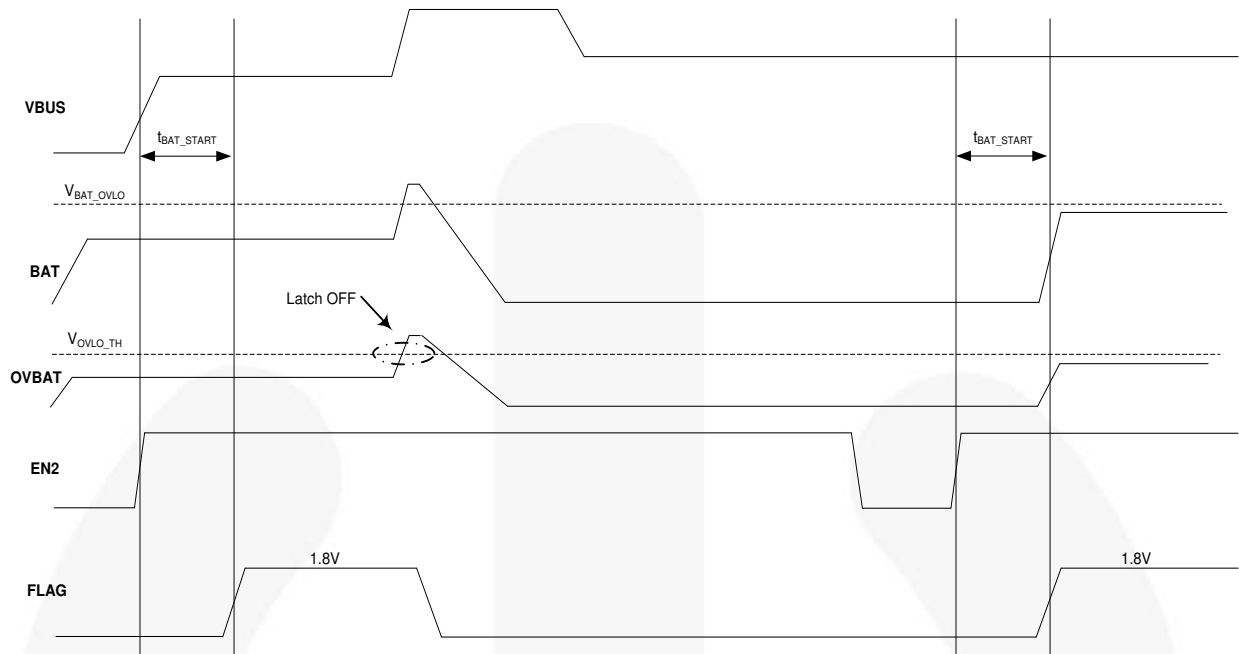


Figure 8. Timing for VBUS to BAT OVLO Operation (EN2=HIGH)

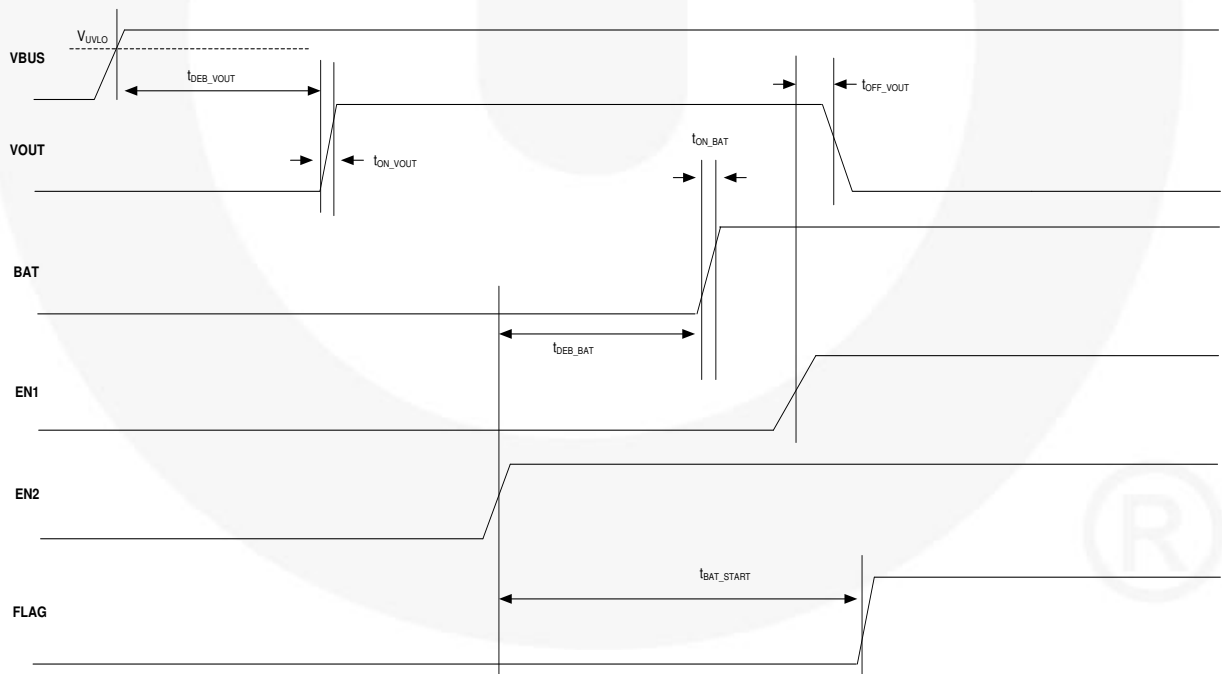


Figure 9. Timing for Overall ON/OFF Operation

Operation and Application Description

Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current when the switches turns, a capacitor must be placed in between the VBUS and GND pins. A high-value capacitor on C_{IN} can be used to reduce the voltage drop in high-current applications.

Under-Voltage Lockout (UVLO)

The under-voltage lockout turns the switches off if the input voltage drops below the lockout threshold. With the enable pins, EN1 & EN2, active, the input voltage rising above the UVLO threshold releases the lockout and enables the switches.

Thermal Shutdown

The thermal shutdown protects the die from internally or externally generated excessive temperature. During an over-temperature condition, the switch is turned off. The switch automatically turns on again if the temperature of the die drops below the threshold temperature.

FLAG Reporting

To indicate the status of channel 2, push-pull output FLAG signal high (typical 1.8V) when channel 2 is turned on. FLAG will output low when channel 2 is turned off.

Over-Voltage Lockout

To protect the system, FPF3489x provide multi level over voltage protection.

For channel 1 (VBUS to VOUT), 3 different levels can be chosen. When OVSEL is tied to GND, OVP will be triggered once VBUS voltage is higher than typical 5.8V. With OVSEL floating, OVP will be triggered when VBUS voltage is higher than typical 13.9V (FPF34891) or 10.4V (FPF34892). FLAG voltage will output low until the over voltage condition disappears.

For channel 2 (VBUS to BAT), both VBUS and BAT voltage will be monitored. Once VBUS voltage is higher than typical 5.8V, channel 2 will be turned off and output low at FLAG pin until VBUS drop below 5.65V (typical). Once BAT voltage is higher than pre-set value (set by external resistors), channel 2 will be turned off and output low at FLAG pin. This status will be latched even after BAT voltage drop to lower than OVP value. To re-active the switch, EN2 need to be toggled.

The OVLO level on BAT can be pre-set by connecting external resistor ladder to the OVBAT pin. Equation (1) can produce the desired trip voltage and resistor values.

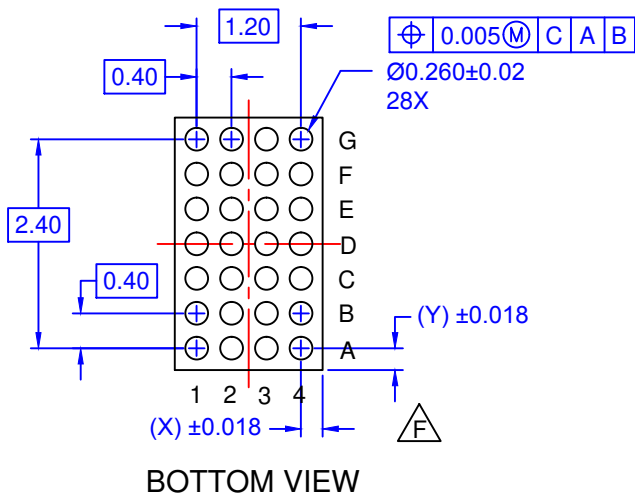
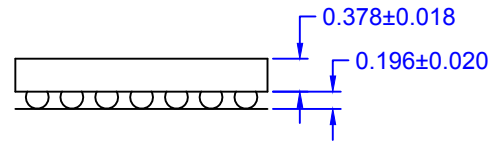
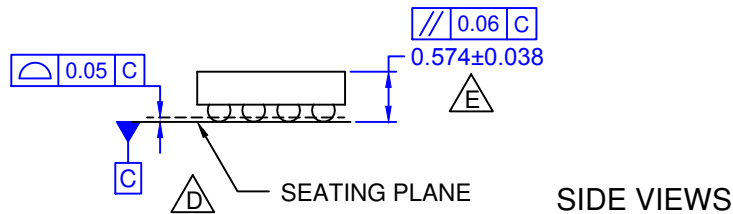
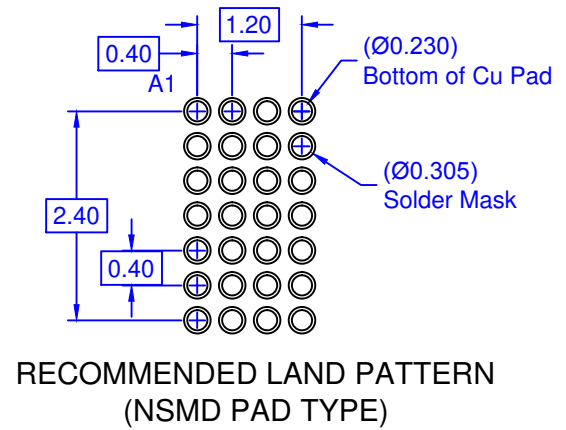
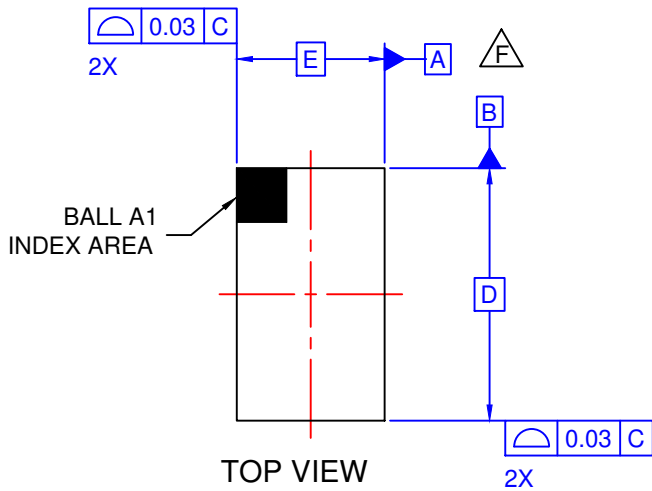
$$V_{BAT_OVLO} = V_{OVLO_TH} \times [1 + R1/R2] \quad (1)$$

Recommended minimum $R1 = 1 \text{ M}\Omega$ to reduce leakage and screen unexpected glitch.

The following information applies to the WL-CSP package dimensions on the next page:

Product-Specific Dimensions

| D | E | X | Y |
|---------------------------------------|---------------------------------------|--------------------------------------|--------------------------------------|
| 2960 $\mu\text{m} \pm 30 \mu\text{m}$ | 1670 $\mu\text{m} \pm 30 \mu\text{m}$ | 235 $\mu\text{m} \pm 18 \mu\text{m}$ | 280 $\mu\text{m} \pm 18 \mu\text{m}$ |



- NOTES**
- A. NO JEDEC REGISTRATION APPLIES.
 - B. DIMENSIONS ARE IN MILLIMETERS.
 - C. DIMENSIONS AND TOLERANCE PER ASMEY14.5M, 2009.
 - D. DATUM C IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.
 - E. PACKAGE NOMINAL HEIGHT IS 574 ± 38 MICRONS (536-612 MICRONS).
 - F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.
 - G. DRAWING FILENAME: MKT-UC028AB REV1.



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