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March 2017

# FPF2281
# Over-Voltage Protection Load Switch

## Features

- Surge Protection
  - IEC 61000-4-5: > 100 V
- Over-Voltage Protection (OVP)
- Over-Temperature Protection (OTP)
- ESD Protection
  - Human Body Model (HBM): > 3.5 kV
  - Charged Device Model (CDM): > 2 kV
  - IEC 61000-4-2 Air Discharge: > 15 kV
  - IEC 61000-4-2 Contact Discharge: > 8 kV

## Applications

- Mobile Handsets and Tablets
- Portable Media Players
- MP3 Players

## Description

The FPF2281 features a low-$R_{ON}$ internal FET and an operating range of 2.5 $V_{DC}$ to 25 $V_{DC}$ (absolute maximum of 29 $V_{DC}$). An internal clamp is capable of shunting surge voltages >100 V, protecting downstream components and enhancing system robustness. The FPF2281 features over-voltage protection that powers down the internal FET if the input voltage exceeds the OVP threshold. The OVP threshold is adjustable with optional external resistors. Over-temperature protection also powers down the device at 130°C (typical). Exceptionally low off-state current (<1 μA maximum) facilitates compliance with standby power requirements.

The FPF2281 is available in a fully “green” compliant 1.3 mm × 1.8 mm Wafer-Level Chip-Scale Package (WLCSP) with backside laminate.

## Related Resources

- http://www.onsemi.com/

## Ordering Information

| Part Number | Operating Temperature Range | Top Mark | Package | Packing Method |
|---|---|---|---|---|
| FPF2281BUCX_F130 | -40°C – 85°C | HE | 12-Ball, 0.4 mm Pitch WLCSP | Tape & Reel |

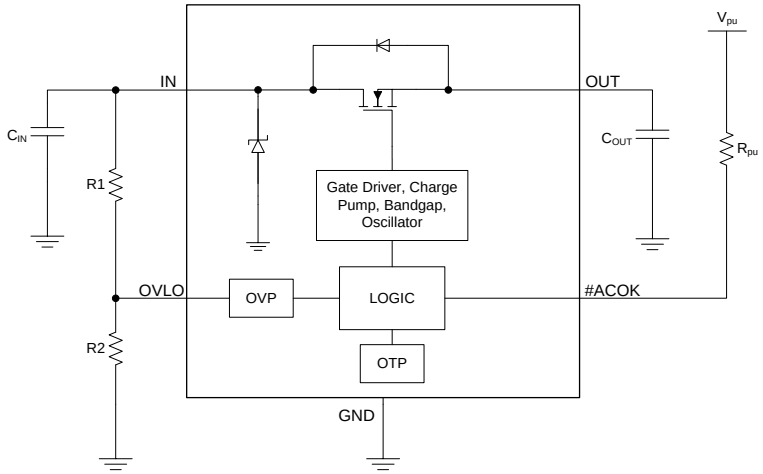
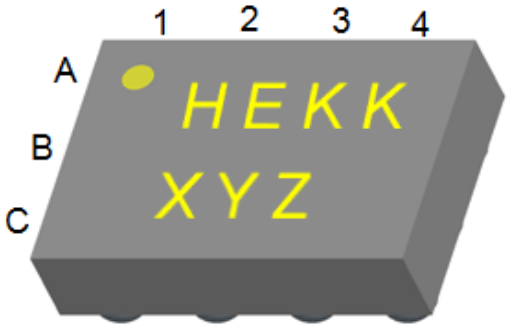
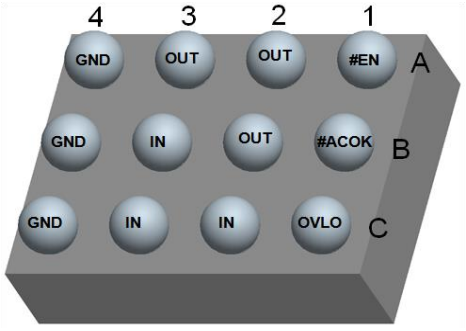



**Figure 1. Functional Block Diagram**

## Pin Configuration



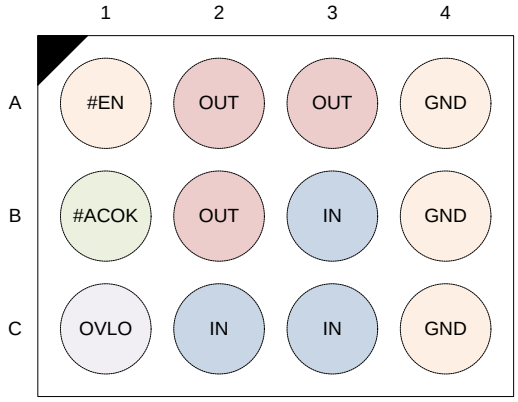




**Figure 2. Pin Configuration (Top View)**

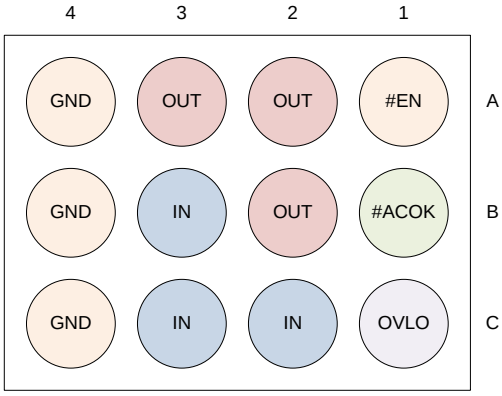



**Figure 3. Pin Configuration (Bottom View)**

## Pin Definitions

| Name | Bump | Type | Description | | |
|---|---|---|---|---|---|
| IN | B3, C2, C3 | Input/Supply | Switch Input and Device Supply | | |
| OUT | A2, A3, B2 | Output | Switch Output to Load | | |
| #ACOK | B1 | Output | Power Good | 1 | $V_{IN} < V_{IN\_min}$ or $V_{IN} \geq V_{OVLO}$ |
| | | | | 0 | Voltage Stable |
| #EN | A1 | Input | Device Enable (Active LOW) | | |
| OVLO | C1 | Input | Over-Voltage Lockout Adjustment Pin | | |
| GND | A4, B4, C4 | Supply | Device Ground | | |

## Over-Voltage Lockout (OVLO) Calculation

OVLO can be set externally and override default OVP. By connecting an external resistor-driver to the OVLO pin. Equation (1) can produce the desired trip voltage and resistor values.

$$V_{IN\_OLVO} = V_{OVLO\_TH} \times [1 + R1/R2] \quad (1)$$

Recommended minimum R1 = 1 MΩ.

## 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 to GND & V_IN to V_OUT = GND or Float | | -0.3 | 29.0 | V |
| $V_{OUT}$ | V_OUT to GND | | -0.3 | $V_{IN}$ + 0.3 | V |
| $V_{OVLO}$ | OVLO to GND | | -0.3 | 25.0 | V |
| $V_{\#EN\_ACOK}$ | Maximum DC Voltage Allowed on #EN or ACOK Pin | | | 6 | V |
| $I_{IN}$ | Switch I/O Current (Continuous) | | | 4.5 | A |
| | Peak Switch I/O Current (10 ms) | | | 9 | A |
| $tP_D$ | Total Power Dissipation at $T_A$ = 25ºC | | | 1.48 | W |
| $T_{STG}$ | Storage Temperature Range | | -65 | +150 | °C |
| $T_J$ | Maximum Junction Temperature | | | +150 | °C |
| $T_L$ | Lead Temperature (Soldering, 10 Seconds) | | | +260 | °C |
| $\Theta_{JA}$ | Thermal Resistance, Junction-to-Ambient[1] (1-in.$^2$ Pad of 2-oz. Copper) | | | 84.1 | °C/W |
| ESD | IEC 61000-4-2 System ESD | Air Gap | 15.0 | | kV |
| | | Contact | 8.0 | | |
| | Human Body Model, ANSI / ESDA / JEDEC JS-001-2012 | All Pins | 3.5 | | |
| | Charged Device Model, JEDEC JESD22-C101 | All Pins | 2.0 | | |
| Surge | IEC 61000-4-5, Surge Protection | $V_{IN}$ | 100 | | V |

**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. ON Semiconductor does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{IN}$ | Supply Voltage | 2.5 | 25.0 | V |
| $T_A$ | Operating Temperature | -40 | +85 | ºC |

## Electrical Characteristics

$T_A$ = -40ºC to 85ºC unless otherwise indicated. Typical values are $V_{IN}$ = 5.0 V, $I_{IN}$ ≤ 3 A, $C_{IN}$ = 0.1 µF and $T_A$ = 25ºC.

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{IN\_CLAMP}$ | Input Clamping Voltage | $I_{IN}$ = 10 mA | | 35 | | V |
| $I_Q$ | Input Quiescent Current | $V_{IN}$ = 5 V, #EN = 0 V | | 58 | 100 | µA |
| $I_{IN\_Q}$ | OVLO Supply Current | $V_{OVLO}$ = 3 V, $V_{IN}$ = 5 V, $V_{OUT}$ = 0 V | | 52 | 100 | µA |
| $V_{IN\_OVLO}$ | Internal Over-Voltage Trip Level | $V_{IN}$ Rising | 13.6 | 14.0 | 14.4 | V |
| | | $V_{IN}$ Falling | 13.0 | | | V |
| $V_{OVLO\_TH}$ | OVLO Set Threshold | $V_{IN}$ = 2.5 V to $V_{OVLO}$ | 1.12 | 1.20 | 1.24 | |
| $V_{OVLO\_RNG}$ | Adjustable OVLO Threshold Range | $V_{IN}$ = 2.5 V to $V_{OVLO}$ | 4 | | 25 | V |
| $V_{OVLO\_SELECT}$ | External OVLO Select Threshold | | | 0.30 | 0.28 | V |
| $V_{UVLO}$ | Under-Voltage Trip Level | VIN Rising, $T_A$= -40 to 85ºC | | 2.25 | 2.4 | V |
| | | VIN Falling, $T_A$= -40 to 85ºC | | 1.95 | 2.1 | V |
| $R_{ON}$ | Resistance from $V_{IN}$ to $V_{OUT}$ | $V_{IN}$ = 5 V, $I_{OUT}$ = 1 A, $T_A$ = 25ºC | | 30 | 39 | mΩ |
| $C_{OUT}$ | OUT Load Capacitance(2) | $V_{IN}$ = 5 V | | | 1000 | µF |
| $I_{OLVO}$ | OVLO Input Leakage Current | $V_{OVLO}$ = $V_{OVLO\_TH}$ | -100 | | 100 | nA |
| $T_{SDN}$ | Thermal Shutdown(2) | | | 130 | | °C |
| $T_{SDN\_HYS}$ | Thermal Shutdown Hysteresis(2) | | | 20 | | °C |
| **Digital Signals** | | | | | | |
| $V_{OL}$ | #ACOK Output Low Voltage | $I_{SINK}$ = 1 mA | | | 0.4 | V |
| VIH_#EN | Enable HIGH Voltage | $V_{IN}$ = 2.5 V to $V_{OVLO}$ | 1.2 | | | V |
| VIL_#EN | Enable LOW Voltage | $V_{IN}$ = 2.5 V to $V_{OVLO}$ | | | 0.5 | V |
| $I_{ACOK\_LEAK}$ | #ACOK Leakage Current | $V_{ACOK}$ = 3 V, #ACOK Deasserted | -0.5 | | 0.5 | µA |
| #EN_Leak | #EN Leakage Current | $V_{IN}$ = 5.0 V, $V_{OUT}$ = Float | -1.0 | | 1.0 | µA |
| **Timing Characteristics** | | | | | | |
| $t_{DEB}$ | Debounce Time | Time from 2.5 V < $V_{IN}$ < $V_{IN\_OVLO}$ to $V_{OUT}$ = 0.1 × $V_{IN}$ | | 15 | | ms |
| $t_{START}$ | Soft-Start Time | Time from $V_{IN}$ = $V_{IN\_min}$ to 0.2 × #ACOK, $V_{IO}$ = 1.8 V with 10 kΩ Pull-up Resistor | | 30 | | ms |
| $t_{ON}$ | Switch Turn-On Time | $R_L$ = 100 Ω, $C_L$ = 22 µF, $V_{OUT}$ from 0.1 × $V_{IN}$ to 0.9 × $V_{IN}$, | | 2 | | ms |
| $t_{OFF}$ | Switch Turn-Off Time(2) | $R_L$ = 100 Ω, $C_L$ = 0 µF, $V_{IN}$ > $V_{OVLO}$ to $V_{OUT}$ = 0.8 × $V_{IN}$ | | 125 | | ns |

**Note:**

2. Guaranteed by characterization and design.

## Timing Diagrams

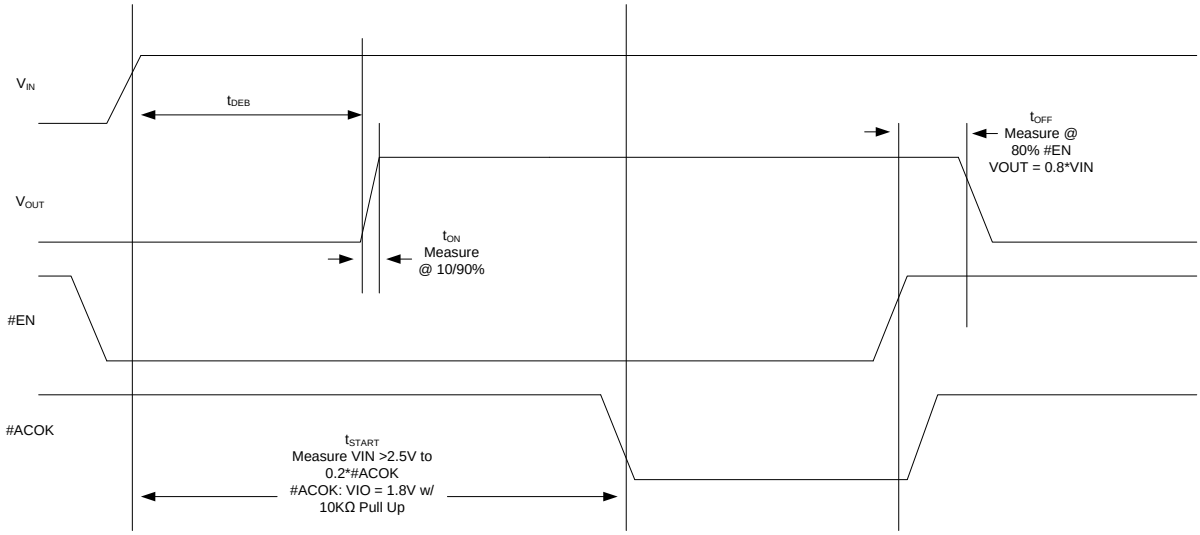



**Figure 4. Timing for Power Up and Normal Operation**

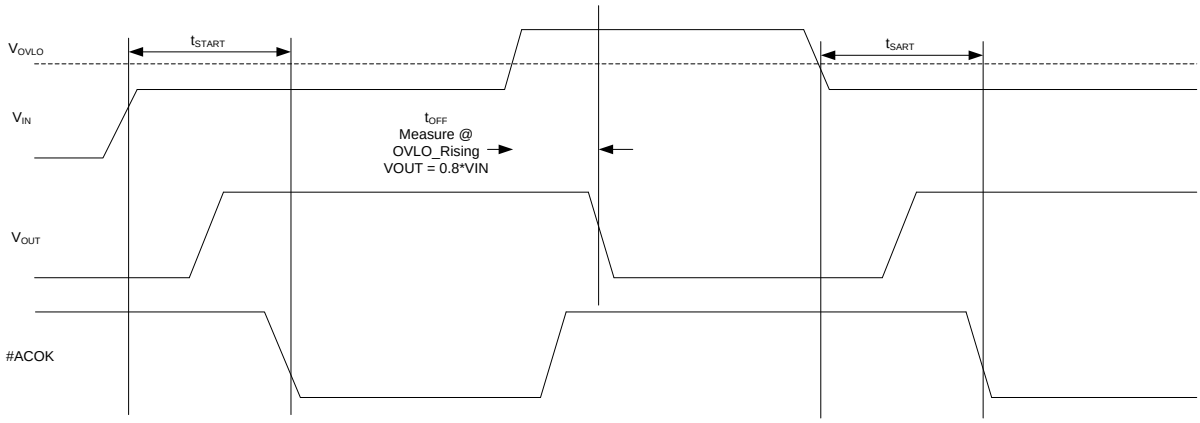
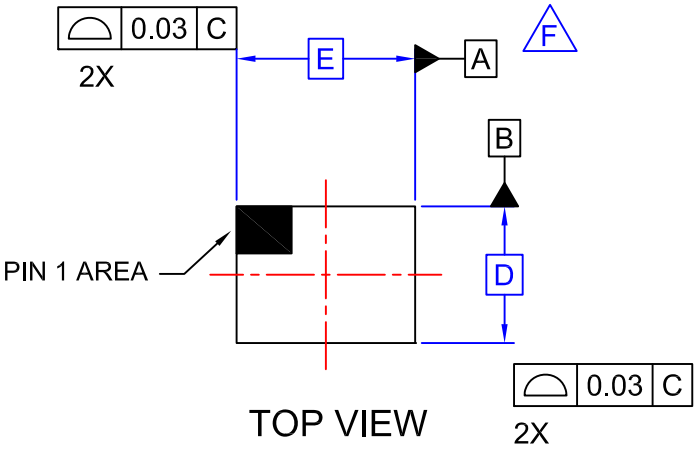



**Figure 5. Timing for OVLO Trip**

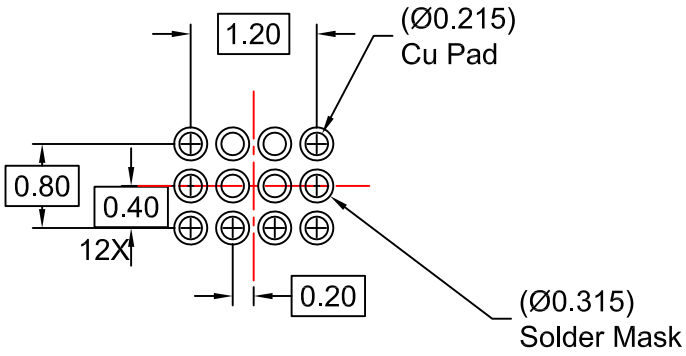
## Product-Specific Dimensions

The table below provides information regarding the WLCSP package on the following page.

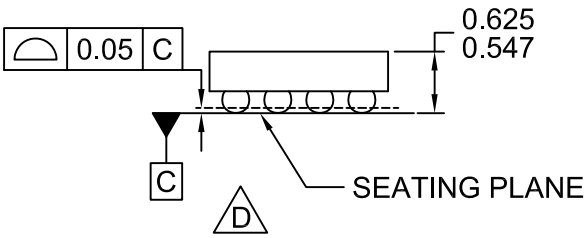
| D | E | X | Y |
|---|---|---|---|
| 1288 µm ±30 µm | 1828 µm ±30 µm | 314 µm ±18 µm | 244 µm ±18 µm |

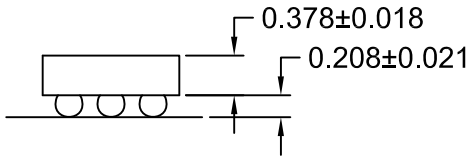



TOP VIEW

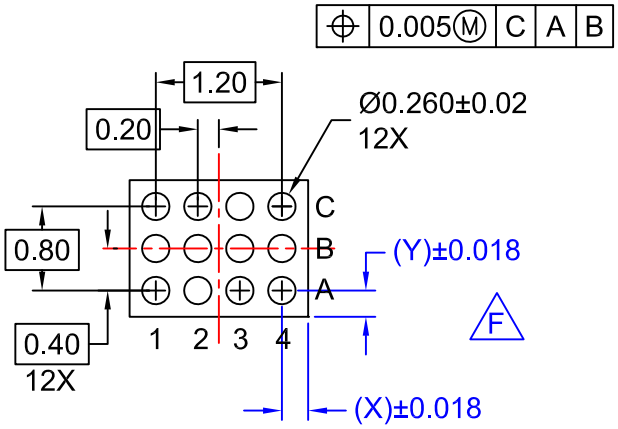



RECOMMENDED LAND PATTERN
(NSMD PAD TYPE)




SIDE VIEWS




BOTTOM VIEW

## NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 2009.

D. DATUM C IS DEFINED BY THE SPHERICAL CROWNS OF THE BALLS.

E. PACKAGE NOMINAL HEIGHT IS 586 MICRONS ±39 MICRONS (547-625 MICRONS).

F. FOR DIMENSIONS D, E, X, AND Y SEE PRODUCT DATASHEET.

G. DRAWING FILENAME: MKT-UC012ZCrev2.

H. FAIRCHILD SEMICONDUCTOR RECOMMENDS THAT LANDS IN THE LANDPATTERN ARE AT LEAST .215MM DIAMETER AS MEASURED AT THE BOTTOM OF THE LAND, NOT THE TOP EDGE.

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