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ON Semiconductor®

# 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  $130^{\circ}C$  (typical). Exceptionally low off-state current ( $<1 \mu A$  maximum) facilitates compliance with standby power requirements.

The FPF2281 is available in a fully “green” compliant  $1.3 \text{ mm} \times 1.8 \text{ mm}$  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	$-40^{\circ}C - 85^{\circ}C$	HE	12-Ball, 0.4 mm Pitch WLCSP	Tape & Reel

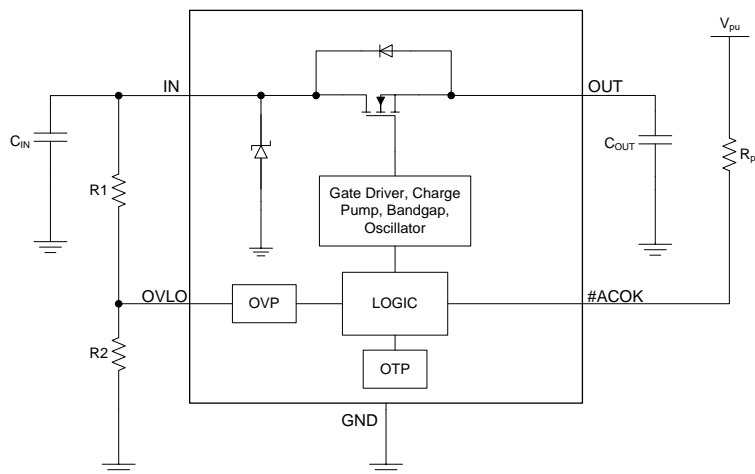


Figure 1. Functional Block Diagram

## Pin Configuration

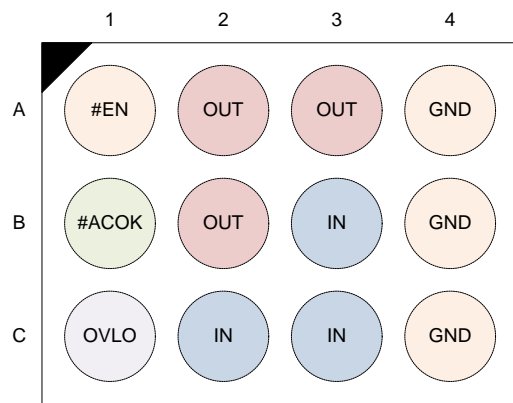
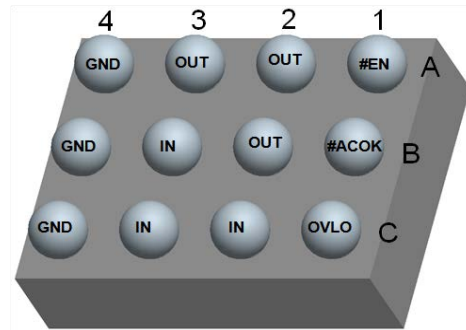


Figure 2. Pin Configuration (Top View)

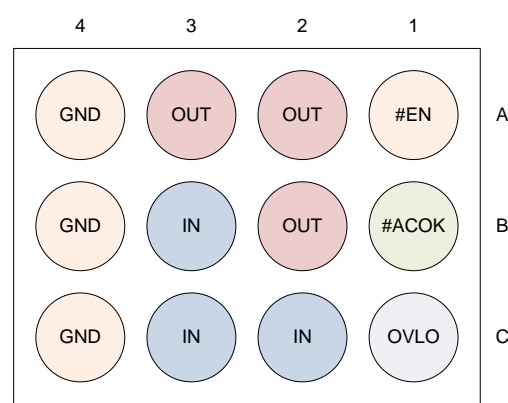


Figure 3. Pin Configuration (Bottom View)

## 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	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  $R1 = 1 \text{ M}\Omega$ .

## 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 <sub>IN</sub>	V <sub>IN</sub> to GND & V <sub>IN</sub> to V <sub>OUT</sub> = GND or Float	-0.3	29.0	V
V <sub>OUT</sub>	V <sub>OUT</sub> to GND	-0.3	V <sub>IN</sub> + 0.3	V
V <sub>OVLO</sub>	OVLO to GND	-0.3	25.0	V
V <sub>#EN_ACOK</sub>	Maximum DC Voltage Allowed on #EN or ACOK Pin		6	V
I <sub>IN</sub>	Switch I/O Current (Continuous)		4.5	A
	Peak Switch I/O Current (10 ms)		9	A
t <sub>Pd</sub>	Total Power Dissipation at T <sub>A</sub> = 25°C		1.48	W
T <sub>STG</sub>	Storage Temperature Range	-65	+150	°C
T <sub>J</sub>	Maximum Junction Temperature		+150	°C
T <sub>L</sub>	Lead Temperature (Soldering, 10 Seconds)		+260	°C
θ <sub>JA</sub>	Thermal Resistance, Junction-to-Ambient <sup>(1)</sup> (1-in. <sup>2</sup> 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 <sub>IN</sub>	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 <sub>IN</sub>	Supply Voltage	2.5	25.0	V
T <sub>A</sub>	Operating Temperature	-40	+85	°C

## Electrical Characteristics

$T_A = -40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  unless otherwise indicated. Typical values are  $V_{IN} = 5.0\text{ V}$ ,  $I_{IN} \leq 3\text{ A}$ ,  $C_{IN} = 0.1\text{ }\mu\text{F}$  and  $T_A = 25^{\circ}\text{C}$ .

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$V_{IN\_CLAMP}$	Input Clamping Voltage	$I_{IN} = 10\text{ mA}$		35		V
$I_Q$	Input Quiescent Current	$V_{IN} = 5\text{ V}$ , $\#EN = 0\text{ V}$		58	100	$\mu\text{A}$
$I_{IN\_Q}$	OVLO Supply Current	$V_{OVLO} = 3\text{ V}$ , $V_{IN} = 5\text{ V}$ , $V_{OUT} = 0\text{ V}$		52	100	$\mu\text{A}$
$V_{IN\_OVLO}$	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	$V_{IN} = 2.5\text{ V}$ to $V_{OVLO}$	1.12	1.20	1.24	
$V_{OVLO\_RNG}$	Adjustable OVLO Threshold Range	$V_{IN} = 2.5\text{ V}$ to $V_{OVLO}$	4		25	V
$V_{OVLO\_SELECT}$	External OVLO Select Threshold			0.30	0.28	V
$V_{UVLO}$	Under-Voltage Trip Level	$V_{IN}$ Rising, $T_A = -40$ to $85^{\circ}\text{C}$		2.25	2.4	V
		$V_{IN}$ Falling, $T_A = -40$ to $85^{\circ}\text{C}$		1.95	2.1	V
$R_{ON}$	Resistance from $V_{IN}$ to $V_{OUT}$	$V_{IN} = 5\text{ V}$ , $I_{OUT} = 1\text{ A}$ , $T_A = 25^{\circ}\text{C}$		30	39	$\text{m}\Omega$
$C_{OUT}$	OUT Load Capacitance <sup>(2)</sup>	$V_{IN} = 5\text{ V}$			1000	$\mu\text{F}$
$I_{OLVO}$	OVLO Input Leakage Current	$V_{OVLO} = V_{OVLO\_TH}$	-100		100	nA
$T_{SDN}$	Thermal Shutdown n <sup>(2)</sup>			130		$^{\circ}\text{C}$
$T_{SDN\_HYS}$	Thermal Shutdown n Hysteresis <sup>(2)</sup>			20		$^{\circ}\text{C}$
<b>Digital Signals</b>						
$V_{OL}$	#ACOK Output Low Voltage	$I_{SINK} = 1\text{ mA}$			0.4	V
$V_{IH\_}\#EN$	Enable HIGH Voltage	$V_{IN} = 2.5\text{ V}$ to $V_{OVLO}$	1.2			V
$V_{IL\_}\#EN$	Enable LOW Voltage	$V_{IN} = 2.5\text{ V}$ to $V_{OVLO}$			0.5	V
$I_{ACOK\_LEAK}$	#ACOK Leakage Current	$V_{ACOK} = 3\text{ V}$ , #ACOK Deasserted	-0.5		0.5	$\mu\text{A}$
$\#EN\_Leak$	#EN Leakage Current	$V_{IN} = 5.0\text{ V}$ , $V_{OUT} = \text{Float}$	-1.0		1.0	$\mu\text{A}$
<b>Timing Characteristics</b>						
$t_{DEB}$	Debounce Time	Time from $2.5\text{ V} < V_{IN} < V_{IN\_OVLO}$ to $V_{OUT} = 0.1 \times V_{IN}$		15		ms
$t_{START}$	Soft-Start Time	Time from $V_{IN} = V_{IN\_min}$ to $0.2 \times$ #ACOK, $V_{IO} = 1.8\text{ V}$ with $10\text{ k}\Omega$ Pull-up Resistor		30		ms
$t_{ON}$	Switch Turn-On Time	$R_L = 100\text{ }\Omega$ , $C_L = 22\text{ }\mu\text{F}$ , $V_{OUT}$ from $0.1 \times V_{IN}$ to $0.9 \times V_{IN}$ ,		2		ms
$t_{OFF}$	Switch Turn-Off Time <sup>(2)</sup>	$R_L = 100\text{ }\Omega$ , $C_L = 0\text{ }\mu\text{F}$ , $V_{IN} > V_{OVLO}$ to $V_{OUT} = 0.8 \times V_{IN}$		125		ns

**Note:**

- Guaranteed by characterization and design.

### Timing Diagrams

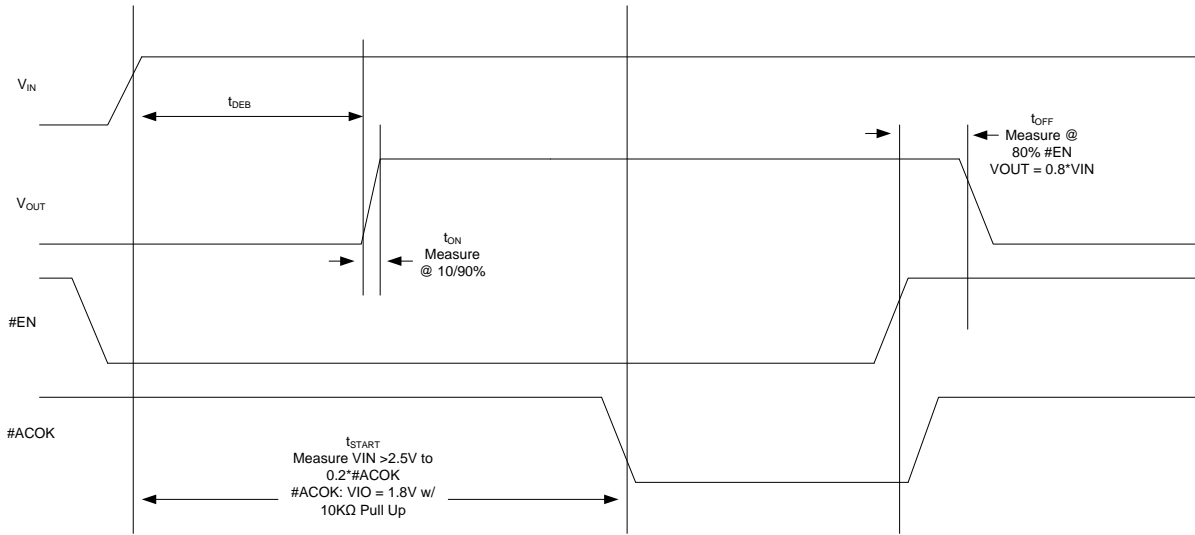


Figure 4. Timing for Power Up and Normal Operation

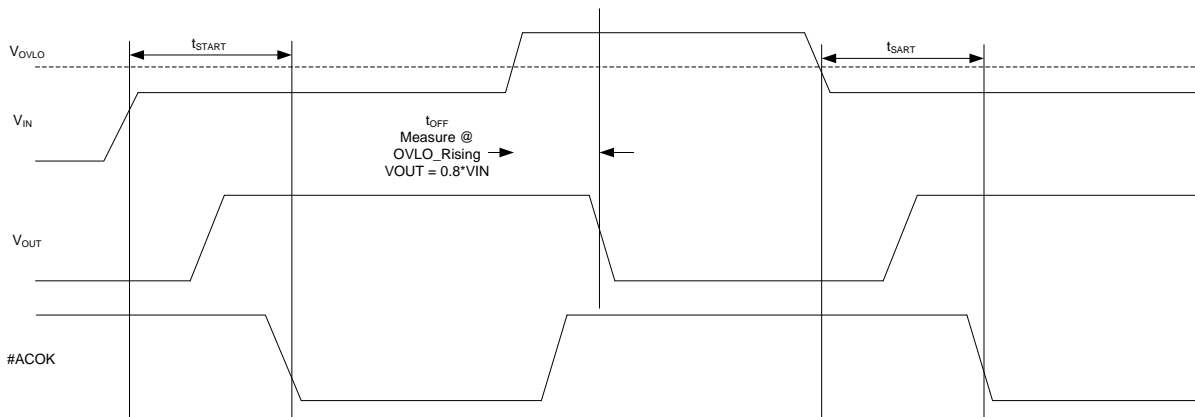


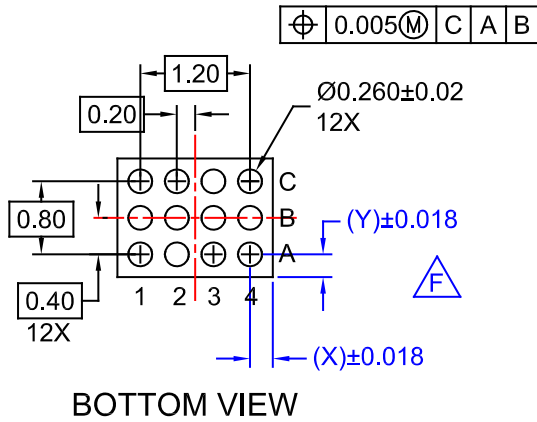
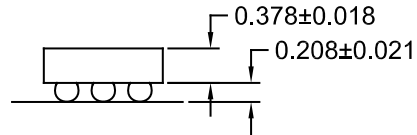
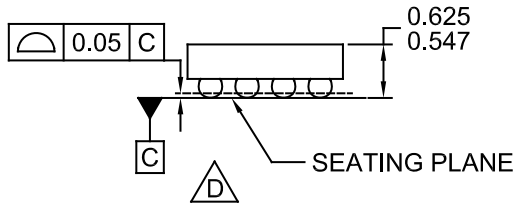
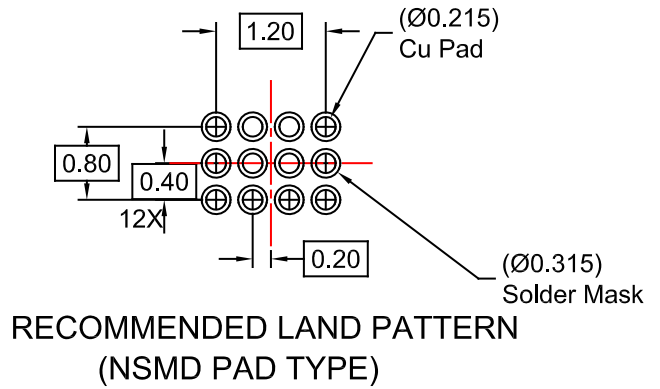
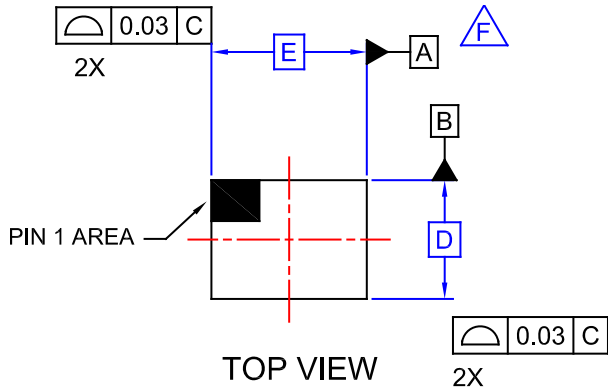
Figure 5. Timing for OVLO Trip

### Product-Specific Dimensions

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

D	E	X	Y
1288 $\mu m \pm 30 \mu m$	1828 $\mu m \pm 30 \mu m$	314 $\mu m \pm 18 \mu m$	244 $\mu m \pm 18 \mu m$

**Physical Dimensions**



**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.

**Figure 6. 12-Ball, 3x4 Array, 0.4 mm Pitch, Wafer-Level Chip-Scale Package (WLCSP)**

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