

# Surge and Over-Voltage Protection Switch for VBUS

## FPF2188UCX


WLCSP20 2.03x1.77x0.585  
CASE 567ZF

### Description

The FPF2188 features a surge and over voltage protection switch for power path in USB type C/PD applications.

The FPF2188 has Single Input Single Output (SISO) power path. Power path ( $V_{BUS}$  to  $V_{OUT}$ ) is an active-low, 28 V / 5.5 A rated, power MOSFET switch with an internal clamp supporting surge protection, selectable OVP at 13.7 V or 21.9 V by GPIO.

BUS\_DET is paired with always ON LDO to power downstream devices when VBUS is greater than 3.1 V, regardless of OVLO and ENB State. This provides system power supply without battery.

The FPF2188 features OTG\_DET pin to supply the device when OTG device is inserted. It will support to turn on the power MOSFET even when VBUS voltage is low.

The FPF2188 has active discharge path at VBUS which can meet USB type C w/ PD compliance.

The FPF2188 is available in a 20-bump, 1.77 mm x 2.03 mm Wafer-Level Chip-Scale Package (WL-CSP) with 0.4 mm pitch.

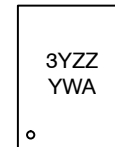
### Features

- SISO (Single Input Single Output) Surge and Over-Voltage Protection Switch
- $\pm 200$  V Surge Protection at  $V_{BUS}$  under IEC 61000-4-5
- VBUS Voltage Range: 2.7 V ~ 21.0 V
- Max Continuous Current Capability: 5.5 A
- Low ON-Resistance: typical 22 m $\Omega$  at 5 V / 25°C
- Selectable OVP Trip Level by GPIO
- Ultra-fast OV Response Time : typ 50 ns
- Always ON LDO Output, BUS\_DET
- OTG\_DET for OTG Start-up Power Supply
- Active Discharge Path at  $V_{BUS}$
- Open Drain OVP FLAGB
- Over-Temperature Protection (OTP)

### Typical Applications

- Mobile Handsets and Tablets

### MARKING DIAGRAM



|    |                        |
|----|------------------------|
| 3Y | = Specific Device Code |
| ZZ | = Assembly Lot Code    |
| Y  | = Year                 |
| W  | = Work Week            |
| A  | = Assembly Location    |

### ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

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## Application Diagram

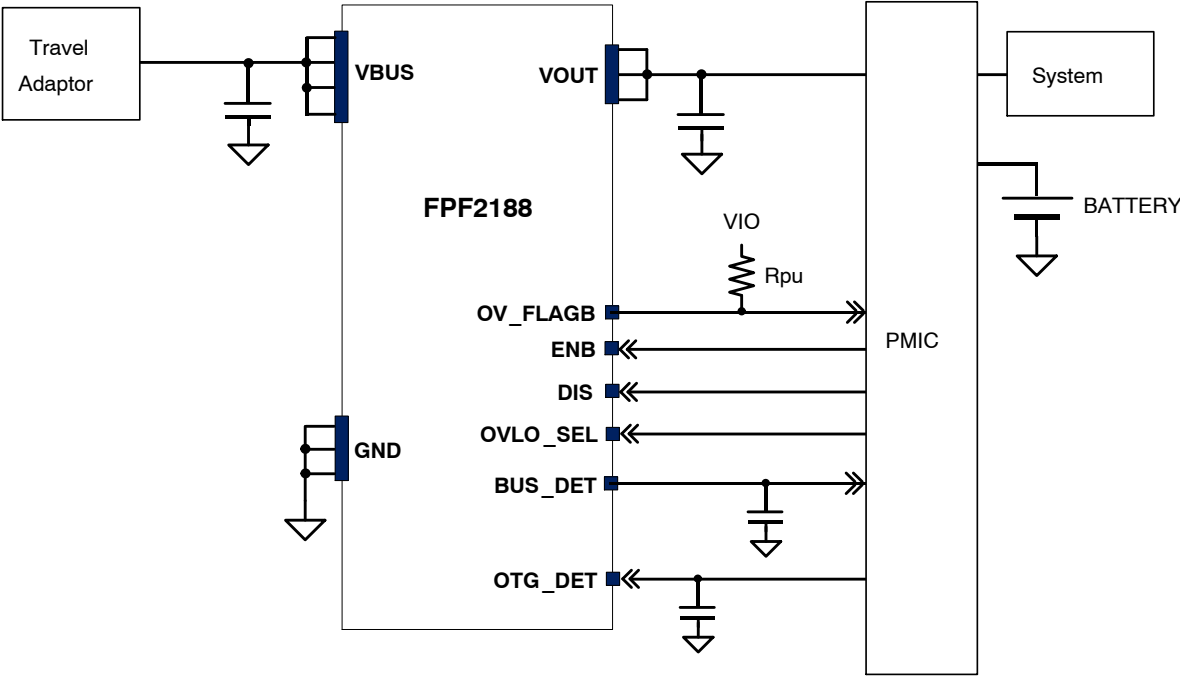


Figure 1. Typical Application Schematic

## Block Diagram

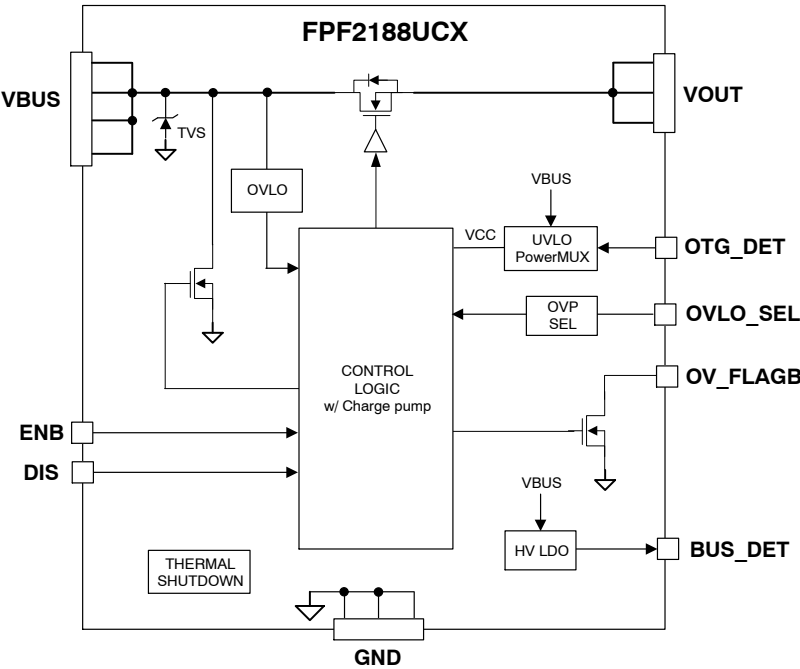


Figure 2. Functional Block Diagram

# FPF2188UCX

## Pin Configuration

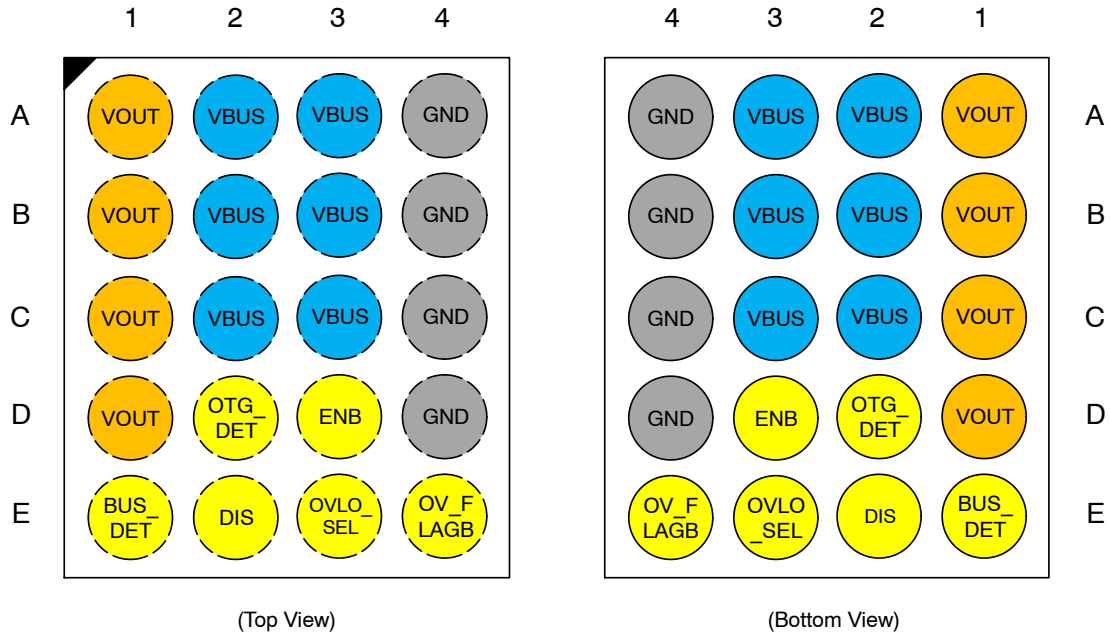


Figure 3. Pin Configuration

Table 1. PIN DEFINITIONS

| Name     | Bump                   | Type          | Description                                                                                                                                                                                                        |
|----------|------------------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VBUS     | A2, A3, B2, B3, C2, C3 | Input/Supply  | Switch Input/Output and Power Paths Block Power Supply                                                                                                                                                             |
| VOUT     | A1, B1, C1, D1         | Output/Supply | Switch Output/Input to Load                                                                                                                                                                                        |
| OTG_DET  | D2                     | Input         | VBUS charge pump power supply for OTG start-up.                                                                                                                                                                    |
| BUS_DET  | E1                     | Output        | Regulated output according to VBUS                                                                                                                                                                                 |
| ENB      | D3                     | Input         | Active LOW for Power Path.<br>Internal pull-down resistor of 1 M $\Omega$ is included.                                                                                                                             |
| DIS      | E2                     | Input         | Active HIGH for discharge path at VBUS node.<br>Internal pull-down resistor of 1 M $\Omega$ is included.                                                                                                           |
| OVLO_SEL | E3                     | Input         | Over-Voltage Lockout Selection for VOUT path.<br>Internal pull-down resistor of 1 M $\Omega$ is included.<br>When OVLO_SEL = LOW then OVLO is set typ 13.7 V.<br>When OVLO_SEL = HIGH then OVLO is set typ 21.9 V. |
| OV_FLAGB | E4                     | Output        | Open drain output for OV state.<br>External pull-up resistor with bias voltage are required.<br>If not used, leaves the pin floating.                                                                              |
| GND      | A4, B4, C4, D4         | GND           | Ground                                                                                                                                                                                                             |

**Table 2. ABSOLUTE MAXIMUM RATINGS**

| Symbol                                | Parameters                                                                      |                                          | Min. | Max.             | Unit |
|---------------------------------------|---------------------------------------------------------------------------------|------------------------------------------|------|------------------|------|
| VBUS                                  | VBUS to GND & VBUS to VOUT = GND or Float                                       |                                          | −0.3 | 28               | V    |
| VOUT                                  | VOUT to GND                                                                     |                                          | −0.3 | 26               | V    |
| BUS_DET                               | BUS_DET to GND                                                                  |                                          | −0.3 | 6                | V    |
| V <sub>ENB_OTG_DET_DIS_OV_FLAGB</sub> | ENB, OTG_DET, DIS, OVLO_SEL or OV_FLAGB to GND                                  |                                          | −0.3 | 6                | V    |
| I <sub>IN_VBUS_VOUT</sub>             | Continuous VBUS to VOUT Current                                                 |                                          | −    | 5.5              | A    |
|                                       | Peak VBUS to VOUT Current (5 ms)                                                |                                          | −    | 11               | A    |
| I <sub>IN_BUS_DET</sub>               | Continuous BUS_DET Current                                                      |                                          | −    | 10               | mA   |
| t <sub>PD</sub>                       | Total Power Dissipation at T <sub>A</sub> = 25°C                                |                                          | −    | 1.66             | W    |
| T <sub>STG</sub>                      | Storage Junction Temperature                                                    |                                          | −65  | +150             | °C   |
| T <sub>J</sub>                        | Operating Junction Temperature                                                  |                                          | −    | +150             | °C   |
| T <sub>L</sub>                        | Lead Temperature (Soldering, 10 Seconds)                                        |                                          | −    | +260             | °C   |
| Θ <sub>JA</sub>                       | Thermal Resistance, Junction-to-Ambient (1in. <sup>2</sup> pad of 2 oz. copper) |                                          | −    | 63.3<br>(Note 1) | °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 at VBUS                    | 15   | −                |      |
|                                       |                                                                                 | Contact Discharge at VBUS                | 8    | −                |      |
| Surge                                 | IEC61000-4-5                                                                    | V <sub>BUS</sub>                         | −200 | +200             | V    |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Measured using 2S2P JEDEC std. PCB

**Table 3. RECOMMENDED OPERATING CONDITIONS**

| Symbol                        | Parameter                                                 | Min. | Max. | Unit |
|-------------------------------|-----------------------------------------------------------|------|------|------|
| V <sub>BUS</sub>              | VBUS Operating Voltage                                    | 2.7  | 21.0 | V    |
| V <sub>OTG_DET</sub>          | OTG_DET Operating Voltage                                 | 3.1  | 4.85 | V    |
| V <sub>OUT_OTG</sub>          | VOUT Operating Voltage in OTG operation                   | 5.0  | 5.4  | V    |
| C <sub>IN</sub> (Note 2)      | Input Capacitance for VBUS. Minimum rating 50 V (Note 3)  | 1    | -    | μF   |
| C <sub>OUT</sub> (Note 2)     | Output Capacitance for VOUT. Minimum rating 25 V (Note 3) | 1    | -    | μF   |
| C <sub>OTG_DET</sub> (Note 2) | Capacitance for OTG_DET. Minimum rating 10 V (Note 3)     | 1    | -    | μF   |
| C <sub>BUS_DET</sub> (Note 2) | Capacitance for BUS_DET. Minimum rating 10 V (Note 3)     | 1    | -    | μF   |
| T <sub>A</sub>                | Ambient Operating Temperature, T <sub>A</sub>             | -40  | 85   | °C   |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

2. Bypass capacitor should be placed to the device as close as possible in order to reduce the parasitic inductance.

3. Each capacitor's DC rating is depending on Samsung's internal guidance.

**Table 4. ELECTRICAL CHARACTERISTICS**

Unless otherwise noted, VBUS = 2.7 to 21.0 V, T<sub>A</sub> = -40 to 85 °C; Typical values are at VBUS = 5 V, I<sub>IN</sub> ≤ 1 A, ENB = DIS = LOW, OVLO\_SEL = GND, BUS\_DET = Floating, C<sub>IN</sub> = 1 μF and T<sub>A</sub> = 25 °C.

| Symbol                 | Parameter                             | Conditions                                                                                                                                                                                | Min. | Typ. | Max. | Unit |
|------------------------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| <b>Basic Operation</b> |                                       |                                                                                                                                                                                           |      |      |      |      |
| I <sub>Q_PWR</sub>     | Power Input Quiescent Current enable  | VBUS = 5 V, ENB = LOW                                                                                                                                                                     | –    | 150  | 220  | μA   |
|                        | Power Input Quiescent Current disable | VBUS = 5 V, ENB = HIGH                                                                                                                                                                    | –    | 130  | 200  |      |
| I <sub>IN_OVLO</sub>   | OVLO Supply Current                   | VBUS = 15 V, VOUT = 0 V, ENB = LOW, OVLO_SEL = GND                                                                                                                                        | –    | 190  | 250  | μA   |
|                        |                                       | VBUS = 23 V, VOUT = 0 V, ENB = LOW, OVLO_SEL = HIGH                                                                                                                                       | –    | 190  | 250  |      |
| V <sub>UVLO</sub>      | Under-Voltage Trip Level              | VBUS Rising, T <sub>A</sub> = -40 to 85 °C                                                                                                                                                | 2.35 | 2.5  | 2.65 | V    |
|                        |                                       | VBUS Falling, T <sub>A</sub> = -40 to 85 °C                                                                                                                                               | 2.2  | 2.35 | 2.5  | V    |
| R <sub>PD</sub>        | VBUS Discharge Resistance             | VBUS = 5 V, DIS = 1.8 V                                                                                                                                                                   | –    | 550  | –    | Ω    |
| t <sub>DIS_ON</sub>    | VBUS Discharge ON Delay Time          | VOUT = 5 V, Time from DIS = HIGH to Discharge path ON                                                                                                                                     | –    | 0.5  | –    | μs   |
| t <sub>DIS_OFF</sub>   | VBUS Discharge OFF Delay Time         | VOUT = 5 V, Time from DIS = LOW to Discharge path OFF                                                                                                                                     | –    | 1    | –    | μs   |
| t <sub>DIS</sub>       | VBUS Discharge Time                   | VOUT = 5 V, V <sub>OTG_DET</sub> = 0 V, C <sub>BUS</sub> = 1 μF, C <sub>OUT</sub> = 1 μF, DIS = ENB = LOW to HIGH, VOUT supply disabled at the same time, Time from 5 V to 0.5 V at VBUS  | –    | 21   | –    | ms   |
|                        |                                       | VOUT = 5 V, V <sub>OTG_DET</sub> = 0 V, C <sub>BUS</sub> = 1 μF, C <sub>OUT</sub> = 10 μF, DIS = ENB = LOW to HIGH, VOUT supply disabled at the same time, Time from 5 V to 0.5 V at VBUS | –    | 90   | –    |      |
| T <sub>SDN</sub>       | Thermal Shutdown (Note 4)             |                                                                                                                                                                                           | –    | 145  | –    | °C   |
| T <sub>SDN_HYS</sub>   | Thermal Shutdown Hysteresis (Note 4)  |                                                                                                                                                                                           | –    | 20   | –    | °C   |

**Integrated Bi-directional TVS**

|                      |                                         |                                                               |      |      |      |   |
|----------------------|-----------------------------------------|---------------------------------------------------------------|------|------|------|---|
| V <sub>RW_P</sub>    | Positive Reverse Working Voltage        |                                                               | –    | –    | 28   | V |
| V <sub>BR_P</sub>    | Positive Breakdown Voltage              | I <sub>IN</sub> = 1 mA                                        | –    | 35   | 38   | V |
| V <sub>CL_P</sub>    | Positive Clamping Voltage (Note 5)      | +200 V Surge (IEC61000-4-5), T <sub>A</sub> = -40 °C to 85 °C | –    | 39   | 42   | V |
| I <sub>IN_PK_P</sub> | Positive Peak Current During Surge test | +200 V Surge (IEC61000-4-5), T <sub>A</sub> = -40 °C to 85 °C | –    | –    | 100  | A |
| V <sub>RW_N</sub>    | Negative Reverse Working Voltage        |                                                               | -0.2 | –    | –    | V |
| V <sub>F_TVS</sub>   | Forward Voltage of TVS                  | I <sub>IN</sub> = -10 mA                                      | -0.2 | -0.6 | -0.8 | V |
| V <sub>CL_N</sub>    | Negative Clamping Voltage               | -200 V Surge (IEC61000-4-5)                                   | -3   | –    | –    | V |
| I <sub>IN_PK_N</sub> | Negative Peak Current During Surge test | -200 V Surge (IEC61000-4-5), T <sub>A</sub> = -40 °C to 85 °C | -103 | –    | –    | A |

**VBUS to VOUT Switch**

|                   |                         |                                                                |      |      |      |   |
|-------------------|-------------------------|----------------------------------------------------------------|------|------|------|---|
| V <sub>OVLO</sub> | Over-Voltage Trip Level | VBUS Rising, OVLO_SEL = GND<br>T <sub>A</sub> = -40 to 85 °C   | 13.4 | 13.7 | 14.0 | V |
|                   |                         | VBUS Falling, OVLO_SEL = GND<br>T <sub>A</sub> = -40 to 85 °C  | –    | 13.4 | –    | V |
|                   |                         | VBUS Rising, OVLO_SEL = HIGH<br>T <sub>A</sub> = -40 to 85 °C  | 21.5 | 21.9 | 22.3 | V |
|                   |                         | VBUS Falling, OVLO_SEL = HIGH<br>T <sub>A</sub> = -40 to 85 °C | –    | 21.5 | –    | V |

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**Table 4. ELECTRICAL CHARACTERISTICS** (continued)

Unless otherwise noted, VBUS = 2.7 to 21.0 V, T<sub>A</sub> = -40 to 85 °C; Typical values are at VBUS = 5 V, I<sub>IN</sub> ≤ 1 A, ENB = DIS = LOW, OVLO\_SEL = GND, BUS\_DET = Floating, C<sub>IN</sub> = 1 μF and T<sub>A</sub> = 25 °C.

| Symbol                         | Parameter                                     | Conditions                                                                                                                                                           | Min. | Typ. | Max. | Unit |
|--------------------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| VBUS to VOUT Switch            |                                               |                                                                                                                                                                      |      |      |      |      |
| R <sub>ON_VOUT</sub>           | On-Resistance (Note 5)                        | VBUS = 5 V, I <sub>OUT</sub> = 200 mA, T <sub>A</sub> = 25 °C                                                                                                        | –    | 21   | 25   | mΩ   |
|                                |                                               | VBUS = 5 V, I <sub>OUT</sub> = 200 mA, T <sub>A</sub> = –40 °C to 85 °C                                                                                              | –    | –    | 30   |      |
|                                |                                               | VBUS = 12 V, I <sub>OUT</sub> = 200 mA, T <sub>A</sub> = 25 °C                                                                                                       | –    | 21   | 25   |      |
|                                |                                               | VBUS = 12 V, I <sub>OUT</sub> = 200 mA, T <sub>A</sub> = –40 °C to 85 °C                                                                                             | –    | –    | 30   |      |
|                                |                                               | VBUS = 21 V, I <sub>OUT</sub> = 200 mA, T <sub>A</sub> = 25 °C                                                                                                       | –    | 21   | 25   |      |
|                                |                                               | VBUS = 21 V, I <sub>OUT</sub> = 200 mA, T <sub>A</sub> = –40 °C to 85 °C                                                                                             | –    | –    | 30   |      |
| t <sub>DEB_VOUT</sub>          | Debounce Time                                 | Time from V <sub>UVLO</sub> < VBUS < V <sub>OVLO</sub> to VOUT = 0.1 × VBUS                                                                                          | –    | 28   | –    | ms   |
| t <sub>ON_VOUT</sub>           | Switch Turn-On Time                           | R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 1 μF, VOUT from 0.1 × VBUS to 0.9 × VBUS,                                                                                   | –    | 200  | –    | μs   |
| t <sub>OFF_OVP</sub>           | Switch Turn-Off Time (Note 5)                 | R <sub>L</sub> = 100 Ω, no C <sub>OUT</sub> , VBUS > V <sub>OVLO</sub> to V <sub>OUT</sub> stop rising, OVLO_SET = HIGH or LOW, Measured under IEC61000–4–5 standard | –    | 50   | 90   | ns   |
| t <sub>OFF_ENB</sub>           | Switch Turn-Off Time by control               | R <sub>L</sub> = 100 Ω, C <sub>OUT</sub> = 1 μF, V <sub>ENB</sub> > V <sub>IH</sub> to V <sub>OUT</sub> = 0.9 × VBUS                                                 | –    | 12   | 18   | μs   |
| VOUT to VBUS Switch (OTG Mode) |                                               |                                                                                                                                                                      |      |      |      |      |
| R <sub>ON_OTG</sub>            | On-Resistance                                 | VOUT = 5 V, I <sub>BUS</sub> = 200 mA, T <sub>A</sub> = 25 °C                                                                                                        | –    | 21   | 25   | mΩ   |
| V <sub>UVLO_OTG</sub>          | OTG_DET Under-Voltage Lockout Level           | OTG_DET Rising, T <sub>A</sub> = –40 to 85 °C                                                                                                                        | 2.80 | 2.95 | 3.10 | V    |
|                                |                                               | OTG_DET Falling, T <sub>A</sub> = –40 to 85 °C                                                                                                                       | 2.65 | 2.80 | 2.95 | V    |
| t <sub>DON_OTG</sub>           | OTG Start-up Delay Time (Note 5)              | Time from OTG_DET > UVLO_OTG to VBUS FET Fully ON                                                                                                                    | –    | 0.6  | 1    | ms   |
| I <sub>OTG_DET</sub>           | Current at OTG_DET                            | OTG_DET < V <sub>POR</sub> , VOUT = 0 V, ENB = LOW, VBUS open, T <sub>A</sub> = –40 °C to 85 °C                                                                      | –    | –    | 2    | μA   |
|                                |                                               | V <sub>POR</sub> < OTG_DET < 2.8 V, VOUT = 0 V, ENB = LOW, VBUS open, T <sub>A</sub> = –40 °C to 85 °C                                                               | –    | –    | 60   |      |
|                                |                                               | OTG_DET = 5 V, VOUT = 0V, ENB = LOW, VBUS open, T <sub>A</sub> = –40 °C to 85 °C                                                                                     | –    | 80   | 120  |      |
|                                |                                               | OTG_DET = 4.85 V, VOUT = 5 V, ENB = LOW, VBUS open, T <sub>A</sub> = –40 °C to 85 °C                                                                                 | –    | –    | 1    |      |
| Always ON LDO, BUS_DET         |                                               |                                                                                                                                                                      |      |      |      |      |
| V <sub>BUS_DET</sub>           | BUS_DET Output Voltage                        | VBUS = 5 V, I <sub>BUS_DET</sub> = 0 mA, T <sub>A</sub> = 25 °C                                                                                                      | 3.8  | 4.0  | 4.2  | V    |
|                                |                                               | VBUS = 21 V, I <sub>BUS_DET</sub> = 0 mA, T <sub>A</sub> = 25 °C                                                                                                     | 3.8  | 4.0  | 4.2  |      |
|                                |                                               | VBUS = 5 V, I <sub>BUS_DET</sub> = 10 mA, T <sub>A</sub> = 25 °C                                                                                                     | 3.8  | 4.0  | 4.2  |      |
|                                |                                               | VBUS = 21 V, I <sub>BUS_DET</sub> = 10 mA, T <sub>A</sub> = 25 °C                                                                                                    | 3.8  | 4.0  | 4.2  |      |
| t <sub>START_BUS_DET</sub>     | BUS_DET Output Startup de-bounce time         | Time from VBUS > V <sub>UVLO</sub> to BUS_DET = 0.1 × V <sub>BUS_DET</sub>                                                                                           | –    | 5.0  | –    | ms   |
| t <sub>R_BUS_DET</sub>         | BUS_DET Output Rising time                    | Time from BUS_DET = 0.1 × V <sub>BUS_DET</sub> to BUS_DET = 0.9 × V <sub>BUS_DET</sub> , C <sub>BUS_DET</sub> = 1 μF, R <sub>L</sub> = 10 kΩ                         | –    | 0.1  | –    | ms   |
| Digital Signals                |                                               |                                                                                                                                                                      |      |      |      |      |
| V <sub>FLAGB_OL</sub>          | OV_FLAGB Output LOW Voltage                   | I <sub>OV_FLAGB</sub> = 1mA                                                                                                                                          | –    | –    | 0.36 | V    |
| t <sub>FLAGB_DELAY</sub>       | OV_FLAGB Assertion delay Time                 | Time from VBUS = V <sub>OVLO</sub> to OV_FLAGB assertion, ENB = HIGH or LOW                                                                                          | –    | –    | 3    | μs   |
| t <sub>FLAGB_REC_EN</sub>      | OV_FLAGB Recovery de-bounce Time when enabled | Time from VBUS < V <sub>OVLO</sub> to OV_FLAGB de-assertion, ENB = LOW                                                                                               | –    | 33   | –    | ms   |

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**Table 4. ELECTRICAL CHARACTERISTICS** (continued)

Unless otherwise noted, VBUS = 2.7 to 21.0 V, T<sub>A</sub> = -40 to 85 °C; Typical values are at VBUS = 5 V, I<sub>IN</sub> ≤ 1 A, ENB = DIS = LOW, OVLO\_SEL = GND, BUS\_DET = Floating, C<sub>IN</sub> = 1 μF and T<sub>A</sub> = 25 °C.

| Symbol                        | Parameter                                                                      | Conditions                                                                                   | Min. | Typ. | Max. | Unit |
|-------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------|------|------|------|
| <b>Digital Signals</b>        |                                                                                |                                                                                              |      |      |      |      |
| t <sub>FLAGB_REC_OT</sub>     | OV_FLAGB Recovery de-bounce<br>Time when the device in thermal shutdown status | Time from VBUS < V <sub>OVLO</sub> to OV_FLAGB de-assertion, device in thermal shutdown mode | –    | 3    | –    | ms   |
| t <sub>FLAGB_REC_DIS</sub>    | OV_FLAGB Recovery de-bounce<br>Time when disabled                              | Time from VBUS = V <sub>OVLO</sub> to OV_FLAGB de-assertion, ENB = HIGH                      | –    | 200  | –    | μs   |
| R <sub>PD_ENB_DIS_OVSEL</sub> | Internal Pull-Down Resistor at ENB, DIS and OVLO_SEL pin                       |                                                                                              | –    | 1    | –    | MΩ   |
| V <sub>IH_ENB_DIS_OVSEL</sub> | Logic Enable HIGH Voltage                                                      | VBUS operating range                                                                         | 1.2  | –    | –    | V    |
| V <sub>IL_ENB_DIS_OVSEL</sub> | Logic Enable LOW Voltage                                                       | VBUS operating range                                                                         | –    | –    | 0.5  | V    |
| I <sub>BUS_DET_LEAK</sub>     | BUS_DET Leakage Current                                                        | V <sub>BUS_DET</sub> = 5 V, VBUS = 0 V                                                       | –    | –    | 1    | μA   |

4. Self-heating is not included
5. Guaranteed by characterization and design.

Timing Diagrams

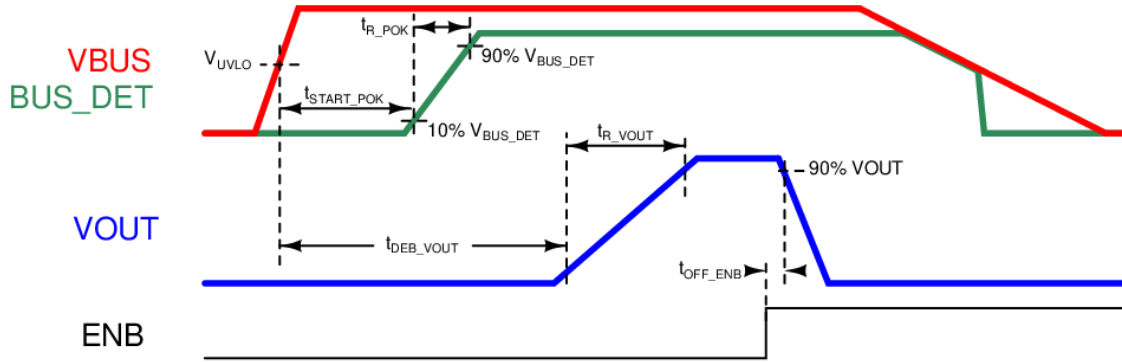


Figure 4. VBUS to VOUT Power Up/Down and Normal Operation

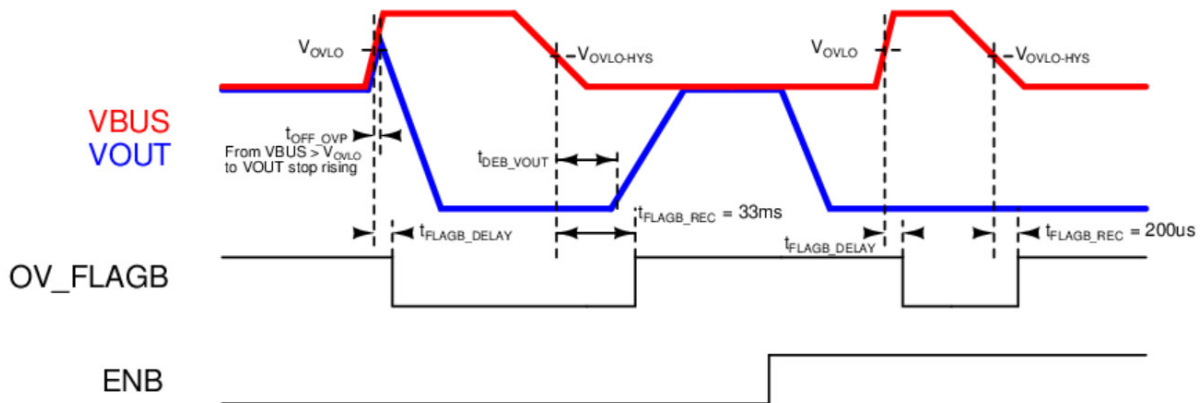


Figure 5. VBUS to VOUT OVLO Operation

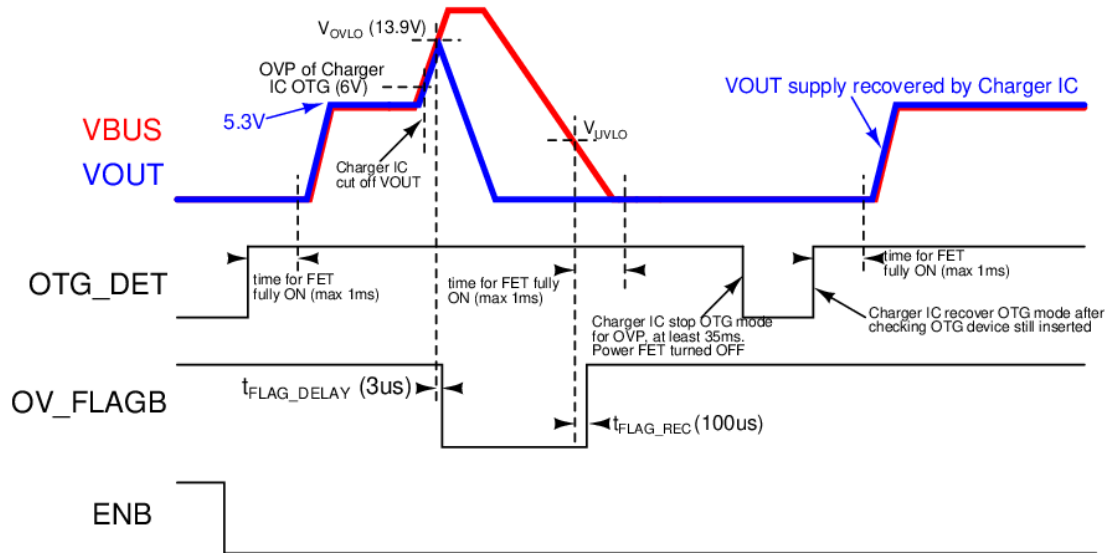


Figure 6. OVP in OTG Mode Operation (with Charger IC Internal OVP 6 V)

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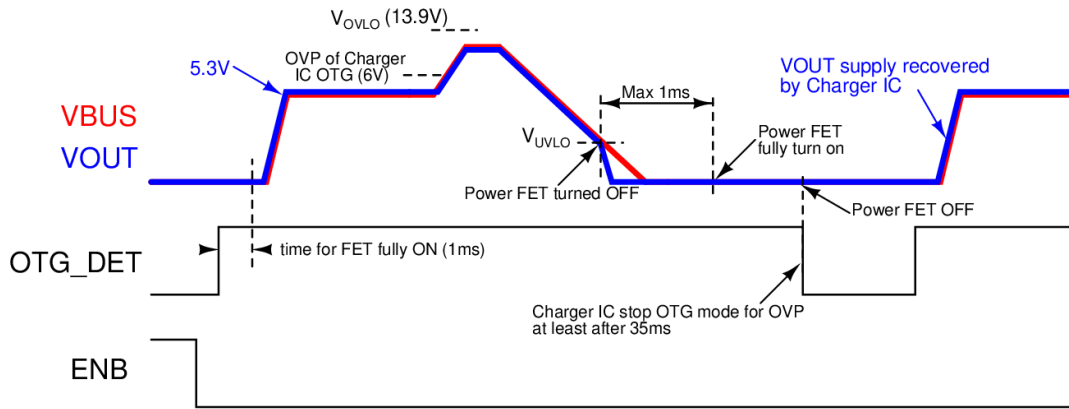


Figure 7. HV Event without OVLO in OTG Mode Operation (with Charger IC Internal OVP 6 V)

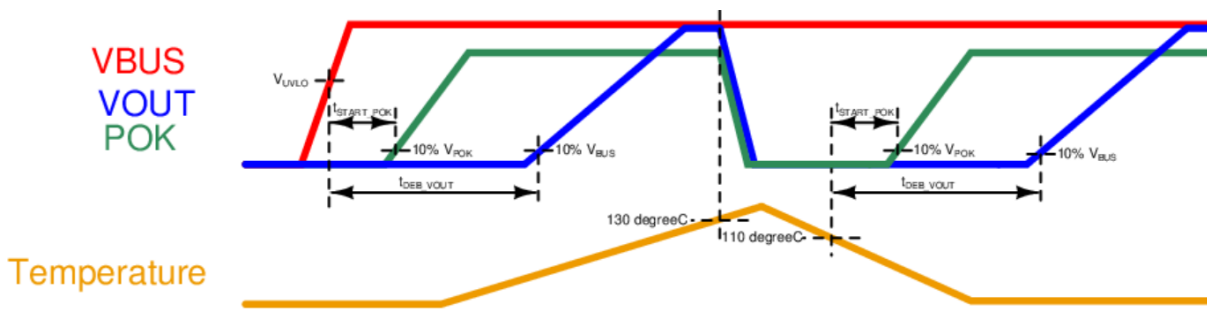


Figure 8. Thermal Shutdown Operation

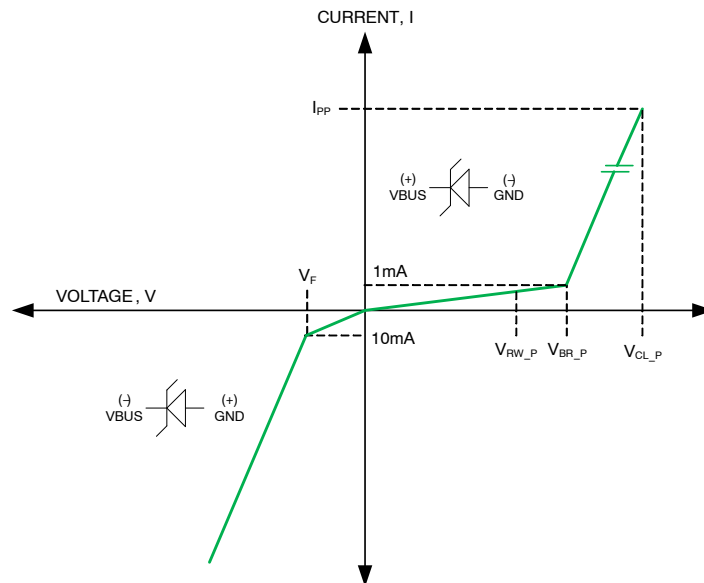


Figure 9. Integrated TVS IV Curve at VBUS

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### ORDERING INFORMATION

| Part Number | Top Marking | Operating Temperature Range | Package           | Shipping <sup>†</sup> |
|-------------|-------------|-----------------------------|-------------------|-----------------------|
| FPF2188UCX  | 3Y          | –40°C to +85°C              | WLCSP20 (Pb-Free) | 3000 / Tape & Reel    |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

# FPF2188UCX

## PACKAGE DIMENSIONS

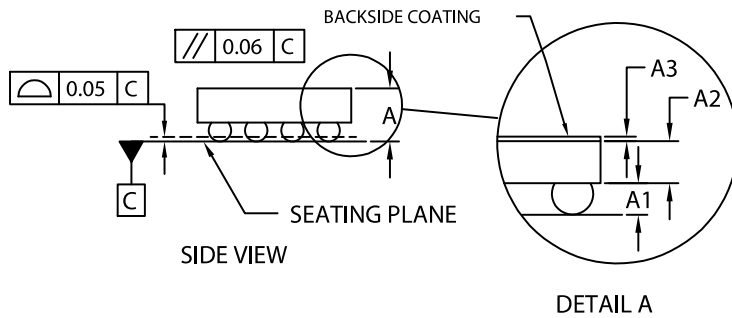
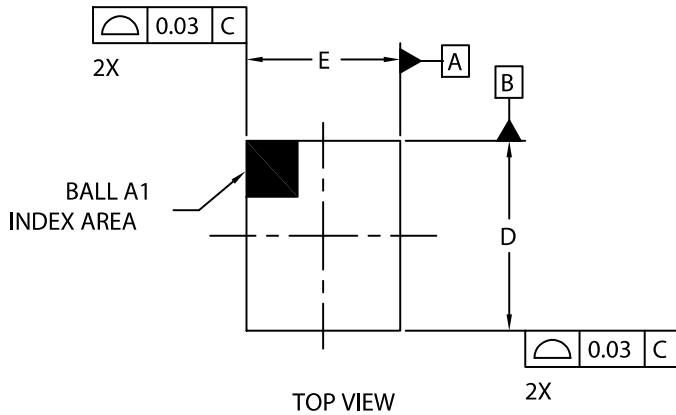
WLCSP20 2.03x1.77x0.585

CASE 567ZF

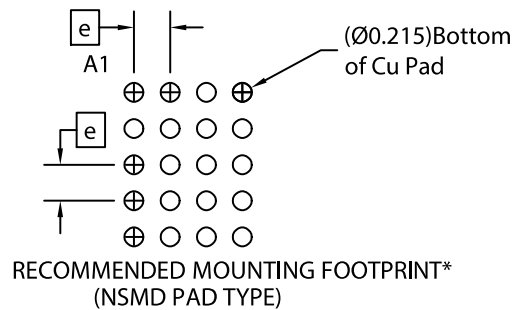
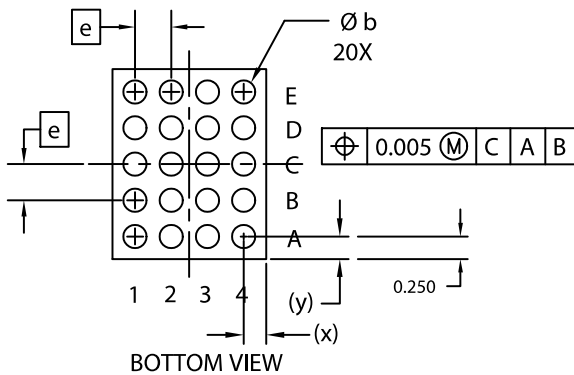
ISSUE A

### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DATUM C APPLIES TO THE SPHERICAL CROWN OF THE SOLDER BALLS



| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN.        | NOM.  | MAX.  |
| A   | 0.560       | 0.585 | 0.610 |
| A1  | 0.184       | 0.194 | 0.204 |
| A2  | 0.354       | 0.366 | 0.378 |
| A3  | 0.022       | 0.025 | 0.028 |
| b   | 0.240       | 0.260 | 0.280 |
| D   | 2.000       | 2.030 | 2.060 |
| E   | 1.740       | 1.770 | 1.800 |
| e   | 0.40 BSC    |       |       |
| x   | 0.270       | 0.285 | 0.300 |
| y   | 0.200       | 0.215 | 0.230 |



\*For additional information on our Pb-Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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