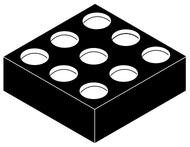
IntelliMAX™ 28 V, Over-Voltage, Over-Current Protection Load Switch with Adjustable Current-Limit Control

FPF2495C



WLCSP9 1.21x1.21x0.586
CASE 567RV

MARKING DIAGRAM

T5	= Specific Device Code
&K	= Lot Run Traceability Code
&.	= Pin One Dot
&2	= Date Code
&Z	= Assembly Plant Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

Description

The FPF2495C advanced load−management switch targets applications requiring a highly integrated solution. It disconnects loads powered from the DC power rail (<6 V) with stringent off−state current targets and high load capacitances (<100 μF). The FPF2495C consists of a slew−rate controlled low−impedance MOSFET switch (100 mΩ maximum) and integrated analog features. The slew−rate controlled turn−on characteristic prevents inrush current and the resulting excessive voltage droop on power rails. FPF2495C has over−voltage protection and over−temperature protection.

The FPF2495C has a True Reverse−Current Blocking (TRCB) function that obstructs unwanted reverse current from V_{OUT} to V_{IN} during ON and OFF states. The exceptionally low off−state current drain (<2 μA maximum) facilitates compliance with standby power requirements. The input voltage range operates from 2.5 V to 5.5 V_{DC} to support a wide range of applications in consumer, optical, medical, storage, portable, and industrial−device power management. Switch control is managed by a logic input (active HIGH) capable of interfacing directly with low−voltage control signal / General−Purpose Input / Output (GPIO) without an external pull−down resistor.

The device is packaged in advanced, fully “green” compliant, 1.21 mm x 1.21 mm, Wafer−Level Chip−Scale Package (WLCSP).

Features

- V_{IN}: 2.5 V~5.5 V
- 28 V Absolute Ratings at V_{OUT}
- Current Capability: 2 A
- Adjustable Current Limit: 0.05 A~2 A (Typ.)
- R_{ON}: Maximum 100 mΩ at 5 V_{IN} and 1 A I_{OUT}
- Output OVP: Min. = 5.6 V, Typ. = 5.8 V, Max. = 6 V
- No Output Discharge During Off State
- Open−Drain OCP on FLAGB
- Thermal Shutdown
- Under−Voltage Lockout (UVLO)
- True Reverse−Current Blocking (TRCB)
- Logic CMOS IO Meets JESD76 Standard for GPIO Interface and Related Power Supply Requirements
- ESD Protected:
  - ♦ Human Body Model: >2 kV
  - ♦ Charged Device Model: >2.5 kV
  - ♦ IEC 61000−4−2 Air Discharge: >15 kV
  - ♦ IEC 61000−4−2 Contact Discharge: >8 kV
- UL Listed − File No. E467988 and IEC60950−1 (ed.2): am1
- This is a Pb−Free Device

Applications

- Smart Phones, Tablet PCs
- Storage, DSLR, and Portable Devices

September, 2022 − Rev. 3

APPLICATION DIAGRAM

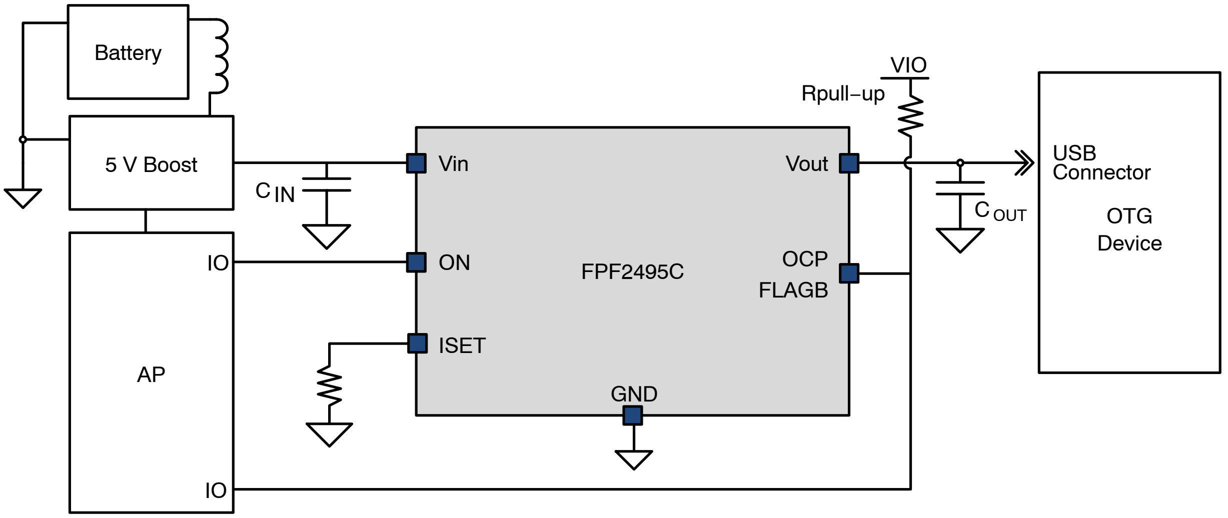


Figure 1. Typical Application

NOTE:

1. C_{IN} and C_{OUT} capacitors recommended for improvement of device stability.

FUNCTIONAL BLOCK DIAGRAM

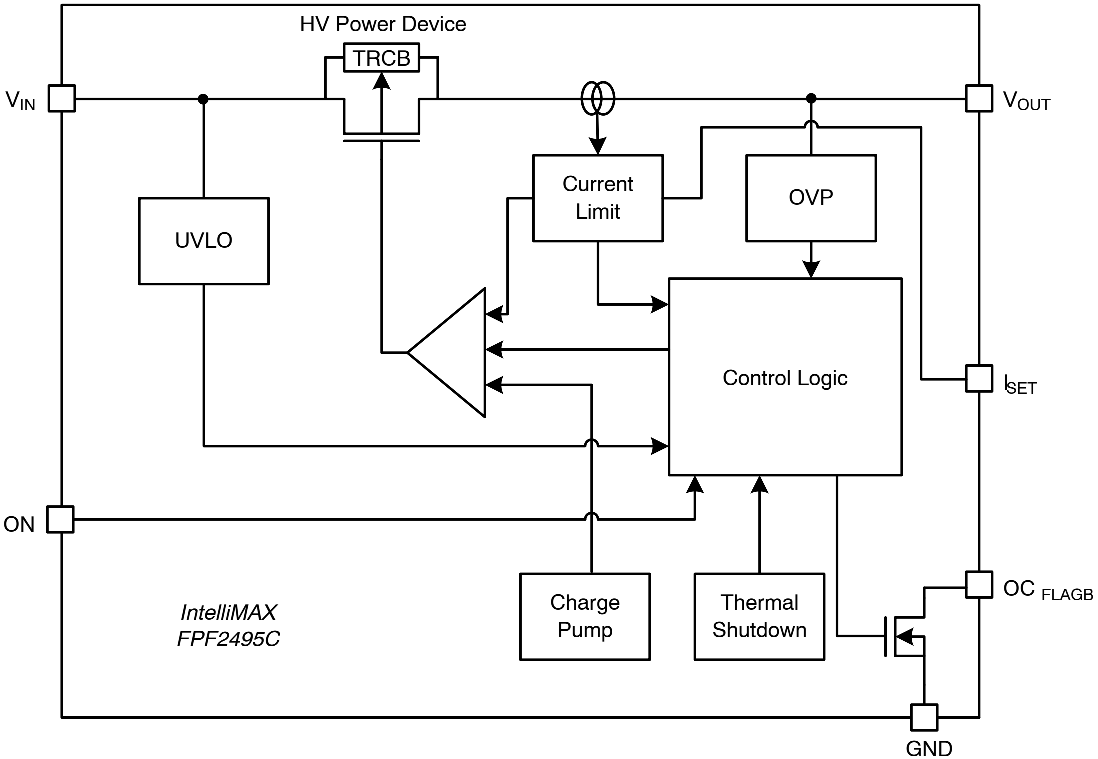


Figure 2. Functional Block Diagram

PIN CONFIGURATIONS

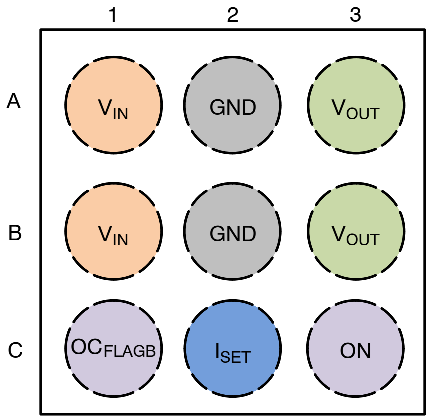


Figure 3. Pin Assignments (Top View)

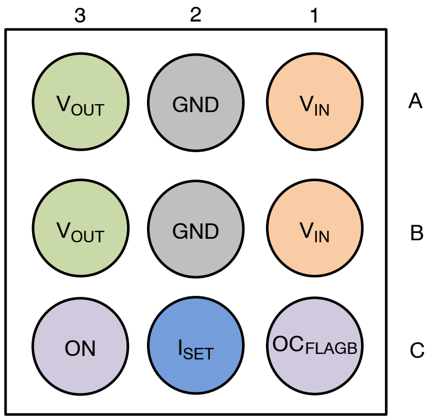


Figure 4. Pin Assignments (Bottom View)

PIN DESCRIPTION

Pin No.	Name	Description		
A3, B3	V_{OUT}	*Switch Output*		
A1, B1	V_{IN}	*Supply Input:* Input to the power switch		
A2	GND	*Ground* (true device ground)		
B2				
C3	ON	*ON/OFF Control Input:* Active HIGH – GPIO compatible	*Logic HIGH*	Switch Enable
			Logic LOW	Switch Disable
C1	OC_{FLAGB}	*Fault Output:* Active LOW, open–drain output that indicates an input over current. External pull–up resistor to V_{CC} is required.		
C2	I_{SET}	*Current Limit Set Input:* A resistor from ISET to ground sets the current limit for the switch.		

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Parameter	Min	Max	Unit
V_{PIN}	V_{OUT} to GND, V_{OUT} to V_{IN}		−0.3	28.0	V
	ON, V_{IN}, FLAGB, I_{SET} to GND		−0.3	6.0	
I_{SW}	Maximum Continuous Switch Current (Note 4)		–	2.2	A
t_{PD}	Total Power Dissipation at T_A = 25°C		–	1.0	W
T_J	Operating Junction Temperature		−40	+150	°C
T_{STG}	Storage Junction Temperature		−65	+150	°C
Q_{JA}	Thermal Resistance, Junction−to−Ambient (1−inch Square Pad of 2 oz. Copper)		–	95 (Note 2)	°C/W
			–	110 (Note 3)	
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22−A114	2.0	–	kV
		Charged Device Model, JESD22−C101	2.5	–	
	IEC61000−4−2 System Level	Air Discharge (V_{IN}, V_{ON}, V_{OUT} to GND)	15.0	–	
		Contact Discharge (V_{IN}, V_{ON}, V_{OUT} to GND)	8.0	–	

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.

2. Measured using 2S2P JEDEC std. PCB.
3. Measured using 2S2P JEDEC PCB cold plate method.
4. Maximum Junction Temperature = 85°C.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V_{IN}	Supply Voltage	2.5	5.5	V
T_A	Ambient Operating Temperature	−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.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 2.5 to 5.5 V, T_A = –40 to +85°C; typical values are at V_{IN} = 5 V and T_A = 25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
BASIC OPERATION						
V_{IN}	Input Voltage		2.5	–	5.5	V
$I_{Q(OFF)}$	Off Supply Current	V_{ON} = GND, V_{OUT} = Open	–	1	2	µA
$I_{SD(OFF)}$	Shutdown Current	V_{IN} = 5.5 V, V_{OUT} = 0 V, V_{ON} = GND	–	0.1	4.0	µA
I_Q	Quiescent Current	I_{OUT} = 0 mA	–	65	100	µA
R_{ON}	On Resistance	V_{IN} = 5.0 V, I_{OUT} = 1 A	–	70	100	mΩ
		V_{IN} = 3.7 V, I_{OUT} = 1 A	–	75	105	
R_{ON}	On Resistance (Note 6)	V_{IN} = 5.0 V, I_{OUT} = 1.5 A	–	70	–	mΩ
V_{IH}	ON Input Logic HIGH Voltage	V_{IN} = 2.5 V to 5.5 V	1.15	–	–	V
V_{IL}	ON Input Logic LOW Voltage	V_{IN} = 2.5 V to 5.5 V	–	–	0.65	V
V_{IL_FLAG}	FLAGB Output Logic LOW Voltage	V_{IN} = 5 V, I_{SINK} = 10 mA	–	0.1	0.2	V
		V_{IN} = 2.5 V, I_{SINK} = 10 mA	–	0.15	0.30	
I_{FLAGB_LK}	FLAGB Output HIGH Leakage Current	V_{IN} = 5 V, Switch On	–	–	1	µA
I_{ON}	On Input Leakage	V_{ON} = 0 V to V_{IN}	–	–	1.0	µA
R_{ON_PD}	Pull–Down Resistance at ON Pin	V_{IN} = 2.5~5.5 V, V_{ON} = HIGH, T_A = –40 to 85°C	–	14	–	MΩ
OVER–VOLTAGE PROTECTION						
V_{OV_TRIP}	Output OVP Lockout	V_{OUT} Rising Threshold	5.50	5.80	6.00	V
		V_{OUT} Falling Threshold	–	5.50	–	
OUT_{HYS}	Output OVP Hysteresis	V_{OUT} Falling Threshold	–	0.3	–	V
t_{OVP}	OVP Response Time (Note 6)	I_{OUT} = 0.5 A, C_L = 1 µF, T_A=25°C, V_{OUT} from 5.5 V to 6.0 V	1	–	4 (Note 6)	µs
OVER–CURRENT PROTECTION						
I_{LIM}	Current Limit	V_{IN} = 5 V, R_{SET} = 9530 Ω, V_{OUT} = 1.68 to 5 V with 25% Accuracy (Note 5)	80	107	134	mA
		V_{IN} = 5 V, R_{SET} = 2100 Ω, V_{OUT} = 1.68 to 5 V with 10% Accuracy (Note 5)	437	486	535	
		V_{IN} = 5 V, R_{SET} = 1070 Ω, V_{OUT} = 1.68 to 5 V with 10% Accuracy (Note 5)	858	953	1048	
V_{UVLO}	Under–Voltage Lockout	V_{IN} Increasing	–	2.4	–	V
		V_{IN} Decreasing	–	2.2	–	
V_{UVLO_HYS}	UVLO Hysteresis		–	200	–	mV
V_{T_RCB}	RCB Protection Trip Point	V_{OUT} – V_{IN}	–	50	–	mV
V_{R_RCB}	RCB Protection Release Trip Point	V_{IN} – V_{OUT}	–	50	–	mV
V_{RCB_HYS}	RCB Hysteresis		–	100	–	mV
t_{RCB}	Default RCB Response Time	V_{IN} = 5 V, V_{ON} = High / Low	–	2	–	µs
I_{RCB}	RCB Current	V_{ON} = 0 V, V_{OUT} = 5.5 V,	–	7	–	µA
t_{HOCP}	Hard Over–Current Response Time	Moderate Over–Current Condition, $I_{OUT} \geq I_{LIM}$, V_{OUT} = 0 V	–	6	–	µs
t_{OCP}	Over–Current Response Time	Moderate Over–Current Condition, $I_{OUT} \geq I_{LIM}$ $V_{OUT} \leq V_{IN}$	–	7	–	µs

ELECTRICAL CHARACTERISTICS

(V_{IN} = 2.5 to 5.5 V, T_A = −40 to +85°C; typical values are at V_{IN} = 5 V and T_A = 25°C unless otherwise noted) (continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{OC_FLAG}	Over−Current Flag Response Time	When Over−Current Occurs to Flag Pulling LOW	–	8	–	ms
TSD	Thermal Shutdown	Shutdown Threshold	–	150	–	°C
		Return from Shutdown	–	130	–	
		Hysteresis	–	20	–	

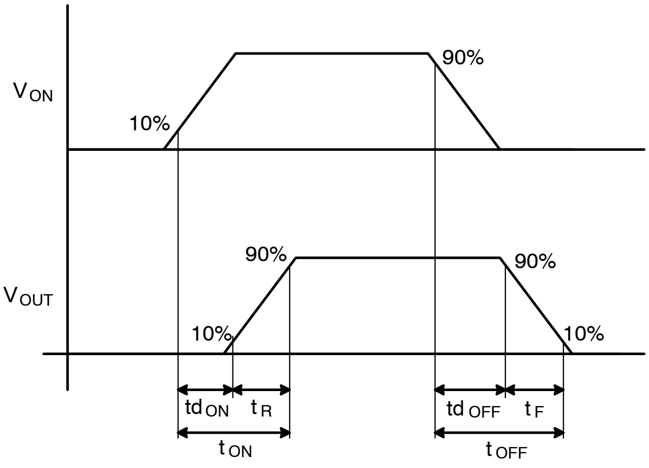
DYNAMIC CHARACTERISTICS

t_{DON}	Turn−On Delay (Note 6, 7)	V_{IN} = 5 V, R_L = 100 Ω, C_L = 1 μF, T_A = 25°C, R_{SET} = 2040 Ω	–	0.67	–	ms
t_R	V_{OUT} Rise Time (Note 6, 7)		–	0.69	–	ms
t_{ON}	Turn−On Time (Note 6, 8)		–	1.36	–	ms
t_{DOFF}	Turn−Off Delay (Note 6, 7)		–	0.01	–	ms
t_F	V_{OUT} Fall Time (Note 6, 7)		–	0.22	–	ms
t_{OFF}	Turn−Off Time (Note 6, 9)		–	0.23	–	ms
t_{DON}	Turn−On Delay (Note 7,10)	V_{IN} = 5 V, R_L = 3.8 Ω, C_L = 10 μF, T_A = −40 to 85°C, R_{SET} = 634 Ω	–	0.65	0.78	ms
t_R	V_{OUT} Rise Time (Note 7,10)		–	0.65	0.82	ms
t_{ON}	Turn−On Time (Note 8,10)		–	1.3	1.6	ms
t_{DOFF}	Turn−Off Delay (Note 7,10)		–	4	10	μs
t_F	V_{OUT} Fall Time (Note 7,10)		–	76	120	μs
t_{OFF}	Turn−Off Time (Note 9,10)		–	80	130	μs

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

5. Characterization based on 1% tolerance resistor. I_{LIM} measured in regulated region (not during the transition when OC_{FLAGB} is triggered).
6. This parameter is guaranteed by design and characterization; not production tested.
7. t_{DON} / t_{DOFF} / t_R / t_F are defined in Figure 5 below.
8. $t_{ON} = t_R + t_{DON}$.
9. $t_{OFF} = t_F + t_{DOFF}$.
10. This parameter is guaranteed by design.

TIMING DIAGRAM



Where:
t_{DON} = Delay On Time
t_R = V_{OUT} Rise Time
t_{ON} = Turn−On Time
t_{DOFF} = Delay Off Time
t_F = V_{OUT} Fall Time
t_{OFF} = Turn Off Time

Figure 5. Timing Diagram

OPERATION AND APPLICATION DESCRIPTION

Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current when the switch turns on into discharge load capacitor; a capacitor must be placed in between the V_{IN} and GND pins. A high−value capacitor on C_{IN} can be used to reduce the voltage drop in high−current applications.

Output Capacitor

An output capacitor should be placed between the V_{OUT} and GND pins. This capacitor prevents parasitic board inductance from forcing V_{OUT} below GND when the switch is on. This capacitor also prevents reverse inrush current from creating a voltage spike that could damage the device in the case of a V_{OUT} short.

Fault Reporting

Upon the detection of an over−current, OC_FLAGB signal the fault by activating LOW.

Current Limiting

The current limit ensures that the current through the switch does not exceed the maximum set value, while not limiting the minimum value. The current at which the part's limit is adjustable through the selection of the external resistor connected to the ISET pin. Information for selecting the resistor is found in the section below. The device acts as a constant−current source when the load draws more than the maximum value set by the device until thermal shutdown occurs. The device recovers if the die temperature drops below the threshold temperature.

Under−Voltage Lockout (UVLO)

The under−voltage lockout turns the switch off if the input voltage drops below the lockout threshold. With the ON pin active, the input voltage rising above the UVLO threshold releases the lockout and enables the switch.

True Reverse−Current Blocking

The true reverse−current blocking feature protects the input source against current flow from output to input regardless of whether the load switch is on or off.

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.

Setting Current Limit

The current limit is set with an external resistor connected between the I_{SET} and GND pins. The resistor is selected using the formula:

$I_{LIM}\ (mA) = ((0.4 / R_{SET}\ \Omega) \times 2550) \times 1000$

Resistor tolerance of 1% or less is recommended.

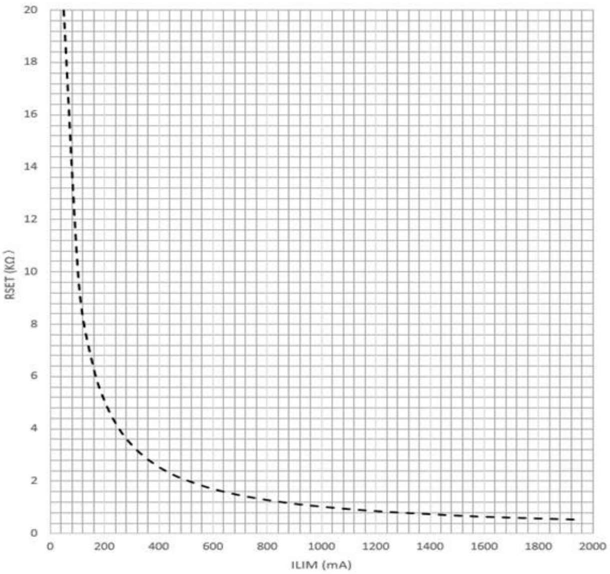


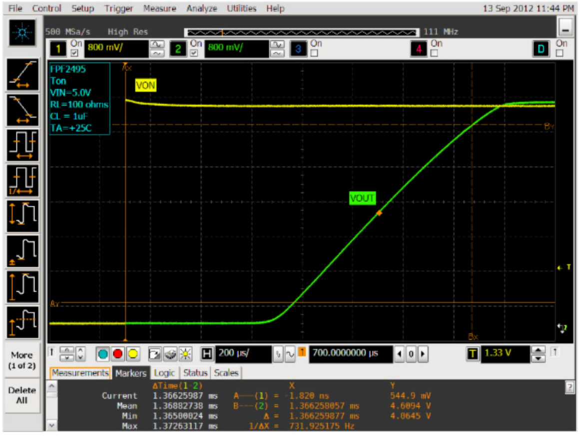
Figure 6. Current Limit Settings by R_{SET} (Note 11)

11. Values based on 1% tolerance resistor.

BOARD LAYOUT

For best performance, all traces should be as short as possible. To be most effective, the input and output capacitors should be placed close to the device to minimize the effect that parasitic trace inductance may have on normal and short−circuit operation. Using wide traces for VIN, VOUT, GND helps minimize parasitic electrical effects along with minimizing the case−to−ambient thermal impedance.

TYPICAL PERFORMANCE CHARACTERISTICS (T_A = 25°C)

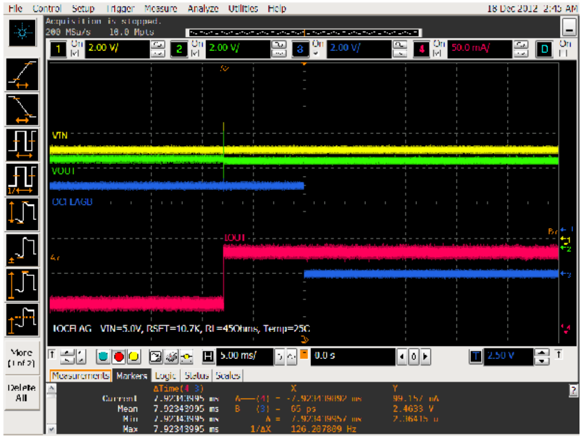


```
            ΔTime(1-2)                    X                  Y
Current     1.36625987 ms   A——(1) = -1.820 ns          544.9 mV
   Mean     1.36882738 ms   B---(2) =  1.366258057 ms   4.6094 V
    Min     1.36500024 ms         Δ =  1.366259877 ms   4.0645 V
    Max     1.37263117 ms      1/ΔX =  731.925175 Hz
```

Figure 7. t_{ON} Response

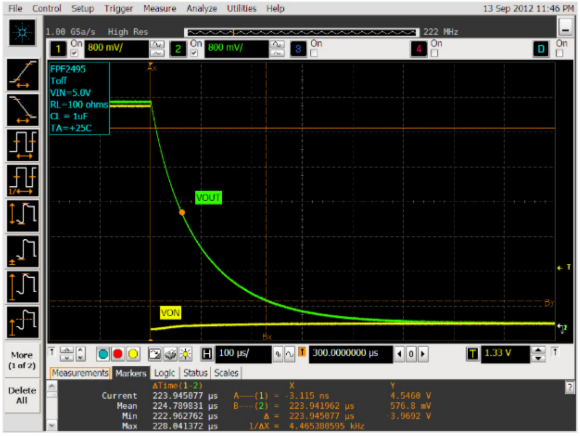
```
            ΔTime(2-2)                    X                  Y
Current     21.0568426 µs   A——(2) =  24.4785611 µs     5.82000 V
   Mean     23.3490299 µs   B---(2) =  45.5354037 µs    5.48001 V
    Min     21.0568426 µs         Δ =  21.0568426 µs    -339.990 mV
    Max     24.8710853 µs      1/ΔX =  47.4905008 kHz
```

Figure 8. OVP Response
(Increase V_{OUT} to OVP Trip Point)



```
            ΔTime(4-3)                    X                  Y
Current     7.92343995 ms   A——(4) = -7.923439892 ms    99.157 mA
   Mean     7.92343995 ms   B   (3) =  65 ps            2.4633 V
    Min     7.92343995 ms         Δ =  7.923439957 ms   2.36415 u
    Max     7.92343995 ms      1/ΔX    126.207809 Hz
```

Figure 9. OC_FLAGB Response Time
(Toggle R_{LOAD} from High to Low Resistance)



```
            ΔTime(1-2)                    X                  Y
Current     223.945077 µs   A——(1) = -3.115 ns          4.5460 V
   Mean     224.789831 µs   B---(2) =  223.941962 µs    576.8 mV
    Min     222.962762 µs         Δ =  223.945077 µs    -3.9692 V
    Max     228.041372 µs      1/ΔX =  4.465380595 kHz
```

Figure 10. t_{OFF} Response

```
                     X                  Y
A——(4) = -666.72 ns          182.52 mA
B   (4) =  9.77773 µs        372.14 mA
      Δ =  10.44444 µs       189.62 mA
   1/ΔX    95.74468 kHz
```

Figure 11. t_{OCP} Response Time

ORDERING INFORMATION

Part Number	Top Mark	Manufacturing	Operating Temperature Range	Package	Shipping†
FPF2495CUCX	T5	Multiple Assembly & Test Sites	−40 to 85°C	WLCSP9 1.21x1.21x0.586 (Pb−Free)	3000 / Tape & Reel

†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.

Table 1. PRODUCT−SPECIFIC DIMENSIONS

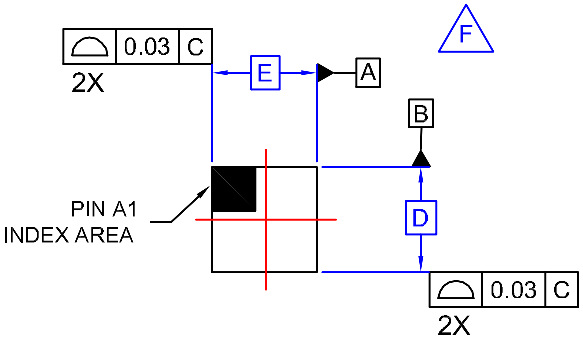
D	E	X	Y
1210 μm ±30 μm	1210 μm ±30 μm	205 μm	205 μm

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

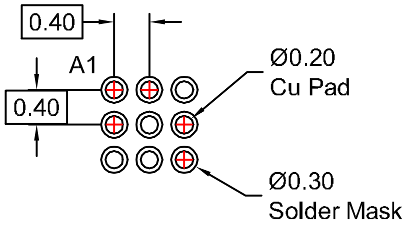
ON Semiconductor®

WLCSP9 1.21x1.21x0.586
CASE 567RV
ISSUE O

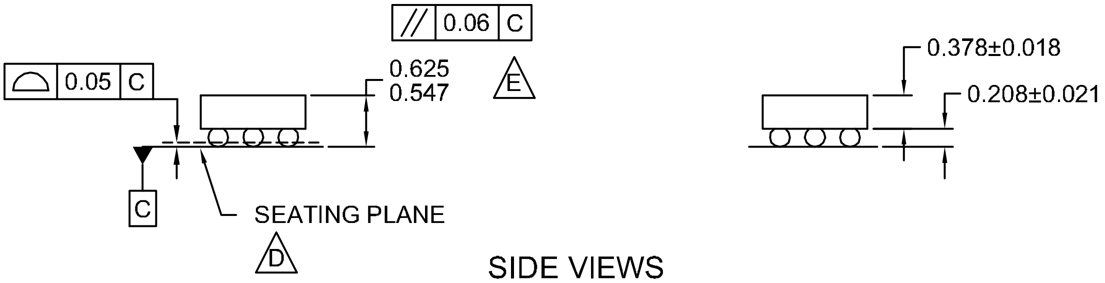
DATE 30 NOV 2016



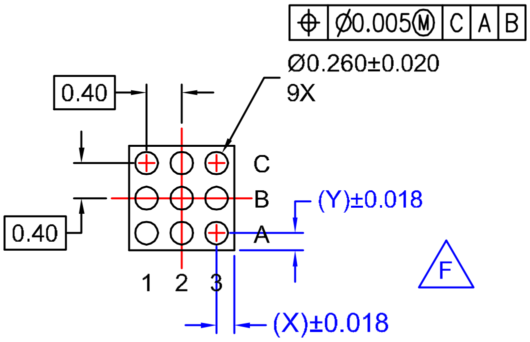
TOP VIEW



LAND PATTERN RECOMMENDATION
(NSMD PAD TYPE)



SIDE VIEWS



BOTTOM VIEW

NOTES:

A. NO JEDEC REGISTRATION APPLIES.

B. DIMENSIONS ARE IN MILLIMETERS.

C. DIMENSIONS AND TOLERANCE PER ASMEY14.5M, 1994.

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.

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