

# Current Limit Switch, with OVP and TRCB, 28 V / 5 A Rated

## FPF2895C

### Description

The FPF2895C features a 28 V and 5 A rated current limit power switch, which offers Over-Current Protection (OCP), Over-Voltage Protection (OVP), and True Reverse Current Block (TRCB) to protect system. It has low On-resistance of typical 27 mΩ with WL-CSP can operate over an input voltage range of 4 V to 22 V.

The FPF2895C supports  $\pm 10\%$  of current limit accuracy, over-current range of 500 mA to 2 A and  $\pm 5\%$  of current limit accuracy, over-current range of 2 A to 5 A, flexible operations such as selectable OVP, selectable ON polarity and selectable OCP behavior, which can be optimized according to system requirements.

The FPF2895C is available in a 24-bump, 1.67 mm x 2.60 mm Wafer-Level Chip-Scale Package (WLCSP) with 0.4 mm pitch.

### Features

- 28 V / 5 A Capability
- Wide Input Voltage Range: 4 V ~ 22 V
- Ultra Low On-Resistance
  - ◆ Typ. 27 mΩ at 5 V and 25 °C
- Adjustable Current Limit with external RSET
  - ◆ 500 mA ~ 5 A
- Selectable OVLO with OV1 and OV2 Logic Input
  - ◆ 5.95 V  $\pm$  50 mV
  - ◆ 10 V  $\pm$  100 mV
  - ◆ 16.8 V  $\pm$  300 mV
  - ◆ 23 V  $\pm$  460 mV
- Selectable ON Polarity
- Selectable Over-Current Behavior
  - ◆ Auto-Restart Mode
  - ◆ Current Source Mode
- True Reverse Current Block
- Thermal Shutdown
- Open Drain Fault FLAGB Output
- UL60950-1 & IEC 60950-1 Certification 5 A Max Loading
- Robust ESD Capability
  - ◆ 2 kV HBM & 1 kV CDM
  - ◆ 15 kV Air Discharge & 8 kV Contact Discharge under IEC 61000-4-2

### Applications

- Laptop, Desktop Computing and Monitor
- Power Accessories



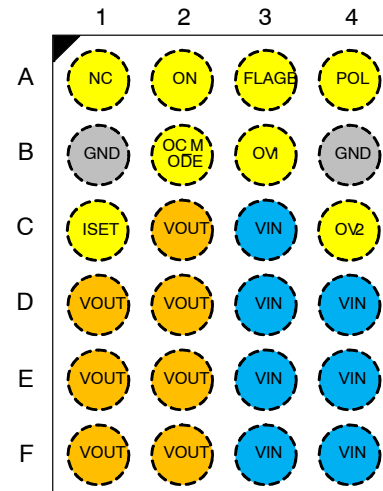
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WLCSP24 2.6x1.67x0.612  
CASE 567TQ

### PIN CONFIGURATION



### ORDERING INFORMATION

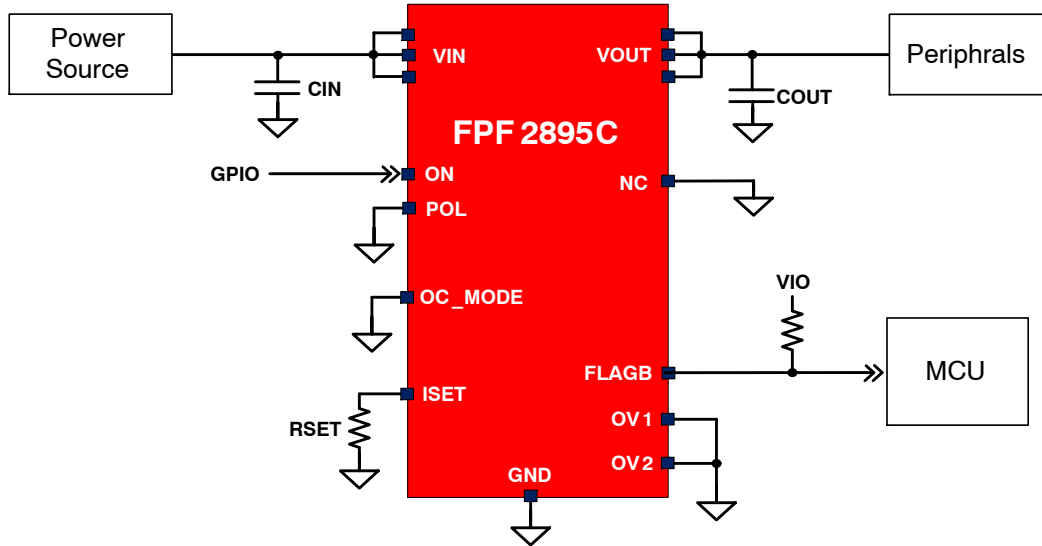
See detailed ordering and shipping information on page 2 of this data sheet.

# FPF2895C

**Table 1. ORDERING INFORMATION**

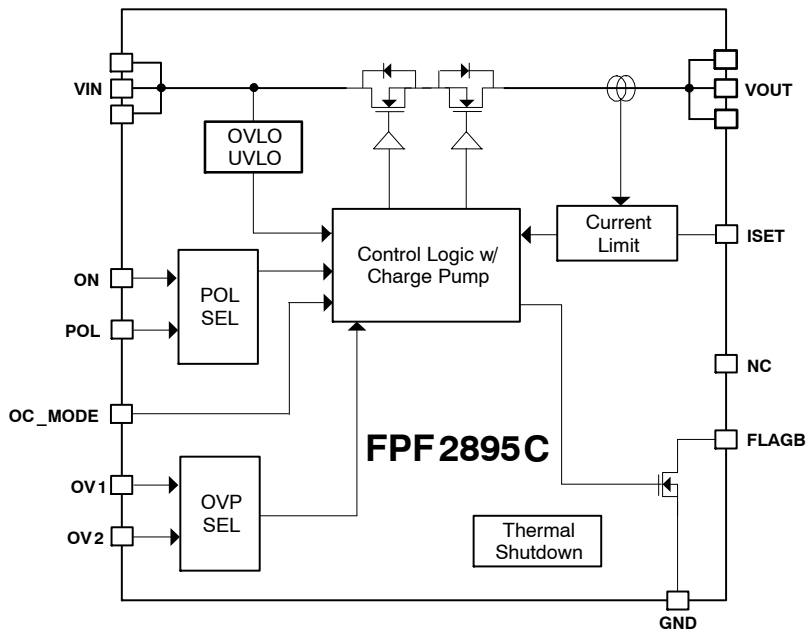
Part Number	Operating Temperature Range	Top Mark	Package	Packing Method
FPF2895CUCX	-40°C – +85°C	3G	24-Ball, 0.4 mm Pitch WLCSP	Tape & Reel

## Application Diagram



**Figure 1. Typical Application**

## Block Diagram



**Figure 2. Functional Block Diagram**

PIN CONFIGURATION

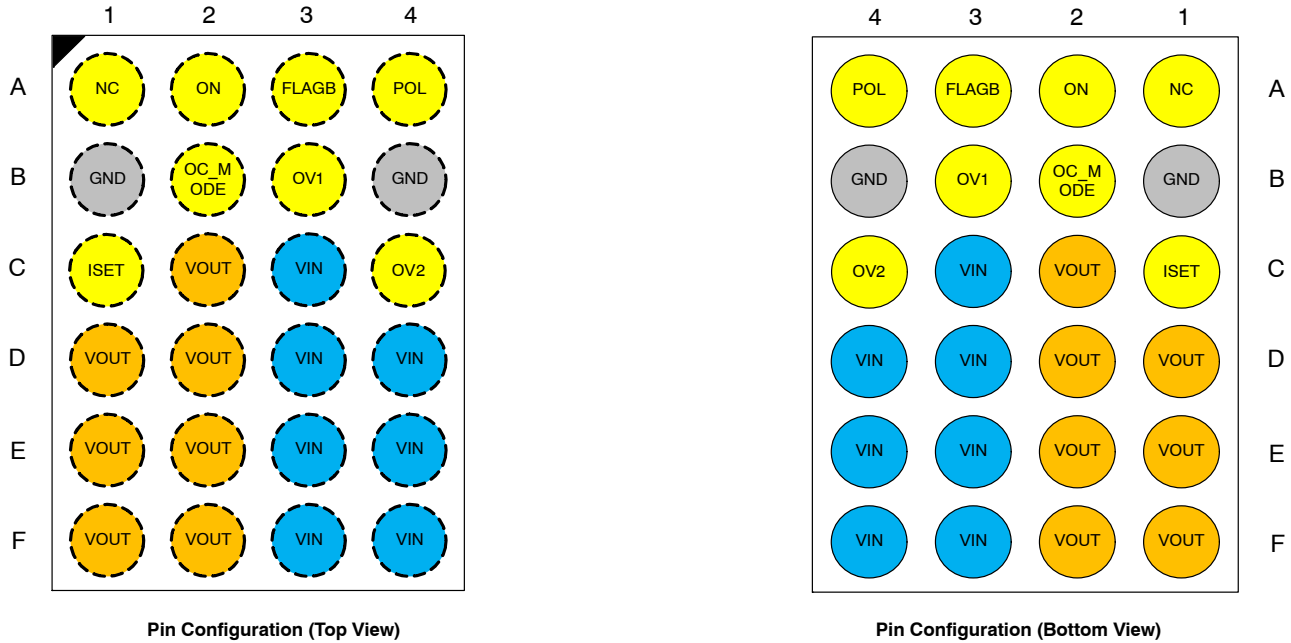


Figure 3. 24 Ball WL\_CSP, 4 x 6 Array, 0.4 mm Pitch, 250 μm Ball

Table 2. PIN DEFINITIONS

Name	Bump	Type	Description
VIN	C3, D3, D4, E3, E4, F3, F4	Input/Supply	Switch Input and Device Supply
VOUT	C2, D1, D2, E1, E2, F1, F2	Output	Switch Output to Load
NC	A1	Dummy	Recommended to connect to GND
ON	A2	Input	Internal pull-down resistor of 1 MΩ is included. Active polarity is depending on POL state (Note 1)
POL	A4	Input	Enable Polarity Selection. Internal pull/up of 1 MΩ is included. HIGH (or Floating): Active LOW LOW: Active HIGH (Note 1)
FLAGB	A3	Output	Active LOW, open drain output indicates an over-current, under-voltage, over-voltage, or over-temperature state.
ISET	C1	Input	A resistor from ISET to ground set the current limit for the switch. See below selection Table 6.
OC_MODE	B2	Input	OCP behavior can be selected. Internal pull-up of 1 MΩ is included. HIGH (or Floating): Auto-restart mode during over-current condition. LOW: Current source mode during over-current condition. (Note 1)
OV1	B3	Input	Over-Voltage Selection Input 1. Internal pull-up of 1 MΩ is included and see below selection Table 7. (Note 1)
OV2	C4	Input	Over-Voltage Selection Input 2. Internal pull-up of 1 MΩ is included and see Table 7 (Note 1)
GND	B1, B4	GND	Device Ground

1. To avoid external noise influence when floating, recommend to connect these pins to a certain level.

# FPF2895C

**Table 3. ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Min.	Max.	Unit
V <sub>IN</sub> , V <sub>OUT</sub>	V <sub>IN</sub> , V <sub>OUT</sub> to GND	-0.3	28.0	V
V <sub>PIN</sub>	ON, POL, OC_MODE, ISET, FLAGB and OV <sub>n</sub> to GND	-0.3	6.0	V
I <sub>SW</sub>	Continuous Switch Current		5.5	A
t <sub>PD</sub>	Total Power Dissipation at T <sub>A</sub> = 25°C		2.08	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)		60 (Note 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	

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.

**Table 4. RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Min.	Max.	Unit
V <sub>IN</sub>	Supply Voltage	4.0	22.0	V
C <sub>IN</sub> /C <sub>OUT</sub>	Input and Output Capacitance	1.0		μF
T <sub>A</sub>	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.

# FPF2895C

**Table 5. ELECTRICAL CHARACTERISTICS** (Unless otherwise noted,  $V_{IN} = 4$  to  $22$  V,  $T_A = -40$  to  $85^\circ\text{C}$ ; typical values are at  $V_{IN} = 5$  V,  $C_{IN} = C_{OUT} = 1$   $\mu\text{F}$ ,  $\text{ON} = \text{HIGH}$ ,  $\text{POL} = \text{OV1} = \text{OV2} = \text{OC\_MODE} = \text{GND}$  and  $T_A = 25^\circ\text{C}$ .)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit	
<b>BASIC OPERATION</b>							
$V_{IN}$	Input Voltage (Note 4)		4		22	V	
$I_{SD\_IN}$	$V_{IN}$ Shutdown Current	$V_{ON} = \text{OFF}$ , $V_{IN} = 5.5$ V, $V_{OUT} = \text{Short to GND}$		75	100	$\mu\text{A}$	
$I_Q$	Quiescent Current	$I_{OUT} = 0$ mA, $V_{ON} = \text{ON}$	$V_{IN} = 5$ V		270	330	$\mu\text{A}$
			$V_{IN} = 12$ V		300	400	
			$V_{IN} = 20$ V		350	450	
$R_{ON}$	On Resistance	$T_A = 25^\circ\text{C}$ , $I_{OUT} = 1$ A	$V_{IN} = 5$ V		27	39	m $\Omega$
			$V_{IN} = 12$ V		27	39	
			$V_{IN} = 20$ V		27	39	
$I_{ON}$	ON Input Leakage	$V_{ON} = V_{IN}$ or GND			10	$\mu\text{A}$	
$V_{IH}$	Logic Pin Input (ON, POL, OV1, OV2, OC_MODE) High Voltage	$V_{IN} = 3$ V ~ $23$ V	1.2			V	
$V_{IL}$	Logic Pin Input (ON, POL, OV1, OV2, OC_MODE) Low Voltage	$V_{IN} = 3$ V ~ $23$ V			0.4	V	
$V_{P\_LOW}$	FLAGB Output Logic Low Voltage	$V_{IN} = 5$ V, $I_{SINK} = 5$ mA		0.1	0.2	V	
$I_{LKG}$	FLAGB Output High, Leakage Current	$V_{IN} = 5$ V, Switch ON			1	$\mu\text{A}$	
<b>PROTECTIONS</b>							
$I_{LIM}$	Current Limit (Note 3)	$V_{IN} = 5$ V, $V_{OUT} = 4$ V, $R_{SET} = 3.01$ k $\Omega$ , $T_A = -40$ to $85^\circ\text{C}$	1.35	1.50	1.65	A	
		$V_{IN} = 5$ V, $V_{OUT} = 4$ V, $R_{SET} = 1.54$ k $\Omega$ , $T_A = -40$ to $85^\circ\text{C}$	2.85	3.00	3.15		
$V_{FOLD}$	ILIM Foldback Trip Voltage (Note 3)	$V_{OUT}$ under ILIM Mode		2		V	
$I_{FOLD}$	ILIM Foldback Current (Note 3)	$V_{IN} = 5$ V, $V_{OUT} < V_{FOLD}$ , $T_A = 25^\circ\text{C}$ , $\text{OC\_MODE} = \text{HIGH}$		500		mA	
		$V_{IN} = 5$ V, $V_{OUT} < V_{FOLD}$ , $T_A = 25^\circ\text{C}$ , $\text{OC\_MODE} = \text{LOW}$		250		mA	
$V_{UVLO}$	Under-Voltage Lockout	$V_{IN}$ Increasing		2.70	2.95	V	
		$V_{IN}$ Decreasing		2.5			
	UVLO Hysteresis			200		mV	
$V_{OVLO}$	Over-Voltage Lockout (Note 3)	OV1 = LOW, OV2 = LOW	$V_{IN}$ Rising	22.20	23.00	23.46	V
			$V_{IN}$ Falling	22.00			
		OV1 = LOW, OV2 = HIGH	$V_{IN}$ Rising	9.80	10.00	10.10	
			$V_{IN}$ Falling	9.75			
		OV1 = HIGH, OV2 = LOW	$V_{IN}$ Rising	16.30	16.80	17.10	
			$V_{IN}$ Falling	16.10			
OV1 = HIGH, OV2 = HIGH	$V_{IN}$ Rising	5.85	5.95	6.00			
	$V_{IN}$ Falling	5.80					
$T_{OVP}$	OVP Response Time (Note 3)	$R_L = 100$ $\Omega$ , $C_L = 0$ $\mu\text{F}$ , $V_{IN} > V_{OVLO}$ to $V_{OUT} = 0.9 \times V_{IN}$			150	ns	
$V_{T\_RCB}$	TRCB Protection Trip Point	$V_{OUT} - V_{IN}$		25	40	mV	

# FPF2895C

**Table 5. ELECTRICAL CHARACTERISTICS** (Unless otherwise noted,  $V_{IN} = 4$  to  $22$  V,  $T_A = -40$  to  $85^\circ\text{C}$ ; typical values are at  $V_{IN} = 5$  V,  $C_{IN} = C_{OUT} = 1$   $\mu\text{F}$ , ON = HIGH, POL = OV1 = OV2 = OC\_MODE = GND and  $T_A = 25^\circ\text{C}$ .)

$V_{R\_RCB}$	TRCB Protection, Release Point	$V_{IN} - V_{OUT}$		25	40	mV
$t_{RCB}$	TRCB Response Time (Note 3)	$V_{IN} = 5$ V, $V_{ON} = \text{HIGH/LOW}$		5		$\mu\text{s}$
$t_{RCB\_Release}$	TRCB Release Time (Note 3)	$V_{IN} = 5$ V, Enabled		1		$\mu\text{s}$
$t_{OC}$	Over Current Response Time (Note 3)	$V_{IN} = 5$ V, Moderate OC		20		$\mu\text{s}$
		$V_{IN} = 5$ V, Hard Short		5		
$I_{SD\_OUT}$	VOUT Shutdown Current	$V_{ON} = \text{OFF}$ , $V_{OUT} = 5$ V, $V_{IN} = \text{Short to GND}$			2	$\mu\text{A}$
TSD	Thermal Shutdown (Note 3)	Shutdown Threshold		150		$^\circ\text{C}$
		Hysteresis		20		

## DYNAMIC BEHAVIOR

$t_{DON}$	Delay On Time	$R_L = 100$ $\Omega$ $C_L = 1$ $\mu\text{F}$		1		ms
$t_R$	VOUT Rise Time	$R_L = 100$ $\Omega$ $C_L = 1$ $\mu\text{F}$		1		ms
$t_{ON}$	Turn-On Time	$R_L = 100$ $\Omega$ $C_L = 1$ $\mu\text{F}$		2		ms
$t_{DOFF}$	Delay Off Time	$R_L = 100$ $\Omega$ $C_L = 1$ $\mu\text{F}$		10		$\mu\text{s}$
$t_F$	VOUT Fall Time	$R_L = 100$ $\Omega$ $C_L = 1$ $\mu\text{F}$		200		$\mu\text{s}$
$t_{OFF}$	Turn-Off Time	$R_L = 100$ $\Omega$ $C_L = 1$ $\mu\text{F}$		210		$\mu\text{s}$
$t_{BLANK}$	Over-Current Blanking Time (Note 3)	OC_MODE = HIGH		5		ms
$t_{RSTRT}$	Auto-Restart Time (Note 3)	OC_MODE = HIGH		200		ms
$t_{QUAL}$	Over-Current Qualification Time (Note 3)	OC_MODE = LOW		5		ms
$t_{DEB}$	FLAGB De-bounce Time (Note 3)	Restart-up during or after OC		3		ms
		Restart-up during or after Thermal shutdown		15		
		Restart-up during or after UVLO		1		

3. Guaranteed by characterization and design, not production test.

4. To avoid output voltage is coupled to high during cold start, the slew rate of  $V_{in}$  should be less than  $10$  mV/ $\mu\text{s}$

## Setting Current Limit

FPF2895C current limit is set with an external resistor connected between  $I_{SET}$  and GND. This resistor is selected using the following equation:

$$R_{SET}(\text{k}\Omega) = \left( \frac{4674.89}{I_{SET}(\text{mA})} \right)^{1/1.0326} \quad (\text{eq. 1})$$

Resistor tolerance of 1% or less is recommended. 5% tolerance can be achieved only when ILIM is set to larger than 2 A.

**Table 6. ILIM VS. RSET LOOK-UP TABLE**

RSET [k $\Omega$ ]	ILIM [mA]		
	Min.	Typ.	Max.
8.75	450	500	550
7.35	540	600	660
6.30	630	700	770
5.55	720	800	880
4.95	810	900	990
4.45	900	1000	1100
4.06	990	1100	1210
3.73	1080	1200	1320

# FPF2895C

**Table 6. ILIM VS. RSET LOOK-UP TABLE**

RSET [kΩ]	ILIM [mA]		
	Min.	Typ.	Max.
3.45	1170	1300	1430
3.21	1260	1400	1540
3.01	1350	1500	1650
2.82	1440	1600	1760
2.66	1530	1700	1870
2.52	1620	1800	1980
2.39	1710	1900	2090
2.28	1900	2000	2100
2.17	1995	2100	2205
2.07	2090	2200	2310
1.99	2185	2300	2415
1.91	2280	2400	2520
1.83	2375	2500	2625
1.77	2470	2600	2730
1.70	2565	2700	2835
1.64	2660	2800	2940
1.59	2755	2900	3045
1.54	2850	3000	3150
1.49	2945	3100	3255
1.44	3040	3200	3360
1.40	3135	3300	3465
1.36	3230	3400	3570
1.32	3325	3500	3675
1.29	3420	3600	3780
1.25	3515	3700	3885
1.22	3610	3800	3990
1.19	3705	3900	4095
1.16	3800	4000	4200
1.14	3895	4100	4305
1.11	3990	4200	4410
1.08	4085	4300	4515
1.06	4180	4400	4620
1.04 (Note 5)	4275	4500	4725
1.02	4370	4600	4830
0.99	4465	4700	4935
0.97	4560	4800	5040
0.96	4655	4900	5145
0.94	4750	5000	5250 (Note 6)

5. Passed UL&CB certification with max. 5 A output current.

6. 6 A absolute limit current value. See Figure 9. for protection timing diagram.

# FPF2895C

**Table 7. OVLO LEVEL SELECTION**

OV1	OV2	OVLO
LOW	LOW	23 V ± 460 mV
LOW	HIGH (Floating)	10 V ± 100 mV
HIGH (Floating)	LOW	16.3 ± V 300 mV
HIGH (Floating)	HIGH (Floating)	5.95 ± V 50 mV

**Table 8. DEVICE ENABLE POLARITY SELECTION**

POL	ON	Device State	ON Polarity
LOW	LOW (Floating)	OFF	Active HIGH
LOW	HIGH	ON	
HIGH (Floating)	LOW (Floating)	ON	Active LOW
HIGH (Floating)	HIGH	OFF	



TIMING DIAGRAMS

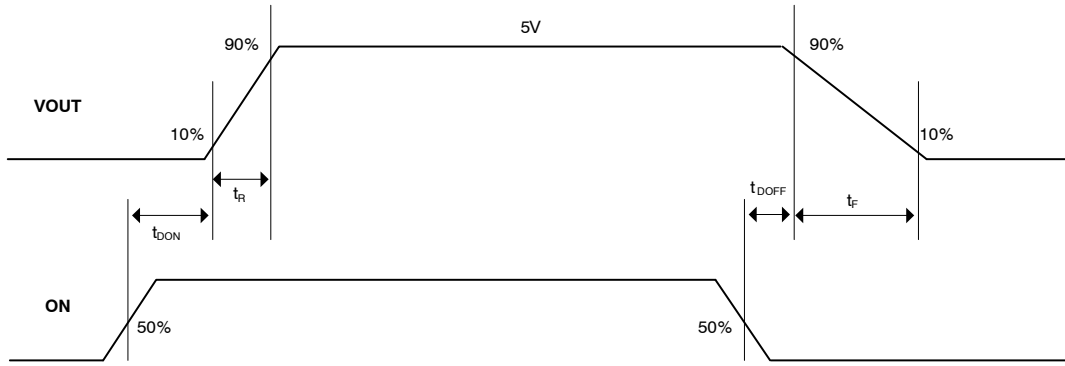


Figure 4. Normal ON/OFF Operation by ON (POL = GND)

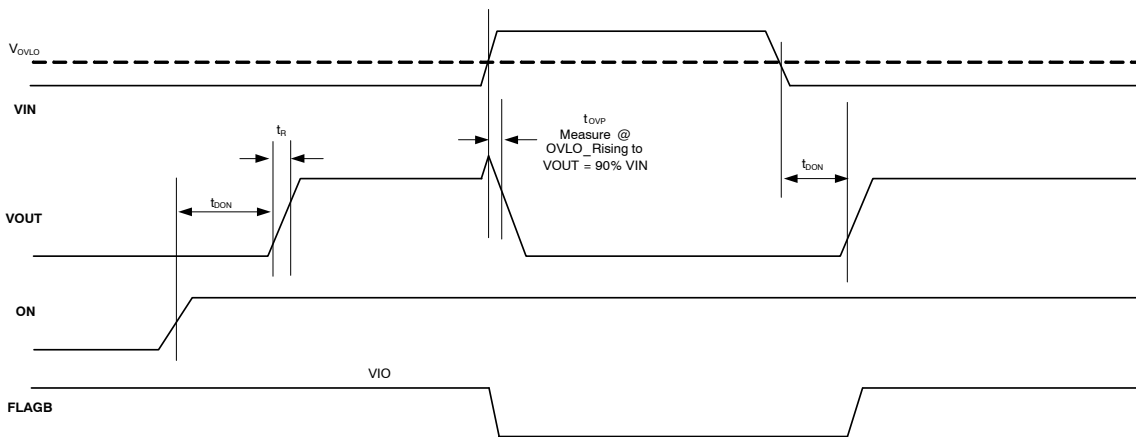


Figure 5. OVLO Operation (POL = GND & FLAGB is Pulled Up With an External VIO)

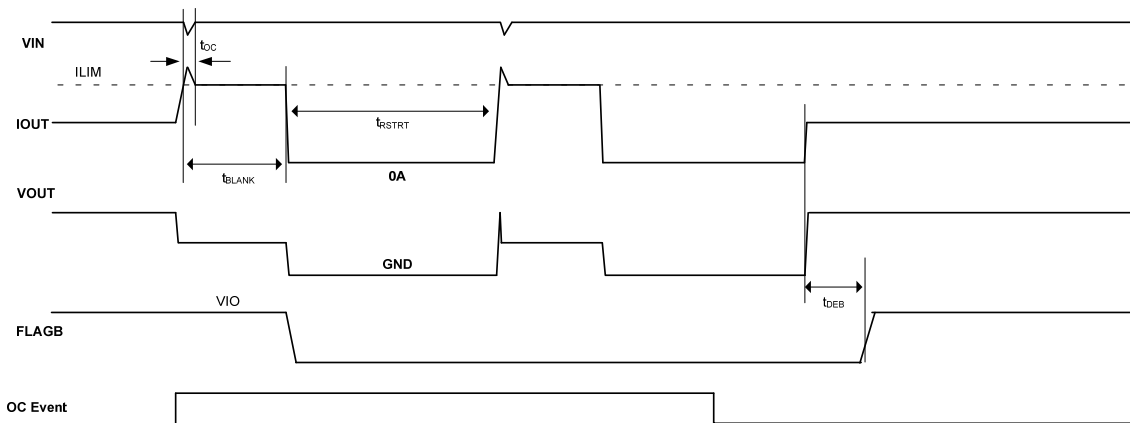


Figure 6. Current Limit Operation (OC\_MODE=HIGH & FLAGB is Pulled Up With an External VIO)

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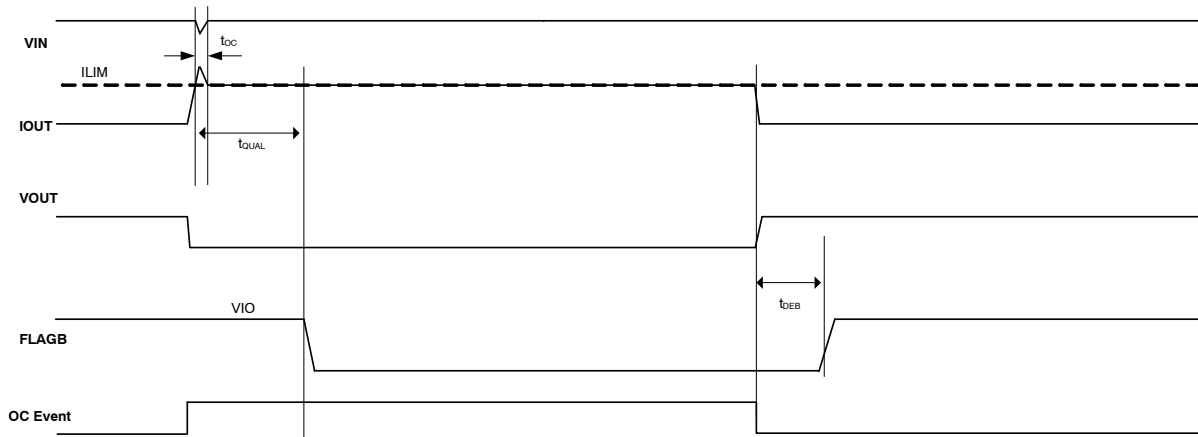


Figure 7. Current Limit Operation (OC\_MODE = LOW & FLAGB Is Pulled Up With an External VIO)

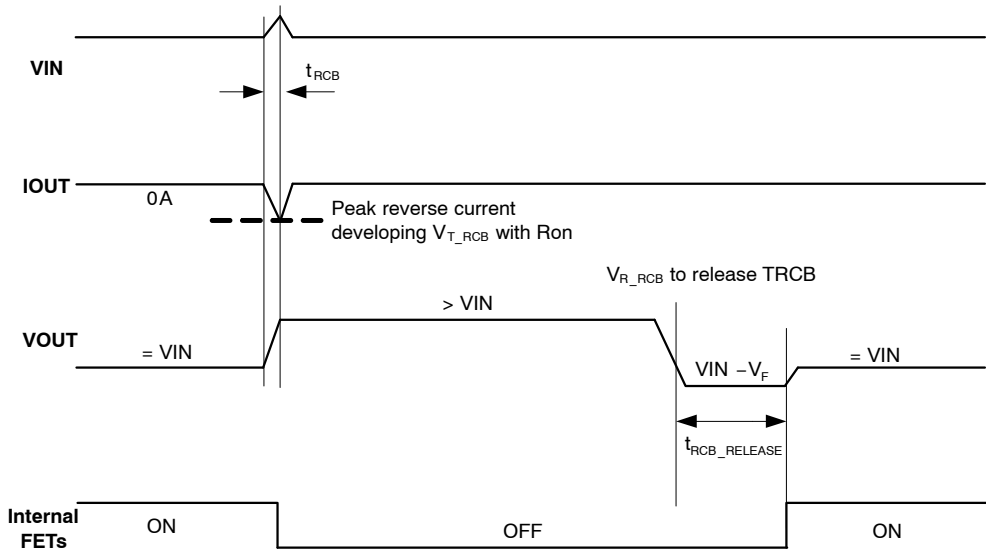


Figure 8. TRCB Operation (Device is Enabled)

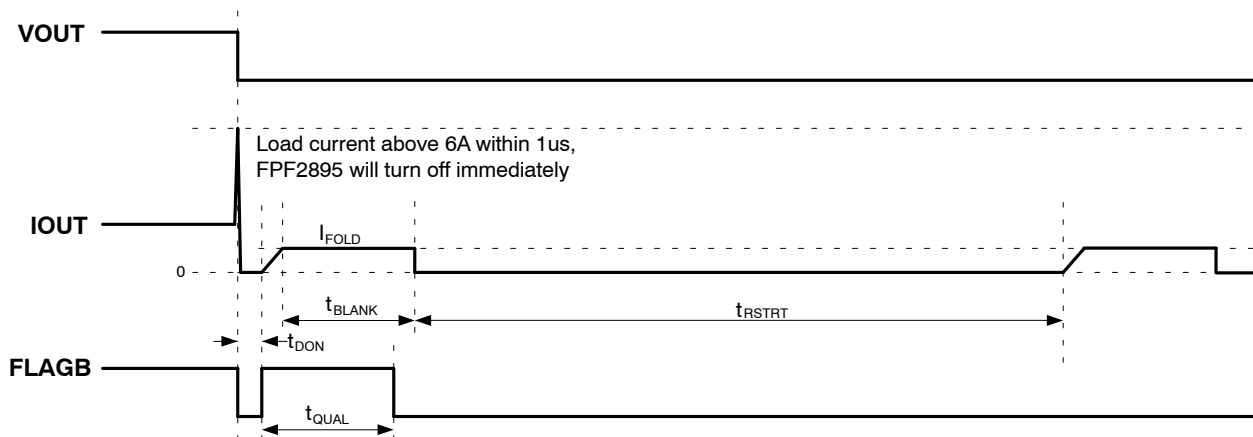


Figure 9. VOUT Hard Short to GND (OC\_MODE=HIGH & FLAGB Is Pulled Up With an External VIO)

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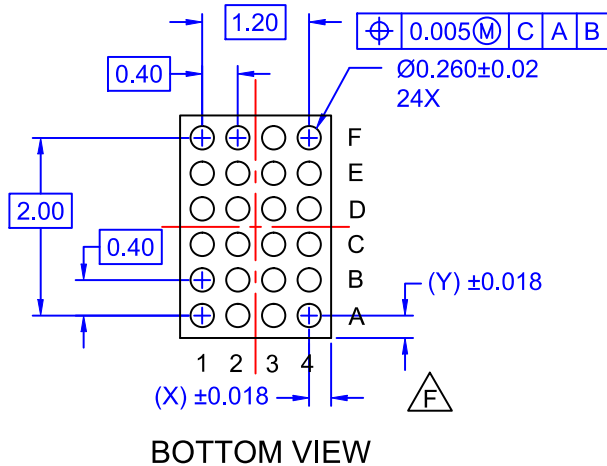
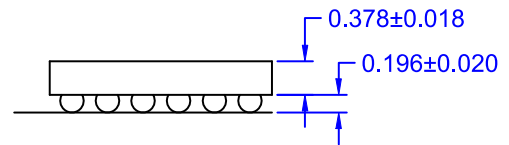
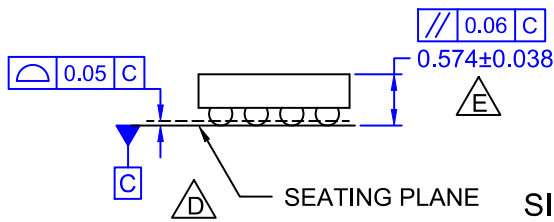
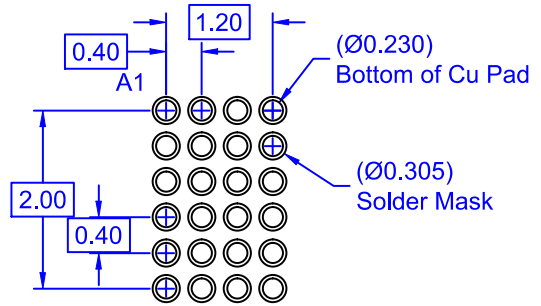
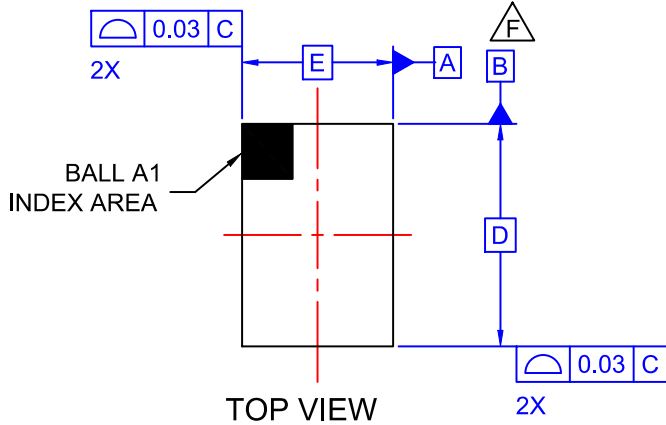
## PRODUCT-SPECIFIC DIMENSIONS

D	E	X	Y
2600 $\mu\text{m} \pm 30 \mu\text{m}$	1670 $\mu\text{m} \pm 30 \mu\text{m}$	235 $\mu\text{m} \pm 18 \mu\text{m}$	300 $\mu\text{m} \pm 18 \mu\text{m}$



**WLCSP24 2.6x1.67x0.612**  
CASE 567TQ  
ISSUE O

DATE 31 MAR 2017




**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.

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