

## AUTOSWITCHING POWER MUX

Check for Samples: [TPS2112A](#), [TPS2113A](#)

### FEATURES

- Two-Input, One-Output Power Multiplexer with Low  $r_{DS(on)}$  Switches:
  - 84 mΩ Typ (TPS2113A)
  - 120 mΩ Typ (TPS2112A)
- Reverse and Cross-Conduction Blocking
- Wide Operating Voltage: 2.8 V to 5.5 V
- Low Standby Current: 0.5 μA Typ
- Low Operating Current: 55 μA Typ
- Adjustable Current Limit
- Controlled Output Voltage Transition Time:
  - Limits Inrush Current
  - Minimizes Output Voltage Hold-Up Capacitance
- CMOS- and TTL-Compatible Control Inputs
- Auto-Switching Operating Mode
- Thermal Shutdown
- Available in TSSOP-8 and 3-mm × 3-mm SON-8 Packages

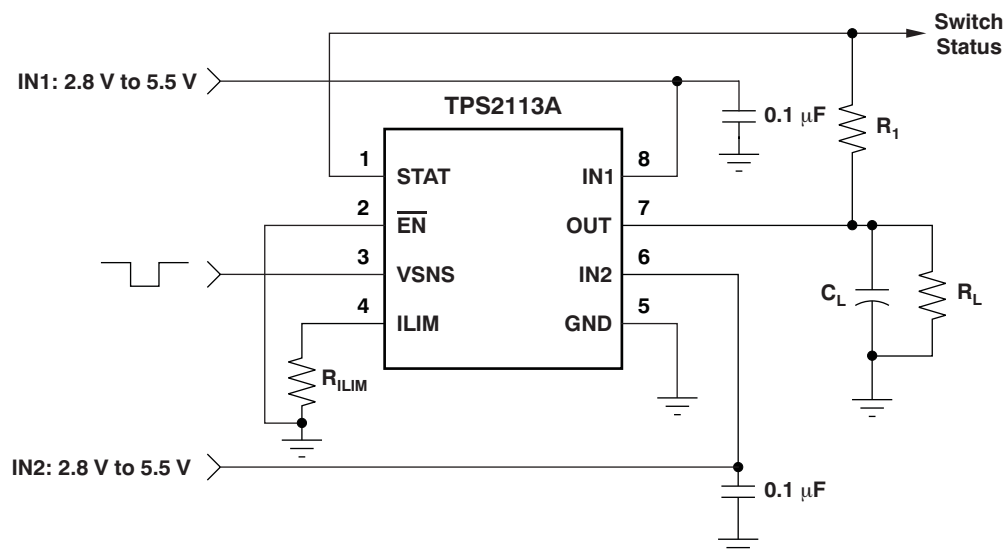
### APPLICATIONS

- PCs
- PDAs
- Digital Cameras
- Modems
- Cell Phones
- Digital Radios
- MP3 Players

### DESCRIPTION

The TPS211xA family of power multiplexers enables seamless transition between two power supplies (such as a battery and a wall adapter), each operating at 2.8 V to 5.5 V and delivering up to 2 A, depending on package. The TPS211xA family includes extensive protection circuitry, including user-programmable current limiting, thermal protection, inrush current control, seamless supply transition, cross-conduction blocking, and reverse-conduction blocking. These features greatly simplify designing power multiplexer applications.

### TYPICAL APPLICATION



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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### AVAILABLE OPTIONS

FEATURE		TPS2110A	TPS2111A	TPS2112A	TPS2113A	TPS2114A	TPS2115A
Current Limit Adjustment Range		0.31 A to 0.75 A	0.63 A to 1.25 A	0.31 A to 0.75 A	0.63 A to 2 A	0.31 A to 0.75 A	0.63 A to 2 A
Switching Modes	Manual	Yes	Yes	No	No	Yes	Yes
	Automatic	Yes	Yes	Yes	Yes	Yes	Yes
Switch Status Output		No	No	Yes	Yes	Yes	Yes

### DEVICE INFORMATION<sup>(1)</sup>

T <sub>A</sub>	PACKAGE	I <sub>OUT</sub> (A)	ORDERING NUMBER	PACKAGE MARKING
-40°C to +85°C	TSSOP-8 (PW)	0.75	TPS2112APW	2112A
		1.25	TPS2113APW	2113A
	SON-8 (DRB)	2	TPS2113ADRB	PTOI

- (1) For the most current package and ordering information see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

### ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

Over recommended junction temperature range, unless otherwise noted.

		TPS2112A, TPS2113A	UNIT
Input voltage range at pins IN1, IN2, $\overline{\text{EN}}$ , VSNS, ILIM <sup>(2)</sup>		-0.3 to 6	V
Output voltage range, V <sub>O(OUT)</sub> , V <sub>O(STAT)</sub> <sup>(2)</sup>		-0.3 to 6	V
Output sink current, I <sub>O(STAT)</sub>		5	mA
Continuous output current, I <sub>O</sub>	TPS2112APW	0.9	A
	TPS2113APW	1.5	A
	TPS2113ADRB, T <sub>J</sub> ≤ 105°C	2.5	A
Continuous total power dissipation		See <a href="#">Dissipation Ratings</a> table	
Junction temperature		Internally Limited	
ESD	Human body model (HBM)	2	kV
	Charged device model (CDM)	500	V

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to GND.

### DISSIPATION RATINGS

PACKAGE	DERATING FACTOR ABOVE T <sub>A</sub> = 25°C	T <sub>A</sub> ≤ 25°C POWER RATING	T <sub>A</sub> = 70°C POWER RATING	T <sub>A</sub> = 85°C POWER RATING
TSSOP-8 (PW)	3.9 mW/°C	387 mW	213 mW	155 mW
SON-8 (DRB) <sup>(1)</sup>	25.0 mW/°C	2.50 mW	1.38 mW	1.0 W

- (1) See TI application note [SLMA002](#) for mounting recommendations.

## RECOMMENDED OPERATING CONDITIONS

		TPS2112A, TPS2113A			UNIT
		MIN	NOM	MAX	
Input voltage at IN1, $V_{I(IN1)}$	$V_{I(IN2)} \geq 2.8 \text{ V}$	1.5		5.5	V
	$V_{I(IN2)} < 2.8 \text{ V}$	2.8		5.5	
Input voltage at IN2, $V_{I(IN2)}$	$V_{I(IN1)} \geq 2.8 \text{ V}$	1.5		5.5	V
	$V_{I(IN1)} < 2.8 \text{ V}$	2.8		5.5	
Input voltage: $V_{I(\overline{EN})}$ , $V_{I(VSNS)}$		0		5.5	V
Nominal current limit adjustment range, $I_{O(OUT)}^{(1)}$	TPS2112APW	0.31		0.75	A
	TPS2113APW	0.63		1.25	
	TPS2113ADRB, $T_J \leq 105^\circ\text{C}$	0.63		2	A
Operating virtual junction temperature, $T_J$		–40		125	$^\circ\text{C}$

(1) Minimum recommended current limit is based on accuracy considerations.

## ELECTRICAL CHARACTERISTICS: Power Switch

Over recommended operating junction temperature,  $R_{ILIM} = 400 \Omega$ , unless otherwise noted.

PARAMETER		TEST CONDITIONS		TPS2112A			TPS2113A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
Drain-source on-state resistance (INx–OUT)	$r_{DS(on)}^{(1)}$	$T_J = 25^\circ\text{C}$ , $I_L = 500 \text{ mA}$	$V_{I(IN1)} = V_{I(IN2)} = 5.0 \text{ V}$		120	140		84	110	m $\Omega$
			$V_{I(IN1)} = V_{I(IN2)} = 3.3 \text{ V}$		120	140		84	110	
			$V_{I(IN1)} = V_{I(IN2)} = 2.8 \text{ V}$		120	140		84	110	
		$T_J = 125^\circ\text{C}$ , $I_L = 500 \text{ mA}$	$V_{I(IN1)} = V_{I(IN2)} = 5.0 \text{ V}$			220			150	m $\Omega$
			$V_{I(IN1)} = V_{I(IN2)} = 3.3 \text{ V}$			220			150	
			$V_{I(IN1)} = V_{I(IN2)} = 2.8 \text{ V}$			220			150	

(1) The TPS211xA can switch a voltage as low as 1.5 V as long as there is a minimum of 2.8 V at one of the input power pins. In this specific case, the lower supply voltage has no effect on the IN1 and IN2 switch on-resistances.

## ELECTRICAL CHARACTERISTICS

Over recommended operating junction temperature,  $I_{O(OUT)} = 0 \text{ A}$ , and  $R_{ILIM} = 400 \Omega$ , unless otherwise noted.

PARAMETER		TEST CONDITIONS	TPS2112A, TPS2113A			UNIT	
			MIN	TYP	MAX		
LOGIC INPUTS ( $\overline{\text{EN}}$ )							
High-level input voltage	$V_{\text{IH}}$		2			V	
Low-level input voltage	$V_{\text{IL}}$		0.7			V	
Input current		$\overline{\text{EN}}$ = High, sink current	1			$\mu\text{A}$	
		$\overline{\text{EN}}$ = Low, source current	0.5	1.4	5		
SUPPLY AND LEAKAGE CURRENTS							
Supply current from IN1 (operating)		$V_{\text{I(VSNS)}} = 1.5 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN1 active), $V_{\text{I(IN1)}} = 5.5 \text{ V}$ , $V_{\text{I(IN2)}} = 3.3 \text{ V}$	55			90	$\mu\text{A}$
		$V_{\text{I(VSNS)}} = 1.5 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN1 active), $V_{\text{I(IN1)}} = 3.3 \text{ V}$ , $V_{\text{I(IN2)}} = 5.5 \text{ V}$ ,	1			12	
		$V_{\text{I(VSNS)}} = 0 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN2 active), $V_{\text{I(IN1)}} = 5.5 \text{ V}$ , $V_{\text{I(IN2)}} = 3.3 \text{ V}$				75	
		$V_{\text{I(VSNS)}} = 0 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN2 active), $V_{\text{I(IN1)}} = 3.3 \text{ V}$ , $V_{\text{I(IN2)}} = 5.5 \text{ V}$				1	
Supply current from IN2 (operating)		$V_{\text{I(VSNS)}} = 1.5 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN1 active), $V_{\text{I(IN1)}} = 5.5 \text{ V}$ , $V_{\text{I(IN2)}} = 3.3 \text{ V}$				1	$\mu\text{A}$
		$V_{\text{I(VSNS)}} = 1.5 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN1 active), $V_{\text{I(IN1)}} = 3.3 \text{ V}$ , $V_{\text{I(IN2)}} = 5.5 \text{ V}$				75	
		$V_{\text{I(VSNS)}} = 0 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN2 active), $V_{\text{I(IN1)}} = 5.5 \text{ V}$ , $V_{\text{I(IN2)}} = 3.3 \text{ V}$	1			12	
		$V_{\text{I(VSNS)}} = 0 \text{ V}$ , $\overline{\text{EN}}$ = Low (IN2 active), $V_{\text{I(IN1)}} = 3.3 \text{ V}$ , $V_{\text{I(IN2)}} = 5.5 \text{ V}$	55			90	

## ELECTRICAL CHARACTERISTICS (continued)

Over recommended operating junction temperature,  $I_{O(OUT)} = 0$  A, and  $R_{ILIM} = 400\ \Omega$ , unless otherwise noted.

			TPS2112A, TPS2113A			UNIT
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	
SUPPLY AND LEAKAGE CURRENTS, <i>Continued</i>						
Quiescent current from IN1 (standby)		$\overline{\text{EN}} = \text{High (inactive)}, V_{\text{I}(\text{IN}1)} = 5.5 \text{ V}, V_{\text{I}(\text{IN}2)} = 3.3 \text{ V}$		0.5	2	$\mu\text{A}$
		$\overline{\text{EN}} = \text{High (inactive)}, V_{\text{I}(\text{IN}1)} = 3.3 \text{ V}, V_{\text{I}(\text{IN}2)} = 5.5 \text{ V}$			1	
Quiescent current from IN2 (standby)		$\overline{\text{EN}} = \text{High (inactive)}, V_{\text{I}(\text{IN}1)} = 5.5 \text{ V}, V_{\text{I}(\text{IN}2)} = 3.3 \text{ V}$			1	$\mu\text{A}$
		$\overline{\text{EN}} = \text{High (inactive)}, V_{\text{I}(\text{IN}1)} = 3.3 \text{ V}, V_{\text{I}(\text{IN}2)} = 5.5 \text{ V}$		0.5	2	
Forward leakage current from IN1 (measured from OUT to GND)		$\overline{\text{EN}} = \text{High (inactive)}, V_{\text{I}(\text{IN}1)} = 5.5 \text{ V}, \text{IN2 open}, V_{\text{O}(\text{OUT})} = 0 \text{ V (shorted)}, T_{\text{J}} = 25^{\circ}\text{C}$		0.1	5	$\mu\text{A}$
Forward leakage current from IN2 (measured from OUT to GND)		$\overline{\text{EN}} = \text{High (inactive)}, V_{\text{I}(\text{IN}2)} = 5.5 \text{ V}, \text{IN1 open}, V_{\text{O}(\text{OUT})} = 0 \text{ V (shorted)}, T_{\text{J}} = 25^{\circ}\text{C}$		0.1	5	$\mu\text{A}$
Reverse leakage current to INx (measured from INx to GND)		$\overline{\text{EN}} = \text{High (inactive)}, V_{\text{I}(\text{INx})} = 0 \text{ V}, V_{\text{O}(\text{OUT})} = 5.5 \text{ V}, T_{\text{J}} = 25^{\circ}\text{C}$		0.3	5	$\mu\text{A}$
STAT OUTPUT						
Leakage current		$V_{\text{O}(\text{STAT})} = 5.5 \text{ V}$		0.01	1	$\mu\text{A}$
Saturation voltage		$I_{\text{I}(\text{STAT})} = 2 \text{ mA}, \text{IN1 switch is on}$		0.13	0.4	V
Deglintch time (falling edge only)				150		$\mu\text{s}$
CURRENT LIMIT CIRCUIT						
Current limit accuracy	TPS2112A	$R_{\text{ILIM}} = 400 \Omega$	0.51	0.63	0.80	A
		$R_{\text{ILIM}} = 700 \Omega$	0.30	0.36	0.50	
	TPS2113A	$R_{\text{ILIM}} = 400 \Omega$	0.95	1.25	1.56	A
		$R_{\text{ILIM}} = 700 \Omega$	0.47	0.71	0.99	
Current limit settling time	$t_{\text{d}}$	Time for short-circuit output current to settle within 10% of its steady state value.		1		ms
Input current at ILIM		$V_{\text{I}(\text{ILIM})} = 0 \text{ V}$	–15		0	$\mu\text{A}$
VSNS COMPARATOR						
VSNS threshold voltage		$V_{\text{I}(\text{VSNS})} \uparrow$	0.78	0.80	0.82	V
		$V_{\text{I}(\text{VSNS})} \downarrow$	0.735	0.755	0.775	
VSNS comparator hysteresis			30		60	mV
Deglintch of VSNS comparator (both $\uparrow \downarrow$ )			90	150	220	$\mu\text{s}$
Input current		$0 \text{ V} \leq V_{\text{I}(\text{VSNS})} \leq 5.5 \text{ V}$	–1		1	$\mu\text{A}$
UVLO						
IN1 and IN2 UVLO		Falling edge	1.15	1.25		V
		Rising edge		1.30	1.35	
IN1 and IN2 UVLO hysteresis			30	57	65	mV
Internal $V_{\text{DD}}$ UVLO (the higher of IN1 and IN2)		Falling edge	2.4	2.53		V
		Rising edge		2.58	2.8	
Internal $V_{\text{DD}}$ UVLO hysteresis			30	50	75	mV
UVLO deglintch for IN1, IN2		Falling edge		110		$\mu\text{s}$

## ELECTRICAL CHARACTERISTICS (continued)

Over recommended operating junction temperature,  $I_{O(OUT)} = 0$  A, and  $R_{LIM} = 400\ \Omega$ , unless otherwise noted.

PARAMETER		TEST CONDITIONS	TPS2112A, TPS2113A			UNIT	
			MIN	TYP	MAX		
REVERSE CONDUCTION BLOCKING							
Minimum output-to-input voltage difference to block switching	$\Delta V_{O(I\_block)}$	$\overline{EN}$ = high, $V_{I(IN1)} = 3.3\text{ V}$ and $V_{I(IN2)} = V_{I(VSNS)} = 0\text{ V}$ . Connect OUT to a 5-V supply through a series 1-k $\Omega$ resistor. Let $\overline{EN}$ = low. Slowly decrease the supply voltage until OUT connects to IN1.	80	100	120	mV	
THERMAL SHUTDOWN							
Thermal shutdown threshold		TPS211xA is in current limit.	135			°C	
Recovery from thermal shutdown		TPS211xA is in current limit.	125			°C	
Hysteresis			10			°C	
IN2–IN1 COMPARATORS							
Hysteresis of IN2–IN1 comparator			0.1		0.2	V	
Deglitch of IN2–IN1 comparator (both $\uparrow \downarrow$ )			10		20	50	$\mu\text{s}$

## SWITCHING CHARACTERISTICS

Over recommended operating junction temperature,  $V_{I(IN1)} = V_{I(IN2)} = 5.5\text{ V}$ , and  $R_{LIM} = 400\ \Omega$ , unless otherwise noted.

PARAMETER	TEST CONDITIONS	TPS2112A			TPS2113A			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$t_R$ Output rise time from an enable	$V_{I(IN1)} = V_{I(IN2)} = 5\text{ V}$ , $V_{I(SNS)} = 1.5\text{ V}$ $T_J = 25^\circ\text{C}$ , $C_L = 1\ \mu\text{F}$ , $I_L = 500\text{ mA}$ ; see Figure 1(a).	0.5	1.0	1.5	1	1.8	3	ms
$t_F$ Output fall time from a disable	$V_{I(IN1)} = V_{I(IN2)} = 5\text{ V}$ , $V_{I(SNS)} = 1.5\text{ V}$ $T_J = 25^\circ\text{C}$ , $C_L = 1\ \mu\text{F}$ , $I_L = 500\text{ mA}$ ; see Figure 1(a).	0.35	0.5	0.7	0.5	1	2	ms
$t_T$ Transition time	IN1 to IN2 transition, $V_{I(IN1)} = 3.3\text{ V}$ , $V_{I(IN2)} = 5\text{ V}$ , $V_{I(\overline{EN})} = 0\text{ V}$ $T_J = 125^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ , $I_L = 500\text{ mA}$ ; measure transition time as 10% to 90% rise time or from 3.4 V to 4.8 V on $V_{O(OUT)}$ . See Figure 1(b).		40	60		40	60	$\mu\text{s}$
$t_{PLH1}$ Turn-on propagation delay from an enable	$V_{I(IN1)} = V_{I(IN2)} = 5\text{ V}$ Measured from enable to 10% of $V_{O(OUT)}$ , $V_{I(SNS)} = 1.5\text{ V}$ $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ , $I_L = 500\text{ mA}$ ; see Figure 1(a).		0.5			1		ms
$t_{PHL1}$ Turn-off propagation delay from a disable	$V_{I(IN1)} = V_{I(IN2)} = 5\text{ V}$ Measured from disable to 90% of $V_{O(OUT)}$ , $V_{I(SNS)} = 1.5\text{ V}$ $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ , $I_L = 500\text{ mA}$ ; see Figure 1(a).		3			5		ms
$t_{PLH2}$ Switch-over rising propagation delay	Logic 1 to Logic 0 transition on VSNS, $V_{I(IN1)} = 1.5\text{ V}$ , $V_{I(IN2)} = 5\text{ V}$ , $V_{I(\overline{EN})} = 0\text{ V}$ , Measured from VSNS to 10% of $V_{O(OUT)}$ $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ , $I_L = 500\text{ mA}$ ; see Figure 1(c).		40	100		40	100	$\mu\text{s}$
$t_{PHL2}$ Switch-over falling propagation delay	Logic 0 to Logic 1 transition on VSNS, $V_{I(IN1)} = 1.5\text{ V}$ , $V_{I(IN2)} = 5\text{ V}$ , $V_{I(\overline{EN})} = 0\text{ V}$ , Measured from VSNS to 90% of $V_{O(OUT)}$ $T_J = 25^\circ\text{C}$ , $C_L = 10\ \mu\text{F}$ , $I_L = 500\text{ mA}$ ; see Figure 1(c).	2	3	10	2	5	10	ms

## PARAMETER MEASUREMENT INFORMATION

### TIMING WAVEFORMS

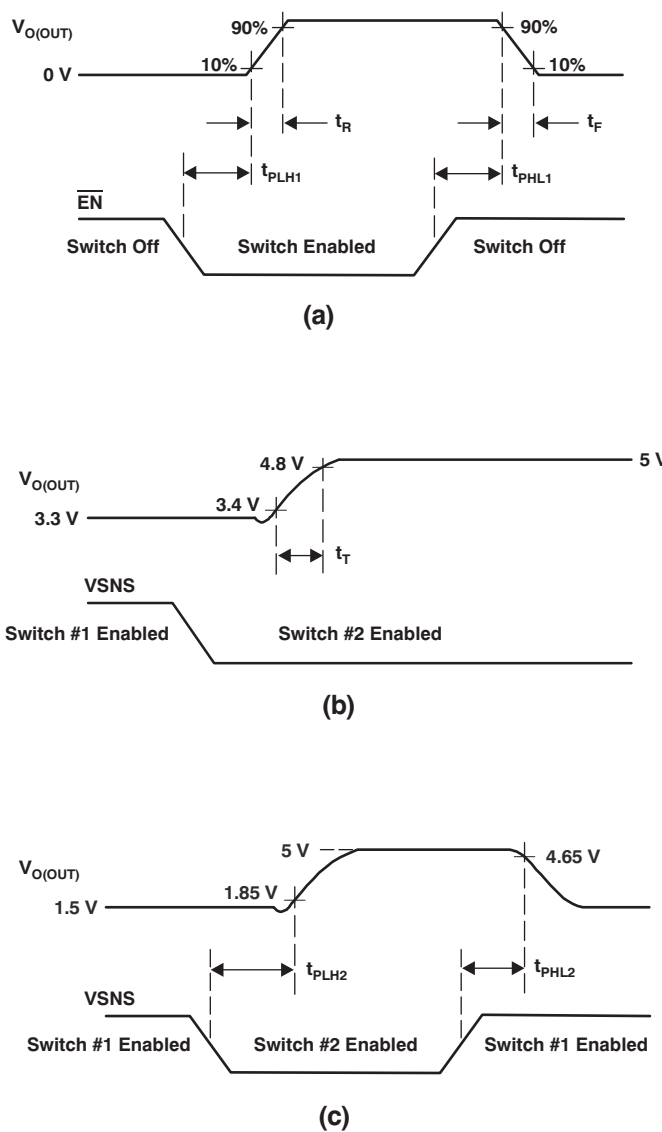


Figure 1. Propagation Delays and Transition Timing Waveforms

## DEVICE INFORMATION

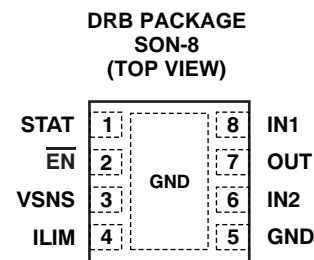
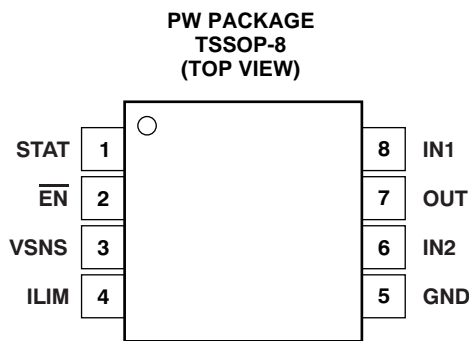
### TRUTH TABLE

$\overline{\text{EN}}$	$V_{\text{I}(\text{VSNS})} > 0.8 \text{ V}^{(1)}$	$V_{\text{I}(\text{IN2})} > V_{\text{I}(\text{IN1})}$	STAT	OUT <sup>(2)</sup>
0	Yes	X	0	IN1
0	No	No	0	IN1
0	No	Yes	Hi-Z	IN2
1	X	X	0	Hi-Z

(1) X = Don't care.

(2) The undervoltage lockout circuit causes the output (OUT) to go Hi-Z if the selected power supply does not exceed the IN1/IN2 UVLO, or if neither of the supplies exceeds the internal  $V_{\text{DD}}$  UVLO.

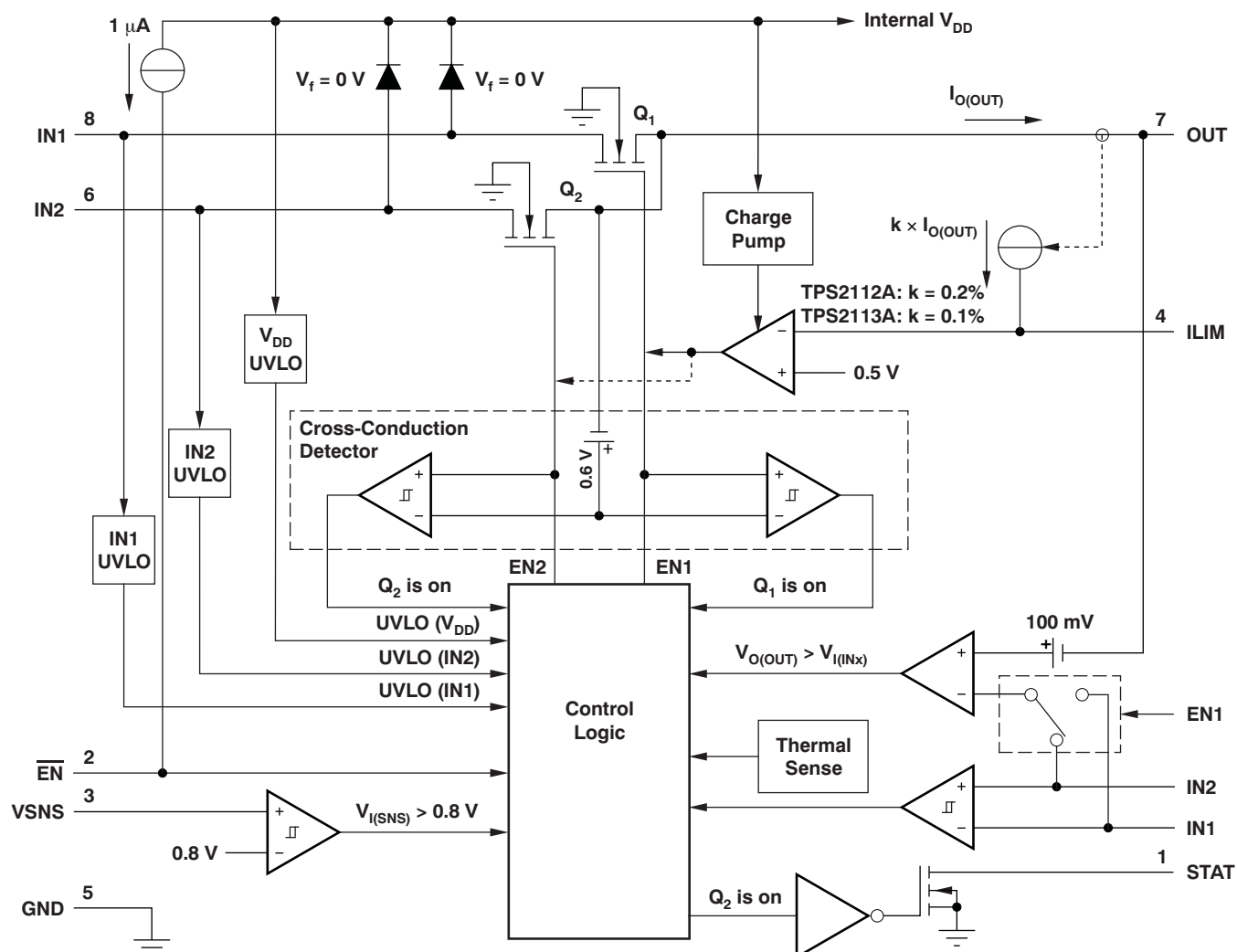
## PIN CONFIGURATIONS



**Table 1. TERMINAL FUNCTIONS**

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
$\overline{\text{EN}}$	2	I	TTL- and CMOS-compatible input with a 1- $\mu\text{A}$ pull-up. The <a href="#">Truth Table</a> illustrates the functionality of $\overline{\text{EN}}$ .
GND	5	Power	Ground
IN1	8	I	Primary power switch input. The IN1 switch can be enabled only if the IN1 supply is above the UVLO threshold and at least one supply exceeds the internal $V_{\text{DD}}$ UVLO.
IN2	6	I	Secondary power switch input. The IN2 switch can be enabled only if the IN2 supply is above the UVLO threshold and at least one supply exceeds the internal $V_{\text{DD}}$ UVLO.
ILIM	4	I	A resistor ( $R_{\text{ILIM}}$ ) from ILIM to GND sets the current limit ( $I_{\text{L}}$ ) to $250/R_{\text{ILIM}}$ and $500/R_{\text{ILIM}}$ for the TPS2112A and TPS2113A, respectively.
OUT	7	O	Power switch output
STAT	1	O	STAT is an open-drain output that is Hi-Z if the IN2 switch is ON. STAT pulls low if the IN1 switch is ON or if OUT is Hi-Z (that is, $\overline{\text{EN}}$ is equal to logic '0')
VSNS	3	I	An internal power FET connects OUT to IN1 if the VSNS voltage is greater than 0.8 V. Otherwise, the FET connects OUT to the higher of IN1 and IN2. The <a href="#">Truth Table</a> illustrates the functionality of VSNS.
Pad	—	Power	<b>DRB package only.</b> Connect to GND. Must be connected to large copper area in order to meet stated package dissipation ratings.

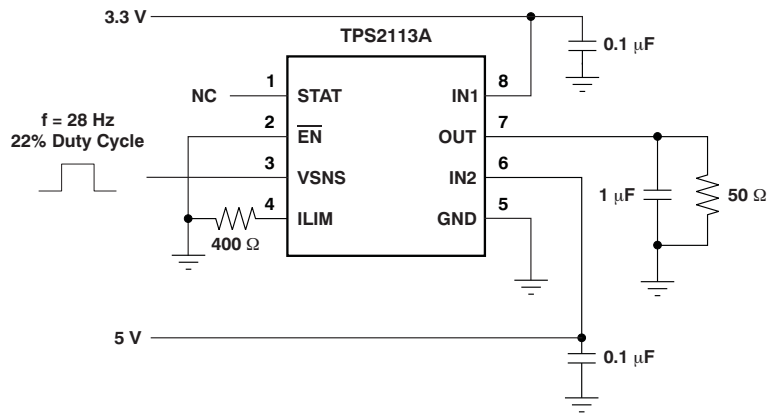
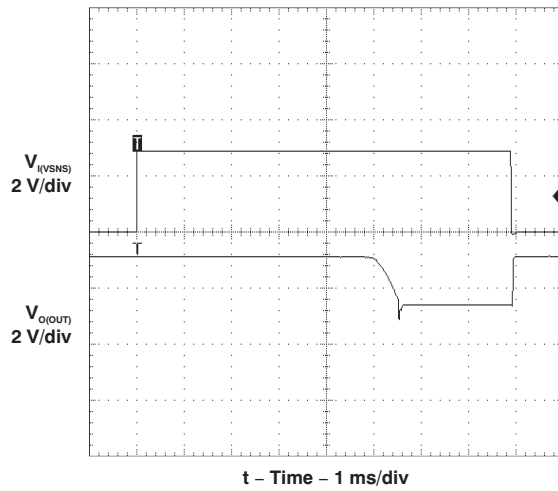
## FUNCTIONAL BLOCK DIAGRAM





## TYPICAL CHARACTERISTICS

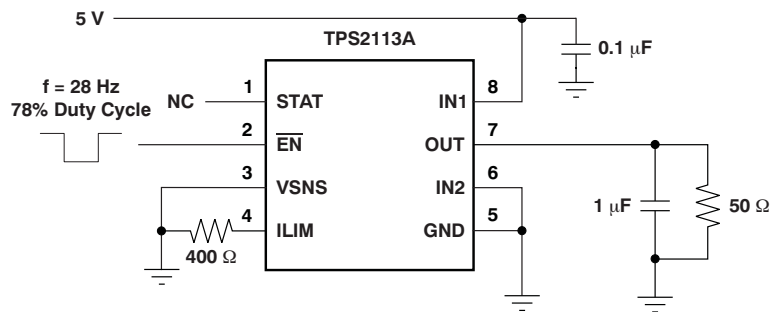
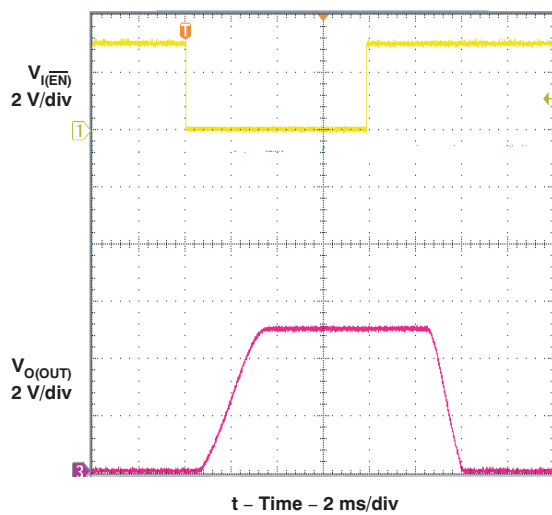
### OUTPUT SWITCHOVER RESPONSE



Output Switchover Response Test Circuit

Figure 2.

### OUTPUT TURN-ON RESPONSE

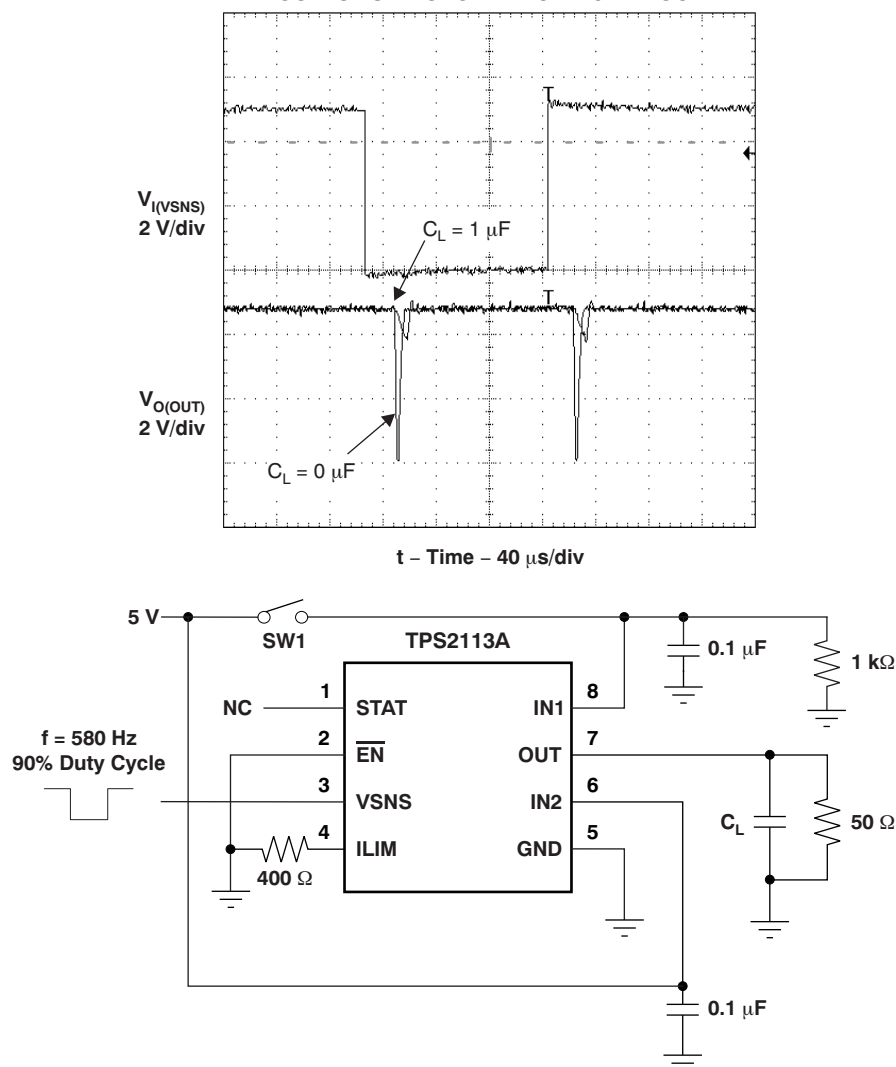


Output Turn-On Response Test Circuit

Figure 3.

## TYPICAL CHARACTERISTICS (continued)

### OUTPUT SWITCHOVER VOLTAGE DROOP



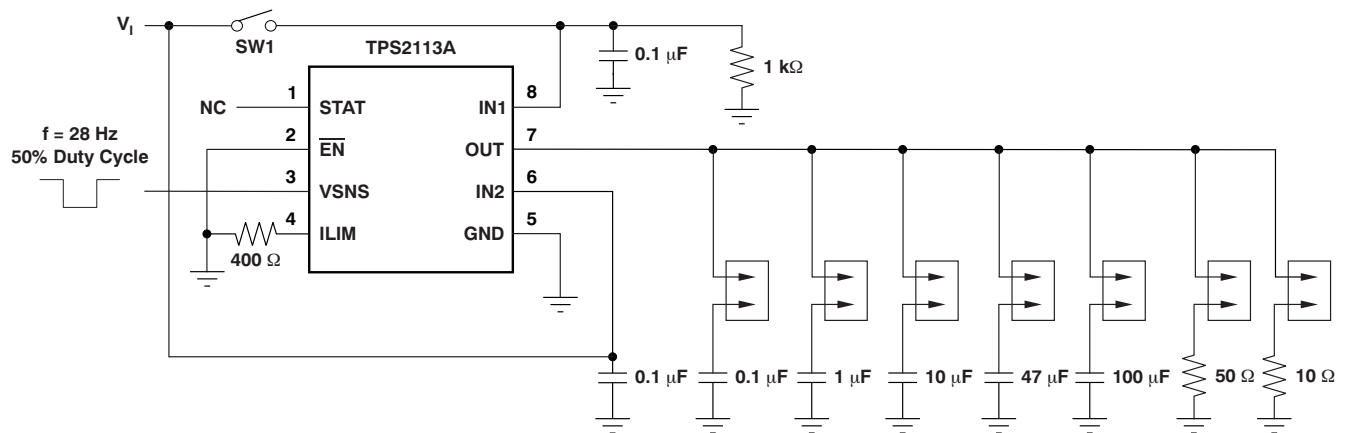
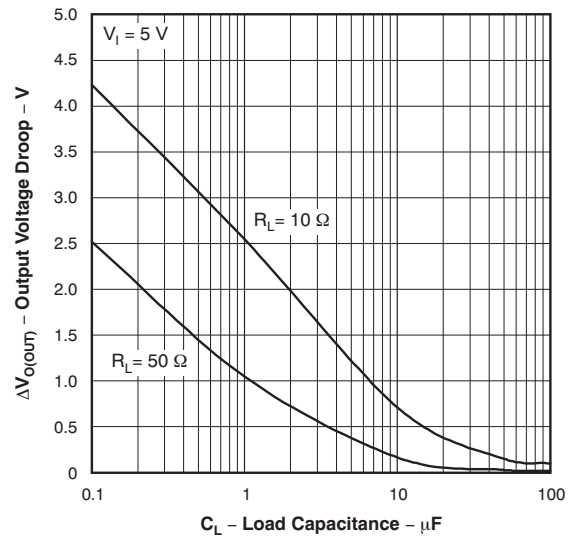
Output Switchover Voltage Droop Test Circuit

Figure 4.

Note: To initialize the TPS2113A for this test, set input VSNS equal to 0 V, turn on the 5-V supply, and then turn on switch SW1.

## TYPICAL CHARACTERISTICS (continued)

OUTPUT SWITCHOVER VOLTAGE DROOP  
vs  
LOAD CAPACITANCE



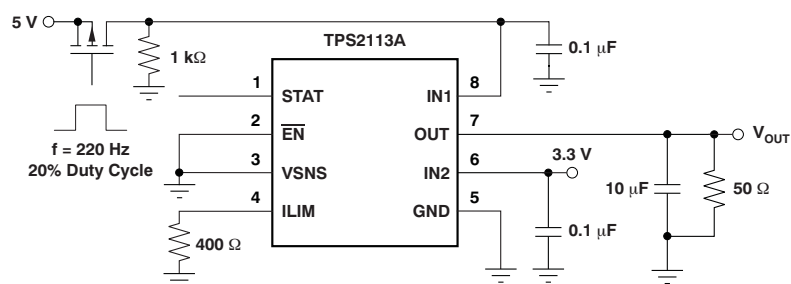
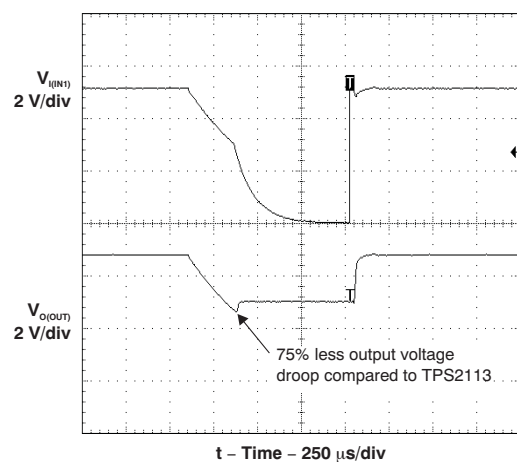
Output Switchover Voltage Droop Test Circuit

Figure 5.

Note: To initialize the TPS2113A for this test, set input VSNS equal to 0 V, turn on the  $V_I$  supply, and then turn on switch SW1.

## TYPICAL CHARACTERISTICS (continued)

### AUTO SWITCHOVER VOLTAGE DROOP

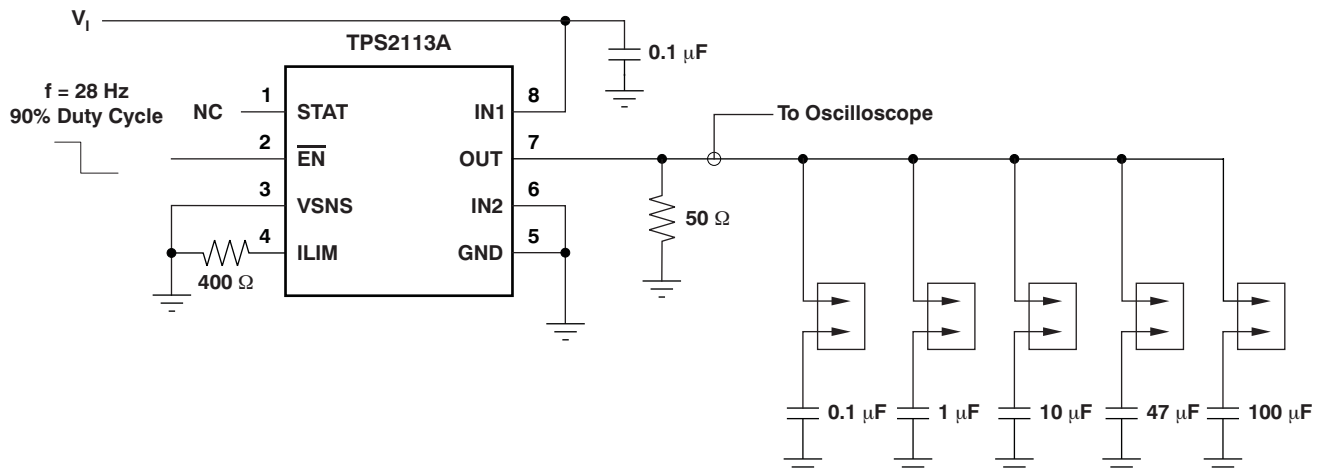
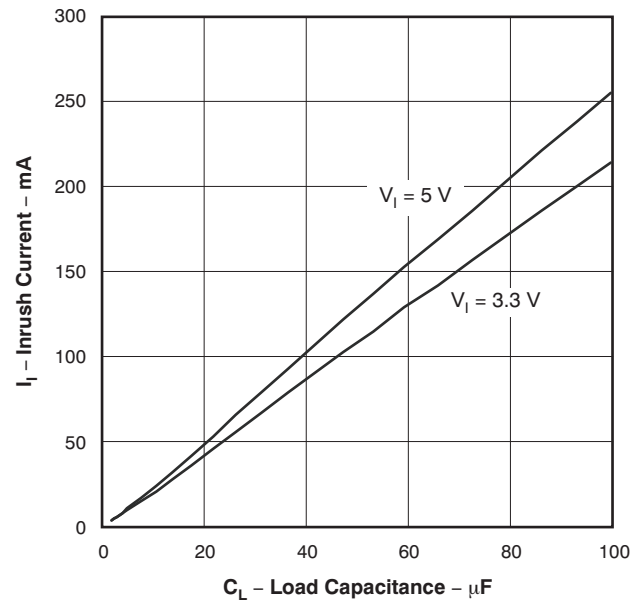


Auto Switchover Voltage Droop Test Circuit

Figure 6.

## TYPICAL CHARACTERISTICS (continued)

INRUSH CURRENT  
vs  
LOAD CAPACITANCE



Output Capacitor Inrush Current Test Circuit

Figure 7.

## TYPICAL CHARACTERISTICS (continued)

SWITCH ON-RESISTANCE  
vs  
JUNCTION TEMPERATURE

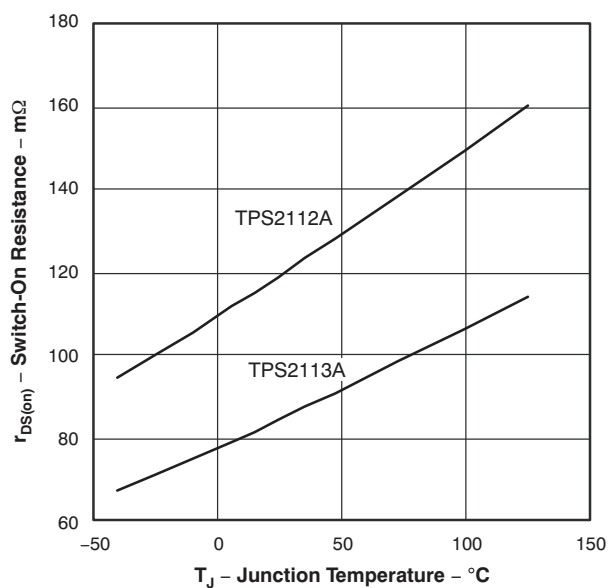


Figure 8.

SWITCH ON-RESISTANCE  
vs  
SUPPLY VOLTAGE

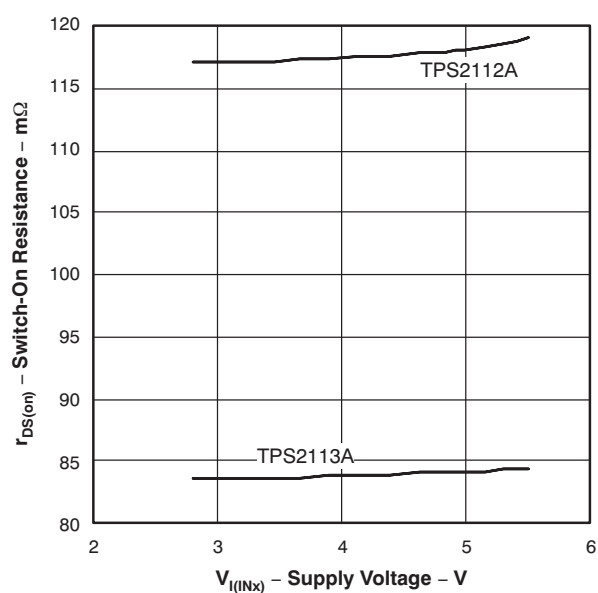


Figure 9.

IN1 SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE

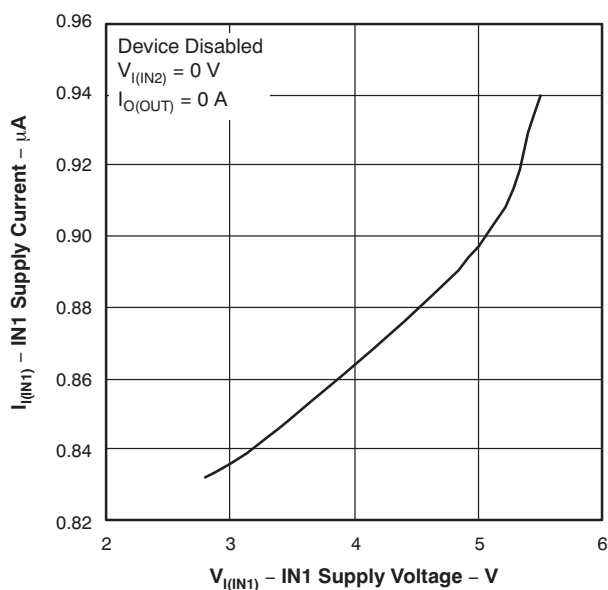


Figure 10.

IN1 SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE

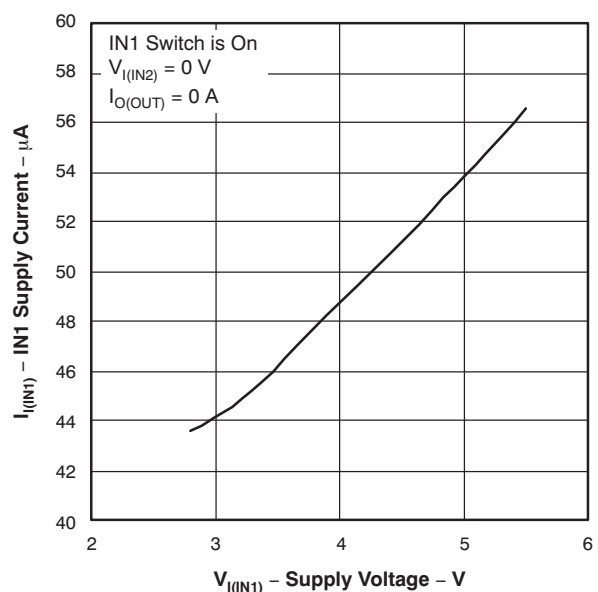


Figure 11.

## TYPICAL CHARACTERISTICS (continued)

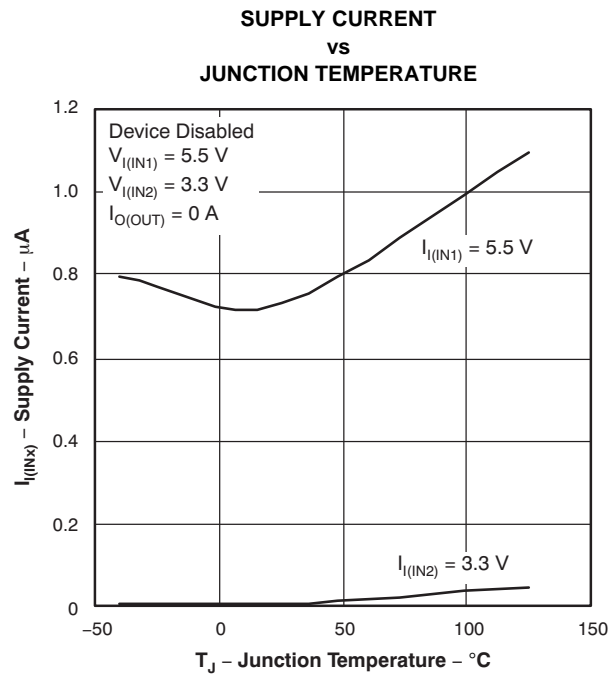


Figure 12.

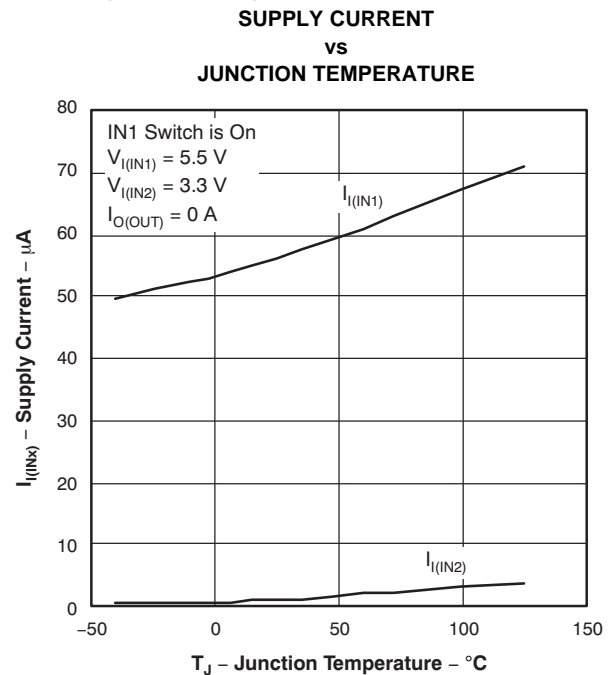
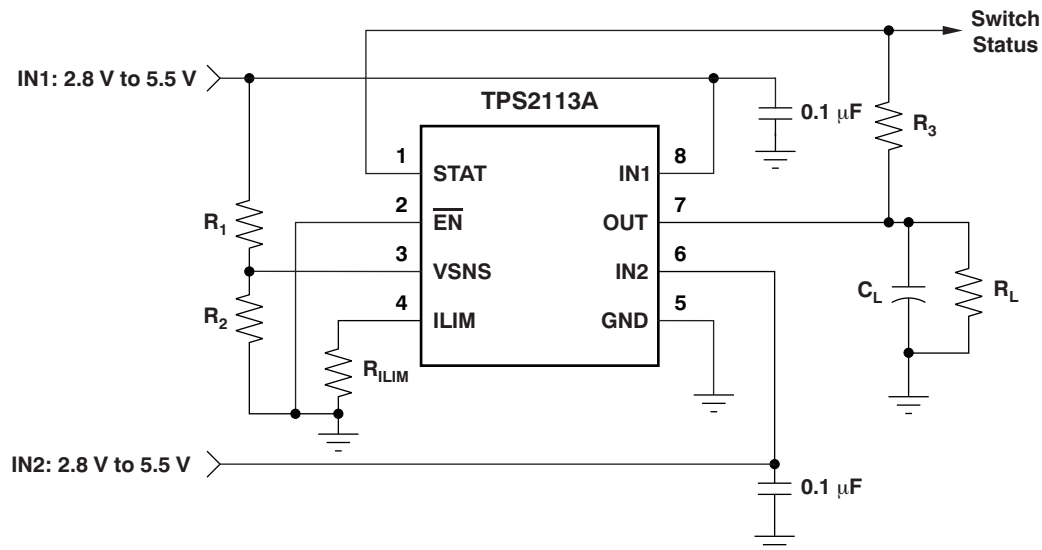


Figure 13.

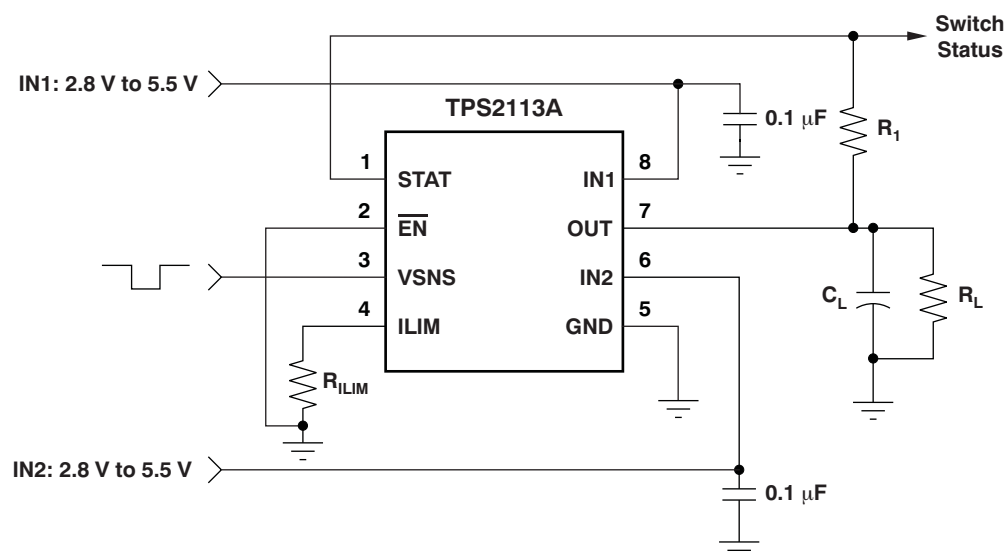
## APPLICATION INFORMATION

Some applications have two energy sources, one of which should be used in preference to another. [Figure 14](#) shows a circuit that will connect IN1 to OUT until the voltage at IN1 falls below a user-specified value. Once the voltage on IN1 falls below this value, the TPS2112A/3A will select the higher of the two supplies. This usually means that the TPS2112A/3A will swap to IN2.



### Figure 14. Auto-Selecting for a Dual Power-Supply Application

In **Figure 15**, the multiplexer selects between two power supplies based upon the VSNS logic signal. OUT connects to IN1 if VSNS is logic '1'; otherwise, OUT connects to IN2 if  $V_{IN2}$  is greater than  $V_{IN1}$ . The logic thresholds for the VSNS terminal are compatible with both TTL and CMOS logic.



### Figure 15. Manually Switching Power Sources



## DETAILED DESCRIPTION

### AUTO-SWITCHING MODE

The TPS2112A/3A only supports the auto-switching mode. In this mode, OUT connects to IN1 if  $V_{I(VSNS)}$  is greater than 0.8 V, otherwise OUT connects to the higher of IN1 and IN2.

The VSNS terminal includes hysteresis equal to 3.75% to 7.5% of the threshold selected for transition from the primary supply to the higher of the two supplies. This hysteresis helps avoid repeated switching from one supply to the other due to resistive drops.

### N-CHANNEL MOSFETs

Two internal high-side power MOSFETs implement a single-pole double-throw (SPDT) switch. Digital logic selects the IN1 switch, IN2 switch, or no switch (Hi-Z state). The MOSFETs have no parallel diodes so output-to-input current cannot flow when the FET is off. An integrated comparator prevents turn-on of a FET switch if the output voltage is greater than the input voltage.

### CROSS-CONDUCTION BLOCKING

The switching circuitry ensures that both power switches will never conduct at the same time. A comparator monitors the gate-to-source voltage of each power FET and allows a FET to turn on only if the gate-to-source voltage of the other FET is below the turn-on threshold voltage.

### REVERSE-CONDUCTION BLOCKING

When the TPS211xA switches from a higher-voltage supply to a lower-voltage supply, current can potentially flow back from the load capacitor into the lower-voltage supply. To minimize such reverse conduction, the TPS211xA will not connect a supply to the output until the output voltage has fallen to within 100 mV of the supply voltage. Once a supply has been connected to the output, it will remain connected regardless of output voltage.

### CHARGE PUMP

The higher of supplies IN1 and IN2 powers the internal charge pump. The charge pump provides power to the current limit amplifier and allows the output FET gate voltage to be higher than the IN1 and IN2 supply voltages. A gate voltage that is higher than the source voltage is necessary to turn on the N-channel FET.

### CURRENT LIMITING

A resistor  $R_{ILIM}$  from ILIM to GND sets the current limit to  $250/R_{ILIM}$  and  $500/R_{ILIM}$  for the TPS2112A and TPS2113A, respectively. Setting resistor  $R_{ILIM}$  equal to zero is not recommended as that disables current limiting.

### OUTPUT VOLTAGE SLEW-RATE CONTROL

The TPS2112A/3A slews the output voltage at a slow rate when OUT switches to IN1 or IN2 from the Hi-Z state (see the [Truth Table](#)). A slow slew rate limits the inrush current into the load capacitor. High inrush currents can glitch the voltage bus and cause a system to hang up or reset. It can also cause reliability issues—like pit the connector power contacts, when hot-plugging a load such as a PCI card. The TPS2112A/3A slews the output voltage at a much faster rate when OUT switches between IN1 and IN2. The fast rate minimizes the output voltage droop and reduces the output voltage hold-up capacitance requirement.

## REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (March 2010) to Revision C	Page
• Changed description of power supplies in <i>Description</i> section .....	1
• Changed <i>Current Limit Adjustment Range</i> parameter TPS2113A and TPS2115A specifications in Available Options table .....	2
• Added $I_{OUT}$ column to Device Information table, changed table name .....	2
• Changed <i>Continuous output current</i> parameter in Absolute Maximum Ratings table .....	2
• Changed <i>Current limit adjustment range</i> parameter in Recommended Operating Conditions table .....	3
• Added footnote 1 to Recommended Operating Conditions table .....	3
• Changed second paragraph in <i>Application Information</i> section .....	16

Changes from Revision A (February, 2006) to Revision B	Page
• Updated document to current format .....	1
• Deleted package information from <i>Available Options</i> table .....	2
• Revised <i>Ordering Information</i> table .....	2
• Deleted <i>storage temperature</i> , <i>operating virtual junction temperature range</i> , and <i>lead temperature</i> specifications from, added <i>electrostatic discharge</i> and <i>junction temperature</i> specifications to <i>Absolute Maximum Ratings</i> table; deleted <i>ESD Protection</i> table .....	2
• Added DRB package information and footnote to <i>Dissipation Ratings</i> table .....	2

## PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">TPS2112APW</a>	Active	Production	TSSOP (PW)   8	150   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2112A
TPS2112APW.A	Active	Production	TSSOP (PW)   8	150   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2112A
<a href="#">TPS2112APWR</a>	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2112A
TPS2112APWR.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2112A
<a href="#">TPS2113ADRBR</a>	Active	Production	SON (DRB)   8	3000   LARGE T&R	Yes	FULL NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PTOI
TPS2113ADRBR.B	Active	Production	SON (DRB)   8	3000   LARGE T&R	Yes	FULL NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PTOI
TPS2113ADRBRG4	Active	Production	SON (DRB)   8	3000   LARGE T&R	Yes	FULL NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PTOI
TPS2113ADRBRG4.B	Active	Production	SON (DRB)   8	3000   LARGE T&R	Yes	FULL NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PTOI
<a href="#">TPS2113ADRBT</a>	Active	Production	SON (DRB)   8	250   SMALL T&R	Yes	FULL NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PTOI
TPS2113ADRBT.B	Active	Production	SON (DRB)   8	250   SMALL T&R	Yes	FULL NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PTOI
<a href="#">TPS2113APW</a>	Active	Production	TSSOP (PW)   8	150   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2113A
TPS2113APW.B	Active	Production	TSSOP (PW)   8	150   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2113A
<a href="#">TPS2113APWR</a>	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2113A
TPS2113APWR.B	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2113A

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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## TAPE AND REEL INFORMATION



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS2112APWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
TPS2113ADRBR	SON	DRB	8	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TPS2113ADRBRG4	SON	DRB	8	3000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TPS2113ADRBT	SON	DRB	8	250	180.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TPS2113APWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS2112APWR	TSSOP	PW	8	2000	353.0	353.0	32.0
TPS2113ADRBR	SON	DRB	8	3000	367.0	367.0	35.0
TPS2113ADRBRG4	SON	DRB	8	3000	367.0	367.0	35.0
TPS2113ADRBT	SON	DRB	8	250	210.0	185.0	35.0
TPS2113APWR	TSSOP	PW	8	2000	353.0	353.0	32.0

## TUBE



\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
TPS2112APW	PW	TSSOP	8	150	530	10.2	3600	3.5
TPS2112APW.A	PW	TSSOP	8	150	530	10.2	3600	3.5
TPS2113APW	PW	TSSOP	8	150	530	10.2	3600	3.5
TPS2113APW.B	PW	TSSOP	8	150	530	10.2	3600	3.5

**DRB 8**

**GENERIC PACKAGE VIEW**

**VSON - 1 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4203482/L





**VSON - 1 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD

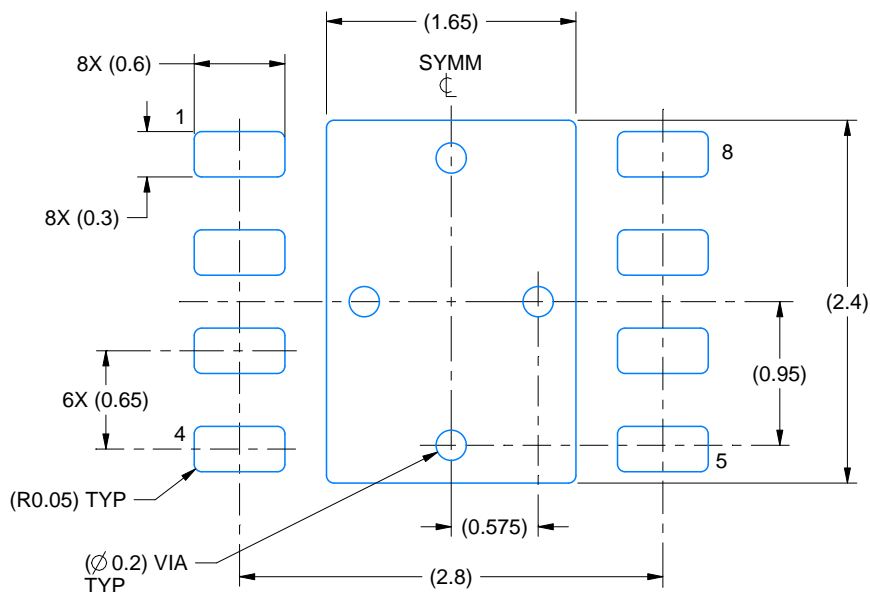


1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

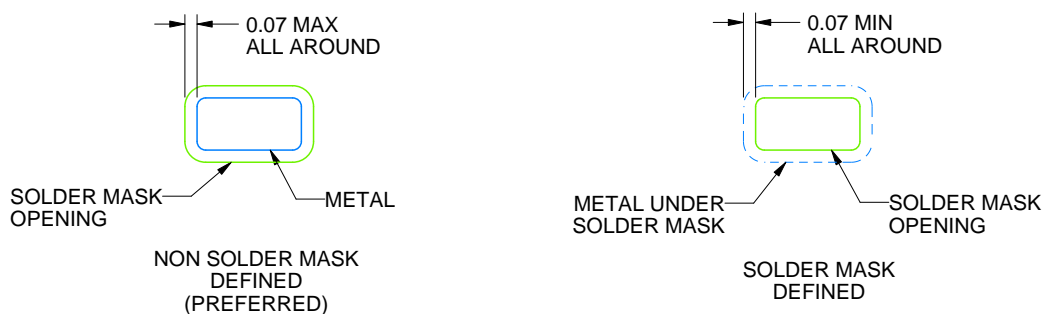
**DRB0008B**

**VSON - 1 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:20X



## SOLDER MASK DETAILS

4218876/A 12/2017

NOTES: (continued)

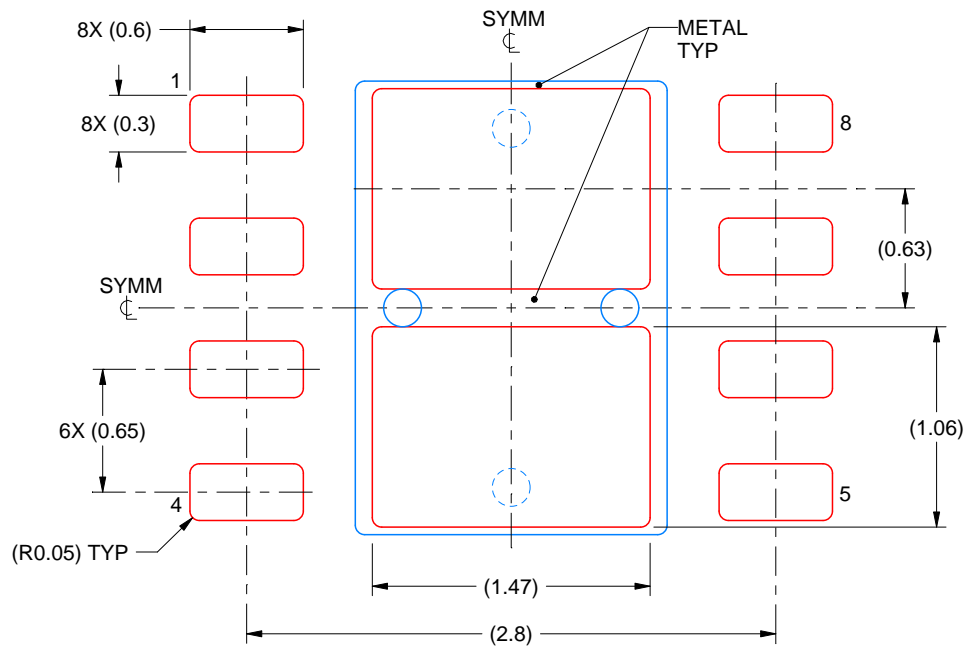
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slue271](http://www.ti.com/lit/slue271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

DRB0008B

VSON - 1 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD  
81% PRINTED SOLDER COVERAGE BY AREA  
SCALE:25X

4218876/A 12/2017

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

PW0008A



# PACKAGE OUTLINE

## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4221848/A 02/2015

### NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.

# EXAMPLE BOARD LAYOUT

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:10X

4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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