

## 6.5-A, 20-V Integrated Hotswap with Programmable Inrush Slew Rate

Check for Samples: [TPS25910](#)

### FEATURES

- Up to 20-V Bus Operation
- Integrated 30-mΩ Pass MOSFET
- Programmable Current Limit from: 0.83 A to 6.5 A
- Programmable Inrush Current Slew Rate
- Thermal Shutdown and fault alert
- 4-mm x 4-mm QFN16
- –40°C to 125°C Junction Temperature Range
- UL2367 Recognized - File Number E169910
- CB Certified

### APPLICATIONS

- Solid State Drive (SSD)
- Hard Disk Drive (HDD)
- RAID Arrays
- Telecommunications
- Plug-In Circuit Boards
- Notebooks and Netbooks
- PCIE
- Fan Control

### DESCRIPTION

The TPS25910 device provides highly integrated hot-swap power management and superior protection in applications up to 20 V. The maximum UV turn-on threshold of 2.9 V makes the TPS25910 device well suited to standard bus voltages as low as 3.3 V. This device is intended for systems where a voltage bus must be protected from undesired permanent and transient overload.

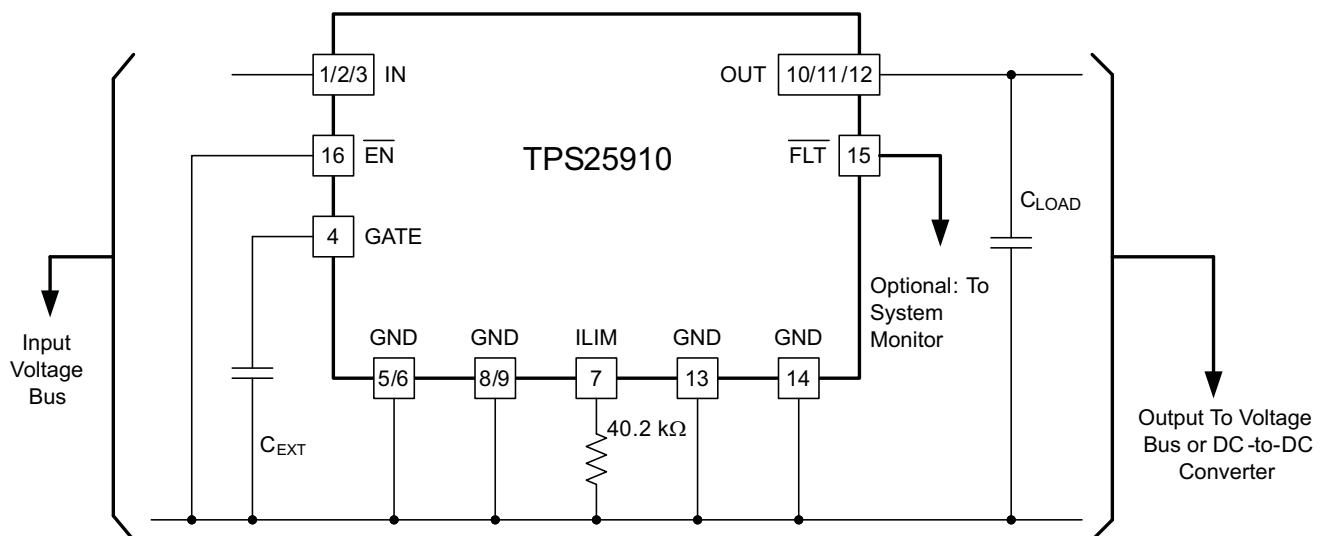
At start-up or when hot plugging into the system bus, the TPS25910 device limits the inrush current by controlling the ramp rate of the output voltage,  $V_{OUT}$ . The slew rate of  $V_{OUT}$  can be adjusted with a capacitor between the GATE pin and the GND pin.

Built in SOA protection ensures that the internal MOSFET operates inside a safe operating area (SOA) under the harshest operating conditions. In addition, the current-limit threshold, which is independent of the power limit, can be adjusted with a resistor between the ILIM pin and the GND pin.

The TPS25910 device provides a fault indicator output when in thermal fault.

The TPS25910 device is available in a 16-pin QFN package.

### 12-V, 4.75-A APPLICATION



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## ABSOLUTE MAXIMUM RATINGS

over device junction temperature range (unless otherwise noted)<sup>(1)(2)</sup>

		MIN	MAX	UNIT
Input voltage range IN, OUT		-0.3	22	V
Voltage range, GATE		-0.3	30	
Voltage range $\overline{\text{FLT}}$		-0.3	20	V
Voltage ILIM			1.75	
Output sink current $\overline{\text{FLT}}$			10	mA
Input voltage range, $\overline{\text{EN}}$		-0.3	6	
Voltage range ILIM <sup>(3)</sup>		-0.3	3	V
ESD rating	Human body model (HBM)		2.5	kV
	Charged device model (CDM)		500	V
Operating junction temperature range, $T_J$		Internally Limited		°C
Storage temperature range, $T_{\text{stg}}$		-65	150	

(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 voltage values are with respect to GND.

(3) Do not apply voltage to pin.

## RECOMMENDED OPERATING CONDITIONS

over device junction temperature range (unless otherwise noted)

PARAMETER	MIN	NOM	MAX	UNIT
Input voltage range IN, OUT	3		20	V
Voltage range $\overline{EN}$	0		5	
Voltage range $\overline{FLT}$	0		20	
Continuous output current I <sub>OUT</sub>	0		5	A
Output sink current $\overline{FLT}$	0		1	mA
External Capacitor, GATE	1		47	nF
dV/dt, V <sub>IN</sub> <sup>(1)</sup>			12	V/μS
R <sub>LIM</sub> <sup>(2)</sup>	0		237k	Ω
Junction temperature	-40		125	°C

 (1) dV/dt, V<sub>IN</sub> should be limited to 12 V/μS to confine the shoot-through current to the load.

 (2) When R<sub>LIM</sub> value is beyond this range, I<sub>LIM</sub> will not be as accurate as within this range.

## THERMAL INFORMATION

THERMAL METRIC <sup>(1)</sup>		TPS25910	UNITS
		RSA (QFN)	
		16 PINS	
θ <sub>JA</sub>	Junction-to-ambient thermal resistance <sup>(2)</sup>	34.8	°C/W
θ <sub>JCtop</sub>	Junction-to-case (top) thermal resistance <sup>(3)</sup>	35.3	
θ <sub>JB</sub>	Junction-to-board thermal resistance <sup>(4)</sup>	11.9	
ψ <sub>JT</sub>	Junction-to-top characterization parameter <sup>(5)</sup>	0.4	
ψ <sub>JB</sub>	Junction-to-board characterization parameter <sup>(6)</sup>	12.0	
θ <sub>JCbot</sub>	Junction-to-case (bottom) thermal resistance <sup>(7)</sup>	3.3	

 (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

(2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.

(3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

(4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.

 (5) The junction-to-top characterization parameter, ψ<sub>JT</sub>, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ<sub>JA</sub>, using a procedure described in JESD51-2a (sections 6 and 7).

 (6) The junction-to-board characterization parameter, ψ<sub>JB</sub>, estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining θ<sub>JA</sub>, using a procedure described in JESD51-2a (sections 6 and 7).

(7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

## ELECTRICAL CHARACTERISTICS

Over operating free-air temperature range,  $V_{IN} = 3\text{ V} - 20\text{ V}$ ,  $\overline{EN} = 0\text{ V}$ ,  $\overline{FLT} = \text{open}$ ,  $R_{(RLIM)} = 40.2\text{ k}\Omega$ , No external capacitors are connected to either GATE or OUT, (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>IN</b>						
	UVLO	$V_{IN} \uparrow$	2.60	2.75	2.9	V
		Hysteresis		100		mV
	Bias current	$\overline{EN} = 2.4\text{ V}$		2.5	4	mA
		$\overline{EN} = 0\text{ V}$		3.3	5	
<b>OUT</b>						
	RON	$R_{(VIN-VOUT)}$ , $I_{(VOUT)} < I_{(RLIM)}$ , $1\text{ A} \leq I_{(VOUT)} \leq 4.5\text{ A}$		29.5	42	mΩ
	Power limit	$V_{IN}: 12\text{ V}$ , $C_{OUT} = 1000\text{ }\mu\text{F}$ , $\overline{EN}: 3\text{ V} \rightarrow 0\text{ V}$	3	5	7.5	W
	Reverse diode voltage	$V_{OUT} > V_{IN}$ , $\overline{EN} = 5\text{ V}$ , $I_{IN} = -1\text{ A}$		0.77	1	V
<b>ILIM</b>						
	current-limit program $I_{VOUT}$ , $V_{(VIN - OUT)} = 0.3\text{ V}$ , pulsed test	$R_{(RLIM)} = 237\text{ k}\Omega$	0.5	0.82	1.1	A
		$R_{(RLIM)} = 200\text{ k}\Omega$	0.75	1	1.25	
		$R_{(RLIM)} = 100\text{ k}\Omega$	1.75	2	2.25	
		$R_{(RLIM)} = 66.5\text{ k}\Omega$	2.65	3	3.3	
		$R_{(RLIM)} = 40.2\text{ k}\Omega$	4.5	5	5.5	
		$R_{(RLIM)} = 29.4\text{ k}\Omega$	5.7	6.5	7.3	
<b>EN</b>						
	Threshold voltage	$V_{(\overline{EN})}$ falling	1.1	1.35		V
		$V_{(\overline{EN})}$ rising		1.5	1.75	
		Hysteresis		150		mV
	Input bias current	$V_{(\overline{EN})} = 2.4\text{ V}$ (sinking)	-1.5	-1	0.5	μA
		$V_{(\overline{EN})} = 0.2\text{ V}$ (sourcing)	-2	-1	0.5	
	Turn on propagation delay	$V_{IN} = 3.3\text{ V}$ , $I_{LOAD} = 1\text{ A}$ , $V_{(\overline{EN})}: 2.4\text{ V} \rightarrow 0.2\text{ V}$ , till $I_{GATE}$ changes direction.		10		μs
	Turn off propagation delay	$V_{IN} = 3.3\text{ V}$ , $I_{LOAD} = 1\text{ A}$ , $V_{(\overline{EN})}: 0.2\text{ V} \rightarrow 2.4\text{ V}$ , till $I_{GATE}$ changes direction.		2.5		
<b>FLT</b>						
	$V_{OL}$	$I_{(FLT)} = 1\text{ mA}$ , Fault active (Over Temperature)		0.2	0.4	V
	Leakage current	$V_{(FLT)} = 18\text{ V}$			1	μA
<b>THERMAL SHUTDOWN</b>						
	Thermal shutdown	$T_J$		160		°C
		Hysteresis		20		
<b>GATE</b>						
	Sourcing current	$V_{(GATE-OUT)} = 3.5\text{ V}$ , $V_{(\overline{EN})} = \text{Low}$	8	11	15	μA
	Strong pull down resistor	$V_{(\overline{EN})} = \text{Low}$	10	40	80	Ω
	Weak pull down current	$V_{(\overline{EN})} = \text{Low}$	250	500	750	μA
	Output Voltage, $V_{(GATE-OUT)}$		5.5	6.6	7.5	V

DEVICE INFORMATION

TPS25910 FUNCTIONAL BLOCK DIAGRAM

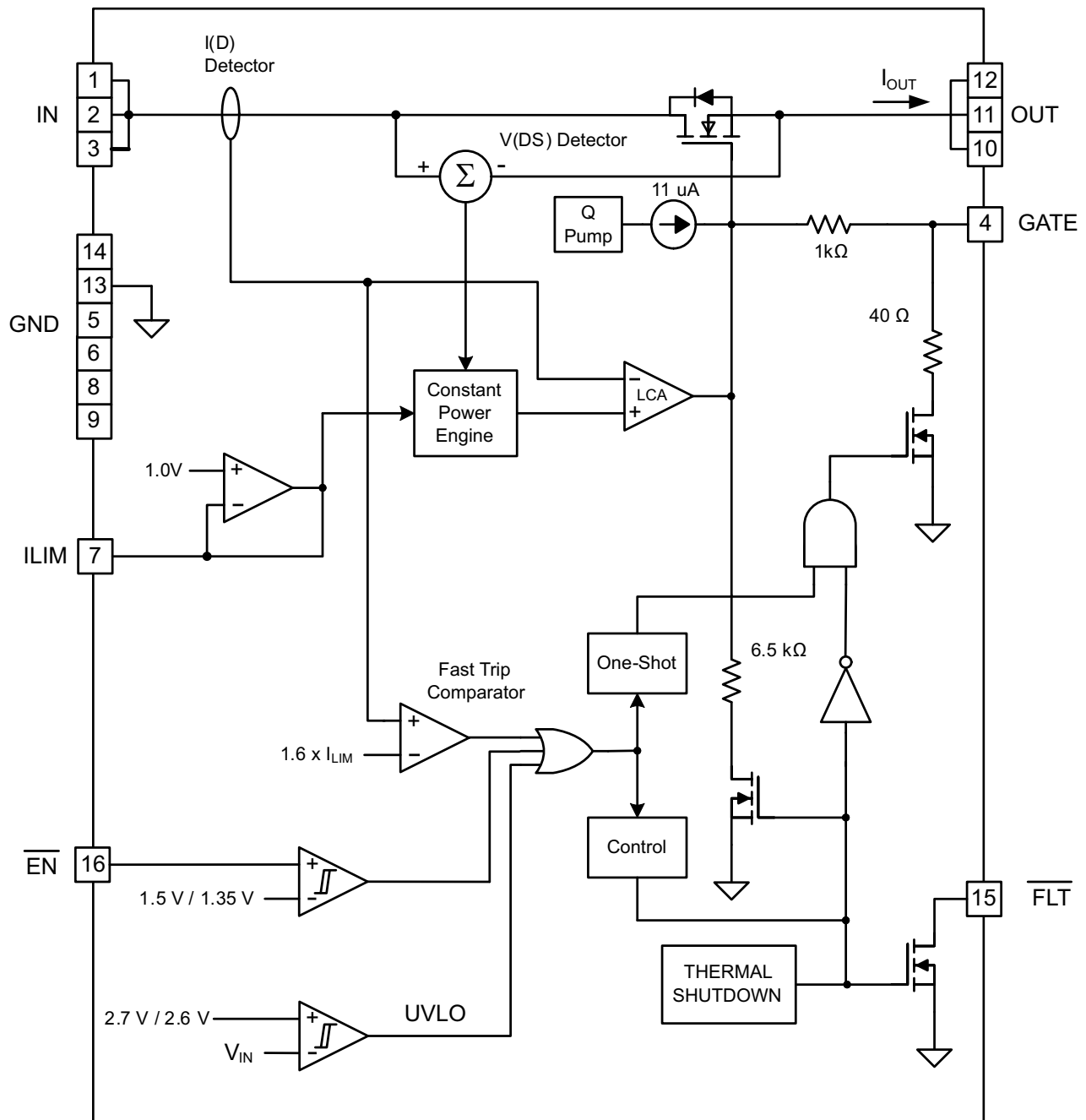
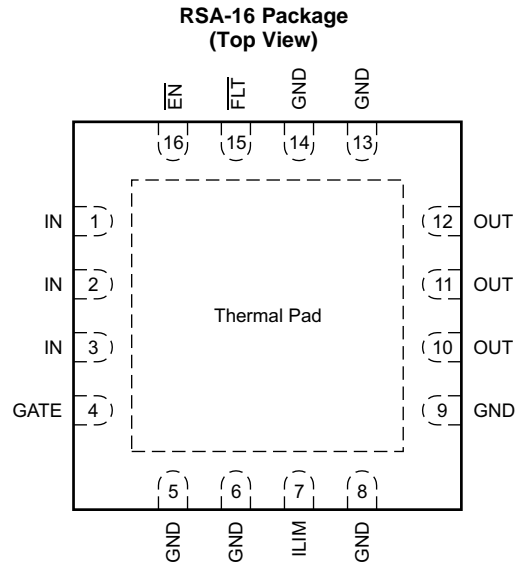


Figure 1. Functional Block Diagram

**TPS25910 PIN ASSIGNMENT**



**PIN FUNCTIONS**

PIN NAME	PIN NUMBER	DESCRIPTION
$\overline{\text{EN}}$	16	Device is enabled when this pin is pulled low.
IN	1, 2, 3	Power In and control supply voltage.
GATE	4	If the chip die temperature exceeds the OTSD rising threshold, GATE is pulled down to GND by a 7.5KOhm resistor.
ILIM	7	A resistor to ground sets the current-limit level.
GND	5, 6, 8, 9, 13, 14	GND
OUT	10, 11, 12	Output to the load.
$\overline{\text{FLT}}$	15	Fault low indicates that the internal pass FET junction temperature exceeds the thermal shutdown threshold

## PIN DESCRIPTION

**FLT:** Open-drain output that pulls low during thermal shutdown.  $\overline{\text{FLT}}$  activates when device thermally shuts down and deactivates when die temperature cools down below the device thermal protection threshold and the device ends thermal shutdown cycle. FLT becomes operational before UV, when  $V_{\text{IN}}$  is greater than 1 V.

**GND:** This is the most negative voltage in the circuit and is used as reference for all voltage measurements unless otherwise specified. All the GND pins must be connected to system power supply negative return point

**GATE:** Output that provides gate drive for the internal pass FET. Its sourcing current is about 11  $\mu\text{A}$ . An internal clamp prevents GATE from rising 6.6 V above OUT.  $C_{\text{INT}}$  is 200 pF.

The GATE pin is disabled by the following mechanisms:

1. When  $\overline{\text{EN}}$  is above its rising threshold, GATE is pulled down by a 40- $\Omega$  resistor connecting to GND for approximately 50  $\mu\text{s}$ . Then, a 7.5-k $\Omega$  resistor ties GATE to GND to ensure the GATE is off.
2. When  $V_{\text{IN}}$  drops below the UVLO threshold, GATE is pulled down by a 40- $\Omega$  resistor connecting to GND for approximately 50  $\mu\text{s}$ . Then, a 7.5-k $\Omega$  resistor ties GATE to GND to ensure the GATE is off.
3. When short circuit fault occurs, GATE is pulled down by a 40- $\Omega$  resistor connecting to GND for approximately 50  $\mu\text{s}$ . Then, a 500- $\mu\text{A}$  current source continues to pull down on the GATE.
4. If the chip die temperature exceeds the OTSD rising threshold, GATE is pulled down to GND by a 7.5-k $\Omega$  resistor.

An external capacitor can be connected from GATE pin to GND pin to create linear inrush profile. The slew rate of the inrush can be controlled by a different capacitor value.

$$I_{\text{CHARGE}} = (C_{\text{EXT}} + C_{\text{INT}}) \frac{dV_{\text{OUT}}}{dt}$$

where

- $I_{\text{CHARGE}}$  is 11  $\mu\text{A}$  (typical)
  - $C_{\text{INT}}$ , the equivalent gate input capacitance of the internal FET (200 pF typical)
- (1)

**ILIM:** A resistor connected from this pin to ground sets  $I_{\text{LIM}}$ .  $R_{\text{LIM}}$  is set by the formula:

$$R_{\text{LIM}} = \frac{197.388}{I_{\text{LIM}}^{0.976944}} \quad \text{for currents below 2 A where } R_{\text{LIM}} \text{ is in k}\Omega.$$
(2)

$$R_{\text{LIM}} = \frac{205.62}{I_{\text{LIM}}^{1.02912}} \quad \text{for currents above 2 A where } R_{\text{LIM}} \text{ is in k}\Omega.$$
(3)

**EN:** When this pin is pulled low, the device is enabled. The input threshold is hysteretic, allowing the user to program a startup delay with an external RC circuit.  $\overline{\text{EN}}$  is pulled to  $V_{\text{IN}}$  by a 10-M $\Omega$  resistor, pulled to GND by 16.8 M $\Omega$  and is clamped to ground by a 7-V Zener diode. Because high impedance pullup and or down resistors are used to reduce current draw, any external FET controlling this pin must be low leakage.

**IN:** Input voltage to the TPS25910 device. The recommended operating voltage range is 3 V to 20 V. All  $V_{\text{IN}}$  pins must be connected together and to the power source.

**OUT:** Output connection for the TPS25910 device. When switched on, the output voltage is approximately:

$$V_{\text{OUT}} = V_{\text{IN}} - 0.04 \times I_{\text{OUT}}$$
(4)

All OUT pins must be connected together and to the load.

TYPICAL CHARACTERISTICS

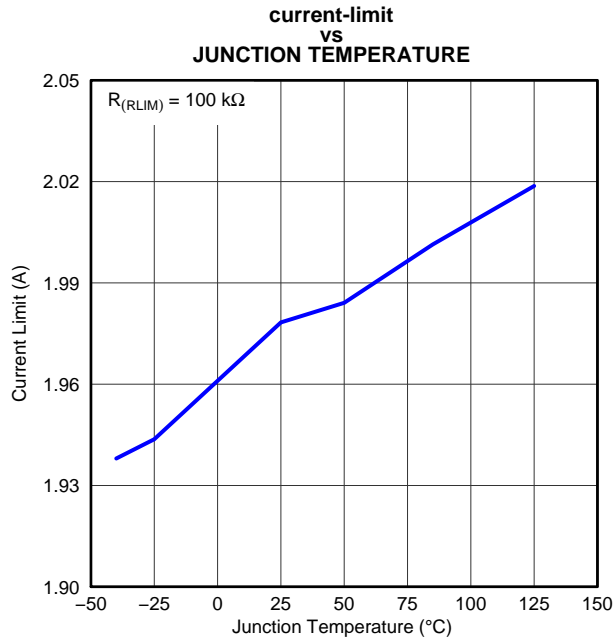


Figure 2.

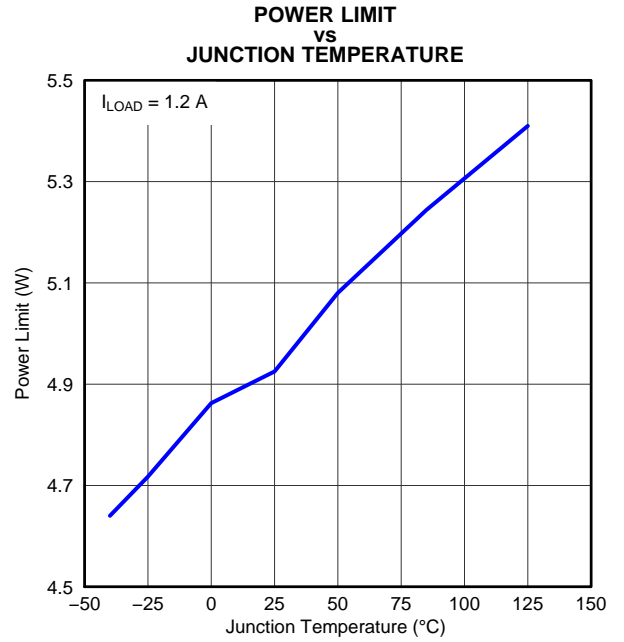


Figure 3.

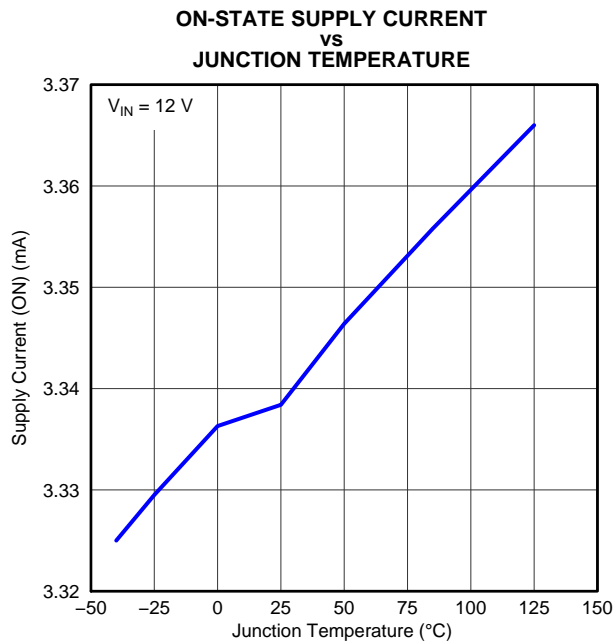


Figure 4.

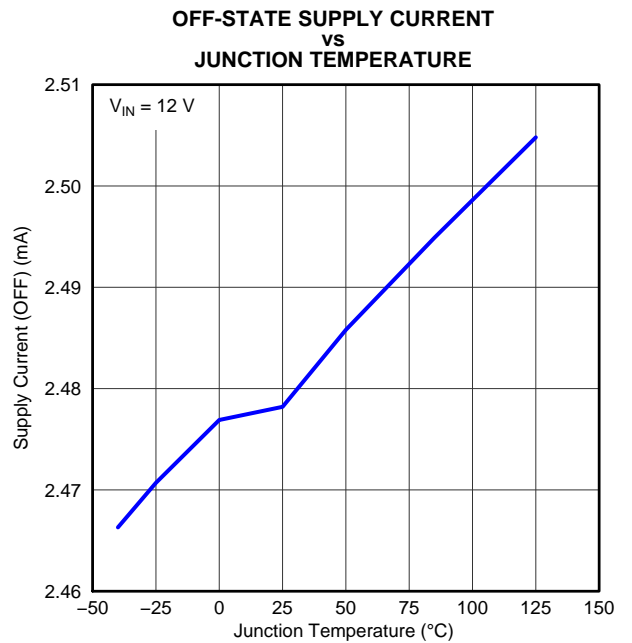


Figure 5.



## APPLICATION INFORMATION

### Programming the Current-Limit Threshold

The over-current threshold is user programmable via an external resistor. The TPS25910 device uses an internal regulation loop to provide a regulated voltage on the ILIM pin. The current-limit threshold is proportional to the current sourced out of ILIM. The recommended 1% resistor range for  $R_{LIM}$  is  $0\text{ k}\Omega \leq R_{LIM} \leq 237\text{ k}\Omega$  to ensure stability of the internal regulation loop. Many applications require that the minimum current-limit is above a certain current level or that the maximum current-limit is below a certain current level, so it is important to consider the tolerance of the over-current threshold when selecting a value for  $R_{LIM}$ . Consult the [ELECTRICAL CHARACTERISTICS](#) table for specific current-limit settings. The traces routing the  $R_{LIM}$  resistor to the TPS25910 device must be as short as possible to reduce parasitic effects on the current-limit accuracy.

Equation 5 through Equation 7 can be used to estimate current-limit below 2 A:

$$I_{LIM(min)} = \frac{1051.9}{R_{LIM(max)}^{1.3854}} \quad (5)$$

$$I_{LIM(typ)} = \frac{223.61}{R_{LIM(typ)}^{1.0236}} \quad (6)$$

$$I_{LIM(max)} = \frac{104.95}{R_{LIM(min)}^{0.8347}} \quad (7)$$

Equation 8 through Equation 10 can be used to estimate current-limit above 2 A:

$$I_{LIM(min)} = \frac{161.24}{R_{LIM(max)}^{0.9796}} \quad (8)$$

$$I_{LIM(typ)} = \frac{176.85}{R_{LIM(typ)}^{0.9717}} \quad (9)$$

$$I_{LIM(max)} = \frac{194.81}{R_{LIM(min)}^{0.9694}} \quad (10)$$

where

- $R_{LIM(max)}$  is the maximum resistor value in factoring in error
- $R_{LIM(typ)}$  is the typical resistor value
- $R_{LIM(min)}$  is the minimum resistor value factoring in error

All resistor values are represented in k $\Omega$ . For example, a 100-k $\Omega$ , 1% resistor would have the following values:

- $R_{LIM(min)} = 99\text{ k}\Omega$
- $R_{LIM(typ)} = 100\text{ k}\Omega$
- $R_{LIM(max)} = 101\text{ k}\Omega$

A plot of the current-limit threshold versus  $R_{ILIM}$  using equations Equation 5 through Equation 10 above is shown in Figure 6.

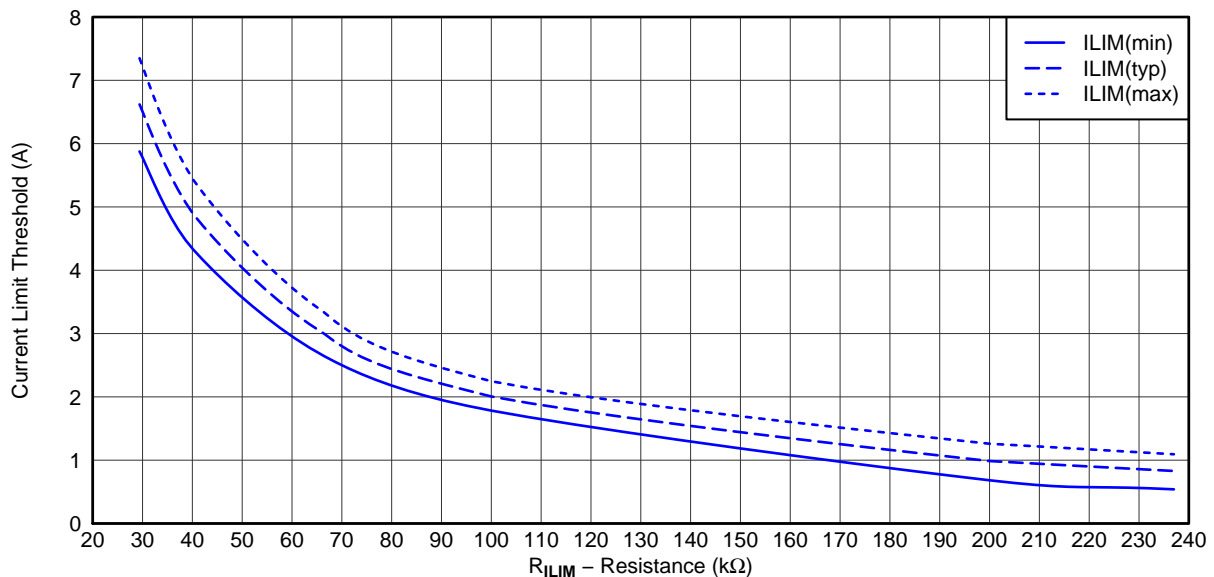


Figure 6. Current-Limit Threshold Versus  $R_{ILIM}$

### Slew Rate Control Using C<sub>GATE</sub>

The TPS25910 device can be used with applications that require constant turn-on currents. The current is controlled by a single capacitor from the GATE terminal to ground. The TPS25910 internal MOSFET appears to operate as a source follower (following the gate voltage) in this implementation. Choose a time to charge,  $\Delta t$ , based on the output capacitor, input voltage  $V_I$ , and desired charge current,  $I_{\text{CHARGE}}$ . Select the device load to be less than 5 W /  $V_{\text{IN}}$ .

$$\Delta t = \frac{C_{\text{LOAD}} \times V_{\text{IN}}}{I_{\text{C-LOAD}}} \tag{11}$$

To select the gate capacitance:

$$C_{\text{EXT}} = I_{\text{CHARGE}} \times \frac{\Delta t}{V_{\text{IN}}} - C_{\text{INT}}$$

- $I_{\text{CHARGE}} = 11 \mu\text{A}$
- $C_{\text{INT}} = 200 \text{ pF}$  (typical)

(12)

Figure 7 and Figure 8 illustrate the effects of  $C_{\text{EXT}} = 0.1 \mu\text{F}$  on inrush current using TPS25910EVM-088.

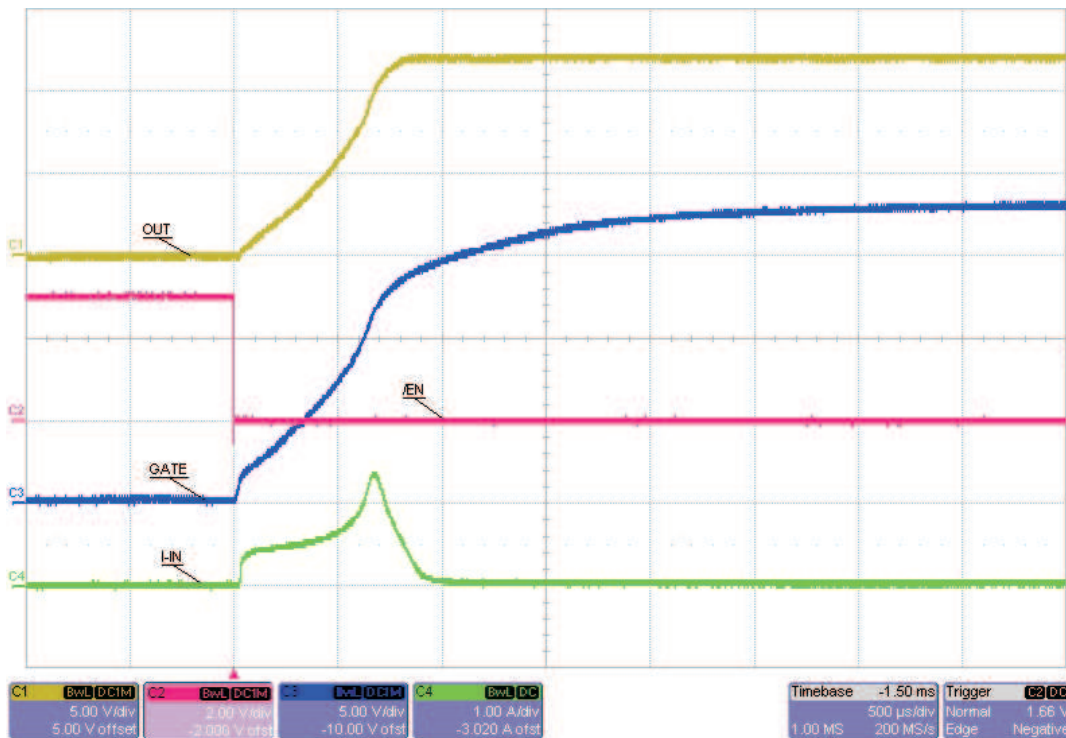


Figure 7. Typical Power Limited Inrush Start Up (No C<sub>EXT</sub>)

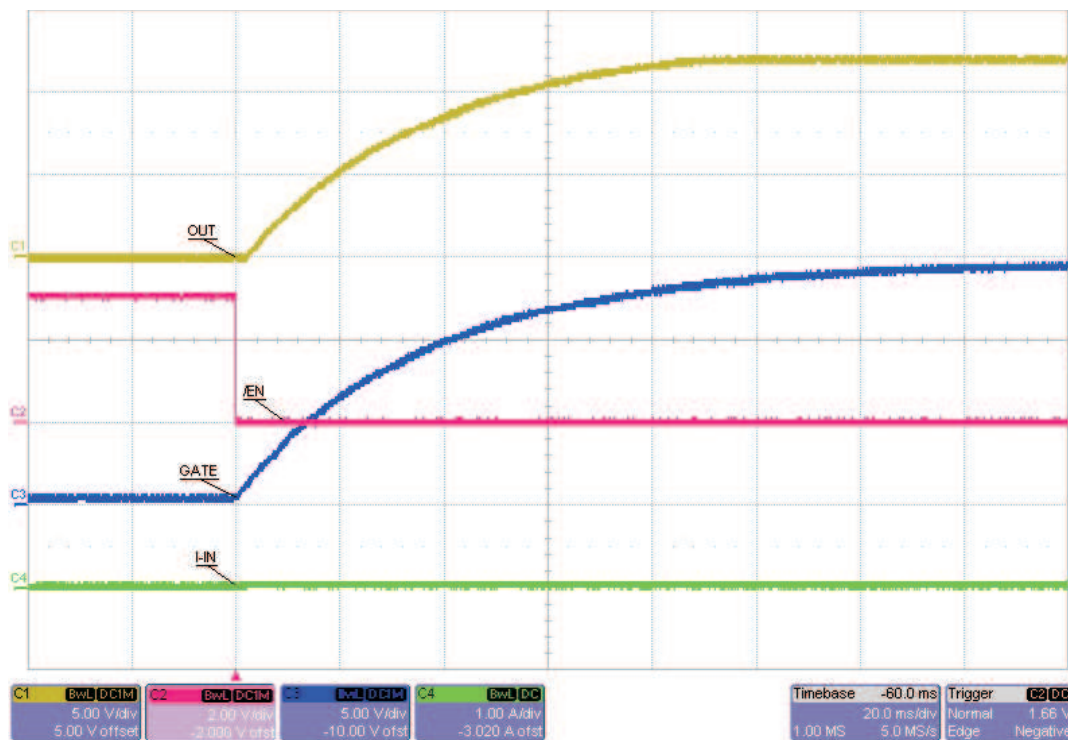


Figure 8. Start-Up With Slew Rate Control ( $C_{EXT} = 0.1 \mu F$ )

### Thermal Sense

The TPS25910 self protects by using a thermal sensing circuit that monitors the operating temperature of the power switch and disables operation if the temperature exceeds the thermal shutdown condition (160°C typical). The TPS25910 device operates in power-limit mode during an overload condition and increases the voltage drop across power switch. The thermal sensor turns off the power switch when the die temperature exceeds 160°C. Hysteresis is built into the thermal sensor, and the switch turns on after the device has cooled approximately 20°C. Figure 9 below illustrates the thermal behavior during output overload.

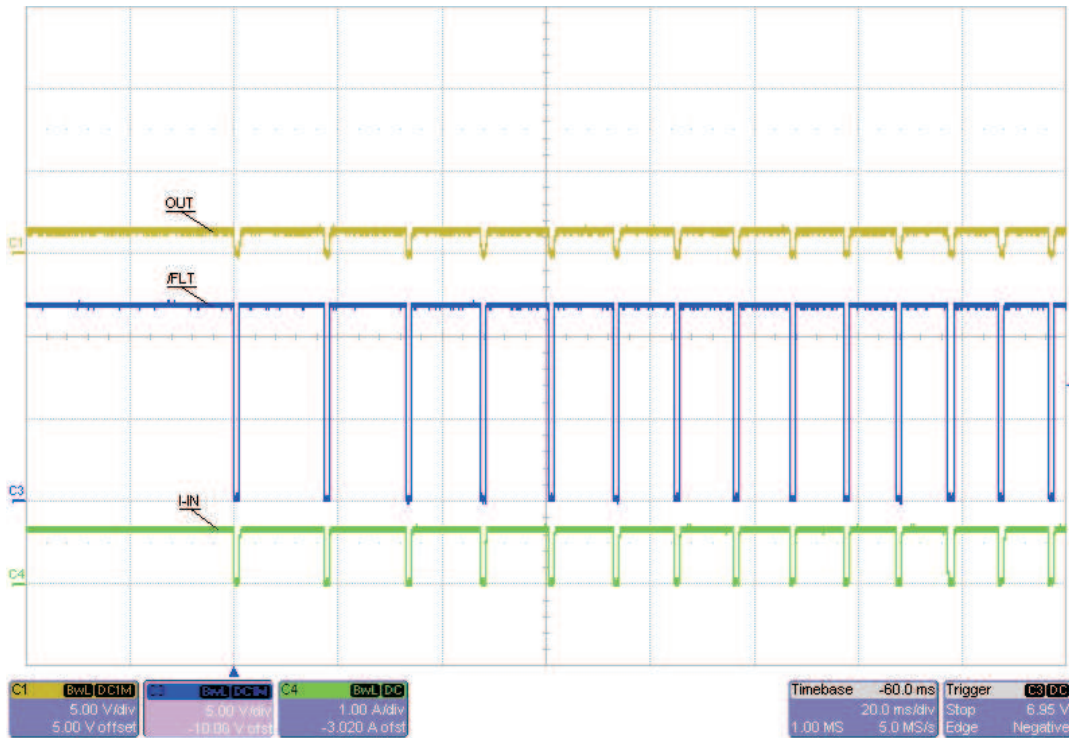


Figure 9. Thermal Sense Behavior

### Back-to-Back (B2B) FET Operation

Many applications require reverse current blocking (from load to input source) so that pending system activities can be completed (such as writing important data to non-volatile memory) prior to power down or during brown out. The TPS25910 device provides the GATE pin externally for slew rate control, but this external connection can also be used to control an external blocking MOSFET, Q1 as shown in Figure 10.

As  $V_{IN}$  drops during input power removal, the comparator circuit de-asserts ENb, GATE falls, and both the TPS25910 internal MOSFET and Q1 is turned off and block any current flow from  $V_{LOAD}$  to  $V_{IN}$ .  $C_{LOAD}$  can then be chosen to furnish the required load current for long enough to complete the required power down system activities.

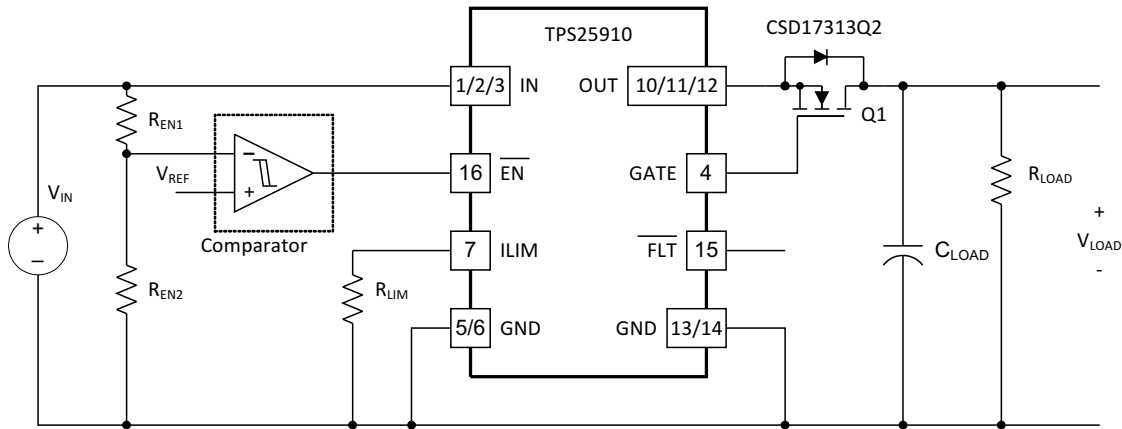


Figure 10. B2B Implementation

**NOTE**

Connecting the load voltage to the non-inverting input of the external comparator can provide a simple ORing function that prevents holdup energy in  $C_{LOAD}$  from discharging through the TPS25910 device to  $V_{IN(source)}$  when  $V_{IN(source)}$  droops or collapses.

Circuit operation is illustrated in Figure 11 and Figure 12. Figure 11 shows the power down event with no load at the output. When  $V_{IN}$  drops to approximately 10 V (threshold of comparator circuit), ENb is de-asserted and GATE falls and enables reverse current blocking. The voltage on  $C_{LOAD}$  then stops following  $V_{IN}$  and remains flat for a long duration.

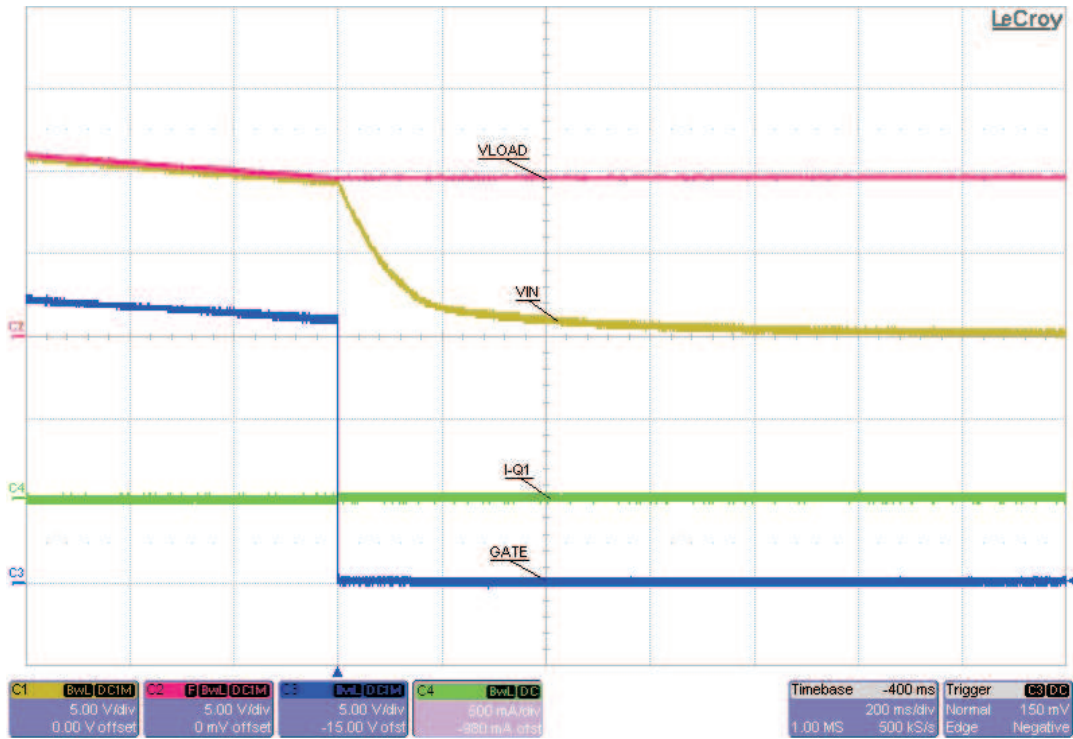


Figure 11. B2B Performance with No-Load

Figure 12 illustrates the power down event with a 200-mA load. As  $V_{IN}$  starts to fall, the output load is supplied by  $C_{LOAD}$ .  $C_{LOAD}$  must be large enough to support  $V_{LOAD}$  for long enough for the power down activities to complete. For the case shown in Figure 12,  $C_{LOAD}$  is a 3900- $\mu\text{F}$  capacitor and can support a droop from approximately 10 V to approximately 5 V for approximately 170 ms.

The TPS3700DDC (dual comparator with wide input voltage range) can be used for the B2B comparator circuit shown in Figure 10. Only one comparator is needed, but the second comparator can be utilized as either a power good flag or as a notification to the system load that a brownout or power down event is about to occur.

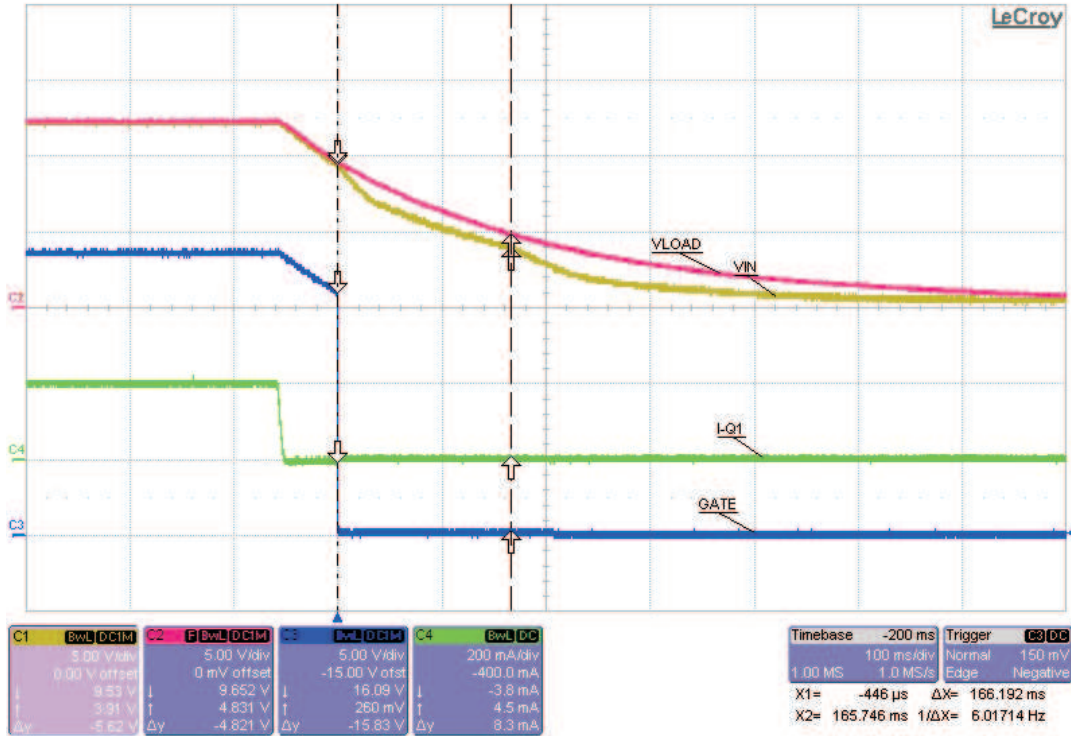


Figure 12. B2B Performance with 200-mA Load



## Maximum Load at Startup

The power limiting function of the TPS25910 device provides effective protection for the internal FET. Expectedly, there is a supply voltage dependent maximum load which the device is able to power up. Loads above this level can cause the device to shut off current before startup is complete. Neglecting any load capacitance, the maximum load (minimum load resistance) is calculated using [Equation 13](#);

$$R_{\text{MIN}} = \frac{V_{\text{IN}}^2}{12} \quad (13)$$

Adding load capacitance may reduce the maximum load which can be present at start up.

If  $\overline{\text{EN}}$  is tied to GND at startup and IN does not ramp quickly, the TPS25910 device can momentarily turn off then on during startup. This can happen if a capacitive load pulls down the input voltage below the UV threshold. If necessary, this can be avoided by delaying the  $\overline{\text{EN}}$  assertion until VIN is fully up.

## Transient Protection

The need for transient protection in conjunction with hot-swap controllers should always be considered. When the TPS25910 device interrupts current flow, input inductance generates a positive voltage spike on the input and output inductance generates a negative voltage spike on the output. Such transients can easily exceed twice the supply voltage if steps are not taken to address the issue. Typical methods for addressing transients include;

- Minimizing lead length/inductance into and out of the device.
- Transient Voltage Suppressors (TVS) on the input to absorb inductive spikes.
- Schottky diode across the output to absorb negative spikes.
- A combination of ceramic and electrolytic capacitors on the input and output to absorb energy.

The following equation estimates the magnitude of these voltage spikes:

Where;

$$V_{\text{SPIKE(absolute)}} = V_{\text{NOM}} + I_{\text{LOAD}} \times \sqrt{\frac{L}{C}}$$

- $V_{\text{NOM}}$  equals the nominal supply voltage
- $I_{\text{LOAD}}$  equals the load current
- C equals the capacitance present at the input or output of the TPS25910 device
- L equals the effective inductance seen looking into the source or the load

(14)

The inductance because of a straight length of wire equals approximately.

Where;

$$L_{\text{straightwire}} \approx 0.2 \times L \times \ln\left(\frac{4 \times L}{D} - 0.75\right) \text{ (nH)}$$

- L equals the length of the wire
- D equals wire diameter

(15)

Some applications may require the addition of a TVS to prevent transients from exceeding the absolute ratings if sufficient capacitance cannot be included.

## REVISION HISTORY

Changes from Original (September 2012) to Revision A	Page
• Changed the 12-V, 4.75-A APPLICATION image .....	1
• Changed <a href="#">Equation 3</a> text From: below 2 A where $R_{LIM}$ is in k $\Omega$ . To: above 2 A where $R_{LIM}$ is in k $\Omega$ . .....	7
• Changed <a href="#">Equation 12</a> .....	11
• Changed <a href="#">Figure 10</a> .....	14
Changes from Revision A (September 2012) to Revision B	Page
• Changed <a href="#">Figure 1</a> LCA polarity symbols .....	5
• Changed <a href="#">Figure 10</a> Q1 connection .....	14
Changes from Revision B (March, 2013) to Revision C	Page
• Added Bullet: <b>UL Listed - File Number E169910</b> to the Features section. ....	1
• Added Bullet: <b>CB Certified</b> to the Features section. ....	1
Changes from Revision C (May 2013) to Revision D	Page
• Deleted the minimum voltage from the voltage range listed in the document title, features list and description .....	1
• Added 6.5-A to document title .....	1
• Changed <i>listed</i> to <i>recognized</i> in last <i>FEATURES</i> bullet .....	1
• Added 2367 to UL number in the <i>FEATURES</i> list. Moved File Number to same list item as UL Recognized .....	1
• Added PCIE and Fan Control to the <i>APPLICATIONS</i> list .....	1
• Deleted <i>where the load is powered by busses up to 20 V</i> from the first paragraph of the <i>DESCRIPTION</i> and replaced it with UV turn-on threshold and bus voltage text .....	1
• Deleted <i>ORDERING INFORMATION</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="#">TPS25910RSAR</a>	Active	Production	QFN (RSA)   16	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPS 25910
TPS25910RSAR.B	Active	Production	QFN (RSA)   16	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPS 25910
TPS25910RSARG4	Active	Production	QFN (RSA)   16	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPS 25910
TPS25910RSARG4.B	Active	Production	QFN (RSA)   16	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPS 25910
<a href="#">TPS25910RSAT</a>	Active	Production	QFN (RSA)   16	250   SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPS 25910
TPS25910RSAT.B	Active	Production	QFN (RSA)   16	250   SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPS 25910

(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**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*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
TPS25910RSAR	QFN	RSA	16	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
TPS25910RSARG4	QFN	RSA	16	3000	330.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2
TPS25910RSAT	QFN	RSA	16	250	180.0	12.4	4.25	4.25	1.15	8.0	12.0	Q2

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS25910RSAR	QFN	RSA	16	3000	346.0	346.0	33.0
TPS25910RSARG4	QFN	RSA	16	3000	346.0	346.0	33.0
TPS25910RSAT	QFN	RSA	16	250	182.0	182.0	20.0

## GENERIC PACKAGE VIEW

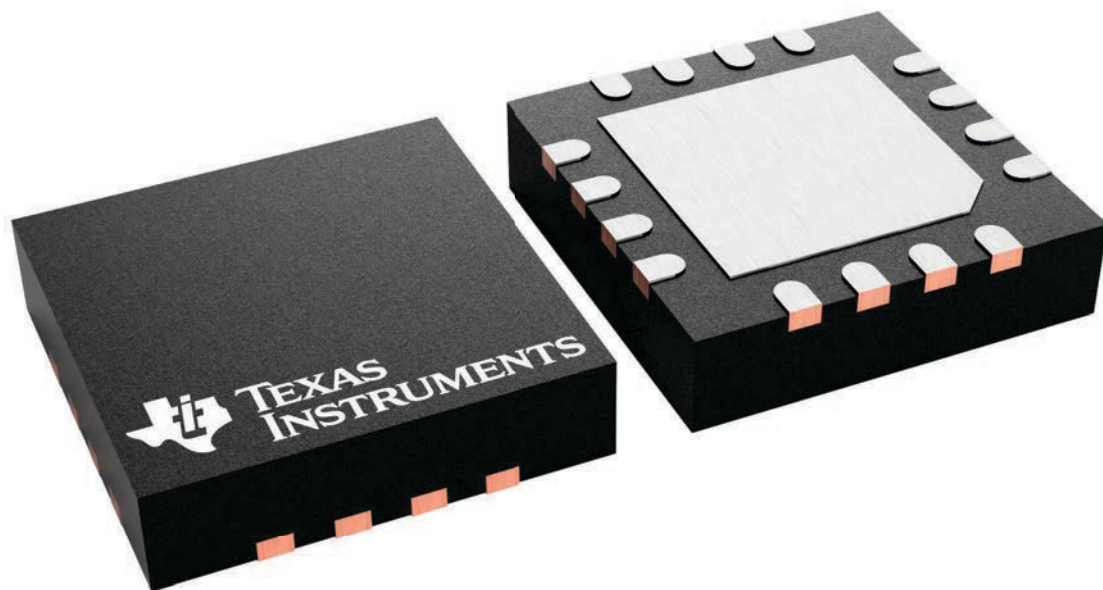
**RSA 16**

**VQFN - 1 mm max height**

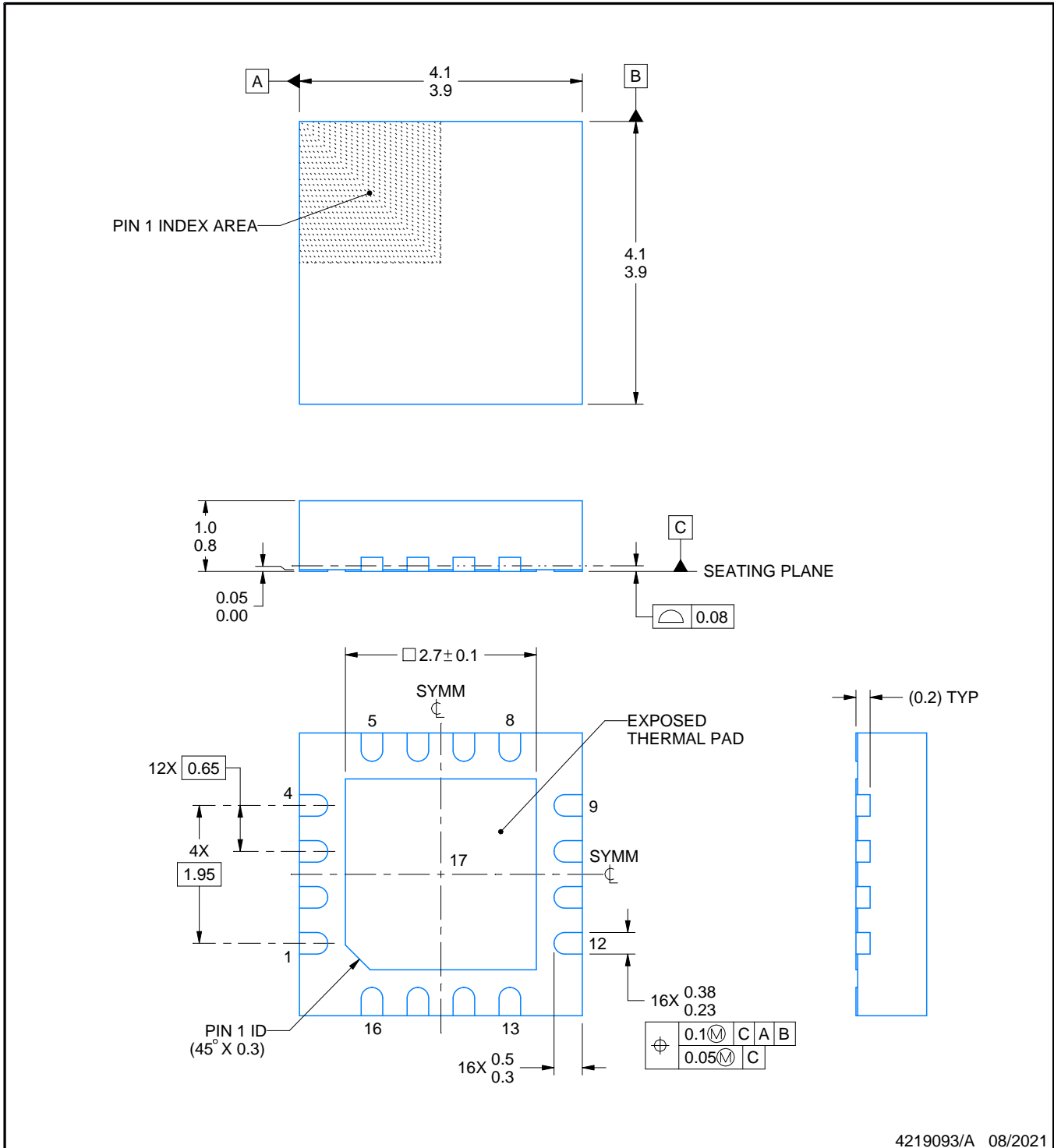
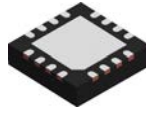
4 x 4, 0.65 mm pitch

PLASTIC QUAD FLATPACK - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



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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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.
4. Reference JEDEC registration MO-220.

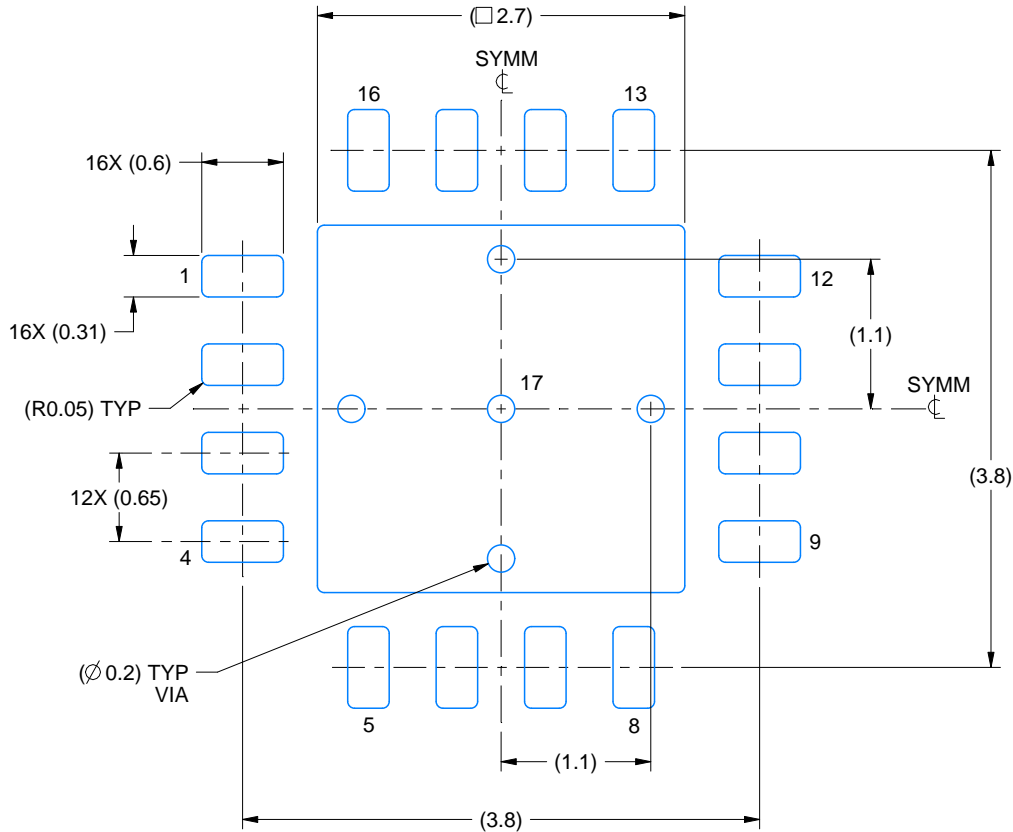


# EXAMPLE BOARD LAYOUT

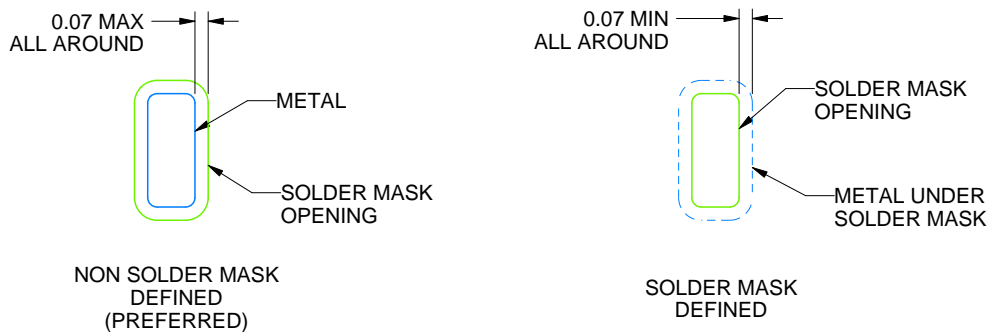
RSA0016B

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:18X



SOLDER MASK DETAILS

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NOTES: (continued)

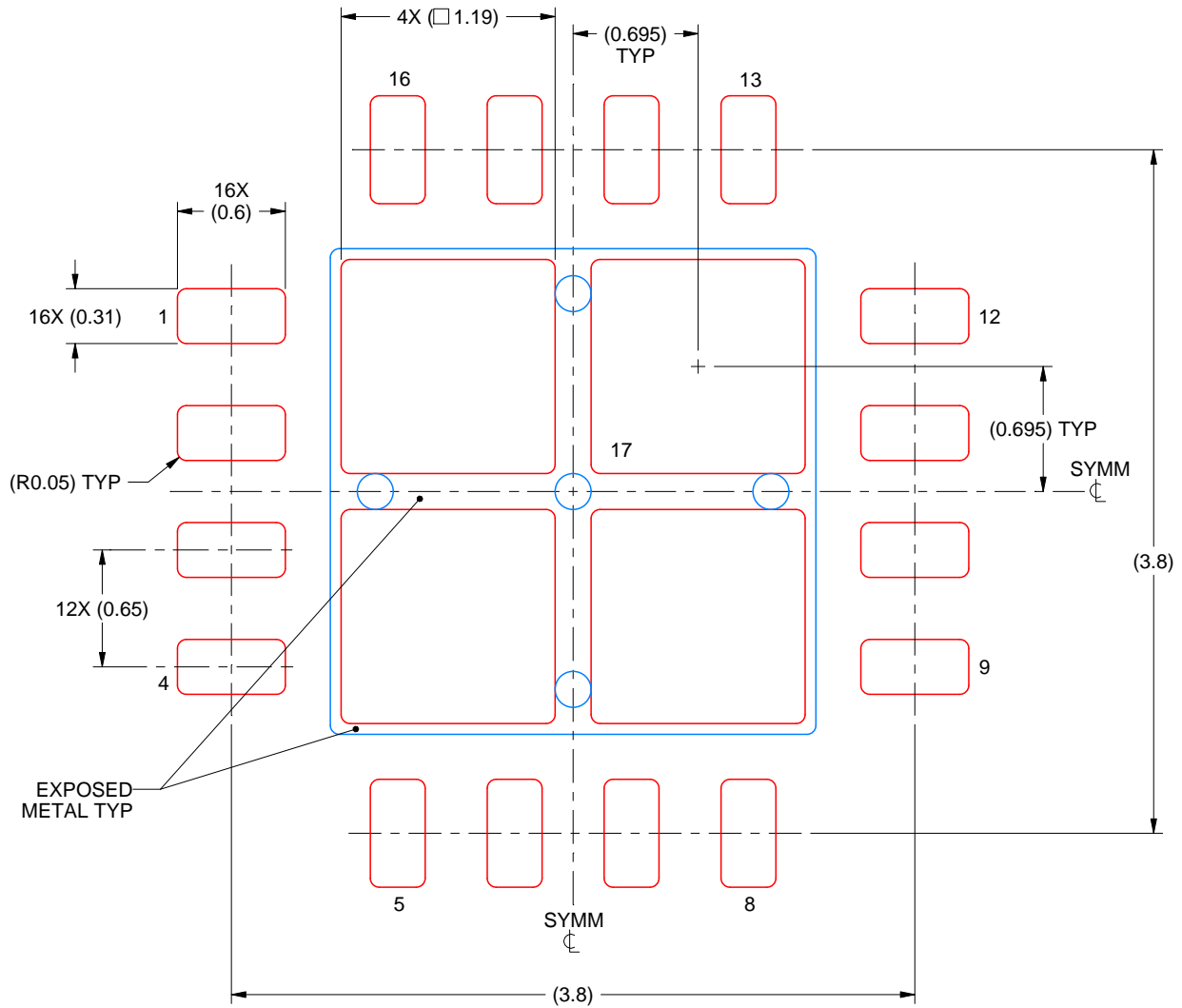
5. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
6. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RSA0016B

VQFN - 1 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



**SOLDER PASTE EXAMPLE**  
 BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD  
 77% PRINTED SOLDER COVERAGE BY AREA  
 SCALE:25X

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NOTES: (continued)

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

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