



# TPS61097A-33 Low-Input Voltage Synchronous-Boost Converter With Low Quiescent Current

## 1 Features

- Up to 93% Efficiency at Typical Operating Conditions
- Connection from Battery to Load via Bypass Switch in Shutdown Mode
- Typical Shutdown Current Less Than 5 nA
- Typical Quiescent Current Less Than 5  $\mu$ A
- Operating Input Voltage Range From 0.9 V to 5.5 V
- Power-Save Mode for Improved Efficiency at Low Output Power
- Overtemperature Protection
- Small 2.8-mm x 2.9-mm 5-Pin SOT-23 Package

## 2 Applications

- MSP430 Applications
- All Single-Cell, Two-Cell, and Three-Cell Alkaline, NiCd, NiMH, or Single-Cell Li-Battery Powered Products
- Personal Medical Products
- Fuel Cell and Solar Cell Powered Products
- PDAs
- Mobile Applications
- White LEDs

## 3 Description

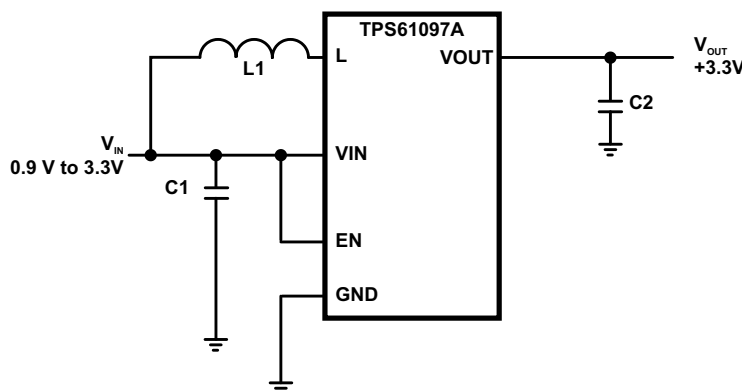
The TPS61097A-33 provides a power supply solution for products powered by either a single-cell, two-cell, or three-cell alkaline, NiCd, or NiMH, or one-cell Li-Ion or Li-polymer battery. They can also be used in fuel cell or solar cell powered devices where the capability of handling low input voltages is essential. Possible output currents depend on the input-to-output voltage ratio. The devices provide output currents up to 100 mA at a 3.3-V output while using a single-cell Li-Ion or Li-Polymer battery. The boost converter is based on a current-mode controller using synchronous rectification to obtain maximum efficiency. The maximum average input current is limited to a value of 400 mA. The converter can be disabled to minimize battery drain. During shutdown, the battery is connected to the load to enable battery backup of critical functions on the load. The device is packaged in a 5-pin SOT-23 package (DBV) measuring 2.8 mm  $\times$  2.9 mm.

### Device Information<sup>(1)</sup>

| PART NUMBER  | PACKAGE    | BODY SIZE (NOM)          |
|--------------|------------|--------------------------|
| TPS61097A-33 | SOT-23 (5) | 2.90 mm $\times$ 2.90 mm |

(1) For all available packages, see the orderable addendum at the end of the datasheet.

### Typical Operating Application



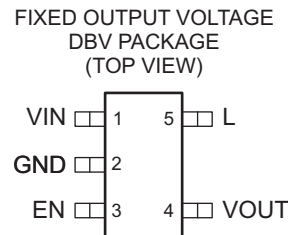
## Table of Contents

|                                                  |          |                                                                  |           |
|--------------------------------------------------|----------|------------------------------------------------------------------|-----------|
| <b>1 Features</b> .....                          | <b>1</b> | 8.3 Feature Description .....                                    | 10        |
| <b>2 Applications</b> .....                      | <b>1</b> | 8.4 Device Functional Modes .....                                | 11        |
| <b>3 Description</b> .....                       | <b>1</b> | <b>9 Application and Implementation</b> .....                    | <b>12</b> |
| <b>4 Revision History</b> .....                  | <b>2</b> | 9.1 Application Information .....                                | 12        |
| <b>5 Pin Configuration and Functions</b> .....   | <b>3</b> | 9.2 Typical Application .....                                    | 13        |
| <b>6 Specifications</b> .....                    | <b>3</b> | <b>10 Power Supply Recommendations</b> .....                     | <b>16</b> |
| 6.1 Absolute Maximum Ratings .....               | 3        | <b>11 Layout</b> .....                                           | <b>16</b> |
| 6.2 ESD Ratings .....                            | 3        | 11.1 Layout Guidelines .....                                     | 16        |
| 6.3 Recommended Operating Conditions .....       | 3        | 11.2 Layout Example .....                                        | 16        |
| 6.4 Thermal Information .....                    | 4        | <b>12 Device and Documentation Support</b> .....                 | <b>17</b> |
| 6.5 Electrical Characteristics .....             | 4        | 12.1 Device Support .....                                        | 17        |
| 6.6 Typical Characteristics .....                | 5        | 12.2 Trademarks .....                                            | 17        |
| <b>7 Parameter Measurement Information</b> ..... | <b>8</b> | 12.3 Electrostatic Discharge Caution .....                       | 17        |
| <b>8 Detailed Description</b> .....              | <b>9</b> | 12.4 Glossary .....                                              | 17        |
| 8.1 Overview .....                               | 9        | <b>13 Mechanical, Packaging, and Orderable Information</b> ..... | <b>17</b> |
| 8.2 Functional Block Diagram .....               | 9        |                                                                  |           |

## 4 Revision History

| Changes from Original (January 2014) to Revision A                                                                                                                                                                                                                                                                                                                                                      | Page     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <ul style="list-style-type: none"> <li>Added <i>Handling Rating</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i>, <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section .....</li> </ul> | <b>1</b> |

## 5 Pin Configuration and Functions



**Pin Functions**

| PIN |      | I/O | DESCRIPTION                                                                           |
|-----|------|-----|---------------------------------------------------------------------------------------|
| NO. | NAME |     |                                                                                       |
| 1   | VIN  | I   | Boost converter input voltage.                                                        |
| 2   | GND  | –   | Control / logic ground.                                                               |
| 3   | EN   | I   | Enable input (1 = enabled, 0 = disabled). EN must be actively terminated high or low. |
| 4   | VOUT | O   | Boost converter output.                                                               |
| 5   | L    | I   | Connection for inductor.                                                              |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|           |                                   | MIN  | MAX | UNIT |
|-----------|-----------------------------------|------|-----|------|
| $V_I$     | Input voltage range               |      |     | V    |
|           | VIN                               | –0.3 | 7   |      |
|           | L                                 | –0.3 | 7   |      |
|           | VOUT                              | –0.3 | 7   |      |
|           | EN                                | –0.3 | 7   |      |
| $I_{MAX}$ | Maximum continuous output current |      | 400 | mA   |
| $T_J$     | Junction temperature range        | –40  | 150 | °C   |
| $T_{stg}$ | Storage temperature range         | –65  | 150 | °C   |

- (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.

### 6.2 ESD Ratings

|             |                                                                                | VALUE | UNIT |
|-------------|--------------------------------------------------------------------------------|-------|------|
| $V_{(ESD)}$ | Electrostatic discharge                                                        |       | V    |
|             | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | ±2000 |      |
|             | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | ±1000 |      |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.  
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

|          |                                      | MIN | MAX | UNIT |
|----------|--------------------------------------|-----|-----|------|
| $V_{IN}$ | Input voltage range                  | 0.9 | 5.5 | V    |
| $V_{EN}$ | Enable voltage range                 | 0   | 5.5 | V    |
| $T_A$    | Operating free air temperature range | –40 | 85  | °C   |
| $T_J$    | Operating junction temperature range | –40 | 125 | °C   |

## 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | TPS61097A-33 | UNIT |
|-------------------------------|----------------------------------------------|--------------|------|
|                               |                                              | DBV          |      |
|                               |                                              | 5 PINS       |      |
| $\theta_{JA}$                 | Junction-to-ambient thermal resistance       | 208.7        | °C/W |
| $\theta_{JCTop}$              | Junction-to-case (top) thermal resistance    | 124.5        |      |
| $\theta_{JB}$                 | Junction-to-board thermal resistance         | 36.9         |      |
| $\psi_{JT}$                   | Junction-to-top characterization parameter   | 14.7         |      |
| $\psi_{JB}$                   | Junction-to-board characterization parameter | 36           |      |

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

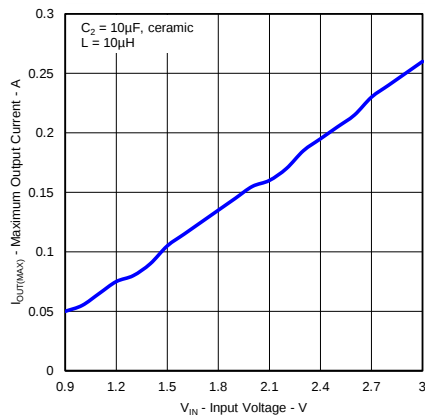
## 6.5 Electrical Characteristics

Over recommended free-air temperature range and over recommended input voltage range (typical at an ambient temperature range of 25°C) (unless otherwise noted)

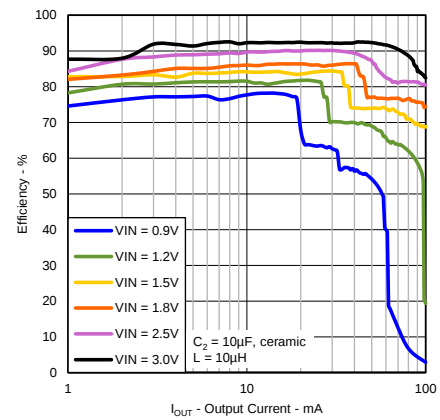
| PARAMETER            |                                              | TEST CONDITIONS                                                                              | MIN  | TYP   | MAX                      | UNIT          |
|----------------------|----------------------------------------------|----------------------------------------------------------------------------------------------|------|-------|--------------------------|---------------|
| <b>DC/DC STAGE</b>   |                                              |                                                                                              |      |       |                          |               |
| $V_{IN}$             | Input voltage                                |                                                                                              | 0.9  |       | 5.5                      | V             |
| $V_{OUT}$            | Output voltage                               | $V_{IN} = 1.2 \text{ V}$ , $I_{OUT} = 10 \text{ mA}$                                         | 3.20 | 3.30  | 3.40                     |               |
| $I_{SW}$             | Switch current limit                         | $V_{OUT} = 3.3 \text{ V}$                                                                    | 200  | 400   | 475                      | mA            |
|                      | Rectifying switch on resistance              | $V_{OUT} = 3.3 \text{ V}$                                                                    |      | 1.0   |                          | $\Omega$      |
|                      | Main switch on resistance                    | $V_{OUT} = 3.3 \text{ V}$                                                                    |      | 1.0   |                          |               |
|                      | Bypass switch on resistance                  | $V_{IN} = 1.2$ , $I_{OUT} = 100 \text{ mA}$                                                  |      | 3.4   |                          |               |
|                      | Line regulation                              | $V_{IN} < V_{OUT}$ , $V_{IN} = 1.2 \text{ V}$ to $1.8 \text{ V}$ , $I_{OUT} = 10 \text{ mA}$ |      | 0.5%  |                          |               |
|                      | Load regulation                              | $V_{IN} < V_{OUT}$ , $I_{OUT} = 10 \text{ mA}$ to $50 \text{ mA}$ , $V_{IN} = 1.8 \text{ V}$ |      | 0.5%  |                          |               |
| $I_Q$                | Quiescent current                            | $I_{OUT} = 0 \text{ mA}$ , $V_{EN} = V_{IN} = 1.2 \text{ V}$ , $V_{OUT} = 3.5 \text{ V}$     |      | 2     | 4                        | $\mu\text{A}$ |
|                      |                                              |                                                                                              |      | 5     | 8                        |               |
| $I_{SD}$             | Shutdown current                             | $V_{EN} = 0 \text{ V}$ , $V_{IN} = 1.2 \text{ V}$ , $I_{OUT} = 0 \text{ mA}$                 |      | 0.005 | 0.15                     | $\mu\text{A}$ |
|                      |                                              | $V_{EN} = 0 \text{ V}$ , $V_{IN} = 3 \text{ V}$ , $I_{OUT} = 0 \text{ mA}$                   |      | 0.005 | 0.15                     |               |
|                      | Leakage current into L                       | $V_{EN} = 0 \text{ V}$ , $V_{IN} = 1.2 \text{ V}$ , $V_L = 1.2 \text{ V}$                    |      | 0.01  | 1                        |               |
| <b>CONTROL STAGE</b> |                                              |                                                                                              |      |       |                          |               |
|                      | EN input current                             | $EN = 0 \text{ V}$ or $EN = V_{IN}$                                                          |      | 0.01  | 0.1                      | $\mu\text{A}$ |
| $V_{IL}$             | Logic low level, EN falling edge             |                                                                                              |      |       | 0.58                     | V             |
| $V_{IH}$             | Logic high level, EN rising edge             |                                                                                              | 0.78 |       | $V_{IN} + 1.0 \text{ V}$ |               |
| OTP                  | Overtemperature protection                   |                                                                                              |      | 150   |                          | °C            |
| OTP <sub>HYST</sub>  | Overtemperature hysteresis                   |                                                                                              |      | 20    |                          |               |
| $V_{UVLO}$           | Undervoltage lock-out threshold for turn off | $V_{IN}$ decreasing                                                                          |      | 0.6   | 0.8                      | V             |

## 6.6 Typical Characteristics

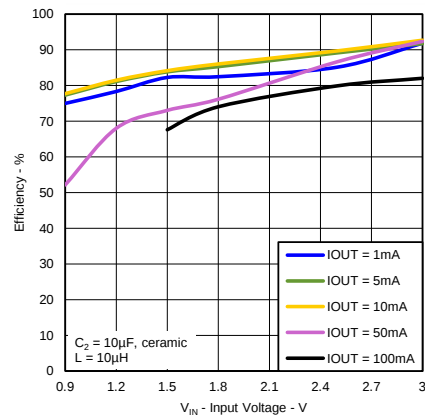
Refer to [Figure 19](#) for reference designators.



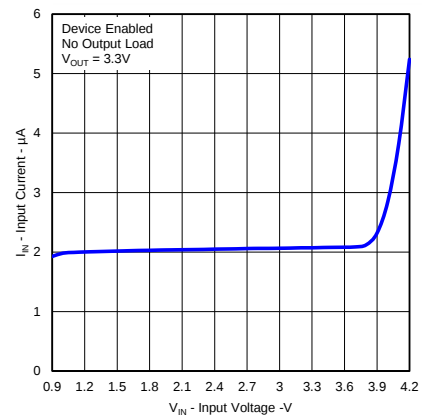
**Figure 1. Maximum Output Current vs Input Voltage**



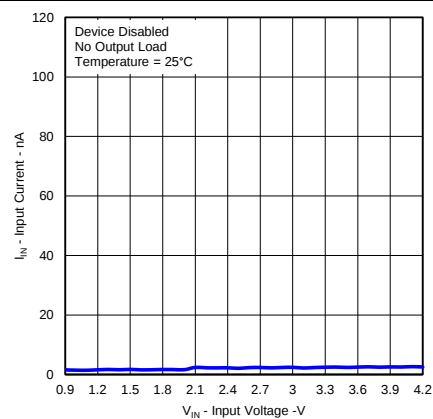
**Figure 2. Efficiency vs Output current**



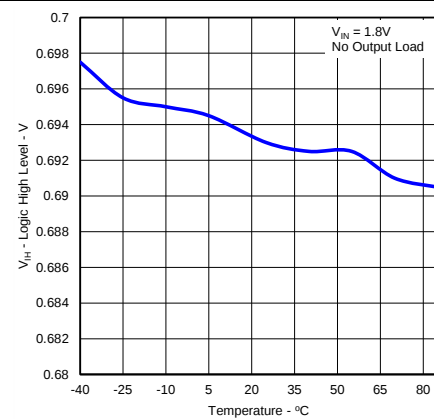
**Figure 3. Efficiency vs Input Voltage**



**Figure 4. Input Current vs Input Voltage**

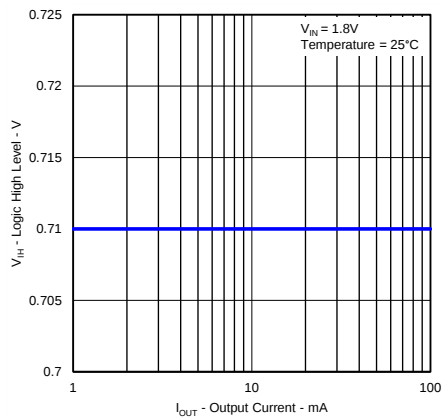


**Figure 5. Input Current vs Input Voltage**

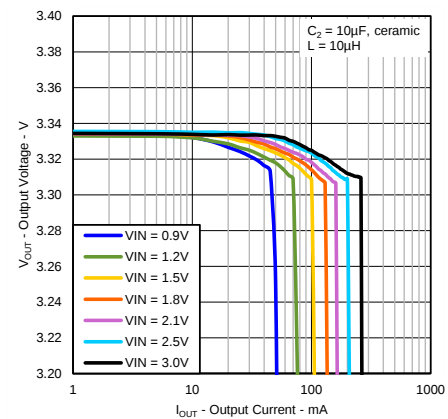


**Figure 6.  $V_{IH}$  vs Temperature**

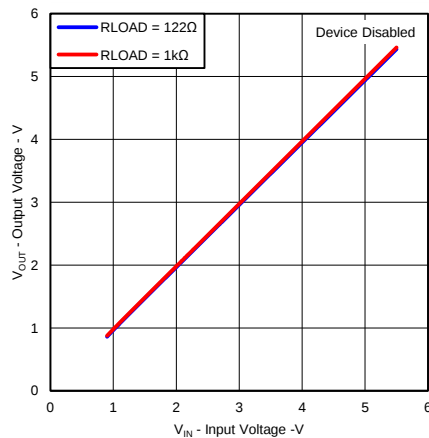
## Typical Characteristics (continued)



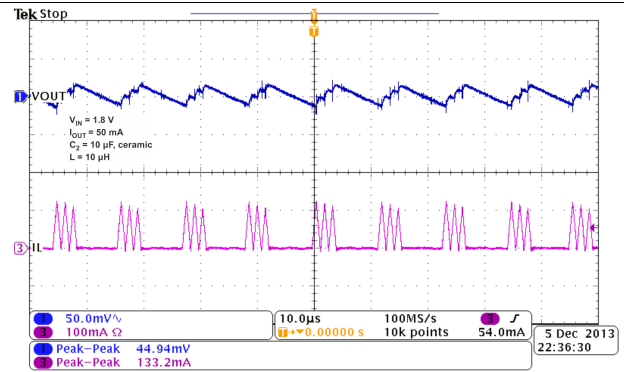
**Figure 7.  $V_{IH}$  vs Output Current**



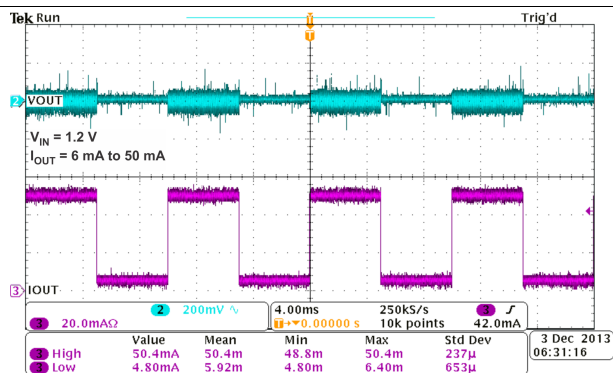
**Figure 8. Output Voltage vs Output Current**



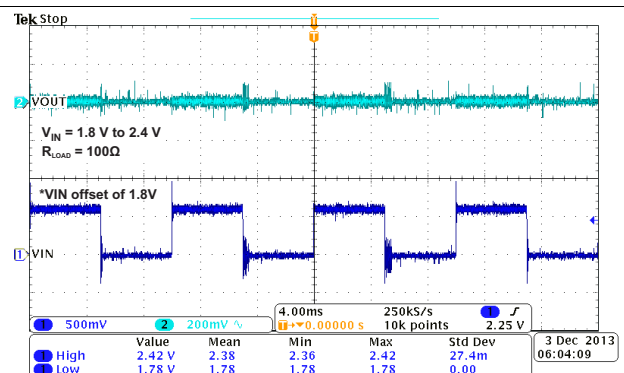
**Figure 9. Output Voltage vs Input Voltage**



**Figure 10. Output Voltage Ripple**

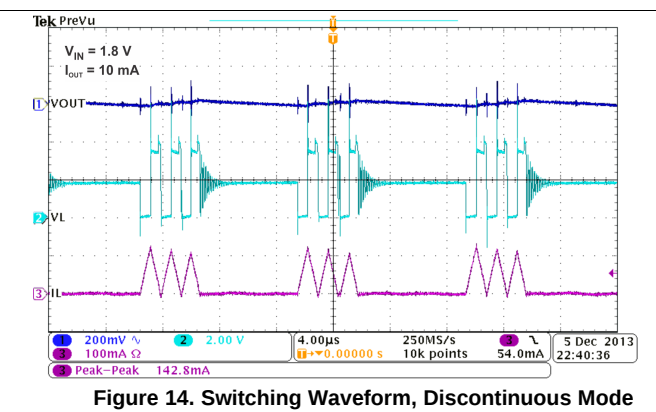
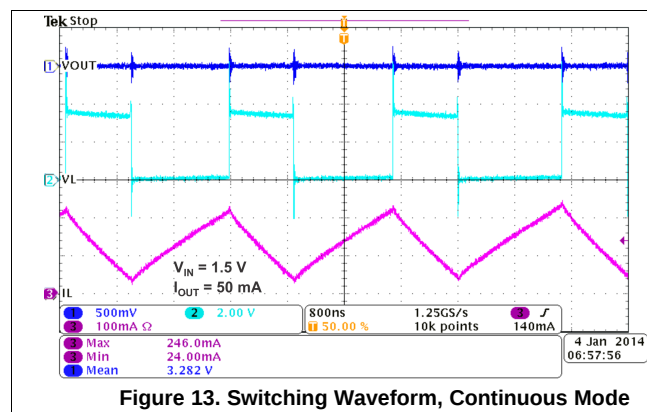


**Figure 11. Load Transient Response**

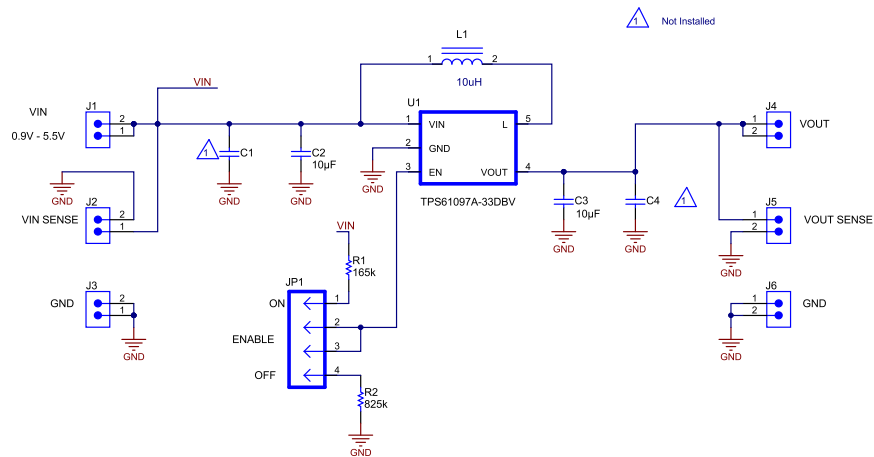


**Figure 12. Line Transient Response**

## Typical Characteristics (continued)



## 7 Parameter Measurement Information



**Figure 15. Measurement Test Circuit**

**Table 1. List of Components**

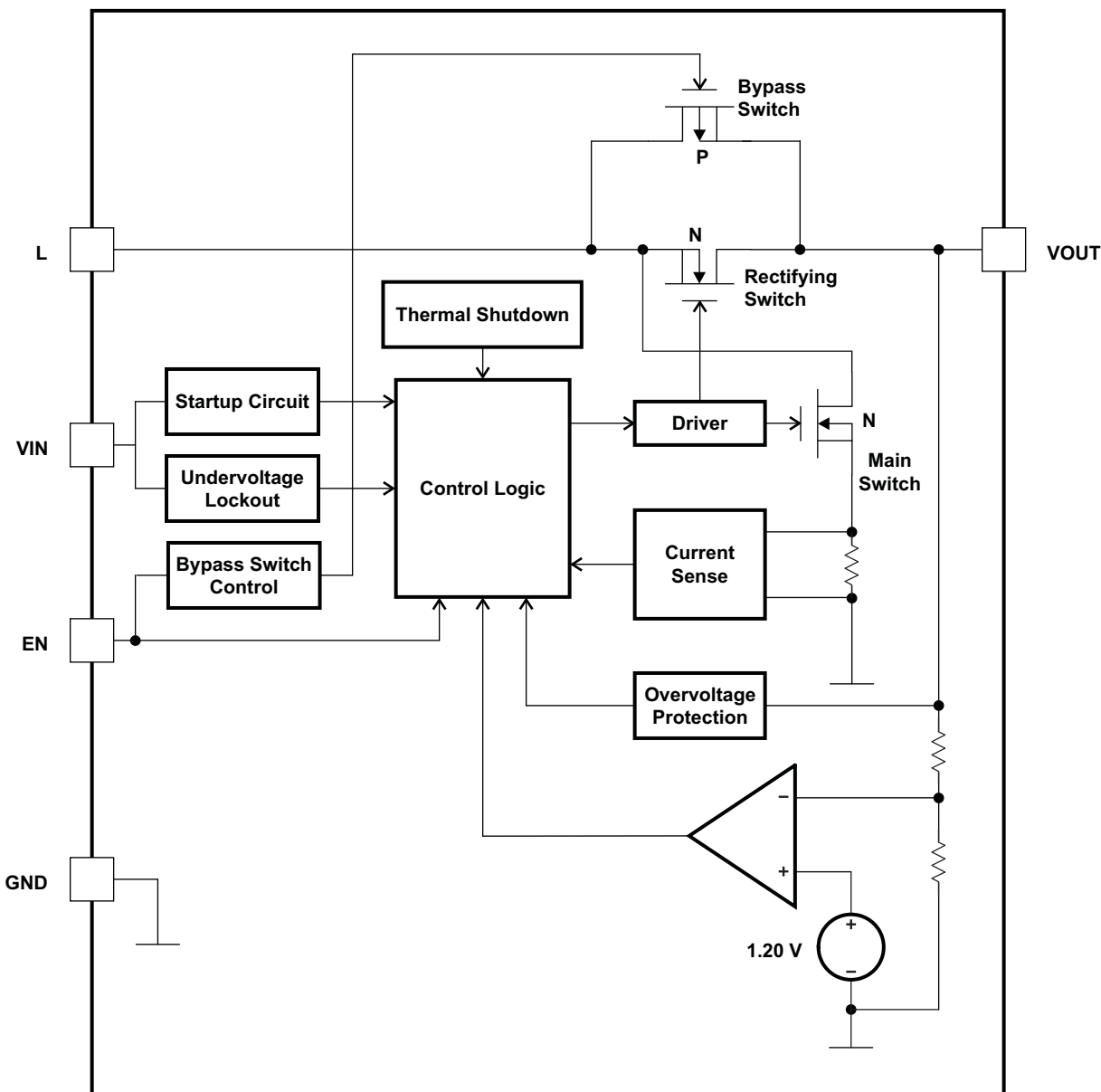
| REFERENCE | MANUFACTURER | PART NO.                                |
|-----------|--------------|-----------------------------------------|
| C2        | Murata       | GRM319R61A106KE19 10µF 10V X5R 1206 20% |
| C3        | Murata       | GRM319R61A106KE19 10µF 10V X5R 1206 20% |
| L1        | Coilcraft    | DO3314-103MLC                           |

## 8 Detailed Description

### 8.1 Overview

The TPS61097A-33 is a high performance, high efficiency switching boost converter. To achieve high efficiency the power stage is realized as a synchronous boost topology. For the power switching, two actively controlled low  $R_{DS(on)}$  power MOSFETs are implemented.

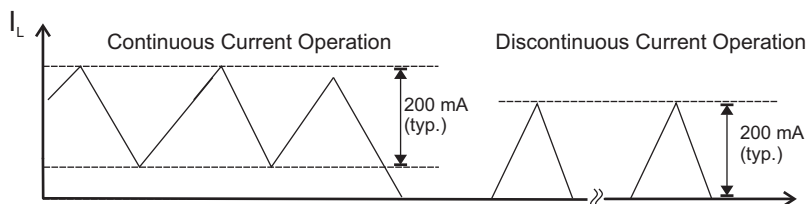
### 8.2 Functional Block Diagram



## 8.3 Feature Description

### 8.3.1 Controller Circuit

The device is controlled by a hysteretic current mode controller. This controller regulates the output voltage by keeping the inductor ripple current constant in the range of 200 mA and adjusting the offset of this inductor current depending on the output load. If the required average input current is lower than the average inductor current defined by this constant ripple the inductor current goes discontinuous to keep the efficiency high at low load conditions.



**Figure 16. Hysteretic Current Operation**

The output voltage  $V_{OUT}$  is monitored via the feedback network which is connected to the voltage error amplifier. To regulate the output voltage, the voltage error amplifier compares this feedback voltage to the internal voltage reference and adjusts the required offset of the inductor current accordingly.

### 8.3.2 Device Enable and Shutdown Mode

The device is enabled when EN is set high and shut down when EN is low. During shutdown, the converter stops switching and all internal control circuitry is turned off.

### 8.3.3 Bypass Switch

The TPS61097A-33 contains a P-channel MOSFET (Bypass Switch) in parallel with the synchronous rectifying MOSFET. When the IC is enabled ( $V_{EN} > V_{IH}$ ), the Bypass Switch is turned off to allow the IC to work as a standard boost converter. When the IC is disabled ( $V_{EN} < V_{IL}$ ) the Bypass Switch is turned on to provide a direct, low impedance connection from the input voltage (at the L pin) to the load (VOUT). The Bypass Switch is not impacted by Undervoltage lockout, Overvoltage or Thermal shutdown.

### 8.3.4 Startup

After the EN pin is tied high, the device starts to operate. If the input voltage is not high enough to supply the control circuit properly a startup oscillator starts to operate the switches. During this phase the switching frequency is controlled by the oscillator and the maximum switch current is limited. As soon as the device has built up the output voltage to about 1.8 V, high enough for supplying the control circuit, the device switches to its normal hysteretic current mode operation. The startup time depends on input voltage and load current.

### 8.3.5 Operation at Output Overload

If in normal boost operation the inductor current reaches the internal switch current limit threshold the main switch is turned off to stop further increase of the input current. In this case the output voltage will decrease since the device can not provide sufficient power to maintain the set output voltage.

If the output voltage drops below the input voltage the backgate diode of the rectifying switch gets forward biased and current starts flow through it. Because this diode cannot be turned off, the load current is only limited by the remaining DC resistances. As soon as the overload condition is removed, the converter automatically resumes normal operation and enters the appropriate soft start mode depending on the operating conditions.

### 8.3.6 Undervoltage Lockout

An undervoltage lockout function stops the operation of the converter if the input voltage drops below the typical undervoltage lockout threshold. This function is implemented in order to prevent malfunctioning of the converter. The undervoltage lockout function has no control of the Bypass Switch. If the Bypass Switch is enabled ( $V_{EN} < V_{IL}$ ) there is no impact during an undervoltage condition, and the Bypass Switch remains on.

## Feature Description (continued)

### 8.3.7 Overtemperature Protection

The device has a built-in temperature sensor which monitors the internal IC temperature. If the temperature exceeds the programmed threshold (OTP), the device stops operating. As soon as the IC temperature has decreased below the programmed threshold (OTP - OTP<sub>HYST</sub>), it starts operating again. There is a built-in hysteresis to avoid unstable operation at IC temperatures at the overtemperature threshold.

## 8.4 Device Functional Modes

| EN | DEVICE STATE    |
|----|-----------------|
| H  | Boost Converter |
| L  | Bypass Switch   |

## 9 Application and Implementation

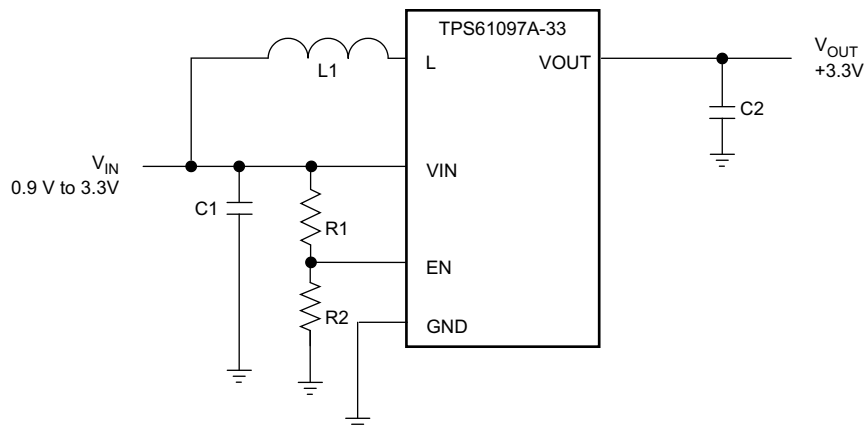
### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 9.1 Application Information

#### 9.1.1 Adjustable Bypass Switching

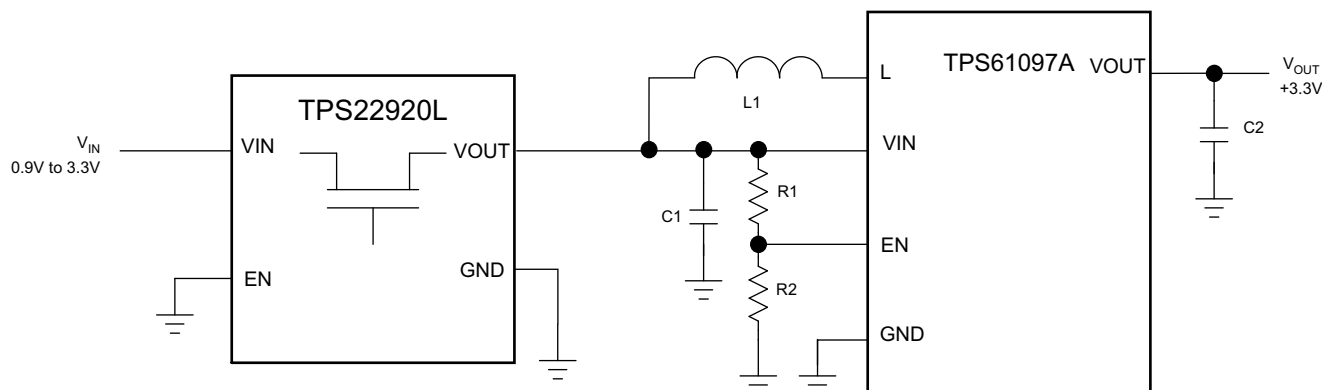
The EN pin can be set up as a low voltage control for the bypass switch. By setting the desired ratio of R1 and R2, the TPS61097A-33 can be set to switch on the bypass at a defined voltage level on VIN. For example, setting R1 and R2 to 200 K $\Omega$  would set V<sub>EN</sub> to half of VIN. The voltage level of VIN engaging the bypass switch is based on the V<sub>IL</sub> level of EN (0.58 V). If VIN is less than 1.16 V then the bypass switch will be enabled. For VIN values above 1.56 V (50% of V<sub>IH</sub>) the bypass switch is disabled.



**Figure 17. Adjustable Bypass Switching**

#### 9.1.2 Managing Inrush Current

Upon startup, the output capacitor of the boost converter can act as a virtual short circuit. The amount of inrush current is dependent on the rate of increase of the input voltage, the inductance used with the converter, the output capacitance and the parasitic circuit resistance. One method to reduce the inrush current is to use a load switch with controlled turn-on. Texas Instruments has a large offering of controlled slew rate load switches which can be found at [www.ti.com/loadswitches](http://www.ti.com/loadswitches). Below is an example circuit that has a load switch with controlled turn-on.



**Figure 18. Example Circuit with Load Switch**

## Application Information (continued)

### 9.1.3 Thermal Considerations

Implementation of integrated circuits in low-profile and fine-pitch surface-mount packages typically requires special attention to power dissipation. Many system-dependent issues such as thermal coupling, airflow, added heat sinks and convection surfaces, and the presence of other heat-generating components affect the power-dissipation limits of a given component.

Three basic approaches for enhancing thermal performance are listed below.

- Improving the power dissipation capability of the PCB design
- Improving the thermal coupling of the component to the PCB
- Introducing airflow in the system

The maximum recommended junction temperature ( $T_J$ ) of the TPS61097A-33 devices is 125°C. Specified regulator operation is assured to a maximum ambient temperature  $T_A$  of 85°C. Therefore, the maximum power dissipation is about 191.7 mW. More power can be dissipated if the maximum ambient temperature of the application is lower.

## 9.2 Typical Application

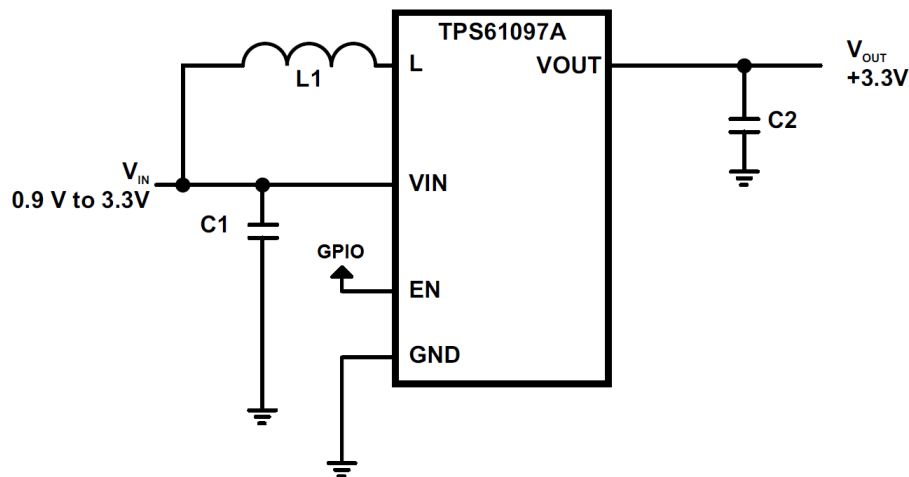


Figure 19. Typical Application Schematic

### 9.2.1 Design Requirements

| DESIGN PARAMETERS            | EXAMPLE VALUE  |
|------------------------------|----------------|
| Input Voltage ( $V_{IN}$ )   | 1.2 V to 1.8 V |
| Output Voltage ( $V_{OUT}$ ) | 3.3 V          |
| Output Current ( $I_{OUT}$ ) | 10 mA          |

### 9.2.2 Detailed Design Procedure

#### 9.2.2.1 Inductor Selection

To make sure that the TPS61097A-33 devices can operate, a suitable inductor must be connected between pin VIN and pin L. Inductor values of 4.7  $\mu$ H show good performance over the whole input and output voltage range .

Choosing other inductance values affects the switching frequency  $f$  proportional to  $1/L$  as shown in [Equation 1](#).

$$L = \frac{1}{f \times 200 \text{ mA}} \times \frac{V_{IN} \times (V_{OUT} - V_{IN})}{V_{OUT}} \quad (1)$$

Choosing inductor values higher than 4.7  $\mu\text{H}$  can improve efficiency due to reduced switching frequency and therefore with reduced switching losses. Using inductor values below 2.2  $\mu\text{H}$  is not recommended.

Having selected an inductance value, the peak current for the inductor in steady state operation can be calculated. Equation 2 gives the peak current estimate.

$$I_{L,MAX} = \begin{cases} \frac{V_{OUT} \times I_{OUT}}{0.8 \times V_{IN}} + 100 \text{ mA}; & \text{continuous current operation} \\ 200 \text{ mA}; & \text{discontinuous current operation} \end{cases} \quad (2)$$

$I_{L,MAX}$  is the inductor's required minimum current rating. Note that load transient or over current conditions may require an even higher current rating.

Equation 3 provides an easy way to estimate whether the device is operating in continuous or discontinuous operation. As long as the equation is true, continuous operation is typically established. If the equation becomes false, discontinuous operation is typically established.

$$\frac{V_{OUT} \times I_{OUT}}{V_{IN}} > 0.8 \times 100 \text{ mA} \quad (3)$$

Due to the use of current hysteretic control in the TPS61097A-33, the series resistance of the inductor can impact the operation of the main switch. There is a simple calculation that can ensure proper operation of the TPS61097A-33 boost converter. The relationship between the series resistance ( $R_{IN}$ ), the input voltage ( $V_{IN}$ ) and the switch current limit ( $I_{SW}$ ) is shown in Equation 4.

$$R_{IN} < V_{IN} / I_{SW} \quad (4)$$

Examples:

$$I_{SW} = 400 \text{ mA}, V_{IN} = 2.5 \text{ V} \quad (5)$$

In Equation 5,  $R_{IN} < 2.5 \text{ V} / 400 \text{ mA}$ ; therefore,  $R_{IN}$  must be less than 6.25  $\Omega$ .

$$I_{SW} = 400 \text{ mA}, V_{IN} = 1.8 \text{ V} \quad (6)$$

In Equation 6,  $R_{IN} < 1.8 \text{ V} / 400 \text{ mA}$ ; therefore,  $R_{IN}$  must be less than 4.5  $\Omega$ .

The following inductor series from different suppliers have been used with TPS61097A-33 converters:

**Table 2. List of Inductors**

| VENDOR      | INDUCTOR SERIES |
|-------------|-----------------|
| Coilcraft   | DO3314          |
| TDK         | NLC565050T      |
| Taiyo Yuden | CBC2012T        |

## 9.2.2.2 Capacitor Selection

### 9.2.2.2.1 Input Capacitor

The input capacitor should be at least 10- $\mu\text{F}$  to improve transient behavior of the regulator and EMI behavior of the total power supply circuit. The input capacitor should be a ceramic capacitor and be placed as close as possible to the VIN and GND pins of the IC.

### 9.2.2.2.2 Output Capacitor

For the output capacitor  $C_2$ , it is recommended to use small ceramic capacitors placed as close as possible to the VOUT and GND pins of the IC. If, for any reason, the application requires the use of large capacitors which can not be placed close to the IC, the use of a small ceramic capacitor with a capacitance value of around 2.2  $\mu\text{F}$  in parallel to the large one is recommended. This small capacitor should be placed as close as possible to the VOUT and GND pins of the IC.

A minimum capacitance value of 4.7  $\mu\text{F}$  should be used, 10  $\mu\text{F}$  are recommended. If the inductor exceeds 4.7  $\mu\text{H}$ , the value of the output capacitance value needs to be half the inductance value or higher for stability reasons, see Equation 7.

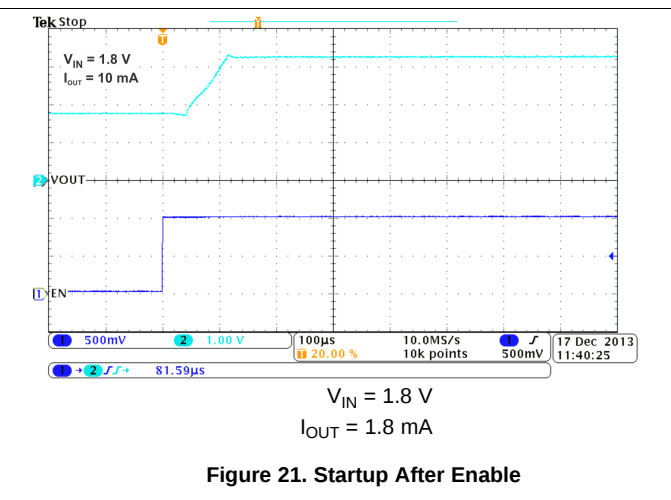
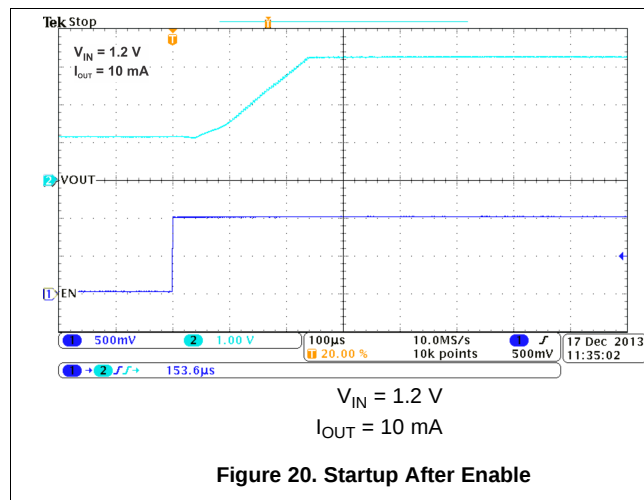
$$C_2 \geq \frac{L}{2} \times \frac{\mu F}{\mu H} \quad (7)$$

Using low ESR capacitors, such as ceramic capacitors, is recommended to minimize output voltage ripple. If heavy load changes are expected, the output capacitor value should be increased to avoid output voltage drops during fast load transients.

**Table 3. Recommended Output Capacitors**

| VENDOR | CAPACITOR SERIES                     |
|--------|--------------------------------------|
| Murata | GRM188R60J106M47D 10μF 6.3V X5R 0603 |
| Murata | GRM319R61A106KE19 10μF 10V X5R 1206  |

### 9.2.3 Application Curves



## 10 Power Supply Recommendations

The TPS61097A-33 DC-DC converters are intended for systems powered by a single up to triple cell Alkaline, NiCd, NiMH battery with a typical terminal voltage between 0.9 V and 5.5 V. They can also be used in systems powered by one-cell Li-Ion or Li-Polymer with a typical voltage between 2.5 V and 4.2 V. Additionally, any other voltage source like solar cells or fuel cells with a typical output voltage between 0.9 V and 5.5 V can power systems where the TPS61097A-33 is used. The TPS61097A-33 does not down-regulate VIN; therefore, if VIN is greater than VOUT, VOUT tracks VIN.

## 11 Layout

### 11.1 Layout Guidelines

As for all switching power supplies, the layout is an important step in the design, especially at high peak currents and high switching frequencies. If the layout is not carefully done, the regulator could show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current path and for the power ground tracks. The input and output capacitor, as well as the inductor should be placed as close as possible to the IC. Use a common ground node for power ground and a different one for control ground to minimize the effects of ground noise. Connect these ground nodes at any place close to one of the ground pins of the IC.

The feedback divider should be placed as close as possible to the control ground pin of the IC. To lay out the control ground, it is recommended to use short traces as well, separated from the power ground traces. This avoids ground shift problems, which can occur due to superimposition of power ground current and control ground current.

### 11.2 Layout Example

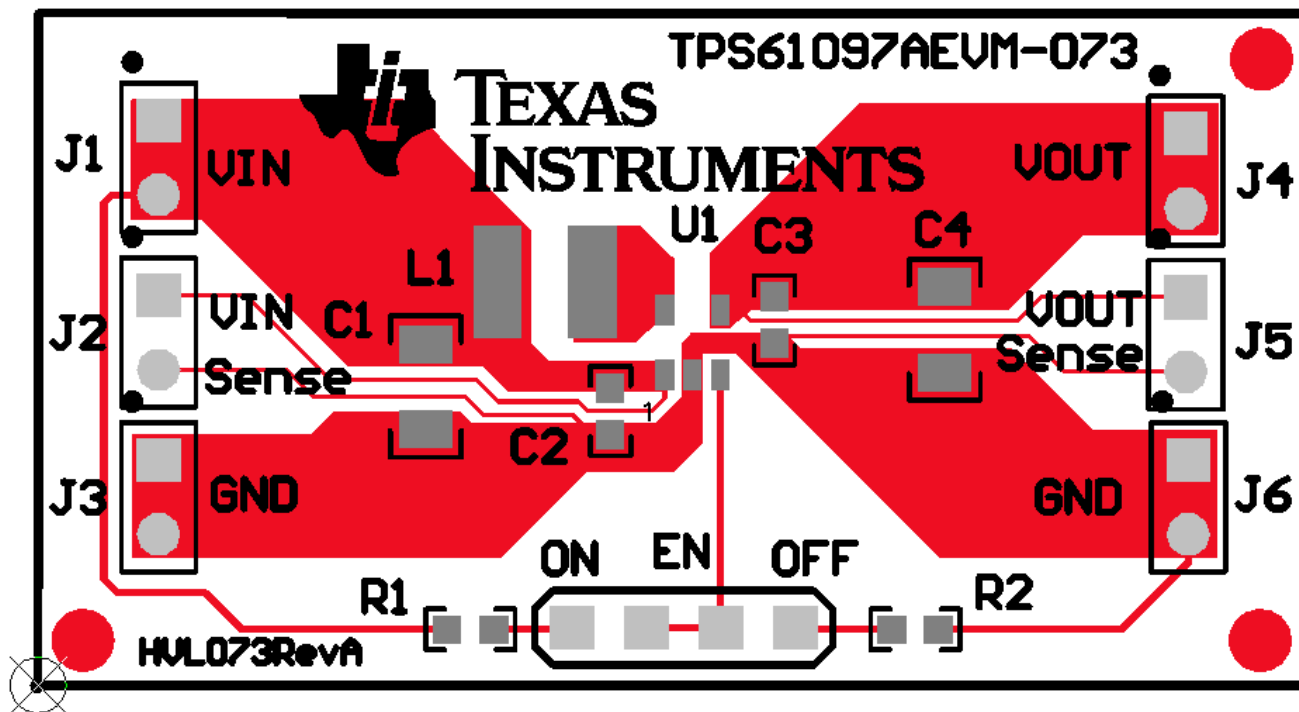


Figure 22. Layout Example

## 12 Device and Documentation Support

### 12.1 Device Support

#### 12.1.1 Third-Party Products Disclaimer

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### 12.2 Trademarks

All trademarks are the property of their respective owners.

### 12.3 Electrostatic Discharge Caution



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.

### 12.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## PACKAGING INFORMATION

| Orderable part number            | Status<br>(1) | Material type<br>(2) | Package   Pins   | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6) |
|----------------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| <a href="#">TPS61097A-33DBVR</a> | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU   SN                          | Level-1-260C-UNLIM                | -40 to 125   | (NG5F, NG5K)        |
| TPS61097A-33DBVR.A               | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | (NG5F, NG5K)        |
| TPS61097A-33DBVR.B               | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | (NG5F, NG5K)        |
| TPS61097A-33DBVRG4               | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | NG5K                |
| TPS61097A-33DBVRG4.A             | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | NG5K                |
| TPS61097A-33DBVRG4.B             | Active        | Production           | SOT-23 (DBV)   5 | 3000   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | NG5K                |
| <a href="#">TPS61097A-33DBVT</a> | Active        | Production           | SOT-23 (DBV)   5 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | NG5K                |
| TPS61097A-33DBVT.B               | Active        | Production           | SOT-23 (DBV)   5 | 250   SMALL T&R       | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -40 to 125   | NG5K                |

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

<sup>(2)</sup> **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.

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

<sup>(4)</sup> **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.

<sup>(5)</sup> **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.

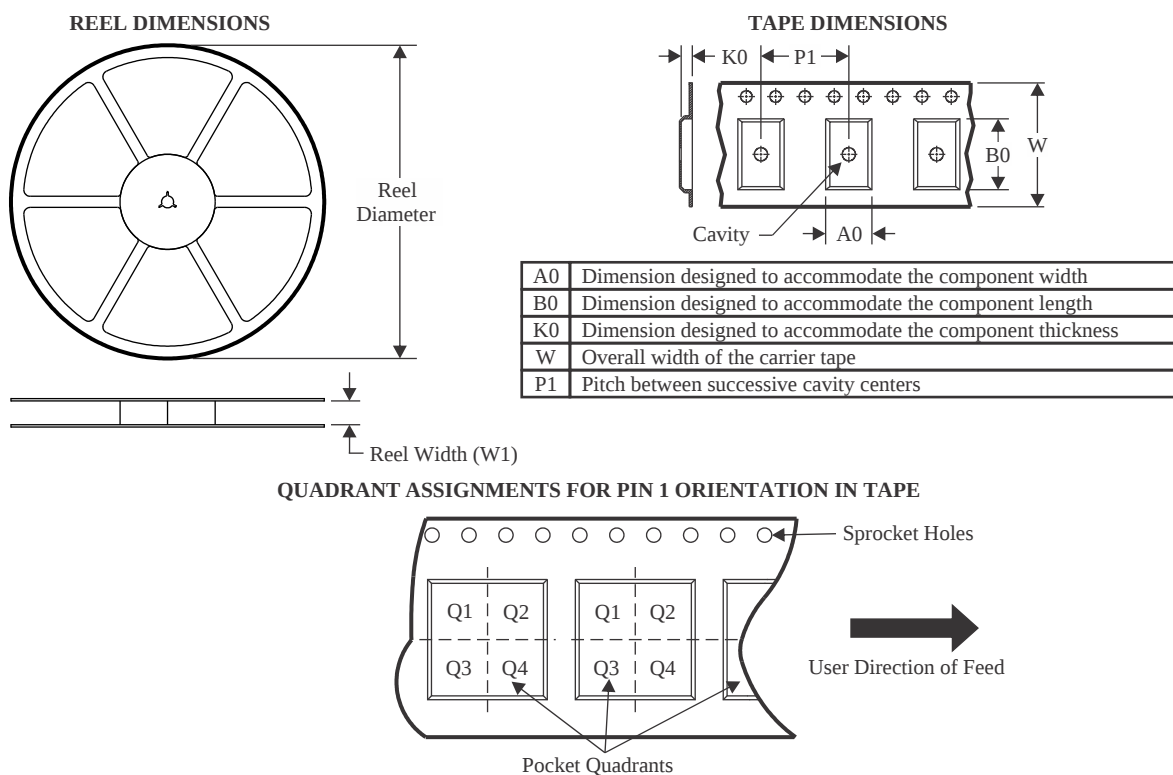
<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

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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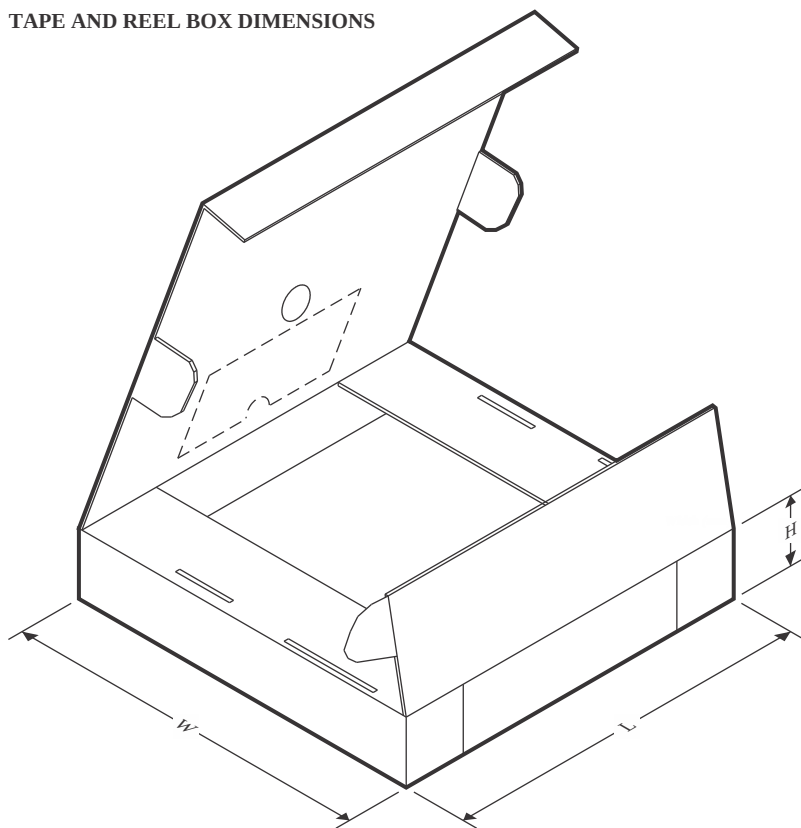
## TAPE AND REEL INFORMATION



\*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 |
|--------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS61097A-33DBVRG4 | SOT-23       | DBV             | 5    | 3000 | 180.0              | 8.4                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |
| TPS61097A-33DBVT   | SOT-23       | DBV             | 5    | 250  | 180.0              | 8.4                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device             | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS61097A-33DBVRG4 | SOT-23       | DBV             | 5    | 3000 | 183.0       | 183.0      | 20.0        |
| TPS61097A-33DBVT   | SOT-23       | DBV             | 5    | 250  | 183.0       | 183.0      | 20.0        |



## SOT-23 - 1.45 mm max height

**Front View:**

- Overall Dimensions: 3.0 (width) x 2.6 (height)
- PIN 1 INDEX AREA
- Feature Callouts: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z
- Dimensions: 1.75, 1.45, 1.9, 3.05, 2.75, 0.1, 0.15, 0.95, 1.9, 0.5, 0.3, 0.2, 0.1, 0.15, 0.90, 0.15, 0.00
- Note 5: Points to a specific feature.

**Side View:**

- Wall Thickness: 0.1
- Internal Features: 0.1, 0.15

**End View:**

- Profile Dimensions: 1.1 (width), 0.15 (height)
- Angles: 4X 0°-15°, 4X 4°-15°

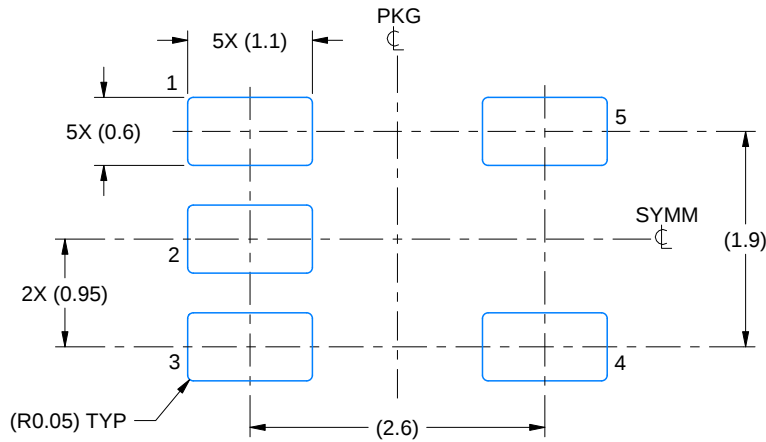
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.

# EXAMPLE BOARD LAYOUT

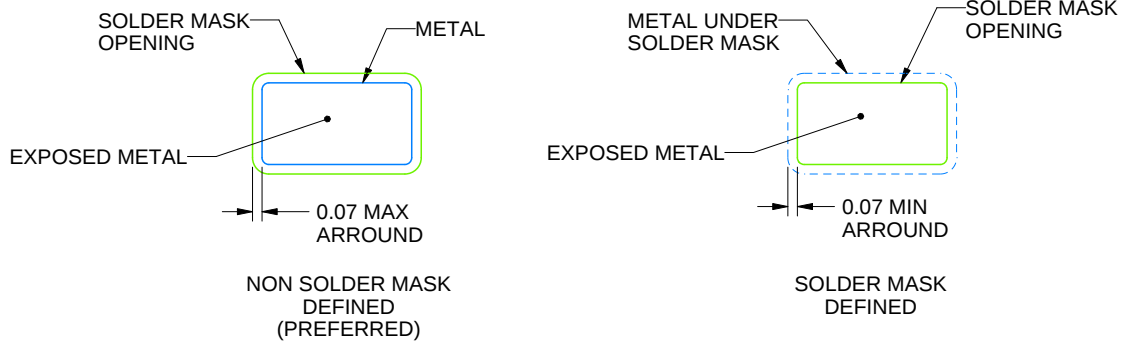
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

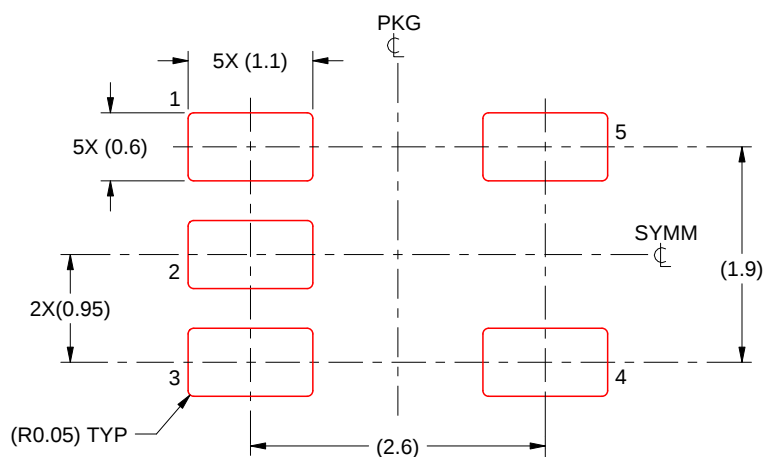
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

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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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