

## LOW INPUT VOLTAGE SYNCHRONOUS BOOST CONVERTER WITH LOW QUIESCENT CURRENT

### FEATURES

- Up to 95% 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
- Fixed Output Voltage Options From 1.8 V to 5.0 V
- Power-Save Mode for Improved Efficiency at Low Output Power
- Overtemperature Protection

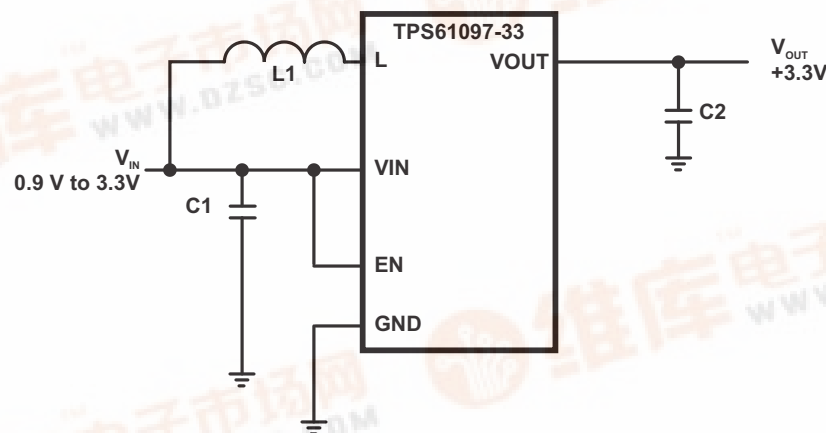
- Small 2.8-mm x 2.9-mm 5-Pin SOT-23 Package (6-Pin for Adjustable)

### 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

### DESCRIPTION

The TPS61097 provide 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 provides 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 350 mA. The output voltage can be programmed by an external resistor divider, or it is fixed internally on the chip. 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 fixed output device is packaged in a 5-pin SOT-23 package (DBV) measuring 2.8 mm x 2.9 mm. The adjustable output version (TPS61097-01) is packaged in a 6-pin SOT-23 (DBV).



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AVAILABLE DEVICE OPTIONS<sup>(1)</sup> <sup>(2)</sup>

T <sub>A</sub>	OUTPUT VOLTAGE DC/DC	PACKAGE <sup>(3)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	Adjustable	6-pin SOT-23 – DBV	Reel of 3000	TPS61097-01DBVR	PREVIEW
			Reel of 250	TPS61097-01DBVT	
	1.8 V	5-pin SOT-23 – DBV	Reel of 3000	TPS61097-18DBVR	PREVIEW
			Reel of 250	TPS61097-18DBVT	
	2.7 V	5-pin SOT-23 – DBV	Reel of 3000	TPS61097-27DBVR	PREVIEW
			Reel of 250	TPS61097-27DBVT	
	3.0 V	5-pin SOT-23 – DBV	Reel of 3000	TPS61097-30DBVR	PREVIEW
			Reel of 250	TPS61097-30DBVT	
	3.3 V	5-pin SOT-23 – DBV	Reel of 3000	TPS61097-33DBVR	YC4L
			Reel of 250	TPS61097-33DBVT	
	5.0 V	5-pin SOT-23 – DBV	Reel of 3000	TPS61097-50DBVR	PREVIEW
			Reel of 250	TPS61097-50DBVT	

- (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).
- (2) Contact the factory for availability of other fixed output voltage versions.
- (3) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

## ABSOLUTE MAXIMUM RATINGS

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

$V_I$	Input voltage range	VIN, L, VOUT, EN, FB	-0.3 V to 7 V
$I_{sc}$	Short-circuit current		400 mA
$T_J$	Junction temperature range		-40°C to 150°C
$T_{stg}$	Storage temperature range		-65°C to 150°C
ESD	Electrostatic discharge rating	Human-Body Model (HBM) <sup>(2)</sup>	2000 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) ESD testing is performed according to the respective JESD22 JEDEC standard.

## DISSIPATION RATINGS TABLE

PACKAGE	THERMAL RESISTANCE $\theta_{JA}$	POWER RATING $T_A \leq 25^\circ\text{C}$	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$
DBV	255°C/W	390 mW	-3.92 mW/°C

## RECOMMENDED OPERATING CONDITIONS

		MIN	MAX	UNIT
$V_{IN}$	Supply voltage at VIN	0.9	5.5	V
$V_{OUT}$	Adjustable output voltage	1.8	5.5	V
$T_A$	Operating free air temperature range	-40	85	°C
$T_J$	Operating junction temperature range	-40	125	°C

## ELECTRICAL CHARACTERISTICS

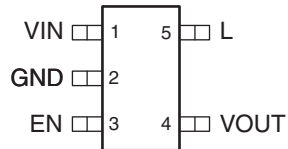
over recommended free-air temperature range and over recommended input voltage range (typical at an ambient temperature range of 25°C) (unless otherwise noted)

DC/DC STAGE							
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT	
$V_{IN}$	Input voltage		0.9		5.5	V	
$V_{OUT}$	TPS61097-01 output voltage range	$V_{IN} < V_{OUT}$	1.8		5.0	V	
$V_{FB}$	TPS61097-01 feedback voltage	$V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 10\text{ mA}$	1.16	1.20	1.24	V	
$V_{OUT}$	TPS61097-18	$V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 10\text{ mA}$	1.75	1.80	1.85	V	
	TPS61097-27	$V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 10\text{ mA}$	2.62	2.70	2.78		
	TPS61097-30	$V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 10\text{ mA}$	2.91	3.00	3.09		
	TPS61097-33	$V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 10\text{ mA}$	3.20	3.30	3.40		
	TPS61097-50	$V_{IN} = 2.4\text{ V}$ , $I_{OUT} = 10\text{ mA}$	4.85	5.00	5.15		
$I_{SW}$	Switch current limit	$V_{OUT} = 3.3\text{ V}$	200	350	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		$\Omega$	
	Bypass switch on resistance	$V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 100\text{ mA}$		3.4		$\Omega$	
	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	$V_{IN}$	$I_O = 0\text{ mA}$ , $V_{EN} = V_{IN} = 1.2\text{ V}$ , $V_{OUT} = 3.4\text{ V}$		1	2.5	$\mu\text{A}$
		$V_{OUT}$			4	6.5	$\mu\text{A}$
$I_{SD}$	Shutdown current	$V_{IN}$	$V_{EN} = 0\text{ V}$ , $V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 0\text{ mA}$		0.005	0.15	$\mu\text{A}$
	Leakage current into L		$V_{EN} = 0\text{ V}$ , $V_{IN} = 1.2\text{ V}$ , $V_L = 1.2\text{ V}$		0.01	1	$\mu\text{A}$

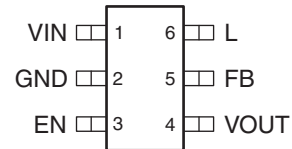
CONTROL STAGE						
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
	EN input current	$EN = 0\text{ V}$ or $EN = V_{IN}$		0.01	0.1	$\mu\text{A}$
$V_{IL}$	Logic low level, EN falling edge				0.65	V
$V_{IH}$	Logic high level, EN rising edge		0.78		$V_{IN} + 1.0\text{ V}$	V
	Overvoltage protection threshold	TPS61097-01	5.5	6.5	7	V
	Overtemperature protection			150		$^{\circ}\text{C}$
	Overtemperature hysteresis			20		$^{\circ}\text{C}$
VUVLO	Undervoltage lock-out threshold for turn off	$V_{IN}$ decreasing		0.5	0.7	

## PIN ASSIGNMENTS

**FIXED OUTPUT VOLTAGE  
DBV PACKAGE  
(TOP VIEW)**



**ADJUSTABLE OUTPUT VOLTAGE  
DBV PACKAGE  
(TOP VIEW)**

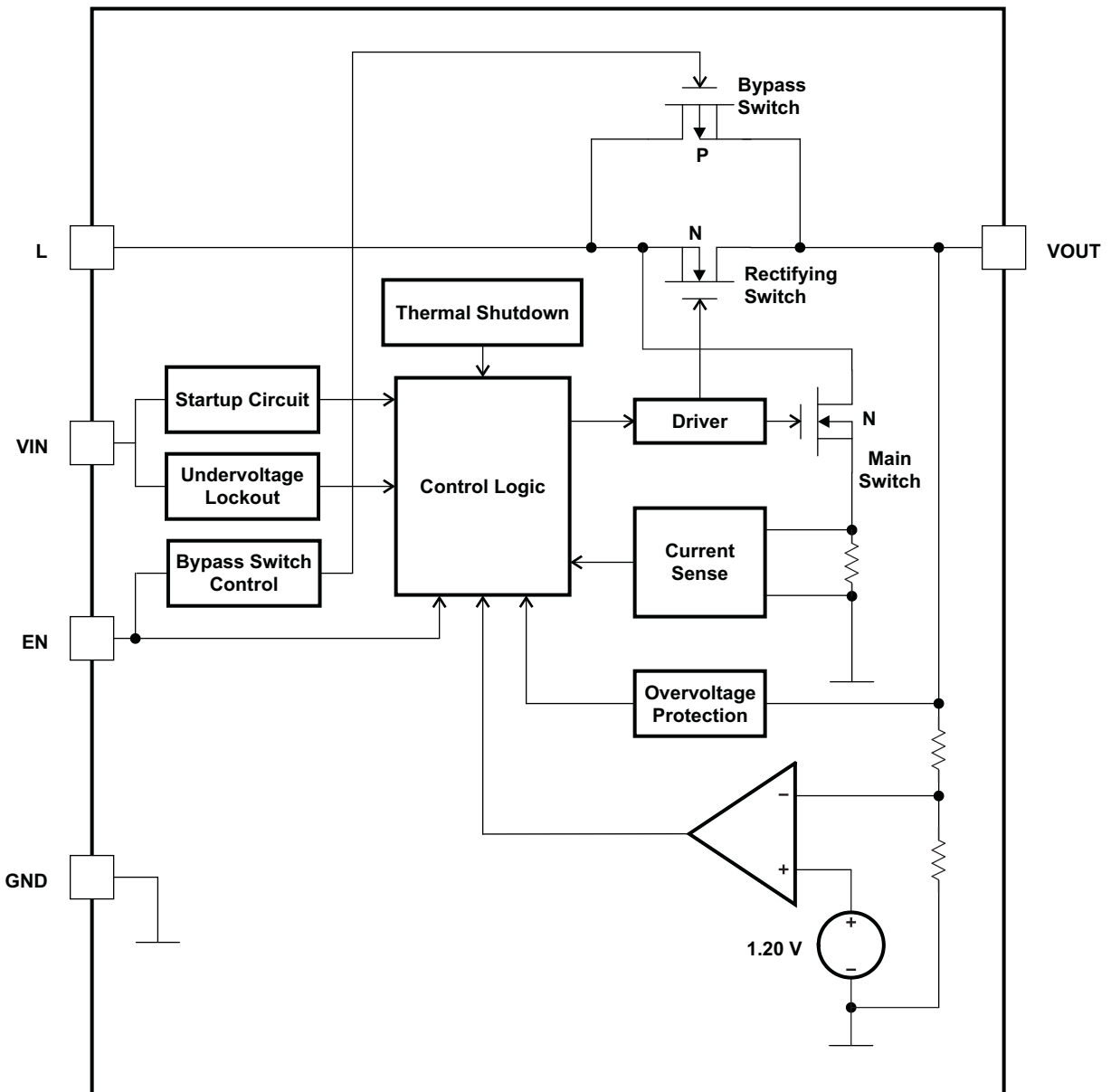


## Terminal Functions

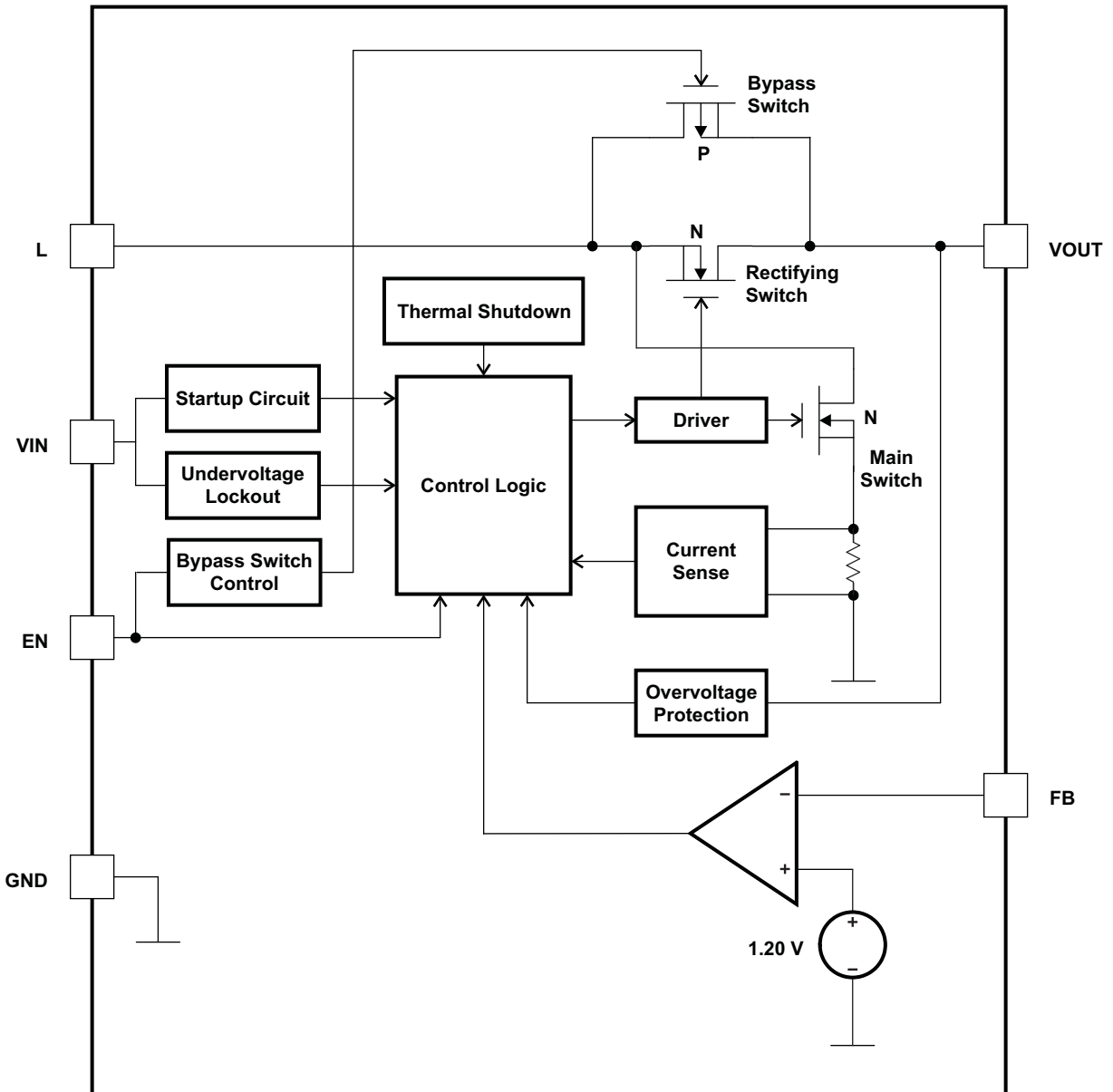
TERMINAL		NO.	I/O	DESCRIPTION
NAME	Fixed			
VIN	1	1	I	Boost converter input voltage
GND	2	2		Control / logic ground
EN	3	3	I	Enable input (1 = enabled, 0 = disabled). EN must be actively terminated high or low.
VOUT	4	4	O	Boost converter output
L	5	6	I	Connection for inductor
FB	–	5	I	(Adjustable versions) Voltage feedback of adjustable versions.

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FUNCTIONAL BLOCK DIAGRAM (FIXED OUTPUT VERSION)

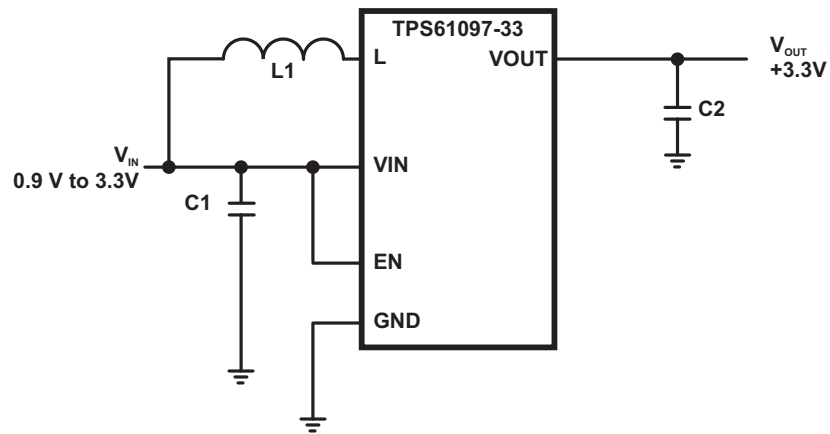


FUNCTIONAL BLOCK DIAGRAM (ADJUSTABLE OUTPUT VERSION)



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**PARAMETER MEASUREMENT INFORMATION**



C1	10 $\mu$ F
C2	10 $\mu$ F
L	10 $\mu$ H

**Table 1. List of Components**

REFERENCE	MANUFACTURER	PART NO.
C1	Murata	GRM319R61A106KE19 10 $\mu$ F 10V X5R 1206 20%
C2	Murata	GRM319R61A106KE19 10 $\mu$ F 10V X5R 1206 20%
L1	Coilcraft	DO3314-103MLC



TYPICAL CHARACTERISTICS

Table 2. Table of Graphs

		FIGURE
Maximum Output Current	vs Input Voltage	1
Efficiency	vs Output Current	2
	vs Input Voltage	3
Input Current	vs Input Voltage (Device Enabled, No Output Load, $V_{OUT} = 3.3\text{ V}$ )	4
	vs Input Voltage (Device Disabled, No Output Load)	5
Startup Voltage	vs Temperature	6
	vs Output Current	7
Output Voltage	vs Output Current	8
	vs Input Voltage	9
Waveforms	Output Voltage Ripple	10
	Load Transient Response	11
	Line Transient Response	12
	Switching Waveform, Continuous Mode	13
	Switching Waveform, Discontinuous Mode	14
	Startup After Enable ( $V_{IN} = 1.2\text{ V}$ , $I_{OUT} = 10\text{ mA}$ )	15
	Startup After Enable ( $V_{IN} = 1.8\text{ V}$ , $I_{OUT} = 10\text{ mA}$ )	16

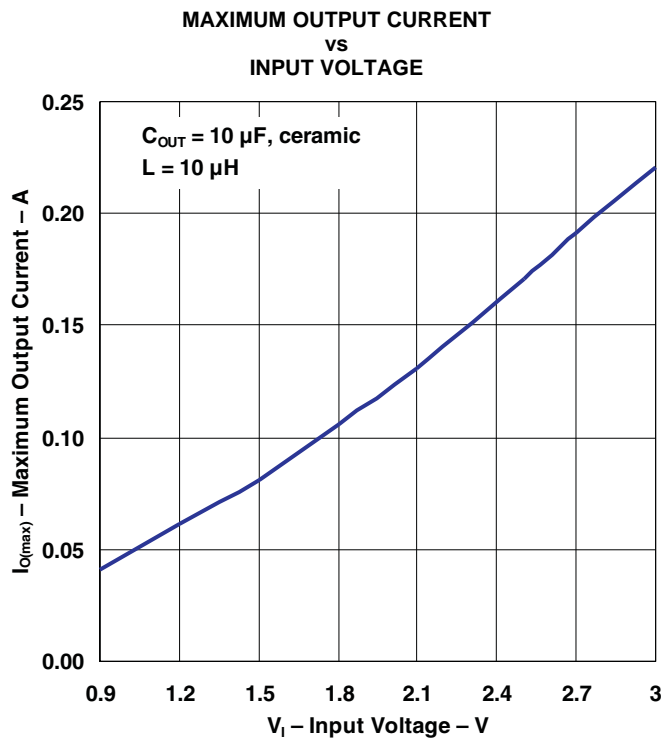


Figure 1.

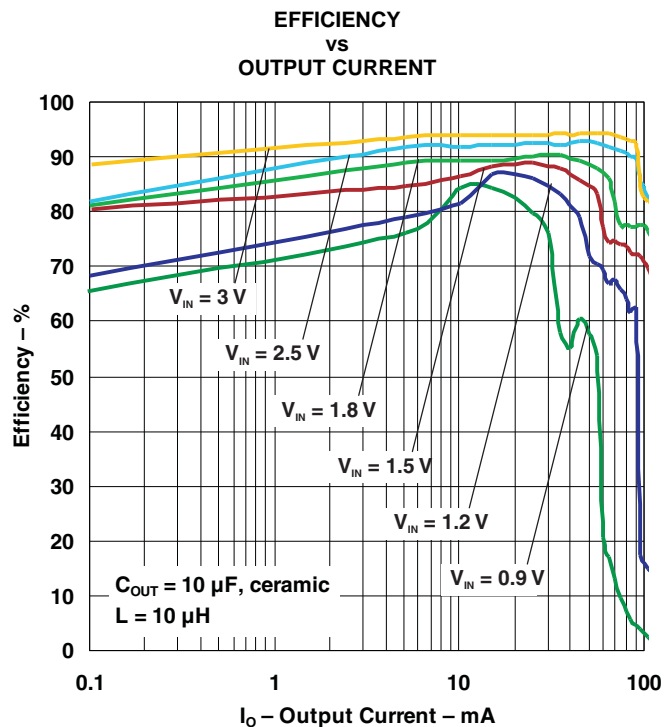


Figure 2.

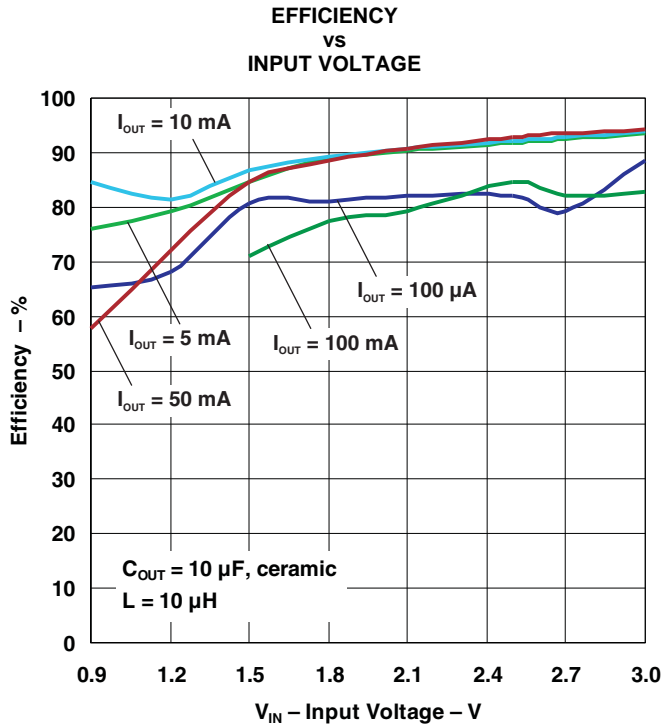


Figure 3.

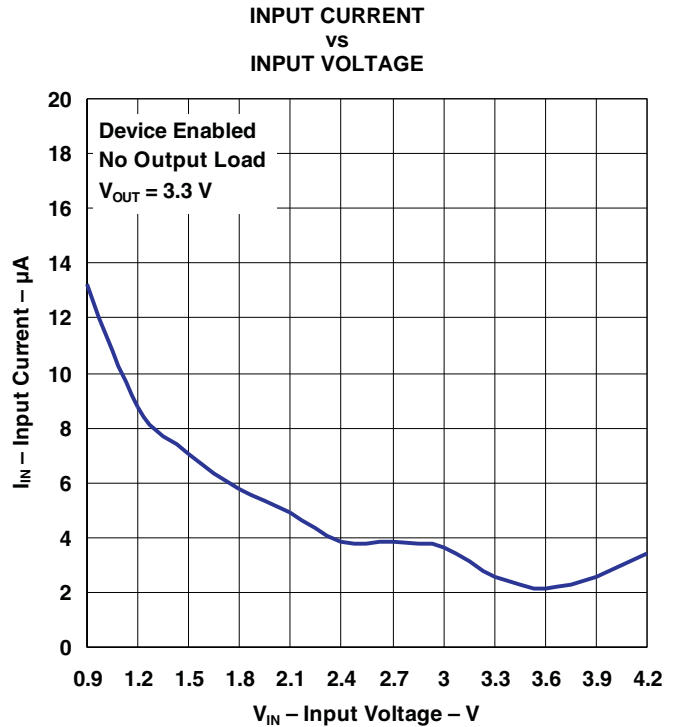


Figure 4.

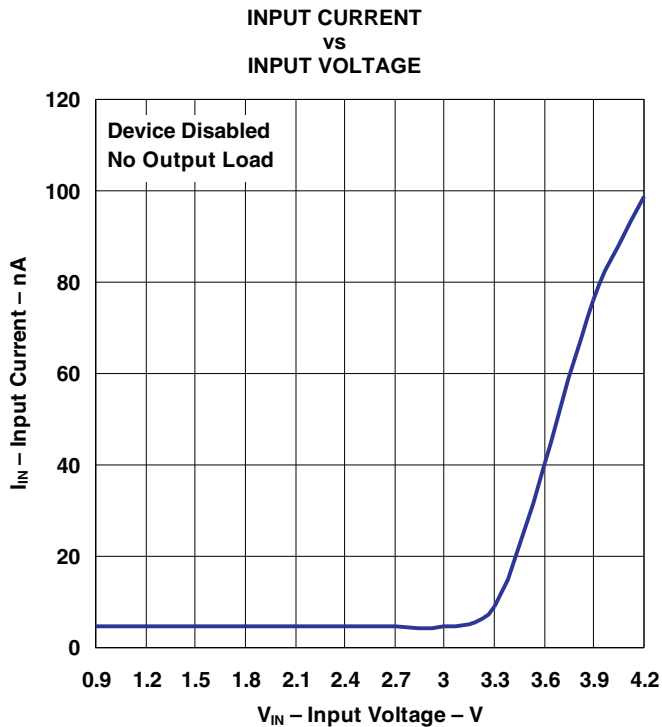


Figure 5.

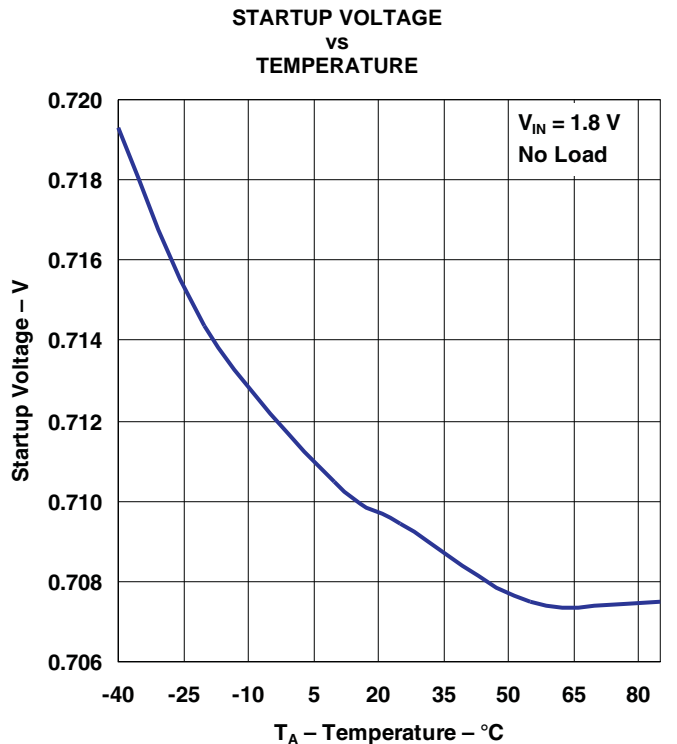


Figure 6.

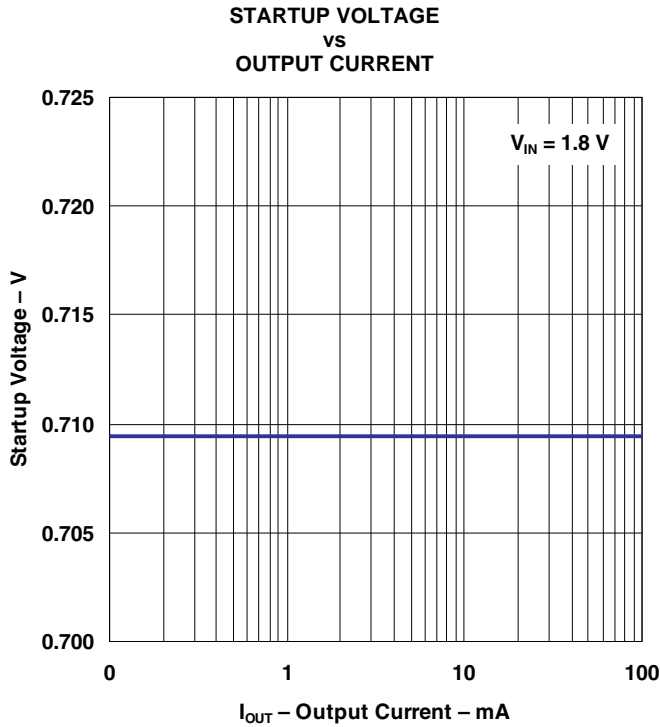


Figure 7.

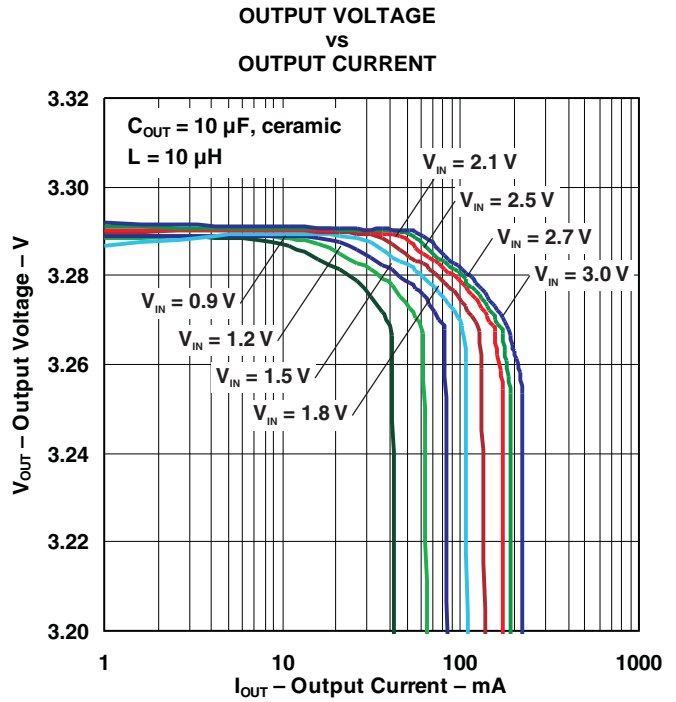


Figure 8.

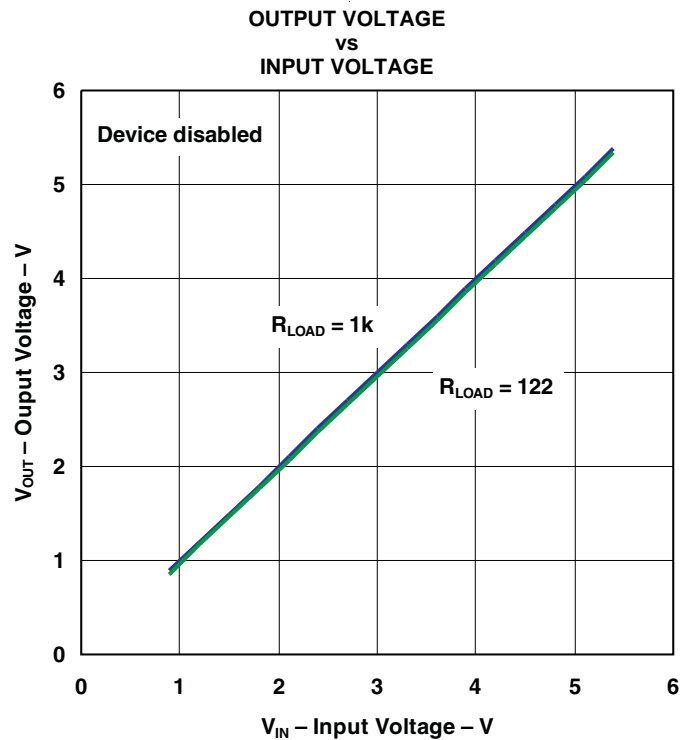


Figure 9.

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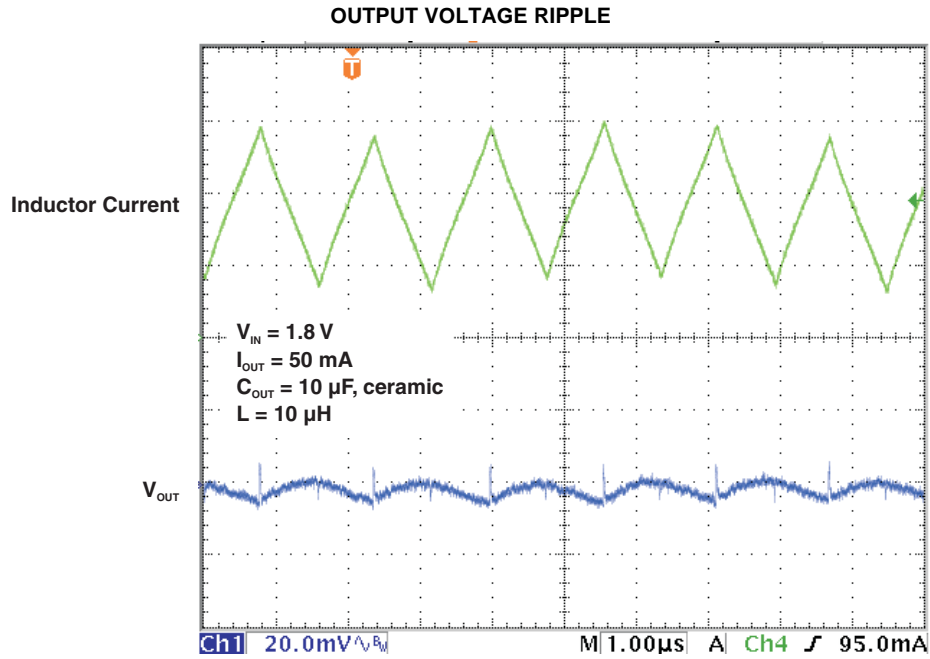


Figure 10.

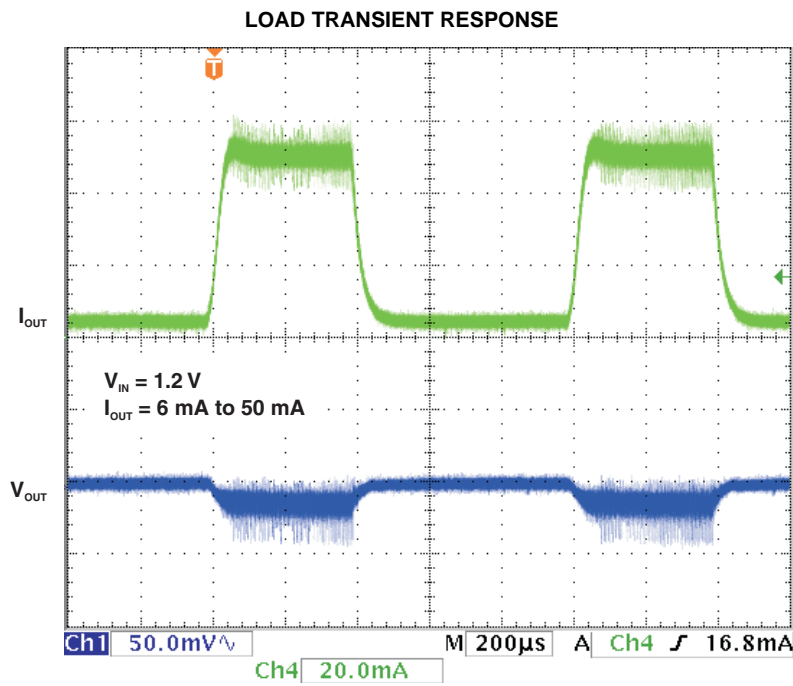


Figure 11.

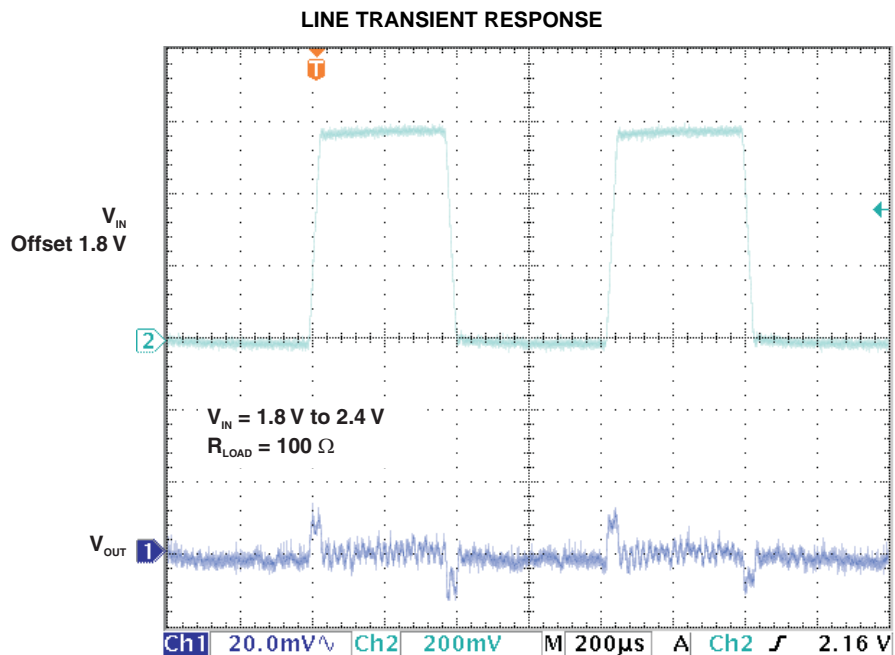


Figure 12.

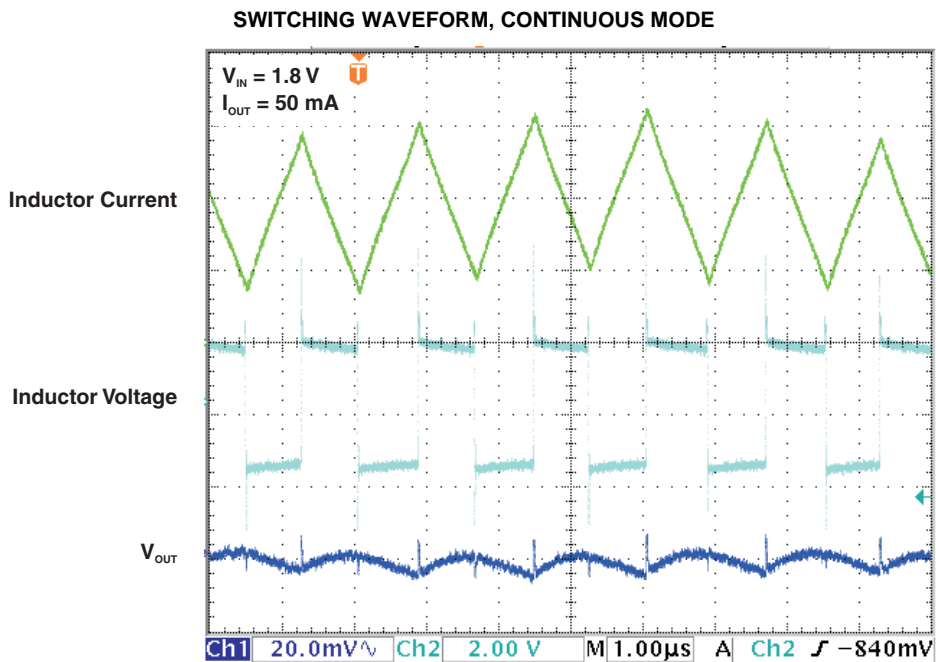


Figure 13.

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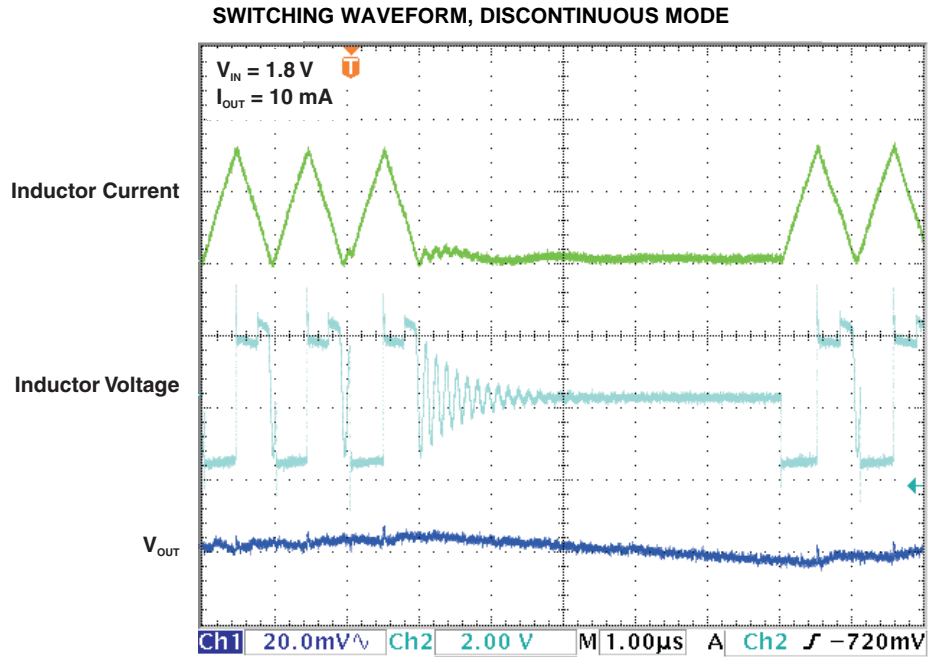


Figure 14.

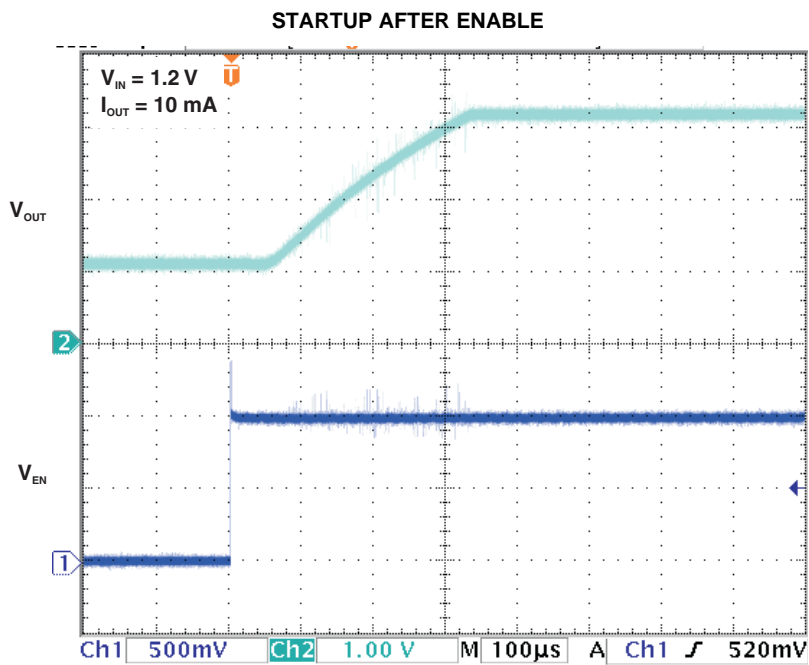


Figure 15.

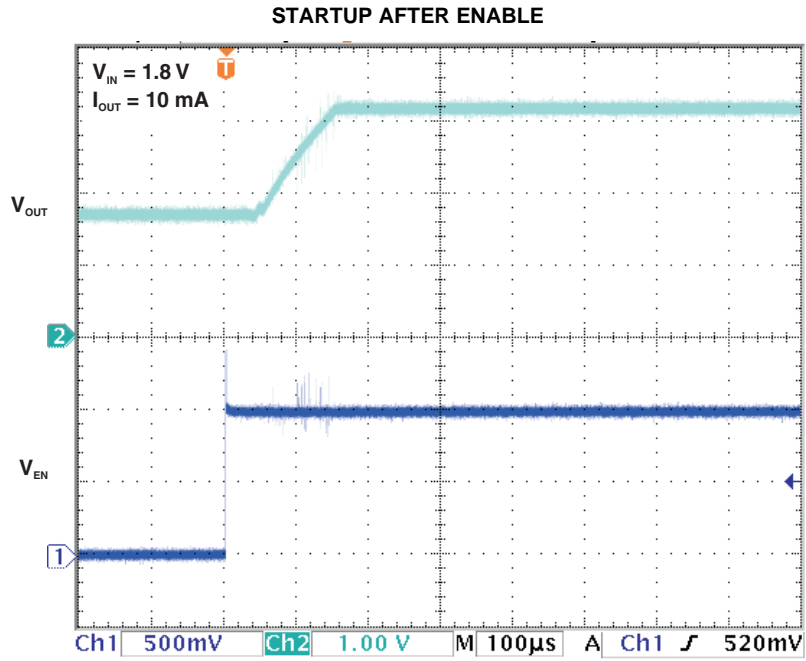


Figure 16.

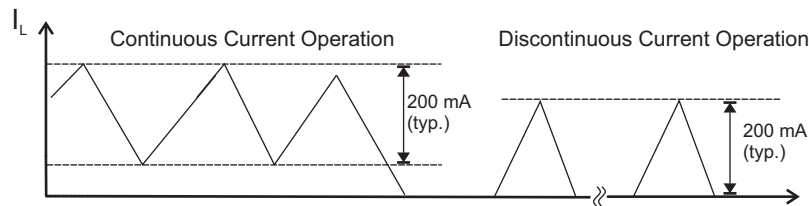
## DETAILED DESCRIPTION

### Operation

The TPS61097 is a high performance, high efficient family of switching boost converters. To achieve high efficiency the power stage is realized as a synchronous boost topology. For the power switching two actively controlled low  $R_{DSon}$  power MOSFETs are implemented.

### 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 17. 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. For fixed output voltage versions, the feedback function is connected internally. A resistive divider network is required to set the output voltage with the adjustable option.

The self oscillating hysteretic current mode architecture is inherently stable and allows fast response to load variations. It also allows using inductors and capacitors over a wide value range.

### 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.

### Bypass Switch

The TPS61097 contains a P-channel MOSFET (Bypass Switch) in parallel with the synchronous rectifying MOSFET. When the IC is enabled ( $EN = V_{IH}$ ), the Bypass Switch is turned off to allow the IC to work as a standard boost converter. When the IC is disabled ( $EN = V_{IL}$ ) the Bypass Switch is turned on to provide a direct, low impedance connection from the input voltage (at the L pin) to the load ( $V_{OUT}$ ). The Bypass Switch is not impacted by Undervoltage lockout, Overvoltage or Thermal shutdown.

### 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.

### 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.

### 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 ( $EN = V_{IL}$ ) there is no impact during an undervoltage condition, the Bypass Switch remains on.

### Overvoltage Protection

If, for any reason, TPS61097-01 output voltage is not properly connected to the input of the voltage amplifier, the IC cannot control the output voltage. Therefore an overvoltage protection is implemented to keep the output voltage from exceeding the absolute maximum voltage ratings of the IC and to protect the load. For this protection the TPS61097-01 output voltage is also monitored internally. In case it reaches the internally programmed threshold of 6.5 V typically the voltage amplifier regulates the output voltage to this value.

If the TPS61097-01 is used to drive LEDs, this feature protects the circuit if the LED fails.

### Overtemperature Protection

The device has a built-in temperature sensor which monitors the internal IC temperature. If the temperature exceeds the programmed threshold (150 °C typical), the device stops operating. As soon as the IC temperature has decreased below the programmed threshold, it starts operating again. There is a built-in hysteresis to avoid unstable operation at IC temperatures at the overtemperature threshold.

## APPLICATION INFORMATION

### Design Procedure

The TPS61097 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 TPS61097 is used. The TPS61097 does not down-regulate VIN; therefore, if VIN is greater than VOUT, VOUT tracks VIN.

### Programming the Output Voltage

Within the TPS61097 family, there are fixed and adjustable output voltage versions available. For the adjustable output voltage versions, an external resistor divider is used to adjust the output voltage. The resistor divider must be connected between VOUT, FB, and GND. When the output voltage is regulated properly, the typical value of the voltage at the FB pin is 1.2 V. The maximum recommended value for the output voltage is 5.5 V. The current through the resistive divider should be about 100 times greater than the current into the FB pin. The typical current into the FB pin is 0.01  $\mu$ A, and the voltage across the resistor between FB and GND, R2, is typically 1.2 V. Based on those two values, the recommended value for R2 should be lower than 500 k $\Omega$ , in order to set the divider current at 1  $\mu$ A or higher. It is recommended to keep the value for this resistor in the range of 100 k $\Omega$ . [Equation 1](#) calculates the value of R1 to set the desired output voltage:

$$R1 = R2 \times \left( \frac{V_{OUT}}{V_{FB}} - 1 \right) \quad (1)$$

As an example, if an output voltage of 2.5 V is needed, a 162-k $\Omega$  resistor should be chosen for R1 when a 150-k $\Omega$  has been selected for R2.

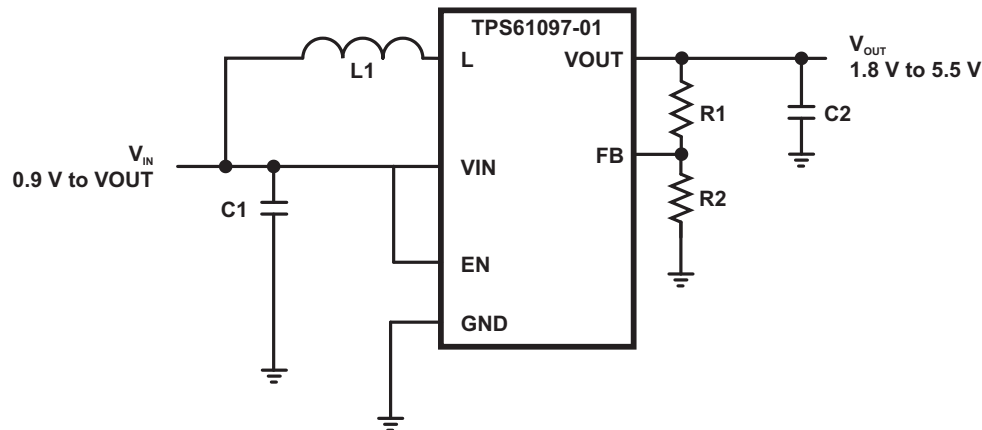


Figure 18. Typical Application Circuit for Adjustable Output Voltage Option

### 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 TPS61097 can be set to switch on the bypass at a defined voltage level on VIN. For example, setting R1 and R2 to 200k  $\Omega$  would set VEN to half of VIN. The voltage level of VIN engaging the bypass switch is based on the VIL level of EN (0.65 V). If VIN is less than 1.30 V then the bypass switch will be enabled. For VIN values above 1.50 V (50% of VIH) the bypass switch is disabled.

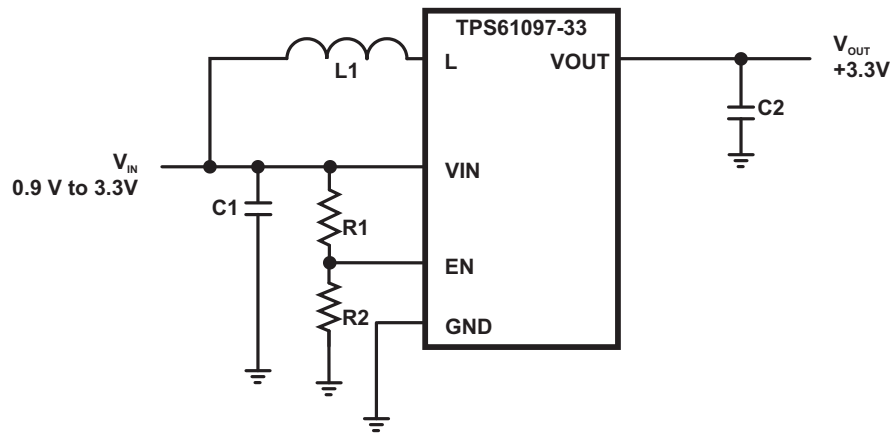


Figure 19. Adjustable Bypass Switching

### Inductor Selection

To make sure that the TPS61097 devices can operate, a suitable inductor must be connected between pin VIN and pin L. Inductor values of 4.7  $\mu\text{H}$  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 2](#).

$$L = \frac{1}{f \times 200 \text{ mA}} \times \frac{V_{\text{IN}} \times (V_{\text{OUT}} - V_{\text{IN}})}{V_{\text{OUT}}} \quad (2)$$

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 3](#) gives the peak current estimate.

$$I_{L,\text{MAX}} = \begin{cases} \frac{V_{\text{OUT}} \times I_{\text{OUT}}}{0.8 \times V_{\text{IN}}} + 100 \text{ mA}; & \text{continuous current operation} \\ 200 \text{ mA}; & \text{discontinuous current operation} \end{cases} \quad (3)$$

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

[Equation 4](#) 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.

$$\frac{V_{\text{OUT}} \times I_{\text{OUT}}}{V_{\text{IN}}} > 0.8 \times 100 \text{ mA} \quad (4)$$

Due to the use of current hysteretic control in the TPS61097, 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 TPS61097 boost converter. The relationship between the series resistance ( $R_{\text{IN}}$ ), the input voltage ( $V_{\text{IN}}$ ) and the switch current limit ( $I_{\text{SW}}$ ) is shown in [Equation 5](#).

$$R_{\text{IN}} < V_{\text{IN}} / I_{\text{SW}} \quad (5)$$

Examples:

$$I_{\text{SW}} = 400 \text{ mA}, V_{\text{IN}} = 2.5 \text{ V} \quad (6)$$

In [Equation 6](#),  $R_{\text{IN}} < 2.5 \text{ V} / 400 \text{ mA}$ ; therefore,  $R_{\text{IN}}$  must be less than 6.25  $\Omega$ .

$$I_{SW} = 400 \text{ mA}, V_{IN} = 1.8 \text{ V} \quad (7)$$

In Equation 7,  $R_{IN} < 1.8 \text{ V} / 400 \text{ mA}$ ; therefore,  $R_{IN}$  must be less than  $4.5 \Omega$ .

The following inductor series from different suppliers have been used with TPS61097 converters:

**Table 3. List of Inductors**

VENDOR	INDUCTOR SERIES
Coilcraft	DO3314
TDK	NLC565050T
Taiyo Yuden	CBC2012T

## Capacitor Selection

### Input Capacitor

The input capacitor should be at least  $10\text{-}\mu\text{F}$  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.

### 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 an 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 value 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 8.

$$C_2 \geq \frac{L}{2} \times \frac{\mu\text{F}}{\mu\text{H}} \quad (8)$$

The TPS61097 is not sensitive to the ESR in terms of stability. 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 4. Recommended Output Capacitors**

VENDOR	CAPACITOR SERIES
Murata	GRM188R60J106M47D $10\mu\text{F}$ 6.3V X5R 0603
Murata	GRM319R61A106KE19 $10\mu\text{F}$ 10V X5R 1206

## Layout Considerations

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.

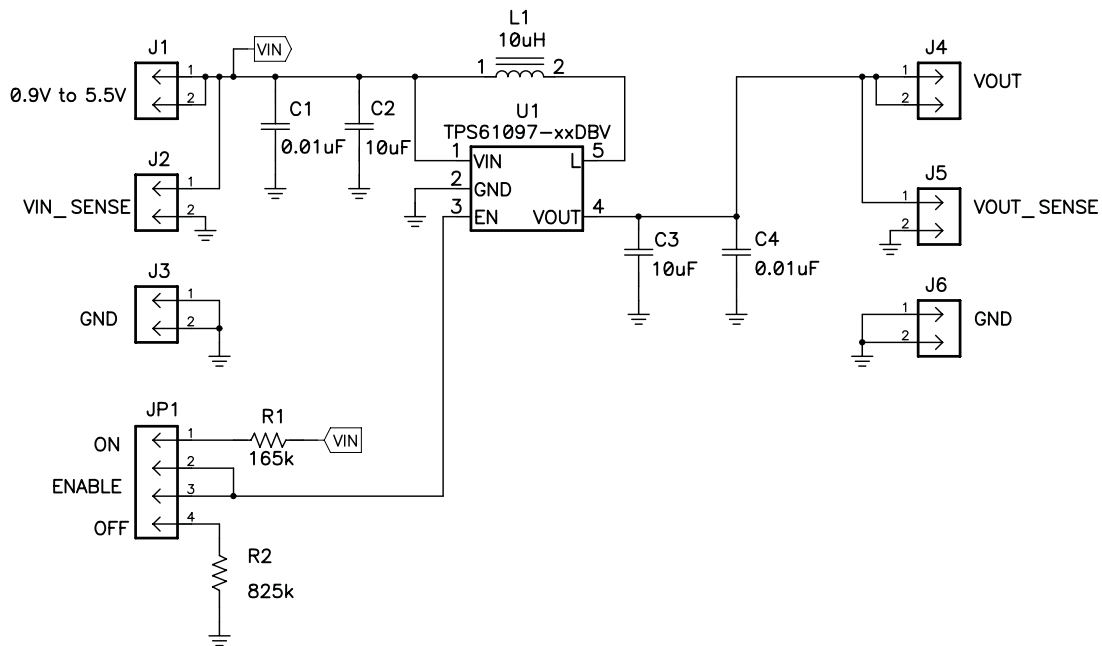


Figure 20. Layout Schematic

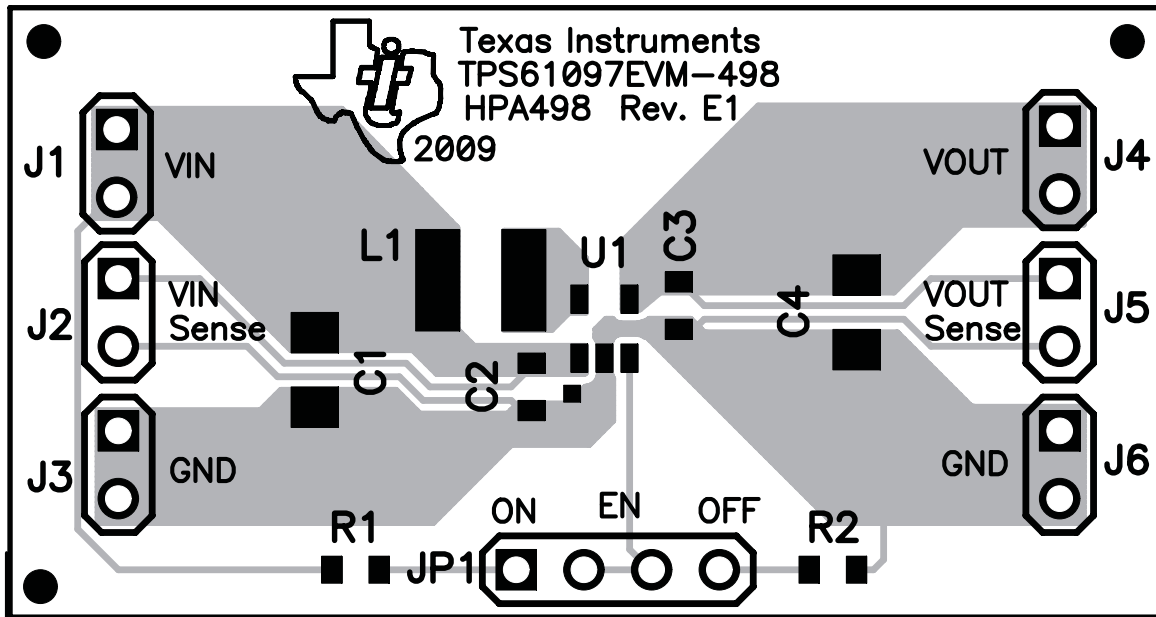


Figure 21. PCB Top View

### Thermal Information

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 TPS61097 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 TBD mW. More power can be dissipated if the maximum ambient temperature of the application is lower.

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
TPS61097-33DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TPS61097-33DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

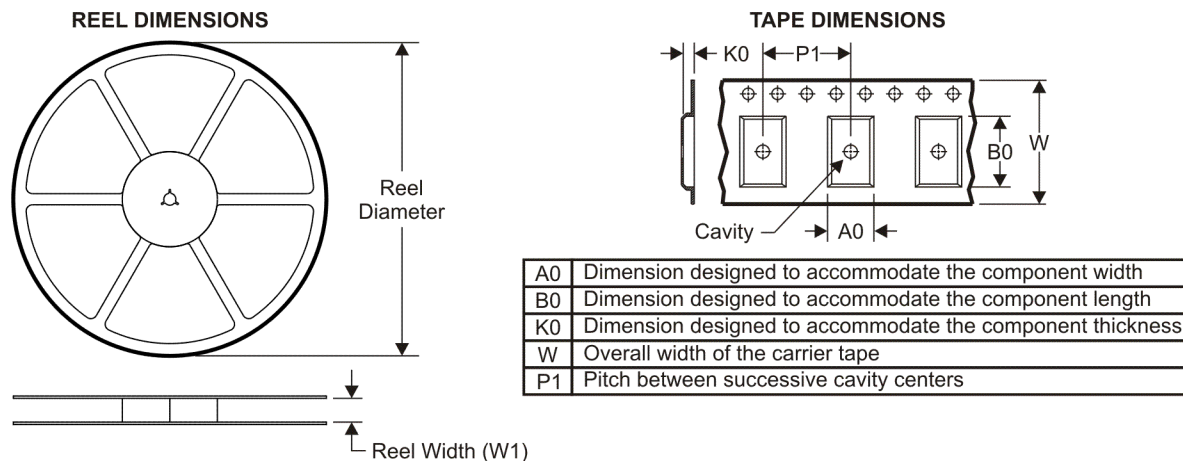
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

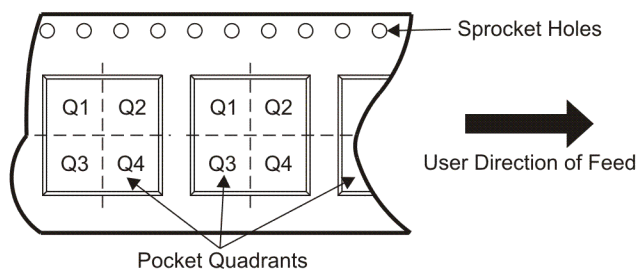
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TAPE AND REEL INFORMATION



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
TPS61097-33DBVR	SOT-23	DBV	5	3000	180.0	9.2	3.23	3.17	1.37	4.0	8.0	Q3
TPS61097-33DBVT	SOT-23	DBV	5	250	180.0	9.2	3.23	3.17	1.37	4.0	8.0	Q3



**TAPE AND REEL BOX DIMENSIONS**

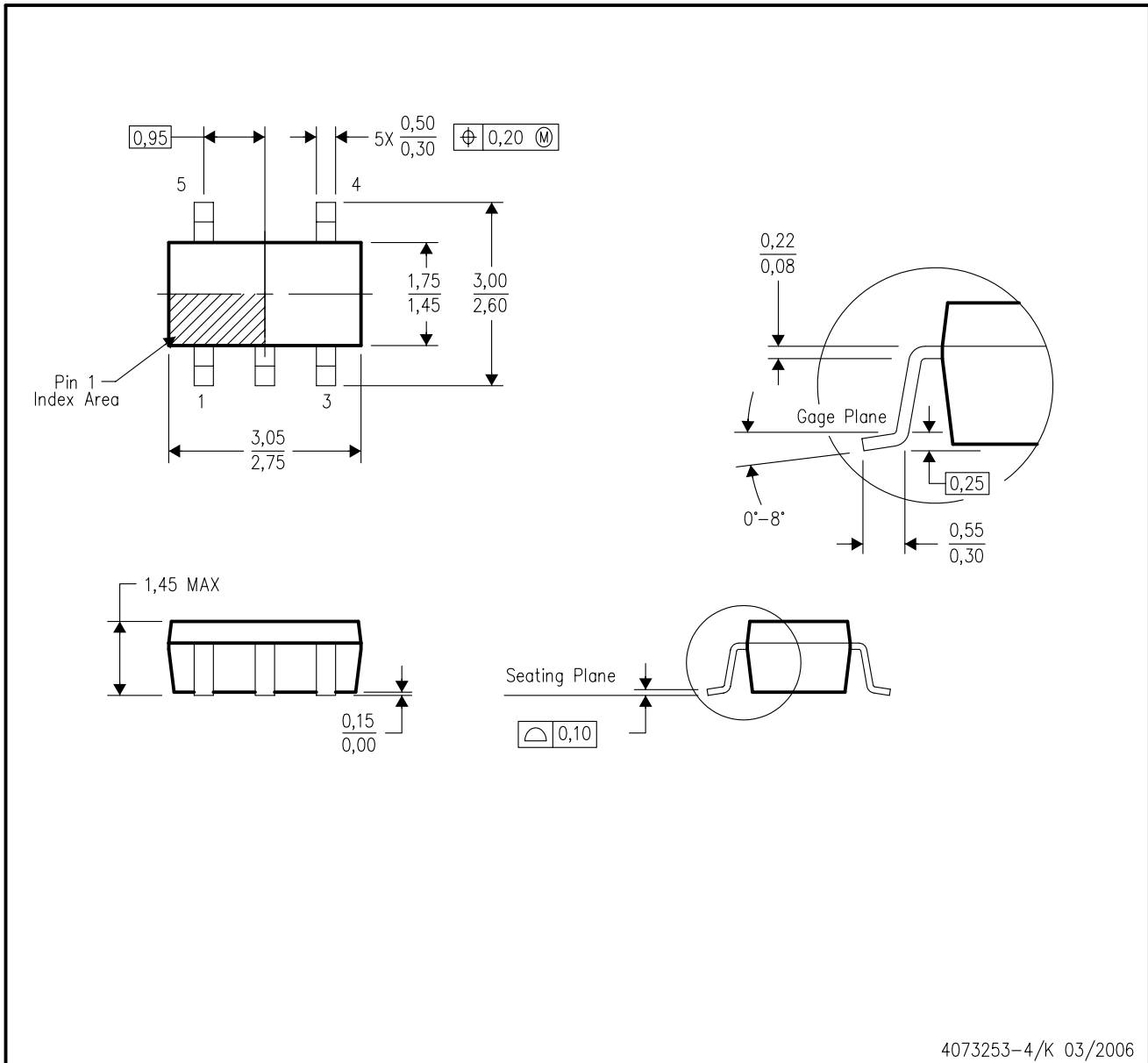


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS61097-33DBVR	SOT-23	DBV	5	3000	205.0	200.0	33.0
TPS61097-33DBVT	SOT-23	DBV	5	250	205.0	200.0	33.0

## DBV (R-PDSO-G5)

## PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - Falls within JEDEC MO-178 Variation AA.

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Logic	<a href="http://logic.ti.com">logic.ti.com</a>	Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
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