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 µA
- 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

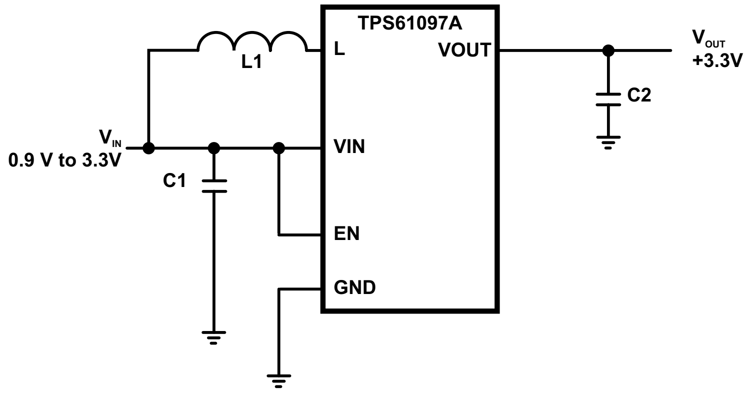
The TPS61097A-33 provides a power supply solution for products powered by either a single-cell, two-cell, or three-cell alkaline, NiCd, or NiMH, or one-cell Li-Ion or Li-polymer battery. They can also be used in fuel cell or solar cell powered devices where the capability of handling low input voltages 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 × 2.9 mm.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS61097A-33	SOT-23 (5)	2.90 mm × 2.90 mm

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

Typical Operating Application



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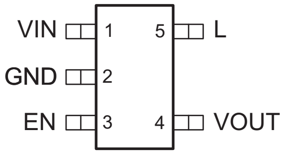
4 Revision History

Changes from Original (January 2014) to Revision A **Page**

- Added *Handling Rating* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section 1

5 Pin Configuration and Functions

FIXED OUTPUT VOLTAGE
DBV PACKAGE
(TOP VIEW)



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)(1)

			MIN	MAX	UNIT
V_I	Input voltage range	VIN	–0.3	7	V
		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	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±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[1]		TPS61097A-33	UNIT
		DBV	
		5 PINS	
θ_{JA}	Junction-to-ambient thermal resistance	208.7	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	124.5	
θ_{JB}	Junction-to-board thermal resistance	36.9	
ψ_{JT}	Junction-to-top characterization parameter	14.7	
ψ_{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
DC/DC STAGE							
V_{IN}	Input voltage			0.9		5.5	V
V_{OUT}	Output voltage		V_{IN} = 1.2 V , I_{OUT} = 10 mA	3.20	3.30	3.40	
I_{SW}	Switch current limit		V_{OUT} = 3.3 V	200	400	475	mA
	Rectifying switch on resistance		V_{OUT} = 3.3 V		1.0		Ω
	Main switch on resistance		V_{OUT} = 3.3 V		1.0		
	Bypass switch on resistance		V_{IN} = 1.2 I_{OUT} = 100 mA		3.4		
	Line regulation		$V_{IN} < V_{OUT}$, V_{IN} = 1.2 V to 1.8 V, I_{OUT} = 10 mA		0.5%		
	Load regulation		$V_{IN} < V_{OUT}$, I_{OUT} = 10 mA to 50 mA, V_{IN} = 1.8 V		0.5%		
I_Q	Quiescent current	V_{IN}	I_{OUT} = 0 mA, V_{EN} = V_{IN} = 1.2 V, V_{OUT} = 3.5 V		2	4	μA
		V_{OUT}			5	8	
I_{SD}	Shutdown current	V_{IN}	V_{EN} = 0 V, V_{IN} = 1.2 V, I_{OUT} = 0 mA		0.005	0.15	μA
			V_{EN} = 0 V, V_{IN} = 3 V, I_{OUT} = 0 mA		0.005	0.15	
	Leakage current into L		V_{EN} = 0 V, V_{IN} = 1.2 V, V_L = 1.2 V		0.01	1	
CONTROL STAGE							
	EN input current		EN = 0 V or EN = V_{IN}		0.01	0.1	μA
V_{IL}	Logic low level, EN falling edge					0.58	V
V_{IH}	Logic high level, EN rising edge			0.78		VIN + 1.0 V	
OTP	Overtemperature protection				150		°C
OTP_{HYST}	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.

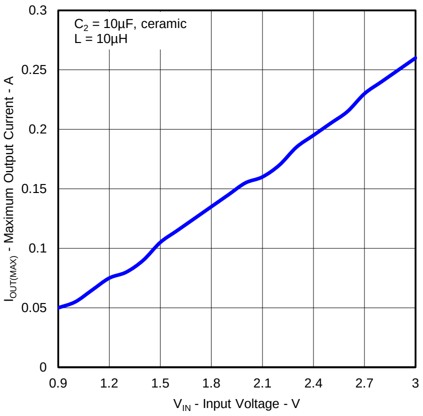


Figure 1. Maximum Output Current vs Input Voltage

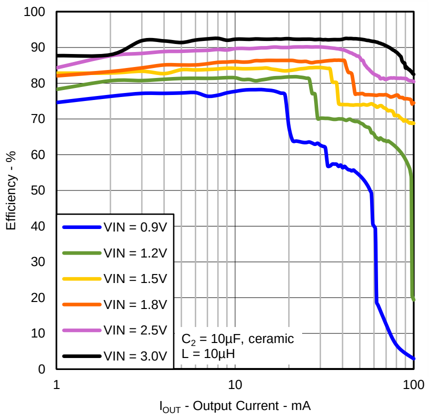


Figure 2. Efficiency vs Output current

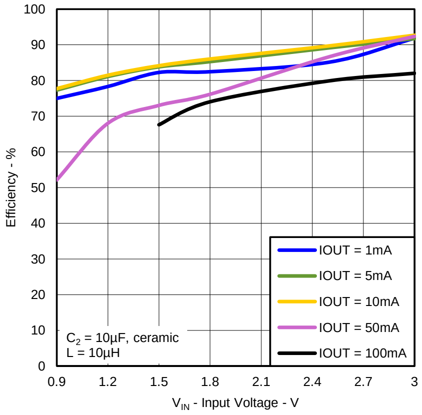


Figure 3. Efficiency vs Input Voltage

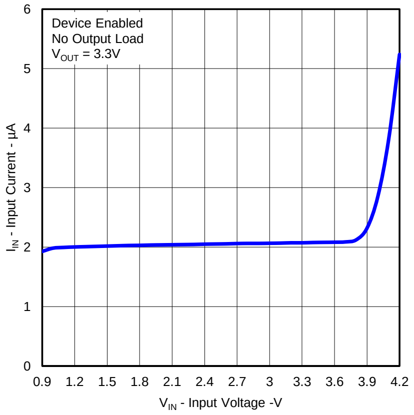


Figure 4. Input Current vs Input Voltage

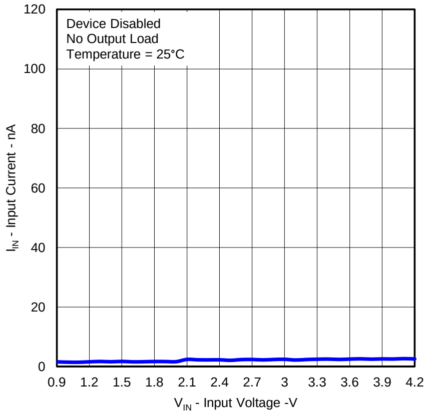


Figure 5. Input Current vs Input Voltage

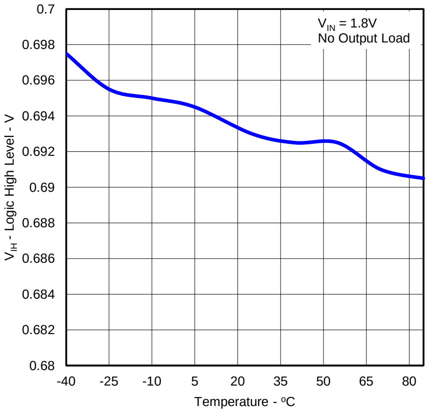


Figure 6. V_{IH} vs Temperature

Typical Characteristics (continued)

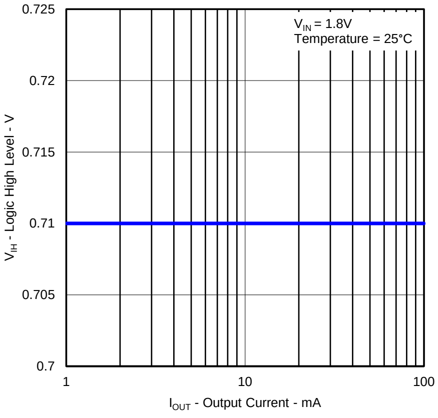


Figure 7. V_{IH} vs Output Current

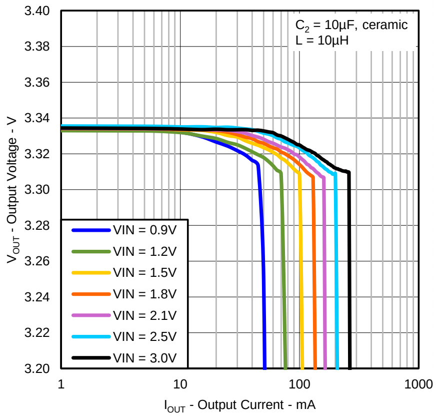


Figure 8. Output Voltage vs Output Current

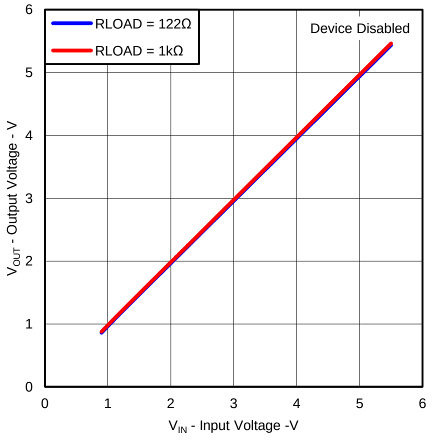


Figure 9. Output Voltage vs Input Voltage

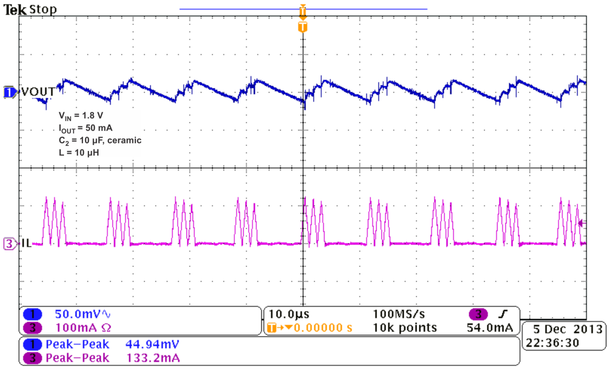


Figure 10. Output Voltage Ripple

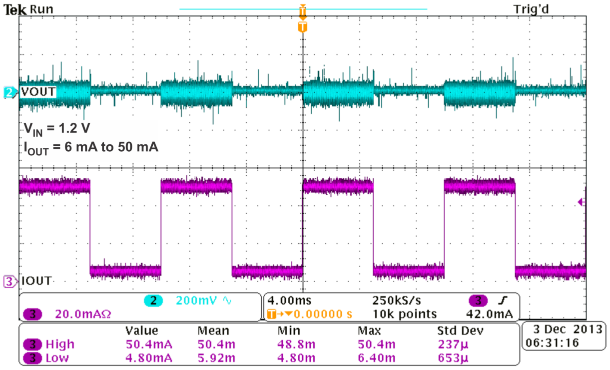


Figure 11. Load Transient Response

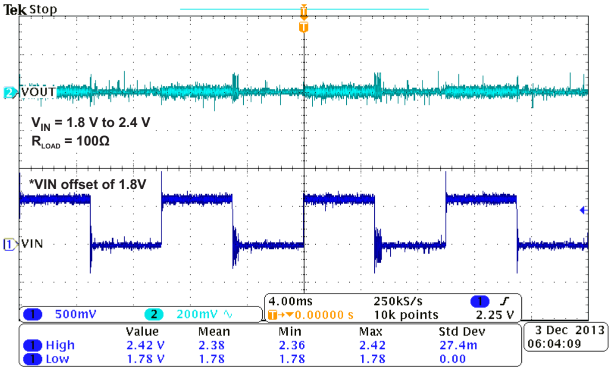


Figure 12. Line Transient Response

Typical Characteristics (continued)

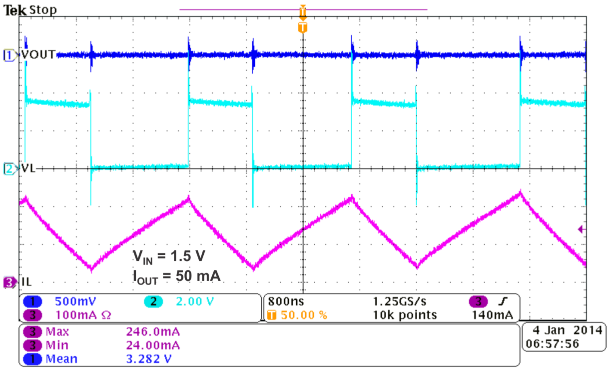


Figure 13. Switching Waveform, Continuous Mode

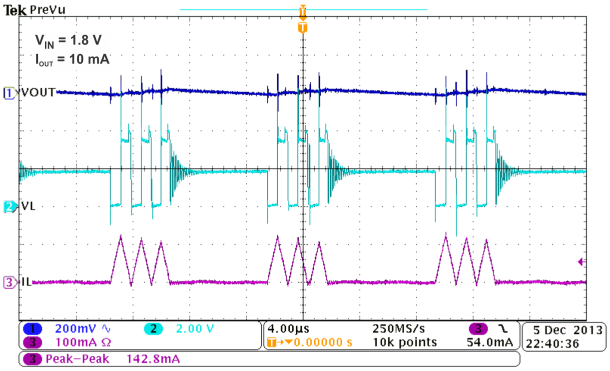


Figure 14. Switching Waveform, Discontinuous Mode

7 Parameter Measurement Information

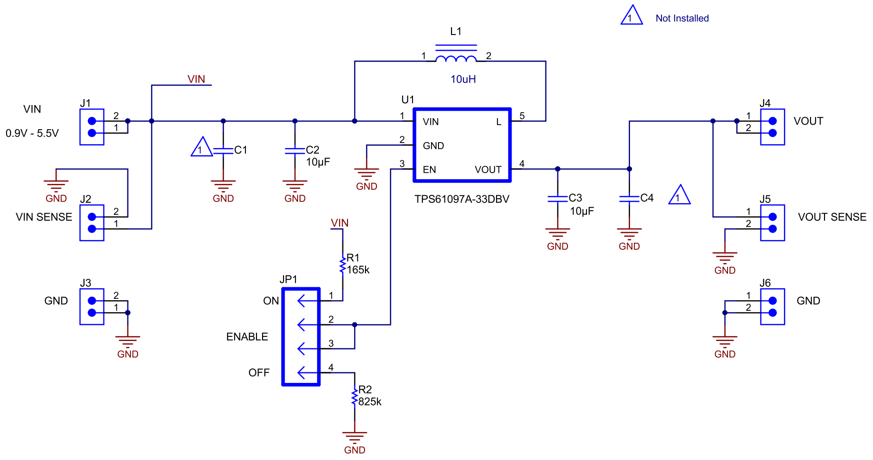


Figure 15. Measurement Test Circuit

Table 1. List of Components

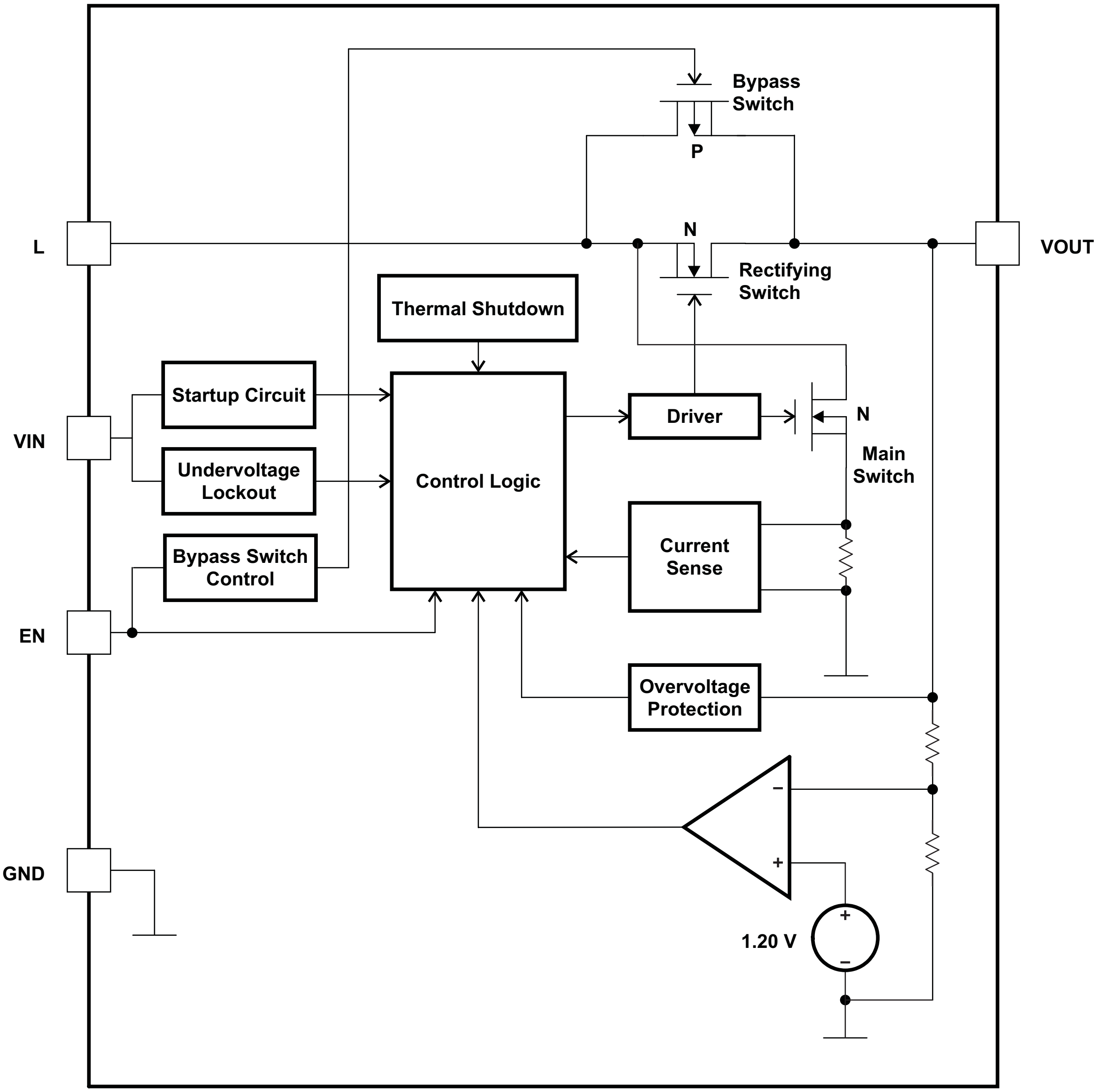
REFERENCE	MANUFACTURER	PART NO.
C2	Murata	GRM319R61A106KE19 10µF 10V X5R 1206 20%
C3	Murata	GRM319R61A106KE19 10µF 10V X5R 1206 20%
L1	Coilcraft	DO3314-103MLC

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_{DSon} 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.

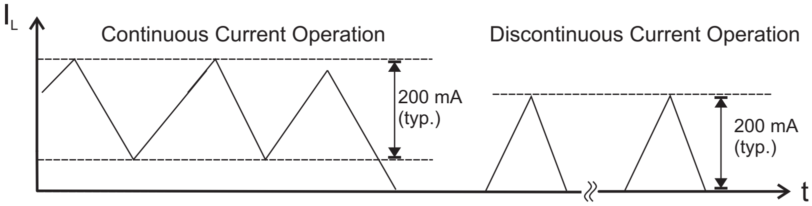


Figure 16. Hysteretic Current Operation

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 $_{HYST}$), 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 KΩ would set V_{EN} to half of VIN. The voltage level of VIN engaging the bypass switch is based on the V_{IL} 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_{IH}) the bypass switch is disabled.

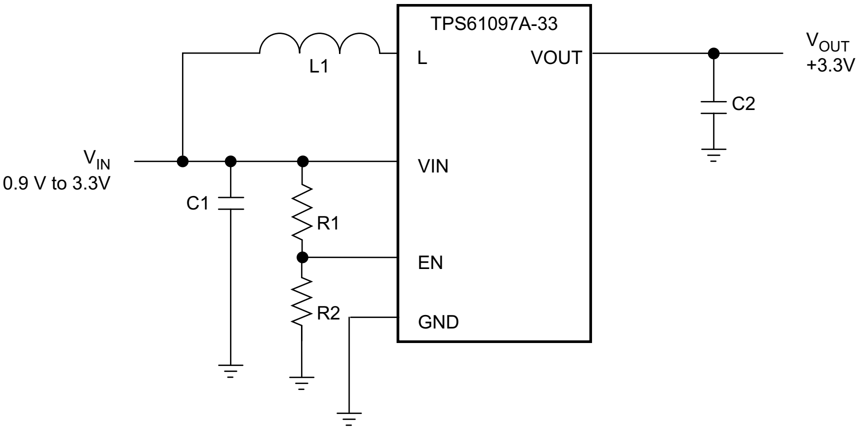


Figure 17. Adjustable Bypass Switching

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. Below is an example circuit that has a load switch with controlled turn-on.

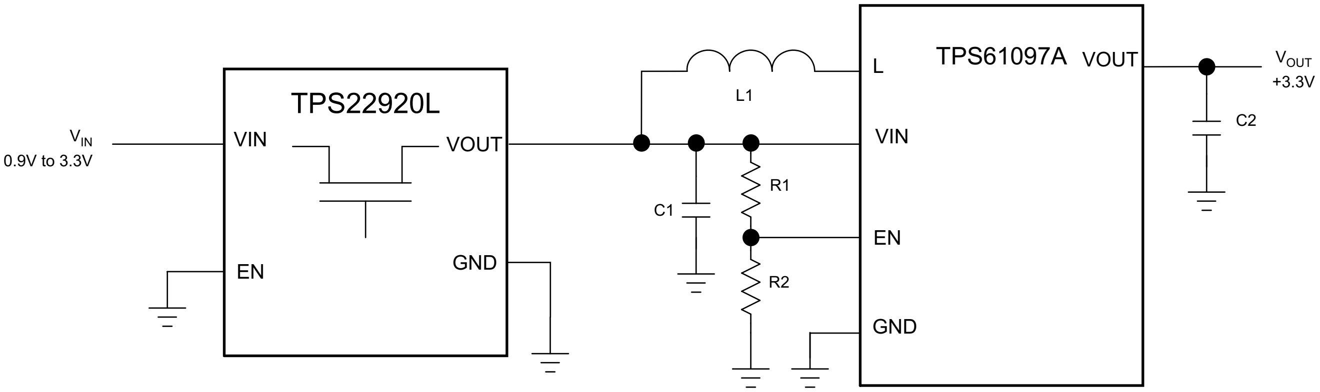


Figure 18. Example Circuit with Load Switch

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

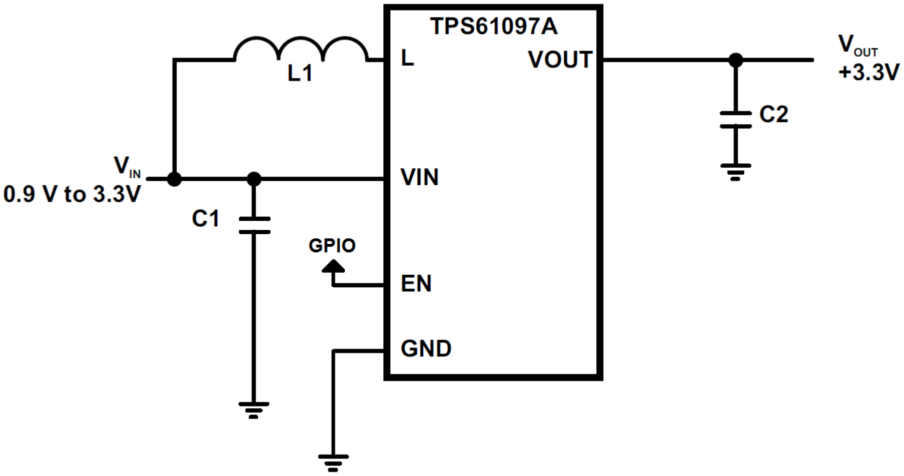


Figure 19. Typical Application Schematic

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 µH 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.

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

Choosing inductor values higher than 4.7 µH can improve efficiency due to reduced switching frequency and therefore with reduced switching losses. Using inductor values below 2.2 µH 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.

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

$I_{L,MAX}$ 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.

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

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.

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

Examples:

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

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

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

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

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-µF 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 µF 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 µF should be used, 10 µF are recommended. If the inductor exceeds 4.7 µH, the value of the output capacitance value needs to be half the inductance value or higher for stability reasons, see Equation 7.

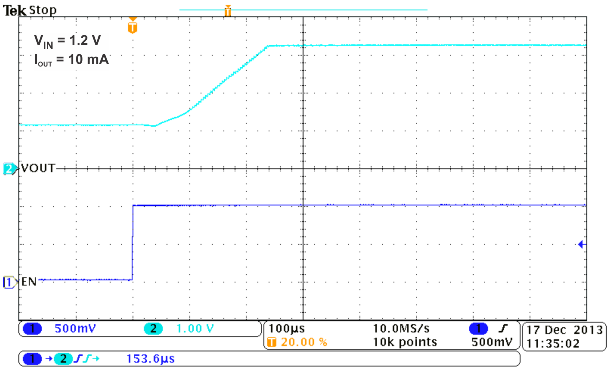
$$C_2 \geq \frac{L}{2} \times \frac{\mu F}{\mu H} \tag{7}$$

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

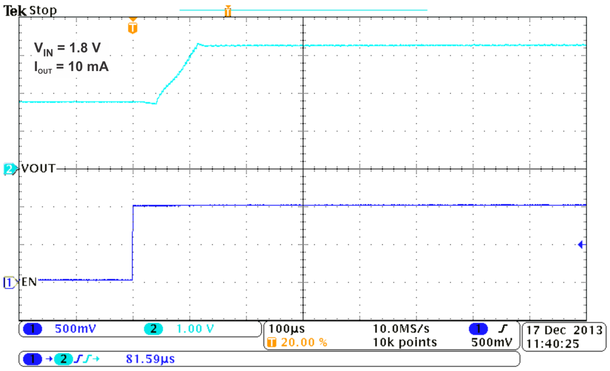
VENDOR	CAPACITOR SERIES
Murata	GRM188R60J106M47D 10µF 6.3V X5R 0603
Murata	GRM319R61A106KE19 10µF 10V X5R 1206

9.2.3 Application Curves



V_{IN} = 1.2 V
I_{OUT} = 10 mA

Figure 20. Startup After Enable



V_{IN} = 1.8 V
I_{OUT} = 1.8 mA

Figure 21. Startup After Enable

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

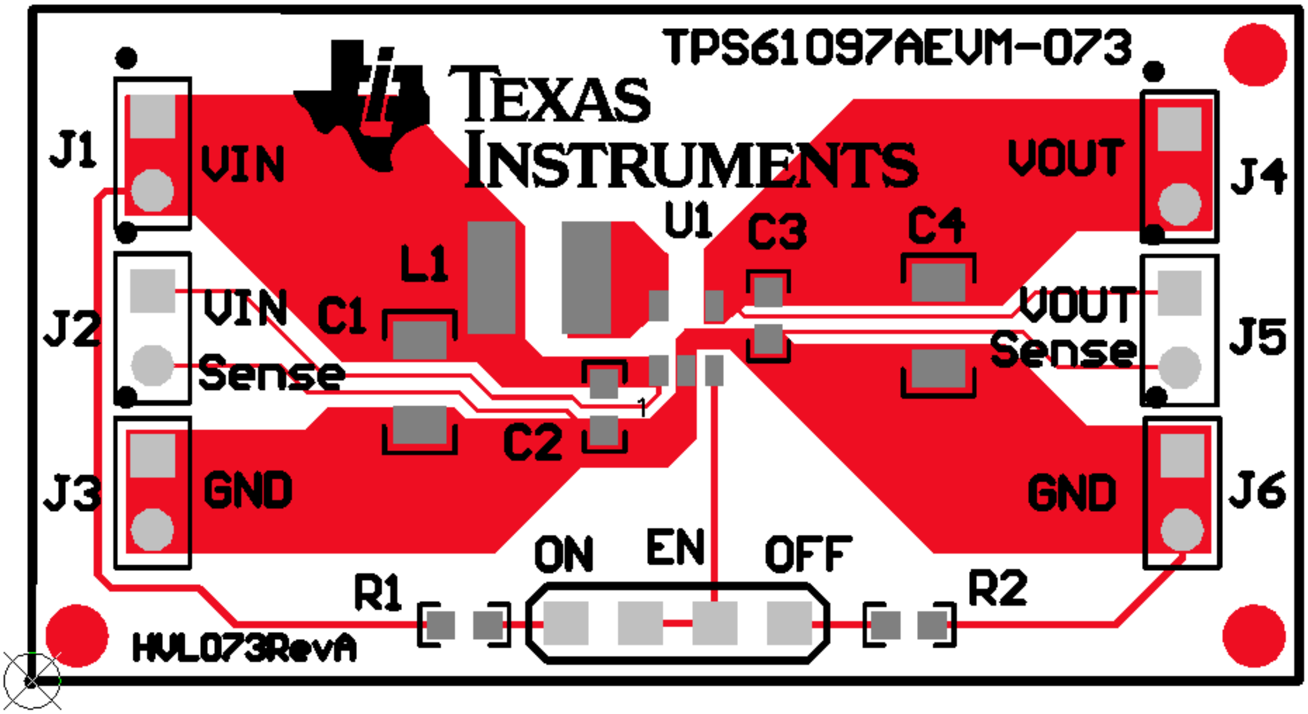


Figure 22. Layout Example

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.

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS61097A-33DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU | CU SN	Level-1-260C-UNLIM	-40 to 85	(NG5F ~ NG5K)	Samples
TPS61097A-33DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	NG5K	Samples

[1] 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.

[2] 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)

[3] MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

[4] There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

[5] Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

[6] Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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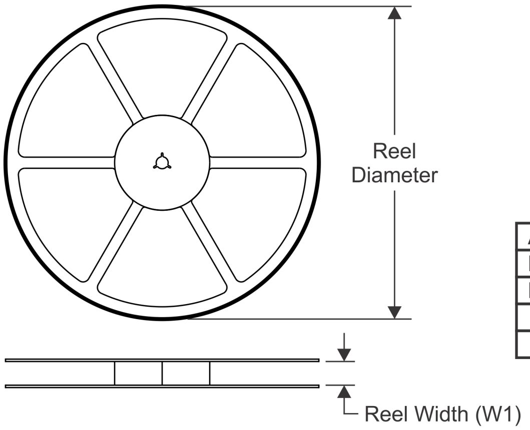
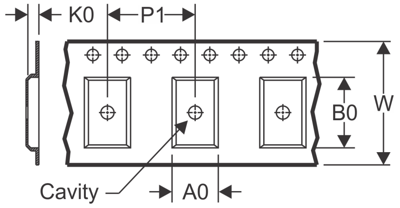
TAPE AND REEL INFORMATION

REEL DIMENSIONS

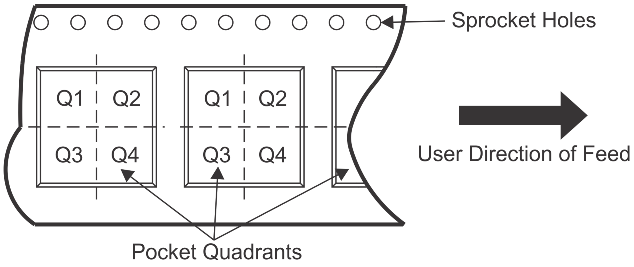


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

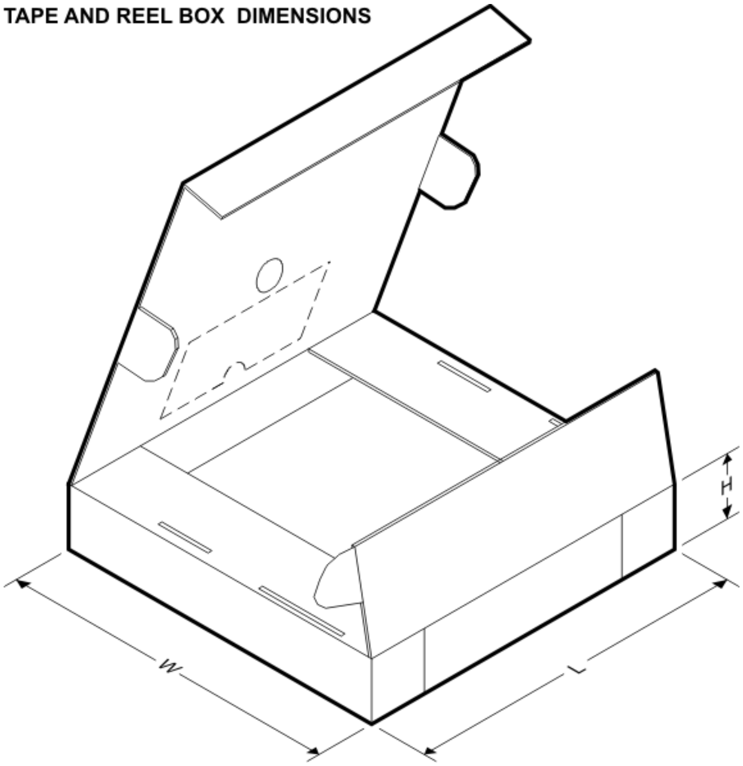
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS61097A-33DBVR	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

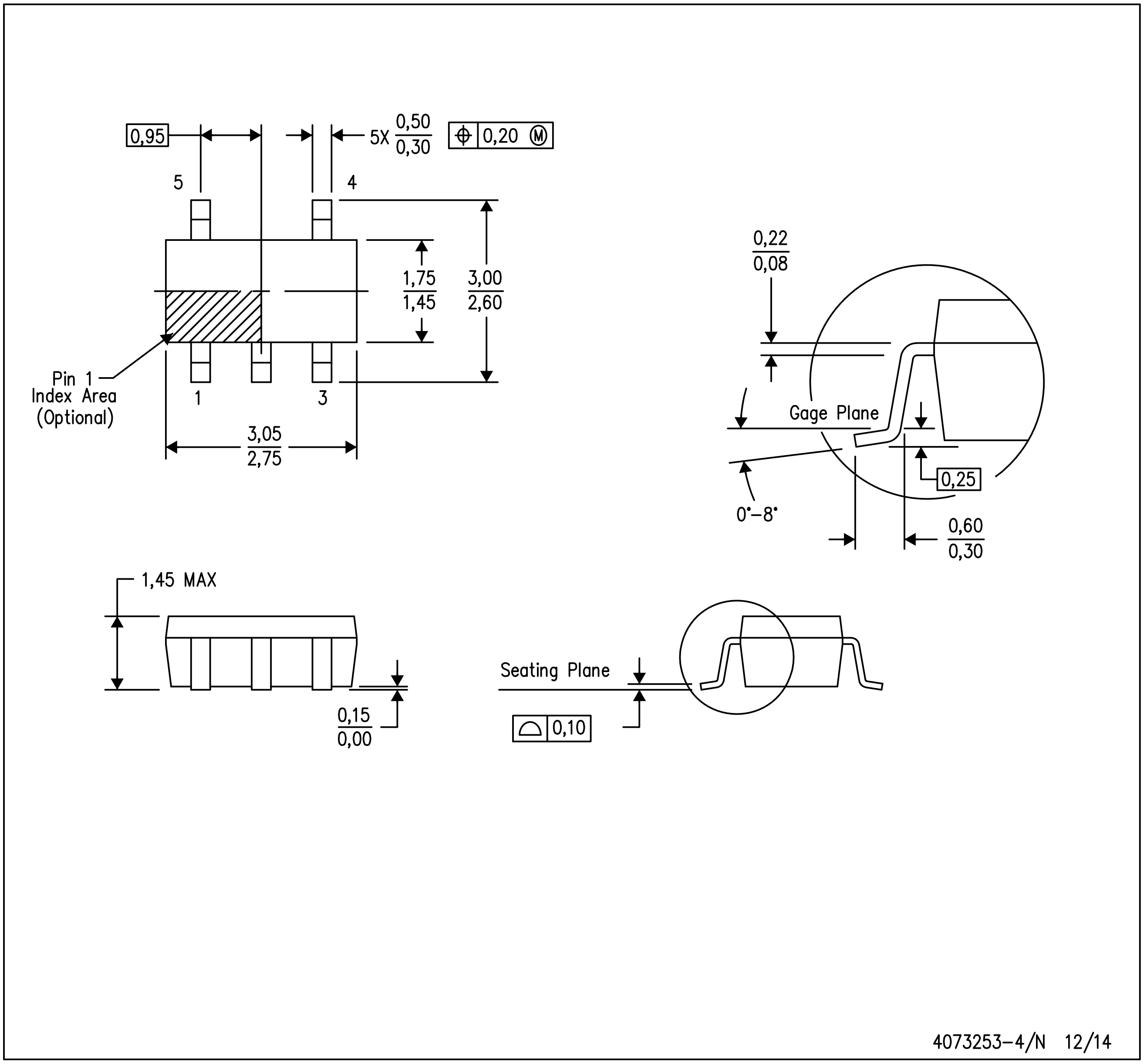
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

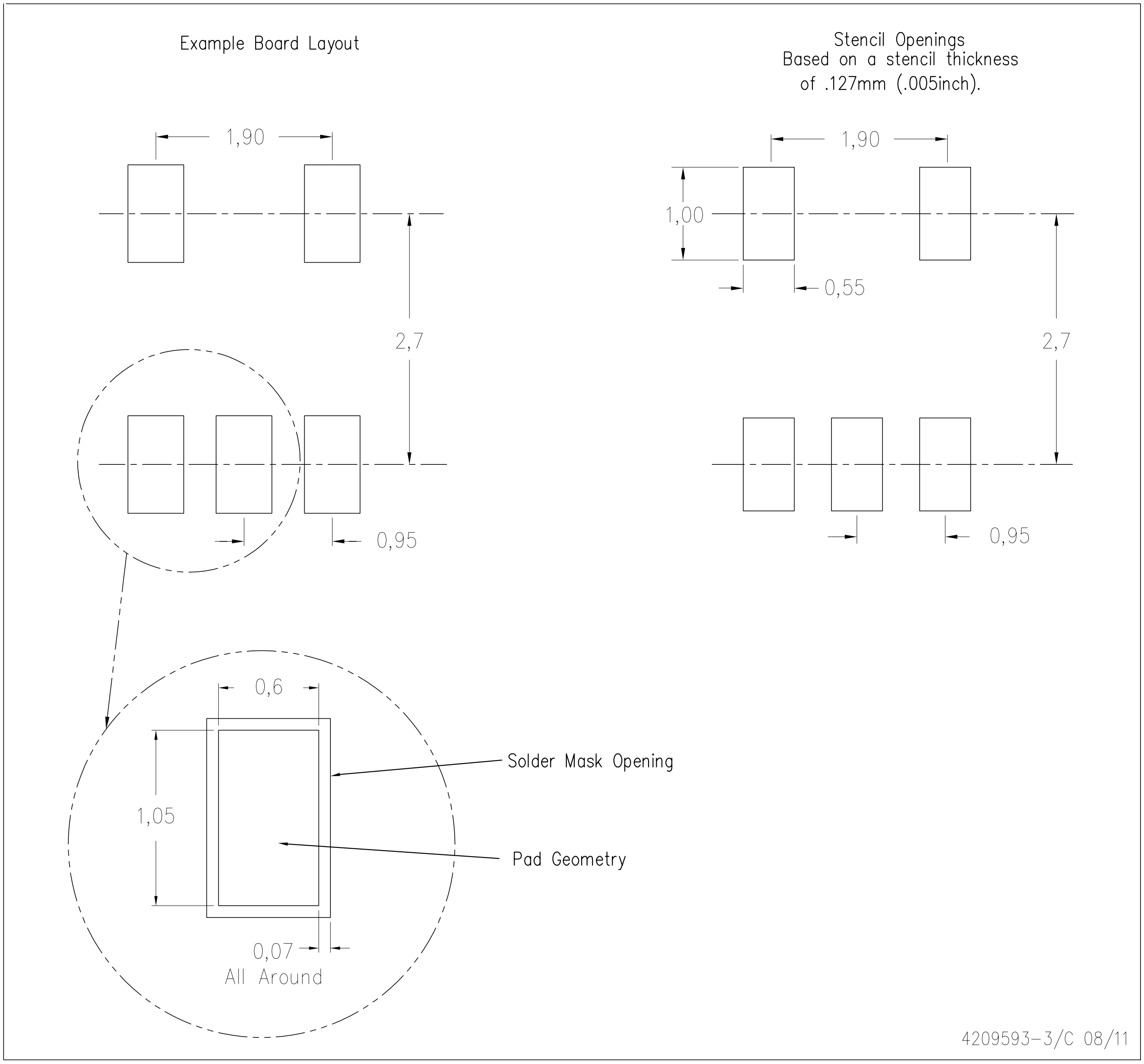
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS61097A-33DBVR	SOT-23	DBV	5	3000	202.0	201.0	28.0
TPS61097A-33DBVT	SOT-23	DBV	5	250	202.0	201.0	28.0

DBV (R-PDSO-G5) PLASTIC SMALL-OUTLINE PACKAGE



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

DBV (R-PDSO-G5) PLASTIC SMALL OUTLINE



NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
- D. Publication IPC-7351 is recommended for alternate designs.
- E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

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