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Evaluating the ADP5034 TSSOP Micro Power Management Unit (Micro PMU)

FEATURES

Full featured evaluation board for the ADP5034 TSSOP
Standalone capability
Simple device measurements, including line and load regulation, demonstrable with
- **A single voltage supply**
- **A voltmeter**
- **An ammeter**
- **Load resistors**

Easy access to external components
Cascading options to supply the low dropout (LDO) regulator from either buck regulator
Dedicated enable option for each channel
Mode option to change buck regulators from power save mode (PSM) to pulse-width modulation (PWM) operation

GENERAL DESCRIPTION

This user guide describes the hardware for the evaluation of the ADP5034 and includes detailed schematics and PCB layouts. The ADP5034 is available in either a 24-lead LFCSP package or a 28-lead TSSOP package. Note that this user guide refers to the ADP5034 TSSOP evaluation board, ADP5034RE-EVALZ. Refer to UG-271 for information on the ADP5034 LFCSP.

The ADP5034 TSSOP evaluation board has two step-down regulators with two LDO regulators that enable evaluation of the ADP5034. The evaluation board is available in an adjustable voltage option.

Full details on the ADP5034 are provided in the ADP5034 data sheet available from Analog Devices, Inc., which must be consulted in conjunction with this evaluation board user guide.

DIGITAL PICTURE OF THE ADP5034 TSSOP EVALUATION BOARD

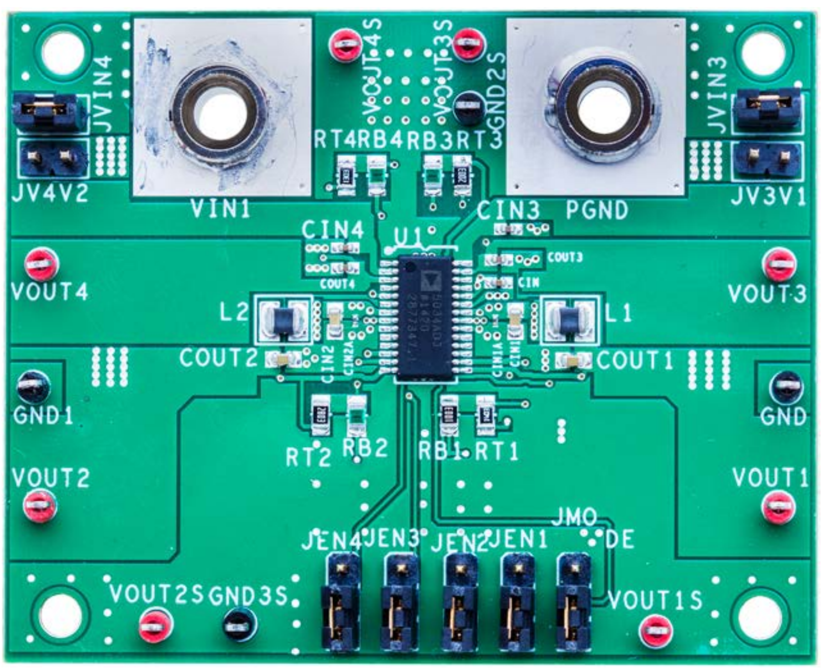

Figure 1.

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REVISION HISTORY

4/2017—Rev. 0 to Rev. A

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8/2012—Revision 0: Initial Version

USING THE EVALUATION BOARD

POWERING UP THE EVALUATION BOARD

The ADP5034 TSSOP evaluation board, ADP5034RE-EVALZ, is supplied fully assembled and tested. Before applying power to the evaluation board, follow the procedures in this section.

Enable

Each channel has its own enable pin (EN1, EN2, EN3, and EN4), which must be pulled high via the corresponding jumpers to enable that channel (see Table 1).

Table 1. Channels of the Enable Jumper

Channel	Enable Jumper
1	JEN1
2	JEN2
3	JEN3
4	JEN4

Jumper JMODE (MODE)

Jumper JMODE, as shown in Figure 1, connects the MODE pin of the device to either ground or VIN1. To force Buck 1 and Buck 2 into forced PWM operation, shunt the center contact of Jumper JMODE to the top pin header to pull the MODE pin high to VIN1. To allow Buck 1 and Buck 2 to operate in automatic PWM/PSM operation, shunt the center contact of JMODE to the bottom pin header to pull the MODE pin low to PGND on the ADP5034RE-EVALZ.

Input Power Source

If the input power source includes a current meter, use that meter to monitor the input current. VIN1 directly connects to AVIN and VIN2. Attach a header on JVIN3 to connect the supply of LDO1 to VIN1, and attach a header on JVIN4 to connect the supply of LDO2 to VIN1. Connect the positive terminal of the power source to VIN1 on the evaluation board and the negative terminal of the power source to PGND.

If the power source does not include a current meter, connect a current meter in series with the input source voltage. Connect the positive lead (+) of the power source to the ammeter positive (+) connection, the negative lead (−) of the power source to PGND on the evaluation board, and the negative lead (−) of the ammeter to VIN1 on the board. Be aware that the current meters add resistance to the input source, and this voltage reduces with high output currents.

Output Load

Connect an electronic load or resistor to set the load current. If the load includes an ammeter, or if the current is not measured, connect the load directly to the evaluation board, with the positive (+) load connected to one of the channels. For example, connect the Buck 1 output, VOUT1, and the negative (−) load connection to PGND.

If an ammeter is used, connect it in series with the load. Connect the positive (+) ammeter terminal to the evaluation board for Buck 1, VOUT1, the negative (−) ammeter terminal to the positive (+) load terminal, and the negative (−) load terminal to the evaluation board at PGND.

Input and Output Voltmeters

Measure the input and output voltages with voltmeters. Make sure to connect the voltmeters to the appropriate evaluation board terminals and not to the load or power sources themselves.

If the voltmeters are not connected directly to the evaluation board, the measured voltages are incorrect due to the voltage drop across the leads and/or connections between the evaluation board, the power source, and/or the load.

Connect the input voltage measuring voltmeter positive terminal (+) to the evaluation board at VIN1, and input voltage measuring voltmeter negative (−) terminal to the evaluation board at PGND.

Connect the output voltage measuring voltmeter positive (+) terminal to the evaluation board at VOUT1 to measure the output voltage of Buck 1, and connect the output voltage measuring voltmeter negative (−) terminal to the evaluation board at GND.

Turning On the Evaluation Board

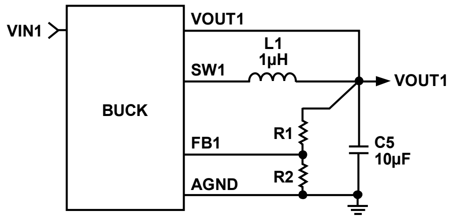
When the power source and load are connected to the evaluation board, the board can be powered for operation. Ensure the following:

- The power source voltage for the buck regulators (VIN1, VIN2) is from 2.3 V to 5.5 V.
- The power source voltage for the LDO regulators (VIN3, VIN4) is from the LDO output voltage + 0.5 V (or 1.7 V, whichever is greater) to 5.5 V.
- The voltage supplied on VIN3 and VIN4 must be equal to or less than the voltage supplied on VIN1 and VIN2.
- The desired channel is enabled and monitors the output voltage.

If the load is not enabled, enable the load; check that it is drawing the proper current and that the output voltage maintains voltage regulation.

Setting the Output Voltage of the Buck Regulators

The buck output voltage is set through external resistor dividers, shown in Figure 2 for Buck 1. The output voltage can optionally be factory programmed to default values as indicated in the data sheet. In this event, R1 and R2 are not needed, and FB1 can be left unconnected. In all cases, VOUT1 must be connected to the output capacitor. FB1 is 0.5 V.



$$V_{OUT1} = V_{FB1}\left(\frac{R1}{R2} + 1\right)$$

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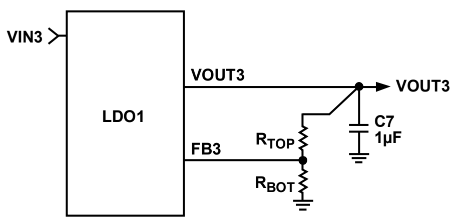
Figure 2. BUCK1 External Output Voltage Setting

Setting the Output Voltage of the LDO Regulators

Each LDO output voltage is set through external resistor dividers, as shown in Figure 3, for LDO1. The output voltage can optionally be factory programmed to default values as indicated in the ADP5034 data sheet. In this event, FB3 must be connected to the top of the capacitor on VOUT3 by placing a 0 Ω resistor on R_{TOP}, and leave R_{BOT} unpopulated. Refer to Table 2 for the corresponding 0 Ω resistor placements on R_{TOP} per channel.



$$V_{OUT1} = V_{FB3}\left(\frac{R1}{R2} + 1\right)$$

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Figure 3. LDO1 External Output Voltage Setting

External Resistor Divider Setting for Buck and LDO Regulators

The ADP5034 TSSOP evaluation boards are supplied with fixed resistor dividers with values chosen for a target output voltage. Varying the resistor values of the resistor divider networks varies the output voltage accordingly.

Table 2. External Resistor Dividers

Resistor Divider	Buck 1	Buck 2	LDO1	LDO2
R_{TOP}	RT1	RT2	RT3	RT4
R_{BOT}	RB1	RB2	RB3	RB4

MEASURING EVALUATION BOARD PERFORMANCE

Measuring Output Voltage Ripple of Buck Regulators

To observe the output voltage ripple of Buck 1, place an oscilloscope probe across the output capacitor (COUT1) with the probe ground lead at the negative (−) capacitor terminal and the probe tip at the positive (+) capacitor terminal.

Set the oscilloscope to ac, 10 mV/division, and 2 µs/division time base, with the bandwidth set to 20 MHz to prevent noise from interfering with the measurements. It is also recommended to shorten the ground loop of the oscilloscope probe to minimize coupling. One way of measuring the output voltage ripple is to solder a wire to the negative (−) capacitor terminal and wrap it around the barrel of the probe, while the tip directly connects to the positive (+) capacitor terminal, as shown on Figure 4.

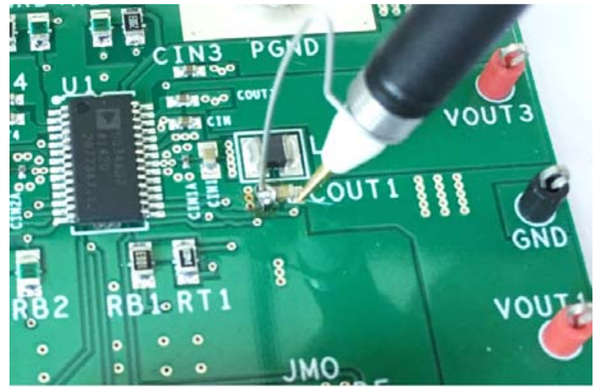

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Figure 4. Measuring Output Voltage Ripple

Measuring the Switching Waveform of Buck Regulators

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at the end of the inductor with the probe ground at GND. Set the oscilloscope to dc, 2 V/division, and 200 ns/division time base. When the MODE pin is set to high, the buck regulators operate in forced PWM mode. When the MODE pin is set to low and the load is above a predefined threshold, the buck regulators operate in PWM mode. When the load current falls below a predefined threshold, the regulator operates in PSM, improving the light load efficiency. Typical PWM and PSM switching waveforms are shown in Figure 5 and Figure 6.

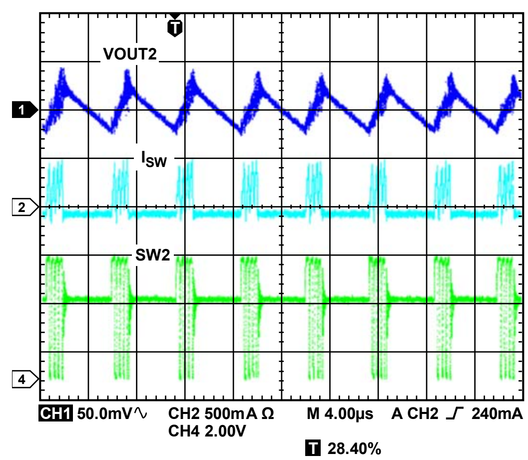

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Figure 5. Typical Waveforms, V_{OUT2} = 3.3 V, I_{OUT2} = 30 mA, PSM Mode

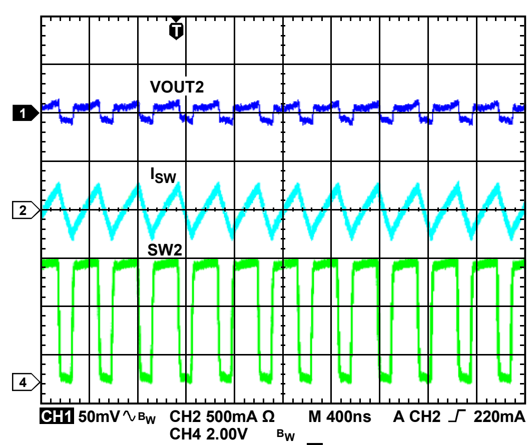

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Figure 6. Typical Waveforms, V_{OUT2} = 3.3 V, I_{OUT2} = 30 mA, PWM Mode

Measuring Load Regulation of the Buck Regulator

Test the load regulation by increasing the load at the output and examining the change in output voltage. The input voltage must be held constant during this measurement. To minimize voltage drop, use short low resistance wires, especially for loads approaching maximum current. The buck regulator load regulation plots for V_{OUT2} = 3.3 V and V_{OUT2} = 1.8 V are shown in Figure 7 and Figure 8, respectively.

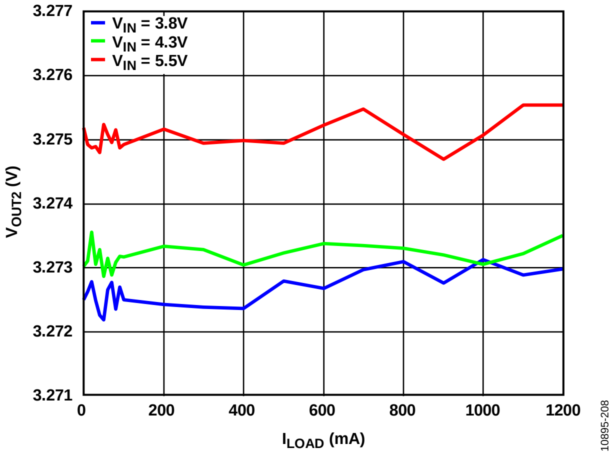

Figure 7. Buck Load Regulation, V_{OUT2} = 3.3 V

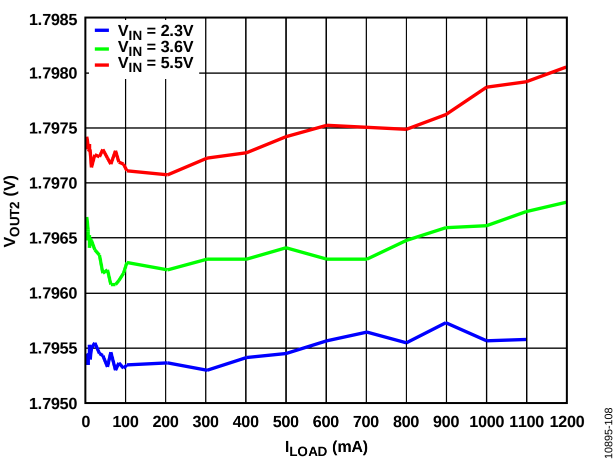

Figure 8. Buck Load Regulation, V_{OUT2} = 1.8 V

Measuring Line Regulation of the Buck Regulator

Test the line regulation by increasing the input voltage and examining the change in the output voltage. The buck regulator line regulation plots for V_{OUT2} = 3.3 V and V_{OUT2} = 1.8 V are shown in Figure 9 and Figure 10, respectively.

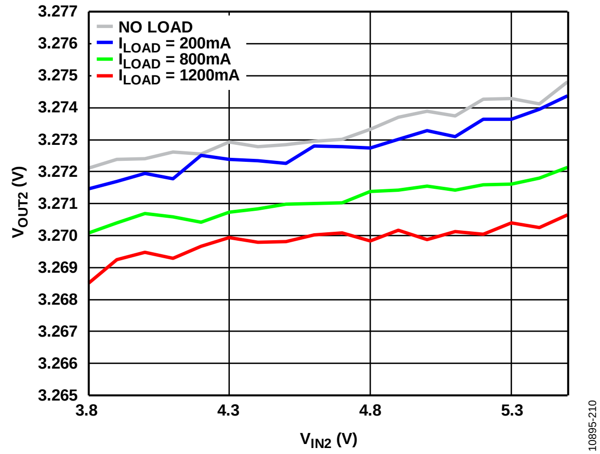

Figure 9. Buck Regulator Line Regulation, V_{OUT2} = 3.3 V

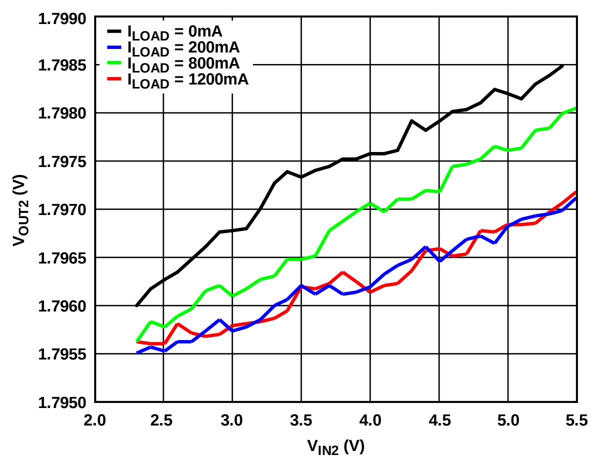

Figure 10. Buck Regulator Line Regulation, V_{OUT2} = 1.8 V

Measuring Efficiency of the Buck Regulator

Measure the efficiency, η, by comparing the input power with the output power.

$$\eta = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}}$$

Measure the input and output voltages as close as possible to the input and output capacitors to reduce the effect of IR drops.

The buck regulator efficiency plots for V_{OUT2} = 3.3 V and V_{OUT2} = 1.8 V are shown in Figure 11 and Figure 12, respectively.

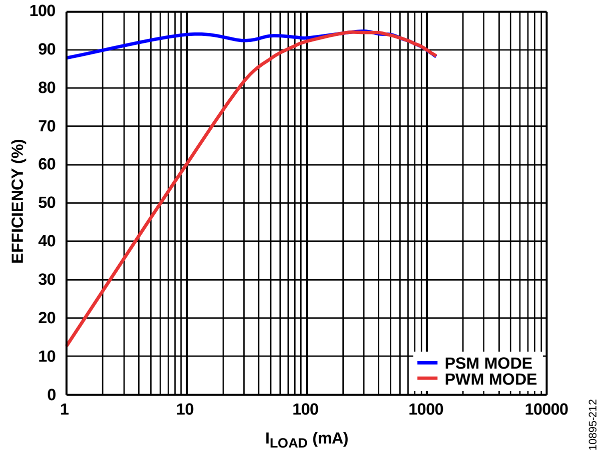

Figure 11. Buck Regulator Efficiency, V_{IN2} = 4.2 V, V_{OUT2} = 3.3 V

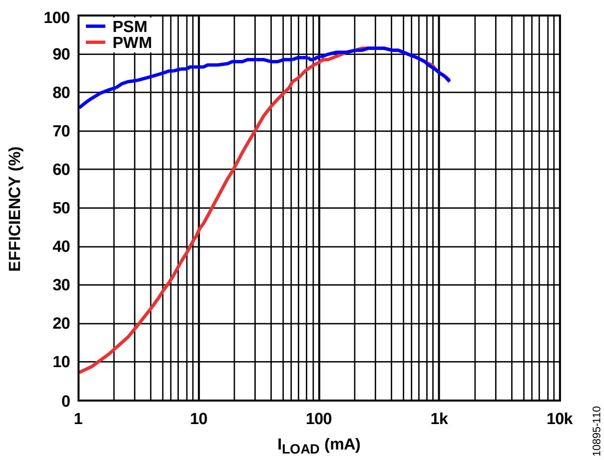

Figure 12. Buck Regulator Efficiency, V_{IN2} = 3.6 V, V_{OUT2} = 1.8 V

Measuring Inductor Current

Measure the inductor current by removing one end of the inductor from its pad and connecting a current loop in series. Connect a current probe to this wire.

Measuring Line Regulation of LDO Regulators

For line regulation measurements, the output of the regulator is monitored while its input is varied. For optimal line regulation, the output must change as little as possible with varying input levels.

To ensure that the device is not in dropout mode during this measurement, V_{IN} must be varied between V_{OUT} nominal + 0.5 V (or 2.3 V, whichever is greater) and V_{IN} maximum. For example, a fixed 3.3 V output needs V_{IN} to be varied between 3.8 V and 5.5 V. This measurement can be repeated under different load conditions. Figure 13 shows the typical line regulation performance of the LDO regulator with a fixed 3.3 V output.

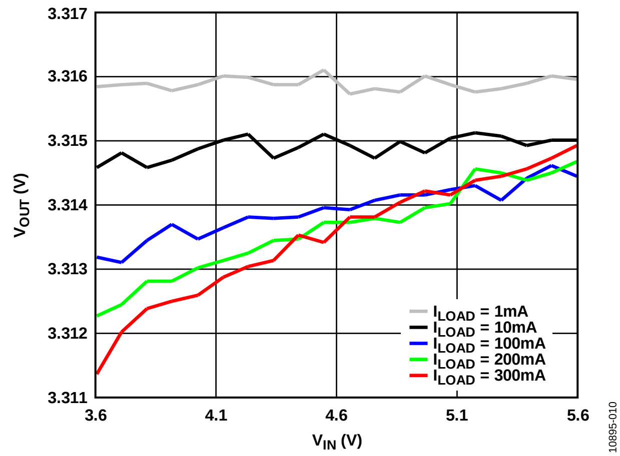

Figure 13. V_{OUT} vs. V_{IN}, LDO Line Regulation for an Output of 3.3 V

Measuring Load Regulation of LDO Regulators

For load regulation measurements, the regulator output is monitored while the load is varied. For optimal load regulation, the output must change as little as possible with varying loads. The input voltage must be held constant during this measurement. The load current can be varied from 0 mA to 300 mA. Figure 14 shows the typical load regulation performance of the LDO regulator with a 3.3 V output for different input voltages.

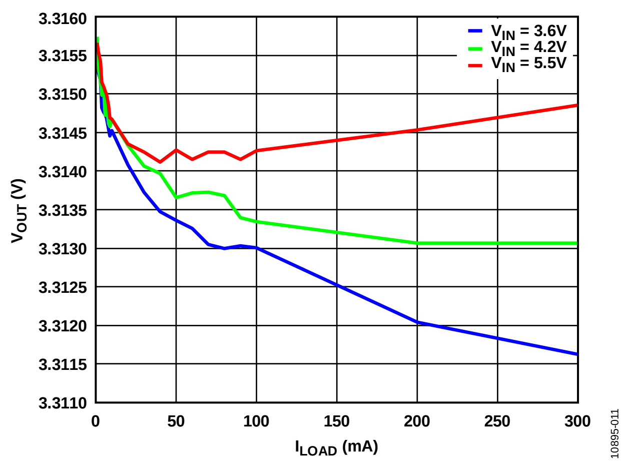

Figure 14. V_{OUT} vs. I_{LOAD}, LDO Load Regulation

Measuring Dropout Voltage of LDO Regulators

Dropout voltage is defined as the input-to-output voltage differential when the input voltage is set to the nominal output voltage. One way to measure dropout voltage is to obtain the output voltage (V_{OUT} nominal) with V_{IN} initially set to V_{OUT} nominal + 0.5 V; set the output load to 100 µA. Then, force the input voltage equal to V_{OUT} nominal, and measure the output voltage accordingly (V_{OUT} dropout). Dropout voltage is then calculated as V_{OUT} nominal − V_{OUT} dropout. This calculation applies only for output voltages greater than 1.7 V.

Dropout voltage increases with larger loads. For more accurate measurements, use a second voltmeter to monitor the input voltage across the input capacitor. The input supply voltage may need to be adjusted to account for IR drops, especially if large load currents are used.

Cascading an LDO Regulator from the Buck Regulator

For certain applications such as analog circuit supplies, the LDO regulators are preferred over the buck regulators because of improved noise performance. When none of the buck regulator outputs are being used, the input supply of the LDO regulators can be taken from these outputs. An example evaluation board connection is shown in Figure 15, wherein VOUT1 is tied to VIN3, which is the supply of LDO1, by shunting Jumper JV3V1. Subsequently, VIN4, which is the supply of LDO2 can also be connected to VOUT2 through Jumper JV4V2. In this configuration, the output voltage of the buck regulator has enough headroom with the desired output voltage of the LDO regulator to guarantee that the LDO regulator operates within specifications.

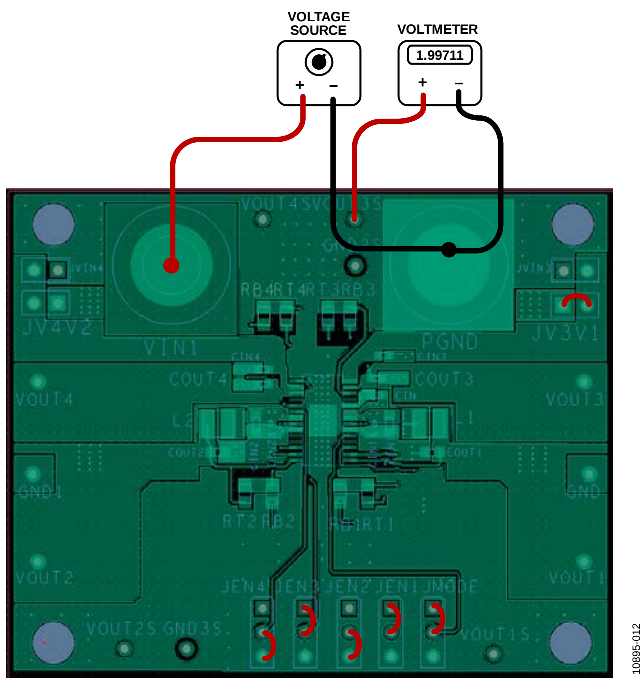

Figure 15. Cascading an LDO Regulator from the Buck Regulator

MEASURING OUTPUT VOLTAGE

Figure 16 shows how the evaluation board can be connected to a voltage source and a voltmeter for basic output voltage accuracy measurements. It shows a voltage source connected to VIN1 and a voltmeter connected to VOUT1S, which is the output voltage sense terminal of Buck 1. JEN1 is connected to VIN1 via a shunt that enables Buck 1; JEN2, JEN3, and JEN4 are connected to ground, disabling the other channels.

When measuring the voltages on VOUT2, VOUT3, and VOUT4, ensure that the respective channels are enabled, and the volt meters are connected to the respective outputs. A resistor can be used as the load for the regulator. Ensure that the resistor has a power rating adequate to handle the power expected to be dissipated across it. An electronic load can also be used as an alternative. Ensure that the voltage source supplies enough current for the expected load levels.

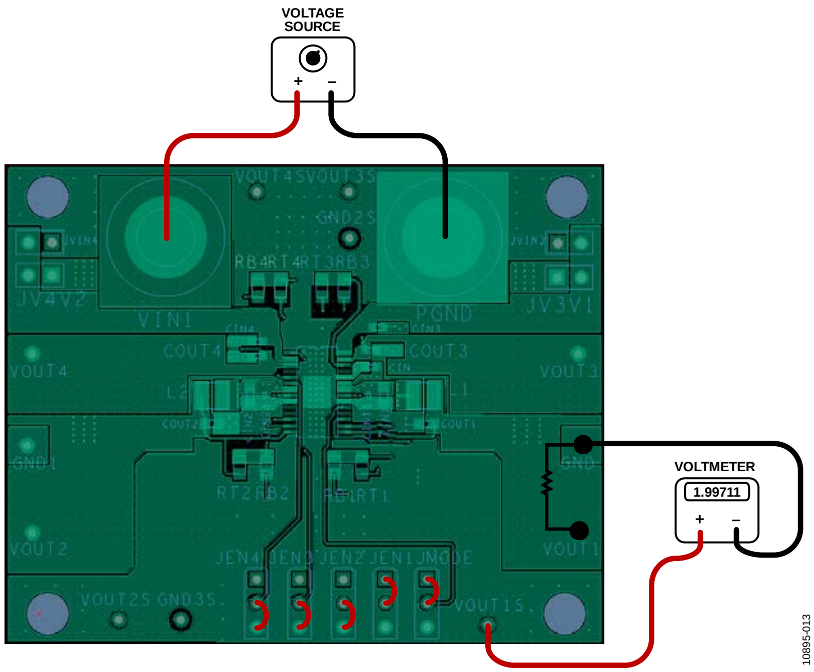

Figure 16. Output Voltage Measurement

MEASURING GROUND CURRENT

MEASURING GROUND CURRENT CONSUMPTION OF LDO REGULATORS

Ground current measurements can determine how much current the internal circuits of the regulator consume while the circuits perform the regulation function. To be efficient, the regulator needs to consume as little current as possible. Typically, the regulator uses the maximum current when supplying its largest load level (300 mA). When the device is disabled, the ground current drops to less than 1 µA.

Figure 17 shows the evaluation board connected to a voltage source and an ammeter for ground current measurements. A resistor can be used as the load for the regulator.

Ensure that the resistor has a power rating that is adequate to handle the power expected to be dissipated across it. An electronic load can be used as an alternative. Ensure that the voltage source can supply enough current for the expected load levels.

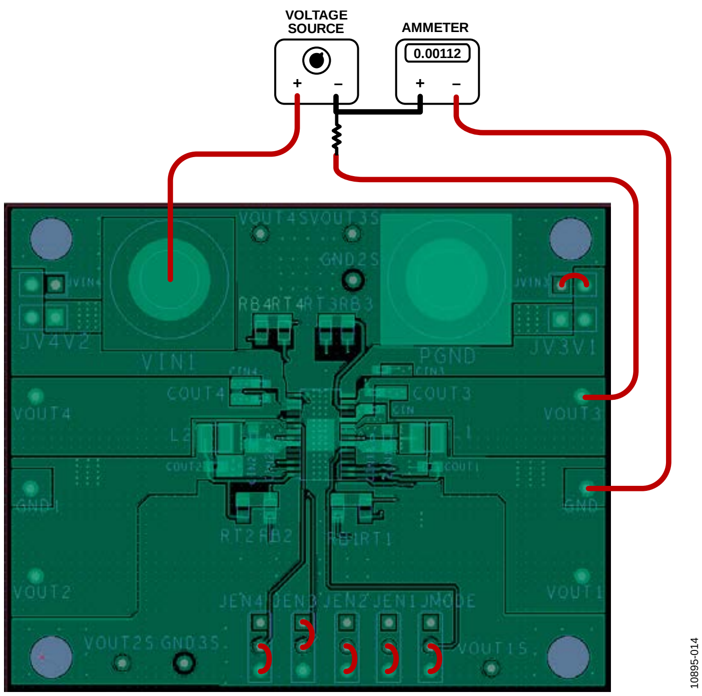

Figure 17. Ground Current Measurement

EVALUATION BOARD SCHEMATIC AND ARTWORK

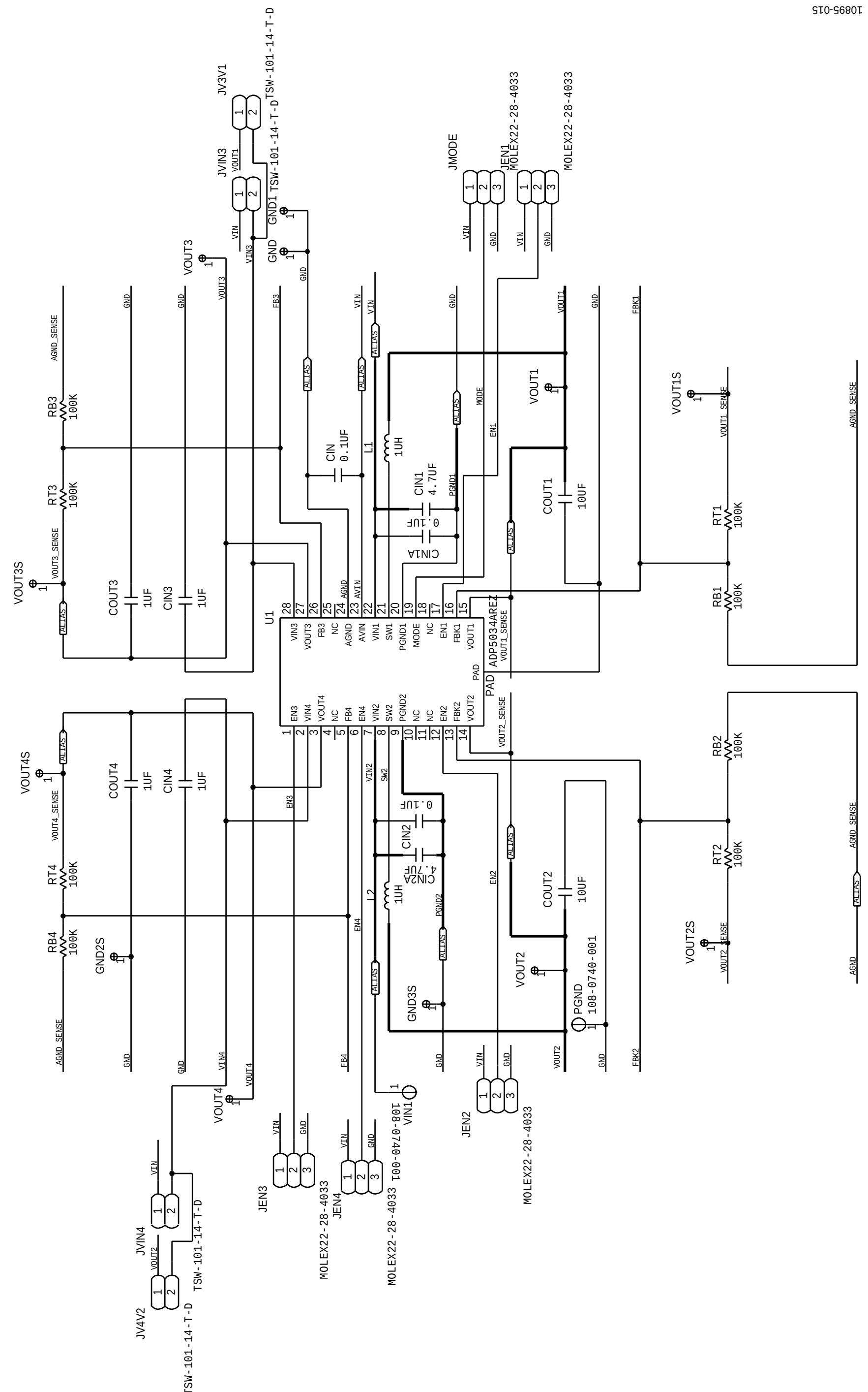

Figure 18. Evaluation Board Schematic of the ADP5034 TSSOP

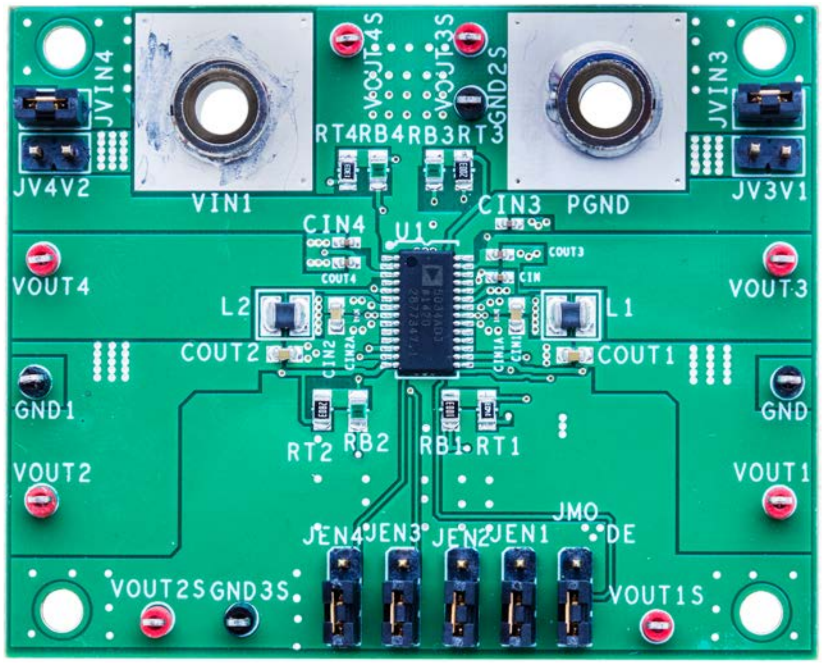

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Figure 19. Evaluation Board of the ADP5034 TSSOP

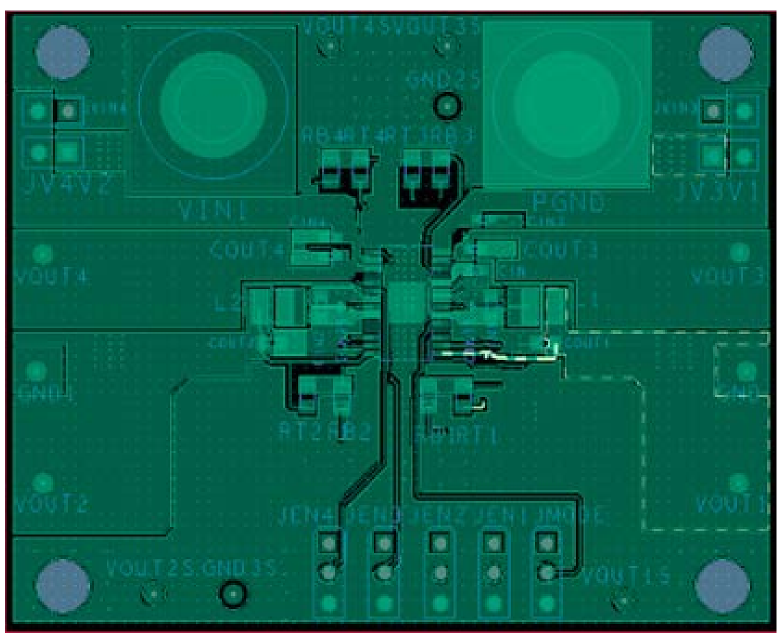
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Figure 20. Top Layer, Recommended Layout for ADP5034 TSSOP

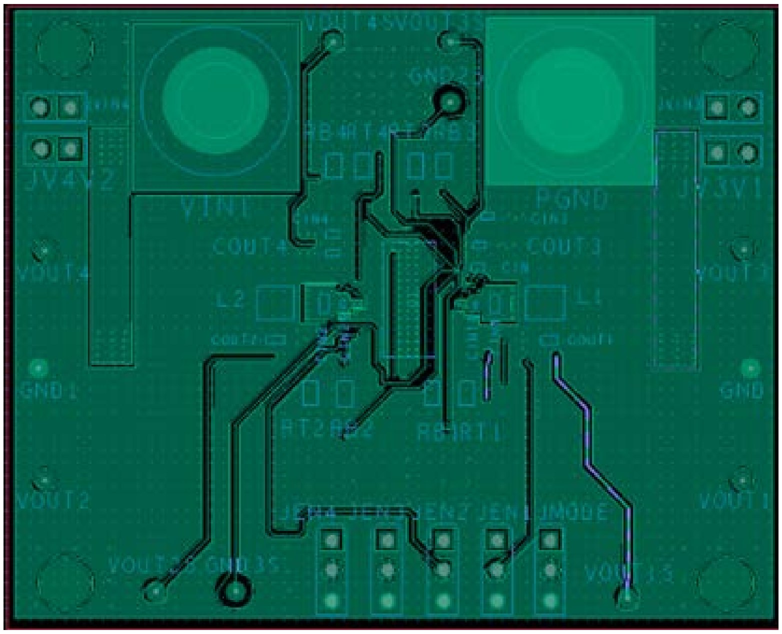

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Figure 21. Bottom Layer, Recommended Layout for ADP5034 TSSOP

ORDERING INFORMATION

BILL OF MATERIALS

Table 3.

Qty.	Reference Designator	Description	Manufacturer	Part Number
1	U1	Micro PMU	Analog Devices	ADP5034
2	CIN1, CIN2	Capacitor, MLCC, 4.7 µF	Murata	GRM188R60J475ME19D
4	CIN3, CIN4, COUT3, COUT4	Capacitor, MLCC, 1.0 µF	Murata	GRM155R61A105KE15D
2	COUT_2, COUT_1	Capacitor, MLCC, 10.0 µF	Murata	GRM188R60J106ME47D
1	CIN	Capacitor, MLCC, 0.1 µF	Taiyo Yuden	GMK105BJ104MV-F
2	CIN1A, CIN2A	Capacitor, MLCC, 0.1 µF	Taiyo Yuden	LMK063BJ10KPF
2	L1, L2	Inductor, 1.0 µH	Murata	LQM2HPN1R0MJ0L
1	RT1	Resistor, 0805, 140 kΩ	Vishay	TNPW0805140KBEEA
1	RT2	Resistor, 0805, 280 kΩ	Vishay	TNPW0805280KBEEA
1	RT3	Resistor, 0805, 200 kΩ	Vishay	TNPW0805200KBEEA
1	RT4	Resistor, 0805, 130 kΩ	Vishay	TNPW0805130KBEEA
1	RB1	Resistor, 0805, 100 kΩ	Vishay	TNPW0805100KBEEA
3	RB2, RB3, RB4	Resistor, 0805, 50 kΩ	Vishay	PNM0805E5002BST5

RELATED LINKS

Resource	Description
ADP5023	Dual 3 MHz, 800 mA Buck Regulator with One 300 mA LDO
ADP5024	Dual 3 MHz, 1200 mA Buck Regulators with One 300 mA LDO
ADP5034	Dual 3 MHz, 1200 mA Buck Regulator with Two 300 mA LDOs
ADP5037	Dual 3 MHz, 800 mA Buck Regulators with Two 300 mA LDOs
UG-271	Evaluation Board User Guide for ADP5034 LFCSP

UG10895-0-4/17(A)

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