

## Evaluating the **ADP5304** Ultralow Step-Down Regulator

### FEATURES

Ultralow quiescent current  
Input voltage monitoring  
Few external components and compact solution size  
AC and dc input source available

### EQUIPMENT NEEDED

**ADP5304** evaluation board  
Power supply  
Function generator  
Electronic load  
Multimeter

### DOCUMENTS NEEDED

**ADP5304** data sheet  
**ADP5304-EVALZ** user guide

### GENERAL DESCRIPTION

The **ADP5304** is an ultralow power, synchronous step-down dc-to-dc regulator in a 10-lead LFCSP package. The **ADP5304** runs from input voltages of 2.15 V to 6.50 V and requires minimal external components to provide a high efficiency solution with an integrated power switch, synchronous rectifier, and internal compensation.

The **ADP5304** evaluation board with full bridge rectifier can support both an ac and dc voltage power source and regulate the input voltage as a maximum power point as the preset VINOK threshold.

The **ADP5304** evaluation board provides an easy way to evaluate the device. This user guide describes how to quickly set up the board to collect performance data.

Complete information about the **ADP5304** is available in the **ADP5304** data sheet, which should be consulted in conjunction with this user guide when using the evaluation board.

### **ADP5304** EVALUATION BOARD

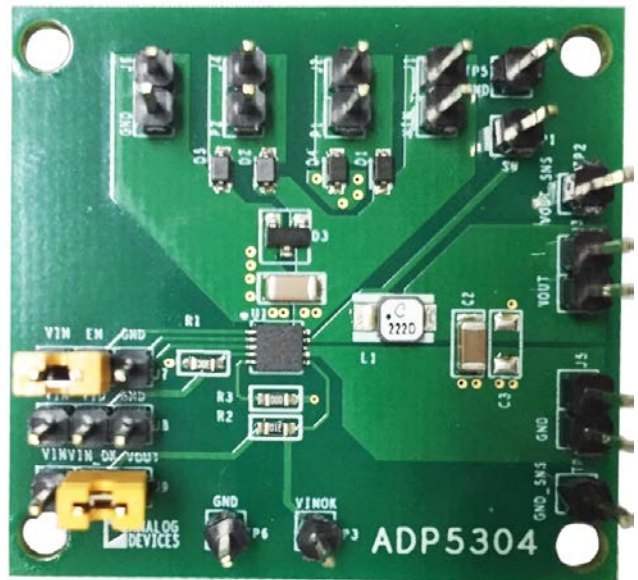


Figure 1.

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**REVISION HISTORY**

12/15—Revision 0: Initial Version

## SETTING UP THE EVALUATION BOARD

### POWERING UP THE EVALUATION BOARD

The [ADP5304](#) evaluation board is fully assembled and tested. Before applying power to the evaluation board, follow the setup procedures in this section.

#### Jumper Settings

Table 1 describes the jumper settings. Before selecting the jumper settings, ensure the enable input, EN, is high.

Table 1. Jumper Settings

Jumper	State or Connection	Function
J7 (EN)	High	Enable VOUT
	Low	Disable VOUT
J8 (VID)	VIN	2.5 V
	GND	3 V
	Floating	Program VOUT by external resistor
J9 (VIN_OK)	VIN	Pull VINOK to VIN
	VOUT	Pull VINOK to VOUT

#### High Impedance DC Voltage Power Source Connection

Before connecting a power source to the [ADP5304](#) evaluation board, ensure the board is turned off. If the input power source includes a current meter, use the meter to monitor the input current as follows:

1. Connect the positive terminal of the power source to the VIN terminal (J1) on the evaluation board.
2. Connect the negative terminal of the power source to the GND terminal (J5) on the board.

If the power source does not include a current meter, connect a current meter in series with the input source voltage as follows:

1. Connect the positive terminal of the power source to the positive terminal of the current meter.
2. Connect the negative terminal of the power source to the GND terminal (J5) on the evaluation board.
3. Connect the negative terminal of the current meter to the VIN terminal (J1) on the evaluation board.

#### Output Load Connection

Before connecting the load to the [ADP5304](#) evaluation board, ensure the board is turned off. If the load includes a current meter or if the current is not measured, connect the load directly to the evaluation board as follows:

1. Connect the positive load connection to the VOUT terminal (J3).
2. Connect the negative load connection to the GND terminal (J6).

If a current meter is used, connect it in series with the load as follows:

1. Connect the positive terminal of the current meter to the VOUT (J3) terminal on the evaluation board.
2. Connect the negative terminal of the current meter to the positive terminal of the load.
3. Connect the negative terminal of the load to the GND terminal (J6) on the evaluation board.

#### Input and Output Voltmeter Connections

Measure the input and output voltages with voltmeters. Ensure the voltmeters connect to the appropriate test points on the evaluation board. If the voltmeters are not connected to the correct test point, the measured voltages may be incorrect due to the voltage drop across the leads or due to the connections between the board, the power source, and/or the load.

1. Connect the positive terminal of the voltmeter measuring the input voltage to the TP2 test point on the board.
2. Connect the negative terminal of the voltmeter measuring the input voltage to the TP4 test point on the board.

#### High impedance AC Voltage Power Source Connection

The ac voltage power source can connect to the J2 and J4 input terminals of the [ADP5304](#) evaluation board. Ensure the voltage at the J1 terminal does not exceed 6.5 V even though the Zener diode (D3) clamps the voltage to 6.5 V.

#### Power On the Evaluation Board

When the power source and load are connected to the [ADP5304](#) evaluation board, the board can power on. If the voltage at VIN is above the VINOK rising threshold, the output voltage rises to 1.8 V by default. The [ADP5304](#) stops switching when the voltage at VIN is below the VINOK falling threshold. If the input energy is weak, the input voltage regulates at the typical value 3.0 V.

## MEASURING PERFORMANCE OF THE EVALUATION BOARD

#### Measuring the Switching Waveform

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at the TP1 and TP5 test points with the probe ground connected to GND. Set the oscilloscope to a dc coupling, 2 V/division, 1  $\mu$ s/division time base. The switching waveform alternates between 0 V and the approximate input voltage.

#### Measuring Load Regulation

Test load regulation by increasing the load at the output and measuring the output voltage between the TP2 and TP4 test points.

**Measuring Line Regulation**

Vary the input voltage and measure the output voltage at a fixed output current. The input voltage can be measured between J1 and J5 terminals. The output voltage is measured between the TP2 and TP4 test points.

**Measuring Efficiency**

The efficiency,  $\eta$ , is measured by comparing the input power with the output power.

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

**Measuring Inductor Current**

Measure the inductor current can by removing one end of the inductor from the pad on the board and using a wire connected between the pad and the inductor. Use a current probe to measure the inductor current through the wire.

**Measuring Output Voltage Ripple**

To observe the output voltage ripple, place an oscilloscope probe across the C2 and C3 output capacitors with the probe ground lead placed at the negative capacitor terminal and the probe tip placed at the positive capacitor terminal. Set the oscilloscope to an ac coupling, 10 mV/division, 2  $\mu$ s/division time base and 20 MHz bandwidth.

A standard oscilloscope probe has a long wire ground clip. For high frequency measurements, this ground clip picks up high frequency noise and injects it into the measured output ripple.

**Output Voltage Change**

The output voltage of the [ADP5304](#) evaluation board is preset to 1.8 V. However, the output voltage can be adjusted using a different resistor at the VID pin and restarting the power-on sequence.

# EVALUATION BOARD SCHEMATIC AND ARTWORK

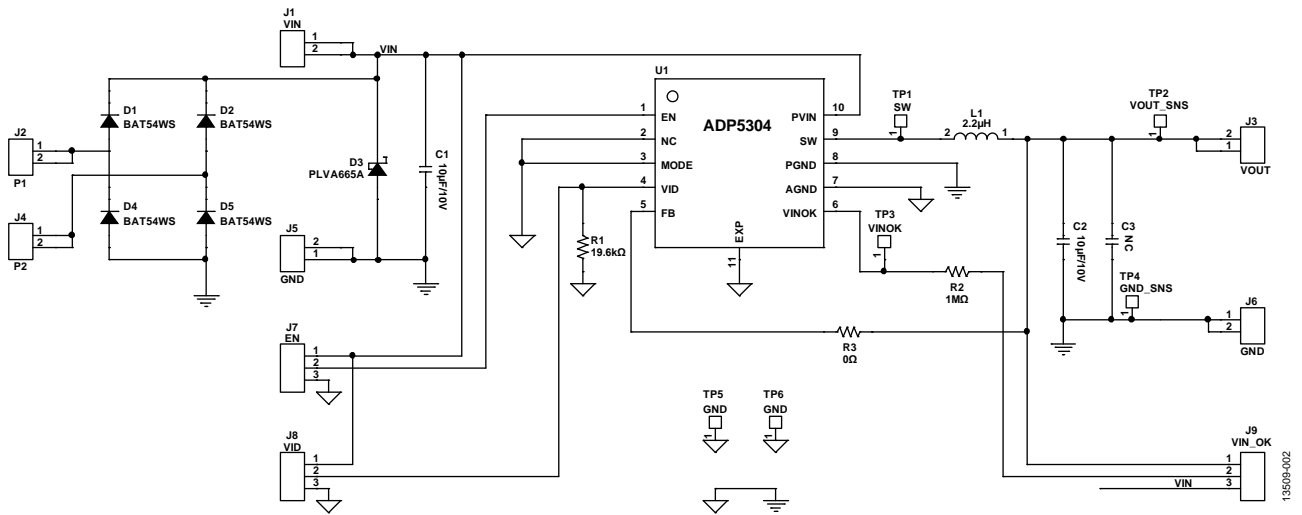


Figure 2. Schematic of the ADP5304 Evaluation Board

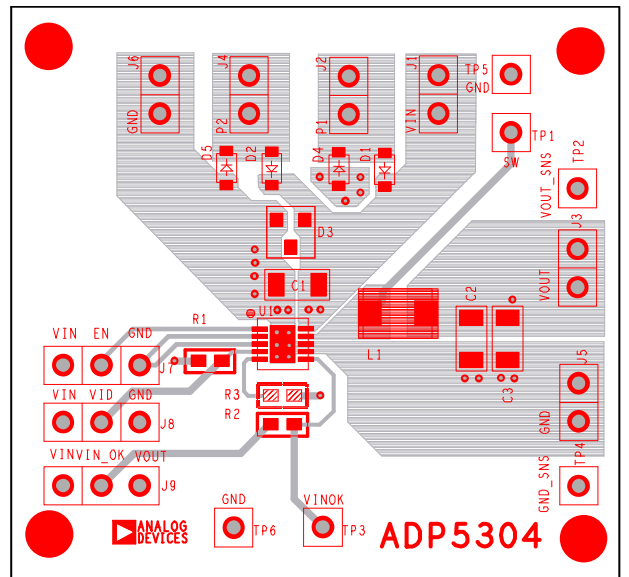


Figure 3. Top Layer

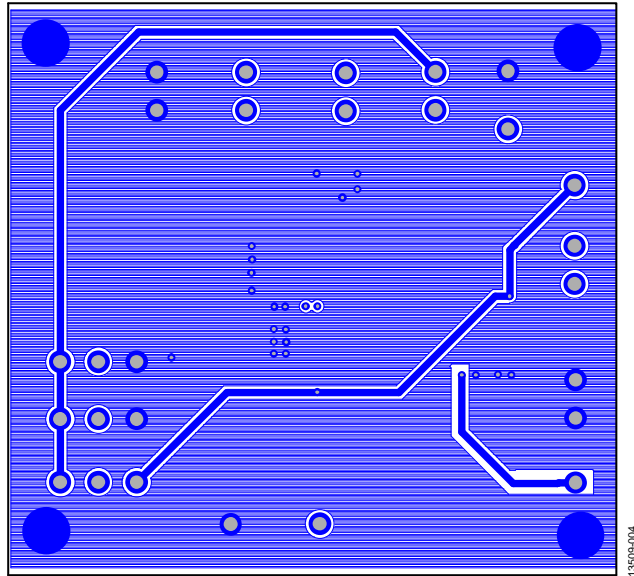


Figure 4. Bottom Layer

## ORDERING INFORMATION

### BILL OF MATERIALS

Table 2. ADP5304 Evaluation Board Bill of Materials

Qty	Reference Designator	Description	Part Number	Printed Circuit Board Footprint	Manufacturer
2	C1, C2	10 $\mu$ F/10 V	GRM31CR71A106KA01	C1206	Murata
1	C3	Not connected	Not applicable	C1206	Not applicable
4	D1, D2, D4, D5	Schottky barrier diode	BAT54WS-7-F	SOD-323	Diodes
1	D3	Low voltage avalanche regulator diode	PLVA665A	SOT23	NXP
1	J1	VIN	M20-9990245	SIP2	Harwin
1	J2	P1	M20-9990245	SIP2	Harwin
1	J3	VOUT	M20-9990245	SIP2	Harwin
1	J4	P2	M20-9990245	SIP2	Harwin
2	J5, J6	GND	M20-9990245	SIP2	Harwin
1	J7	EN	M20-9990246	SIP3	Harwin
1	J8	VID	M20-9990246	SIP3	Harwin
1	J9	VIN_OK	M20-9990246	SIP3	Harwin
1	L1	2.2 $\mu$ H	LPS3015-222MR	Inductor45x32	Coilcraft
		2.2 $\mu$ H	74438334022	Inductor45x32	Wurth Elektronik
1	R1	19.6 k $\Omega$	CRCW060319K6FKEA	R0603	Vishay Dale
1	R2	1 M $\Omega$	CRCW06031M00FKEA	R0603	Vishay Dale
1	R3	0 $\Omega$	CRCW06030000FKEA	R0603	Vishay Dale
1	TP1	SW	M20-9990245	SIP1	Harwin
1	TP2	VOUT_SNS	M20-9990245	SIP1	Harwin
1	TP3	VINOK	M20-9990245	SIP1	Harwin
1	TP4	GND_SNS	M20-9990245	SIP1	Harwin
2	TP5, TP6	GND	M20-9990245	SIP1	Harwin
1	U1	ADP5304	ADP5304ACPZ-1-R7	QFN10_3x3	Analog Devices, Inc.



#### ESD Caution

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

#### Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.