

Evaluation Board for the **ADP2164** Step-Down Regulator

GENERAL DESCRIPTION

The **ADP2164** is a synchronous, step-down dc-to-dc regulator in a compact, 4 mm × 4 mm LFCSP package. The **ADP2164** requires minimal external components to provide a high efficiency solution with integrated power switch, synchronous rectifier, and internal compensation. The input voltage range of the **ADP2164** is 2.7 V to 6.5 V.

The **ADP2164** 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 **ADP2164** is available in the **ADP2164** data sheet, which should be consulted in conjunction with this user guide when using the evaluation board.

DIGITAL PICTURE OF THE EVALUATION BOARD



Figure 1.

TABLE OF CONTENTS

General Description	1	Typical Performance Characteristics	5
Digital Picture of the Evaluation Board.....	1	Evaluation Board Schematics.....	6
Revision History	2	Evaluation Board Layout	7
Setting Up the Evaluation Board	3	Ordering Information	8
Powering Up the Evaluation Board.....	3	Bill of Materials.....	8
Measuring Evaluation Board Performance.....	4		

REVISION HISTORY

1/12—Revision 0: Initial Version

SETTING UP THE EVALUATION BOARD

POWERING UP THE EVALUATION BOARD

The [ADP2164](#) 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, make sure that the enable input, EN, is high.

Table 1. Jumper Settings

Jumper	State or Connection	Function
J2 (EN)	High Low	Enable output voltage Disable output voltage
J4 (SYNC)	High or low External clock	Force PWM Synchronize to the external clock
J7 (RT)	High Low External resistor	Set frequency to 1.2 MHz Set frequency to 600 kHz Set frequency from 500 kHz to 1.4 MHz
J10 (TRK)	High External voltage	Tracking function not used Tracking with the external voltage

Input Power Source Connection

Before connecting the power source to the [ADP2164](#) evaluation board, make sure that 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 (J3) on the evaluation board.
2. Connect the negative terminal of the power source to the GND terminal (J6) on the evaluation 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 (J6) on the evaluation board.
3. Connect the negative terminal (–) of the current meter to the VIN terminal (J3) on the evaluation board.

Output Load Connection

Before connecting the load to the [ADP2164](#) evaluation board, make sure that 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 terminal (+) of the load to the VOUT terminal (J9) on the evaluation board.
2. Connect the negative terminal (–) of the load to the GND terminal (J12) on the evaluation board.

If a separate 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 terminal (J9) 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 (J12) on the evaluation board.

Input and Output Voltmeter Connections

Measure the input and output voltages with voltmeters. Make sure that the voltmeters are connected to the appropriate test points on the board. If the voltmeters are not connected to the correct test points, 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 input voltage measuring voltmeter to Test Point T1 on the evaluation board.
2. Connect the negative terminal (–) of the input voltage measuring voltmeter to Test Point T2 on the board.
3. Connect the positive terminal (+) of the output voltage measuring voltmeter to Test Point T3 on the board.
4. Connect the negative terminal (–) of the output voltage measuring voltmeter to Test Point T5 on the board.

Power On the Evaluation Board

When the power source and load are connected to the [ADP2164](#) evaluation board, the board can be powered on. If the input power source is above 2.7 V, the output voltage rises to 1.2 V by default.

MEASURING EVALUATION BOARD PERFORMANCE

Measuring the Switching Waveform

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at Test Point T4 with the probe ground connected to GND. Set the oscilloscope to a dc coupling, 2 V/division, 1 μ s/division time base. The switching waveform should alternate between 0 V and the approximate input voltage.

Measuring Load Regulation

Load regulation should be tested by increasing the load at the output and measuring the output voltage between the T3 and T5 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 the T1 and T2 test points. The output voltage is measured between the T3 and T5 test points.

Measuring Efficiency

The efficiency, η , 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

The inductor current can be measured by removing one end of the inductor from the pad on the board and connecting a wire between the pad and the inductor. A current probe can then be used to measure the inductor current.

Measuring Output Voltage Ripple

To observe the output voltage ripple, place an oscilloscope probe across Output Capacitor C4 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 μ 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.

Figure 2 shows a simple way to properly measure the output ripple. It requires removing the oscilloscope probe sheath and wrapping a nonshielded wire around the oscilloscope probe. By keeping the ground length of the oscilloscope probe as short as possible, true ripple can be measured.



Figure 2. Output Ripple Measurement

Output Voltage Change

The output voltage of the [ADP2164](#) evaluation board is preset to 1.2 V. However, the output voltage can be adjusted using the following equation:

$$V_{OUT} = 0.6 \text{ V} \times \left(\frac{R4 + R3}{R3} \right)$$

TYPICAL PERFORMANCE CHARACTERISTICS

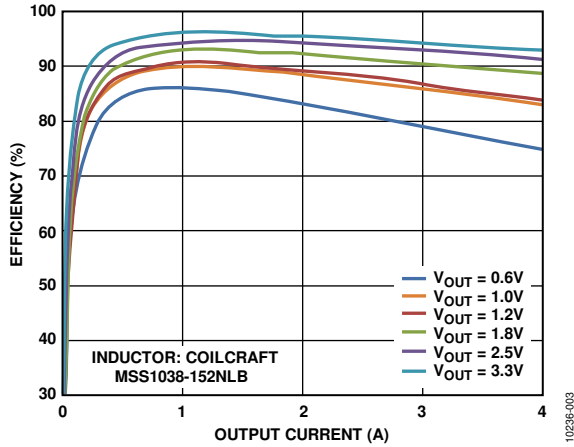


Figure 3. Efficiency vs. Output Current, $V_{IN} = 5\text{ V}$, $f_s = 600\text{ kHz}$

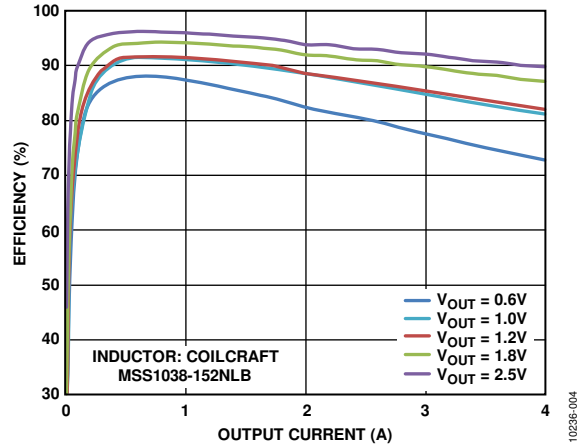


Figure 6. Efficiency vs. Output Current, $V_{IN} = 3.3\text{ V}$, $f_s = 600\text{ kHz}$

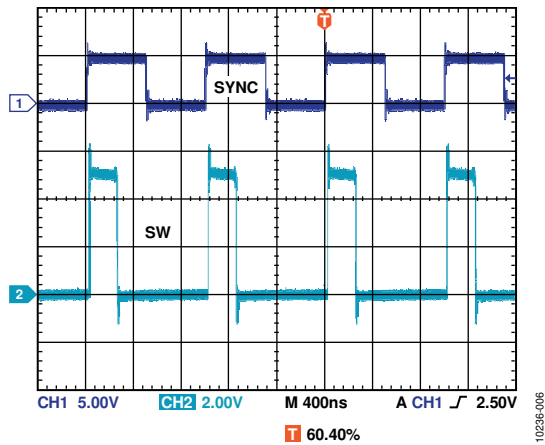


Figure 4. ADP2164 Synchronized to 1 MHz, in Phase

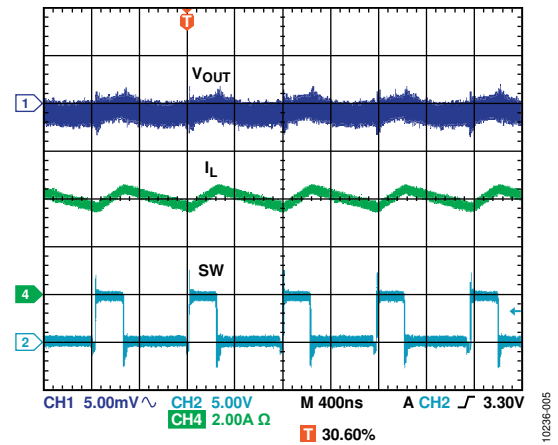


Figure 7. Steady Waveform, $V_{IN} = 5\text{ V}$, $V_{OUT} = 1.2\text{ V}$, $f_s = 1.2\text{ MHz}$

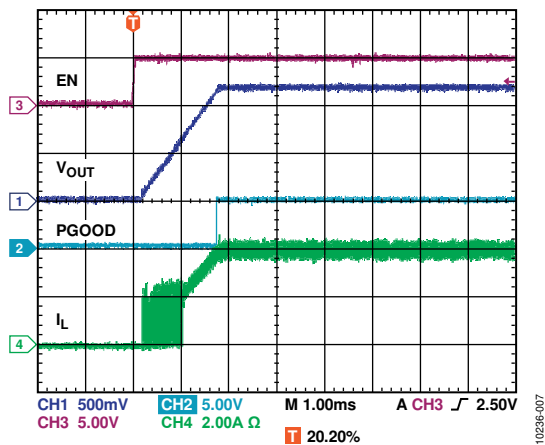


Figure 5. Soft Start with Full Load, $V_{IN} = 5\text{ V}$, $V_{OUT} = 1.2\text{ V}$, $f_s = 1.2\text{ MHz}$

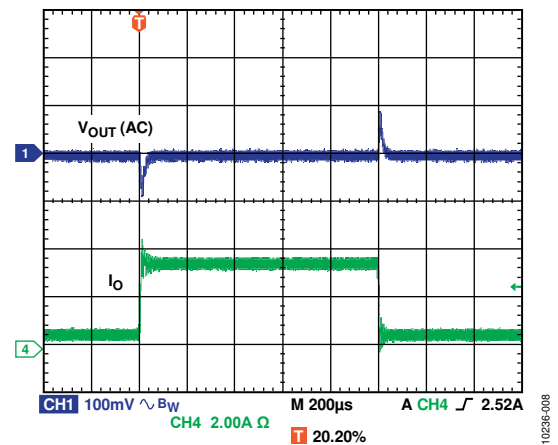
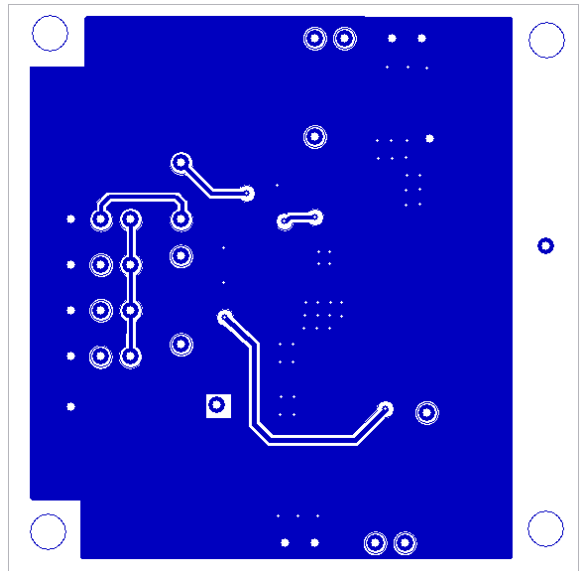
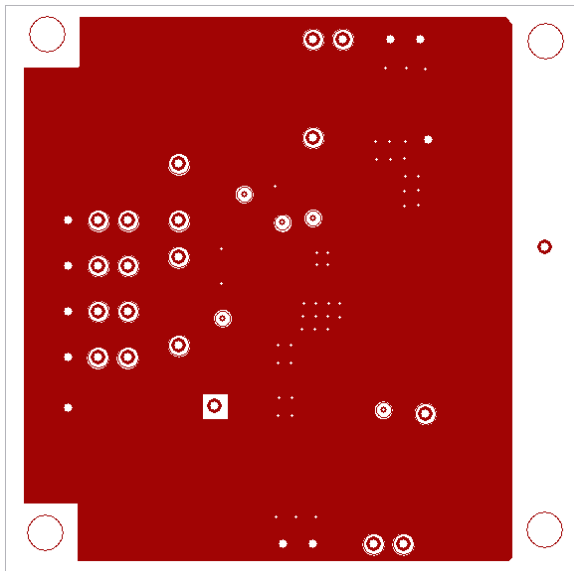
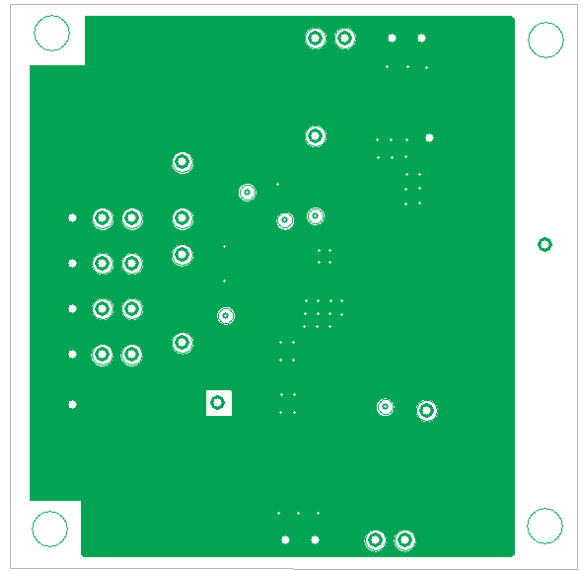
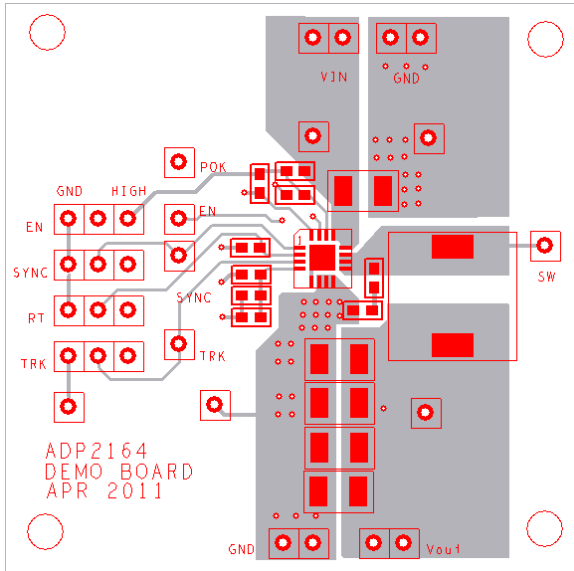


Figure 8. Load Transient, 0.5 A to 3.5 A Load Step, $V_{IN} = 5\text{ V}$, $V_{OUT} = 1.2\text{ V}$, $f_s = 1.2\text{ MHz}$

EVALUATION BOARD LAYOUT



ORDERING INFORMATION

BILL OF MATERIALS

Table 2.

Qty	Reference Designator	Description	PCB Footprint	Vendor	Part No.
1	C1	Capacitor, 0.1 μ F	C0603	Murata	GRM188R61E104KA01D
1	C2	Capacitor, 47 μ F, 16 V	C1210	Murata	GRM32ER61C476ME15L
2	C3, C4	Capacitor, 100 μ F, 6.3 V	C1210	Murata	GRM32ER60J107ME20L
2	C5, C6	Capacitor, optional	C0603		
2	C7, C8	Capacitor, optional	C1210		
1	L1	Inductor, 1 μ H	Coilcraft_Mss1038	Coilcraft	MSS1038-102NL
1	R1	Resistor, 10 Ω	R0603	Vishay	CRCW0603-10R0F
3	R2, R3, R4	Resistor, 10 k Ω	R0603	Vishay	CRCW0603-1002F
1	R5	Resistor, optional	R0603		
1	R6	Resistor, 100 k Ω	R0603	Vishay	CRCW0603-1003F
1	U1	IC	16-lead LFCSP_WQ	Analog Devices, Inc.	ADP2164ACPZ-R7
10	J1, J5, J8, J11, J13, T1, T2, T3, T4, T5	Test point	SIP1	Harwin	M20-9990245
4	J3, J6, J9, J12	Connector	SIP2	Harwin	M20-9990245
4	J2, J4, J7, J10	Jumper	SIP3	Harwin	M20-9990346



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.