

## Evaluating the **ADP1614** 650 kHz/1.3 MHz, 4 A, Step-Up, PWM, DC-to-DC Switching Converter

### FEATURES

- 2.5 V to 5.5 V input voltage range**
- 650 kHz or 1.3 MHz fixed frequency options**
- Adjustable current limit up to 4 A**
- Output voltage**
  - 5 V for **ADP1614**-650-EVALZ**
  - 15 V for **ADP1614**-1.3-EVALZ**
- Jumper for enable/shutdown control**
- Components optimized for the indicated output voltages**

### GENERAL DESCRIPTION

The **ADP1614** evaluation board is a complete step-up, dc-to-dc switching converter application with components selected to allow operation over the full range of input and load conditions for the 5 V (**ADP1614**-650-EVALZ) and 15 V (**ADP1614**-1.3-EVALZ) output voltages. The boost switching frequency is fixed to either 650 kHz (**ADP1614**-650-EVALZ) or 1.3 MHz (**ADP1614**-1.3-EVALZ). The evaluation boards can be adjusted for different output voltages by changing the feedback resistors, R1 and R2. To ensure stable operation, external components L1, R<sub>CL</sub>, C<sub>OUT</sub>, R<sub>COMP</sub>, and C<sub>COMP</sub> may also need to be recalculated and adjusted when the output voltage is changed.

The **ADP1614** evaluation board operates in current mode, pulse-width modulation (PWM) with up to 94% efficiency. The current mode PWM architecture allows for excellent transient response, easy noise filtering, and the use of small, cost-saving external inductors and capacitors. Other key features include a 47 nF soft start capacitor, undervoltage lockout (UVLO), thermal shutdown (TSD), and jumper selected enable. The evaluation board demonstrates the operation and performance of the **ADP1614**.

This user guide includes I/O descriptions, setup instructions, the schematic, and the PCB layout drawings for the **ADP1614** step-up converter evaluation board.

Complete specifications for the **ADP1614** are available in the **ADP1614** data sheet and should be consulted in conjunction with this document when using the evaluation board.

### TYPICAL APPLICATION CIRCUIT

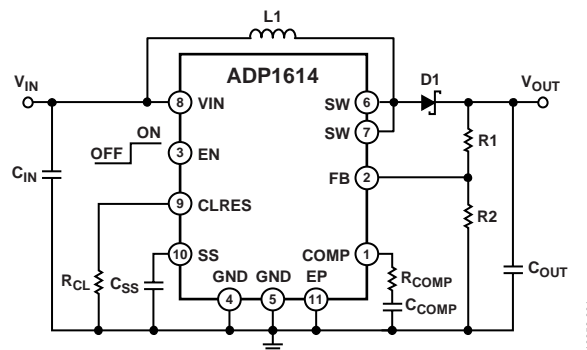


Figure 1. Step-Up Regulator Configuration

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**REVISION HISTORY**

**7/12—Revision 0: Initial Version**

## EVALUATION BOARD HARDWARE

The [ADP1614](#) evaluation board is fully assembled and tested. The following sections describe the various connectors on the board, the proper evaluation setup, and the testing capabilities of the evaluation board.

### INPUT/OUTPUT CONNECTORS

#### EN Test Bus

The EN connector is used to enable/disable the converter via the EN pin. Use one of the following methods to enable the converter. Do not leave the EN pin floating.

- Use a jumper to connect the top two pins of the EN test bus. This connects EN to VIN and enables the converter (see Figure 2).

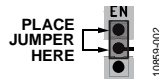


Figure 2. Enabled Jumper Position

- Use a jumper to connect the bottom two pins of the EN test bus. This connects EN to GND and disables the converter (see Figure 3).

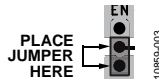


Figure 3. Disabled Jumper Position

- Alternatively, connect a voltage between VIN and GND to the center pin of the EN test bus for independent control of the EN pin voltage (see Figure 4).

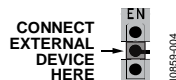


Figure 4. EN Pin Direct Connection

#### VIN Test Bus

The VIN test bus connects the positive input supply voltage to the VIN pin. Connect the power supply to this bus and keep the wires as short as possible to minimize the EMI transmission.

#### SW Test Point

The SW test point is for monitoring the switch node (SW pin) behavior and switching frequency. Connect a BNC cable to this test point to measure the [ADP1614](#) switching frequency.

#### VOUT Test Bus

The output voltage at the VOUT test bus is set by the resistive voltage divider network, R1 and R2. A load can be attached from the VOUT test bus to the GND test bus.

#### GND Test Bus

The GND test bus is the power ground connection for the part via the GND pin as well as the bypass capacitors. Connect ground connections from external equipment to this bus.

### EVALUATION SETUP

To ensure proper operation of the [ADP1614](#) evaluation board:

- Connect the input supply ground to GND.
- Connect the positive input supply to VIN.
- Connect the desired load between VOUT and GND. The maximum continuous output current of the [ADP1614](#) is dependent upon the input and output voltage conditions.
- Apply a voltage between 2.5 V and 5.5 V to the VIN test bus.
- Move the jumper on the EN test bus to the enabled position.

If the feedback resistors, R1 and R2, are adjusted to change the output voltage, recalculate the recommended values for the external components ( $L1$ ,  $R_{CL}$ ,  $C_{OUT}$ ,  $R_{COMP}$ , and  $C_{COMP}$ ) using the applications information from the [ADP1614](#) data sheet.

### PERFORMANCE EVALUATION

The following sections discuss tests and the resulting oscilloscope waveforms. Oscilloscope waveforms and typical performance characteristics are provided in the [ADP1614](#) data sheet.

#### Line Regulation

The line regulation is observed and measured by monitoring the output voltage (VOUT) while varying the input voltage (VIN).

#### Load Regulation

The load regulation is observed and measured by monitoring the output voltage (VOUT) while sweeping the applied load between VOUT and GND. To minimize voltage drop, use short low resistance wires, especially for heavy loads.

#### Efficiency

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

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

#### Line Transient

The line transient performance is evaluated by generating a high speed voltage transient on the input (VIN) and observing the behavior of the evaluation board at the output (VOUT).

#### Load Transient

The load transient performance is evaluated by generating a fast current transient on the output (VOUT) and observing the behavior of the evaluation board at the output (VOUT).

#### Oscillator Frequency

The oscillator frequency can be measured by connecting an oscilloscope to the SW pin.

#### Inductor Current

The inductor current is made accessible by removing one side of the inductor from its pad and connecting a current loop in series. Place an oscilloscope current probe on the loop to view the current waveform.

EVALUATION BOARD SCHEMATIC AND LAYOUT

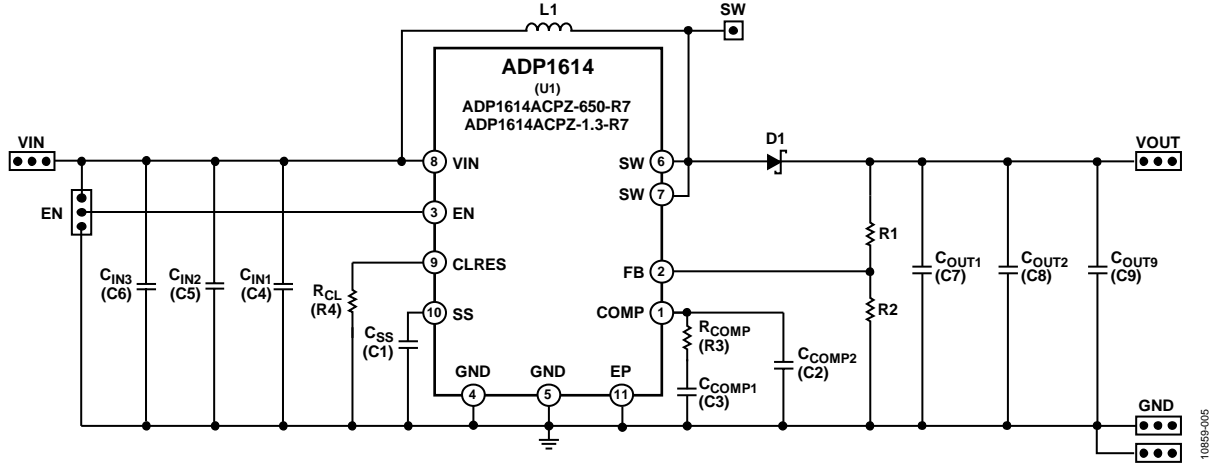


Figure 5. ADP1614 Boost Application Evaluation Board Schematic

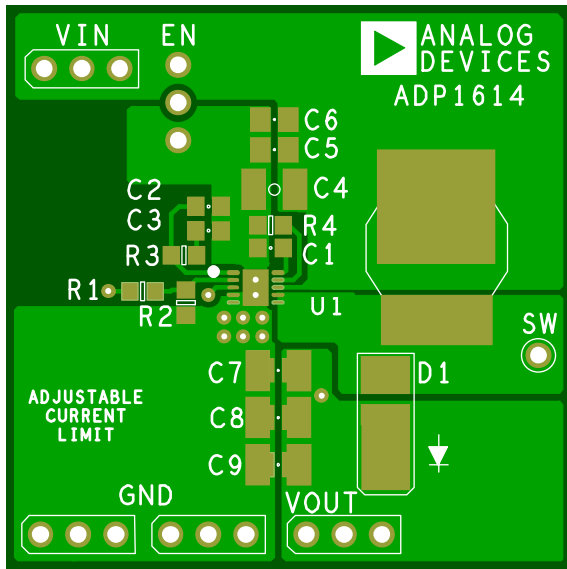


Figure 6. ADP1614 Boost Application Printed Circuit Board (PCB) Top Layer

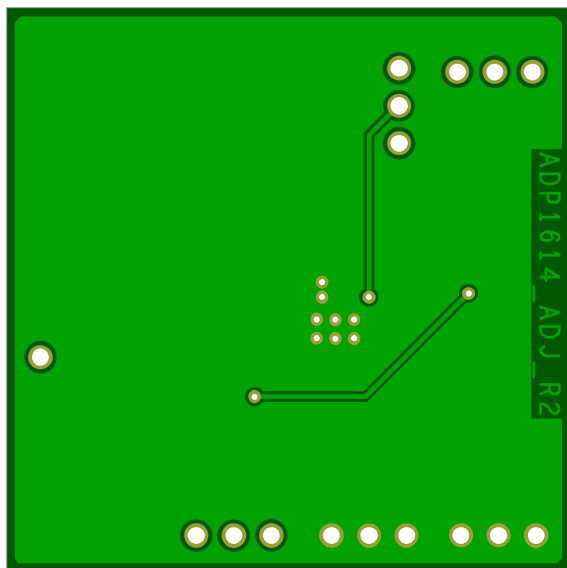


Figure 7. ADP1614 Boost Application PCB Bottom Layer

LAYOUT GUIDELINES

For high efficiency, good regulation, and stability, a well-designed PCB layout is required.

When designing PCBs, use the following guidelines:

- Keep the low ESR input capacitor ( $C_{IN}$ ) close to the VIN and GND pins. This minimizes noise injected into the part from the board parasitic inductance.
- Keep the high current path from  $C_{IN}$  through the L1 inductor to the SW and GND pins as short as possible.
- Keep the high current path from the VIN pin through L1, the rectifier (D1), and the output capacitor ( $C_{OUT}$ ) as short as possible.
- Keep high current traces as short and as wide as possible.
- Place the feedback resistors, R1 and R2, as close to the FB pin as possible to prevent noise pickup. Connect the ground of the feedback network directly to an AGND plane to make a Kelvin connection to the GND pin.
- Place the compensation components as close as possible to the COMP pin. Connect the ground of the compensation network directly to an AGND plane that makes a Kelvin connection to the GND pin.
- Avoid routing high impedance traces from the compensation and feedback resistors near any node connected to SW or near the inductor to prevent radiated noise injection.
- Connect the soft start capacitor ( $C_{SS}$ ) as close to the device as possible. Connect the ground of the soft start capacitor to an AGND plane that makes a Kelvin connection to the GND pin.
- Connect the current limit set resistor ( $R_{CL}$ ) as close as possible to the device. Connect the ground of  $R_{CL}$  to an AGND plane that makes a Kelvin connection to the GND pin.
- The PCB must be properly designed to conduct the heat away from the package. This is achieved by adding thermal vias to the PCB that provide a thermal path to the inner or bottom layers. Place thermal vias on the PCB under the exposed pad of the LFCSP and in the GND plane around the ADP1614 package to improve thermal performance of the application.

## ORDERING INFORMATION

### BILL OF MATERIALS

Table 1. **ADP1614-650-EVALZ** ( $f_{sw} = 650$  kHz,  $V_{out} = 5$  V)

Qty	Reference Designator	Description	Manufacturer <sup>1</sup>	Part Number
1	U1	<b>ADP1614</b> step-up converter with $f_{sw} = 650$ kHz	Analog Devices, Inc.	<b>ADP1614</b> ACPZ-650-R7
1	L1	Inductor, 4.7 $\mu$ H, 4.3 A	Coilcraft	XAL5030-472MEB
1	D1	Schottky rectifier, 30 V, 5 A	Toshiba	CMS05(TE12L,Q,M)
1	C1	Soft start capacitor, 47000 pF, 50 V, 0805, $\pm 10\%$	Kemet	C0805C473K5RACTU
1	C2	Compensation capacitor, 33 pF, 50 V, 0805, $\pm 5\%$	Panasonic Electronic Components	ECJ-2VC1H330J
1	C3	Compensation capacitor, 22000 pF, 50 V, 0805, $\pm 10\%$	TDK Corporation	C2012X7R1H223K/0.60
1	C4	Input capacitor, 10 $\mu$ F, 16 V, 0805, $\pm 10\%$	Murata Electronics	GRM21BR61C106KE15L
	C5, C6	Input capacitors	Open	
2	C7, C8	Output capacitors, 10 $\mu$ F, 25 V, 0805, $\pm 10\%$	Murata Electronics	GRM21BR61E106KA73L
	C9	Output capacitor	Open	
1	R1	Output voltage divider resistor, 30.9 k $\Omega$ , 0805, $\pm 1\%$	Vishay Dale	CRCW080530K9FKEA
1	R2	Output voltage divider resistor, 10.0 k $\Omega$ , 0805, $\pm 1\%$	Panasonic Electronic Components	ERJ-6ENF1002V
1	R3	Compensation resistor, 2 k $\Omega$ , 0805, $\pm 1\%$	Yageo	9C08052A2001FKHFT
1	R4	Current limit set resistor, 66.5 k $\Omega$ , 0805, $\pm 1\%$	Vishay Dale	CRCW080566K5FKEA
1	EN	Headers, 0.100 in, single, straight, 3-pin	Sullins Connector Solutions	PBC03SAAN <sup>2</sup>
1	SW	Headers, 0.100 in, single, straight, 1-pin	Sullins Connector Solutions	PBC01SAAN <sup>2</sup>
4	VIN, VOUT, GNDx2	Test point loop connectors	Aavid Thermalloy	125800D00000G

<sup>1</sup> Equivalent substitutions may be made for all resistors and capacitors.

<sup>2</sup> Alternatively, PBC36SAAN can be purchased and cut as necessary.

Table 2. ADP1614-1.3-EVALZ ( $f_{sw} = 1.3 \text{ MHz}$ ,  $V_{OUT} = 15 \text{ V}$ )

Qty	Reference Designator	Description	Manufacturer <sup>1</sup>	Part Number
1	U1	ADP1614 step-up converter with $f_{sw} = 1.3 \text{ MHz}$	Analog Devices, Inc.	ADP1614ACPZ-1.3-R7
1	L1	Inductor, 10 $\mu\text{H}$ , 5A	Coilcraft	XAL6060-103MEB
1	D1	Schottky rectifier, 30V, 5A	Toshiba	CMS05(TE12L,Q,M)
1	C1	Soft start capacitor, 47000 pF, 50 V, 0805, $\pm 10\%$	Kemet	C0805C473K5RACTU
1	C2	Compensation capacitor, 18 pF, 50V, 0805, $\pm 5\%$	Yageo	CC0805JRNPO9BN180
1	C3	Compensation capacitor, 47000 pF, 50 V, 0805, $\pm 10\%$	Kemet	C0805C473K5RACTU
1	C4	Input capacitor, 10 $\mu\text{F}$ , 16 V, 0805, $\pm 10\%$	Murata Electronics	GRM21BR61C106KE15L
	C5, C6	Input capacitors	Open	
2	C7, C8	Output capacitors, 10 $\mu\text{F}$ , 25 V, 0805, $\pm 10\%$	Murata Electronics	GRM21BR61E106KA73L
	C9	Output capacitor	Open	
1	R1	Output voltage divider resistor, 110.0 k $\Omega$ , 0805, $\pm 1\%$	Panasonic, ECG	ERJ-6ENF1103V
1	R2	Output voltage divider resistor, 10.0 k $\Omega$ , 0805, $\pm 1\%$	Panasonic, ECG	ERJ-6ENF1002V
1	R3	Compensation resistor, 1 k $\Omega$ , 0805, $\pm 1\%$	Vishay Dale	CRCW08051K00FKEA
1	R4	Current limit set resistor, 60.4 k $\Omega$ , 0805, $\pm 1\%$	Yageo	RC0805FR-0760K4L
1	EN	Headers, 0.100 in, single, straight, 3-pin	Sullins Connector Solutions	PBC03SAAN <sup>2</sup>
1	SW	Headers, 0.100 in, single, straight, 1-pin	Sullins Connector Solutions	PBC01SAAN <sup>2</sup>
4	VIN, VOUT, GNDx2	Test point loop connectors	Aavid Thermalloy	125800D00000G

<sup>1</sup> Equivalent substitutions may be made for all resistors and capacitors.<sup>2</sup> Alternatively, PBC36SAAN can be purchased and cut as necessary.

**NOTES**

## NOTES

**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.

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