

### FEATURES

**95% efficiency**

**Input voltage range: 2.7 V to 5.5 V**

**Fixed output voltage range: 0.8 V to 1.875 V**

**Adjustable output voltage range from 0.8 V to 3.3 V**

**Enable/shutdown logic input**

**Selectable PSM/PWM mode**

**Operating temperature range: -40°C to +125°C**

### GENERAL DESCRIPTION

The ADP2102 evaluation board is a complete step-down, dc-to-dc converter solution using the [ADP2102](#) step-down, dc-to-dc converter. It provides a  $\pm 1\%$  accurate ( $\pm 2\%$  over all conditions) regulated output voltage with load currents up to 600 mA. It comes in two versions: fixed output with output voltages ranging from 0.8 V to 1.875 V and adjustable output with output voltages

ranging from 0.8 V to 3.3 V. Refer to the Ordering Guide for details on the available models.

The ADP2102 is a synchronous, step-down, dc-to-dc converter, which uses a constant on-time, valley current mode control scheme to regulate the output voltage. At medium-to-heavy load currents, the ADP2102 operates in continuous conduction mode (CCM) for high efficiency and smoothly transitions to a power-save mode (PSM) at light loads to conserve power.

The power switch and synchronous rectifier are integrated for minimal external part count and high efficiency. The ADP2102 is optimized for operation with small ceramic inductors and tiny ceramic capacitors to deliver the maximum output power per square inch of the PCB board area.

It is recommended that this evaluation board data sheet be read in conjunction with the ADP2102 data sheet, which provides more detailed information about the converter.

### FUNCTIONAL BLOCK DIAGRAM

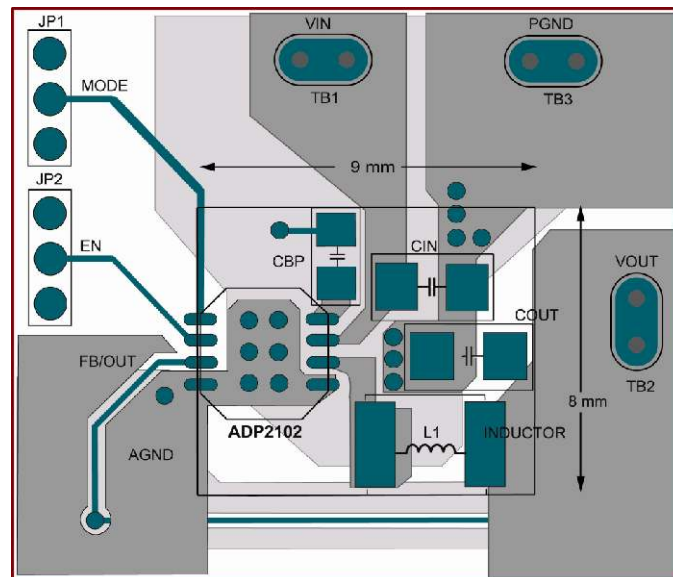


Figure 1. ADP2102 Evaluation Board

### Rev. A

Evaluation boards are only intended for device evaluation and not for production purposes. Evaluation boards are supplied "as is" and without warranties of any kind, express, implied, or statutory including, but not limited to, any implied warranty of merchantability or fitness for a particular purpose. No license is granted by implication or otherwise under any patents or other intellectual property by application or use of evaluation boards. Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Analog Devices reserves the right to change devices or specifications at any time without notice. Trademarks and registered trademarks are the property of their respective owners. Evaluation boards are not authorized to be used in life support devices or systems.

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## REVISION HISTORY

### 6/08—Rev. 0 to Rev. A

Changes to Features Section.....	1
Changes to General Description Section .....	1
Changes to Turning on the Evaluation Board Section .....	3
Changes to Modifying the Evaluation Board Section.....	4
Deleted Figure 4 and Figure 7; Renumbered Sequentially.....	6
Deleted Pin Configuration and Function Descriptions Section.....	8
Changes to Figure 7 and Figure 8.....	8
Changes to Table 1 and Table 2.....	10
Changes to Ordering Guide .....	10

### 7/07—Revision 0: Initial Version

## EVALUATION BOARD HARDWARE

### POWERING UP THE EVALUATION BOARD

The ADP2102 evaluation boards are supplied fully assembled and tested. Before applying power to the evaluation board, follow the procedures in this section.

#### **Jumper JP2**

Before turning on the ADP2102 evaluation board, make sure that all the components are present, but that Jumper JP2 is removed. Jumper JP2 enables the part.

#### **Jumper JP1**

The ADP2102 can be configured to operate in low noise continuous conduction mode (CCM) or in power-save mode (PSM), depending on the MODE pin polarity. If the MODE pin is pulled high, ADP2102 operates in forced continuous conduction mode, and if the MODE pin is pulled low, ADP2102 operates in power-save mode.

#### **Input Power Source**

Before connecting the power source to the ADP2102 evaluation board, make sure it is turned off. If the input power source includes a current meter, use that meter to monitor the input current. Connect the positive terminal of the power source to the VIN terminal on the evaluation board, and the negative terminal of the power source to the GND terminal of the evaluation board. 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 the GND terminal on the evaluation board, and the negative lead (–) of the ammeter to the VIN terminal on the board.

#### **Output Load**

Although the ADP2102 evaluation board can sustain the sudden connection of the load, it is possible to damage the load if it is not properly connected. Make sure the board is turned off before connecting the load. 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 connection to the VOUT terminal and negative (–) load connection to the GND terminal. If an ammeter is used, connect it in series with the load: connect the positive (+) ammeter terminal to the evaluation board VOUT terminal, the negative (–) ammeter terminal to the positive (+) load terminal, and the negative (–) load terminal to the evaluation board GND terminal.

Once the load is connected, make sure it is set to the proper current before powering the ADP2102 evaluation board.

#### **Input and Output Voltmeters**

Measure the input and output voltages with voltmeters. Make sure that the voltmeters are connected to the appropriate evaluation board terminals and not to the load or power source themselves. If the voltmeters are not connected directly to the evaluation board, the measured voltages would be 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 VIN terminal, and the negative (–) terminal to the evaluation board GND terminal. Connect the output voltage measuring voltmeter positive (+) terminal to the evaluation board VOUT terminal and the negative (–) terminal to the evaluation board GND terminal.

#### **Turning On the Evaluation Board**

Once the power source and load are connected to the ADP2102 evaluation board, the board can be powered for operation. Slowly increase the input power source voltage until the input voltage exceeds the minimum input operating voltage of 2.7 V. Insert Jumper JP2 and check to see if the output voltage rises to the regulated output voltage (for example, 1.2 V for the ADP2102-1.2-EVALZ). Ensure that the minimum input supply voltage is greater than 4.5 V for powering up the adjustable ADP2102-4-EVALZ. The input voltage range for the 2.5 V to 3.3 V adjustable output voltage option is from  $4.5\text{ V} < V_{\text{IN}} < 5.5\text{ V}$  only.

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

### MEASURING EVALUATION BOARD PERFORMANCE

#### **Measuring Output Voltage Ripple**

To observe the output voltage ripple, place an oscilloscope probe across the output capacitor (C2) with the probe ground lead at the negative (–) capacitor terminal and the probe tip at the positive (+) capacitor terminal. Set the oscilloscope to ac, 20 mV/division, and 2  $\mu\text{s}$ /division time base.

#### **Measuring the Switching Waveform**

To observe the switching waveform with an oscilloscope, place the oscilloscope probe tip at the end of the inductor that is connected to the LX pin with the probe ground at GND. Set the oscilloscope to dc, 2 V/division, and 2  $\mu\text{s}$ /division time base. The switching waveform must alternate between 0 V and approximately the input voltage.

#### **Measuring Load Regulation**

The load regulation must be tested by increasing the load at the output and looking at the change in output voltage. To minimize voltage drop, use short low resistance wires, especially for heavy loads.

# EVAL-ADP2102

## Measuring Line Regulation

Vary the input voltage and examine the change in the output voltage. In forced continuous conduction mode, the output voltage ripple is small (<50 mV), but in power-save mode, the output voltage ripple can be as large as 50 mV.

## Measuring Efficiency

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

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

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

## Measuring Inductor Current

The inductor current can be measured by removing one end of the inductor from its pad and connecting a current loop in series with it. Then a current probe can be used to measure the current flowing through the current loop, as shown in Figure 2.

## MODIFYING THE EVALUATION BOARD

The ADP2102 evaluation board is supplied fully assembled and tested for proper operation. It comes in two versions: fixed output with output voltages ranging from 0.8 V to 1.875 V and adjustable output with output voltages ranging from 0.8 V to 3.3 V. Refer to the Ordering Guide for model details.

## Changing the Output Voltage for the Adjustable Option

The ADP2102-x-EVALZ output regulation voltage can be changed from 3.3 V to output voltages as low as 0.8 V by altering its external components. The output regulation voltage of fixed output voltage boards cannot be changed.

The output regulation voltage of adjustable voltage boards is set by a resistive voltage divider consisting of Resistor R1 and Resistor R2.

The output regulation voltage is determined by the equation

$$V_{OUT} = V_{FB} (1 + R1/R2)$$

where:

$V_{OUT}$  is the regulated output voltage (V).

$V_{FB} = 0.8$  V, the feedback voltage and the internal reference.

$R1$  is the feedback resistor from  $V_{OUT}$  to  $V_{FB}$ .

$R2$  is the feedback resistor from  $V_{FB}$  to GND.

To set the output regulation voltage to the desired value, first determine the value of the bottom resistor, R2, by

$$R2 = V_{FB}/I_{STRING}$$

where:

$V_{FB} = 0.8$  V, the internal reference.

$I_{STRING}$  is the resistive divider string current (8  $\mu$ A nominally).

Once R2 is determined, calculate the value of the top resistor, R1, by

$$R1 = R2 (V_{OUT} - V_{FB})/(V_{FB})$$

For example, to set the output regulation voltage of the ADP2102-4-EVALZ to 3.0 V, calculate the value of Resistor R1 and Resistor R2.

$$R2 = V_{FB}/I_{STRING} = 0.8 \text{ V}/8 \mu\text{A} = 100 \text{ k}\Omega$$

$$R1 = R2 (V_{OUT} - V_{FB})/(V_{FB}) \\ = 100 \text{ k}\Omega (3.0 \text{ V} - 0.8 \text{ V})/(0.8 \text{ V}) = 275 \text{ k}\Omega$$

Refer Table 1 for the recommended  $V_{OUT}$  configurations to ensure stable operation.

A feedforward capacitor is required across the top resistor, R1, for adjustable outputs greater than 1.875 V. This capacitor provides a better transient response for medium to high load steps. This feedforward capacitor provides additional phase margin by creating a zero along with Resistor R1 at a frequency given by

$$CFF = \frac{1}{(2\pi \times R1 \times (f_{CO}/2))}$$

For example, in a 5 V input to 3.3 V output application, if the output capacitor is 4.7  $\mu$ F, a 6.8 pF feedforward capacitor is required. This is based on a loop crossover frequency ( $f_{CO}$ ) of 150 kHz for a 4.7  $\mu$ F capacitor.

## Changing the Load Transient Response

The ADP2102 evaluation board load transient response can be altered by changing the output capacitor, COUT. Ceramic output capacitors are recommended for the ADP2102. By default, the load transient response of the ADP2102 evaluation board is set to 2% of the output voltage for a 600 mA load transient. When using additional capacitance for better load transient performance, the loss of capacitance due to dc bias should be taken into account.

Table 1. ADP2102-x-EVALZ Configurations for  $V_{OUT}$

$V_{OUT}$ (V)	R1 (k $\Omega$ )	R2 (k $\Omega$ )	CFF (pF)	L1 ( $\mu$ H)	CIN (pF)	COUT (pF)
0.8	1	80.6	None	2.2	2.2	4.7
1.0	20	100	None	2.2	2.2	4.7
1.2	49.9	100	None	2.2	2.2	4.7
1.25	56.2	100	None	2.2	2.2	4.7
1.375	71.5	100	None	2.2	2.2	4.7
1.5	88.7	100	None	2.2	2.2	4.7
1.8	124	100	None	2.2	2.2	4.7
1.875	133	100	None	2.2	2.2	4.7
2.0	150	100	15	2.2	2.2	4.7
2.5	215	100	10	2.2	2.2	4.7
3.0	274	100	8.2	2.2	2.2	4.7
3.3	316	100	6.8	2.2	2.2	4.7

# MEASUREMENT SETUP

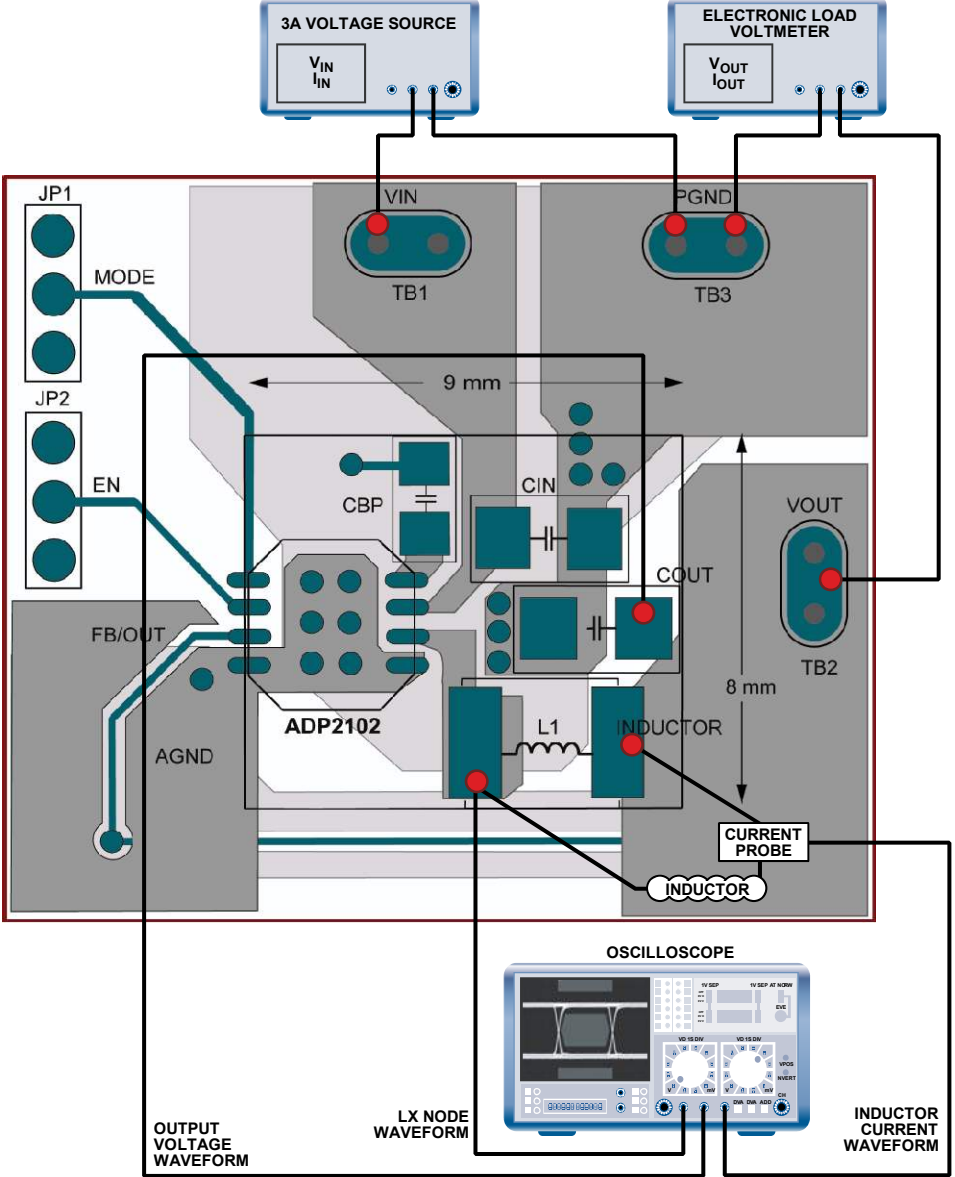


Figure 2. Typical Measurement Setup

## TYPICAL PERFORMANCE CHARACTERISTICS

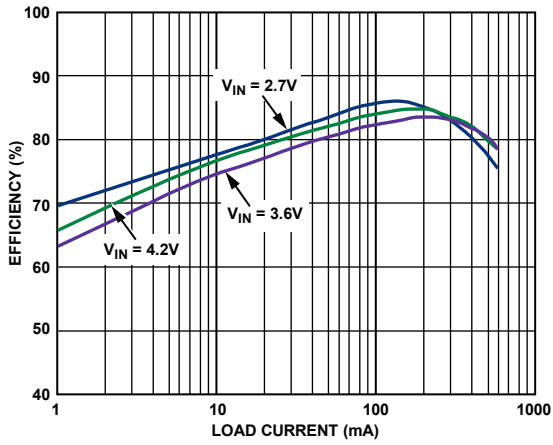


Figure 3. Efficiency vs. Load Current—ADP2102-1.2-EVALZ (1.2 V Output)

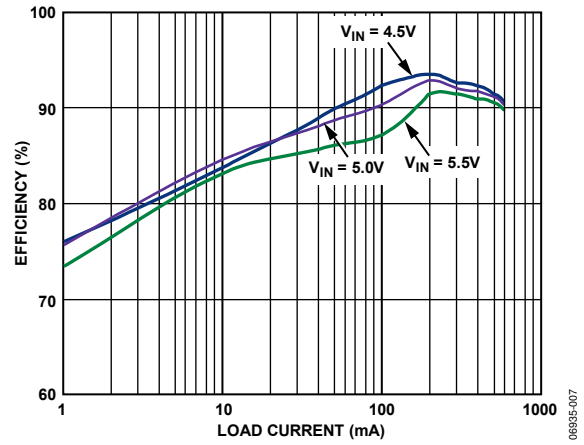


Figure 5. Efficiency vs. Load Current—ADP2102-4-EVALZ (3.3 V Output)

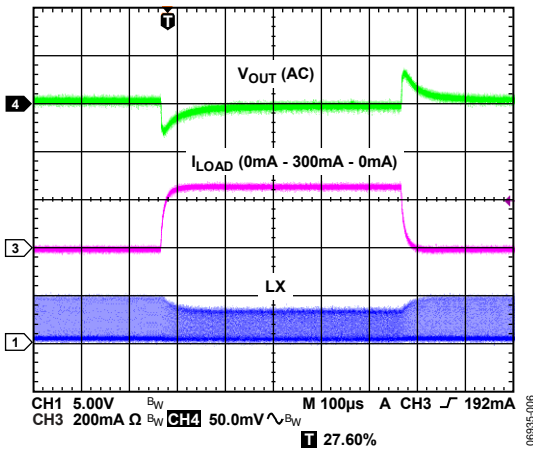


Figure 4. Load Transient Response for ADP2102-1.2-EVALZ (1.2 V Output)

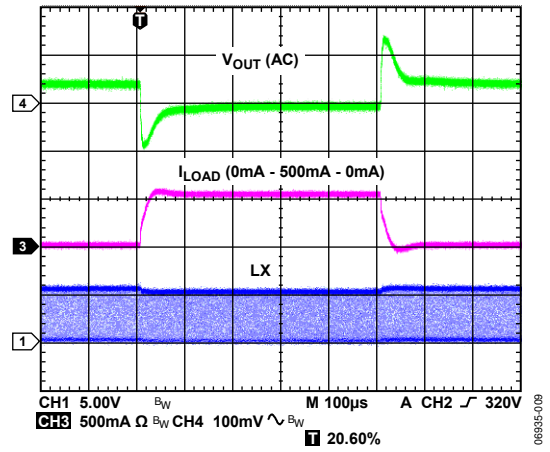


Figure 6. Load Transient Response for ADP2102-4-EVALZ (3.3 V Output)

## CIRCUIT BOARD LAYOUT RECOMMENDATIONS

Good circuit board layout is essential in obtaining the best performance from the ADP2102 (see Figure 9, Figure 10, and Figure 11). Poor circuit layout degrades the output ripple and regulation, as well as the EMI and electromagnetic compatibility performance.

Refer to the following guidelines for optimum layout:

- Use separate analog and power ground planes. Connect the ground reference of sensitive analog circuitry, such as output voltage divider components, to analog ground. In addition, connect the ground references of power components, such as input and output capacitors, to power ground. Connect both ground planes to the exposed pad of the ADP2102.
- Place the input capacitor as close to the PVIN pin as possible and connect the other end to the closest power ground plane.
- For low noise and better transient performance, a filter is recommended between PVIN and AVIN. Place the 0.1  $\mu$ F, 10  $\Omega$  low-pass input filter as close to AVIN as possible, between the AVIN pin and the PVIN pin; or the AVIN can be bypassed with a  $\geq 1$  pF capacitor to the nearest GND plane.
- Ensure that the high current loops are as short and as wide as possible. Make the high current path from CIN through L1, COUT, and the PGND plane back to CIN as short as possible. To accomplish this, ensure that the input and output capacitors share a common PGND plane. In addition, make the high current path from the PGND pin through L1 and COUT and back to the PGND plane as short as possible. To do this, ensure that the PGND pin of the ADP2102 is tied as close as possible to the input and output capacitors on the PGND plane.
- Place the feedback resistor divider network as close as possible to the FB pin to prevent noise pickup. Try to minimize the length of the trace connecting the top of the feedback resistor divider to the output while keeping away from the high current traces and the switch node (LX) that can lead to noise pickup. To reduce noise and parasitic capacitance pickup, place an analog ground plane on either side of the FB trace and make it as small as possible.

## EVALUATION BOARD SCHEMATICS AND ARTWORK

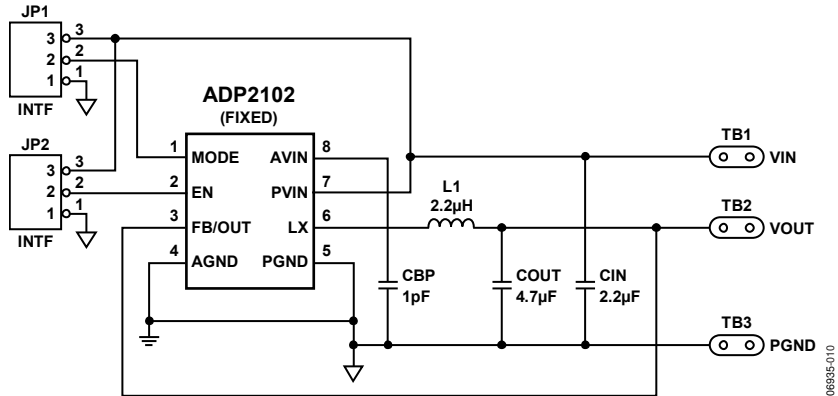


Figure 7. ADP2102-x.x-EVALZ Schematic (Fixed Output Voltage)

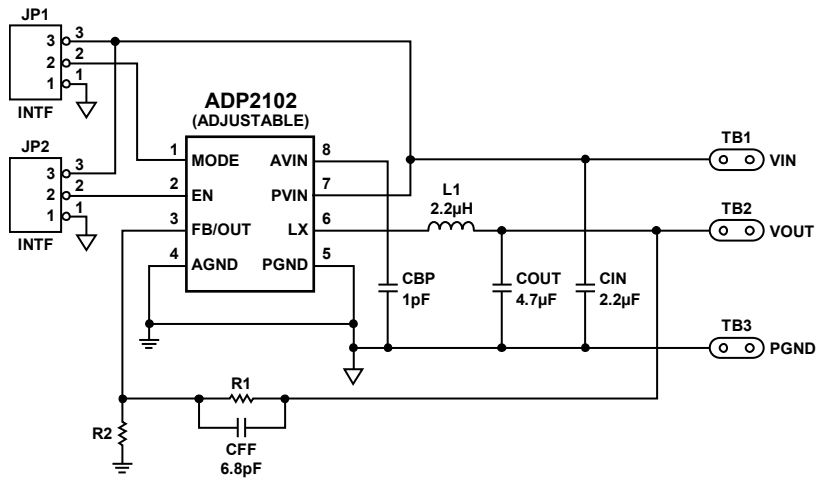


Figure 8. ADP2102-x-EVALZ Schematic (Adjustable Output Voltage)



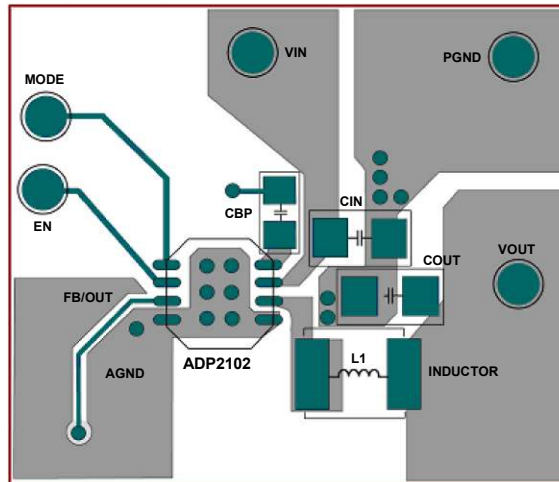


Figure 9. Recommended Layout of the Top Layer of the ADP2102 Fixed Output Voltage Evaluation Board

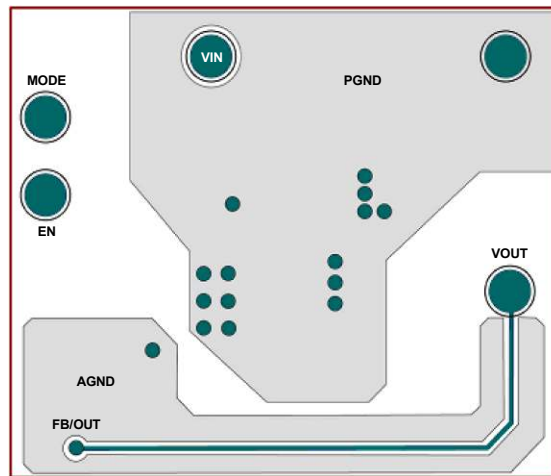


Figure 10. Recommended Layout of the Bottom Layer of the ADP2102 Fixed Output Voltage Evaluation Board

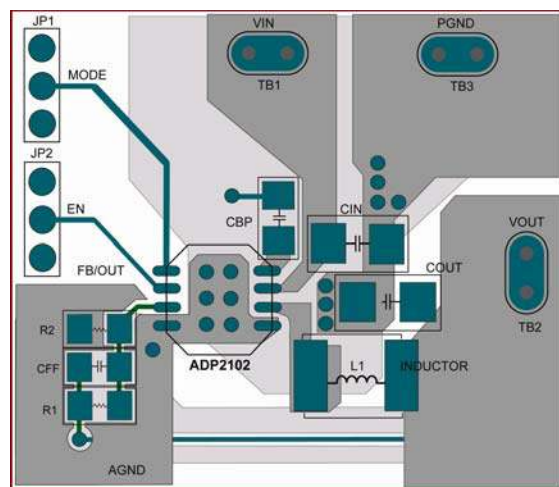


Figure 11. Recommended Layout of the ADP2102 Adjustable Output Voltage Evaluation Board

# EVAL-ADP2102

## ORDERING INFORMATION

### BILL OF MATERIALS

Table 2. Bill of Materials for ADP2102-x.x-EVALZ (Fixed Output Voltage)

Qty	Reference Designator	Description	Manufacturer	Mfg. Part Number
1	CIN	Capacitor, MLCC, 2.2 $\mu$ F, 6.3 V, 0603, X5R, SMD	Murata	GRM188R60J225K
1	COUT	Capacitor, MLCC, 4.7 $\mu$ F, 6.3 V, 0603, X5R, SMD	Murata	GRM188R60J475K
1	CBP	Capacitor, MLCC, 1 pF, 50 V, 0402, X7R, SMD	Murata	GJM1554C1H1R0JB01C
1	L1	Inductor, 2.2 $\mu$ H	FDK	MIPF2520D2R2
1	U1	Fixed output voltage, 0.6 A, step-down, dc-to-dc converter	Analog Devices	ADP2102-x.x-EVALZ
5	VOUT, VIN, PGND, JP2, JP1	Headers, 0.10 in, single, straight	Sullins Electronics or equivalent	PTC36SAAN

Table 3. Bill of Materials for ADP2102-x-EVALZ (Adjustable Output Voltage)

Qty	Reference Designator	Description	Manufacturer	Mfg. Part Number
1	CIN	Capacitor, MLCC, 2.2 $\mu$ F, 6.3 V, 0603, X5R, SMD	Murata	GRM188R60J225K
1	COUT	Capacitor, MLCC, 4.7 $\mu$ F, 6.3 V, 0603, X5R, SMD	Murata	GRM188R60J475K
1	CBP	Capacitor, MLCC, 1 pF, 50 V, 0402, X7R, SMD	Murata	GJM1554C1H1R0JB01C
1	R1	Resistor, variable resistance(for example, 316 k $\Omega$ for 3.3 V operation), 1%, 0402, SMD	Vishay Dale	CRCW04023163F
1	R2	Resistor, variable resistance (for example,100 k $\Omega$ for 3.3 V operation), 1%, 0402, SMD	Vishay Dale	CRCW04021003F
1	CFF	Capacitor, MLCC, 6.8 pF, 25 V, 0402, X7R,SMD	Vishay Dale	VJ0402A 6R8 KXAA
1	L1	Inductor, 2.2 $\mu$ H	FDK	MIPF2520D2R2
1	U1	Adjustable output voltage, 0.6 A, step-down, dc-to-dc converter	Analog Devices	ADP2102-x-EVALZ
5	VOUT, VIN, PGND, JP2, JP1	Headers, 0.10 in, single, straight	Sullins Electronics or equivalent	PTC36SAAN

### ORDERING GUIDE

Model	Description
ADP2102-0.8-EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 0.8 V)
ADP2102-1.0-EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 1.0 V)
ADP2102-1.2-EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 1.2 V)
ADP2102-1.25-EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 1.25 V)
ADP2102-1.375EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 1.375 V)
ADP2102-1.5-EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 1.5 V)
ADP2102-1.8-EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 1.8 V)
ADP2102-1.875EVALZ <sup>1</sup>	Evaluation Board (Fixed Output 1.875 V)
ADP2102-1-EVALZ <sup>1</sup>	Evaluation Board (Adjustable Output 0.8 V to 1.2 V)
ADP2102-2-EVALZ <sup>1</sup>	Evaluation Board (Adjustable Output 1.2 V to 1.5 V)
ADP2102-3-EVALZ <sup>1</sup>	Evaluation Board (Adjustable Output 1.5 V to 1.875 V)
ADP2102-4-EVALZ <sup>1</sup>	Evaluation Board (Adjustable Output 2.5 V to 3.3 V)

<sup>1</sup> Z = RoHS Compliant Part.

### 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.

**NOTES**

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