Evaluating the AD8410A, −2 V to 70 V Wide Input Voltage Range, 2.2 MHz High Bandwidth, Current-Sense Amplifier with PWM Rejection

FEATURES

- Enables quick breadboarding and prototyping
- Easily configurable for unidirectional or bidirectional operation
- Includes provision for current-sense shunt resistor
- Easy connection to test equipment
- Includes provisions for an input filter and an output filter
- Decoupled supply line

EVALUATION KIT CONTENTS

- AD8410AR-EVALZ evaluation board
- AD8410ARM-EVALZ evaluation board

DOCUMENTS NEEDED

- AD8410A data sheet

GENERAL DESCRIPTION

This user guide is designed to aid in the evaluation of the AD8410A current-sense amplifier. The AD8410AR-EVALZ and the AD8410ARM-EVALZ are designed for easy configuration of different modes of operation and allow flexibility with loads. A shunt resistor (R1), with a maximum standard size of 2818, can be soldered to both boards.

The AD8410AR-EVALZ accommodates the AD8410A in a standard small outline package (SOIC_N). The AD8410ARM-EVALZ accommodates the AD8410A in a mini small outline package (MSOP). The AD8410ARM-EVALZ and AD8410AR-EVALZ are hereafter referred to as the AD8410A evaluation board in this user guide.

Full specifications on the AD8410A are available in the AD8410A data sheet available from Analog Devices, Inc., and must be consulted with this user guide when using the AD8410A evaluation board.

TABLE OF CONTENTS

REVISION HISTORY

8/2023—Rev. 0 to Rev. A

Changes to Evaluation Kit Contents Section.. 1
Changes to General Description Section.. 1
Changed AD8410AR-EVALZ Evaluation Board Photographs Section to AD8410A Evaluation Board Photographs Section.. 3
Added Figure 3 and Figure 4; Renumbered Sequentially.. 3
Changes to Quick Start Section.. 4
Change to Power Supplies Section.. 4
Changes to Components Section.. 4
Changes to Setting the Reference Voltage Section.. 4
Changes to Unidirectional Operation Section.. 4
Changes to Bidirectional Operation Section.. 4
Change to External Referenced Output Section.. 5
Changes to Input Filter Section.. 5
Changed Evaluation Board Schematic Section to AD8410A Evaluation Board Schematic Section.. 6
Changes to Figure 6 Caption.. 6
Changes to Table 4.. 7

2/2023—Revision 0: Initial Version

AD8410A EVALUATION BOARD PHOTOGRAPHS

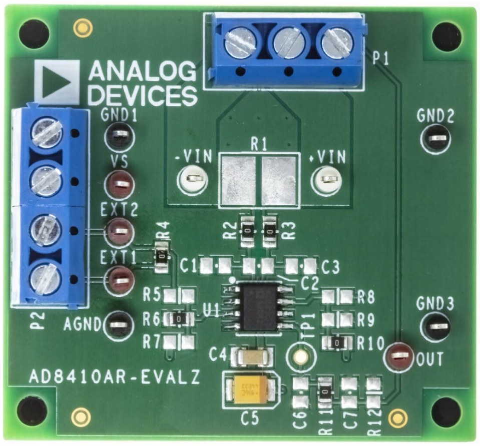

Figure 1. AD8410AR-EVALZ Top View

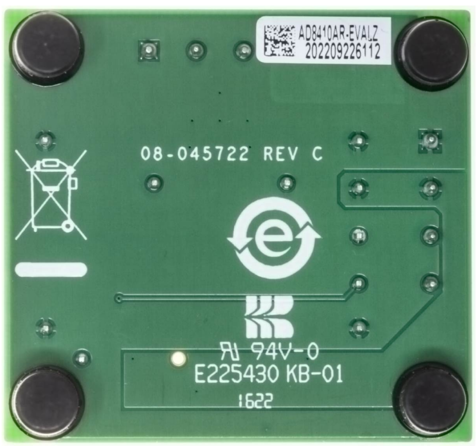

Figure 2. AD8410AR-EVALZ Bottom View

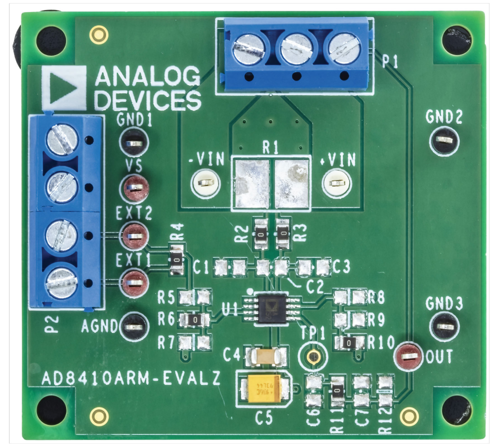

Figure 3. AD8410ARM-EVALZ Top View

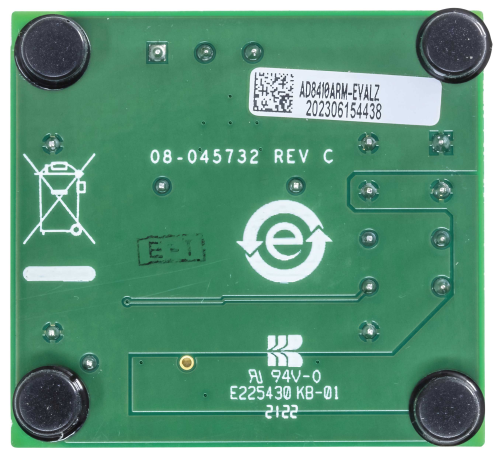

Figure 4. AD8410ARM-EVALZ Bottom View

QUICK START

By default, $V_{REF}1$ is connected to V_S and $V_{REF}2$ is connected to the GND pin. This split supply configuration sets the output to midsupply and allows bidirectional current sensing. Connect 5 V to the V_S test point on the AD8410A evaluation board, connect the ground of the supply to the AGND test point on the AD8410A evaluation board, and place a 0.1 V differential voltage between the +VIN test point and the −VIN test point on the AD8410A evaluation board. This small 0.1 V differential input voltage represents the voltage drop across the shunt resistor that is used in the application.

$$V_{OUT} = (2.5\text{V} + (V_{DIFF} \times \text{GAIN})) \quad (1)$$

After the AD8410A evaluation board is powered, the output reads as:

$$4.5\text{V} = (2.5\text{V} + (0.1\text{V} \times 20\text{V/V})) \quad (2)$$

Then swap the input differential voltage leads (move the lead on the +VIN test point to the −VIN test point and move the lead that was on the −VIN test point to the +VIN test point). The output then reads as:

$$0.5\text{V} = (2.5\text{V} - (0.1\text{V} \times 20\text{V/V})) \quad (3)$$

POWER SUPPLIES

The AD8410A has a power-supply operating range from 2.9 V to 5.5 V. Power is applied to the V_S test point. Decoupling capacitors of 10 μF and 0.1 μF are preinstalled on the AD8410A evaluation board.

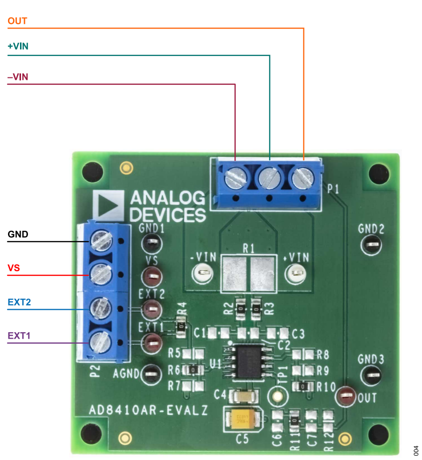

Figure 5. Connections to Terminal Blocks

COMPONENTS

The AD8410A can be used for a variety of current monitoring applications. The AD8410A evaluation board has a provision for a current-sense shunt resistor with a maximum standard size of 2818. There are also provisions with 0805 footprints for a capacitive-load, a resistive load, an input electromagnetic interference (EMI) filter, an output filter, and provisions to set the reference voltage. Terminal blocks (P1 and P2) are provided to allow easy wiring and evaluation.

SETTING THE REFERENCE VOLTAGE

Three resistor spaces (R8, R9, and R10) are on the right side of the AD8410A on the AD8410A evaluation board. These three resistors are used to set $V_{REF}1$. Fill only one of these resistor spaces at a time with a 0 Ω, 0805 resistor. See Table 1 for the resistor spaces that must be filled with 0 Ω to set $V_{REF}1$.

Three resistor spaces (R5, R6, and R7) are on the left side of the AD8410A on the AD8410A evaluation board. These three resistors are used to set $V_{REF}2$. Fill only one of these resistor spaces at a time with a 0 Ω, 0805 resistor. See Table 2 for the resistor spaces that must be filled with 0 Ω to set $V_{REF}2$.

Table 1. $V_{REF}1$ Pin Connections

Pin	R8	R9	R10
V_S	X	X	✓
GND	X	✓	X
EXT1	✓	X	X

Table 2. $V_{REF}2$ Pin Connections

Pin	R5	R6	R7
V_S	X	X	✓
GND	X	✓	X
EXT2	✓	X	X

Unidirectional Operation

For unidirectional operation, the output can be set at the negative rail (near ground) or at the positive rail (near the supply voltage) when the differential voltage is 0 V. To set the AD8410A evaluation board for a ground referenced output, solder the 0 Ω resistor on the left side of the AD8410A in the R6 space and the 0 Ω resistor on the right side of the AD8410A in the R9 space.

To set the AD8410A evaluation board for a supply voltage referenced output, solder the 0 Ω resistor on the left side of the AD8410A in the R7 space and the 0 Ω resistor on the right side of the AD8410A in the R10 space.

Bidirectional Operation

For bidirectional operation, the output is typically set at half scale for equal range in both directions. To configure the output to be at midsupply in the presence of 0 A of current through the shunt resistor on the AD8410A evaluation board, solder the 0 Ω resistor on the left side of the AD8410A in the R6 space and the 0 Ω resistor on the right side of the AD8410A in the R10 space.

By default, the output of the AD8410A evaluation board is biased at midsupply.

Table 3 shows which resistor must be filled with 0 Ω resistor to set the AD8410A evaluation board for different operations. In unidirectional operation, it can be ground referenced output and supply

QUICK START

voltage-referenced output whereas in the bidirectional operation, the output can be set to midsupply.

Table 3. Operation Connection

Mode	R6	R7	R9	R10
UNIDIRECTIONAL				
Ground Referenced	✓	X	✓	X
Supply Voltage Referenced	X	✓	X	✓
BIDIRECTIONAL				
Midsupply	✓	X	X	✓

External Referenced Output

An external supply can also be used to set the reference voltage. To bias the output to a single external supply, solder a 0 Ω, 0805 resistor in the R4 space. Then, solder the 0 Ω resistor on the left side of the AD8410A in the R5 space and solder the 0 Ω resistor on the right side of the AD8410A in the R8 space. The external supply voltage can then be applied to any one of the EXTx test points on the AD8410A evaluation board, and this configuration biases the output to the external supply.

The external supply can also be divided by 2 and used as a reference level. For this reference level, solder the 0 Ω resistor on the left side of the AD8410A in the R6 space, desolder the resistor in the R4 space, and solder the 0 Ω resistor on the right side of the AD8410A in the R8 space. Apply the external supply to the EXT1 test point or EXT1 terminal block input, and the output of the AD8410A is referenced to half of the external supply.

Two separate external supplies can also be used to set the reference for the output. Desolder the 0 Ω resistor from the R4 space. Solder the 0 Ω resistor on the left side of the AD8410A in the R5 space and solder the 0 Ω resistor on the right side of the AD8410A in the R8 space. Apply the first external supply, $V_{EXT}1$, to the EXT1 test point or EXT1 terminal block input. Apply the second external supply, $V_{EXT}2$, to the EXT2 test point or EXT2 terminal block input. This configuration references the output to:

$$\frac{(V_{EXT}1 + V_{EXT}2)}{2} \quad (4)$$

INPUT FILTER

The AD8410A evaluation board includes provisions for the components necessary for an input filter. By default, R2 and R3 are 0 Ω, 0805 resistors and C1, C2, and C3 are left unpopulated. It is required to filter at the input of the device to reduce EMI. The EMI specifications vary depending on the application. Filtering at the input must be preferred if the output cannot be filtered because filtering at the output changes the low output impedance seen by the components attached to the output of the AD8410A. The +IN and –IN inputs of the AD8410A have balanced input bias currents. This means that the input series resistors, R2 and R3, must be the same measured value to not have a large offset voltage added on the output of the device as a result of R2 and R3. It is recommended to keep R2 and R3 below 100 Ω.

The EMI filter has two different bandwidths, common-mode (BW_{CM}) and differential (BW_{DIFF}). The differential bandwidth defines the frequency response of the filter with a differential input signal applied between the two inputs of the amplifier, which are +IN and −IN. C1 and C3 must be the same value for the following equations.

The −3 dB differential bandwidth for the filter is:

$$BW_{DIFF} = \frac{1}{2\pi \times R2 \times ((2 \times C2) + C1)} \quad (5)$$

The common-mode bandwidth defines what a common-mode RF signal experiences between ground and the +IN and –IN inputs of the amplifier tied together.

The −3 dB common-mode bandwidth for the filter is:

$$BW_{CM} = \frac{1}{2\pi \times R2 \times C1} \quad (6)$$

Keep the resistor values to a 1% tolerance and the filter capacitors to a 5% tolerance to assist with reducing AC common-mode rejection (CMR) errors. Choose C2 to be at least 10× larger than C1 or C3 to reduce AC CMR errors, which are caused by component mismatching.

Figure 1 shows the top view and Figure 2 shows the bottom view of the AD8410AR-EVALZ evaluation board. Figure 3 shows the top view and Figure 4 shows the bottom view of the AD8410ARM-EVALZ evaluation board. Figure 6 shows the default schematic of the AD8410A evaluation board. The dotted lines in Figure 6 are routed under the printed circuit board (PCB).

AD8410A EVALUATION BOARD SCHEMATIC

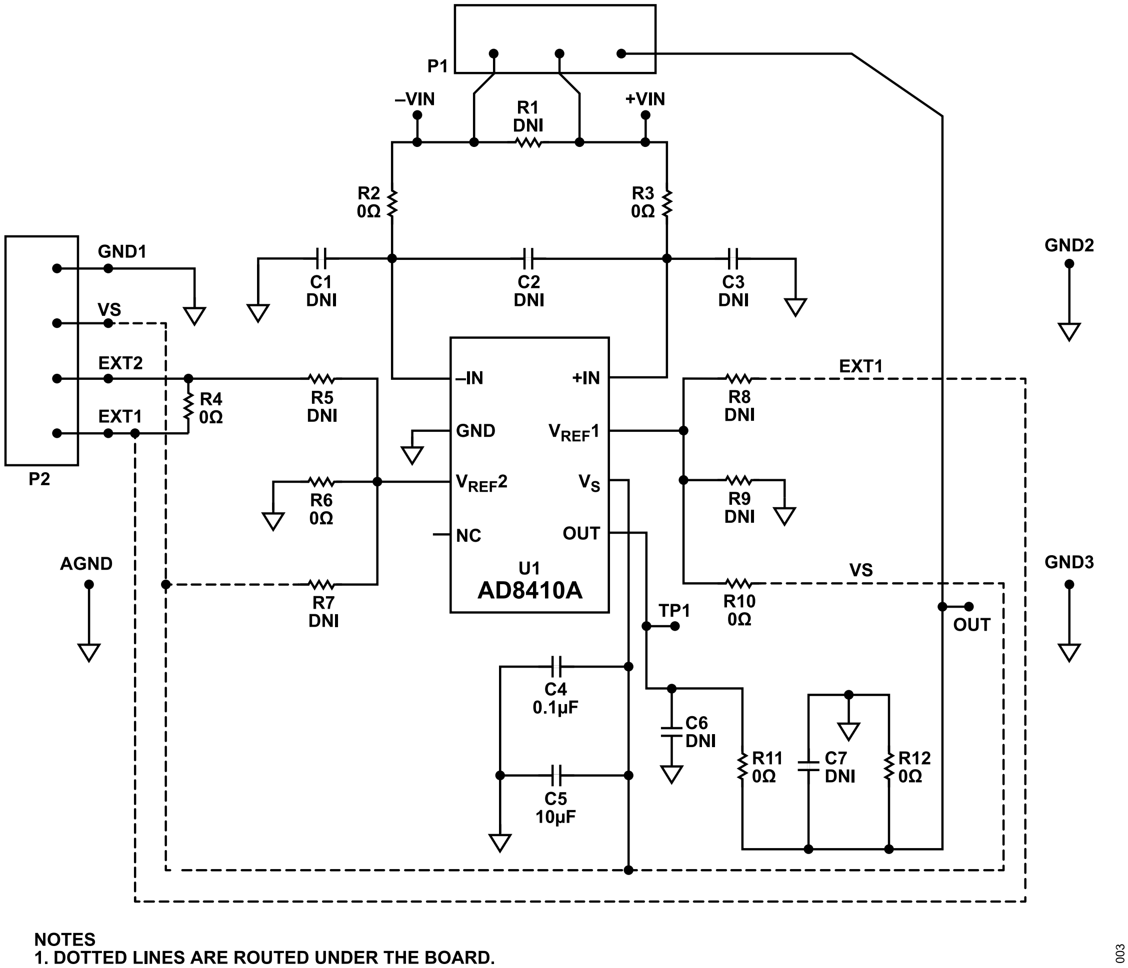

Figure 6. AD8410AR-EVALZ/AD8410ARM-EVALZ Evaluation Board Schematic