AD8412ARM-EVALZ

Evaluating the AD8412A, −2V to 50V Wide Input Voltage Range, 1.8MHz 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

- AD8412ARM-EVALZ evaluation board

DOCUMENTS NEEDED

- *AD8412A* data sheet

GENERAL DESCRIPTION

This user guide evaluates the AD8412A current-sense amplifier. The AD8412ARM-EVALZ is designed for easy configuration of different modes of operation and to allow flexibility with loads. A shunt resistor (R1), with a maximum standard size of 2818, can be soldered to the board.

The AD8412ARM-EVALZ accommodates the AD8412A in a mini small outline package (MSOP). The AD8412ARM-EVALZ is hereafter referred to as the AD8412A evaluation board in this user guide.

Full specifications on the AD8412A are available in the AD8412A data sheet available from Analog Devices. Consult it with this user guide when using the AD8412A evaluation board.

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AD8412A EVALUATION BOARD PHOTOGRAPHS

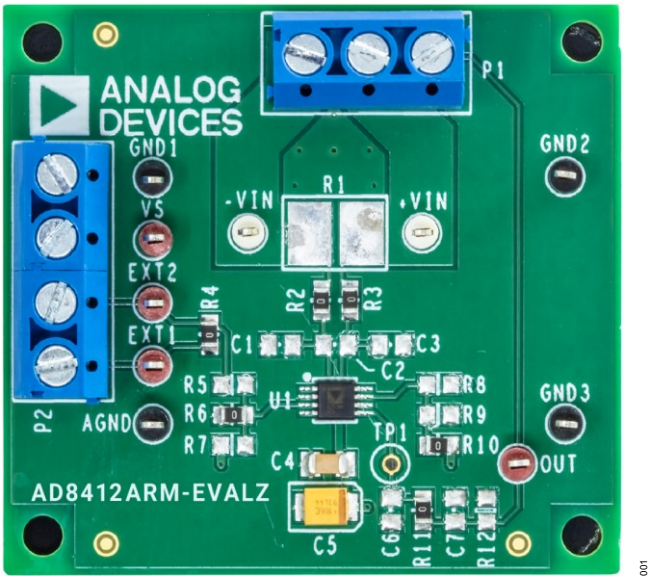

Figure 1. AD8412ARM-EVALZ Top View

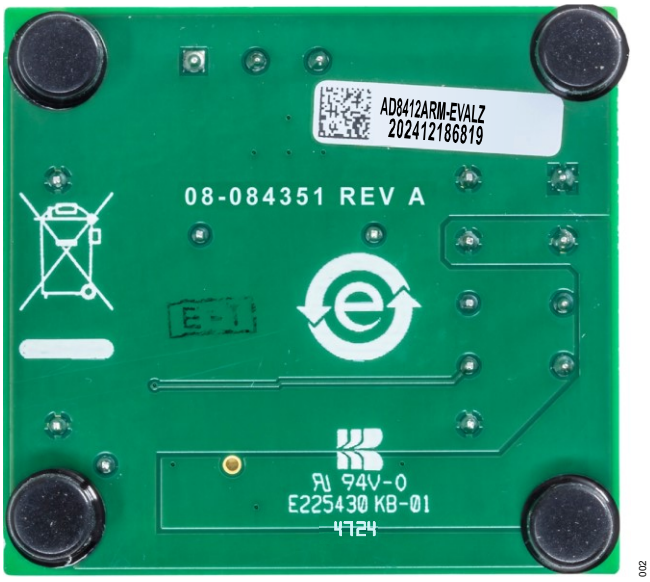

Figure 2. AD8412ARM-EVALZ Bottom View

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 5V to the V_S test point on the AD8412A evaluation board, connect the ground of the supply to the AGND test point on the AD8412A evaluation board, and place a 0.1V differential voltage between the +V_{IN} test point and the −V_{IN} test point on the AD8412A evaluation board. This small 0.1V differential input voltage represents the voltage drop across the shunt resistor used in the application.

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

After the AD8412A evaluation board is powered, the output reads as:

3.5V = (2.5V + (0.1V × 10V/V)) (2)

Then, swap the input differential voltage leads (move the lead on the +V_{IN} test point to the −V_{IN} test point and move the lead on the −V_{IN} test point to the +V_{IN} test point). The output then reads as:

1.5V = 2.5V − 0.1V × 10V/V (3)

Power Supplies

The *AD8412A* has a power-supply operating range from 2.9V to 5.5V. Power is applied to the V_S test point. Decoupling capacitors of 10µF and 0.1µF are preinstalled on the AD8412A evaluation board.

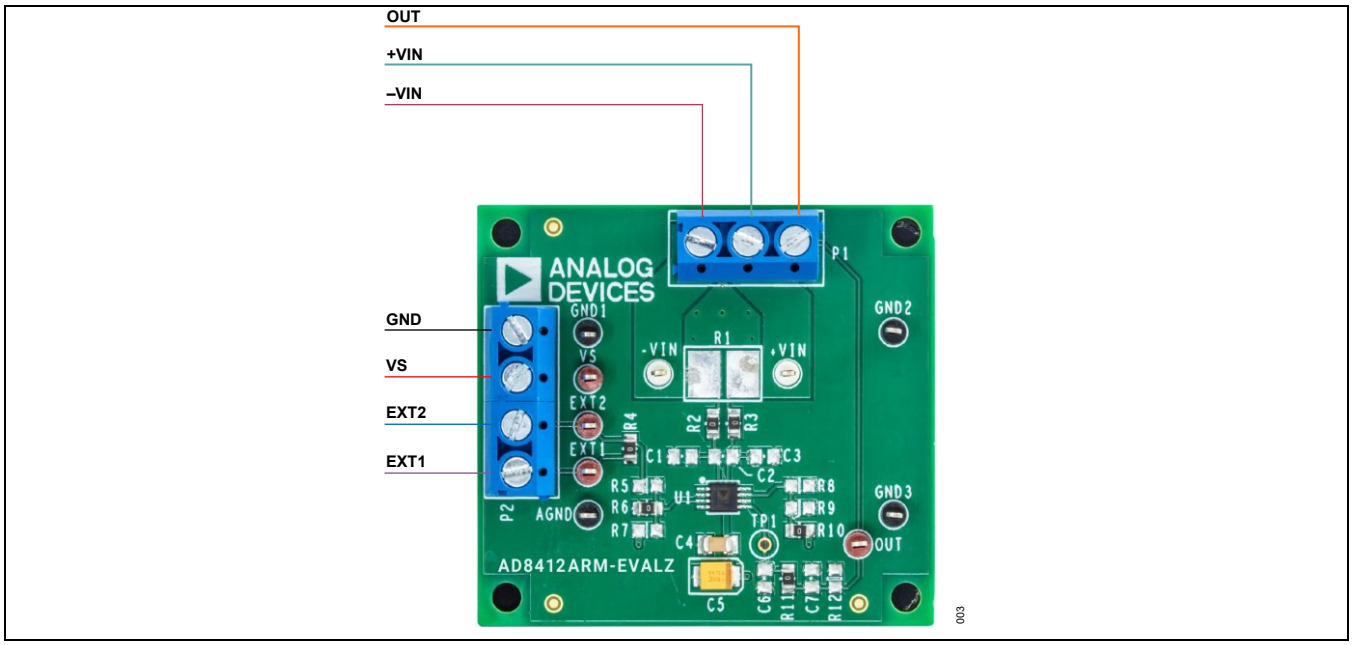

Figure 3. Connections to Terminal Blocks

Components

The AD8412A can be used for a variety of current monitoring applications. The AD8412A 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 AD8412A on the AD8412A evaluation board. These three resistors are used to set $V_{REF}1$. Fill only one of these resistor spaces at a time with a 0Ω, 0805 resistor. See *Table 1* for the resistor spaces that must be filled with 0Ω to set $V_{REF}1$.

Three resistor spaces (R5, R6, and R7) are on the left side of the AD8412A on the AD8412A evaluation board. These three resistors are used to set $V_{REF}2$. Fill only one of these resistor spaces at a time with a 0Ω, 0805 resistor. See *Table 2* for the resistor spaces that must be filled with 0Ω to set $V_{REF}2$.

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

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

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

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

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 0V. To set the AD8412A evaluation board for a ground referenced output, solder the 0Ω resistor on the left side of the AD8412A in the R6 space and the 0Ω resistor on the right side of the AD8412A in the R9 space.

To set the AD8412A evaluation board for a supply voltage referenced output, solder the 0Ω resistor on the left side of the AD8412A in the R7 space and the 0Ω resistor on the right side of the AD8412A 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 0A of current through the shunt resistor on the AD8412A evaluation board, solder the 0Ω resistor on the left side of the AD8412A in the R6 space and the 0Ω resistor on the right side of the AD8412A in the R10 space.

By default, the output of the AD8412A evaluation board is biased at midsupply.

Table 3 shows which resistor must be filled with the 0Ω resistor to set the AD8412A evaluation board for different operations. In unidirectional operation, it can be ground-referenced output and supply 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	✓	×	✓	×
Supply Voltage Referenced	×	✓	×	✓
BIDIRECTIONAL				
Midsupply	✓	×	×	✓

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 0Ω, 0805 resistor in the R4 space. Then, solder the 0Ω resistor on the left side of the AD8412A in the R5 space and solder the 0Ω resistor on the right side of the AD8412A in the R8 space. The external supply voltage can then be applied to any one of the EXTx test points on the AD8412A evaluation board, and this configuration biases the output to the external supply.

The external supply can also be divided by two and used as a reference level. For this reference level, solder the 0Ω resistor on the left side of the AD8412A in the R6 space, desolder the resistor in the R4 space, and solder the 0Ω resistor on the right side of the AD8412A in the R8 space. Apply the external supply to the EXT1 test point or EXT1 terminal block input, and the output of the AD8412A 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 0Ω resistor from the R4 space. Solder the 0Ω resistor on the left side of the AD8412A in the R5 space and solder the 0Ω resistor on the right side of the AD8412A 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:

$$\frac{(V_{EXT1} + V_{EXT2})}{2} \qquad (4)$$

Input Filter

The AD8412A evaluation board includes provisions for the components necessary for an input filter. By default, R2 and R3 are 0Ω, 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 AD8412A. The +IN and –IN inputs of the AD8412A have balanced input bias currents. This means 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 because of R2 and R3. It is recommended to keep R2 and R3 below 100Ω.

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:

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

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:

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

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 AD8412A evaluation board. *Figure 4* shows the default schematic of the AD8412A evaluation board. The dotted lines in *Figure 4* are routed under the printed circuit board (PCB).

AD8412A EVALUATION BOARD SCHEMATIC

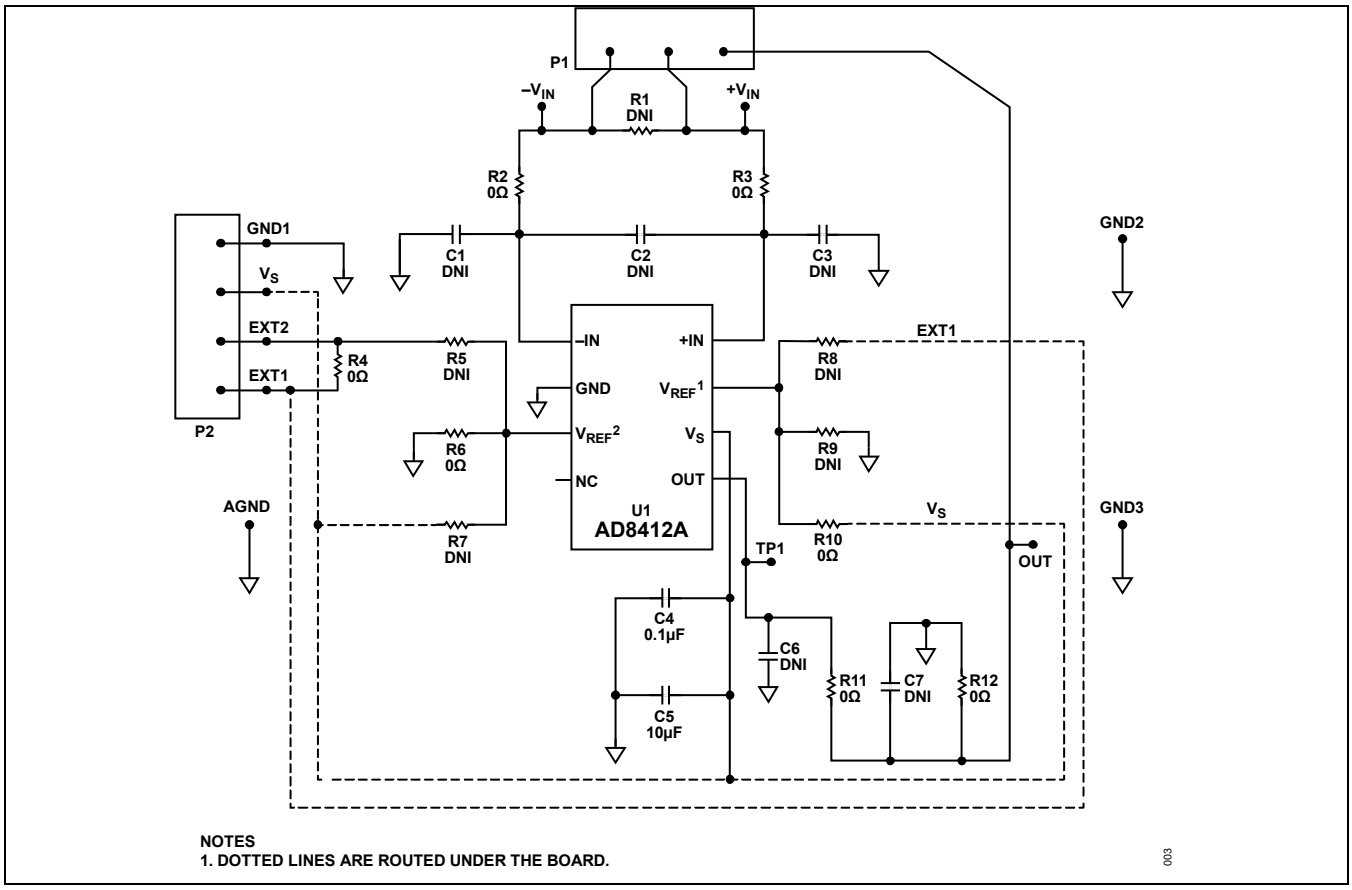

Figure 4. AD8412A Evaluation Board Schematic

Ordering Information

Table 4. Bill of Materials

Item	Quantity	Reference Designator	Part Description	Manufacturer, Part Number
1	1	A1	IC, high voltage, high bandwidth, current-sense amplifier, automotive	Analog Devices Inc., AD8412ABRMZ
2	2	+VIN, −VIN	Connectors-PCB, test point white	Keystone Electronics, 5002
3	4	AGND, GND1, GND2, GND3	Connectors-PCB, test point black	Keystone Electronics, 5001
4	1	C4	Capacitor, ceramic, 0.1µF, 50V, 10%, X7R, 1206	Yageo, CC1206KRX7R9BB104
5	1	C5	Capacitor, tantalum, 10µF, 16V, 10%, 3528-20	AVX Corporation, TAJB106K016RNJ
6	4	EXT1, EXT2, OUT, VS	Connectors-PCB, test point red	Keystone Electronics, 5000
7	1	P1	Connector-PCB, terminal block vertical, 5mm pitch	On Shore Technology, OSTTC030162
8	1	P2	Connector-PCB, terminal block, 5mm pitch, 3.5mm solder tail	On Shore Technology, OSTTC040162
9	6	R2, R3, R4, R6, R10, R11	Resistors, SMD, 0Ω, 1/10 W, 0805	Multicomp (SPC), MC 0.1 W 0805 0R
10	4	Standard Grip	Miscellaneous, bumper cylindrical, size 0.312" diameter (7.92mm), thickness 0.215" (5.46mm), black with adhesive	3M, SJ61A6
11	5	C1, C2, C3, C6, C7	Not installed, capacitors, C0805	NA
12	1	R1	Not installed, resistor, 2818	NA
13	5	R5, R7, R8, R9, R12	Not installed, resistors, R0805	NA
14	1	TP1	Not installed, connector-PCB, test point black	NA

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	01/25	Initial release	—`

Notes

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