

Evaluating the AD8494 to AD8497 Series Thermocouple Amplifiers

FEATURES

J type or K type thermocouple (provided)

Low cost

Pretrimmed for J type or K type thermocouple

Internal cold junction compensation

Reference pin allows offset adjustment

EQUIPMENT NEEDED

±5 V dc power supply

GENERAL DESCRIPTION

This user guide is a description of functionality for the AD8494 series evaluation board. The evaluation board can be configured for the AD8494, AD8495, AD8496, and AD8497 to ensure that the metals and alloys are properly matched for the thermocouple type for which the device is trimmed. The 4-layer evaluation board (shown in Figure 1 and Figure 2 with different components) is designed to allow users to quickly prototype the precision thermocouple amplifiers for various user defined configurations for different applications. The evaluation board has three modes of operation: linear mode, setpoint controller mode, and hysteresis on setpoint controller mode.

The AD8494/AD8495/AD8496/AD8497 data sheet is available at www.analog.com. This data sheet provides additional information on the AD8494, AD8495, AD8496, and AD8497 and must be consulted in conjunction with this user guide when using the evaluation board.

EVALUATION BOARD PHOTOGRAPHS

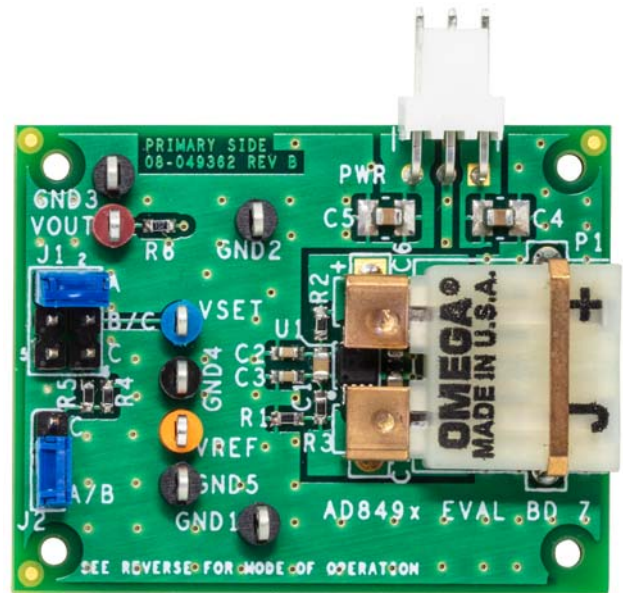


Figure 1. AD8494 Series Evaluation Board with J Type Female Thermocouple Connector for AD8494 and AD8496

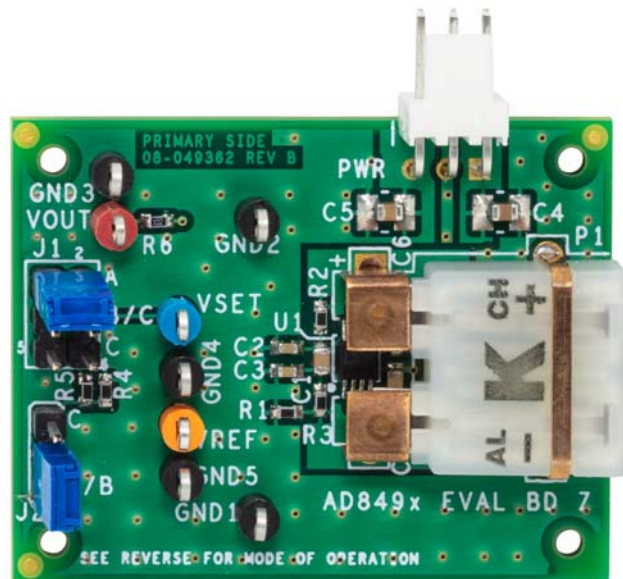


Figure 2. AD8494 Series Evaluation Board with K Type Female Thermocouple Connector for AD8495 and AD8497

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REVISION HISTORY

11/2019—Revision 0: Initial Version

QUICK START

The AD8494 series evaluation board is shipped in linear mode by default, as shown in Figure 3. To configure the board in linear mode, ensure that the jumpers are set to the default values shown in Table 1.

Table 1. Linear Mode Settings (Default)

| Label | Position | Setting |
|-------|----------|--|
| J1 | A | Linear mode (SENSE shorted with V _{OUT} output voltage) |
| J2 | A/B | Linear mode (V _{REF} is grounded) |

SETUP PROCEDURE

Take the following steps to set up the AD8494 series evaluation board:

1. Plug the thermocouple into the thermocouple connector on the AD8494 series evaluation board.
2. Ensure that the jumper on J1 is set at Position A and that the jumper on J2 is set at Position A/B, as described in Table 1.
3. Connect the evaluation board PWR pins to ±5 V and ground.
4. The output signal with respect to the reference voltage (V_{REF}) is available at the V_{OUT} terminal on the evaluation board.

MODES OF OPERATION

Linear Mode

Linear mode is the default mode of operation set for the board. Figure 3 shows linear mode connections for the AD8494 series evaluation board using a J type or K type thermocouple input.

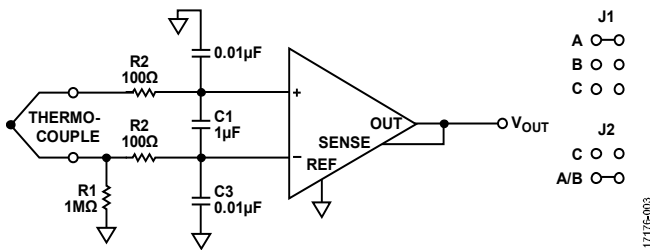


Figure 3. Linear Connection

The output voltage of the AD8494/AD8495/AD8496/AD8497 is calculated as follows:

$$V_{OUT} = (T_{MJ} \times 5 \text{ mV}/^{\circ}\text{C}) + V_{REF}$$

where T_{MJ} is the thermocouple measurement junction temperature.

If the linear connection is not working, disconnect the thermocouple and short both inputs to ground. If the system reads the ambient temperature correctly, the problem is related to the thermocouple. If the system does not read the ambient temperature correctly, the problem is either with the AD8494/AD8495/AD8496/AD8497 or with the downstream circuitry.

Setpoint Controller Mode

The AD8494 series evaluation board operates as a temperature setpoint controller when configured with either a thermocouple input from a remote location or with the AD8494/AD8495/AD8496/AD8497 being used as a temperature sensor (see Table 2 and Figure 4). When the measured temperature is below the setpoint temperature, the output voltage goes to $-V_s$. When the measured temperature is above the setpoint temperature, the output voltage goes to $+V_s$. For optimal accuracy and common-mode rejection ratio (CMRR) performance, the setpoint voltage must be created with a low impedance source. If the setpoint voltage is generated with a voltage divider, a buffer is recommended.

Table 2. Setpoint Controller Settings

| Label | Position | Setting |
|-------|----------|--|
| J1 | B | Setpoint control mode |
| J2 | A/B | Setpoint control mode (V _{REF} is grounded) |

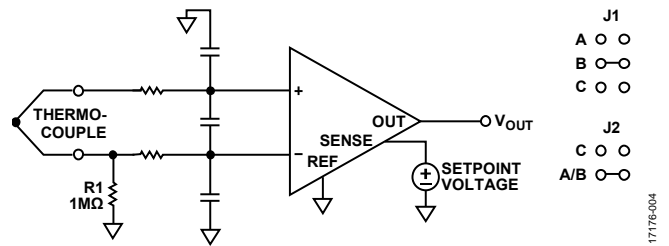


Figure 4. Setpoint Controller

Hysteresis on Setpoint Controller Mode

Hysteresis can be added to the setpoint controller by using a resistor divider from the output to the reference pin, as shown in Figure 5. The jumper positions must be updated to those in the Table 3. An additional jumper at J1 is required to make a total of three connections to maintain setpoint control and add hysteresis mode.

Table 3. Hysteresis on Setpoint Controller Settings

| Label | Position | Setting |
|-------|----------|--|
| J1 | B and C | Hysteresis on setpoint controller mode |
| J2 | C | Hysteresis on setpoint controller mode |

The hysteresis in $^{\circ}\text{C}$ is calculated as

$$T_{HYST} = \frac{V_s \times (R4 / (R4 + R5))}{5 \text{ mV}/^{\circ}\text{C}}$$

where:

T_{HYST} is the hysteresis temperature.

V_s is the supply voltage.

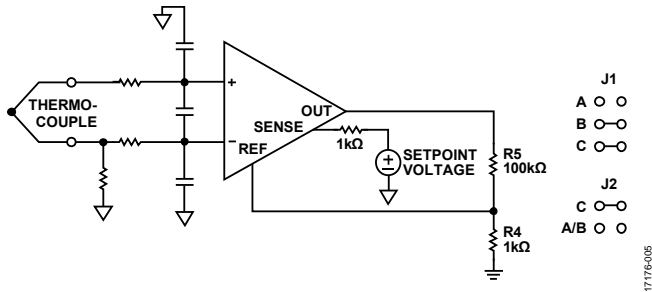


Figure 5. Adding 10°C of Hysteresis

The resistors installed on the evaluation board are 1 kΩ and 100 kΩ, which creates a window of approximately 10°C around the setpoint temperature for a +V_s of 5 V. A resistor equivalent to the output resistance of the divider must be connected to the SENSE pin to preserve the high performing CMRR.

Measuring Negative Temperatures

The AD8494 series evaluation board can measure negative temperatures using either single or dual supplies. When operating on dual supplies with the J2 jumper in A/B position

(reference pin grounded), a negative output voltage indicates a negative temperature at the thermocouple measurement junction.

When operating the AD8494 series evaluation board on a single supply level, apply a positive voltage (less than +V_s) on the reference pin to shift the output. The jumper from J2 must be removed so that the reference pin is not grounded. An output voltage less than V_{REF} indicates a negative temperature at the thermocouple measurement junction.

Reference Pin and Offset Adjustment

The VREF pin can be used to level shift the output voltage of the AD8494 series evaluation board. Level shifting the output voltage is useful when measuring negative temperatures on a single supply and when offsetting any initial calibration errors. Remove the jumper from J2 and apply a small reference voltage proportional to the error to nullify the effect of the calibration error on the output. The output voltage of the AD8494/AD8495/AD8496/AD8497 is calculated as follows:

$$V_{OUT} = (T_{MJ} \times 5 \text{ mV}/^{\circ}\text{C}) + V_{REF}$$

EVALUATION BOARD SCHEMATIC AND ARTWORK

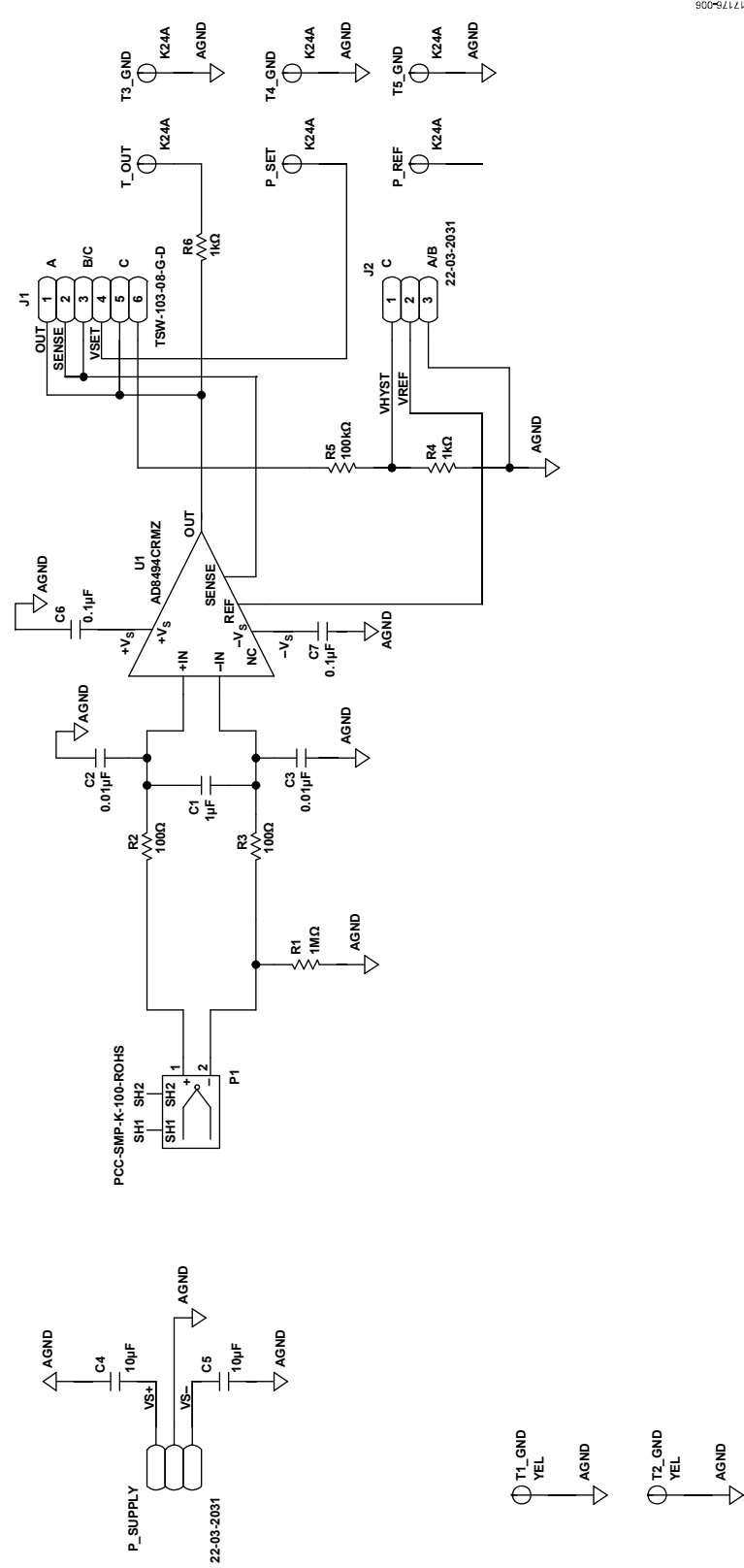


Figure 6. Evaluation Board Schematic, Device Under Test (DUT) Analog Input Circuits

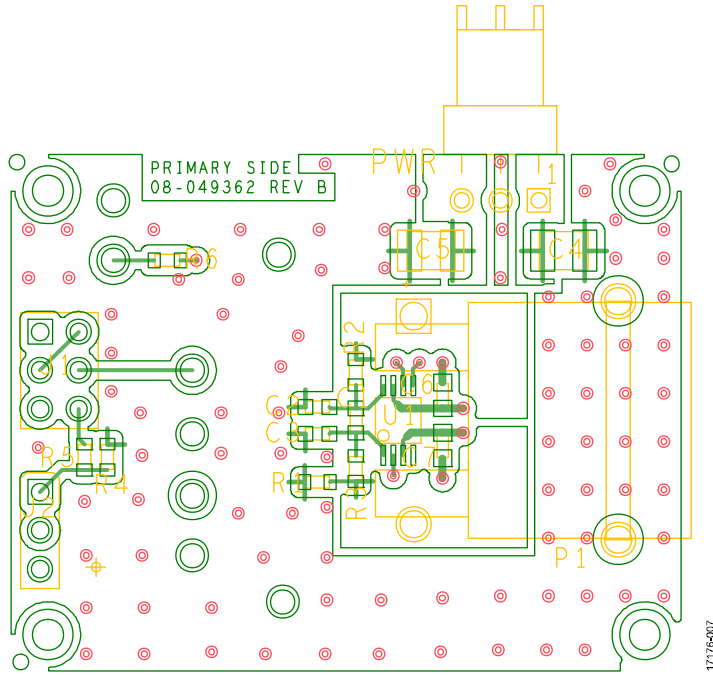


Figure 7. Evaluation Board Layout, Top Side

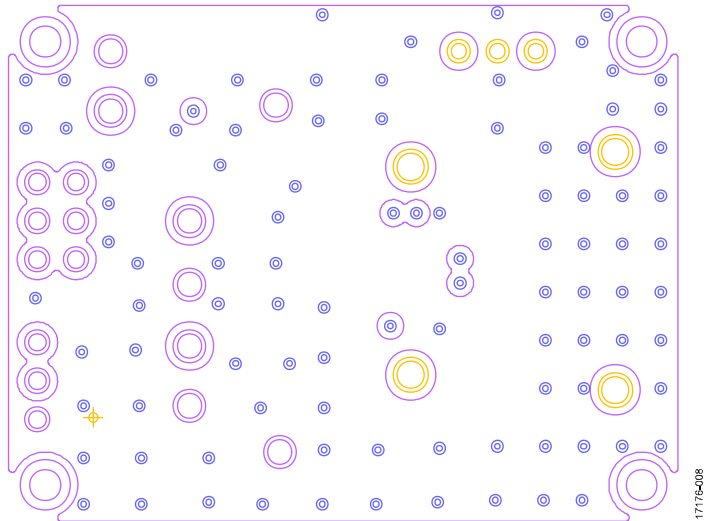


Figure 8. Evaluation Board Layout, Ground Plane (Layer 2)

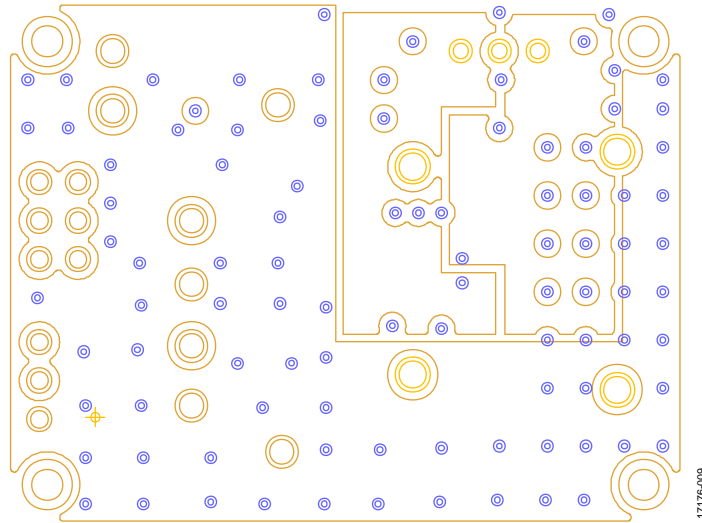


Figure 9. Evaluation Board Layout, Power Plane (Layer 3)

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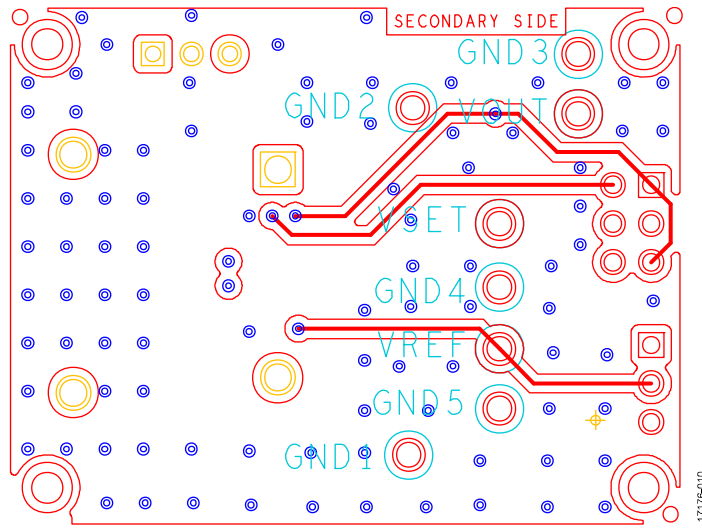


Figure 10. Evaluation Board Layout, Bottom Side

17776-010

ORDERING INFORMATION

BILL OF MATERIALS

Table 4.

| Reference Designator | Description | Value | Tolerance | Voltage | Manufacturer | Part Number |
|--|---|--|----------------|----------------|---------------------------------|--|
| Not applicable | Printed circuit board (PCB) | Not applicable | Not applicable | Not applicable | Analog Devices, Inc. (supplied) | 08_049362B |
| C1 | Capacitor, ceramic X5R, general-purpose | 1 μ F | 10 | 16 V | Murata | GRM188R61C105KA93D |
| C2, C3 | Capacitors, ceramic X7R, general-purpose | 0.01 μ F | 10 | 16 V | Murata | GRM188R71C103KA01D |
| C4, C5 | Capacitors, ceramic X7R, for general use | 10 μ F | 10 | 63 V | Murata | GRM32ER71J106KA12L |
| C6, C7 | Capacitors, ceramic broadband, X7R | 0.1 μ F | 20 | 25 V | Dielectric Labs | P62BN820MA2636 |
| T1_GND, T2_GND, T3_GND, T4_GND, T5_GND | Connected PCB test point blocks | Block | Not applicable | Not applicable | Components Corporation | TP-104-01-00 |
| J1 | Connected PCB Berg header, double string male, 6-position | TSW-103-08-G-D | Not applicable | Not applicable | Samtec | TSW-103-08-G-D |
| J2 | Connected PCB header, 2.54 mm, 3-position, vertical | 22-03-2031 | Not applicable | Not applicable | Molex | 22-03-2031 |
| P1 | Connected PCB thermocouple, miniature size, calibration Type K and Type J, 1X M025043 | PCC-SMP-K-100-RoHS, PCC-SMP-J-100-RoHS | Not applicable | Not applicable | Omega Engineering | PCC-SMP-K-100-RoHS, PCC-SMP-J-100-RoHS |
| PWR | Connected PCB header, right arm (RA) friction lock | 22-12-2034 | Not applicable | Not applicable | Molex | 22-12-2034 |
| R1 | Resistor precision thick film chip, R0603 | 1 MB | 1 | Not applicable | Panasonic | ERJ-3EKF1004V |
| R2, R3 | Resistor thin film chips, high reliability | 100 Ω | 0.1 | Not applicable | Panasonic | ERA-3AEB101V |
| R4 | Resistor chip, SMD, 0603 | 1 k Ω | 0.05 | Not applicable | Susumu Co., Ltd. | RG1608N-102-W-T1 |
| R5 | Resistor precision thick film chip | 100 k Ω | 1 | 50 V | Panasonic | ERJ-3EKF1003V |
| R6 | Resistor metal film chip | 1 k Ω | 0.1 | Not applicable | Panasonic | ERA-3AEB102V |
| U1 | IC precision thermocouple amplifier with cold junction compensation | AD8494CRMZ , AD8495CRMZ , AD8496CRMZ , AD8497CRMZ | Not applicable | Not applicable | Analog Devices | AD8494CRMZ , AD8495CRMZ , AD8496CRMZ , AD8497CRMZ |
| VOUT | Connected PCB, test point red | Red | Not applicable | Not applicable | Components corporation | TP-104-01-02 |
| VREF | Connected PCB, test point yellow | Yellow | Not applicable | Not applicable | Components corporation | TP-104-01-04 |
| VSET | Connected PCB, test point blue | Blue | Not applicable | Not applicable | Components corporation | TP104-01-06 |
| Not applicable | Mounting bracket for thermocouple connector, PCC-SMP | Not applicable | Not applicable | Not applicable | Omega Engineering | PCC-SMP-CLIP |

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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