ADS124S08: Calibration of ADS124S08

Vijay

Prodigy 170 points
Community Member

Part Number: ADS124S08
Other Parts Discussed in Thread: ADS125H02

Hello Team,
We are planning to use the ADC ADS124S08 for one of our applications to measure the temperature using RTD sensors like (PT100 and PT1000).
The excitation current of 1mA for the PT100 and PT1000 sensors is generated through a Howland current source (Link).
We are planning to use an external PGA (MPN - ADA4254ARUZ-R7).

What is the best method to calibrate the ADC?
Here is an article showing how to calibrate the offset error and gain error of the ADC
Can anyone comment on this?

8 months ago

Bryan Lizon86 *8 months ago*

TI_Mastermind 36061 points

Hi Vijay,

Out of curiosity, why are you using external current sources and a PGA instead of using the ADS124S08 IDACs and PGA for your RTD measurement? The ADS124S08 is intended to be an all-in-one solution for RTD measurements.

The best way to calibrate an RTD measurement system is to use calibration resistors near the extremes of your temperature measurement range. These high accuracy resistors take the place of the actual RTD, and allow you to calibrate the transfer function of your system (ADC + PGA + reference resistor error) to the RTD response curve

You could also perform an offset and gain calibration using the methods specified in the article, this can calibrate the ADC or the signal chain, depending on how you implement it

-Bryan

Shibin Varghese *8 months ago in reply to Bryan Lizon86*

Intellectual 835 points

Hello Bryan,

Thank you for your reply.

The excitation curent of the ADS124 ranges only from 10uA to 2000uA. We are also using sensors like diode whose excitation current is 100nA. This is the reason why we are using how land current source.

Can you please tel us the calibration procedure for gain and offset error calibration for ADS124.

Some documents says we need to short the inputs of the ADC to 0V to get the offset error.

Then the inputs of the ADC should be shorted to the FSR voltage of the ADC to get the gain error and thus the slope of the ADC transfer cave curve is rotated.

Since ADS124 is a differential ADC what is the procedure for connecting the differential inputs to 0V and FSR

Bryan Lizon86 *8 months ago in reply to Shibin Varghese* TI__Mastermind 36061 points

Hi Shibin Varghese,

Thanks for letting me know, the original request only mentioned Pt100 and Pt1000 where the ADS124S08's integrated current sources would be sufficient

You could also consider a device like our ADS125H02, which has an integrated high voltage gain amplifier. This would be similar to an ADA4254 + ADC. Let me know if this is an interesting solution for you

Perform ADC offset calibration by shorting a differential ADC input pair to a mid supply voltage ([AVDD - AVSS] / 2). Then take several measurements and average them together to determine the offset

Perform ADC gain calibration by applying a high precision, near full-scale input voltage to one of the ADC differential input pairs. Note that full-scale changes depending on the gain you are using, and the PGA common-mode restrictions must be met. Take several measurements and average them together to determine the gain error.

The article that Vijay linked to in the initial post describes in detail how to use these measured values to determine the gain scaling coefficient that must be applied to each output code. You would then subtract the offset value from each code and multiply by the gain scaling coefficient

-Bryan

Shibin Varghese *8 months ago in reply to Bryan Lizon86* Intellectual 835 points

Hello Bryan,
Thank you for your reply.
The ADC is configured as a differential ADC.
The voltage across the PT100 sensor is taken differentially, and is fed to the PGA and the output of the PGA is also differnetial.
The differential signal is fed to the differential input of the ADC.
We need system calibration and not just ADC calibration alone.
Also, when the differential inputs of the ADC are shorted and connected to 0V we will get zero offset error.
When the ADC inputs are shorted and the voltage is set to the FSR voltage, the differential voltage across the ADC will still be 0V.
Please correct me if I am wrong.

Bryan Lizon86 *8 months ago in reply to Shibin Varghese* TI__Mastermind 36061 points

Hi Shibin Varghese,

When you apply a 0V input using the method I described, the measured result is the ADC noise + offset. You can average multiple samples together to reduce the noise and achieve a higher accuracy offset measurement. This method can be used either at the ADC inputs or at the system inputs to measure the ADC or system offset, respectively.

The gain calibration requires a near full-scale input, which is therefore nonzero. The ADS124S08 has a full-scale range of 2*VREF / gain, so a full-scale input would be +VREF / gain. If VREF = 2.5V and gain = 8 for example, then you would need to apply a 2.5V / 8 = 0.3125V signal. In practice, you would need to apply a slightly smaller signal in case the gain error was positive and resulted in an ADC code >+FS i.e. a clipped code. So something like 0.3V would work in this example. Note that this has to be a very high precision signal, as the accuracy of the calibration is only as good as the accuracy of the source. You also need to ensure that the applied signal meets the (internal or external) PGA common-mode limitations. If you were using the amplifier inside the ADS124S08 for example, the common-mode of the input signal generally needs to be centered at mid-supply ([AVDD-AVSS]/2). If you want to use the external amplifier for your application, refer to that device's datasheet for more information

-Bryan

Shibin Varghese *8 months ago in reply to Bryan Lizon86* Intellectual 835 points

Hello Bryan,

Thank you for your reply.

Suppose 0.3V is the full scale input of the ADC, what is the voltage we need to apply at the AINP and AINN of the ADC.

Since the ADC is configured for differential input, if the AINP and AINN of the ADC is shorted together and a 0.3V applied the resultant differential voltage will be 0V. please correct me if I am wrong

Bryan Lizon86 *8 months ago in reply to Shibin Varghese* TI__Mastermind 36061 points

Hi Shibin Varghese,

You short the inputs to a mid-supply voltage for the offset calibration

You do not short the inputs for the gain calibration. As mentioned, you need to apply a near-full-scale input voltage (VIN) that is typically centered at the ADC mid-supply voltage (V_MS). So if AVDD = 5V, AVSS = 0V, then V_MS = 2.5V. The absolute voltage on each pin would therefore be V_MS±(VIN/2). If VIN = 0.3V, that is 2.5V±0.15V, or AINP = 2.65V and AINN = 2.35V. Note that it is also possible to shift the common-mode of the input signal as long as it still meets the PGA common-mode limitations. The ADS124S08 PGA limitations are given by Equation 5 in the datasheet. If you use an external amplifier, refer to that device's datasheet for this information.

-Bryan