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ADS114S08: PGA settings

Harini Madhusudh... Prodigy 160 points
Community Member

Part Number: ADS114S08

Hi,

I would like to understand little more about the PGA settings for this converter ADS114S08.

Background: I am planning to use ADS114S08 to measure 4-20mA signal using a shunt resistance of 100ohm. The power supply would be 0 to 3.3V or 5V ie. AVSS 0 and AVDD 3.3V or 5V.

With this setting my understanding is that the PGA would have to be bypassed. Is this so? Should be looking at AVSS (-) 2.5V and VDD 2.5V and a lower shunt resistor to be able to enable the PGA for higher gains?

Any clarification/additional information would be useful. Thanks!

over 6 years ago

Bob Benjamin *over 6 years ago*

TI__Guru** 113705 points

Hi Harini,

The shunt voltage for the ADS114S08 at 20mA and 100 ohm shunt is 2V. So there is no ability to increase the gain when using 3.3V. So you could use unipolar supply in this case using PGA disabled. You need to disable the PGA because the output cannot drive all the way to AVSS (AGND)

If you wanted to use 5V for AVDD and a 5V reference voltage with a shunt value of 100 ohms you theoretically could use a gain of 2 which requires PGA enabled. The actual input range will not allow the input voltage to be AGND referenced, so here there would be an issue. But in the end is it worth the hassle of bipolar supplies and using a gain of 2, when you can just use the unipolar supply at a gain of 1 and the 2.5V reference?

The LSB value for the 5V reference and gain of 2 is the same as using the 2.5V reference and a gain of 1.

So what happens with using a lower shunt value and higher PGA gain? As stated previously this would require bipolar supplies and proper common-mode. The upside is you can use the PGA, with a smaller shunt. The downside is the effort becomes much higher due to the bipolar supplies and noise may start to be a factor when gaining up any noise on the input from the lower shunt resistance.

To summarize, you will need to use the PGA bypassed with unipolar analog supply. The PGA can be enabled if bipolar supplies are used with a much lower shunt value. In the end you will need to determine if the effort is worth it. You may find that the noise-free resolution remains the same.

Best regards,
Bob B

Harini Madhusudhan *over 6 years ago in reply to Bob Benjamin* — Prodigy 160 points

Thanks for the information, Bob.

If I am just checking if I understood you right.

When I use a unipolar supply of 3.3V or 5V and let us say I use a lower shunt resistance of 30 ohms then the shunt voltage for 20mA would be 0.6V. This means I should be able to use the PGA gain of upto 4 for 3.3V and 8 for 5V right?

I am trying to trade the following options:

1. Unipolar 3.3V/5V with 100 ohm shunt

2. Unipolar 3.3V/5V with 30 ohm or lower shunt

3. Bipolar 2.5V with 30 ohm or lower shunt

Bob Benjamin *over 6 years ago in reply to Harini Madhusudhan* — TI__Guru** 113705 points

Hi Harini,

You didn't state what reference voltage you are expecting to use. If the reference voltage is the supply then the full-scale range (FSR) would be +/- 825mV (3.3/4) or +/- 625mV (5/8). These FSRs would seem to work based on a maximum input voltage of 600mV. But this rough calculation does not consider the input-voltage restrictions of the ADS114S08.

With unipolar supply and with the PGA enabled you cannot reference the shunt input to AGND as there are certain PGA input-voltage requirements (see section 9.3.2.1 on page 32 of the ADS114S08 datasheet). The input voltage and gain must abide by equation 5 in the datasheet. There is a calculator tool to help you understand as well as calculate your desired operation to see if the input restrictions affect the desired configuration. The calculator can be downloaded from:

http://www.ti.com/tool/ads124s08-excel-calc-tool

The above calculator tool will help you see the input range for the gain, reference voltage and analog supply chosen (Common-Mode Range tab). Using the PGA with a unipolar supply even at only a gain of 1 requires that the shunt voltage is offset greater than 0.15V above AGND as the maximum output of the PGA is 150mV from either supply rail. You could add a small offset, but the stability of this offset and any noise in the offset voltage will directly impact the result.

With the theoretical value of 600mV maximum input voltage using a gain of 8 would seem possible to do using a 5V reference and 5V analog supply, but because of the input restrictions the common-mode of the input voltage will be too high to allow a gain of 8 with this type of configuration. Also, using a gain of 8 with a 5V reference has the same resolution as a gain of 4 using a 2.5V reference.

The most gain that can be used with a 5V supply is gain of 4 due to the input requirements. Using +/- 2.5V bipolar supplies will allow the shunt to be referenced to AGND.

When using the 5V unipolar supply and If the shunt is referenced to AGND (VINN is 0V at AGND), the output of the PGA using a 30 ohm shunt and 20mA of current will try to force the PGA outside of the supply rail. However there is an alternative to using this configuration.

If the shunt is referenced to an offset voltage provided from the ADS114S08 you can simply the circuit. One source for this offset is the internal reference output. Using this 2.5V offset will allow the PGA to be enabled using a gain of 4. The 2.5V offset will unfortunately not allow for a gain of 4 with a 3.3V analog supply. However, it may be possible to use the VBIAS (which is mid-analog supply) as the offset. I have used the internal reference as a shunt offset, but I have not used VBIAS, so some experimentation will need to be done. If VBIAS does work as expected, then you should be able to use the PGA at a gain of 4 for both 3.3V and 5V.

Option 1 would require PGA bypassed at a gain of 1.

Option 2 would require an offset for the shunt with a gain of 4 possible.

Option 3 would allow a gain of 4 and the shunt could be AGND referenced.

Best regards.