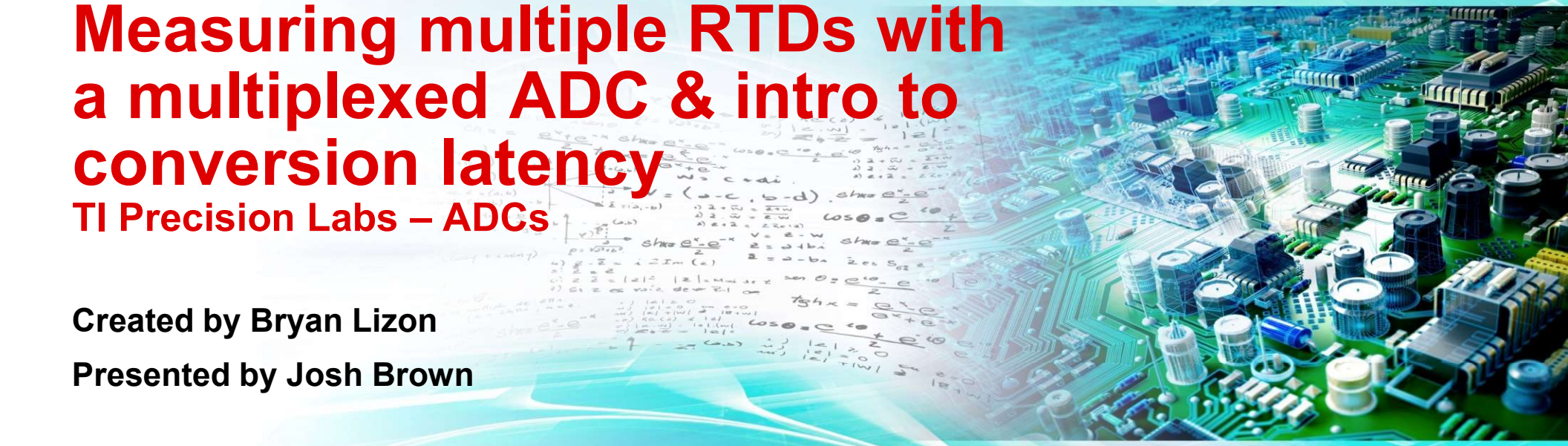
Measuring multiple RTDs with a multiplexed ADC & intro to conversion latency

TI Precision Labs – ADCs



Created by Bryan Lizon

Presented by Josh Brown

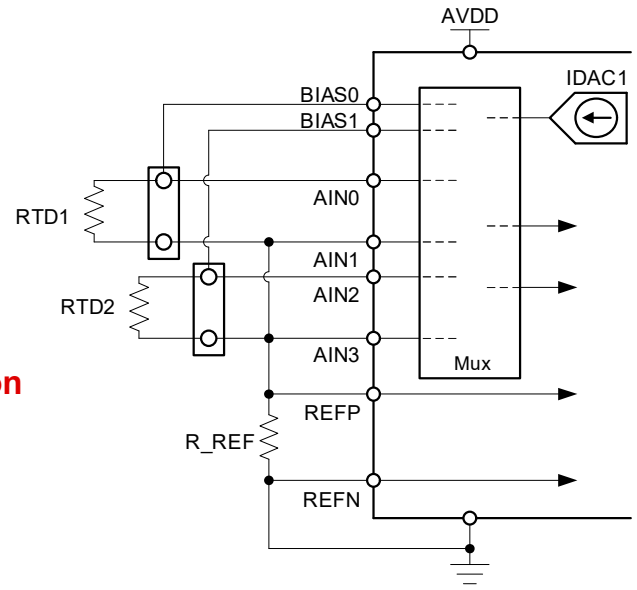
Types of multi-RTD measurement systems

Same wiring configuration for all RTDs

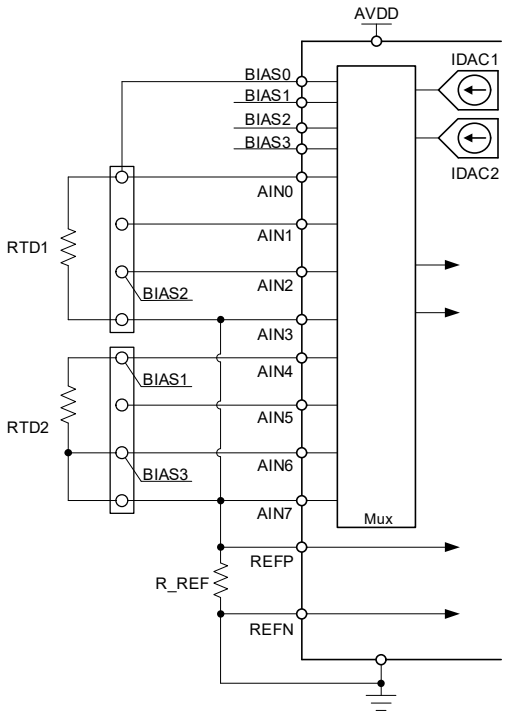
# of wires, not RTD type
e.g. platinum, nickel, etc.

Different wiring configuration for all RTDs

- ✓ **Simple to implement, fewer ADC channels required**
- × **Measure one RTD wiring configuration e.g. 2-wire only**



- ✓ **Can measure 2-, 3-, or 4-wire RTDs with the same hardware**
- × **Requires more inputs per RTD and potentially external jumpers**

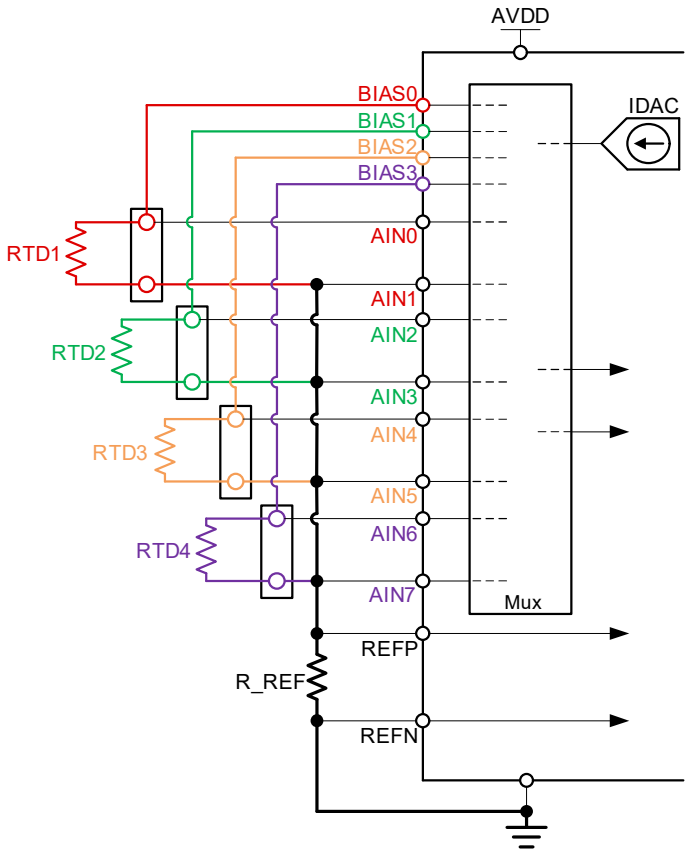


Discussed in **this Precision Labs module**

Discussed in a **separate Precision Labs module**

Measuring multiple RTDs (same wiring config)

Measuring 4x 2-wire RTDs (low-side R_REF)



System requirements:

- 2x analog inputs (AINx) per RTD
- 1x IDAC & 1x output (BIASx) per RTD
- 1x differential reference input (REFx) common to all RTDs
- Common return current path through R_REF

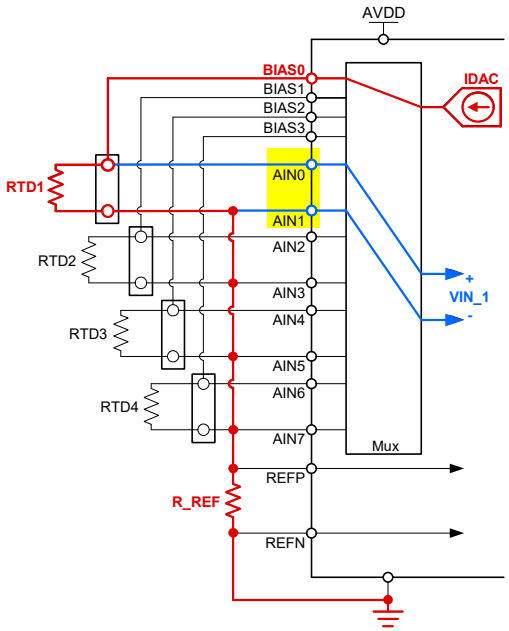
✓ **Same ADC requirements for measuring multiple 4-wire RTDs (greater number of terminal block inputs)**

✗ **More complicated for multiple 3-wire RTDs**

✗ **More complicated for high-side R_REF**

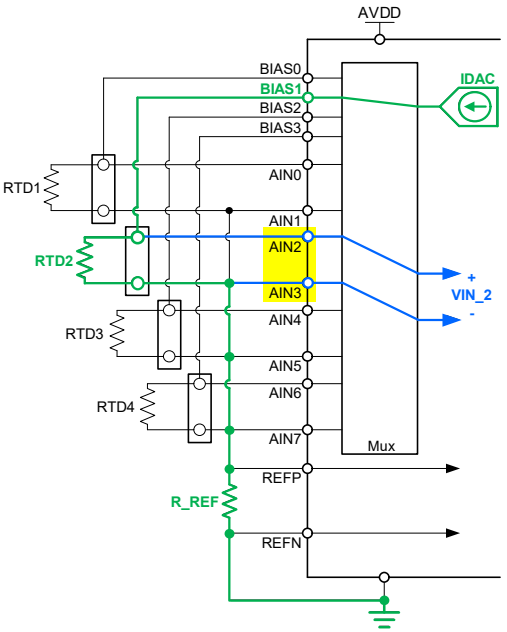
Process for measuring multiple RTDs

Measuring RTD1



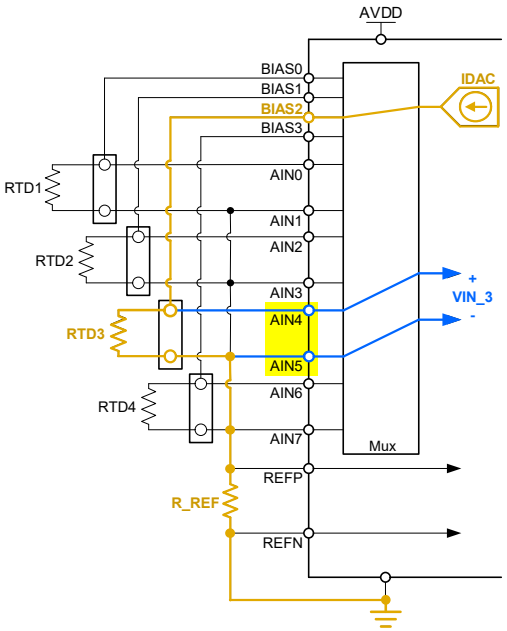
- Switch IDAC to BIAS0
- Switch MUX to AIN0 / AIN1
- Measure VIN_1

Measuring RTD2



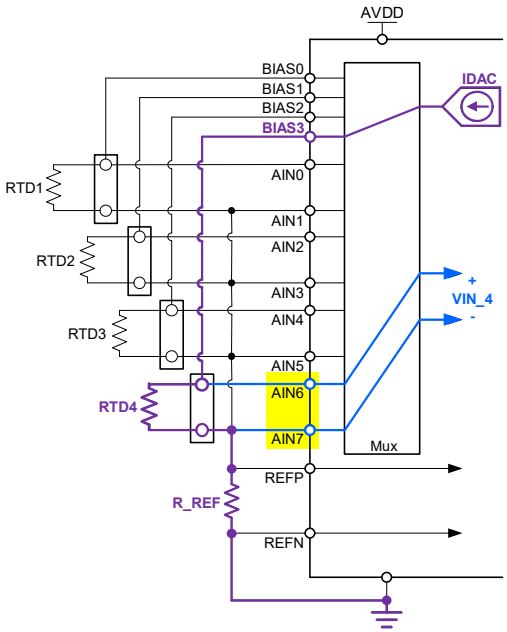
- Switch IDAC to BIAS1
- Switch MUX to AIN2 / AIN3
- Measure VIN_2

Measuring RTD3



- Switch IDAC to BIAS2
- Switch MUX to AIN4 / AIN5
- Measure VIN_3

Measuring RTD4

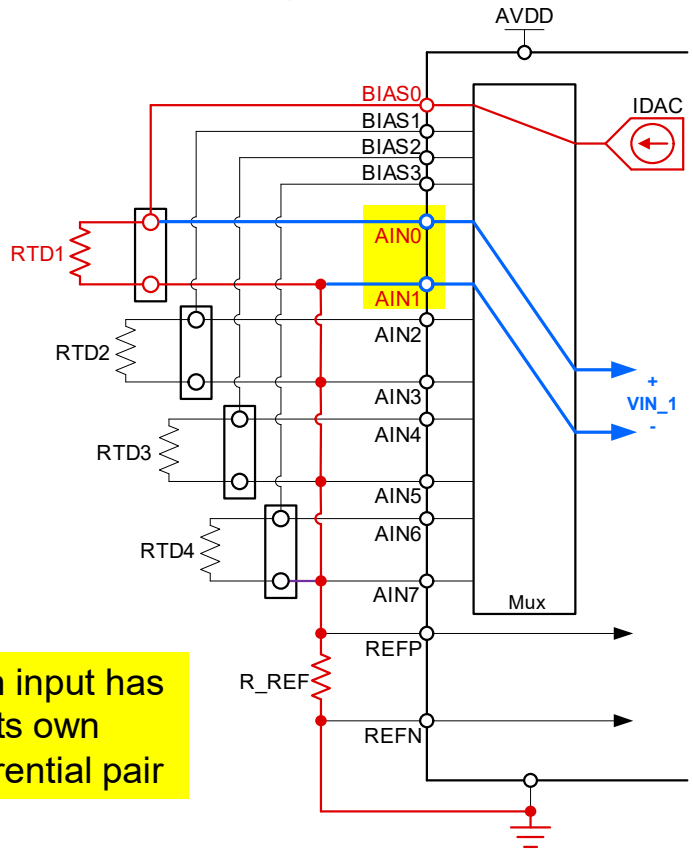


- Switch IDAC to BIAS3
- Switch MUX to AIN6 / AIN7
- Measure VIN_4

Repeat process as needed

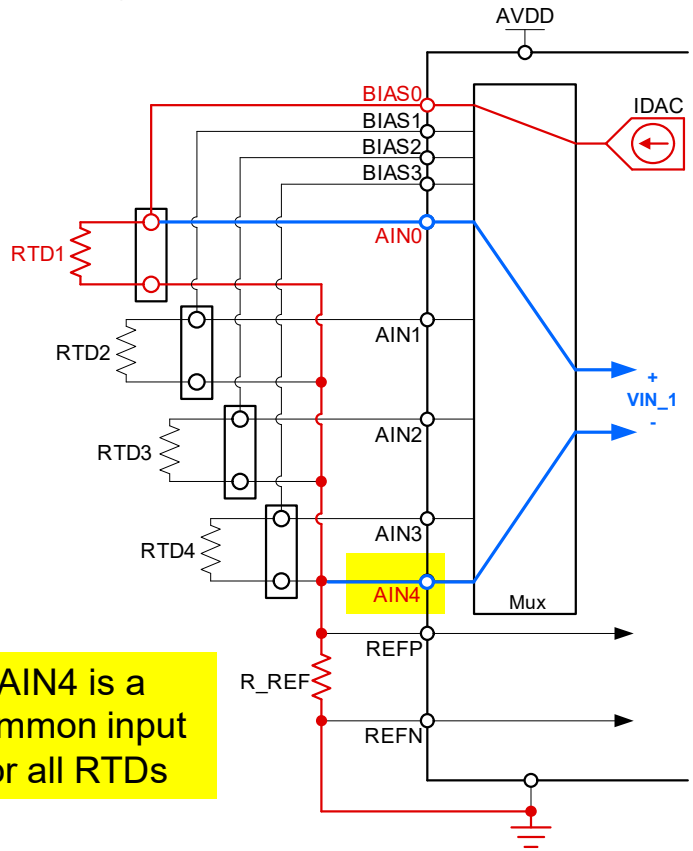
Reducing the number of analog inputs

2x analog inputs per RTD



Each input has its own differential pair

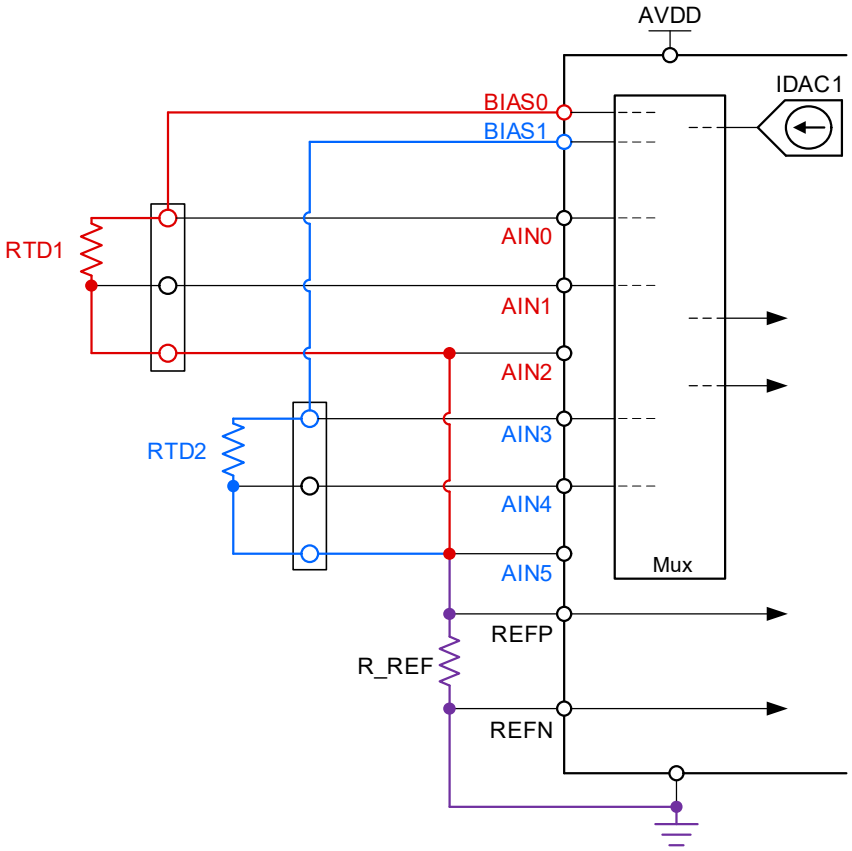
1x analog input per RTD + 1x common input



AIN4 is a common input for all RTDs

Measuring multiple 3-wire RTDs using 1x IDAC

Measuring 2x 3-wire RTDs using 1x IDAC (low-side R_REF)



System requirements:

- 3x analog inputs (AINx) per RTD
- 1x IDAC & 1x output (BIASx) per RTD
- 1x differential reference input (REFx) common to all RTDs
- Common return current path through R_REF

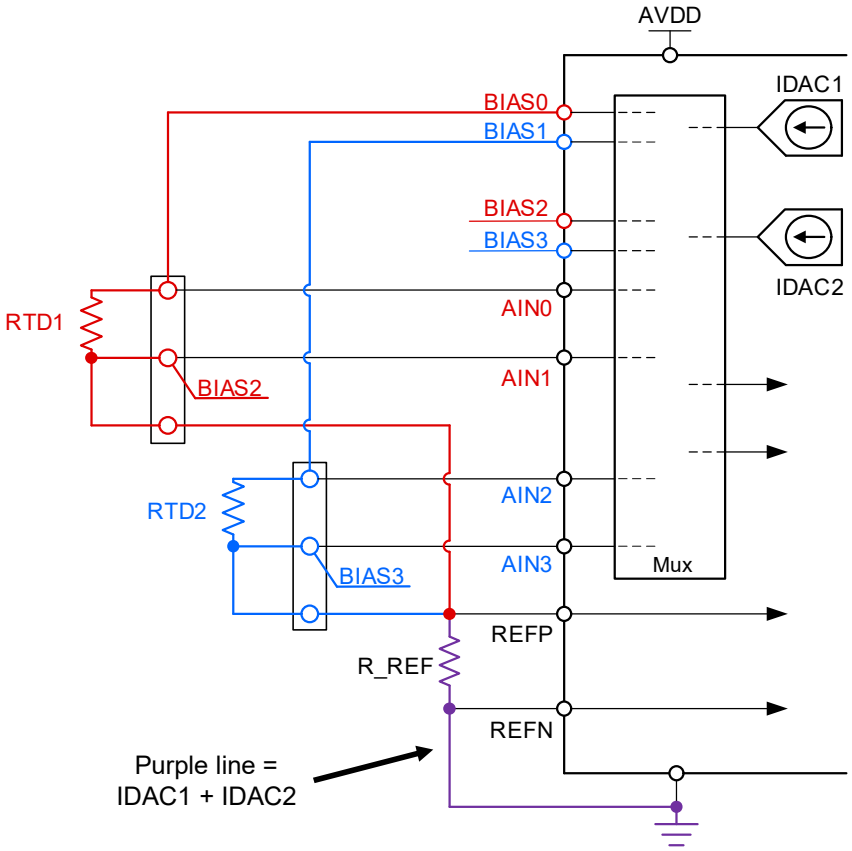
✓ **Fewer IDAC outputs per RTD compared to 2x IDAC solution**

✓ **No IDAC mismatch error**

× **Two measurements per RTD increases conversion latency**

Measuring multiple 3-wire RTDs using 2x IDACs

Measuring 2x 3-wire RTDs using 2x IDACs (low-side R_REF)



System requirements:

- 2x analog inputs (AINx) per RTD
- 1x IDAC & 2x outputs (BIASx) per RTD
- 1x differential reference input (REFx) common to all RTDs
- Common return current path through R_REF

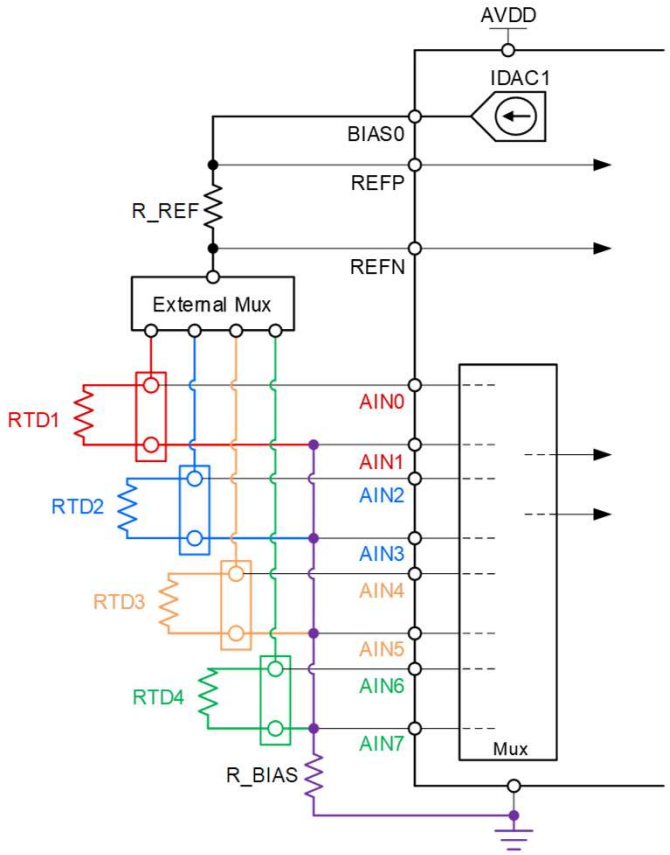
✓ **One conversion per RTD**

× **Additional IDAC output required compared to 1x IDAC solution**

× **Need to consider IDAC mismatch error**

Measuring multiple RTDs with a high-side R_REF

Measuring 4x 2-wire RTDs (high-side R_REF)



System requirements:

- 2x analog inputs (AINx) per RTD
- 1x IDAC output (BIASx) common to all RTDs
- 1x differential reference input (REFx) common to all RTDs
- 1x external multiplexer to route the IDAC current to the correct RTD
- Common return current path through R_BIAS

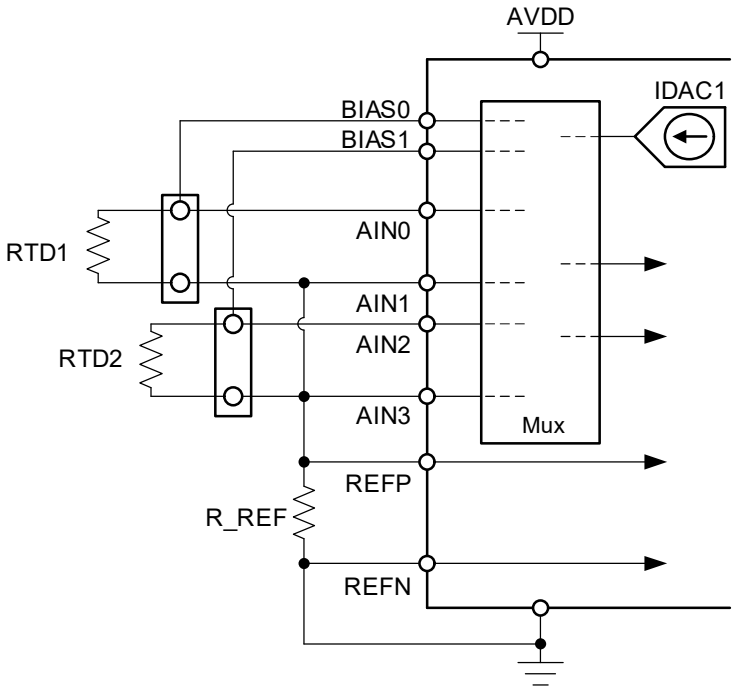
✓ **Fewer IDAC outputs required compared to low-side R_REF**

✓ **If applicable, ADC GPIOs can be used to control the external multiplexer**

× **External multiplexer(s) required**

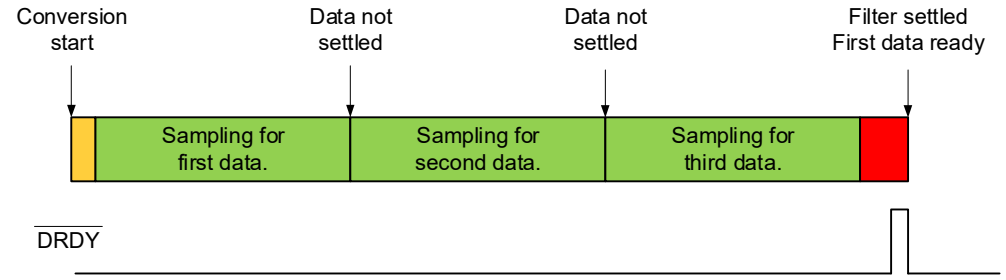
Conversion latency

Measuring multiple RTDs

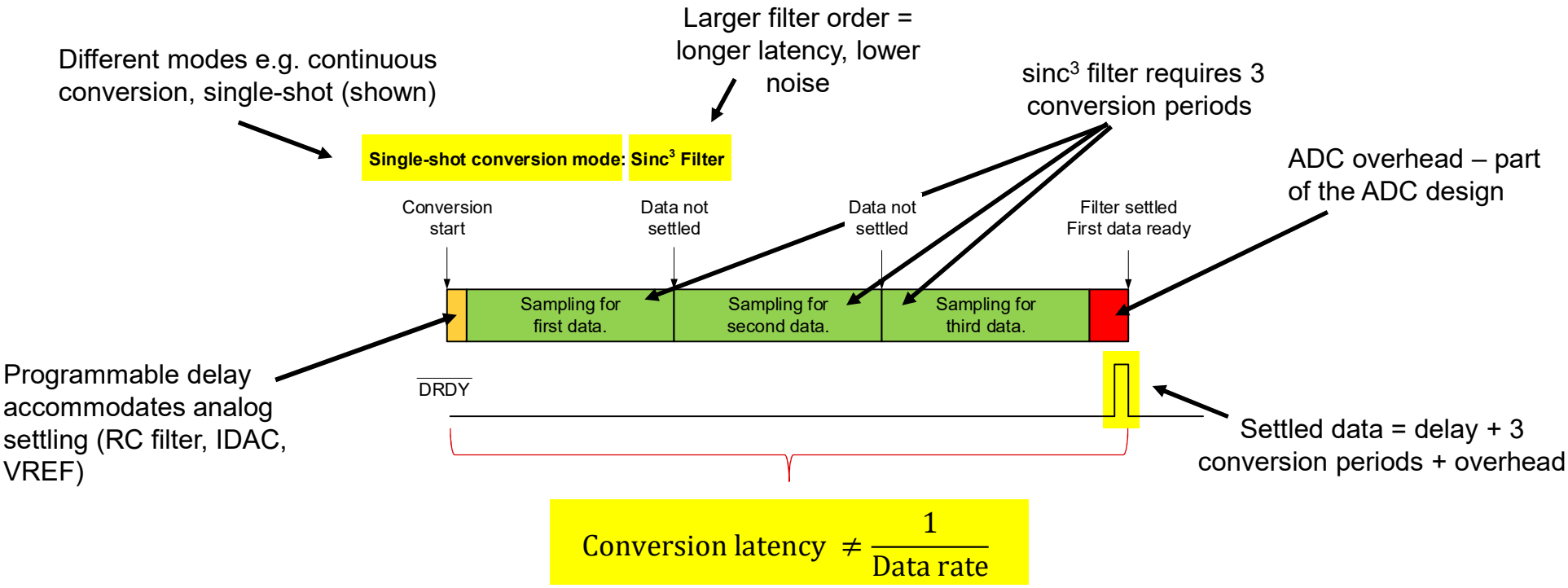


ADS124S08 conversion latency

Single-shot conversion mode: Sinc^3 Filter



Delta-sigma ADC conversion latency considerations

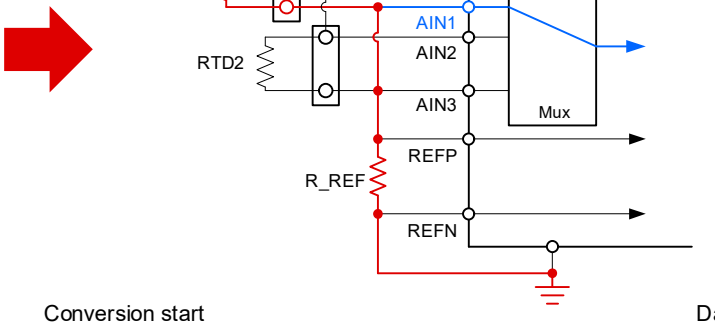


For more detailed information, review TI's app note on conversion latency (SBAA535)

Example: multiple RTD measurement cycle time

Example parameters:

- ADS124S08
- 1 kSPS
- Sinc^3 filter
- Delay = 14*t_{MOD}



**Ignores ADC communication time to change configuration

Thanks for your time!
Please try the quiz.

Quiz: Multiple RTDs & conversion latency

1. (True/False) Some ADCs used to measure RTD signals can require multiple conversion cycles for the signal to settle to an accurate value. This settling time is referred to as conversion latency.
   a) True
   b) False

2. (True/False) When switching multiplexer inputs, some additional delay may be required to account for analog settling. Some ADCs include a programable delay for this purpose.
   a) True
   b) False

Thanks for your time!