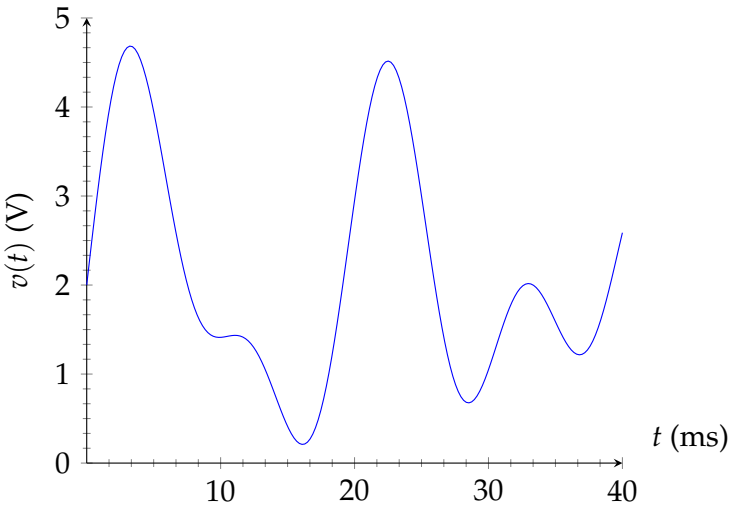
ECE 215 Spring 2025

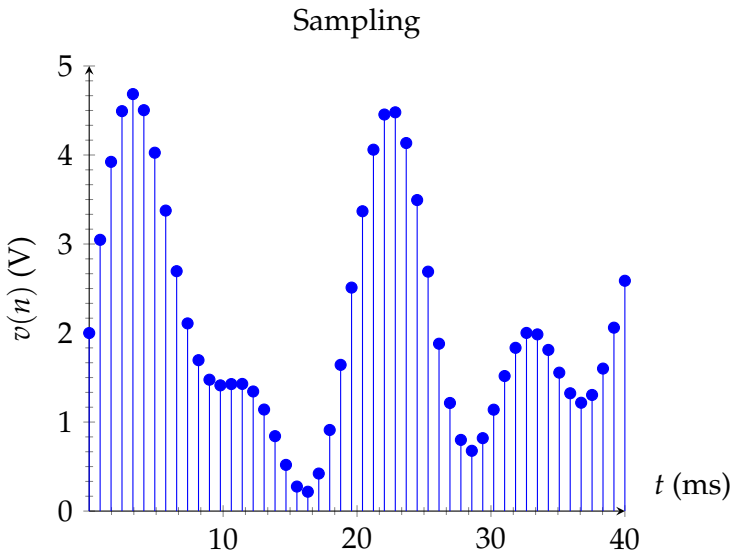
Objective 2.6: Signal Conditioning

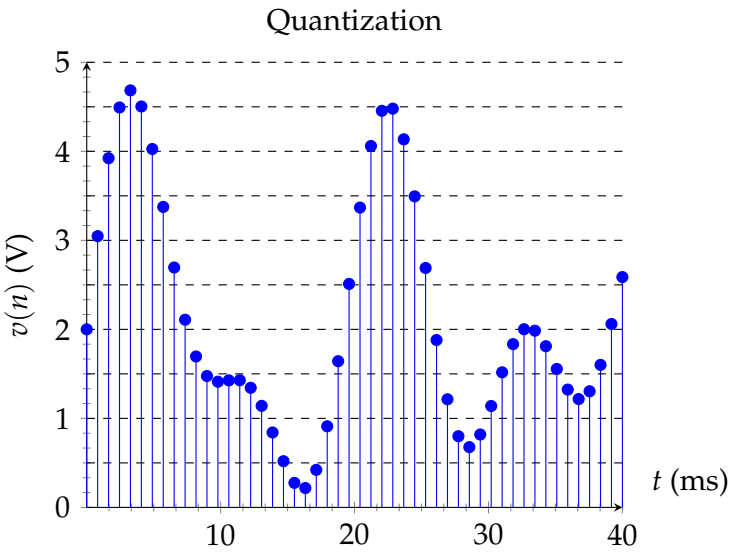
Objective 2.5

I can implement signal conditioning to avoid aliasing and clipping and to ensure maximum compatibility of the dynamic ranges between two devices.

Analog to Digital - Big Picture



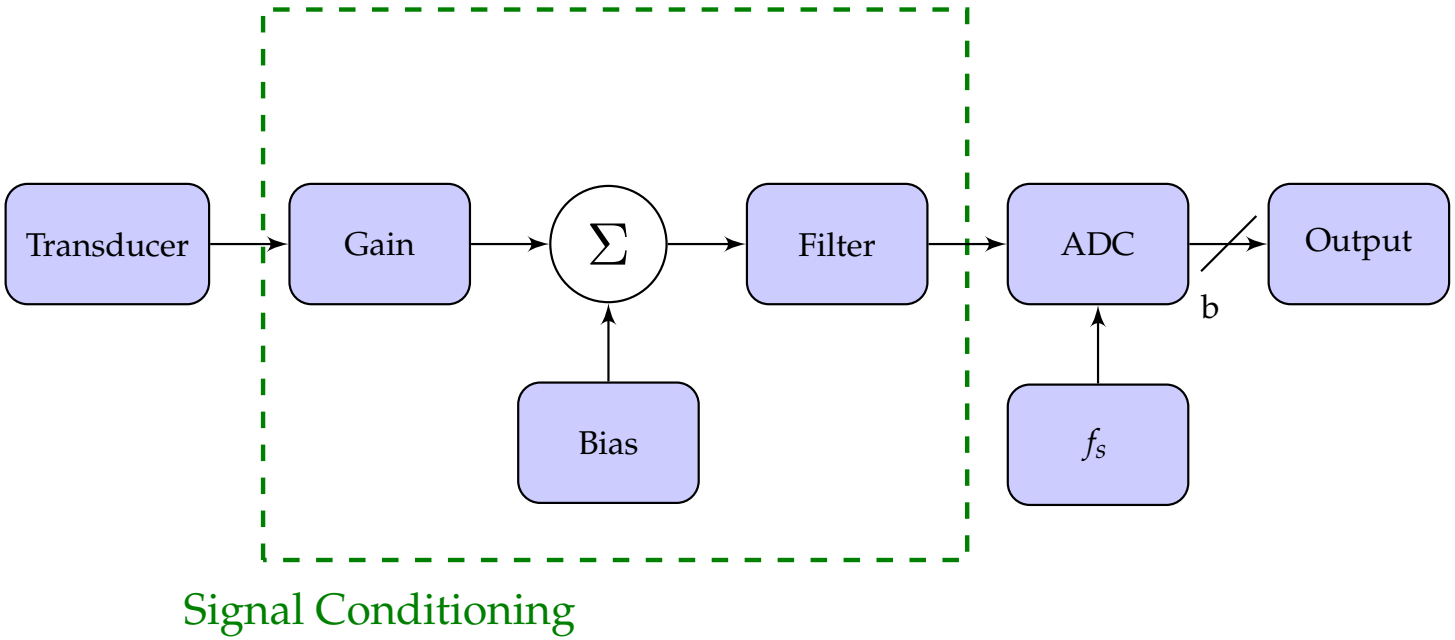




Encoding
=00010100 00011110 00100011 ...

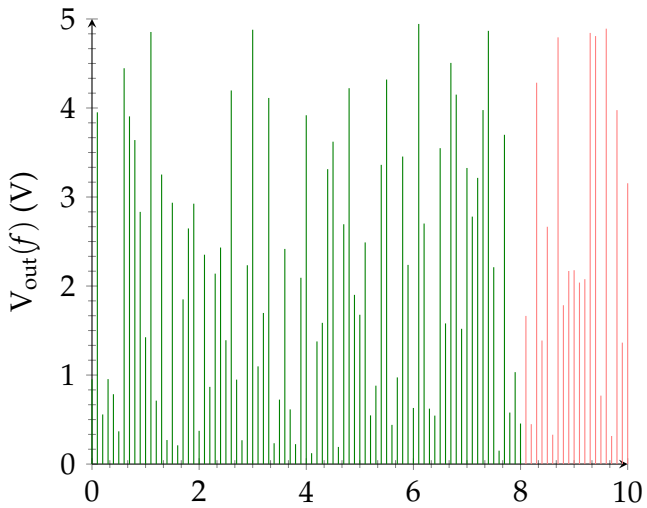
Avoiding Pitfalls: Signal Conditioning

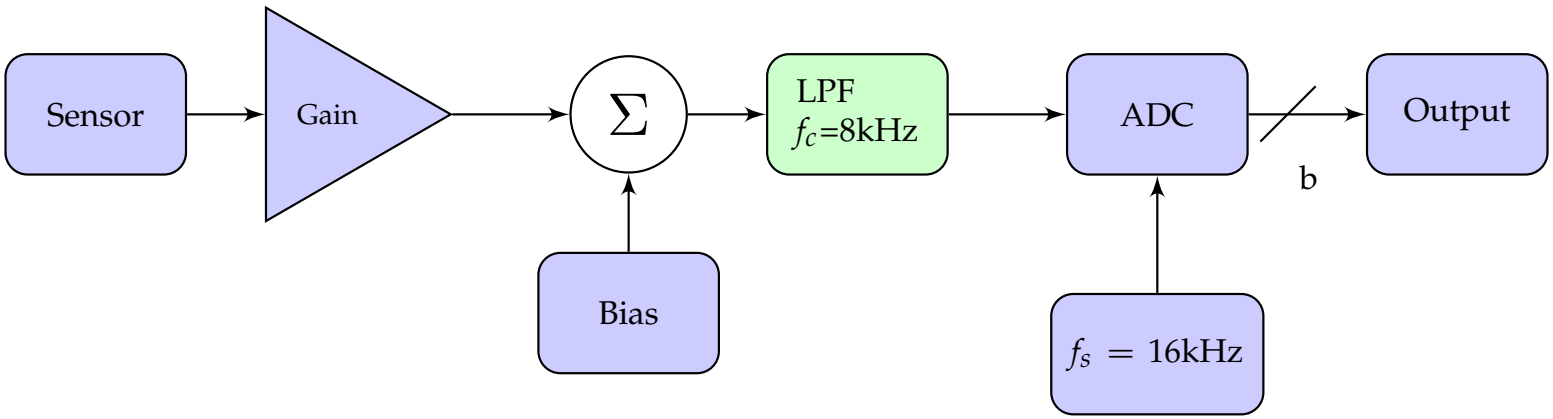
- Aliasing → anti-aliasing filter
- Clipping → amplification/bias correction
- Maximize ADC input range → amplification/bias correction



Avoiding Pitfalls: Anti-Aliasing Filter

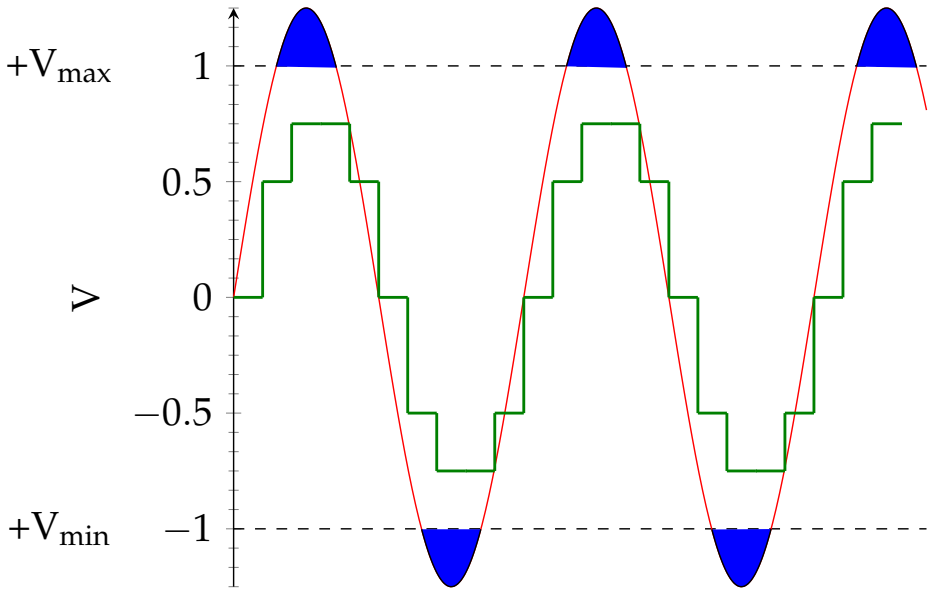
- Can we always know what the highest frequency is to satisfy Nyquist?
- Can we safeguard against aliasing anyway?
- Of course...

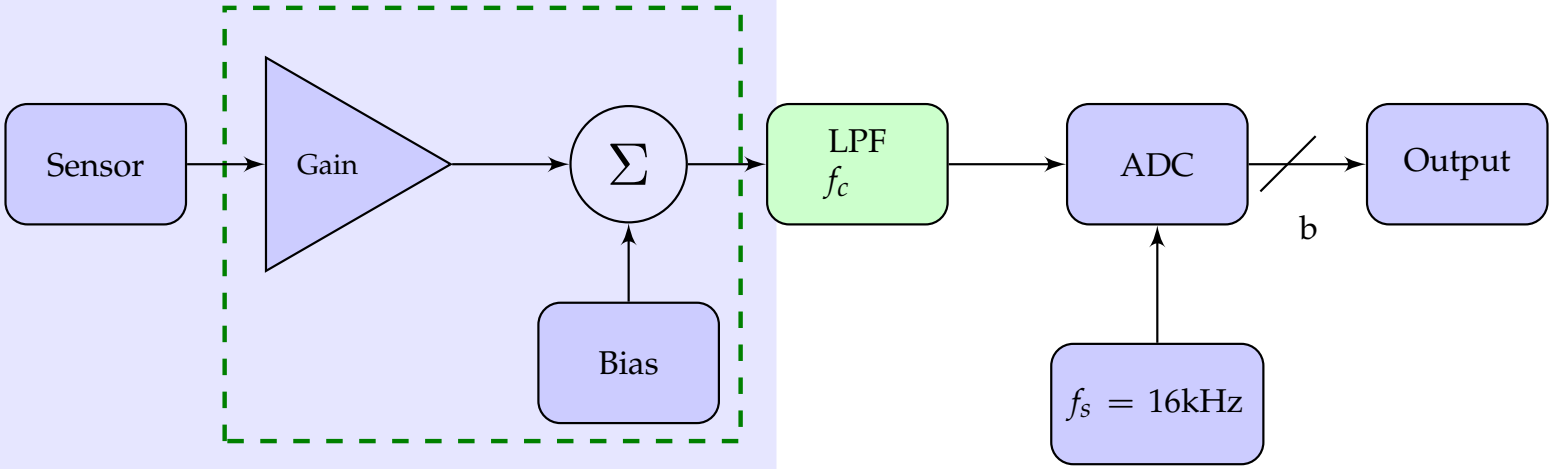




ADC Issues: Clipping

- Clipping happens when input signal is too large for ADC device
- Solution: properly design transducer interfaces





AMPLIFIERS

- Do all transducers output the same voltage levels?
- What voltage level does our system need?
- Line up input signal's max and min with ADC V_{max} and V_{min}
- Amplifiers multiply the output of a transducer by a constant
- Gain K = $\frac{A_{out}}{A_{in}}$
- Same as when we calculated filter gain!

Bias and Amplification

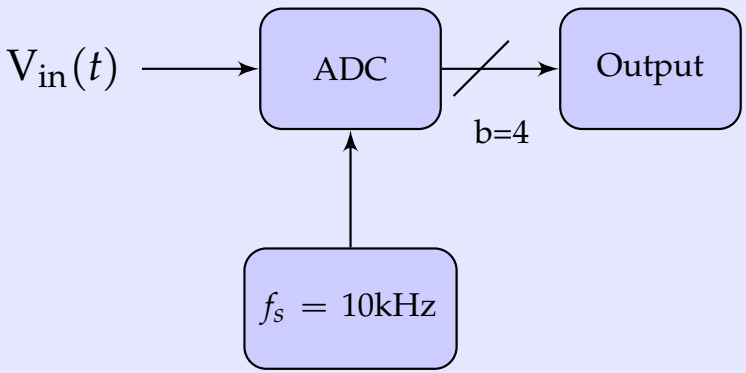
- What if a constant gain isn't sufficient?
- Remember $y = m * x + b$? We can use $V_{out} = KV_{in} + V_{bias}$

Signal Conditioning Example

- We want to digitize a signal with the following characteristics:
  - f_{high} = 3 kHz
  - V_{max} = 50mV
  - V_{min} = -50mV
- Will this ADC work?
  - If not, how can we fix it?

V_{max} = 3.5V

V_{min} 0V



- Check sampling frequency: anti-aliasing filter
- Check for clipping: amplification/bias correction
- Maximize ADC input range: amplification/bias correction

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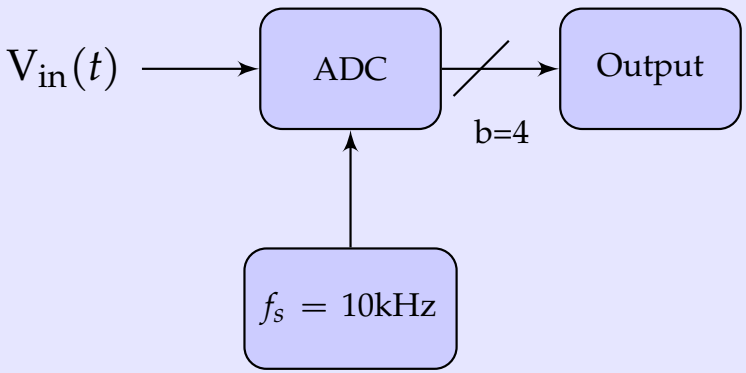
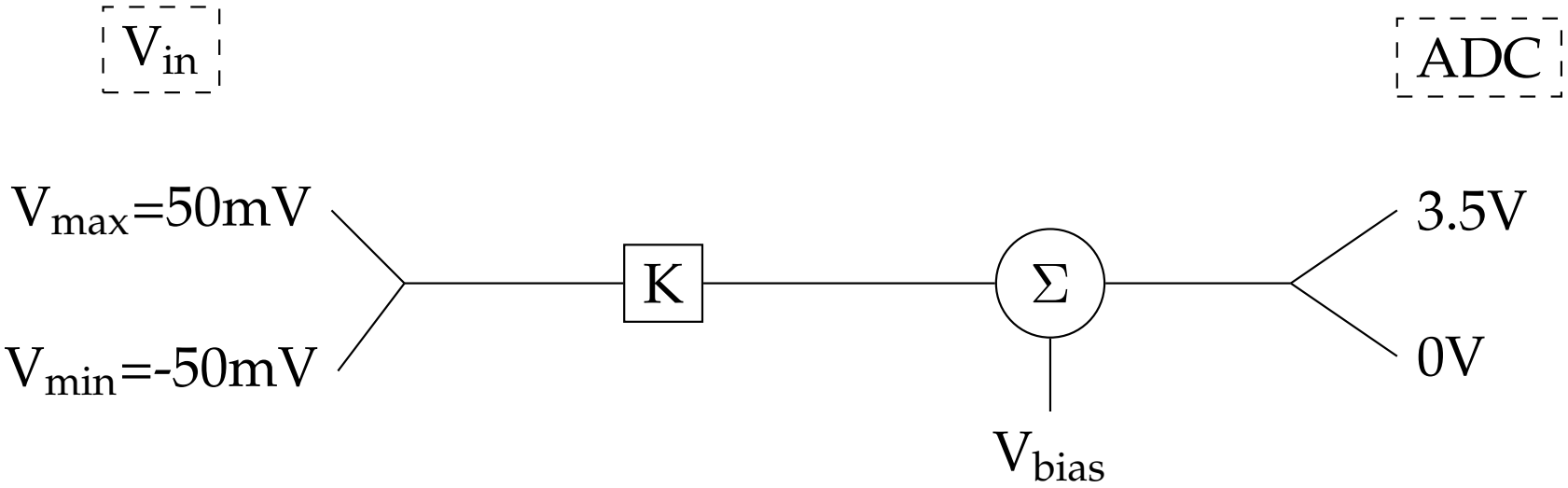


Signal Conditioning Example (Cont'd)



$$(50 \times 10^{-3})K + V_{bias} = 3.5$$
$$-(50 \times 10^{-3})K + V_{bias} = 0$$

$$\boxed{K = 35 \text{ and } V_{bias} = 1.75\text{V}}$$