Introduction to Bioelectricity

Week 7: Practicum
Lecture 7.3: Analog-to-digital conversion

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Week 7: Practicum

• Lecture 7.3: Analog-to-digital conversion
Lecture 7.3: Analog-to-digital conversion

• Dynamic range
  • Describes range of input amplitudes for A/D
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- Dynamic range
  - Here max amplitude is \( \sim 1\text{mV peak-to-peak} \)
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- Dynamic range
  - Dynamic range is determined by max amplitude
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- Resolution
  - Determined by $V_{res} = \frac{Range}{2^{\text{bits}}}$
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- **Resolution**
  - Determined by $V_{res} = \frac{Range}{2^{bits}}$
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- Resolution
  - For 1-bit ADC: $V_{res} = \frac{\text{Range}}{2^{\text{bits}}} = \frac{1}{2} = 0.5 \text{ V}
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- **Resolution**
  - For 2-bit ADC: \( V_{res} = \frac{Range}{2^{\text{bits}}} = \frac{1}{4} = 0.25 \text{ V} \)
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• Resolution
  • For 3-bit ADC: \( V_{res} = \frac{Range}{2^{\text{bits}}} = \frac{1}{8} = 0.125 \, V \)
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- Resolution
  - For 24-bit ADC:
    \[ V_{res} = \frac{Range}{2^{bits}} = \frac{1}{16,777,215} = 60 \text{ nV} \]
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• Resolution
  • Min signal amplitude is limited by noise
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• Resolution
  • Compression and range
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• Sampling rate
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- Sampling rate
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• Sampling rate

N = number of samples
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• Sampling rate

- \( N \) = number of samples
- \( n \) = sample number from 0 through \( N-1 \)
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- **Sampling rate**

  - $N = \text{number of samples}$
  
  - $n = \text{sample number from 0 through } N-1$

  - $T = \text{total interval sampled}$

$N=25$  
$n=1$  
$n=0$  
$t (\text{ms})$  

$V$  

$n=24$
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- **Sampling rate** (more in 6.1)

- \( N = \) number of samples
- \( n = \) sample number from 0 through \( N-1 \)
- \( T = \) total interval sampled
- \( h = \) separation between samples = \( T/(N-1) \)
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- Sampling rate
  - Oversampling can reduce min visible signal
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• Homework 3: analog-to-digital converter
  • Download the datasheet
  • From the datasheet answer the following:
    • What does each pin do?
    • What is the dynamic range?
    • What is the resolution?
    • How do you set the sampling frequency?
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- HW3 Practicum: build ADC

- Maxim 1242
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- HW3 Practicum: build ADC
  - What is $C_6$ for?
  - What is $C_5$ for?
  - Why do you need both?
  - Why does $C_6$ need to be near?
  - Why doesn’t $C_5$?
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- HW3 Practicum: build ADC
  - Analog-to-digital converter (frontside)
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- HW3 Practicum: build ADC
  - Note: moved decoupling cap:
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• HW3 Practicum: build ADC
  • Analog-to-digital converter (frontside)
Lecture 7.3: Analog-to-digital conversion

- HW3 Practicum: build ADC
  - Analog-to-digital converter (backside)