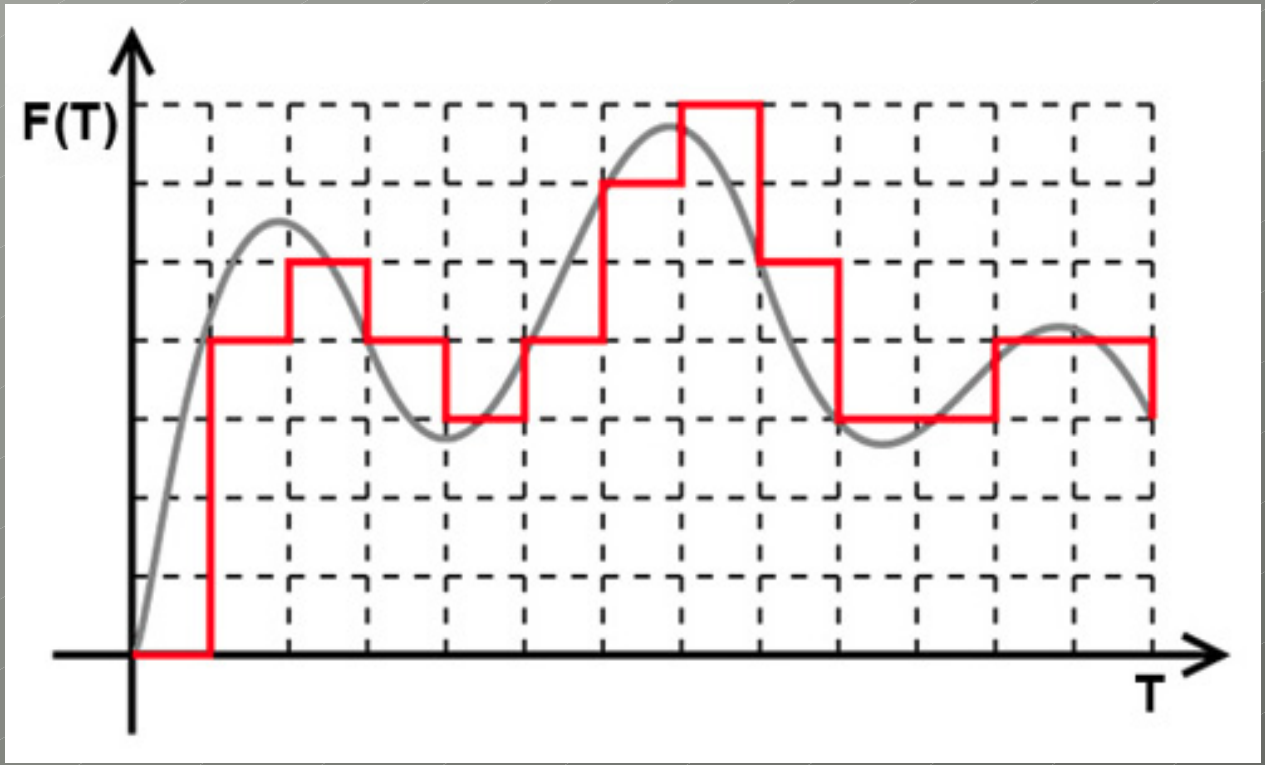
Analog To Digital Converter



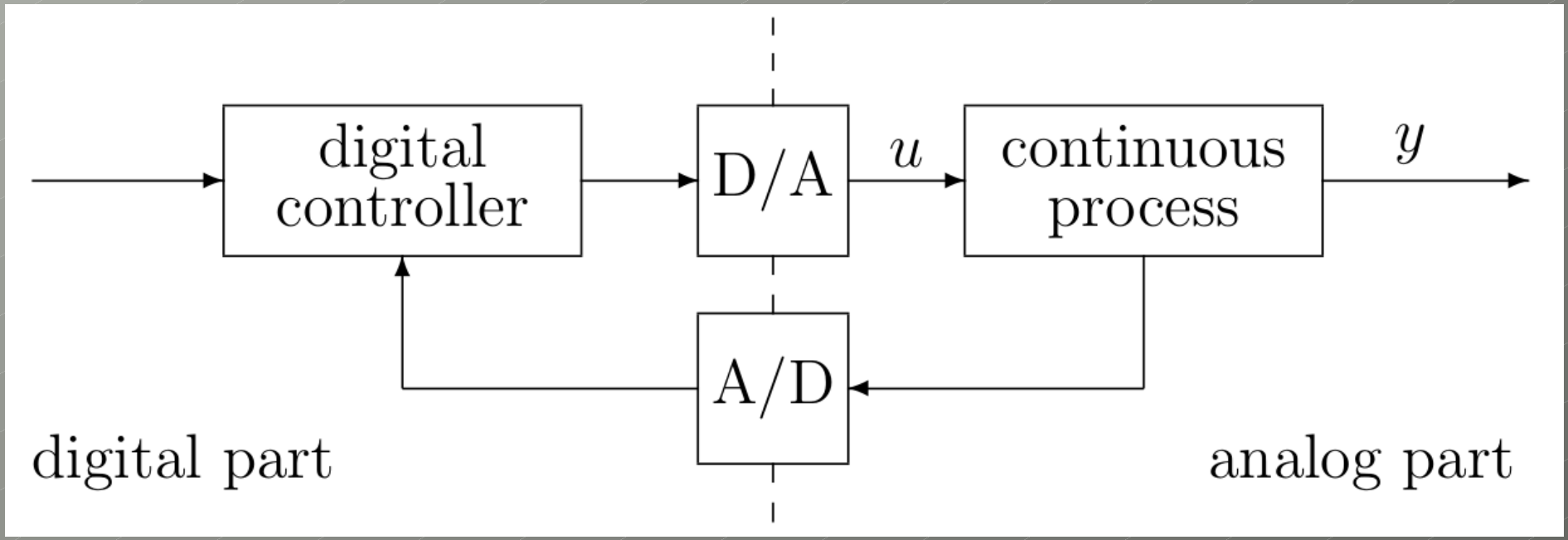
Content

- What is an ADC? (recap)
- Different types of ADCs
- Atmel SAM ADC
- Working example
- Practical considerations

What is an ADC?

- Digital interface to the analog world
  - Approximation of a (true) analog signal
  - Discretization of a continuous time signal
- ADCs are used for
  - Control/Scientific applications
  - Digital Signal Processing
  - Audio (and Video) recording
  - ...

What is an ADC?

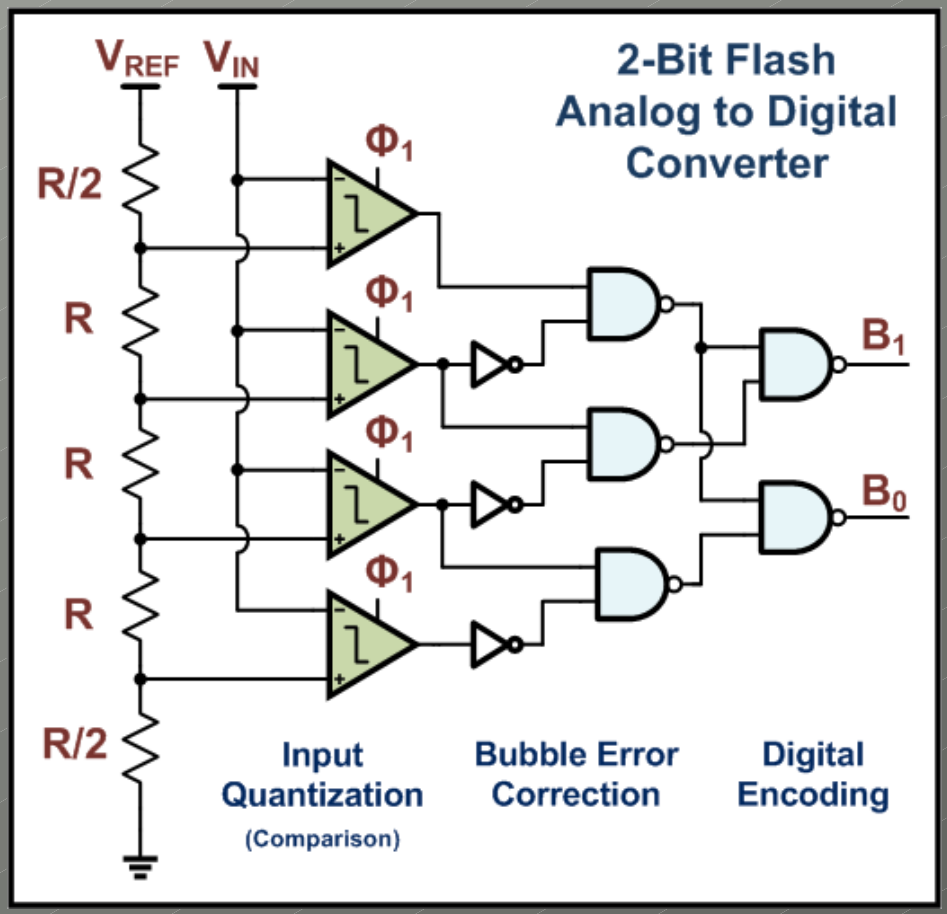


What is an ADC?

- Different ADC differ in many aspects
  - Accuracy
    - Voltage Reference
    - Resolution
  - Sampling Rate
  - Input range
  - Input mode (eg. single ended or differential)

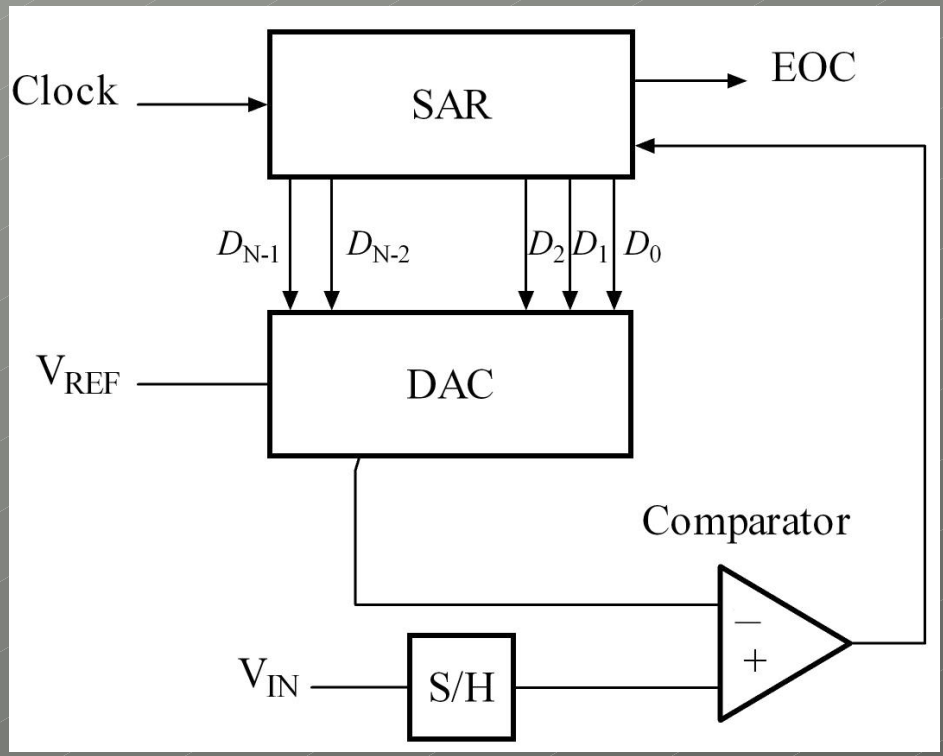
Different Types of ADCs

- Flash ADC
  - Extremely fast
  - Quiet simple
  - Requires logic circuitry only
  - Huge number of comperators
  - Increased power consumption



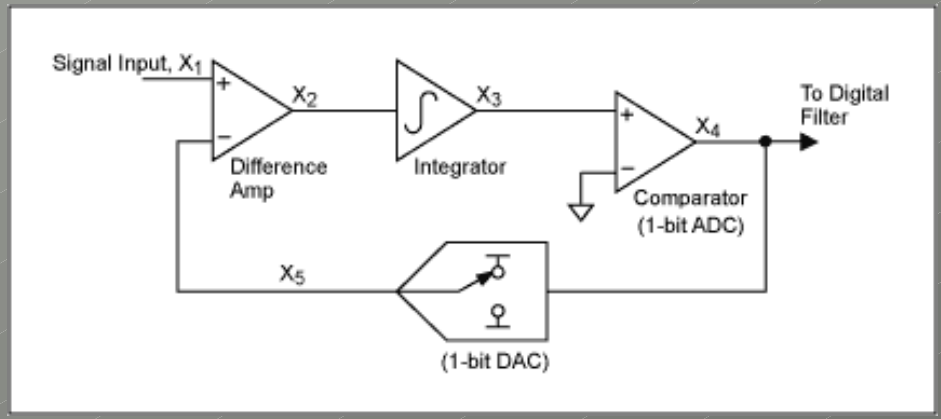
Different Types of ADCs

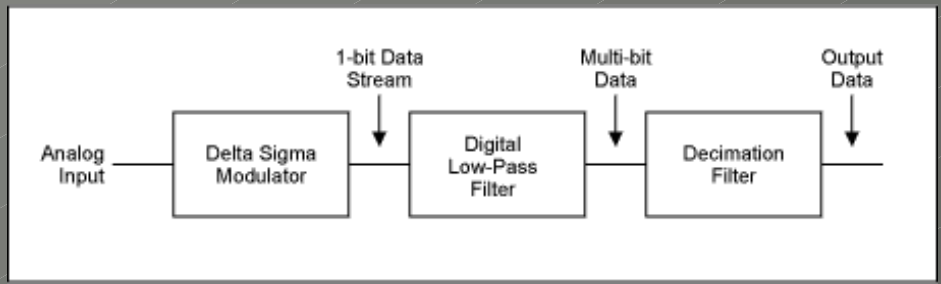
- SAR
  - Digital approximation via binary search
  - Popular for multi channel applications
  - Error can exceed multiple bits



Different Types of ADCs

- Delta Sigma
  - 1 bit Analog ADC
  - More complex digital side
  - Noise shaping by DAC
  -





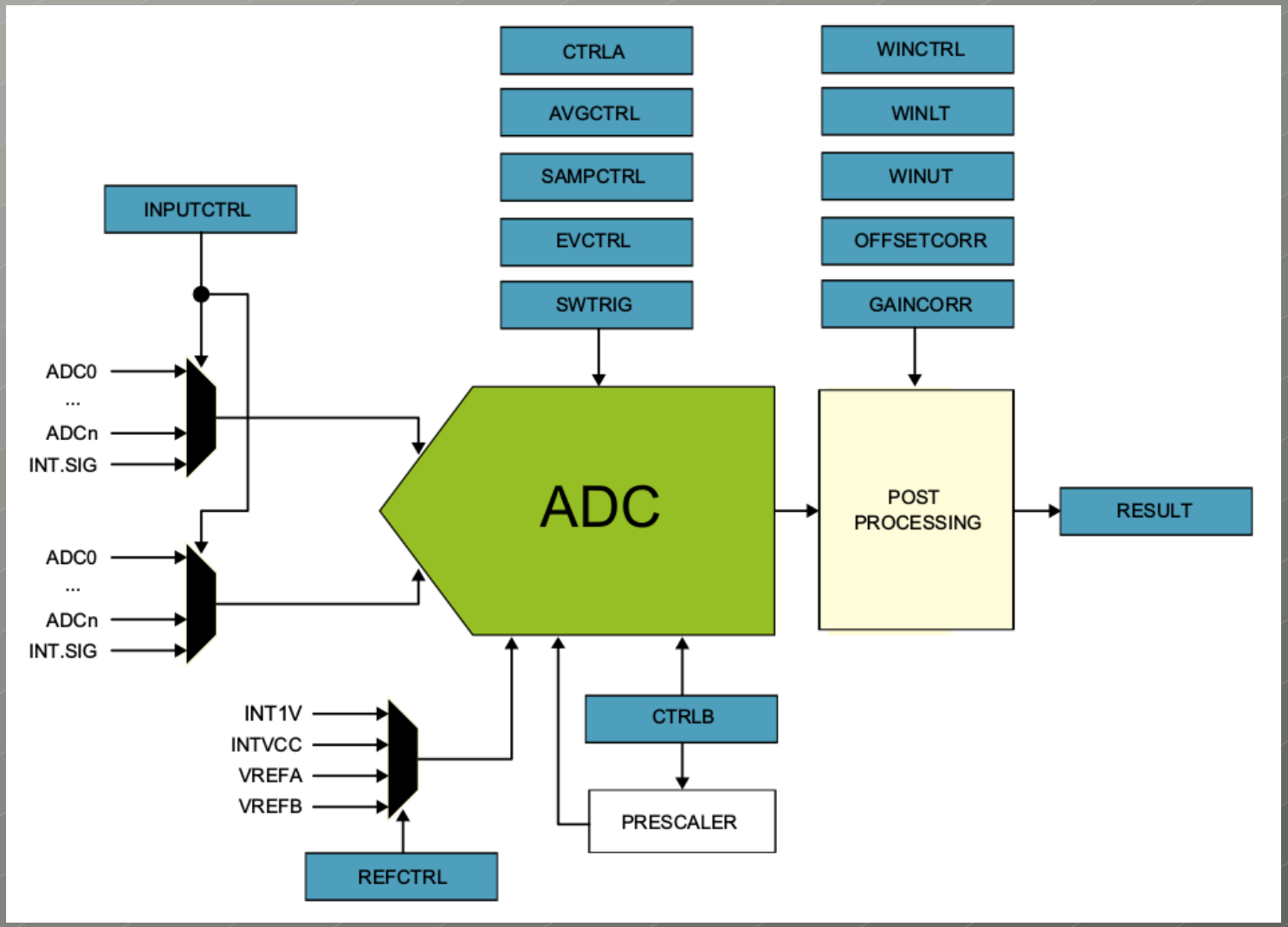
Differnt Types of ADCs

- And many more…
  - Ramp compare
  - Wilkinson
  - Integrating ADC
  - Delta Encoded
  - Pipeline
  - ...

Atmel SAM ADC

- Selectable 8, 10 or 12 bit resolution
  - 16 bit in oversampling
- 350 ksps (thousand samples per second)
- Averaging feature
- Differential and Single Ended inputs
- Built in and external Vref options
- Selectable Gain

Atmel SAM ADC



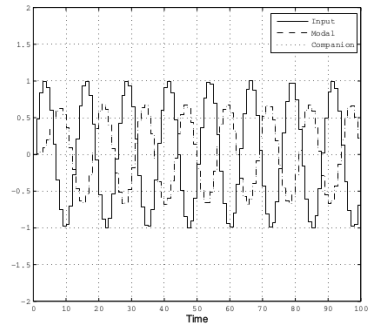
Working Example

<C++>

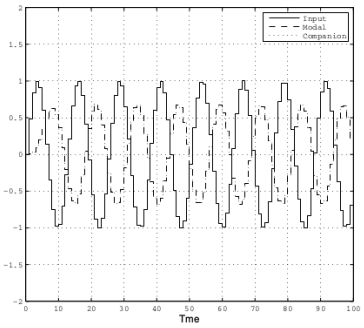
Practical Considerations

- Use internal or external ADC may depend on application and performance
- Sample rate and accuracy are crucial for control systems application
  - Always consider aspects of discretization (!!!)
- Consider the maximal bandwidth of your circuit
  - Nyquist frequency (anti aliasing filters)
  - Analog signal processing

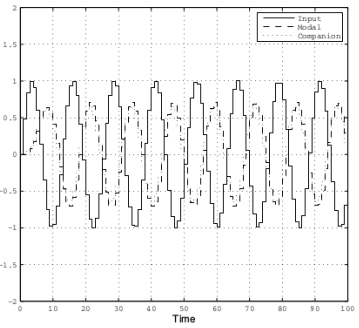
Practical Considerations



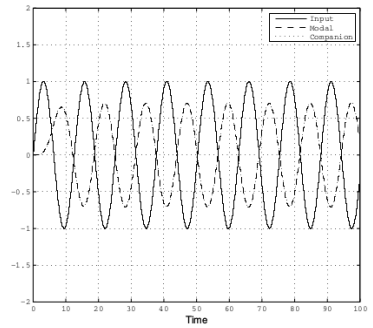
(a) $T_s = 1s$, 32bit



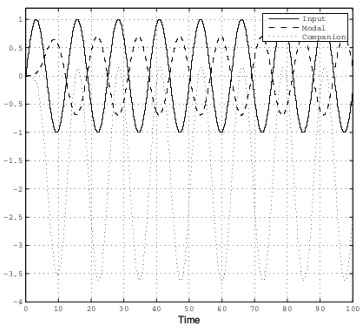
(b) $T_s = 1s$, 16bit



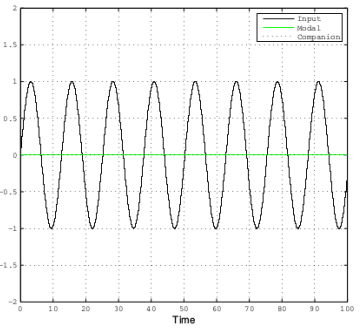
(c) $T_s = 1s$, 8bit



(a) $T_s = 0.1s$, 32bit



(b) $T_s = 0.1s$, 16bit



(c) $T_s = 0.1s$, 8bit

Useful Links

- http://www.analog.com/en/analog-dialogue/articles/the-right-adc-architecture.html
- http://www.hardwaresecrets.com/how-analog-to-digital-converter-adc-works/
- https://www.maximintegrated.com/en/app-notes/index.mvp/id/1870