Analog to Digital Converter (ADC)

CSE 236 – Embedded Systems

Spring 2012

Outline

- Description
- Motivating Example
- Types of ADCs
- Properties of ADCs
- Atmega328's ADC (Registers)
- Arduino sketch example

Description

- Also known as:
  - ADC, A2D, A/D
  - Analog Input (Arduino land)
  - DAQ (Data Acquisition)
    - Not to be confused with DAC (Digital-to-Analog Converter)

Description

Voltage -> ADC -> Number

Example

VCC = 5V, GND = 0V

Input voltage = 1.3V

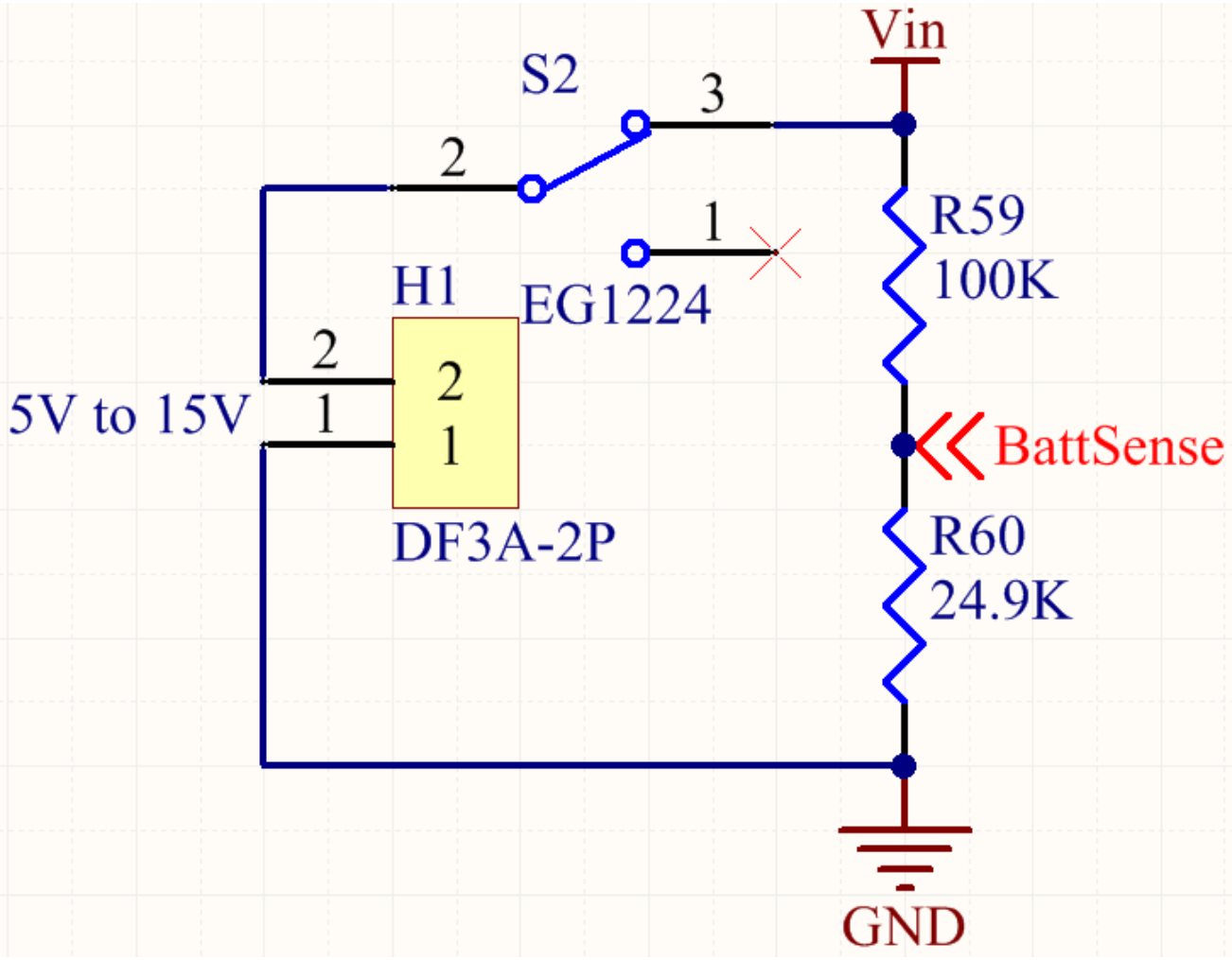
10-bit ADC (0 to 1024)

ADC output = 1.3V/5V * 2^10 = 266

Motivating Examples

- Get battery voltage
- Get oven temperature
- Sample audio signal

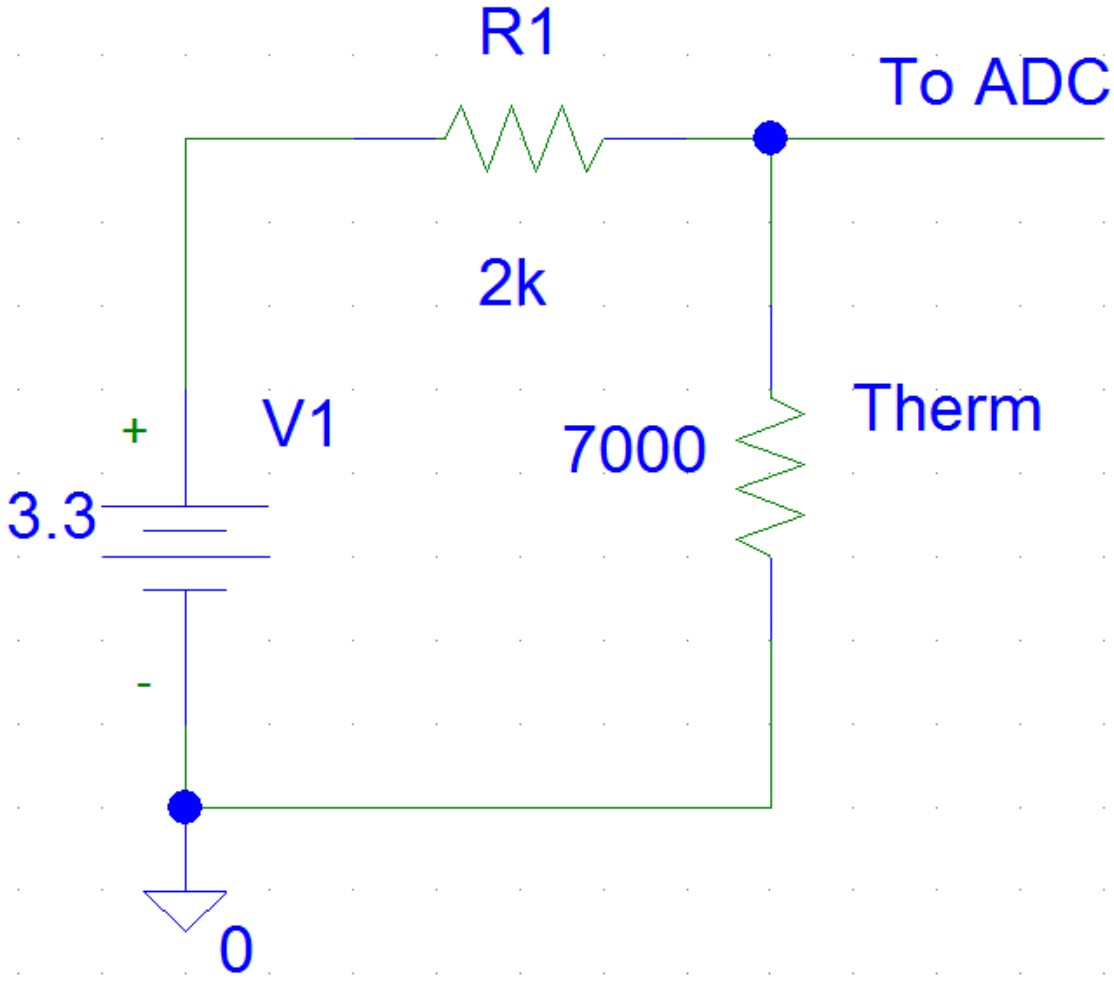
Get Battery Voltage



15V * (25k/125k) = 3V

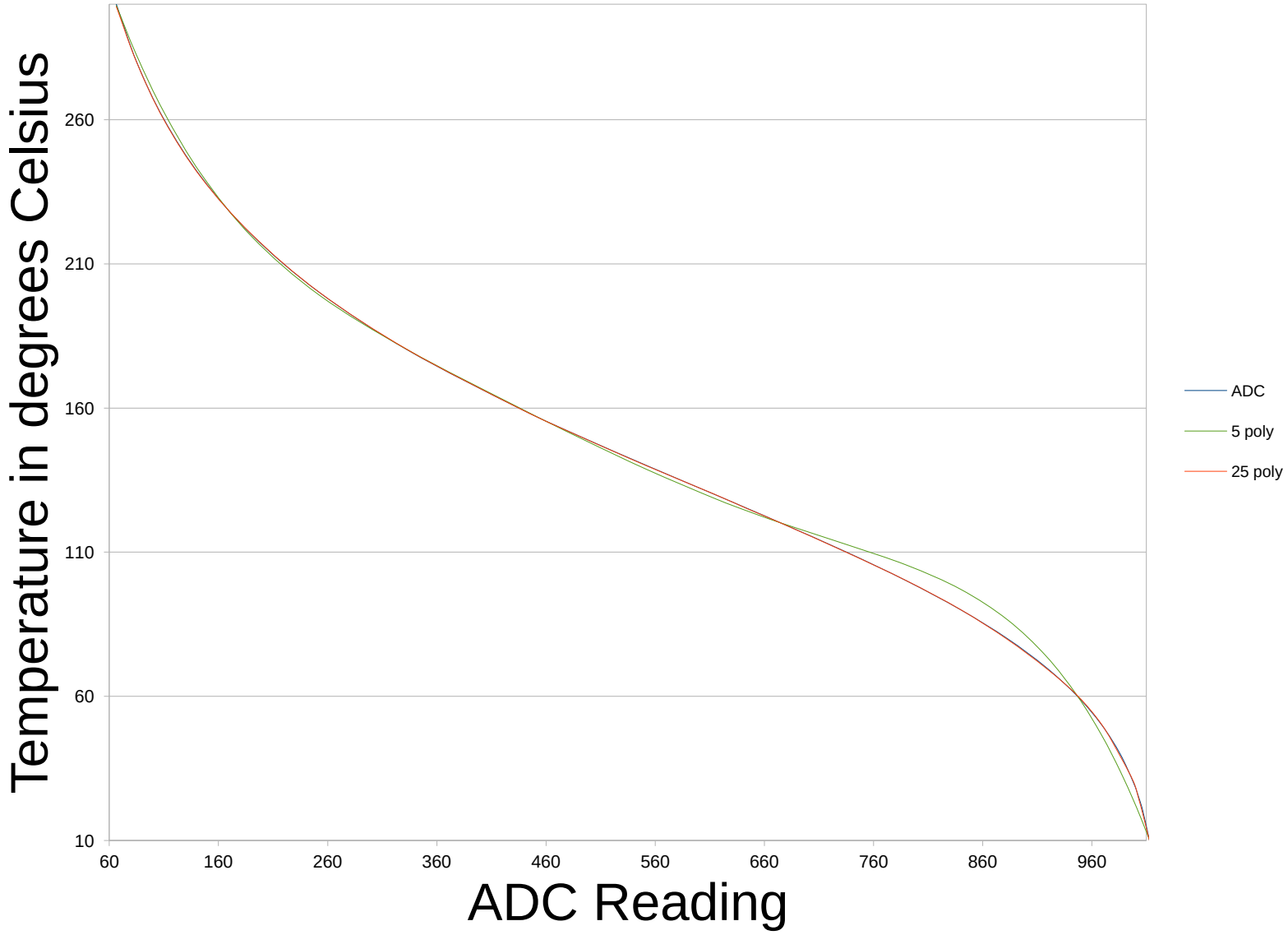
5V * (25k/125k) = 1V

Get Oven Temperature



Thermistor resistance changes with temperature

Get Oven Temperature



Sample audio signal

http://www.audio-production-tips.com/audio-equalizer.html#

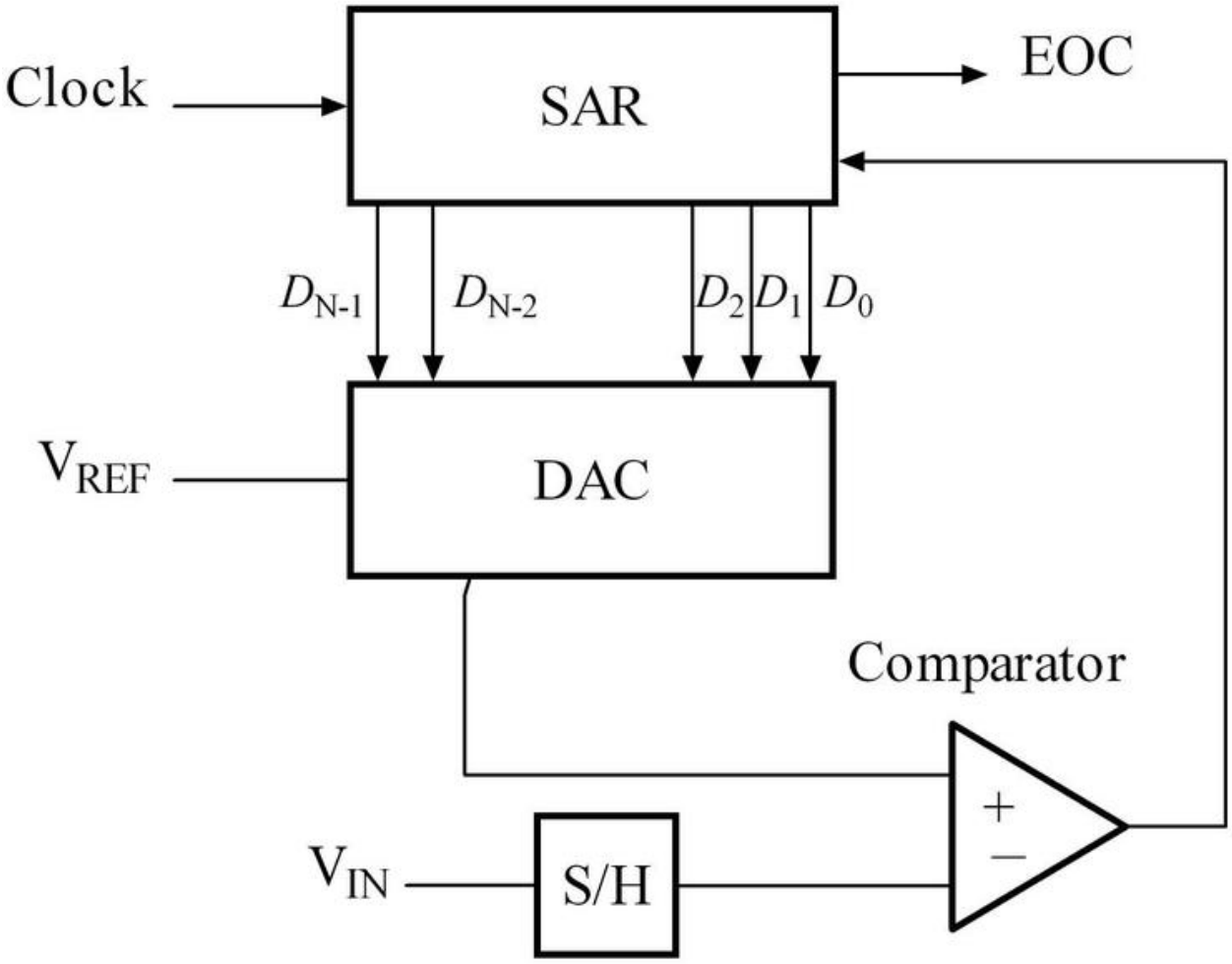
Types of ADCs

- Direct-conversion
- **Successive-approximation**
- Ramp-compare
- Wilkinson ADC
- Pipelined ADC
- Sigma-delta

http://en.wikipedia.org/wiki/Analog-to-digital_converter#ADC_types

Successive-approximation ADC

- Simple binary search algorithm
- Takes N Clock Cycles (no necessarily CPU cycles)



http://en.wikipedia.org/wiki/Successive_Approximation_ADC

Properties of ADCs

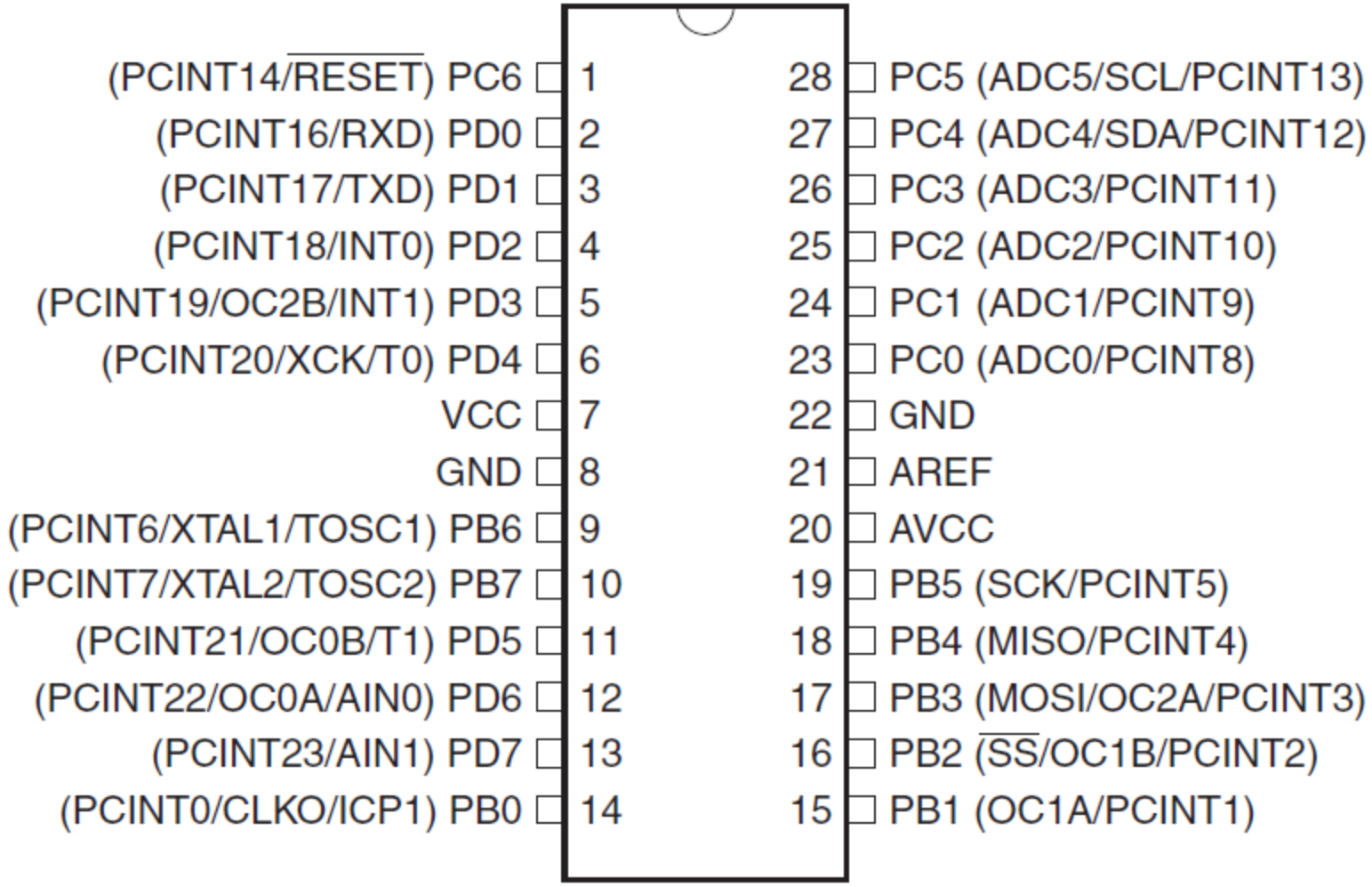
- **Resolution** (10-bit, 12-bit)
- **Speed** (2Msps (Million samples per sec))
  - …concerned with Nyquist Rate
- Accuracy (+/- 2 LSB)
- Response type (Linear, Logarithmic)
- Number of Channels

Atmega328's ADC

24.1 Features

- 10-bit Resolution
- 0.5 LSB Integral Non-linearity
- ± 2 LSB Absolute Accuracy
- 13 - 260µs Conversion Time
- Up to 76.9kSPS (Up to 15kSPS at Maximum Resolution)
- 6 Multiplexed Single Ended Input Channels
- 2 Additional Multiplexed Single Ended Input Channels (TQ
- Temperature Sensor Input Channel
- Optional Left Adjustment for ADC Result Readout
- 0 - V_{CC} ADC Input Voltage Range
- Selectable 1.1V ADC Reference Voltage
- Free Running or Single Conversion Mode
- Interrupt on ADC Conversion Complete
- Sleep Mode Noise Canceler

Atmega328's ADC



1 ADC with 6 channels

Atmega328's ADC (Registers)

- ADMUX –Multiplexer Selection Register
  - Reference Select
  - Input Channel Select
- ADCSRA – Control and Status Register A
  - Enable
  - Start Conversion
  - Interrupt Stuff
  - Prescaler Select
- ADCL and ADCH – ADC Data Register
- ADCSRB – Control and Status Register B
  - Auto Trigger Source
- DIDR0 – Digital Input Disable Register 0

Mention

Reference voltage is not always VCC, but most of the time it is.

Mention Errata: page 556