

# ETH Course 402-0248-00L: Electronics for Physicists II (Digital)

- 1: Setup uC tools, introduction
- 2: Solder SMD Arduino Nano board
- 3: **Build application around ATmega328P**
- 4: Design your own PCB schematic
- 5: Place and route your PCB
- 6: Start logic design with FPGAs

# The ATmega168P / 328P

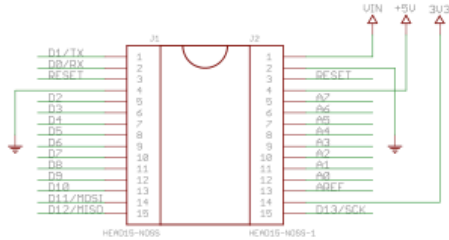
- AT = Atmel: Big microcontroller company
- mega: microcontroller family
- 16: 16KB Flash memory / 32: 32KB Flash
- 8: 8-bit architecture
- P: PicoPower Technology. Optional. For low power battery-based applications.



# ATmega16/328P capabilities (Ex. 3)

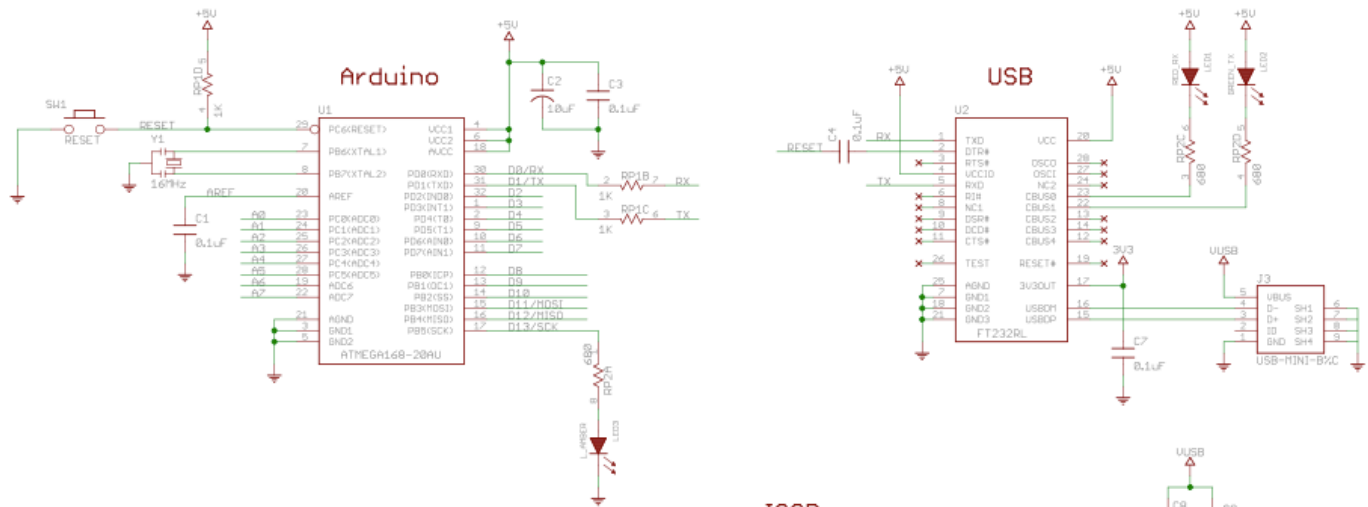
- **System Functions**
  - Power and Clock Manager
  - Low Freq Internal Oscillator
  - Watchdog Timer
  - Real-Time Clock Timer
- **Interrupt Controller**
  - Fixed priority. One level of interruption. Interruptions with flag (can remember) or without. Global Interrupt Enable (I-bit) is disabled during an interrupt service.
- **NO Universal Serial Bus (USB)**
  - This micro hasn't USB. The nano board provide an USB-USART interface from FTDI company.
- **One 16-bit Timer/Counter (TC) with Auto-Reload and PWM**
- **Two 8-bit Timer / Counter (TC) with AR and PWM**
- **One 8-channel 10-bit Analog-To-Digital Converter (ADC), 76.9ks/s**
- **SPI, USART, I2C**

# Arduino Nano v3.0

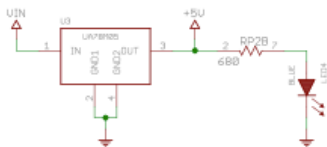


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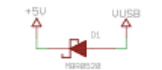
<http://creativecommons.org/licenses/by-sa/2.5/>



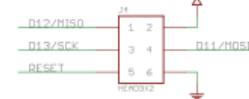
**+5V REG**



**+5V AUTO SELECTOR**



**ICSP**



**NOT USED**



6 x x x x x

TITLE: Arduino Nano2

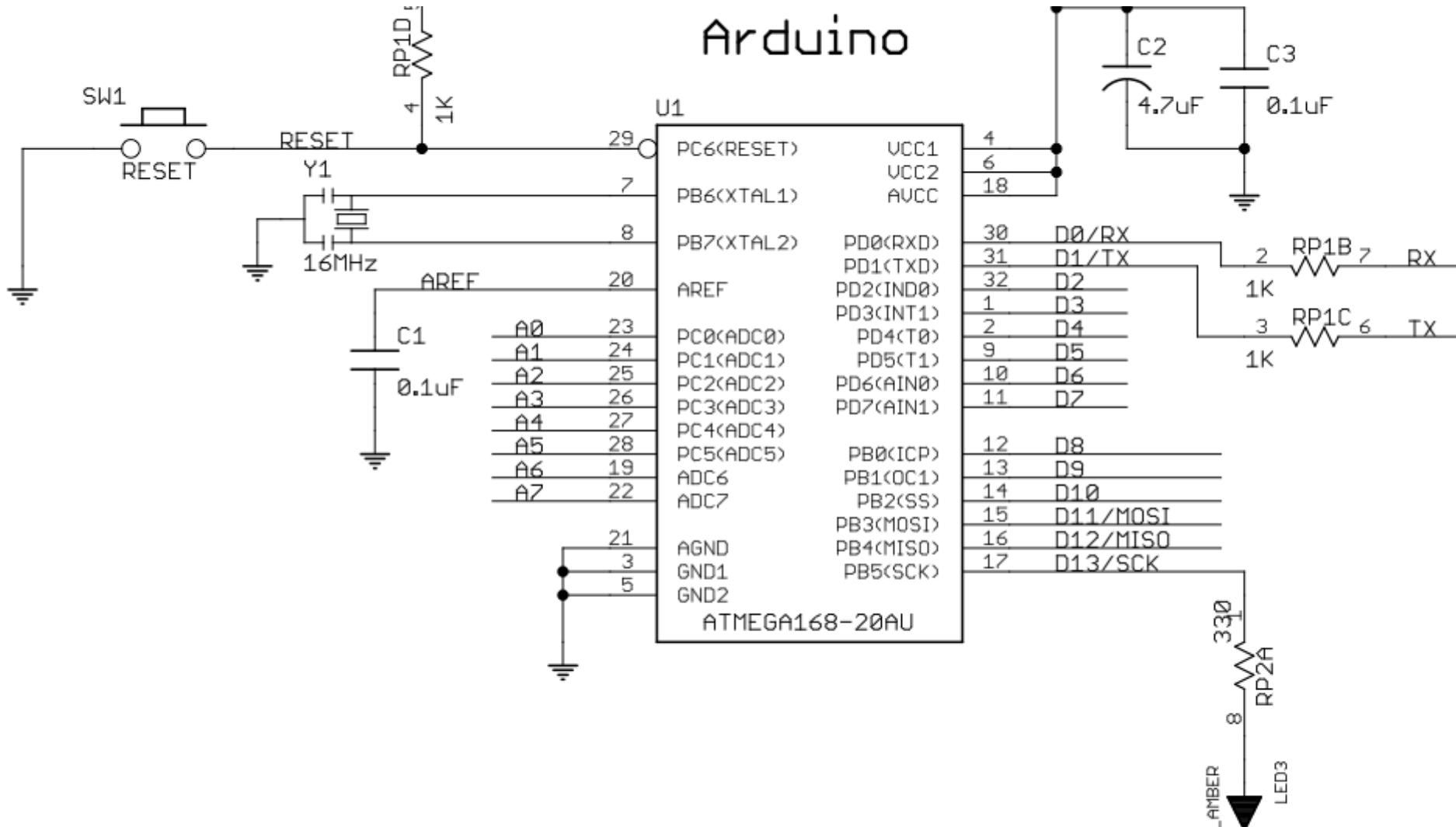
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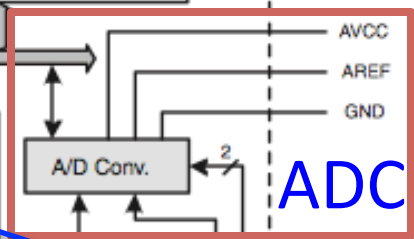
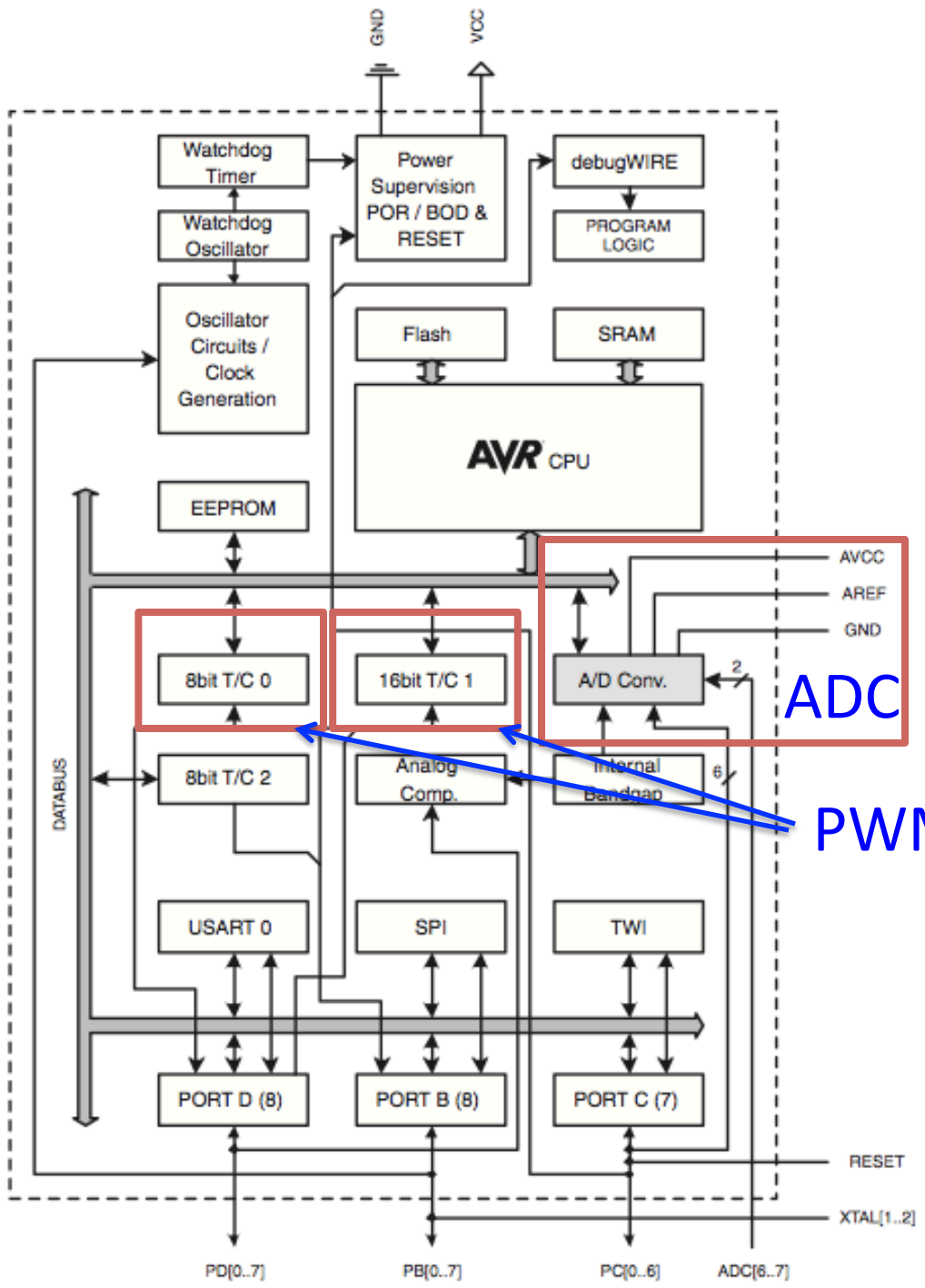
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# Arduino Nano ATmega328P schematics





ADC

PWM

AVR CPU

DATABUS

Watchdog Timer

Watchdog Oscillator

Oscillator Circuits / Clock Generation

EEPROM

Power Supervision POR / BOD & RESET

Flash

SRAM

debugWIRE

PROGRAM LOGIC

8bit T/C 0

16bit T/C 1

A/D Conv.

8bit T/C 2

Analog Comp.

Internal Bandgap

USART 0

SPI

TWI

PORT D (8)

PORT B (8)

PORT C (7)

AVCC

AREF

GND

RESET

XTAL[1..2]

PD[0..7]

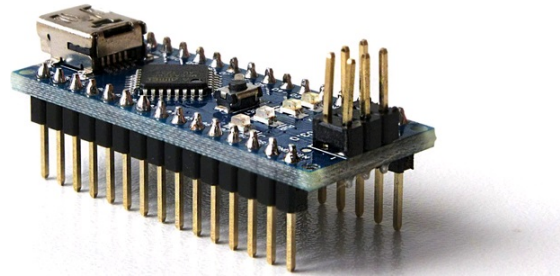
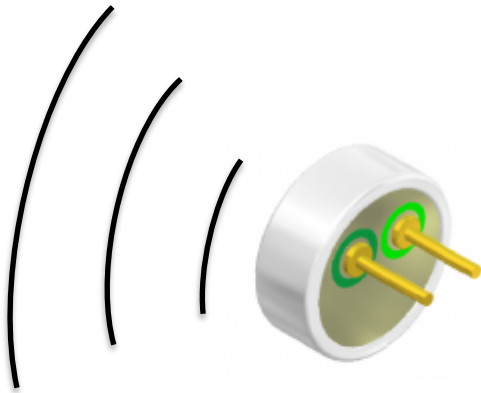
PB[0..7]

PC[0..6]

ADC[6..7]

# Exercise 3: “Sound volume robot”

- measures sound volume and moves arm to indicate loudness
- microphone -> preamp -> ADC -> uC -> PWM output



(“debugging”, programming)

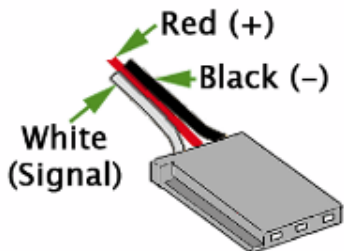


# “RC” servos (Radio-Control Servo-Motors)

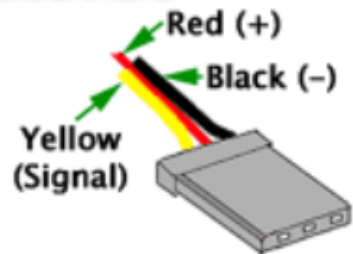


- Position controlled – Servo has internal position measurement and controller
- Rotation angle 120 degrees
- Pulse width from 1-2ms sets desired position
- Pulses must be sent at frequency 50-200Hz
- Pulse height  $>2V$

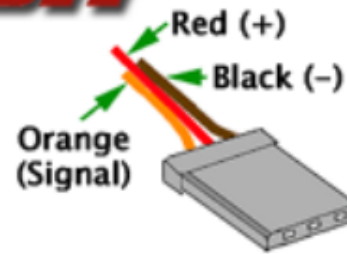
**Futaba**  
"J" Connector



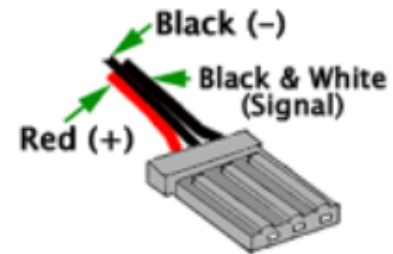
**HITEC**



**JR**

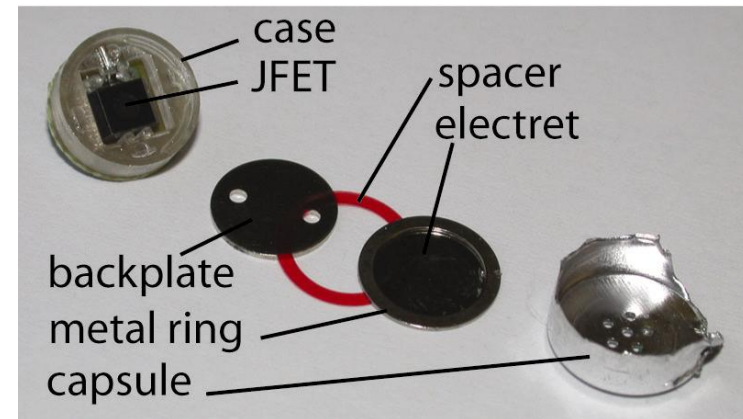
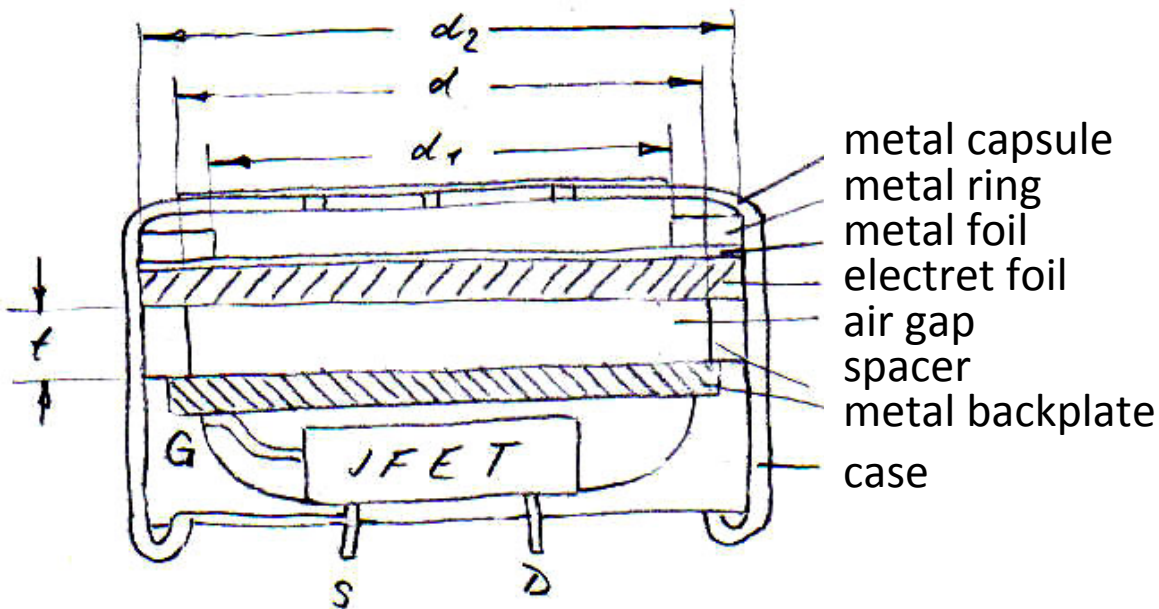


**AIRTRONICS** non-"Z"  
Get The Advantage

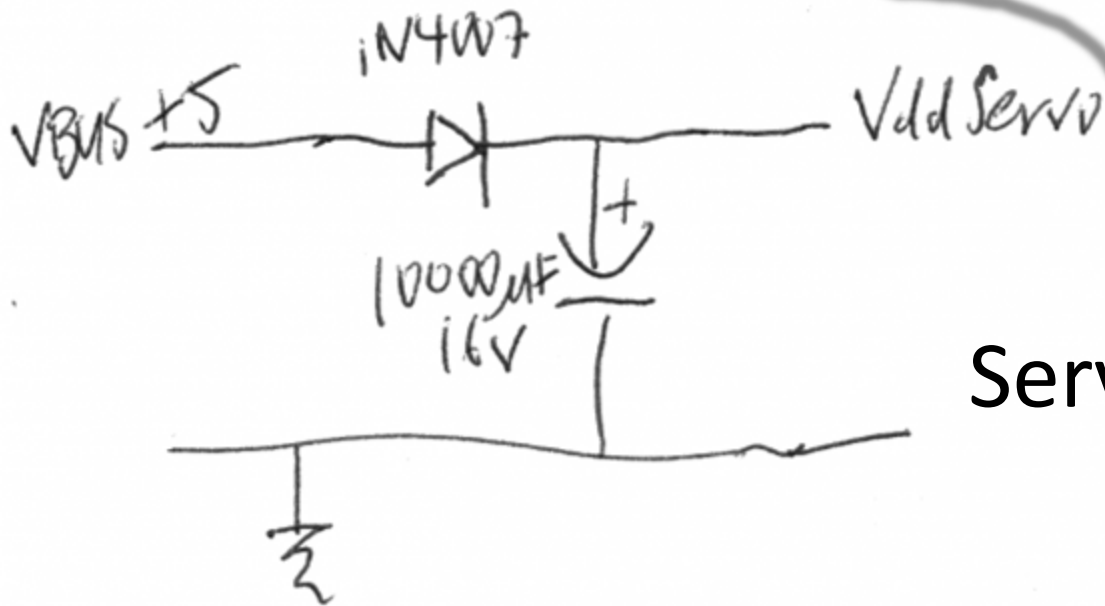
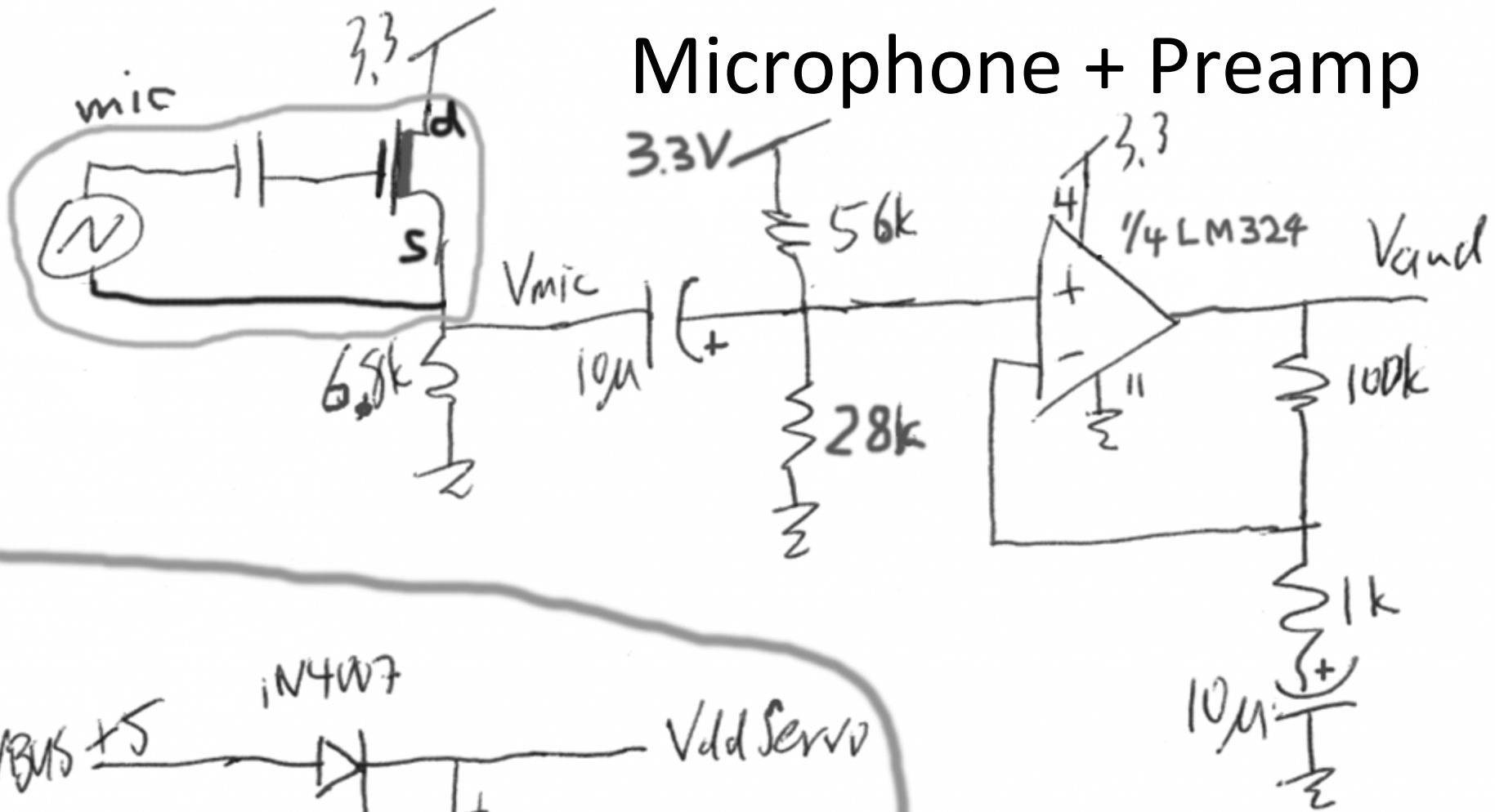


# Electret Microphone

- Cheap (< 1\$)
- Electret material, no polarization voltage is required
- Low-noise JFET buffer
- Metal foil is connected to source of the JFET through metal capsule



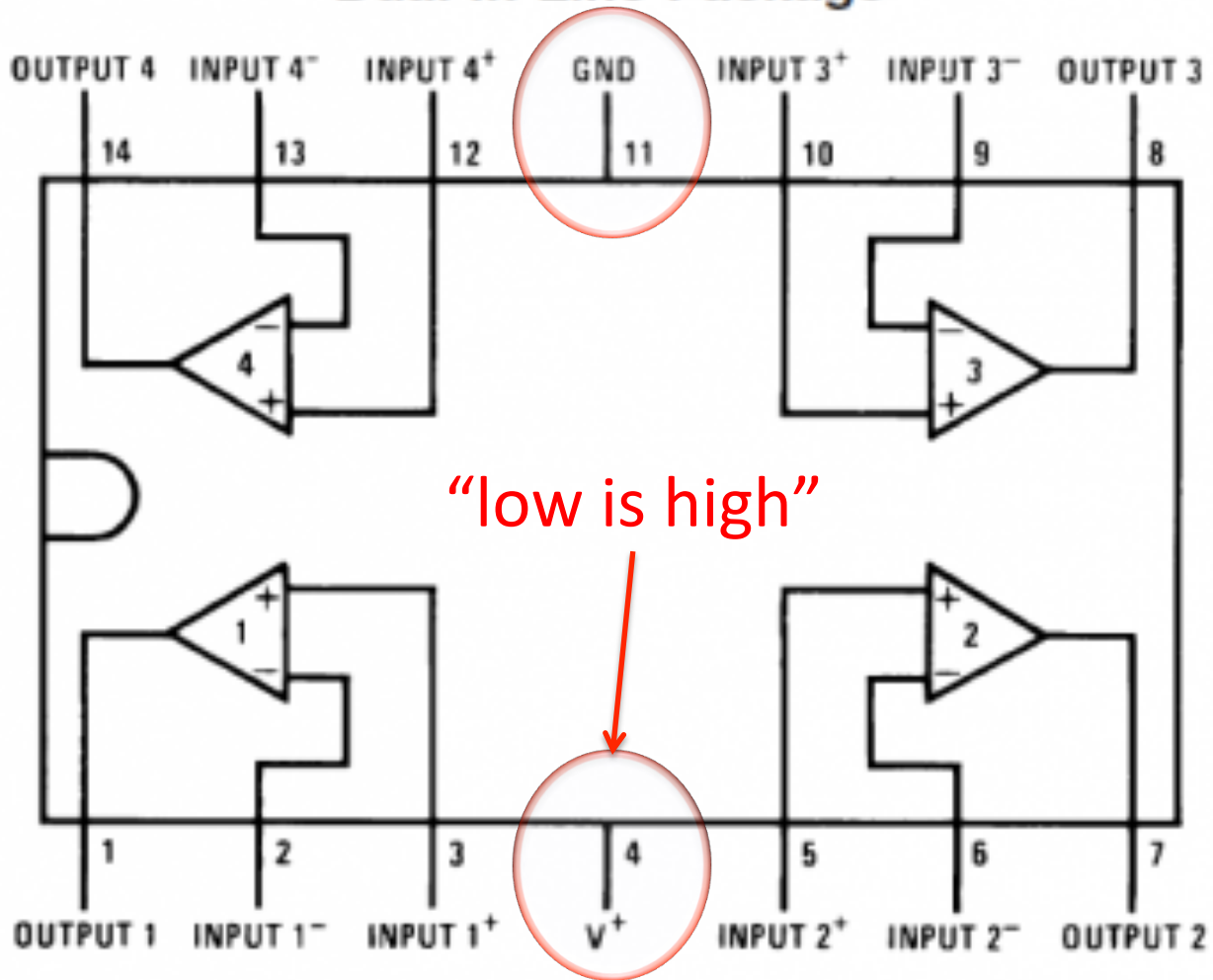
# Microphone + Preamp



# Servo power supply

# LM324 quad JFET opamp

## Dual-In-Line Package

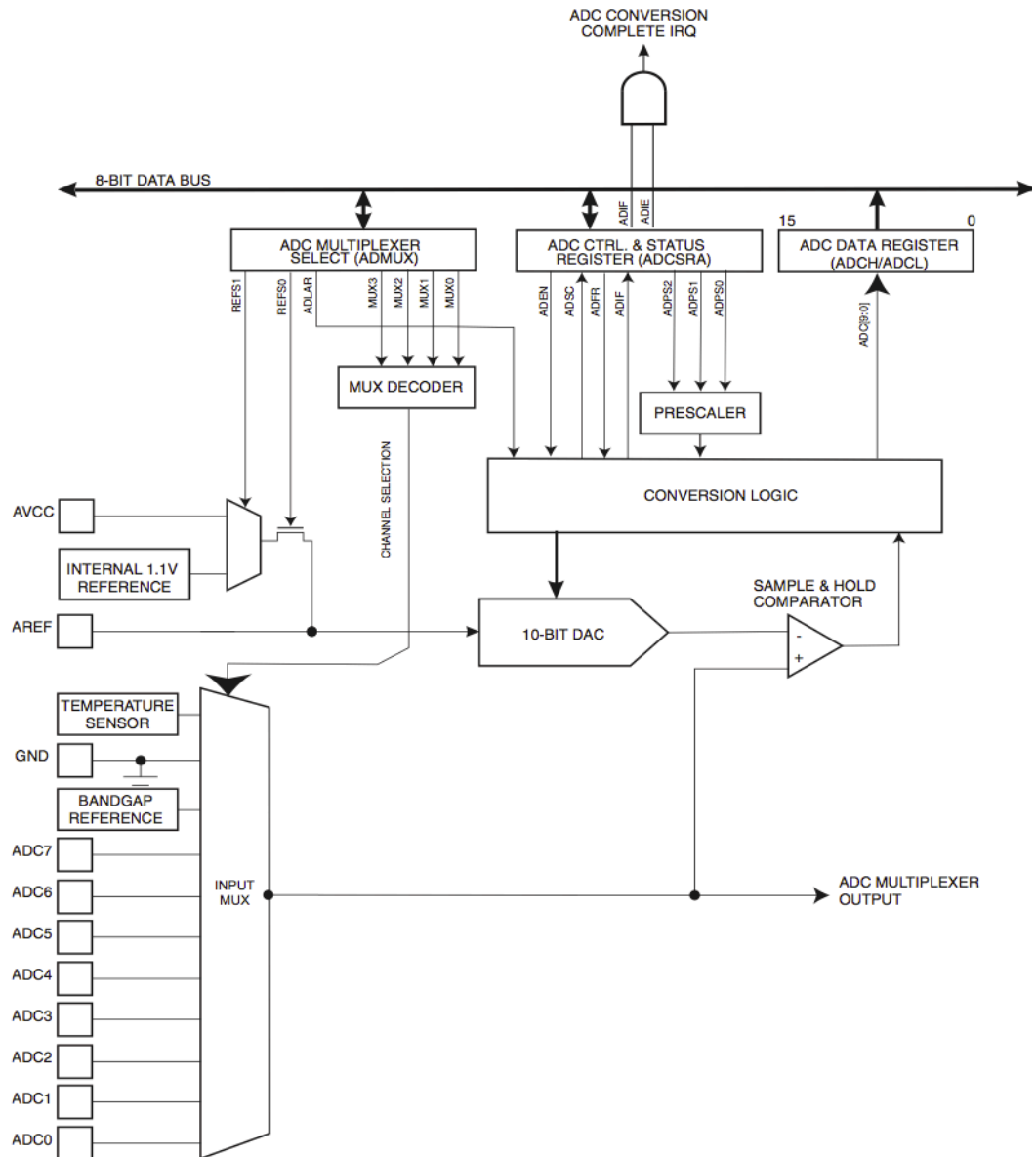


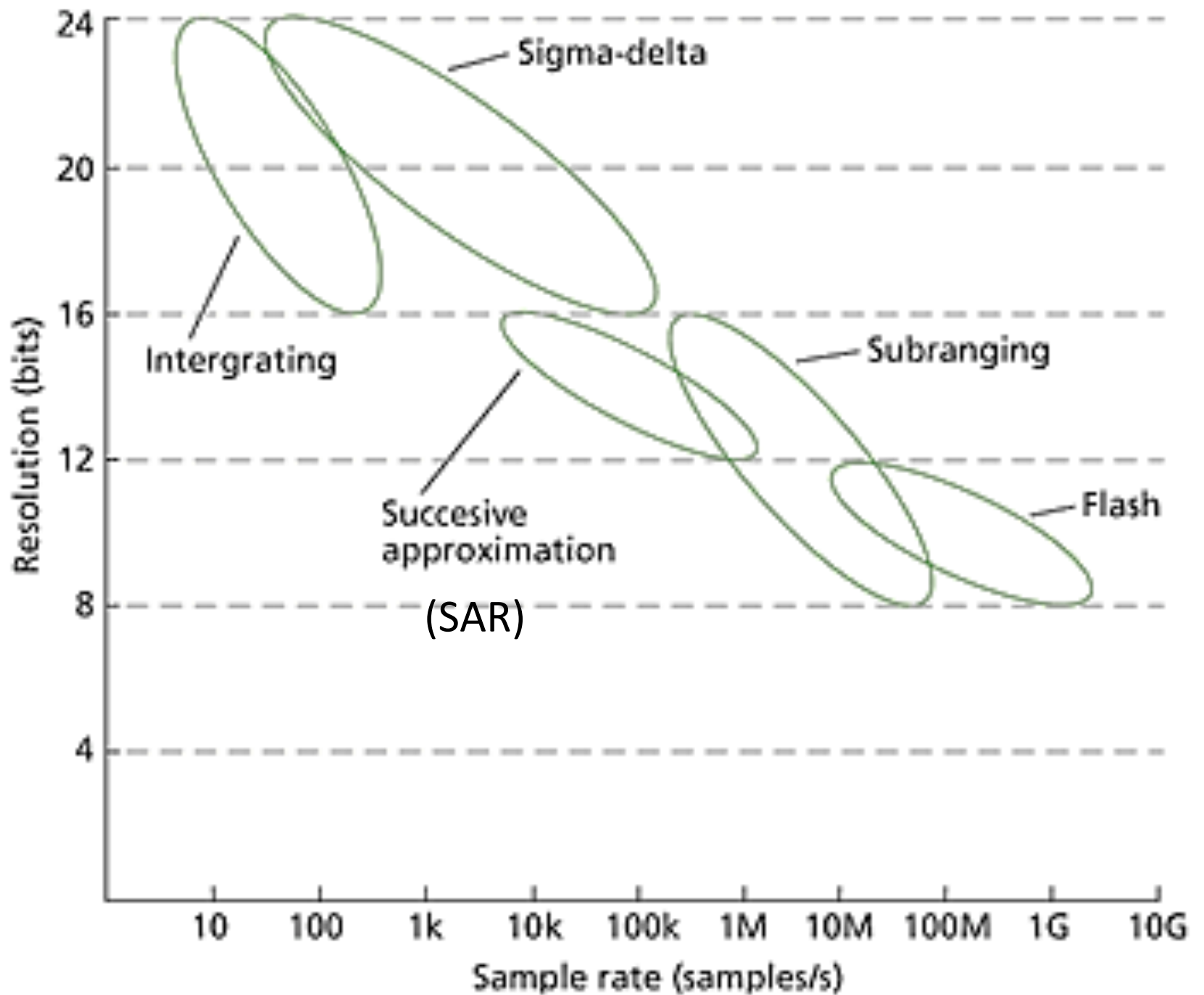
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Top View

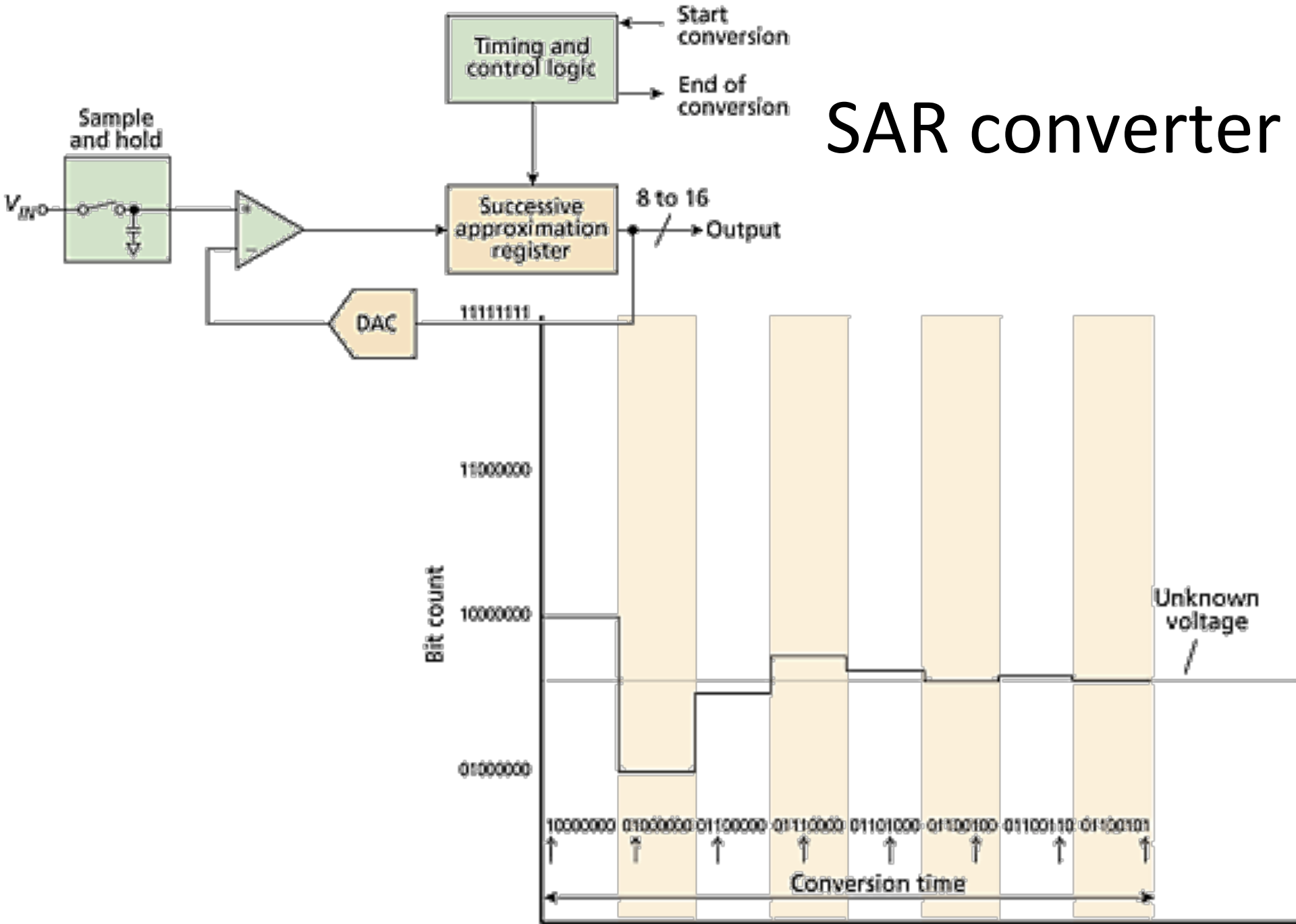
# ATmega328P Analog to Digital converter

- 10-bit Successive approximation register (SAR) type
- 8 multiplexed single-ended input channels
- Internal Temp sensor
- Max combined sample rate 79.6ks/s
- Interrupt on End of Conversion.
- Triggered by:
  - External Interrupt Request 0
  - Timer 0
  - Timer 1
  - Analog Comparator





# SAR converter



# SAR DAC + comparator

