Chapter 7

System Design: Peripheral ICs and Interfacing

Lesson 5

ADC - Analog to Digital Converter

Analog to Digital Conversion (ADC)

- Need of Analog signal to be converted into bits in many applications
- Need a reference input (Vref+) = The maximum input when after conversion output bits= all 1s)
- Need Vref– = The minimum input when after conversion output bits= all 0s)
- Generates Digital output bits proportional to the ADC analog input

ADC output after conversion of analog signal

- n-bit ADC (output) = binary number for

$$\frac{\text{Analog input} * \{(2^n) - 1\}}{(V_{ref+} - V_{ref-})}$$

8-bit ADC example

- Assume that 8-bit ADC Vref+ = 1.275 V and Vref– = 0 V.
- Output bits = all 0s = 00000000 (=0d) when input = 0V,
- Output bits = 10000000 (= 128d) when input = 0.64V and
- Output bits = 11111111 (= 255d) when input = 1.275V

Example of ADC in a Microcontroller

- 80535 ADC with programmable voltage reference
- 80552 10-bit ADC with 8-ch AMUX (Analog multiplexer- same ADC with multiple analog input channels

Example of ADC in a Microcontroller

- ADC04 one channel ADC with voltage reference = 1/2 of maximum permitted analog input
- ADC0808 eight channels ADC with voltage reference + and -inputs
- ADC0816 sixteen channels

Considerations when using an ADC

- Number of bits
- Reference Input single or dual
- Reference programmable or non programmable
- Multi or single channel
- Conversion accuracy
- Sampling rate
- Data throughput rate
- CMOS or Bipolar based

Condition when using an ADC

- Separate analog ground
- Location nearest possible to a signal transducer

ADC0804

- 8 bit ADC
- Interfaces with microcontroller ports or processor data and control bus signals

  D0-D7, $\overline{RD}$ and $\overline{WR}$ and INTR
- Requires Vref/2 input
- Converted output = $1000\ 000_b$ output when analog input = Vref/2
- $\overline{WR}$ input results in start of conversion (**$\overline{\textbf{SOC}}$**)

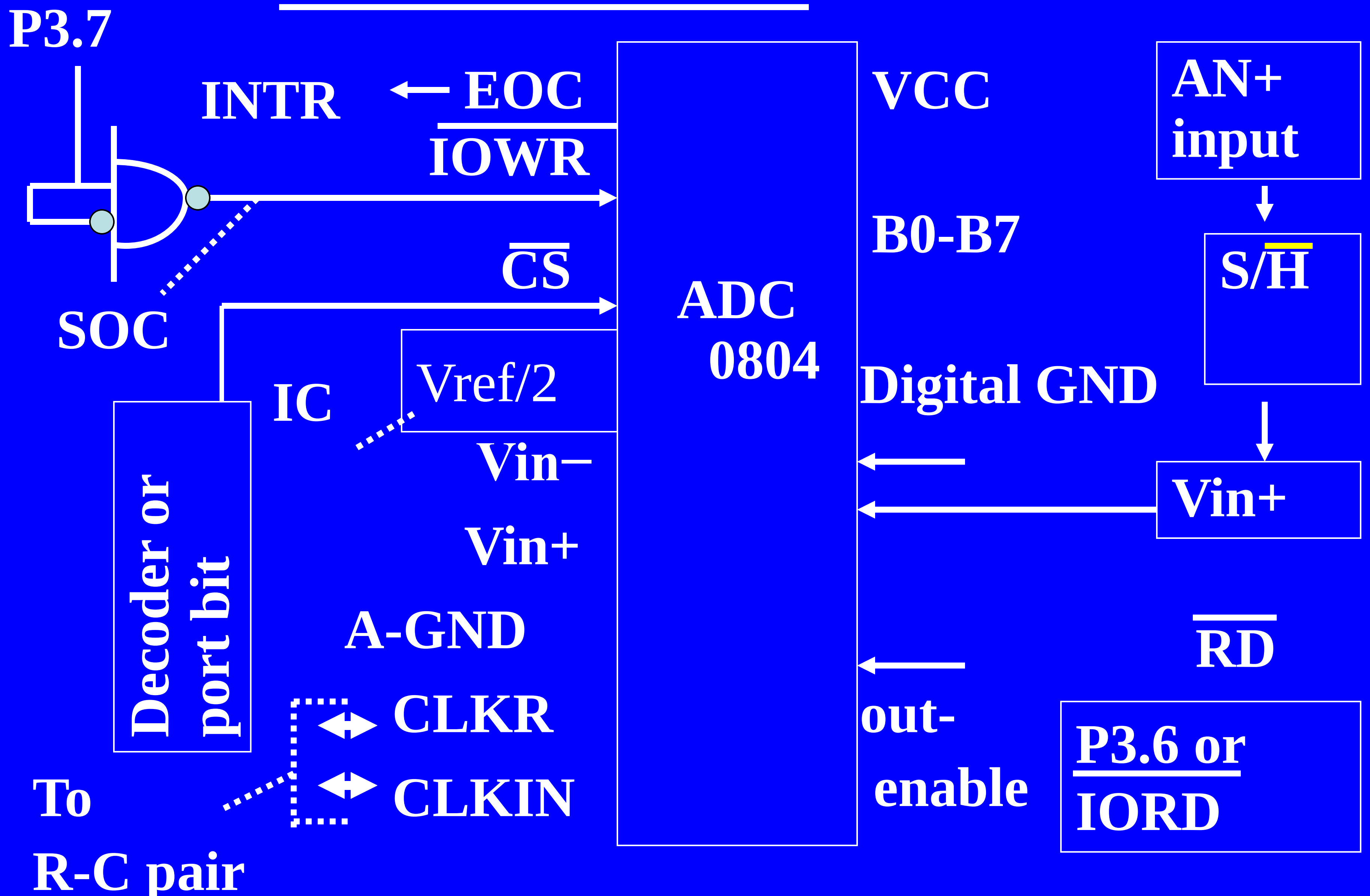
ADC0804

- SOC_input— very short duration pulse (ns) using a NOT-NAND combination
- RD input results in converted bits at output at D0-D7 bus
- EOC output for end of conversion to to facilitate_Interrupt (INTR) driven IO to the processor

ADC0804

- Separate analog and digital grounds to isolate digital transitions noise by direct connection of ANALOG-GND to supply GND
- Clock frequency adjustable by external RC pair timing constant

ADC One Channel Vin+ in ADC0804



ADC0808

- 8 bit ADC
- Interfaces micro-controller ports or processor D0-D7, $\overline{\text{RD}}$, $\overline{\text{WR}}$, ALE (built in latch) for channel select through AD2-AD1-AD0 inputs
- Start of conversion (**$\overline{\textbf{SOC}}$**) using $\overline{\text{WR}}$

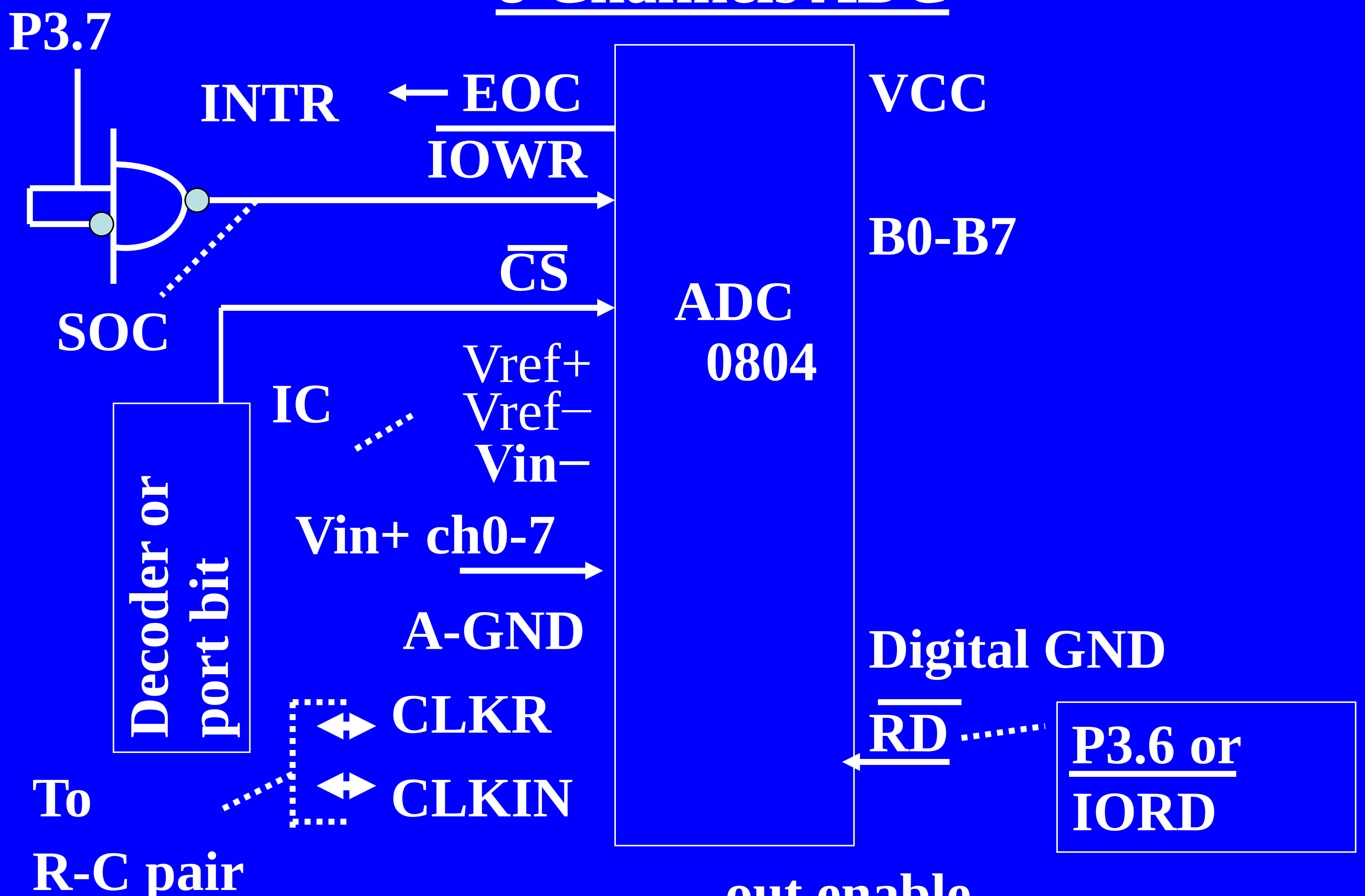
ADC0808

- **SOC** input very short duration (ns) pulse using a NOT-NAND combination
- **output enable** for converted bits on D0-D7 using RD
- EOC output for end of conversion to facilitate **interrupt** (INTR) driven IO

ADC0808

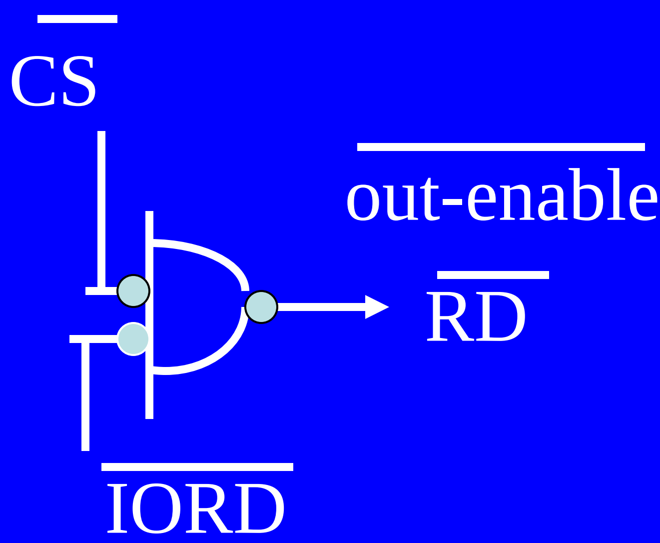
- Separate analog and digital grounds to separate digital transitions noise by direct connection of A-GND to supply GND
- Clock frequency input

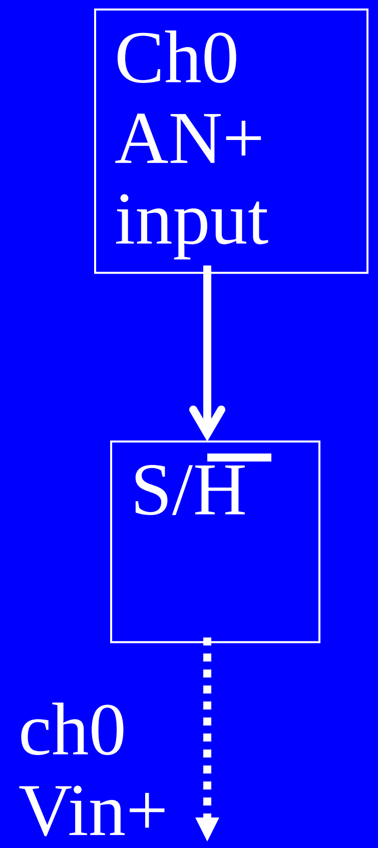
8 Channels ADC



Interfacing ADC0808

B0-B7 connects to data AD0-AD7





ADC0816

- 8 bit ADC
- Interfaces micro-controller ports or processor data buses (D0-D7), RD, WR, ALE for channel select through AD3-AD2-AD1-AD0 bus inputs (also separate A3-A0),
- WR input for start of conversion (**SOC**)

ADC0816

- Separate output enable input for expanding the number of channels
- Analog multiplexer in-built gives the analog output for the filter and $S/\overline{H}$ inputs and then hold outputs to get analog inputs for conversion (External $S/\overline{H}$ and filter not needed for channels)

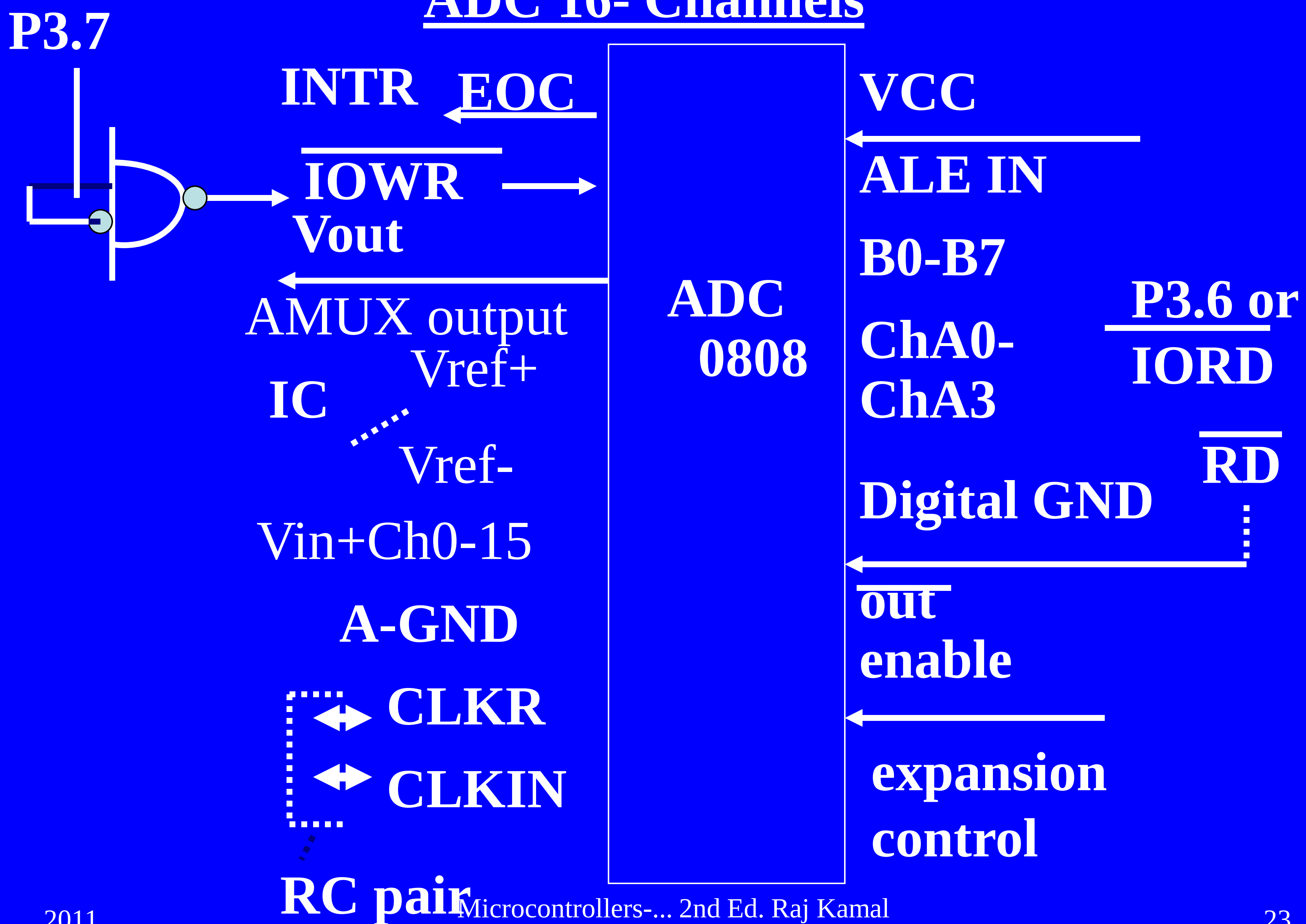
ADC0816

- **SOC** input can be very short pulse (ns) using a NOT-NAND combination
- $\overline{\text{RD}}$ input for converted bits on D0-D7
- EOC output for end of conversion to facilitate **interrupt** (INTR) driven IOs

ADC0816

- Separate analog and digital grounds to separate digital transitions noise by direct connection of A-GND to supply GND
- Clock frequency input

ADC 16- Channels



ChA0-ChA3 connects to A0-A3/AD0-AD3

ALE IN

B0-B7 connects to data D0-D7

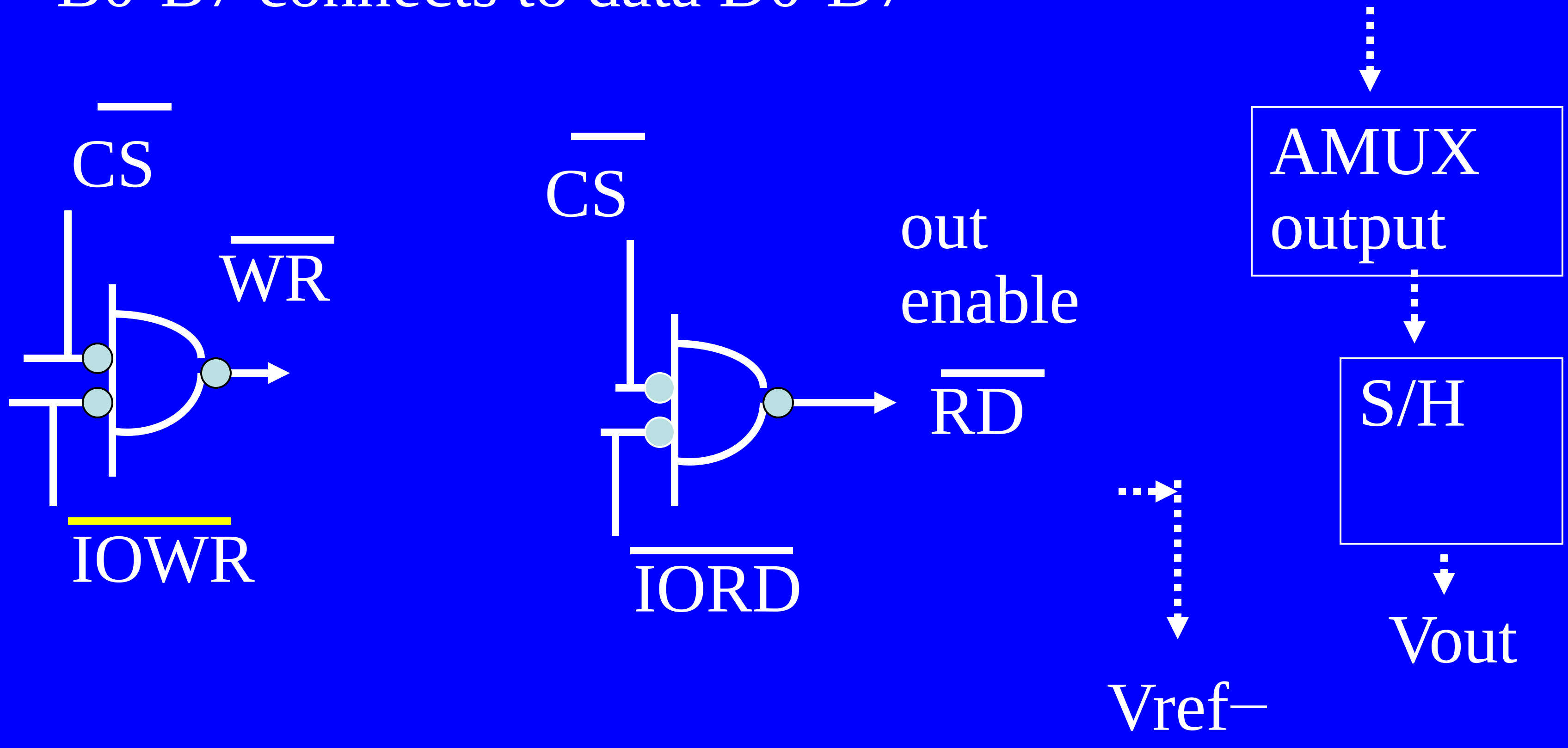


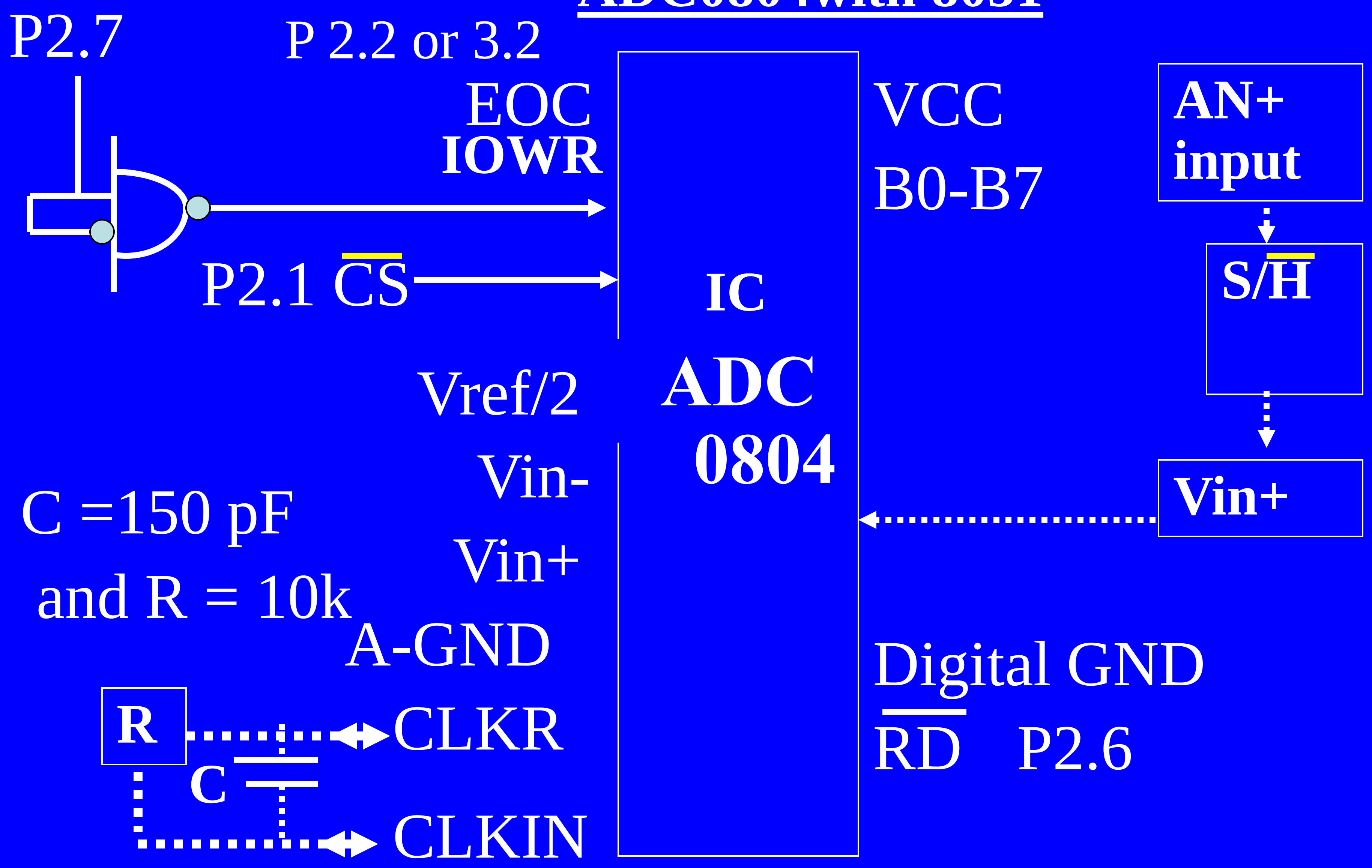
Table 7.19 - Functions of subunits in circuit

Table 7.20 - Each Pin signals

A3-A2-A2-A1 Channel select bits

Table 7.21 - Sixteen Addresses in Exemplary circuit for ADC 08016, when interfacing using An-A7 = 0, A6 =1 A5 = 0 A4 = 0

ADC0804with 8051



C =150 pF and R = 10k

1.Initial condition P2.6 = 1,P2.7 = 1, P3.2 = 1

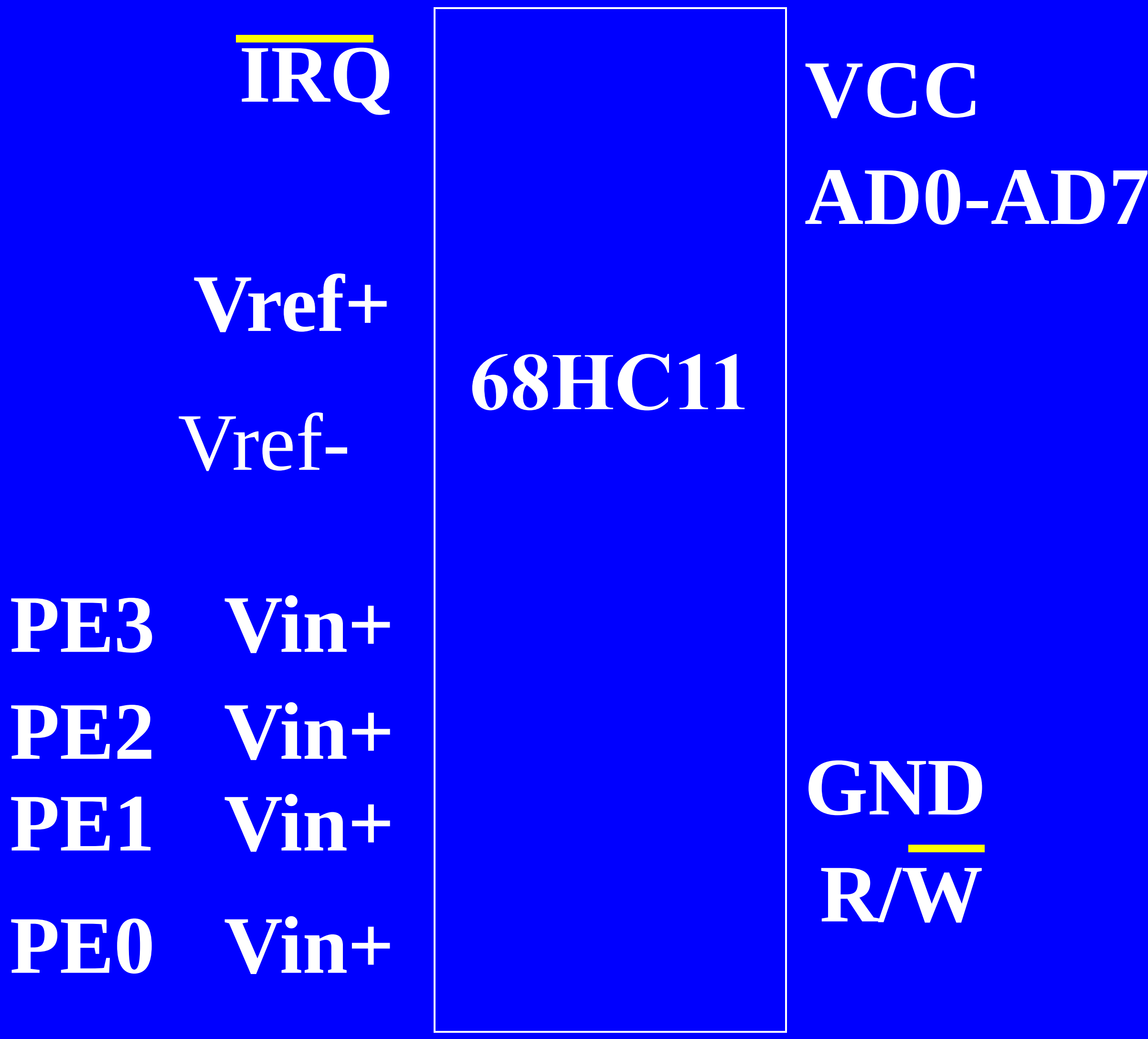
2.Select ADC write P2.1 = 0

3. Pulse Start ADC write P2.7 = 1, then P2.7 = 0

4.Wait till INT0 interrupt or till P2.2

5. Reset P2.6 and Read P1

Interface with 68HC11



Summary

We learnt

- ADC Bits at output
- ADC 0804,0808, 0816
- Internal AMUX and channel address latch
- Multi channel ADC
- ADC Interfacing to ports