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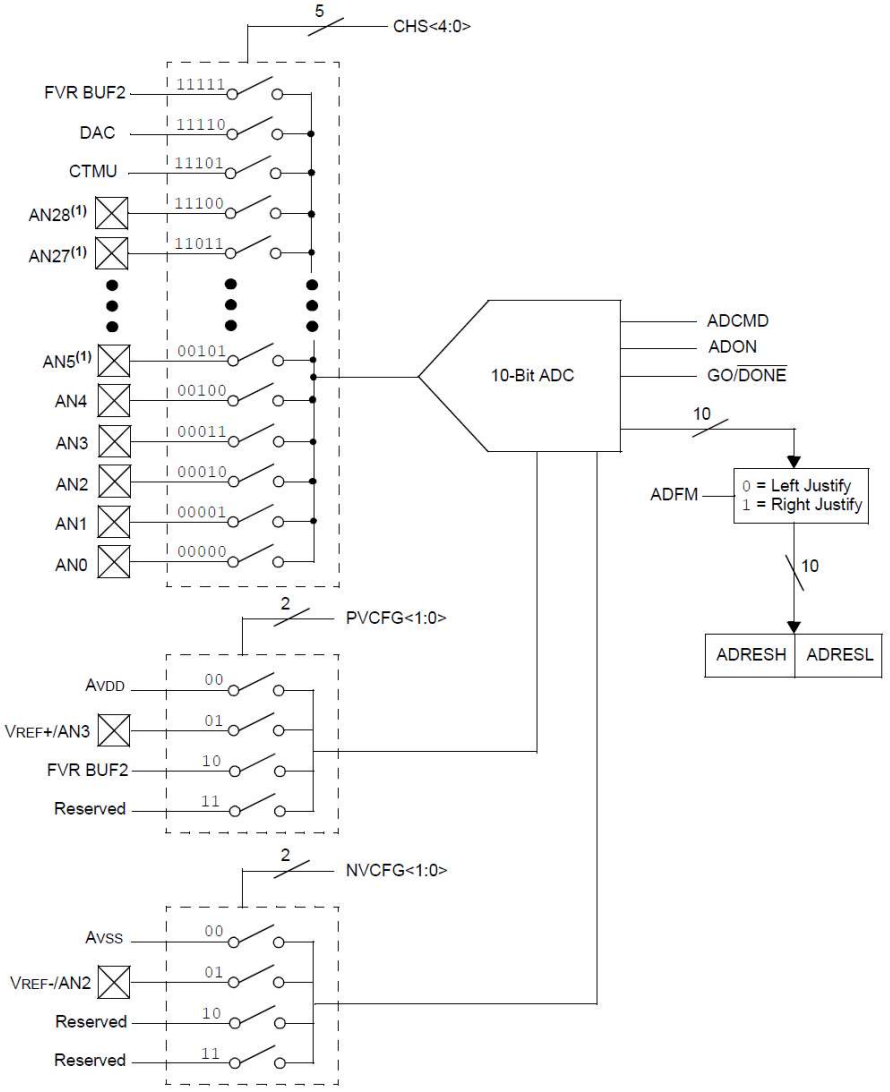
# MICROCONTROLLERS

## LAB – ADC

# Overview

- PIC 18F45K22 has 1 ADC
- **Successive Approximation Register (SAR)** ADC
- 32 multiplexed analog inputs
- Internal/External references
- Internal settable or External clocks
- 10 bit result
- End of conversion can trigger and interrupt event

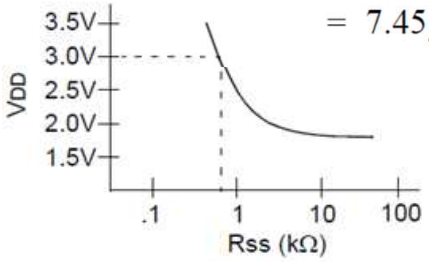



Always read the datasheet before using ADC! Chap. 17 (pag. 288),

and revise its interrupt registers (PIR1, PIE1, IPR1)

# Acquisition Chain

$$T_{ACQ} = \text{Amplifier Settling Time} + \text{Hold Capacitor Charging Time} + \text{Temperature Coefficient}$$
$$= T_{AMP} + T_C + T_{COFF}$$
$$= 5\mu s + T_C + [(\text{Temperature} - 25°C)(0.05\mu s/°C)] = 5\mu s + 1.20\mu s + [(50°C - 25°C)(0.05\mu s/°C)]$$
$$= 7.45\mu s$$




$$T_{CONV} = T_{ACQT} + 11T_{AD} + T_{CY}$$

$T_{ACQ} < T_{ACQT}$ ACQT[2:0]

$T_{ADC} = 11 \cdot T_{AD}$

Ain0

Ain31

AMUX

Vin

$R_S$

S/H

$C_H$ 13,5pF

Vref+

Vref-

ADC SAR 10 bit

[7:0]

[9:8]

ADRES

Wait $T_{CY}$ for discharge $C_H$

CHS[4:0]

$1/T_{AD}$

ADCS[4:0]

MUX

$F_{OSC}/2$ $F_{OSC}/64$ $F_{RC}$

NB

$F_{OSC}$ is MCU in Ide

$T_{CY}$ is $4/F_{OSC}$

# Time Diagram

**FIGURE 17-3: A/D CONVERSION TAD CYCLES (ACQT<2:0> = 000, TACQ = 0)**

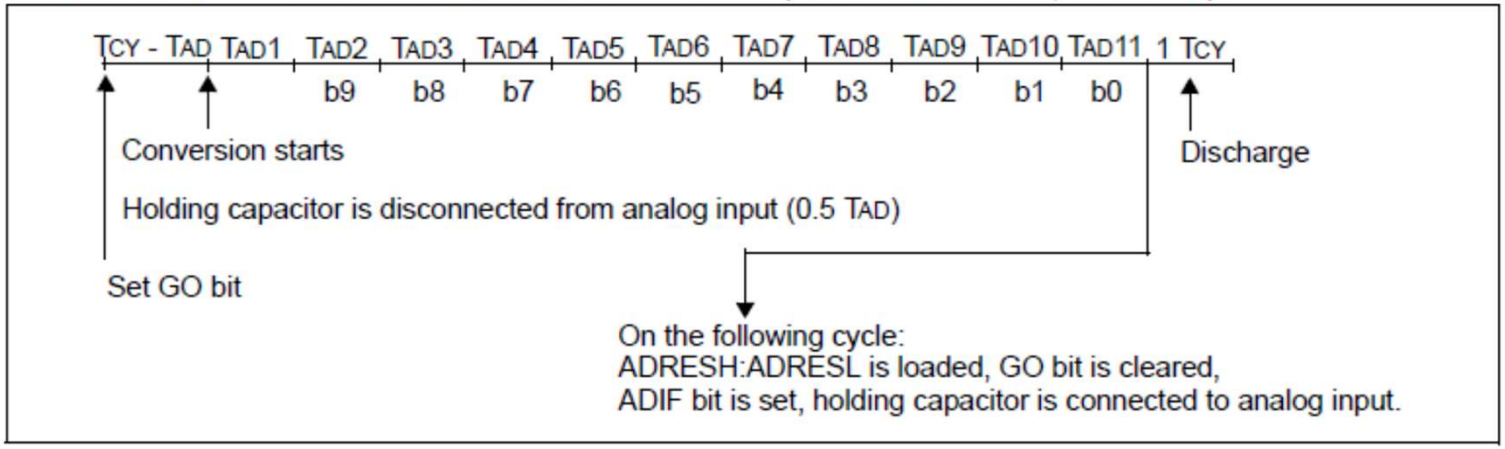
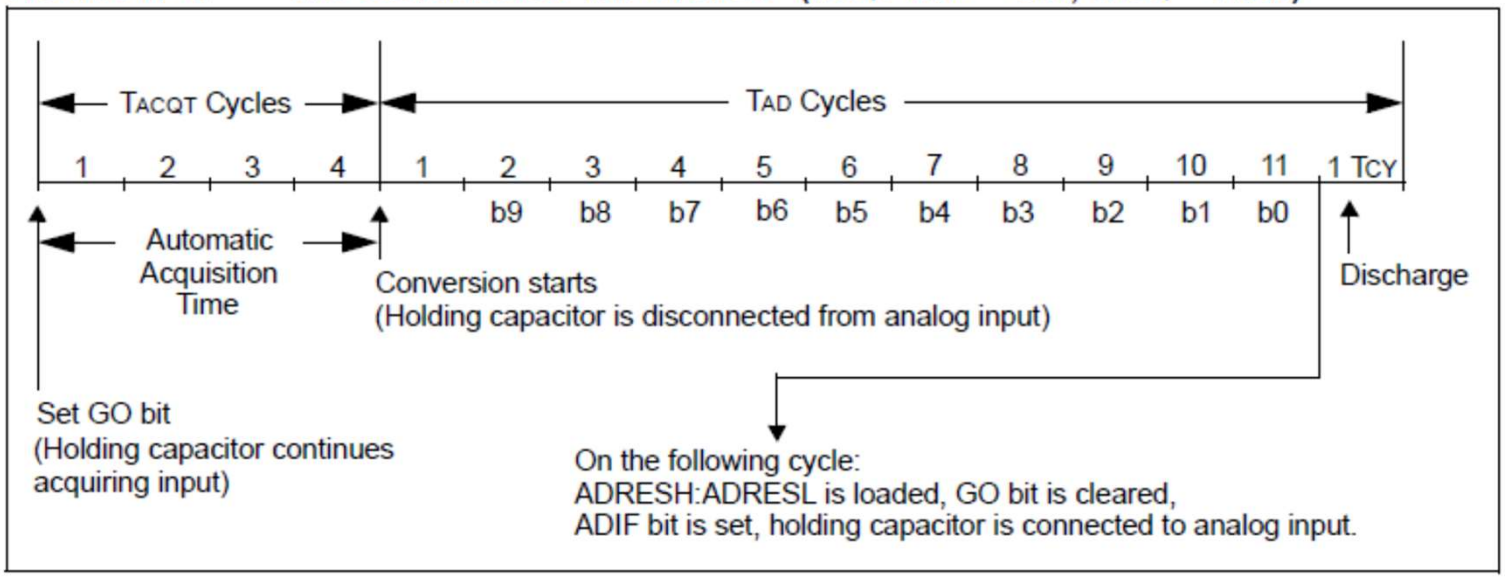



**FIGURE 17-4: A/D CONVERSION TAD CYCLES (ACQT<2:0> = 010, TACQ = 4 TAD)**



# Settings

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- Set analog input

  ADCON0.CHS<4:0>
- Set TAD

  ADCON2.ADCS<2:0>
- Configure voltage references

  ADCON1.PVCFG<1:0>

  ADCON1.NVCFG<1:0>
- Select ACQT

  ADCON2.ACQT<2:0>
- Set justification

  ADCON2.ADFM
- Turn on the ADC

  ADCON0.ADON
- Start A/D conversion

  ADCON0.GO/DONE = 1
- Interrupt/Polling

  Interrupt PIR1.ADIF

  Polling ADCON0.GO/DONE
- Stop A/D conversion (GO/DONE = 0)
- 10 bits result after Tconv

  ADRESH

  ADRESL

# Registers

**REGISTER 17-1: ADCON0: A/D CONTROL REGISTER 0**

| U-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |
|---|---|---|---|---|---|---|---|
| — | CHS<4:0> | | | | | GO/$\overline{\text{DONE}}$ | ADON |
| bit 7 | | | | | | | bit 0 |

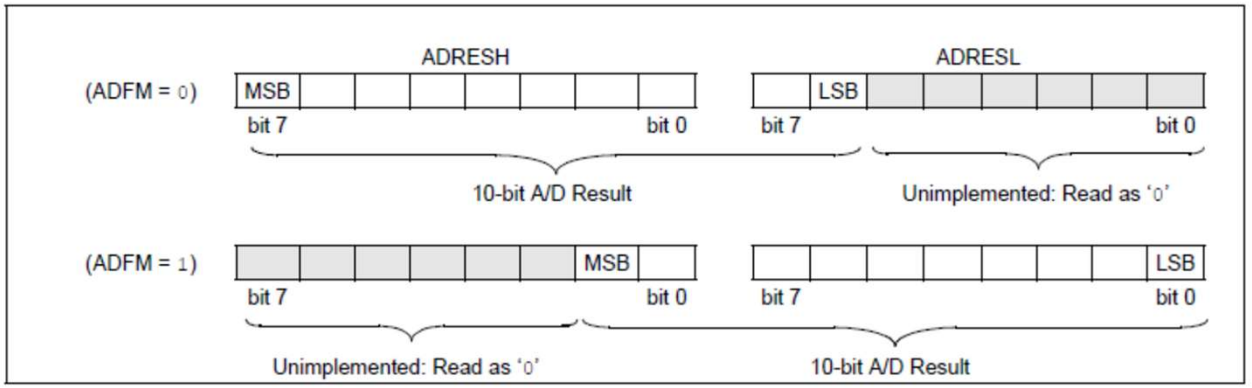
**REGISTER 17-2: ADCON1: A/D CONTROL REGISTER 1**

| R/W-0 | U-0 | U-0 | U-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |
|---|---|---|---|---|---|---|---|
| TRIGSEL | — | — | — | PVCFG<1:0> | | NVCFG<1:0> | |
| bit 7 | | | | | | | bit 0 |

**REGISTER 17-3: ADCON2: A/D CONTROL REGISTER 2**

| R/W-0 | U-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 | R/W-0 |
|---|---|---|---|---|---|---|---|
| ADFM | — | ACQT<2:0> | | | ADCS<2:0> | | |
| bit 7 | | | | | | | bit 0 |

**FIGURE 17-2: 10-BIT A/D CONVERSION RESULT FORMAT**



# Interrupt vs Polling

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## Interrupt

- ADC Interrupt Priority (IPR1.ADIP), not used
- Set ADC Interrupt Enable (PIE1.ADIE=1)
- Clear ADC Interrupt Flag (PIR1.ADIF=0)
- Enable Peripheral interrupt (INTCON.PEIE=1)
- Set Global Interrupt Enable (INTCON.GIE = 1)
- Wait interrupt in ISR
- Check ADC Interrupt Flag
- Clear ADC Interrupt Flag (PIR1.ADIF=0), exit ISR

## Polling

- Polling GO/DONE = 0