Lab 3: Comparators

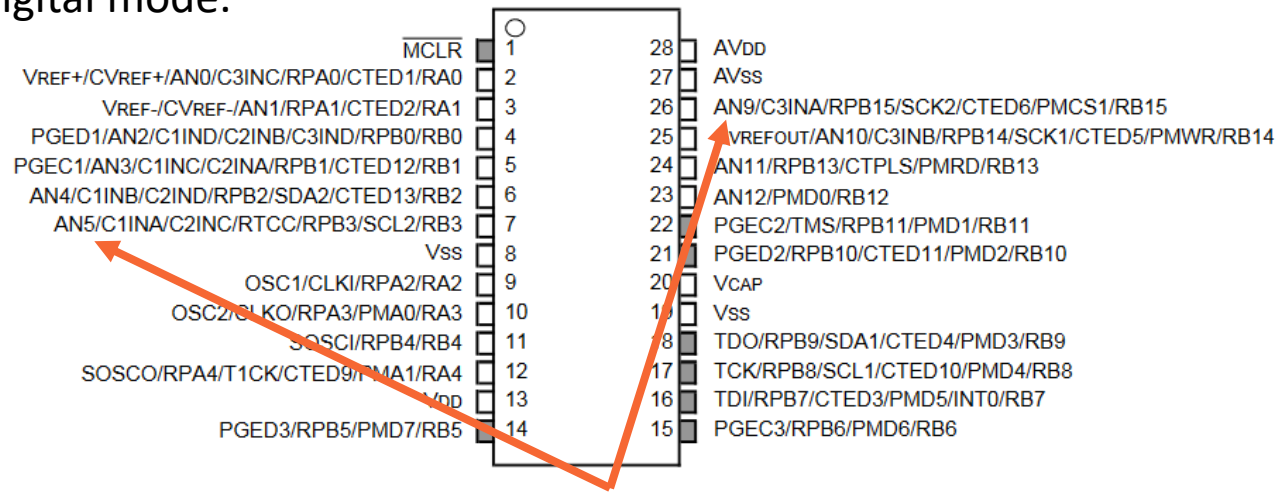
ECE 3720

Preview

A variable, analog voltage will be produced with a potentiometer and connected to three inputs of the microcontroller. Each of the PIC32's three comparators will be set up to compare this input with a different reference voltage. The states of the comparators' outputs will be indicated by LEDs, such that turning the potentiometer clockwise will light up the LEDs in succession.

Analog Capable Pins

- This is the first lab in which we will use the analog capabilities of the PIC32.
- Only some pins of the PIC32 can read analog voltages.
  - Refer to the pinout diagram in the Cmod reference manual to identify these pins.
  - Note that none of these are 5V tolerant.
- Recall that the ANSELx registers are used to set pins to analog or digital mode.



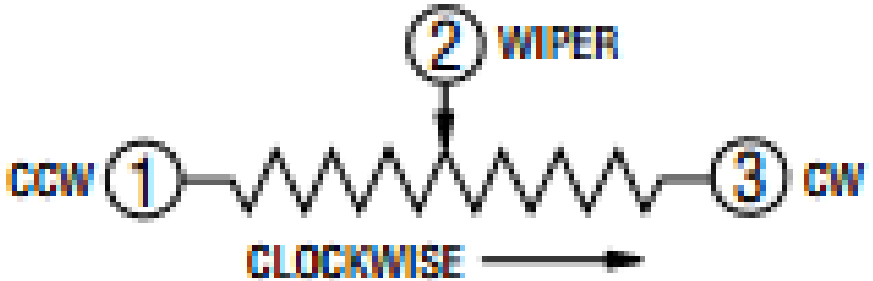
AN# labels indicate analog capable pins

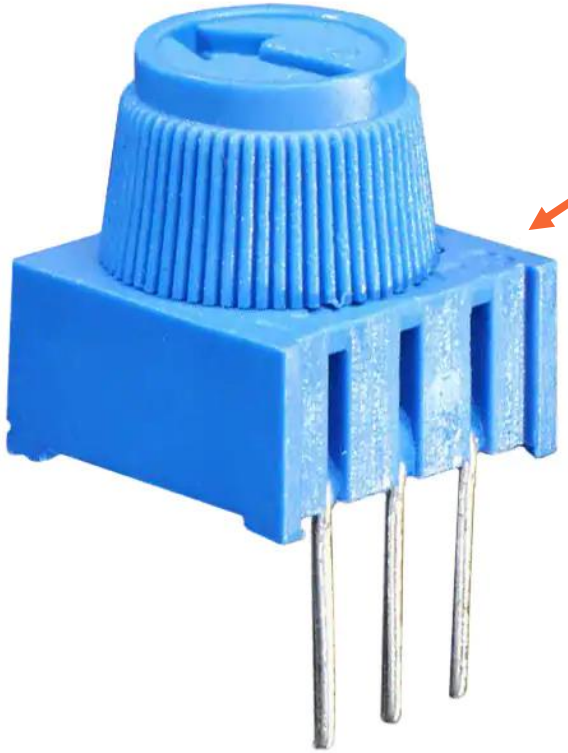
> 11.1.2 CONFIGURING ANALOG AND DIGITAL PORT PINS
>
> The ANSELx register controls the operation of the analog port pins. The port pins that are to function as analog inputs must have their corresponding ANSEL and TRIS bits set. In order to use port pins for I/O functionality with digital modules, such as Timers, UARTs, etc., the corresponding ANSELx bit must be cleared.
>
> The ANSELx register has a default value of 0xFFFF; therefore, all pins that share analog functions are analog (not digital) by default.

PIC32 Datasheet, pg. 144

Potentiometer

- Variable resistor
  - Ours is a 10 kΩ trimming potentiometer (“trimpot”).
- Three pins
  1. Min voltage (GND)
  2. Output
  3. Max voltage (3.3V)
- Turning the knob clockwise increases resistance between pins 1 and 2.

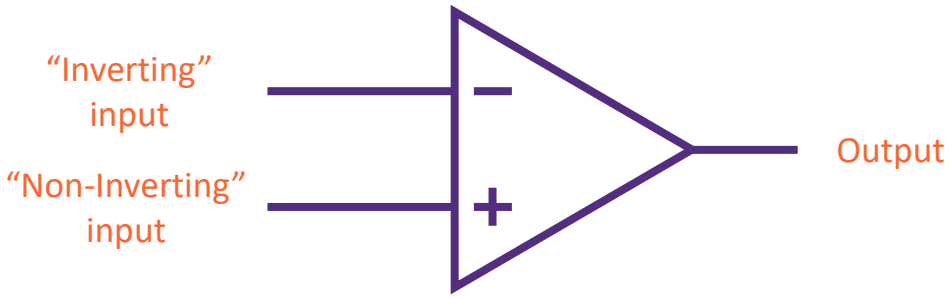




Notice that pins 1 and 3 are labeled on the top face

Comparators

- Compare two input voltages, outputting logical HIGH or LOW depending on which input is greater
- The PIC32 contains 3 comparators
  - We will use all 3 in this lab, each set up to compare the input from the potentiometer to a different voltage.
  - This will be accomplished by using the registers detailed in the next two slides.

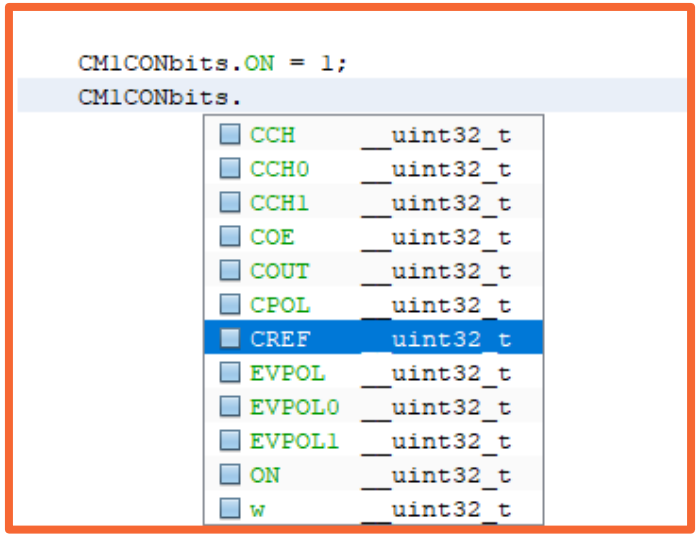


Inputs	Output
Non-Inverting > Inverting	1
Non-Inverting < Inverting	0

Comparator Registers

The following are the registers of interest for this lab. You will need to reference their sections in the datasheet.

- **CMxCON** (datasheet pg. 212)
  - Control registers for each comparator (x is 1, 2, or 3)
  - Used to control the values in and out of the comparators
- **CMSTAT** (pg. 213)
  - Status register that holds the output values from all 3 comparators
- **CVRCON** (pg. 216)
  - Control register used to set the comparator reference voltage (CV_{REF})
  - You will set the values of **CVRSS, CVRR,** and **CVR**
  - **We want CV_{REF} = 0.75 * CV_{RSRC}**
    - CV_{RSRC} will be the difference between V_{REF+} and V_{REF-}, which you will supply externally.
    - Note that you cannot achieve *exactly* 0.75 * CV_{RSRC}, but you can get close.



Comparator Setup

The following are the comparator input combinations used in this lab:

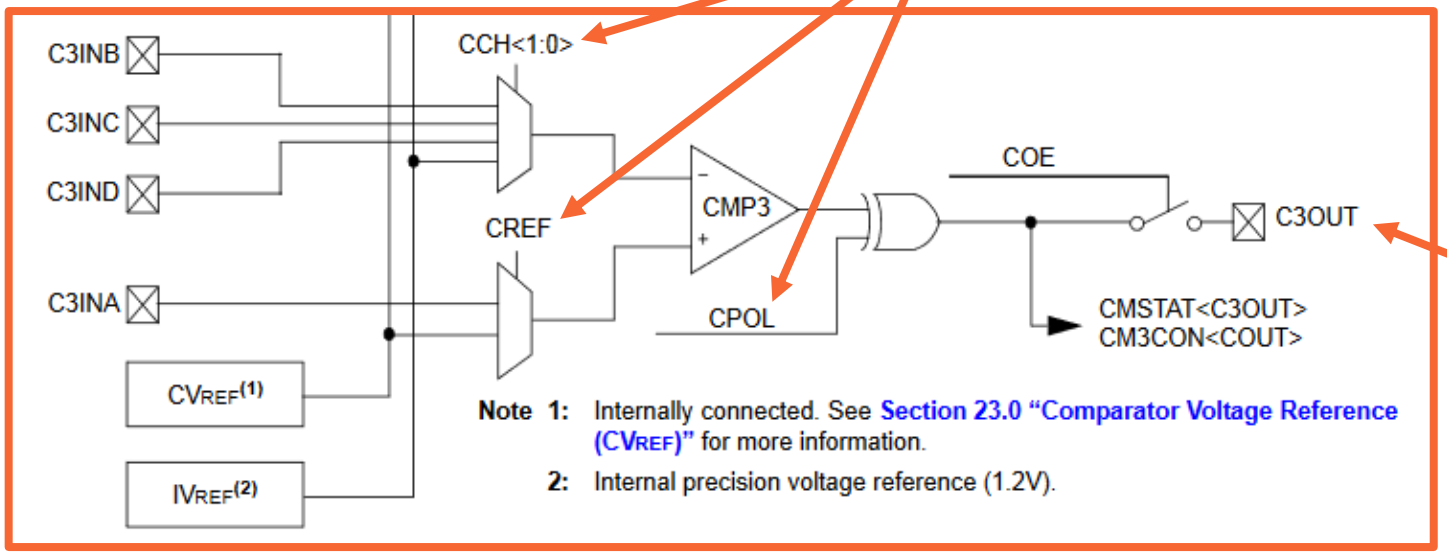
CMP1: IV_{REF} as inverting input and C1INA as non-inverting

CMP2: C2IND as inverting input and VC_{REF} as non-inverting

CMP3: C3IND as inverting input and C3INA as non-inverting

Notice that the values in CMXCON control the multiplexers and the output polarity

This is only 1/3 of the full diagram in the datasheet.

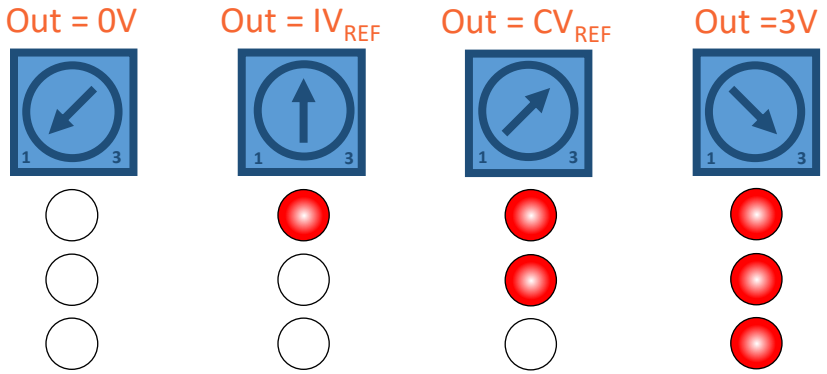


We can't access this right now, so where else can we find the comparator output?

PIC32 datasheet, pg. 211

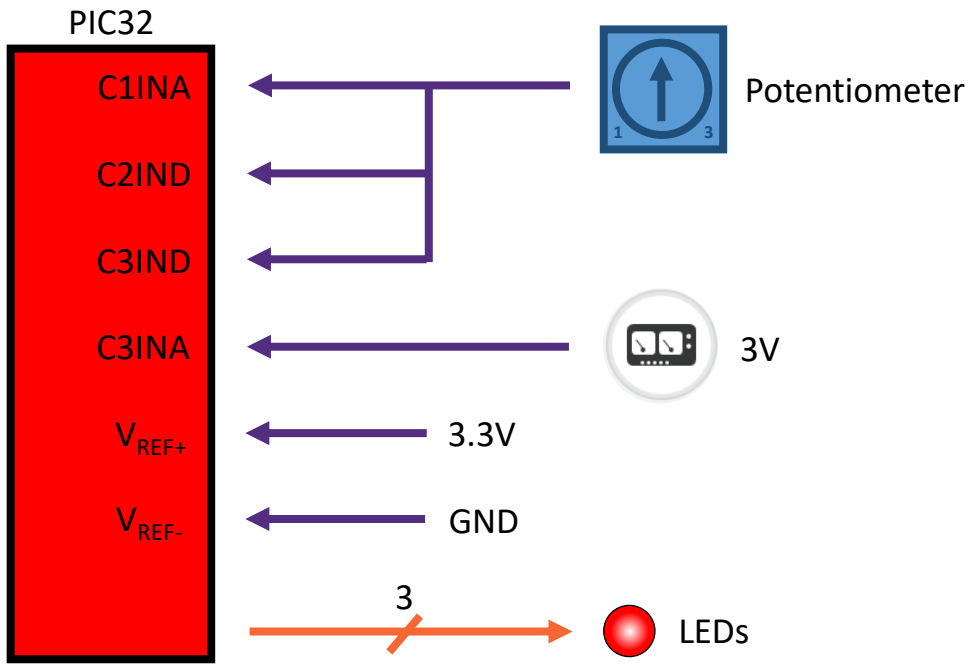
Lab Goals

- Output of the potentiometer will connect to 3 inputs of the MC.
- 3 LEDs will be connected to outputs of the MC and indicate the statuses of the comparators.
- As the potentiometer is turned clockwise and the output voltage increases, the LEDs turn on in sequence.



*not exact trimpot positions

Simple Diagram



Notes

- C1INA, C3IND, V_{REF+} , etc. correspond to specific pins on the MC. Find them in the datasheet pinout diagram.
- You can use the AD2's Wavegen function to provide a 3V DC signal to C3INA
- Your code will feature a bunch of register setup before the while loop, then just a few lines inside the loop.
- If your LEDs turn on in the wrong order or at the wrong voltages,
  - Make sure you are connecting the right pins
  - Make sure you are supplying 3V (not 3.3V) to C3INA
  - Check your CVRCON values (CV_{REF} may be incorrect)
  - Comparators' polarities may need to be flipped
  - If you enabled CVROE, note that the value of CV_{REF} will occupy B14