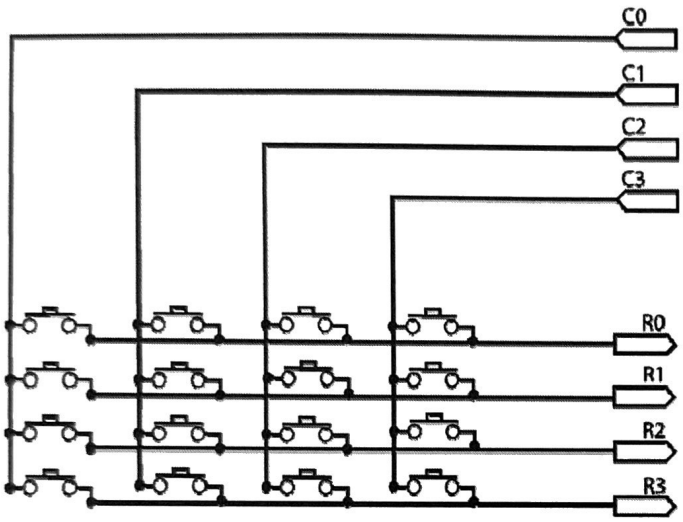
Adding peripheral and interface chips to your microcontroller. Why bother?

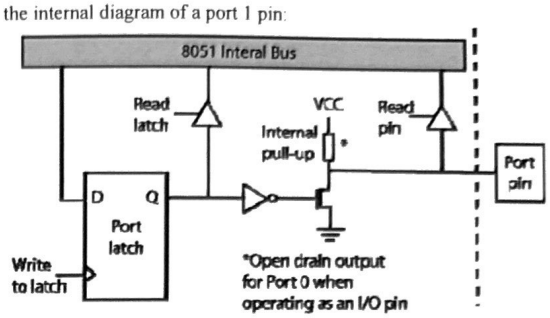
- Add new functionality to the system
- Relieve the micro of burdensome tasks
- Alter signal types (digital to analog, etc.)
- Alter signal levels (voltage, current, power)

EXAMPLE: Adding a "MATRIX" keypad to your kit



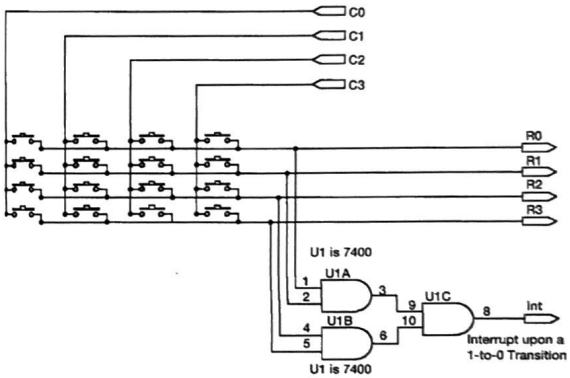
We could use port 1 on the microcontroller to "read" the keypad!

Here is the internal diagram of a port 1 pin:



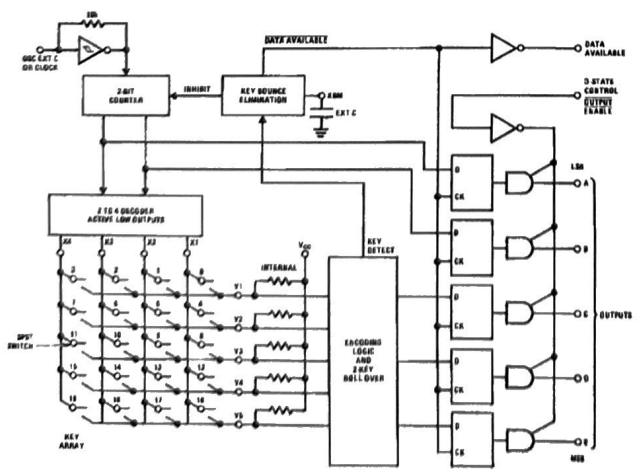
First, write a "1" to this pin to set it up for use as an input port.
Discuss approach for reading a keypress.

Could add some additional logic to try to minimize the micro's burden:



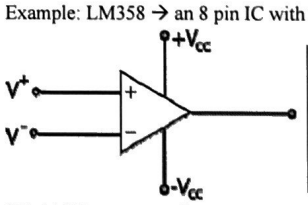
This task is complicated by switch "bounce":

Reading the keypad is a burdensome task. Get help! 74C922:



Signal Conditioning with OP-AMPS:

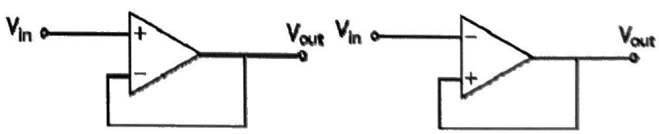
Example: LM358 → an 8 pin IC with 2 op-amps on board



$v_{out} = A(v^+ - v^-)$

Power supply can differ by 30 volts.
(0 to 30, +15 to -15, etc.)

OP-AMPS are generally configured with feedback. Consider these two possibilities:



$v_{out} = A(v_{in} - v_{out})$
let A → ∞
$0 = v_{in} - v_{out}$
$v_{out} = v_{in}$

STABLE
NEGATIVE FEEDBACK

USE THIS CIRCUIT!
☺ A BUFFER

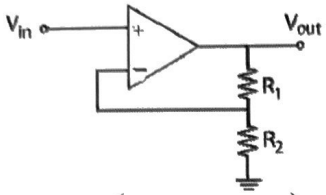
$v_{out} = A(v_{out} - v_{in})$
let A → ∞
$0 = v_{out} - v_{in}$
$v_{out} = v_{in}$

UNSTABLE
POSITIVE FEEDBACK

WILL NOT WORK!!!

A short catalog of other useful circuits:

- Non-Inverting Amplifier



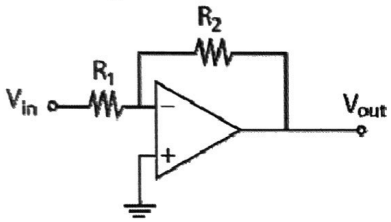
$$v_{out} = A\left(v_{in} - \frac{R_2}{R_1 + R_2} \cdot v_{out}\right)$$

let A → ∞

$$v_{in} = \frac{R_2}{R_1 + R_2} \cdot v_{out} \text{ or } v_{out} = \frac{R_1 + R_2}{R_2} \cdot v_{in}$$

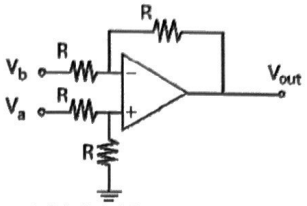
Can make a "variable gain" with a POT
Can limit gain with series resistors.

- Inverting Gain Block



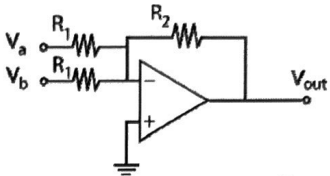
$$v_{out} = -\frac{R_2}{R_1} v_{in}$$

- Subtractor/ Level-Shifter



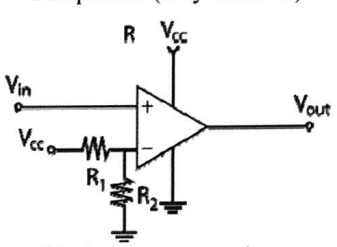
$$v_{out} = (v_a - v_b)$$

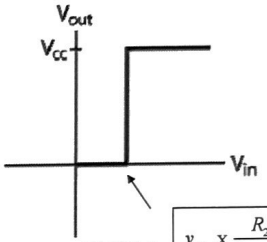
- Initial Adder



$$v_{out} = -\frac{R_2}{R_1}(v_a + v_b)$$

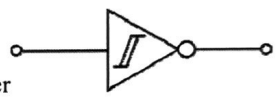
- Comparator (very crude ☺)





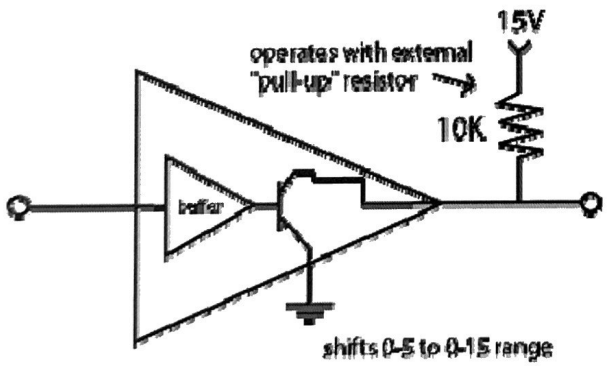
For critical apps, use a real comparator, eg. LM311.

$$v_{cc} \times \frac{R_2}{R_1 + R_2}$$



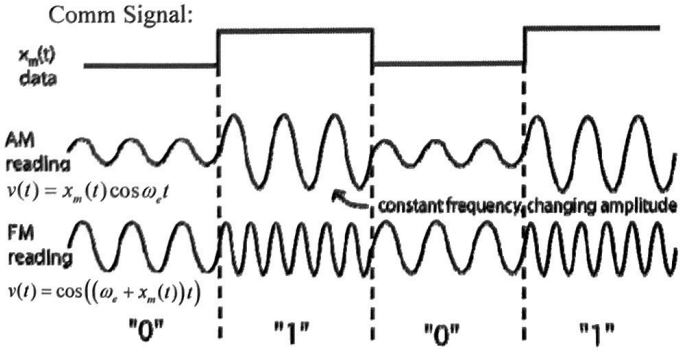
- Schmitt Trigger Inverter
  for cleaning up 0 – 5 V signals

- Open collector Buffer → for " level shifting" e.g. 7407:



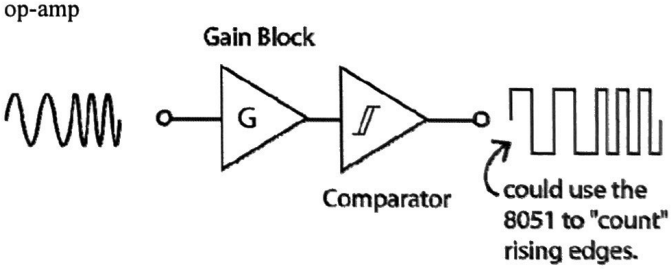
EXAMPLE → COMMUNICATION SYSTEM RECEIVER

Comm Signal:



How do we "decode" frequencies (in an FM input signal) to recover $x_m(t)$.

FM's neat → use huge input gain and a comparator or saturating op-amp



Or, Use a chip like the 567 tone decoder!