



Embedded Software

CS 145/145L



Caio Batista de Melo

Project 1

- built power source;
- powered microcontroller;
- connected programmer and microcontroller;
- controlled external device (LED) from code;
- read input from external device (button) in code;
- added external crystal for stable/precise timing.



Project 2 - Digital Clock



Design an embedded computer centered around the ATmega32 microcontroller.

For input: use a keypad;

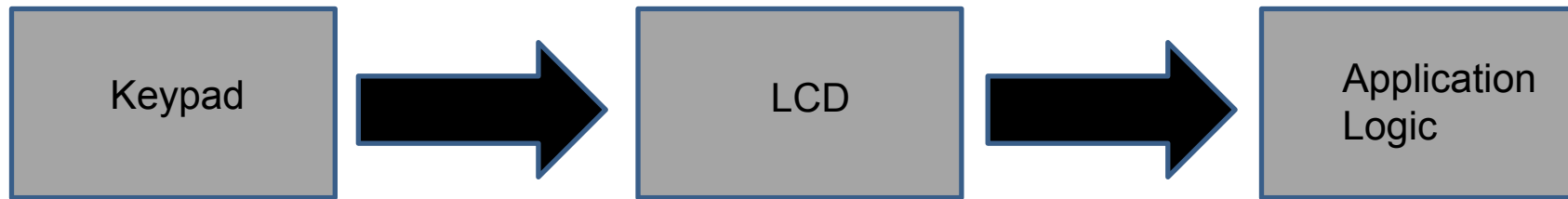
For output: use an LCD;

Write a C program that implements a digital clock, showing date (MM/DD/YYYY or YYYY-MM-DD) on the top row and HH:MM:SS (12h or 24h is fine) on bottom row. Provide all the UI needed to set the date and time on your digital clock.

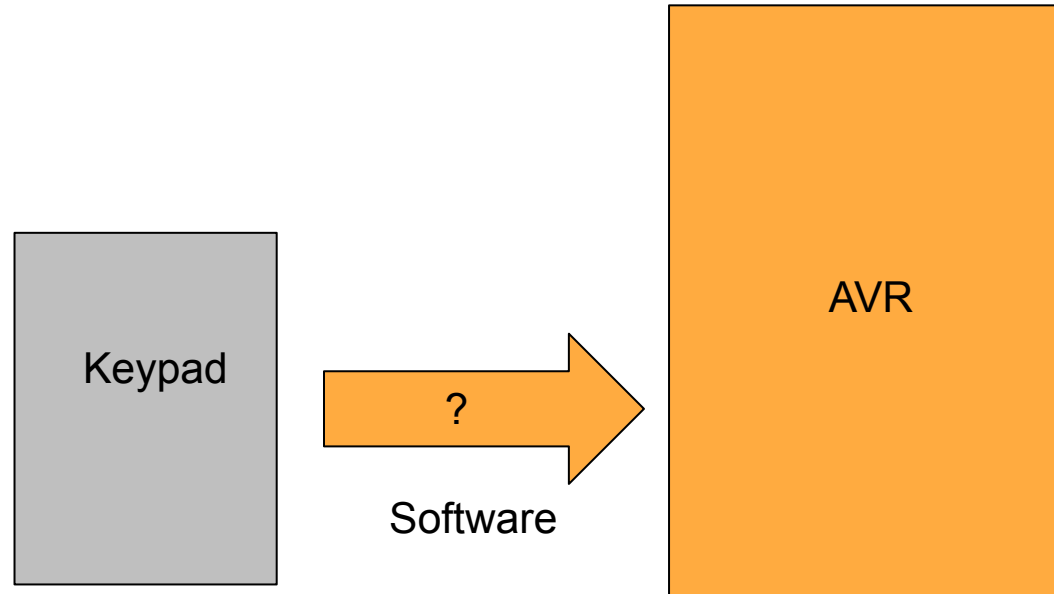
<https://canvas.eee.uci.edu/courses/45047/assignments/929270>



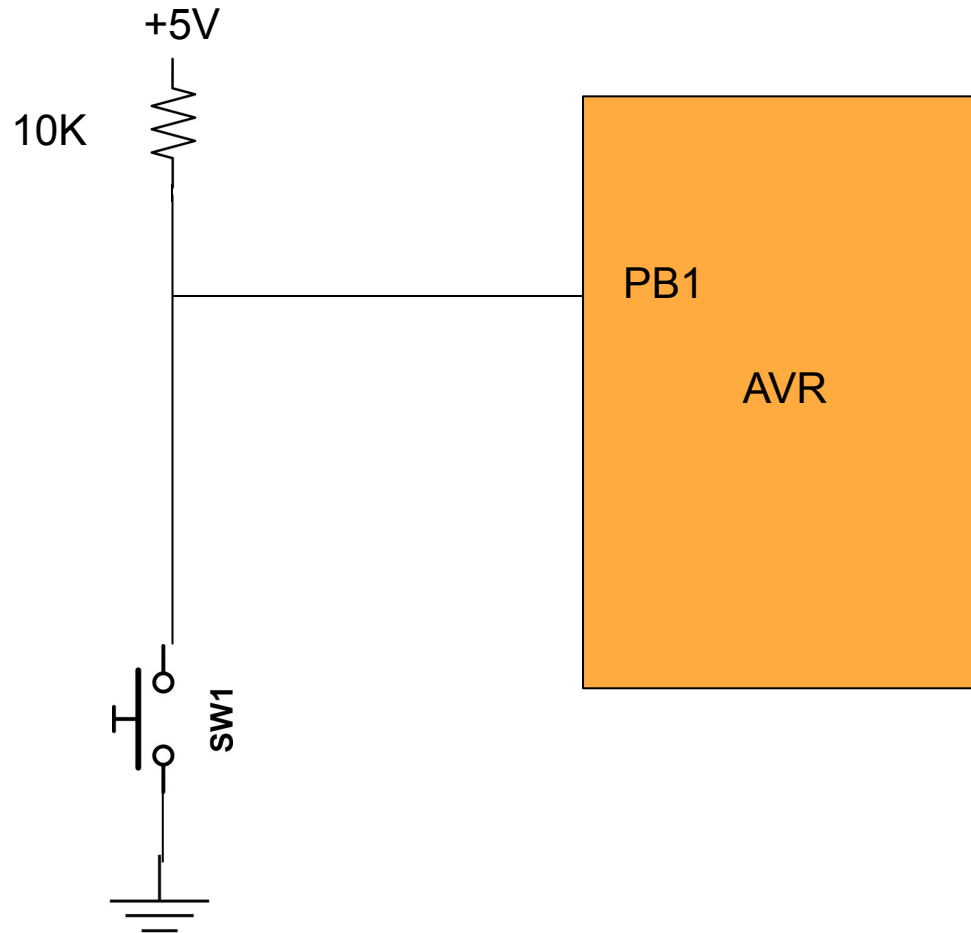
Project 2 Roadmap



Keypad Rough Layout



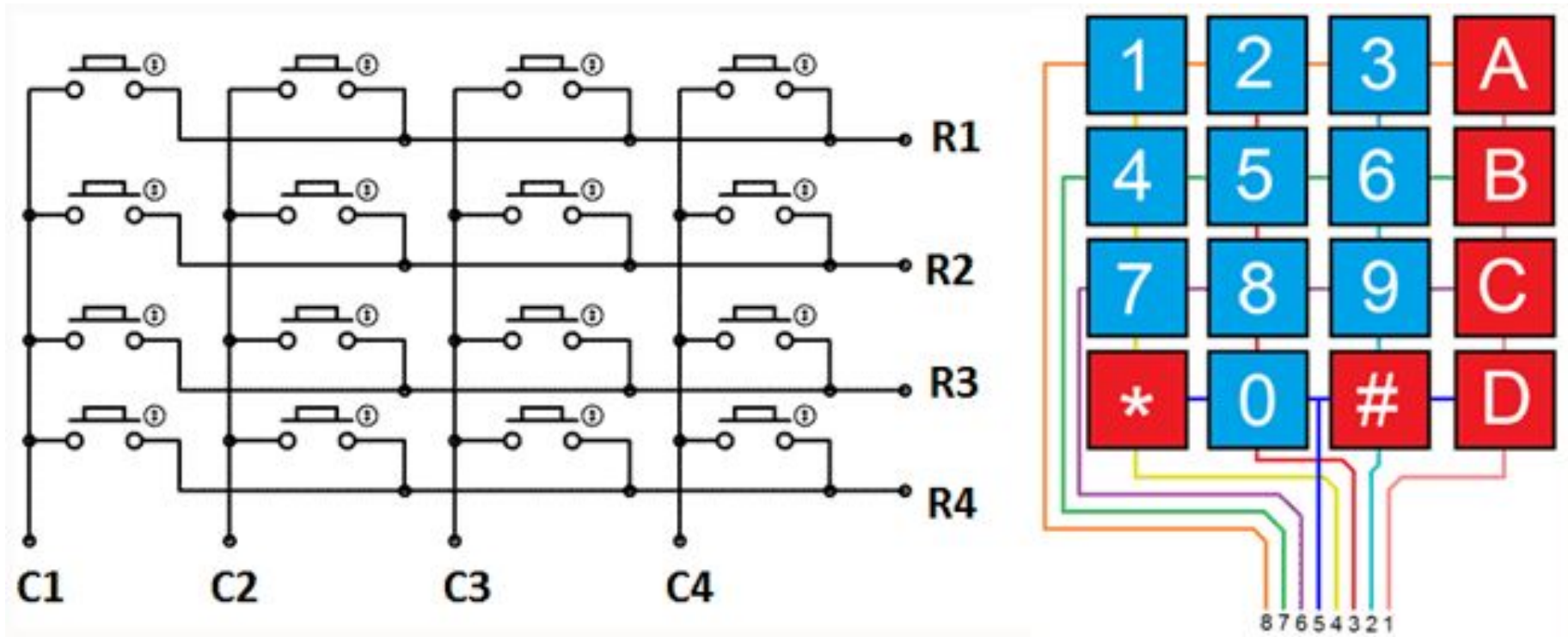
Why use a keypad?



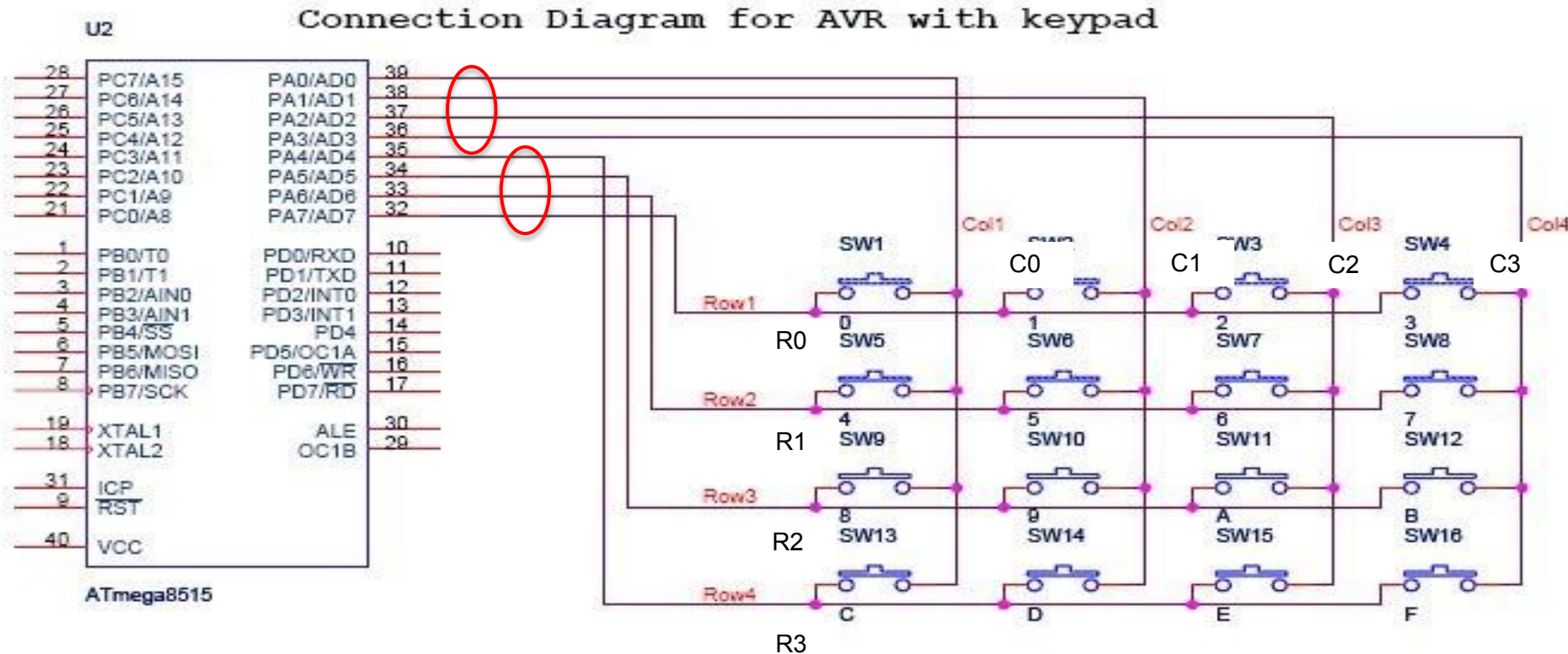
- Schematic of one push button
- It will take a lot of push buttons to design a keypad
- Since there are 16 keys, 16 GPIOs will be used logically which is a lot of resources (pins)



Keypad Internals



Connecting with AVR

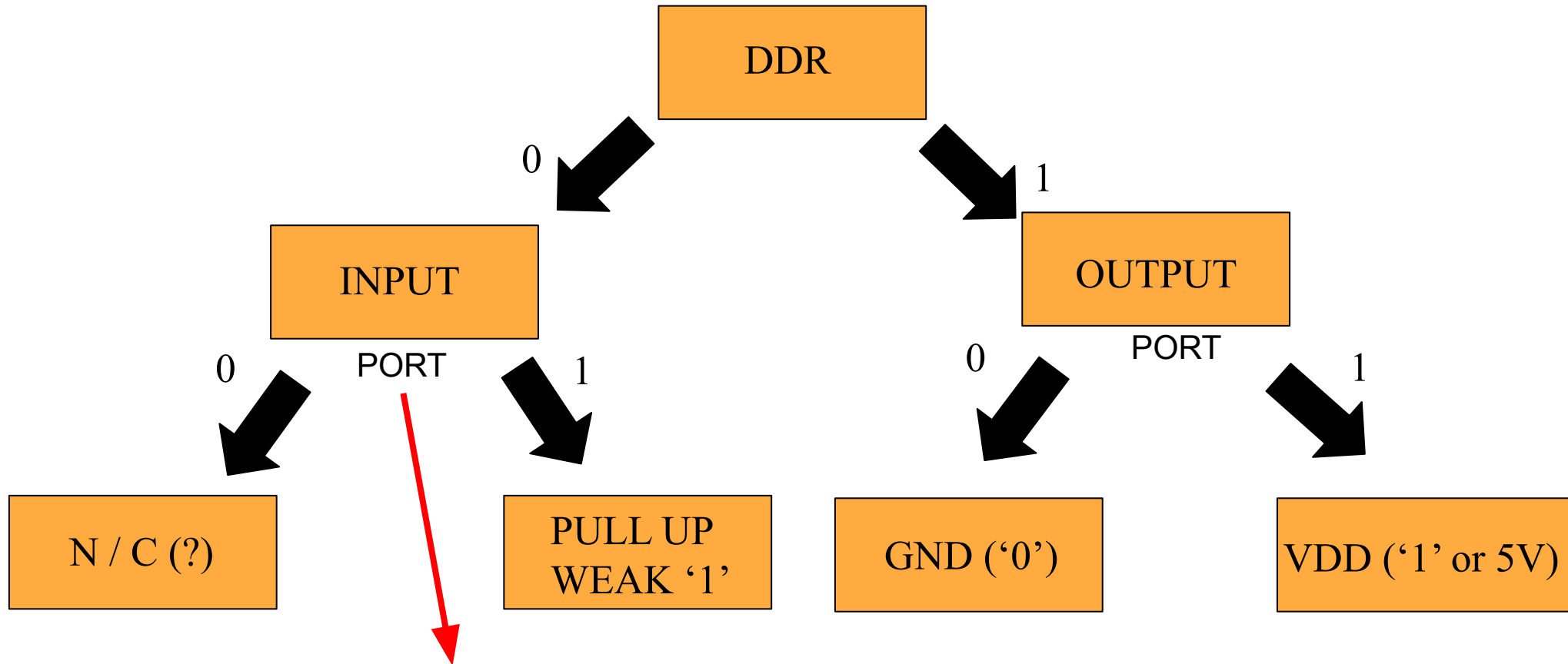


An example of how to connect a keypad to a port

PORT B is needed for ISP and PORT A is needed for future projects. So we need to choose from PORTs C and D; let's save PORT D for LCD.



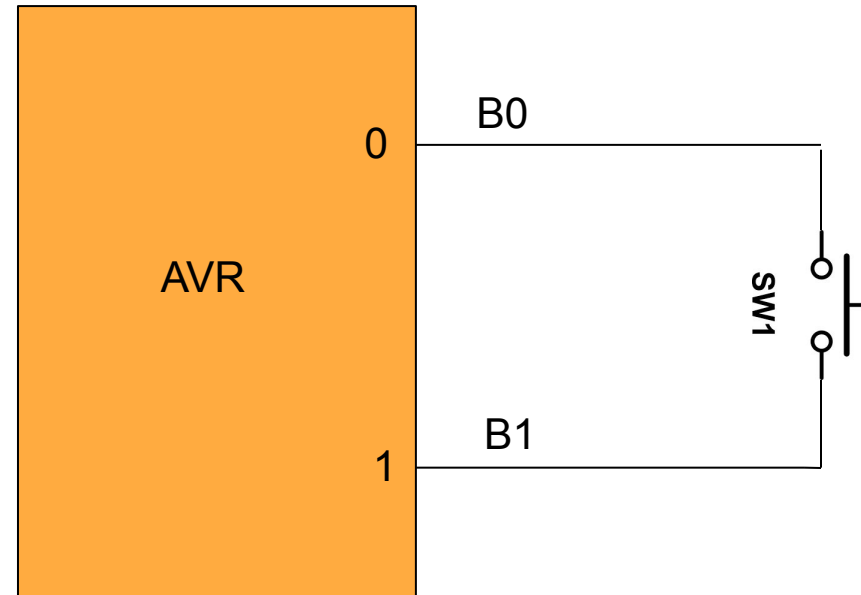
DDR and PORT Logic (Quad-State GPIO)



Read is done through the PIN Register.



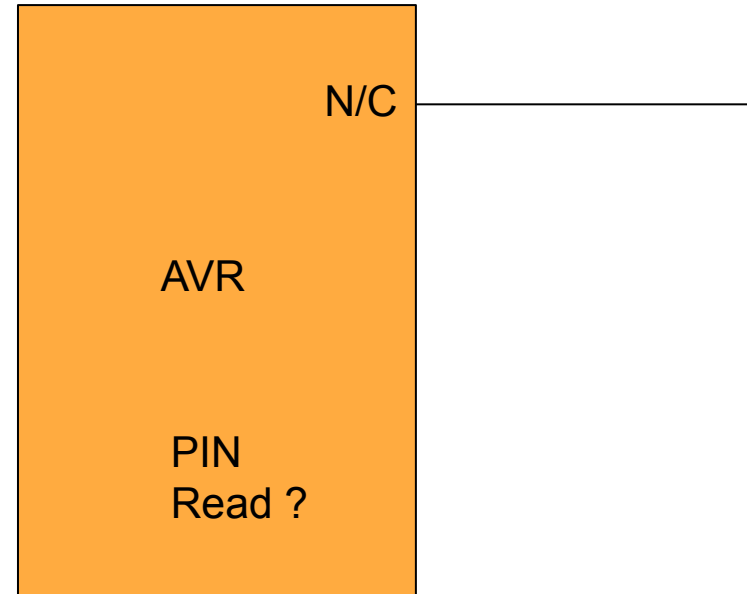
Test Your Understanding



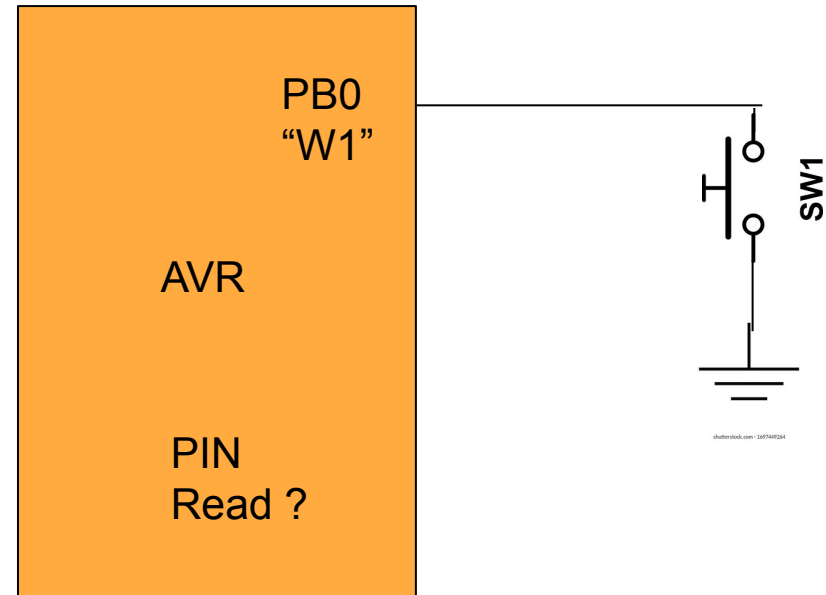
DO NOT DO THIS!



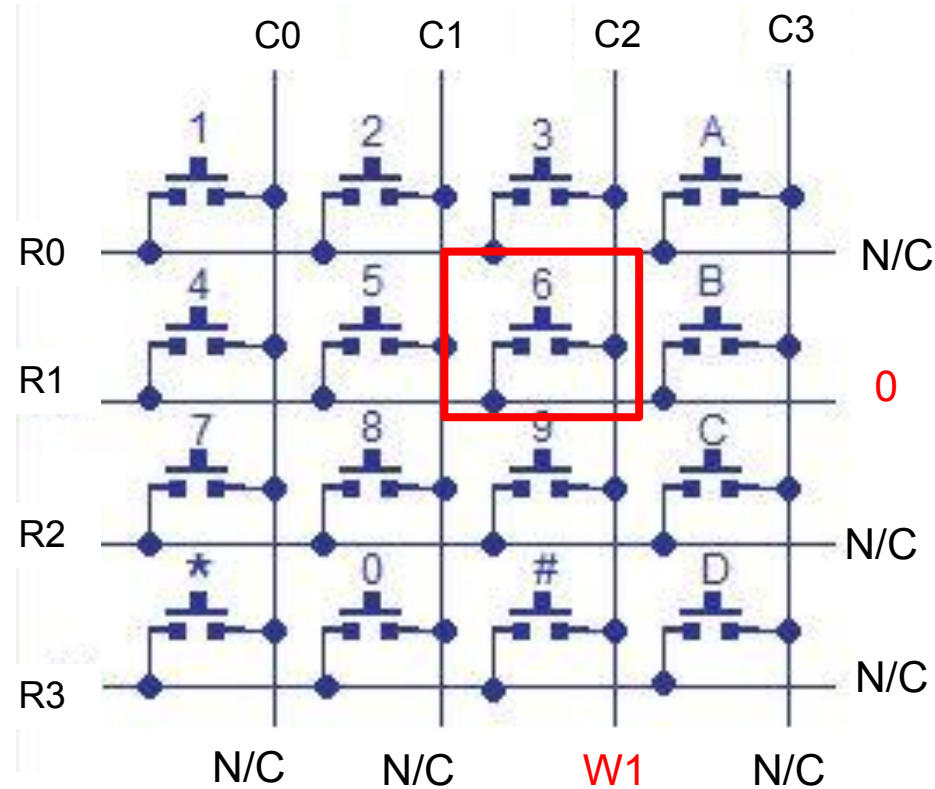
Test Your Understanding



Test Your Understanding



Keypad Working



What is the state now?

What is the state if we read this pin?



Checking for Key Press



```
int get_key() {
    int i, j;
    for (i=0; i < 4; i++) {
        for (j=0; j < 4; j++) {
            if (is_pressed(i, j)) {
                return 4 * i + j + 1;
            }
        }
    }
    return 0;
}
```

```
int is_pressed(int r, int c) {
    // Set all 8 GPIOs to N/C
    DDRC = 0;
    PORTC = 0;
    // Set r to "0"
    // Set c to "w1"
    if (/* value of c == 0 */) {
        return 1;
    }
    return 0;
}
```

What if multiple keys are pressed?

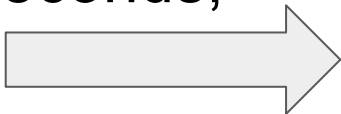


Testing Keypad



Should have a method that gives 16 different combinations for different keys that were pressed!

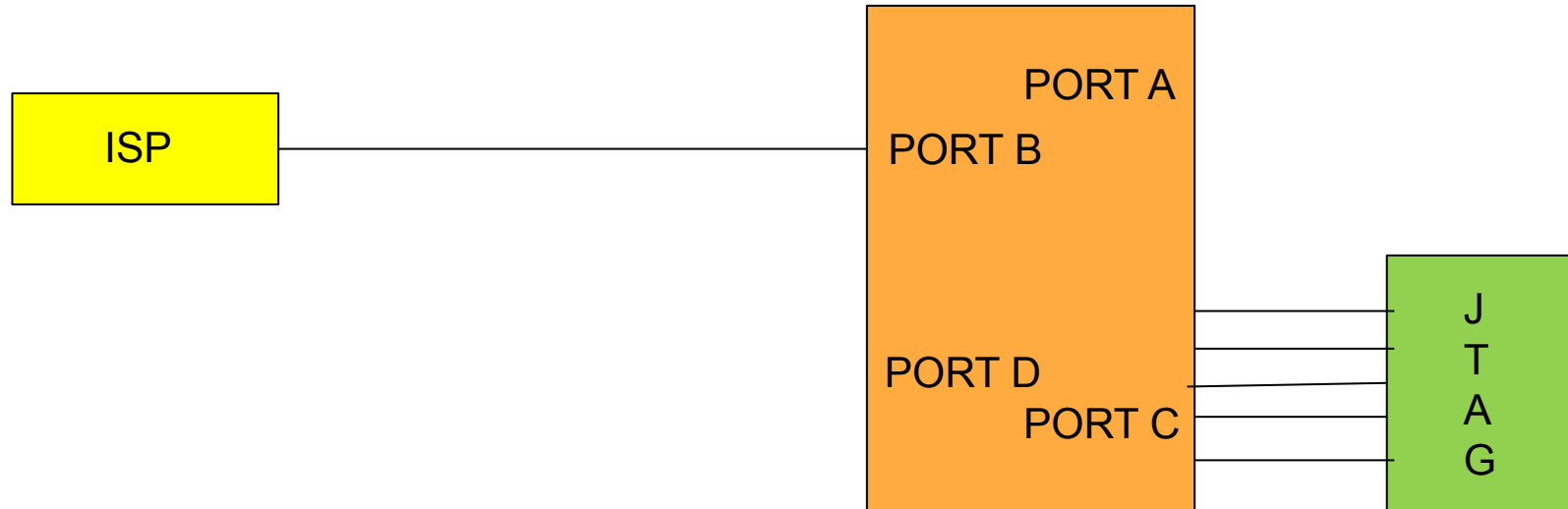
Ideas?

- One LED for each key;
- Turn LED on for *key* seconds;
- Blink LED *key* times; 
- ...

```
int main() {
    while (1) {
        avr_wait(1000);
        int i, k;
        k = get_key();
        for (i=0; i < k; i++) {
            // Turn an LED on.
            avr_wait(500);
            // Turn the LED off.
            avr_wait(500);
        }
    }
    return 0;
}
```



JTAG (Joint Test Action Group)



Disable JTAG Programmer on fuse settings.



Introduction to LCD



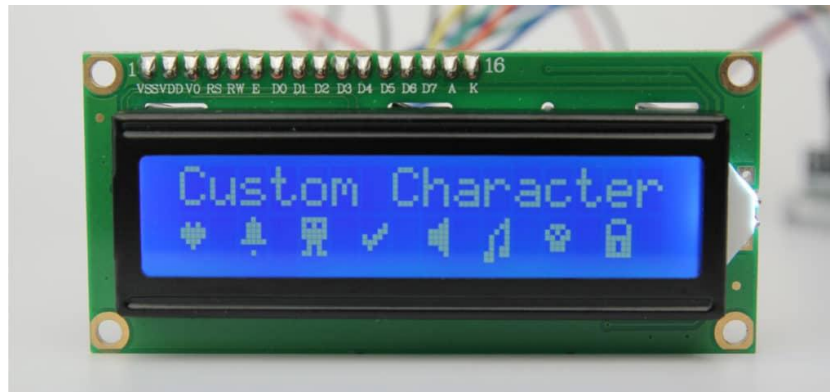
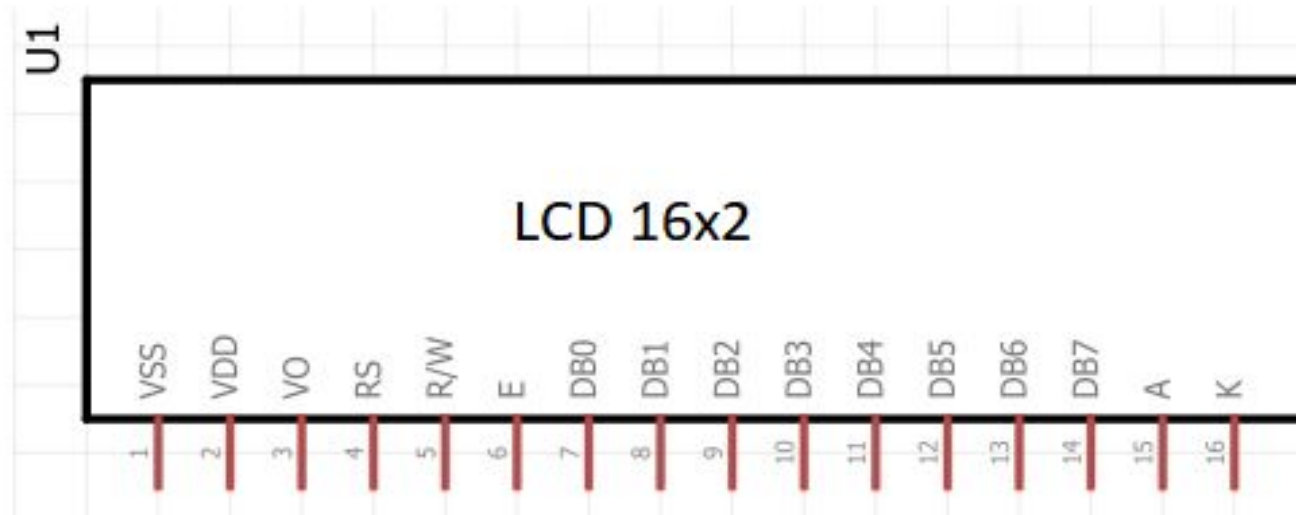
Learn to solder :)

- <https://www.youtube.com/watch?v=QKbJxytERvg>
- https://www.youtube.com/watch?v=oRt_jOJ8IRU
- <https://www.youtube.com/watch?v=k4IDMfMIOiU>

Feel free to use the soldering iron in the lab;
You can ask your TAs for help!



LCD Pinout Diagram



See you next time :)

Q & A