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Microprocessors Laboratory

Exercise 2

Part 4:

Research clocks sources of AVR microcontrollers. When is the internal clock source suitable to use?

There are different clock sources available for AVR: internal RC oscillator, external crystal/ceramic resonator, external clock. Mostly either internal RC oscillator or external crystal is used.



External Crystal Oscillator – [Image Source](#)

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a constant frequency. This frequency is often used to create a square wave to provide the clock source for devices. External crystal oscillator should be used when **accurate** frequency of operation is desired, whereas **if no time critical operation** is present in the system, the internal RC oscillator is the best option.

Many AVRs (like ATmega8, ATmega16, ATmega32) have internal RC oscillator. It is calibrated for 1,2,4 or 8MHz. It has $\pm 3\%$ accuracy. Frequency of oscillator gets affected by VCC and temperature.

References:

<https://www.elecrom.com/configuring-avr-fuse-bits-for-clock-selection>

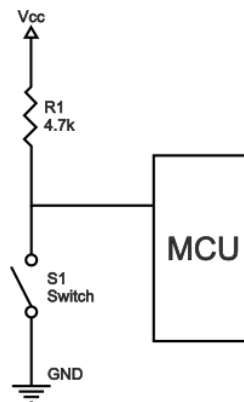
https://en.wikipedia.org/wiki/Crystal_oscillator

Part 5:

Research pull-up/pull-down resistors and explain the procedure of calculating their values.

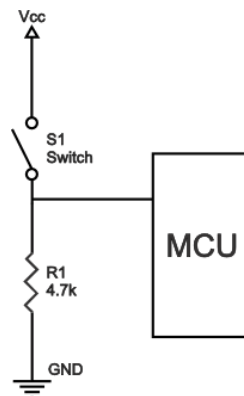
In electronic logic circuits, a pull-up resistor or pull-down resistor is a resistor used to ensure a known state for a signal. They are typically connected to a switch/transistor connected to ground/VCC.

A pull-up resistor connects unused input pins (AND & NAND gates) to the DC supply voltage, (VCC) to keep the given input HIGH.



Pull-up resistor – [Image Source](#)

A pull-down resistor connects unused input pins (OR and NOR gates) to ground, (GND) to keep the given input LOW.



Pull-down resistor – [Image Source](#)

In order to calculate pull-up and pull-down resistance, first it is needed to apply the formula in Ohm's Law: Resistance = Voltage/Current, or $R = V/I$.

But it should be noted that:

- The resistor value should not be too high that it affects the flow of current for the input pin to function.
- The resistor value should not be too low that it allows excess current to flow through, resulting in a short circuit.

For example, assuming a $100\mu\text{A}$ current along with a 5V voltage source in the microcontroller, a pull-up voltage of 4V seems like a good idea, because the VCC is 5V and the pull-up voltage should neither surpass the source voltage, nor be too low.

The formula $R = \frac{V_S - V_{LED}}{I_{LED}}$, supposing that we are using the pull-up resistor on an LED, is derived from the Ohm's law.

By applying the formula $R = \frac{5V - 4V}{100\mu\text{A}} = 10K\Omega$.

References:

<https://www.seeedstudio.com/blog/2020/09/22/resistors-pull-up-and-pull-down-resistors/>

https://en.wikipedia.org/wiki/Pull-up_resistor