Experiment 2

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Question 1:

Write a program that makes port from 1 to 0 in 0.5s with a microcontroller that connects to 1 MHz Crystal

Answers:
This code adding to the source in GitHub:
Experiment 2 -> q1-blinking-ports

Files:

- main.cpp (code)

Question 2:

Design hardware of program in question 1

- **Push-button connect to Port A0**
- **8 LED connect to Port B**
- **LEDs blinking after 0.5 ms when the push button connected**

Answers:
This code adding to the source in GitHub:
Experiment 2 -> q2-blinking-leds

Files:

- Folder code
    - main.cpp
- result.m4v (runtime video)
- schematic.pdsprj

Reference:

- Interfacing of Push Button with Atmega16-AVR-Complete guide

Question 3:

Add additional feature to program in question 1

- **Blinking LEDs one by one**
  - **First LED 0 turn on and after 0.5s LED 0 turn off then LED 1 turn off**
  - **This cycle goes from LED 0 to LED 8 and repeat**

Answers:
This code adding to the source in GitHub:
Experiment 2 -> q3_sequential_blinking_leds

Files:

- Folder code
  - main.cpp
- result.m4v (runtime video)
- schematic.pdsprj

Question 4:

Research about sources of the clock in microcontroller & and answer when we can use internal micro clock

Answer:

The main difference is that the internal oscillator is usually an RC-type oscillator which is not very accurate. External oscillators can be of type quartz crystal which is far more accurate.

In the bottom table we see benchmarking of those types of clocks:

Clock Source	Accuracy	Advantages	Disadvantages
Crystal	Medium to high	Low cost	Sensitive to EMI, vibration, and humidity. Complex circuit impedance matching.
Crystal Oscillator Module	Medium to high	Insensitive to EMI and humidity. No additional components or matching issues.	High cost; high power consumption; sensitivity to vibration; large packaging.
Ceramic Resonator	Medium	Lower cost	Sensitive to EMI, vibration, and humidity.
Integrated Silicon Oscillator	Low to medium	Insensitive to EMI, vibration, and humidity. Fast startup, small size, and no additional components or matching issues.	Temperature sensitivity is generally worse than crystal and ceramic resonator types; high supply current with some types.
RC Oscillator	Very low	Lowest cost	Usually sensitive to EMI and humidity. Poor temperature and supply-voltage rejection performance.

Reference:

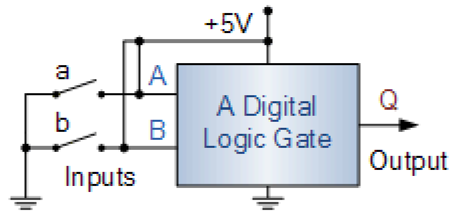
- Difference between internal and external oscillators for a microcontroller?
- Microcontroller Clock Selection Options

Question 5:

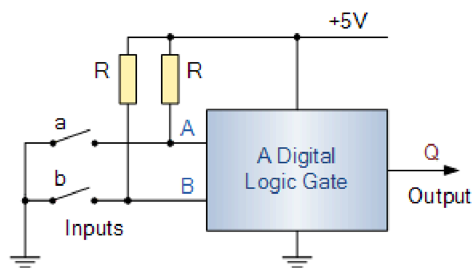
Research about pull-up & pull-down resistors and find a formula to calculator amount of resist

What is a pull-up?

Answer:
One important issue that pins of microcontrollers have is floating inputs which mean they have random voltage or value (0,1) so to solve this problem we can use pull-ups for having High voltage (1) & low voltage (0) for pins. (like the bottom picture)
We can use the bottom circuit to have a pull-up:



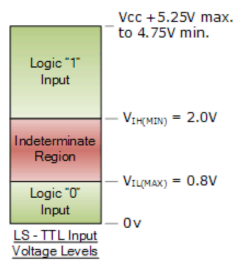
But when a,b connect we get a short circuit between Ground & Vcc that makes a big current and it makes heat. To solve this problem we use a resistor to prevent the high current like the down picture:

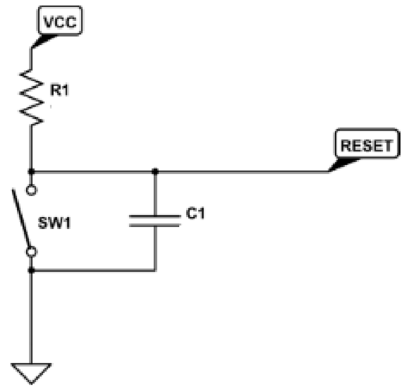


To calculate minimum R for this can use the bottom formula:

$$R_{min} = (V_{cc} - V_{OL}) / I_{OL}$$

R(min): This means minimum pull up resistor
V(cc): is the supply voltage
IOL & VOL: this comes from a logical - voltage diagram. (like bottom example)





Also, we can have a capacitor to have a delay to pull-up.
For the top picture, we use it for the Reset pin.

$$T = RC$$

We can use the top formula to calculate the time of capacity charge.

How to calculate a pull-up resistor?

From reference I get these bottom tips:

1. 1kΩ to 10kΩ for general purposes. (10k is preferred)
2. 10kΩ to 100kΩ if you have a low-power use case such as a device that is battery powered.

Reference:

- [How do I calculate the required value for a pull-up resistor?]
- [Pull Up Your Pins: How to Size Pull-up Resistors | Bench Talk]