Experiment 1

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First Question:

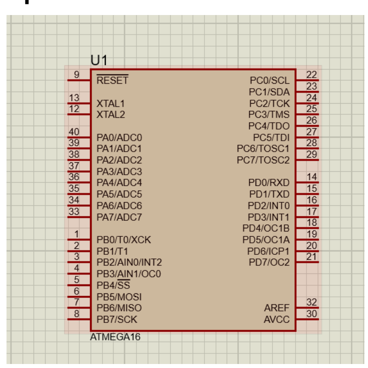
How to set up a microcontroller in the real world?

Answer:

we should use 3 wires:

- VCC
- GND
- AVCC (This should connect to VCC whenever not use)

Note: Top wires are not available in Atmega 16 in the proteus because we don't need them to power up the microcontroller.



Reference:

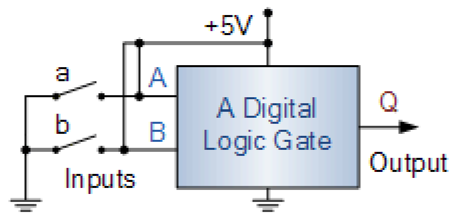
- [How to prepare an AtMega16 micro controller on a breadboard]
- Atmega 16 Datasheet

Second Question:

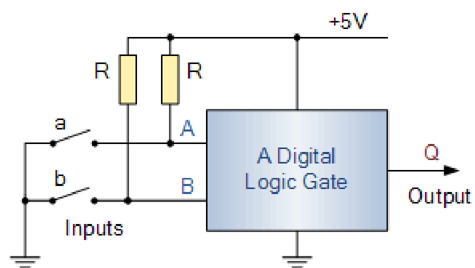
What is a pull-up?

One important issue that pins of microcontrollers have is floating-inputs that means 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 bottom picture)

We can use bottom circuit to have 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 resistor to prevent the high current like down picture:



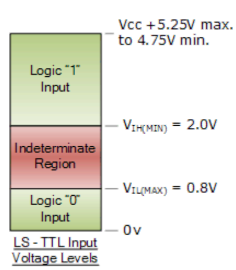
For calculate minimum R for this can use bottom formula:

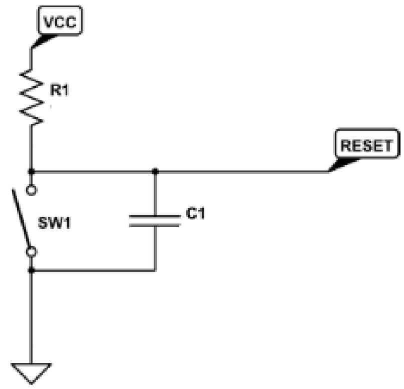
$$R_{min} = (V_{cc} - V_{OL}) / I_{OL}$$

R(min): This means minimum pull up resistor

V(cc) : is 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 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:

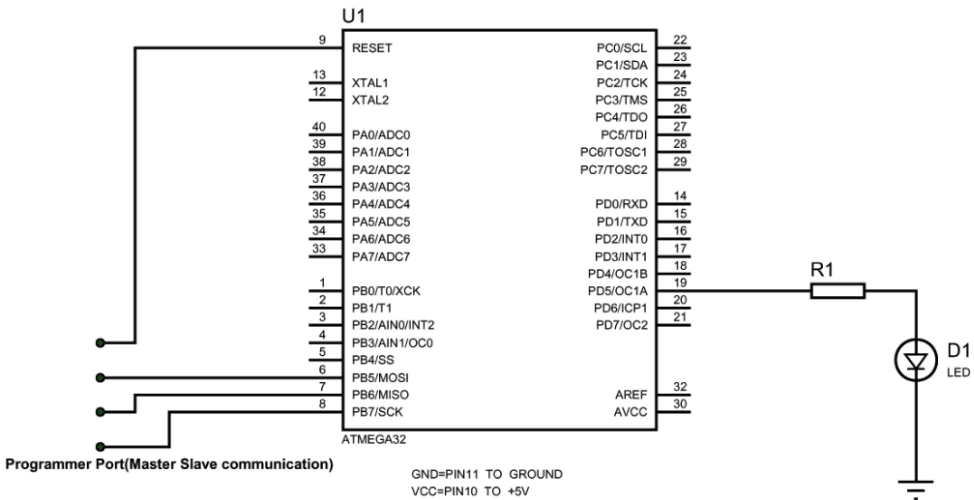
1. 1kΩ to 10kΩ for general purposes. (10k is preferred)
2. 10kΩ to 100kΩ if you have a low-power use case such as a device that is battery powered.

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

Third Question:

Define resistor it for bottom circuit to turn on LED:



Any type of LED have a different Forward Voltage, see examples :

CircuitBread | LED COLORS AND MATERIALS

Color	Wavelength Range (nm)	Forward Voltage (V)	Material
Ultraviolet	< 400	3.1 - 4.4	Aluminium nitride (AlN) Aluminium gallium nitride (AlGaN) Aluminium gallium indium nitride (AlGaInN)
Violet	400 - 450	2.8 - 4.0	Indium gallium nitride (InGaN)
Blue	450 - 500	2.5 - 3.7	Indium gallium nitride (InGaN) Silicon carbide (SiC)
Green	500 - 570	1.9 - 4.0	Gallium phosphide (GaP) Aluminium gallium indium phosphide (AlGaInP) Aluminium gallium phosphide (AlGaP)
Yellow	570 - 590	2.1 - 2.2	Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium phosphide (GaP)
Orange / Amber	590 - 610	2.0 - 2.1	Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaUInP) Gallium phosphide (GaP)
Red	610 - 760	1.6 - 2.0	Aluminium gallium arsenide (AlGaAs) Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium phosphide (GaP)
Infrared	> 760	> 1.9	Gallium arsenide (GaAs) Aluminium gallium arsenide (AlGaAs)

For calculate Resistor we can use this formula:

$$R = (V_s - V_{LED}) / I_{LED}$$

Reference:

- Interfacing an LED to a microcontroller
- End of Laboratory instructions page.

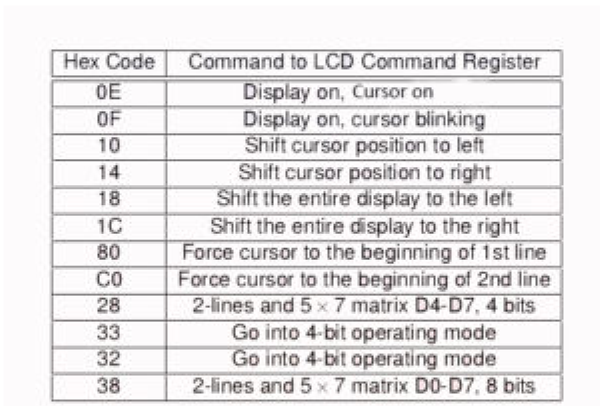
Question four:

Store string with 200 character to EEPROM and send it to another microcontroller with 8 wire

The source code of this project is in gitlab in folder Q4_8_line_communicate with two folder:

- Sender
- Receiver
- Proteus schematic

Note: runtime video is uploaded to github. (question_4_run)
Note: commands of LCD get from this table:



Hex Code	Command to LCD Command Register
0E	Display on, Cursor on
0F	Display on, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to the beginning of 1st line
C0	Force cursor to the beginning of 2nd line
28	2-lines and 5 × 7 matrix D4-D7, 4 bits
33	Go into 4-bit operating mode
32	Go into 4-bit operating mode
38	2-lines and 5 × 7 matrix D0-D7, 8 bits

Reference:

- Avr Atmel Atmega16 Eeprom | Avr Atmega
- 16x2 LCD Interfacing with Atmega16| Black Box Problem Solved

Question five:

Implement question four project with only one wire.

The source code of this project is in gitlab in folder Q5_1_line_communicate with two folder:

- Sender
- Receiver
- Proteus schematic

Note: runtime video is uploaded to github. (question_5_run)

Reference:

- Bit Operation in AVR Microcontroller | by Orvin Demsy | Medium