Microprocessors Lab

3- PWM

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Based on the slides by:
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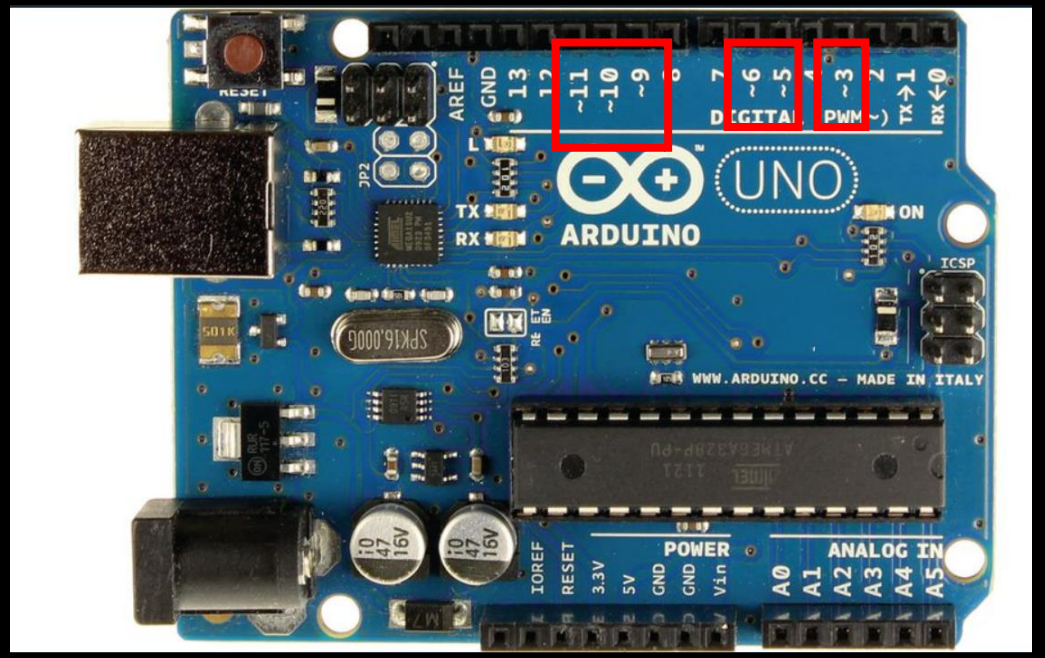
PWM:

Pulse Width Modulator.
If we want to produce a voltage between 0-5 volts (ex: 2.5, 3, etc.), we have to use PWM in order to do so.

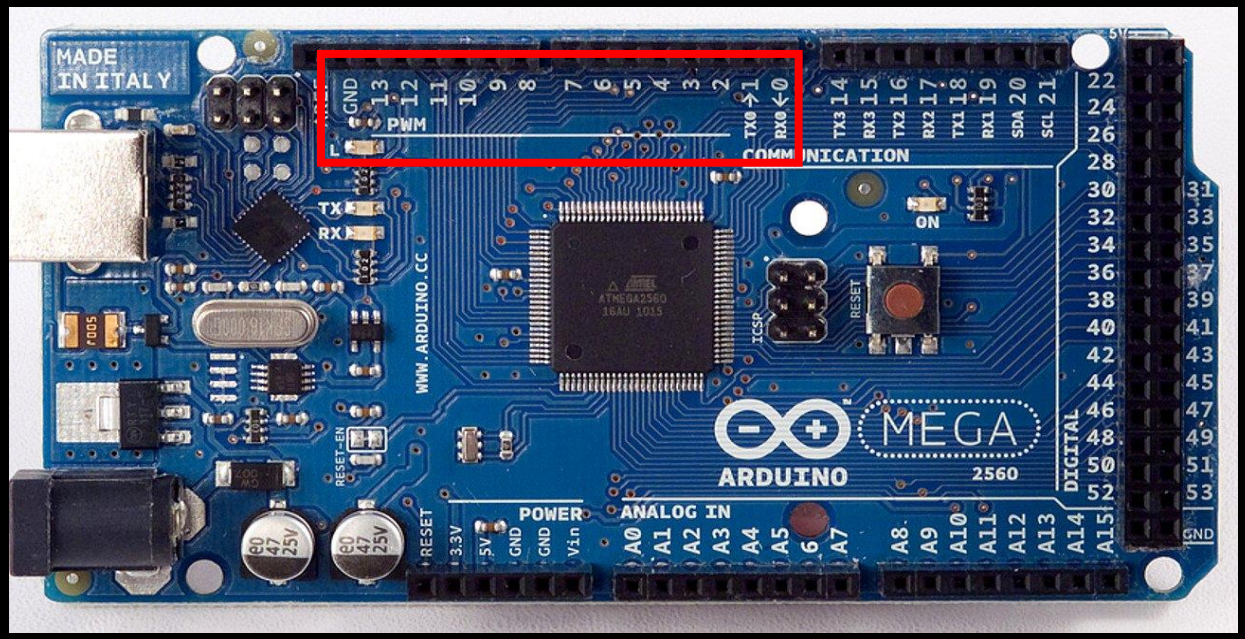
On Arduino Mega, we have distinct set of pins for PWM, but on Arduino Uno, the pins that have a "~"

symbol beside them in the Digital section perform the PWM task.

Remember that you can use pins 0,1 on Arduino Mega as PWM if you are not using Serial module. Use Serial1, Serial2, or Serial3 instead.



Pins:
3,5,6
OR
9,10,11

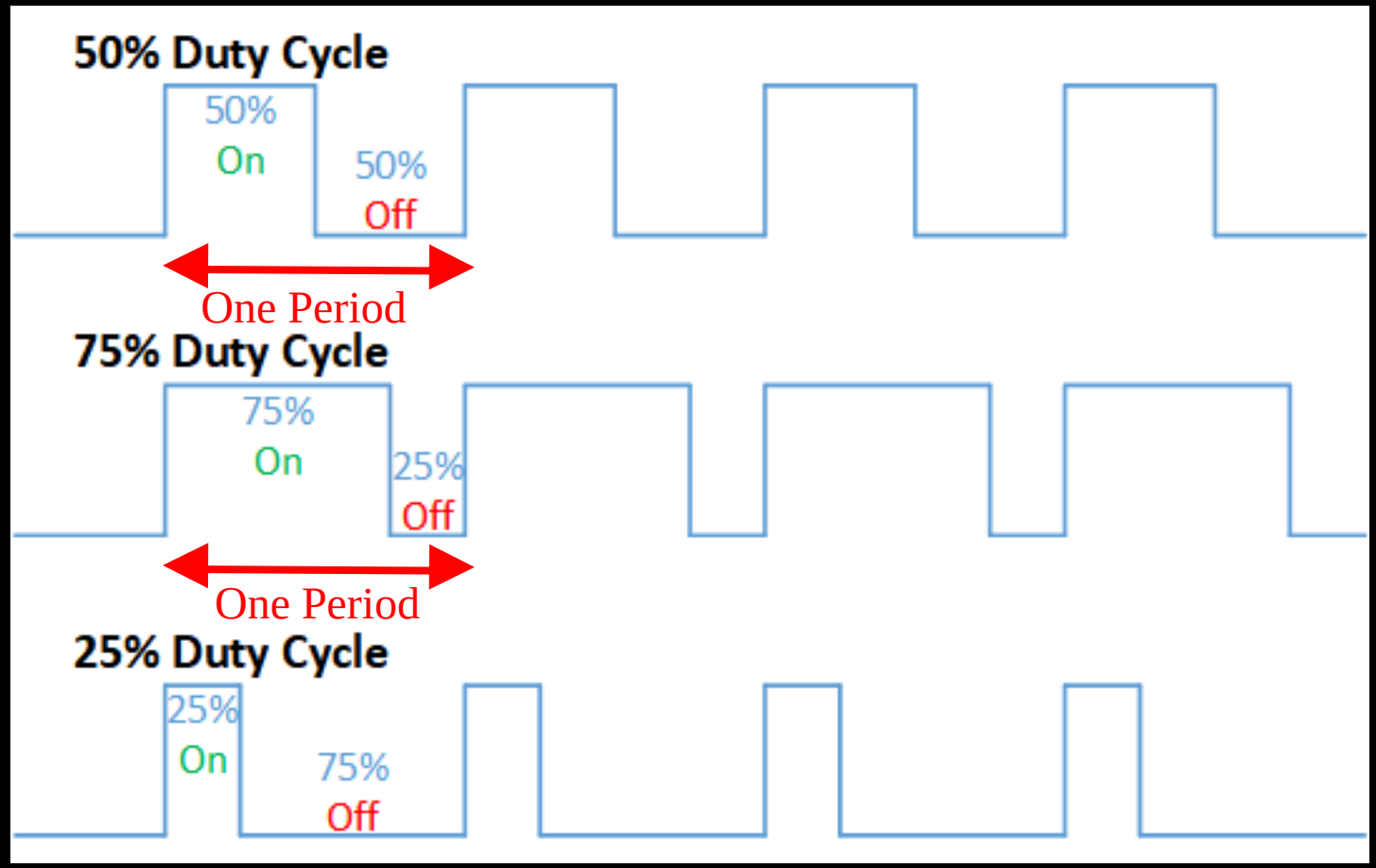


Pins 0-13

Duty Cycle

You must be pretty much familiar with the concept of Duty Cycle (because you have studied it in the Micro Processor Course). The percentage of duty cycle determines the voltage of PWM. For example, if the duty cycle is 25% and we are working with a board that can output 5V, the voltage we are giving out from the PWM pin is 25% * 5 = 1.25 volts.

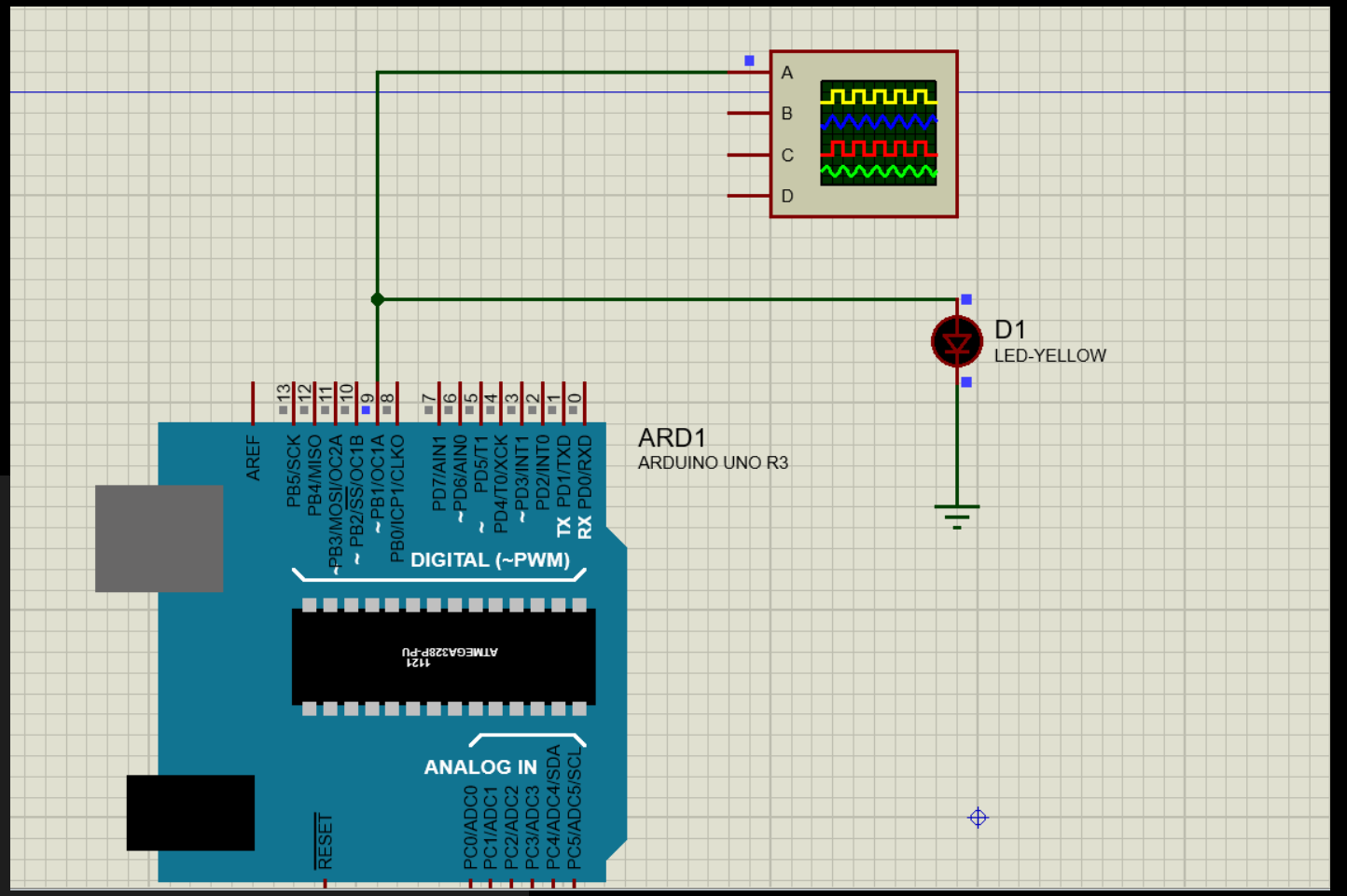
$$Duty\ Cycle = \frac{Period\ ON}{One\ Period}$$



Sample 1:

Test the following code on the given circuit.

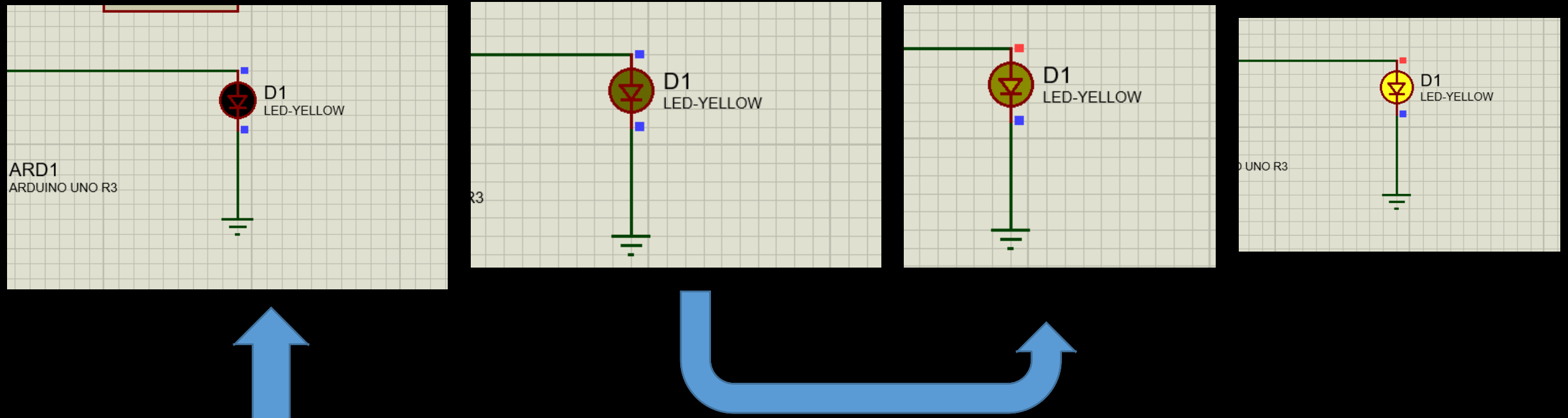
```
#include <Arduino.h>

int LED = 9;

void setup() {
  // put your setup code here, to run once:
  pinMode(LED, OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  for (int i = 0 ; i < 256 ; i += 5){
    analogWrite(LED,i); // We use this function to write on Analog Pins.
    delay(100); //This function is used to let us see the difference better.
  }
}
```



Question:

Why should the loop go until 255? Can we exceed 255 for PWM? Why?

Output:



Start

Remember:
In order to see the analog signal (waves) better, we use an Oscilloscope, Which can bee seen on the top of the design on the previous slide.

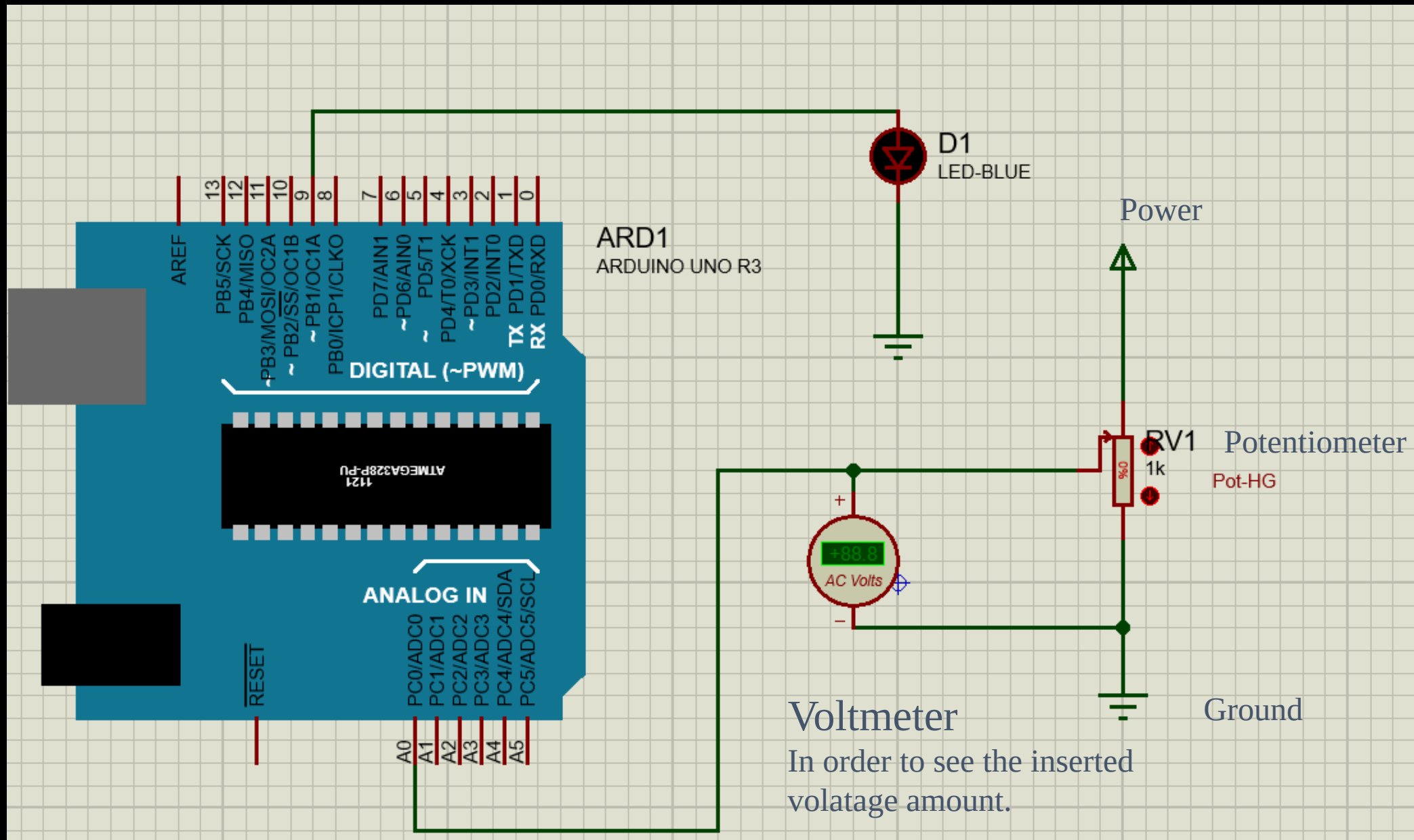
- A **potentiometer** is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a **variable resistor** or **rheostat**.
- Reference: Wikipedia

We use potentiometer to change the input voltage from 0-5 volts. It is clear that this device gives us an analog signal and we have to use PWM unit to determines its given value.

Sample 2:

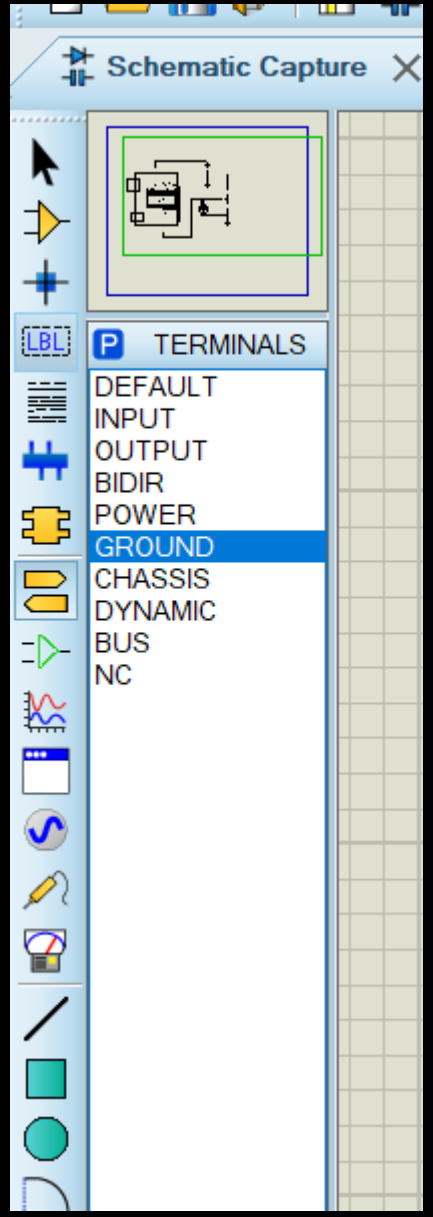
Question:
Why should we divide the output of analogRead() by 4?

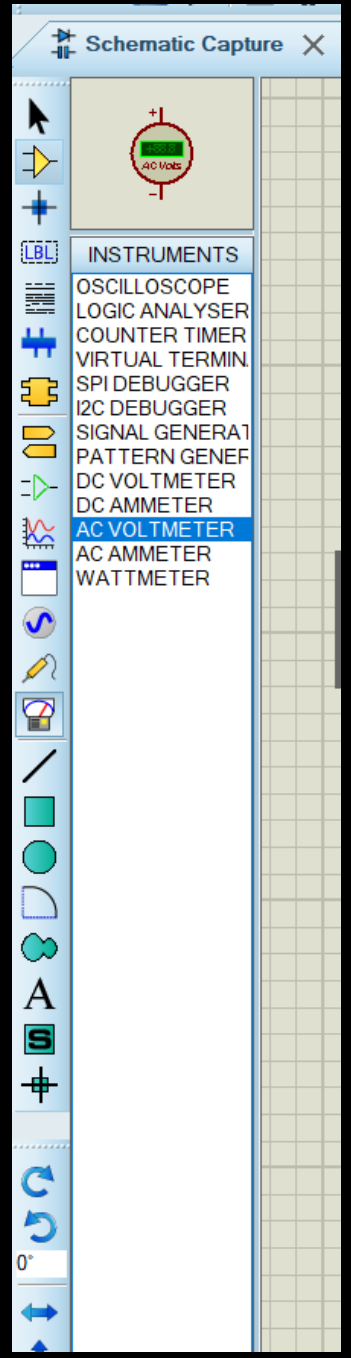
```
1   #include <Arduino.h>
2
3   int LED = 9 ;
4   int Potentiometer = A0 ;
5   int value = 0 ;
6
7
8   void setup() {
9     // put your setup code here, to run once:
10    pinMode(LED,OUTPUT);
11    pinMode(Potentiometer, INPUT);
12  }
13
14  void loop() {
15    // put your main code here, to run repeatedly:
16    value = analogRead(Potentiometer)/4 ;
17    analogWrite(LED,value);
18
19  }
20
```

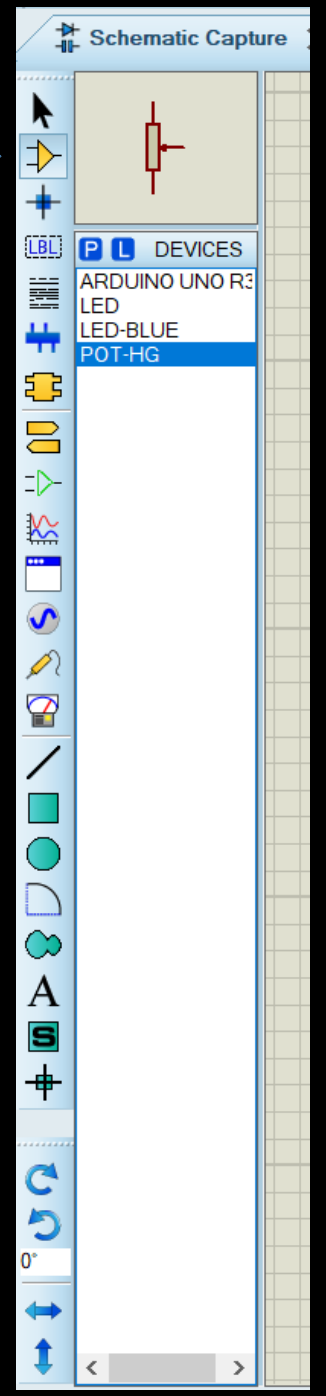


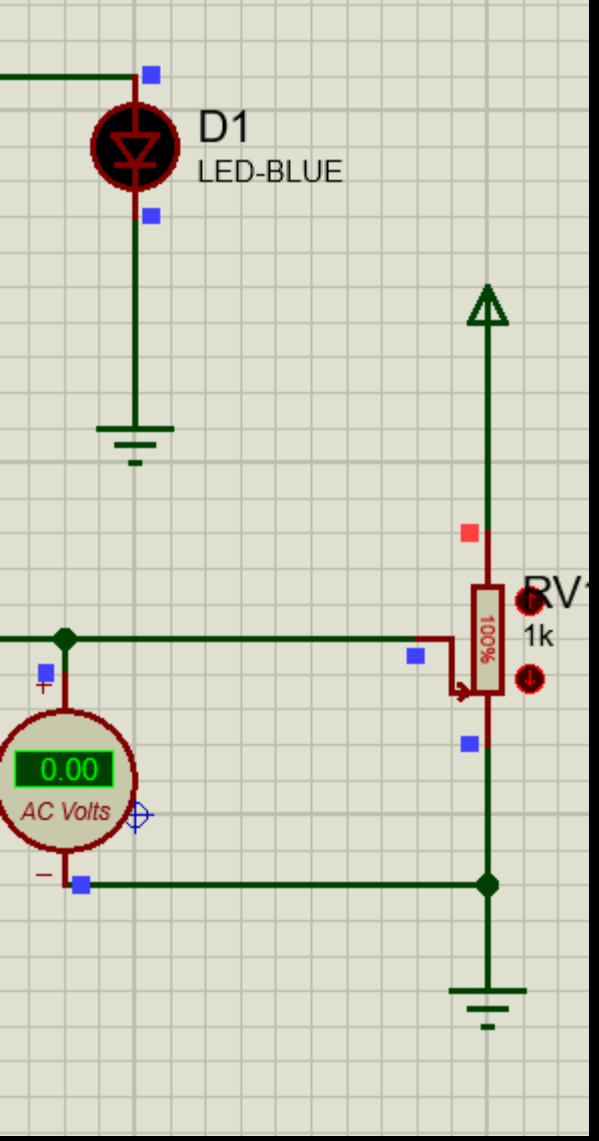
Voltmeter

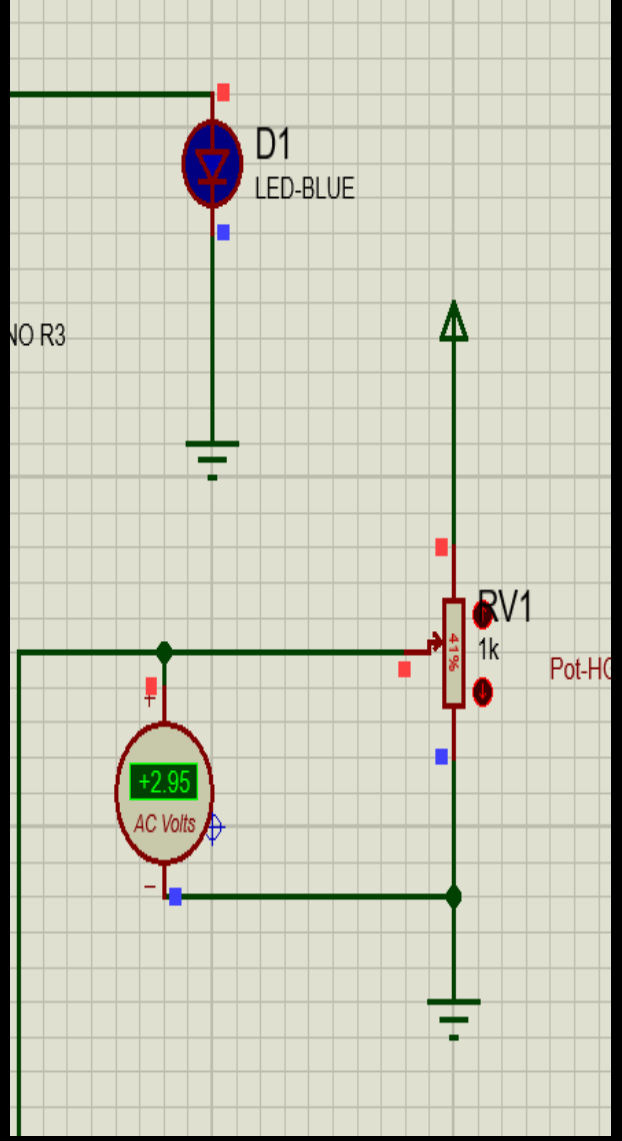
In order to see the inserted volatage amount.

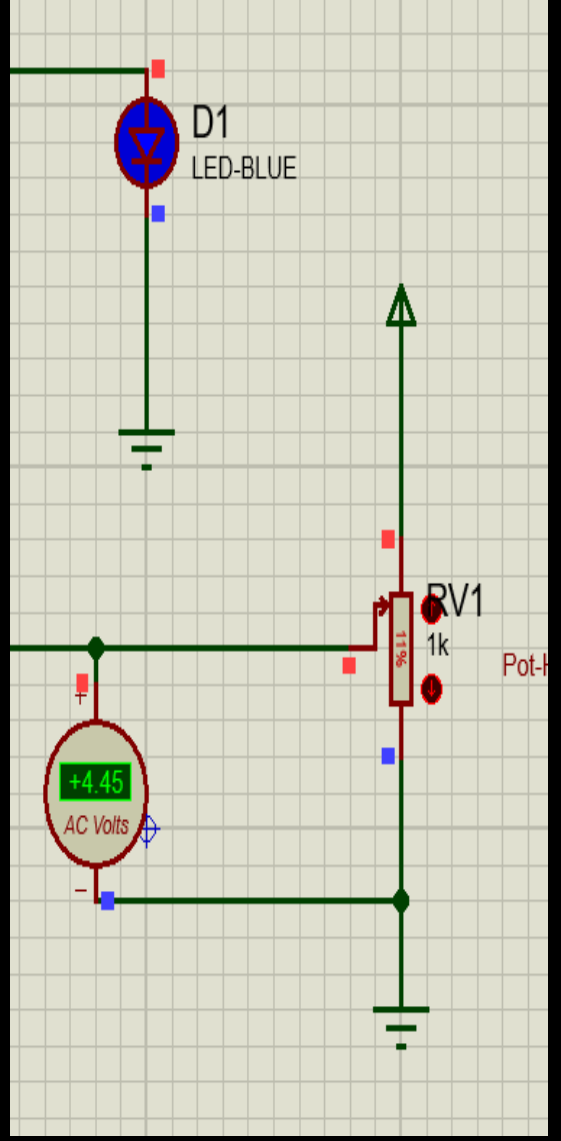

Schematic Capture
TERMINALS
DEFAULT
INPUT
OUTPUT
BIDIR
POWER
GROUND
CHASSIS
DYNAMIC
BUS
NC

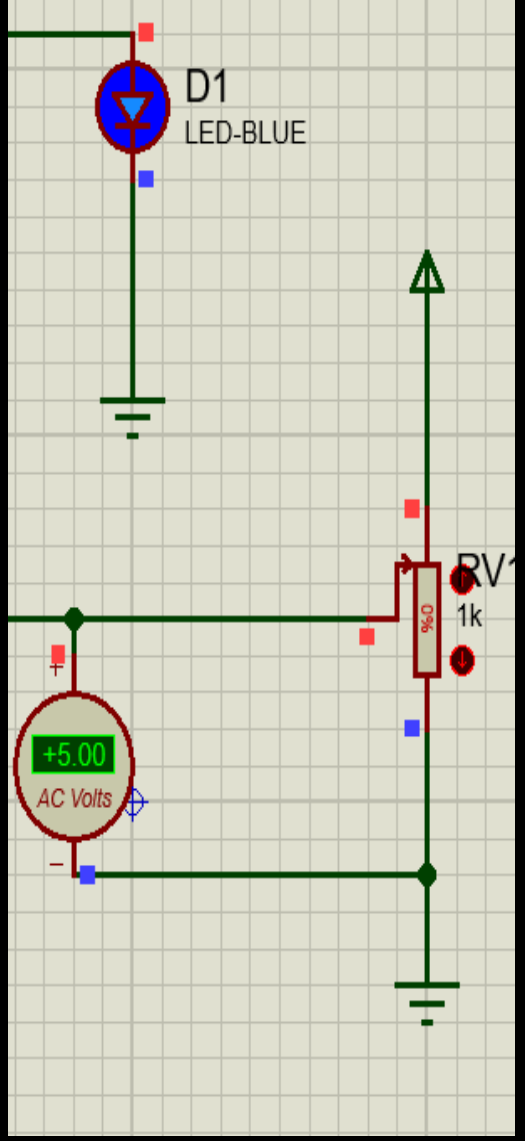

Schematic Capture
INSTRUMENTS
OSCILLOSCOPE
LOGIC ANALYSER
COUNTER TIMER
VIRTUAL TERMIN
SPI DEBUGGER
I2C DEBUGGER
SIGNAL GENERAT
PATTERN GENER
DC VOLTMETER
DC AMMETER
AC VOLTMETER
AC AMMETER
WATTMETER

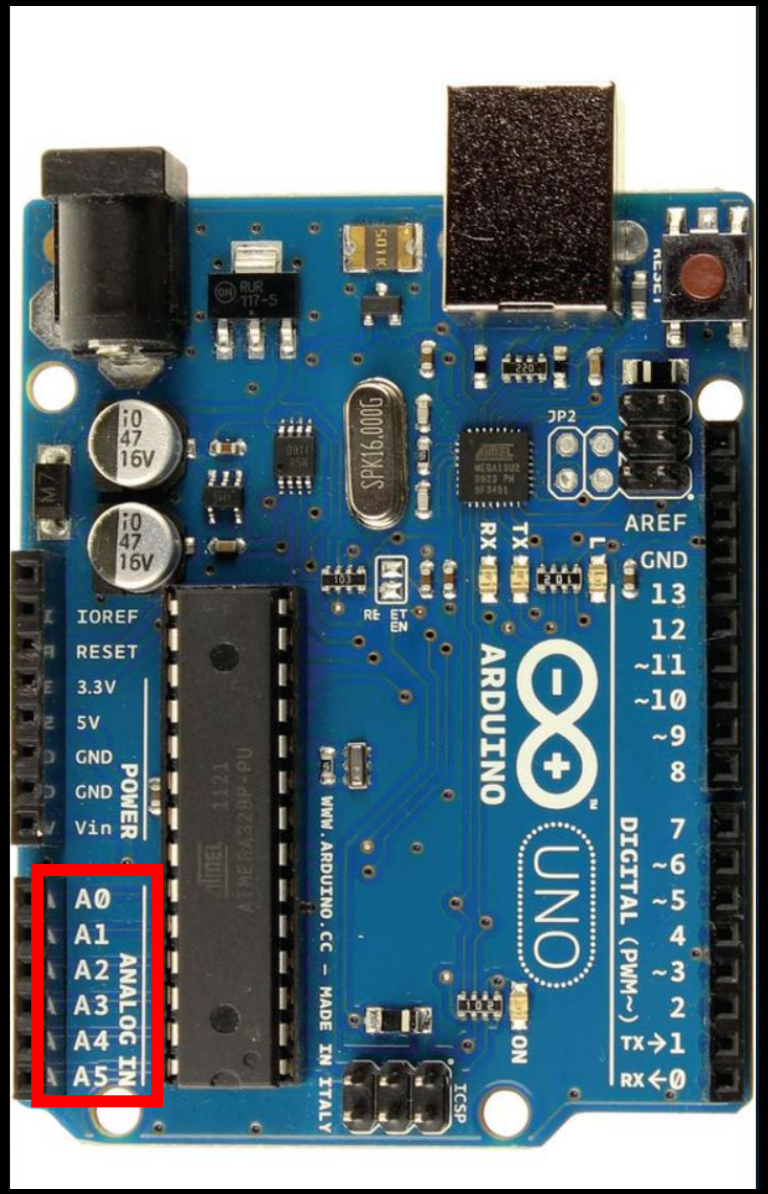

Schematic Capture
DEVICES
ARDUINO UNO R3
LED
LED-BLUE
POT-HG


D1
LED-BLUE
RV1
1k
100%
0.00
AC Volts

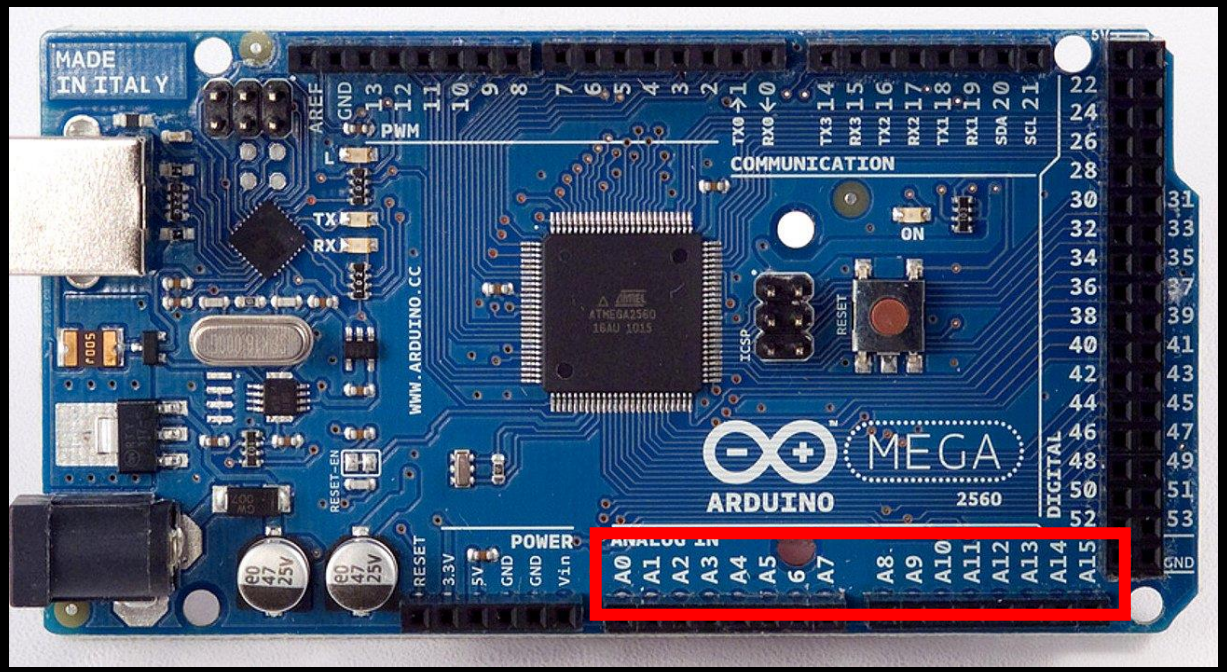

D1
LED-BLUE
RV1
1k
41%
+2.95
AC Volts


D1
LED-BLUE
RV1
1k
11%
+4.45
AC Volts


D1
LED-BLUE
1k
0%
+5.00
AC Volts



- Information inside our boards and chipsets are transferred in digital (0 & 1) format. On the other hand, actuators (motors, sensors, etc.) with analog (waves) format. In order to have these peripherals work with our chipsets, we use something called ADC (Analog to Digital Converter) and DAC (Digital to Analog Converter). These units work with the Analog pins that are on our board.



Class Work I:

Q. Make a circuit, in which, you read data from 3 potentiometers and based on what the values are, turn a RGB LED.

You don’t know how to work with RGB LED? See HERE

- ## Why don’t we just connect heavy loads directly to Arduino board?

  The answer is simple: Current limitations on Arduino pins! According to it’s datasheet each pin can at most deliver 40mA and the total amount of current drawn from all pins shouldn’t exceed 200mA in total or the board will fry!

- ## So what is the solution?!

  This is where the MOSFETs comes into the play. The idea is to use an external power supply that can deliver enough power to the desired device and control it using a switch. You guessed it didn’t you? The switch here is the MOSFET. Every transistor acts as a switch at it’s saturation mode and that’s exactly what we want. We supply the load using the external power source and control it with the help of MOSFET.

  Q. Wait a minute; if all transistors can act as a switch, then, what’s with all these insist on using MOSFET?

  A. Actually that’s a good question and you’re going to answer it along with the rest of your homework.

Class Work II:

Q. Control the RPM of a DC motor using Arduino and a potentiometer. The motor should be **supplied** using proper supply and the **switching** should be done with the help of and N-channel MOSFET with part number IRFZ44N.

NOTE: If you power the motor using Arduino your assignment won't be graded :). Arduino only assigns the RPM of the motor.

Q. Why are we insisting on MOSFET as our switch? Why don't we use any type of transistor?

If you had any questions:

1. Google is your friend!
2. If you did not find your answer on Google, search it on YouTube. There is definitely an Indian fellow answering your questions.
3. After all, you can also ask your graders (: