Introduction to Arduino Sketches :

Analog I/O

Objectives

- Understand the difference between analog and digital values
- Understand how to read analog inputs
- Understand how to scale analog inputs
- Understand how to output analog values

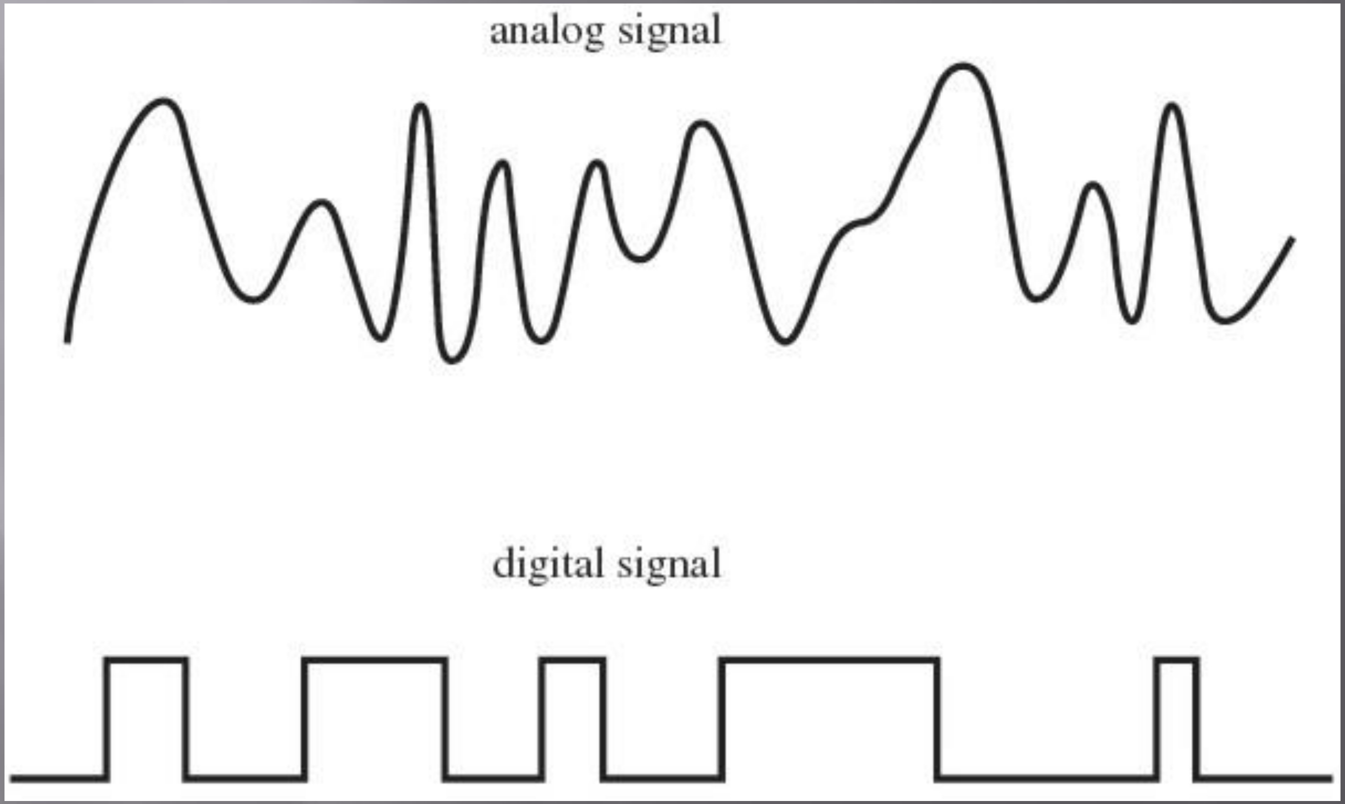
Analog values

- So far we have been working with digitalor "discrete" values:
  - On / Off
  - Low / High
  - 0V / 5V
  - However, many signals in the "real world" are analog in nature – these are "continuous" signals.

Analog signals

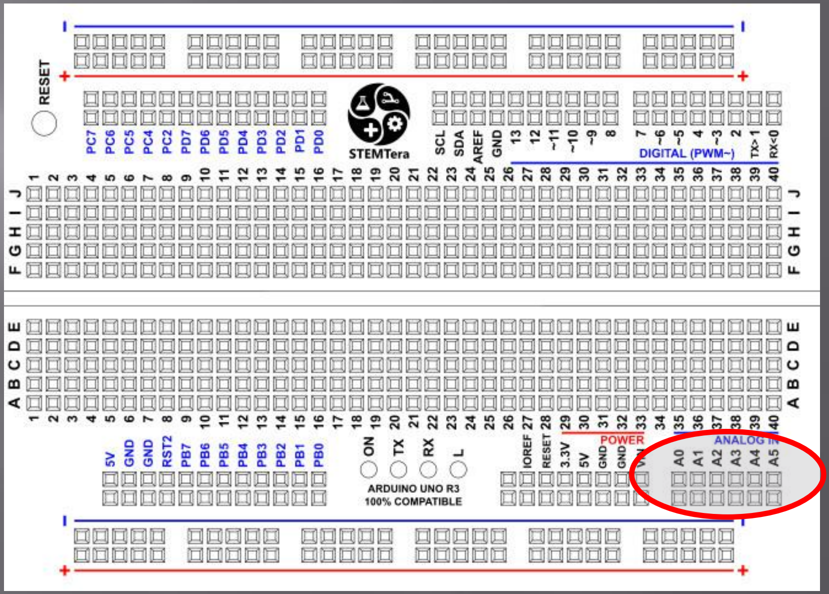
- Examples include:
  - Temperature
  - Velocity
  - Light intensity
  - These values change in small increments (as small as we can measure them) over time.

Analog signals



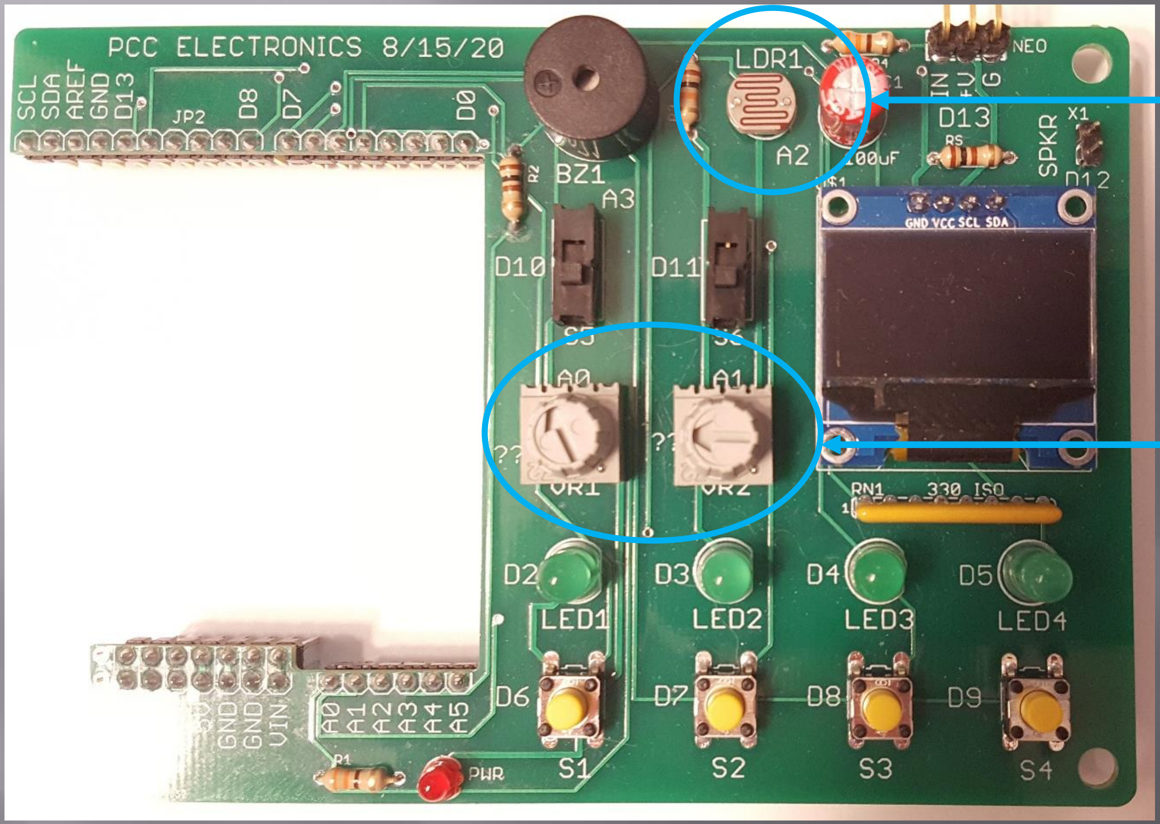
Analog inputs

- We can also use *analog* inputs on the Arduino.
- These inputs can read a range of voltages between 0 and 5 Volts.



These are used to read inputs from potentiometers (variable resistors) or sensors.

I/O Assignments: Analog Inputs



A2= Light Dependent Resistor (LDR)

A0, A1 = Variable Resistors VR1 & VR2

Using analog inputs

Unlike digital inputs, analog inputs do not need to be configured in the setup function. They can just be used in the loop:

Example: `value = analogRead(0);`

This command reads pin A0.

The value read is between 0 and 1023*!

* This is based on a power of 2: $2^{10} = 1024$.
Since zero is a value, this range is from 0 to 1023

Scaling an analog value

We can scale the input value to something more reasonable using the *map* function.

```
val = map(value, fromLow, fromHigh, toLow, toHigh)
```

* Note – val in this example is a variable that stores the analog value

So, we could scale the 0 – 1023 values to 1 to 100 as follows:

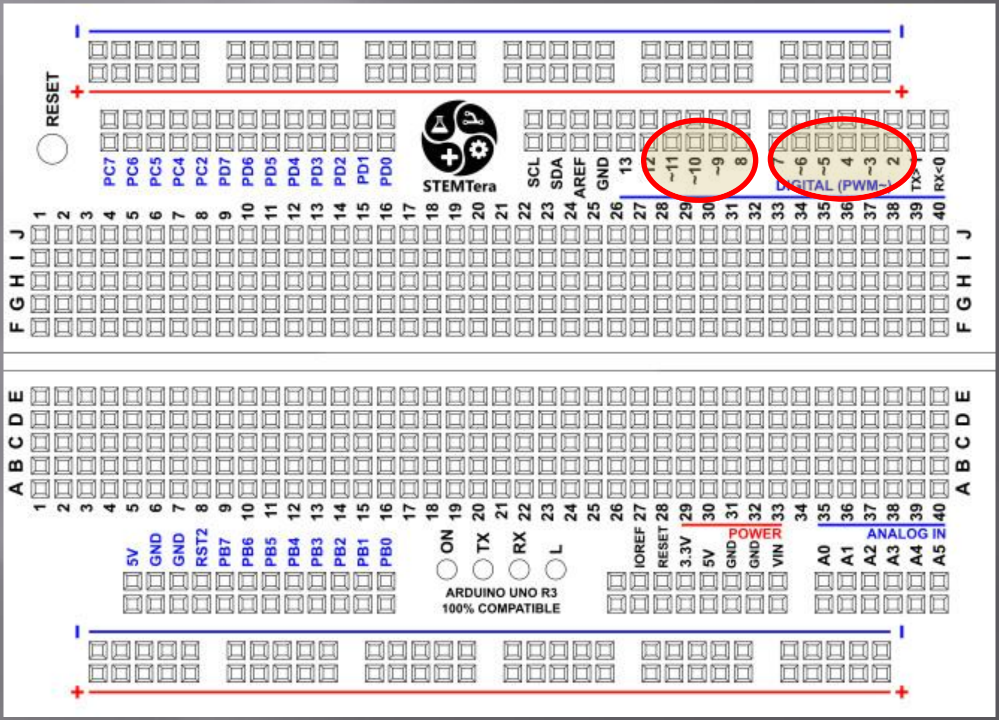
```
newValue = map(value, 0, 1023, 1, 100);
```

Analog Outputs

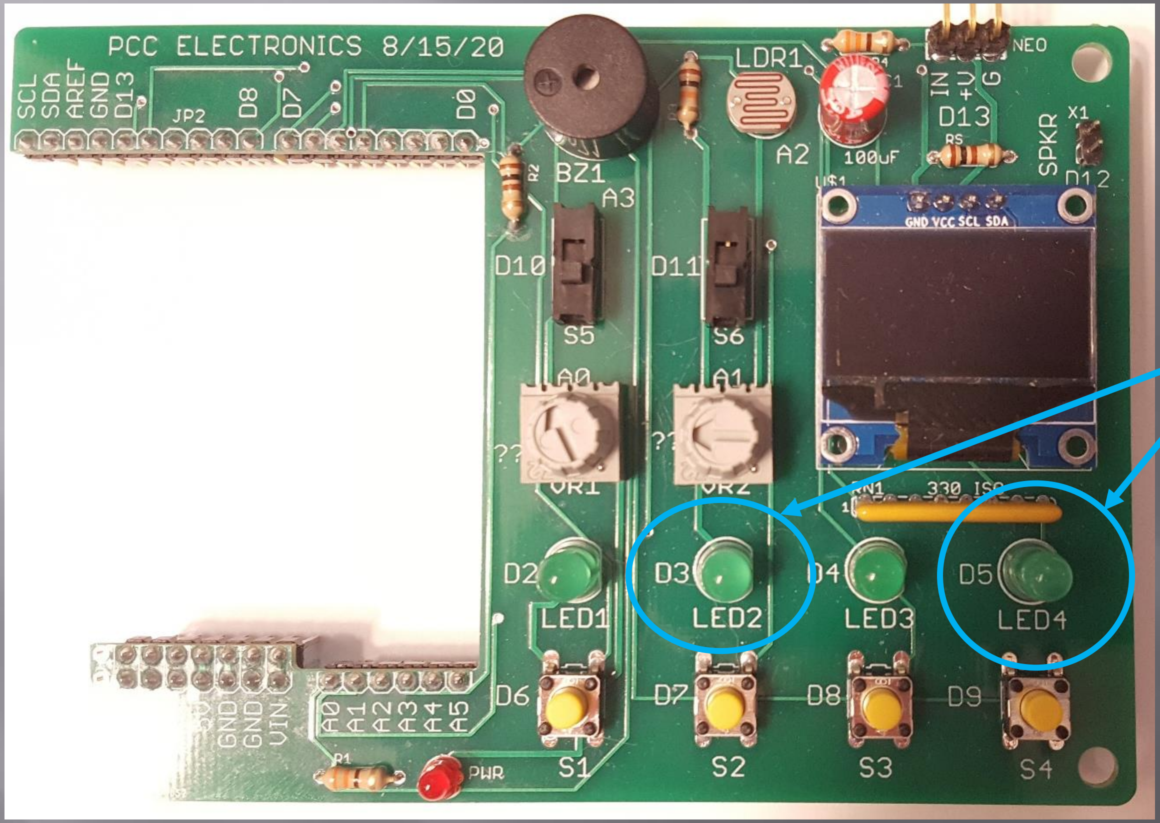
An *analog value* can be produced on the Digital PWM

These pins have a special symbol (~) next to the pin name on the board

Pin numbers are 3,5,6 and 9-11


RESET
PC7 PC6 PC5 PC4 PC2 PD7 PD6 PD5 PD4 PD3 PD2 PD1 PD0
STEMTera
SCL SDA AREF GND 13 12 ~11 ~10 ~9 8 7 ~6 ~5 4 ~3 2 TX>1 RX<0
DIGITAL (PWM~)
5V GND GND RST2 PB7 PB6 PB5 PB4 PB3 PB2 PB1 PB0
ON TX RX L
ARDUINO UNO R3
100% COMPATIBLE
IOREF RESET 3.3V 5V GND GND VIN
POWER
ANALOG IN
A0 A1 A2 A3 A4 A5
A B C D E F G H I J

I/O Assignments: Analog



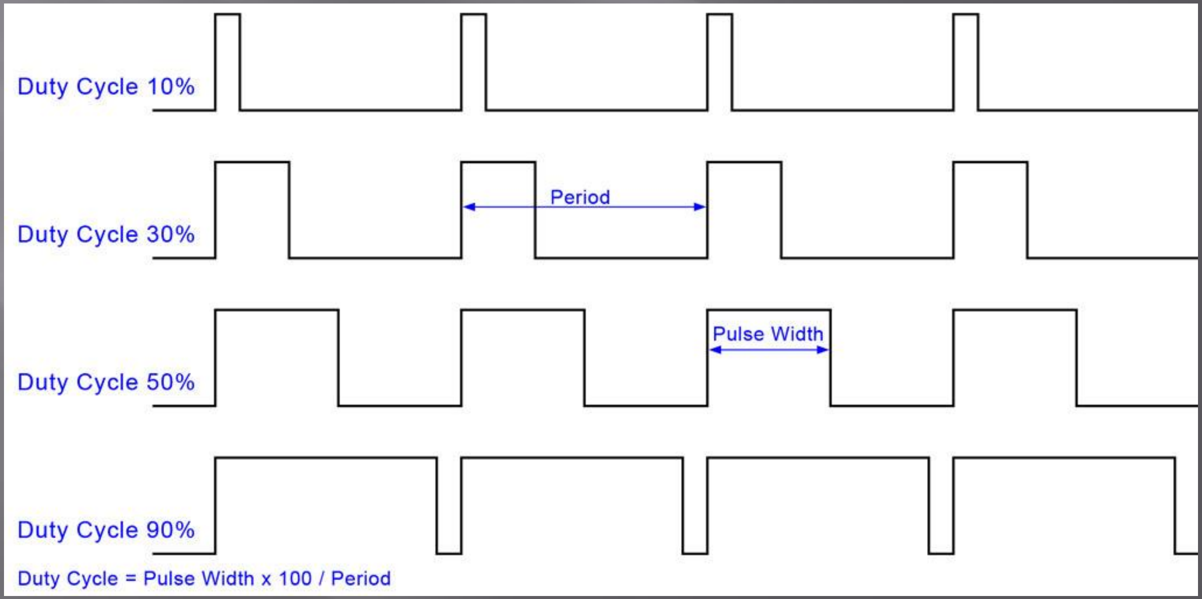
LED2 and LED4 are mapped to D3 and D5. Use these for analog outputs

What is PWM?

PWM Stands for **P**ulse **W**idth **M**odulation.

PWM uses a constant frequency but changes the duty cycle (time on / total time).

The average voltage on the pin is equal to the duty cycle x 5 volts.



Configuring analog outputs

```
int analogOutput = 9;
int voltVal = 128;              // PWM value ranges from 0 – 255

void setup( )
{
   pinMode (~analogOutput, OUTPUT);  // set pin 9 as an output.
}

void (loop)
{
  analogWrite (analogOutput, voltVal);
}
```

- Some important notes:
  - The output is inverted – this means a value of 0 = full on, 255 = full of!
  - To correct this, we can <u>invert</u> the value by writing ~analogOutput instead.