# Digital 1. What's a bit? 1. What we measure 2. Digital Output 1. On the board 2. LED 3. Power 4. Make a heater!

"Arduino boards contain a multichannel, 10-bit analog to digital converter."

So, what happens when we put a voltage across two pins of the arduino?

# I. What's a bit?

MO	RSE C	ODE
A •-	N -•	1
В -•••	0 ••	2
С •••	P	3
D -••	Q	4
Ε.	R • ••	5
F •-•	s •••	6
G•	Τ –	7
Н ••••	U ••-	8
••	۰۰۰۰ ۷	9
J	W •	0
К	Х	
L	Y	
M	Ζ	



The bits of Morse Code



Magentic Domains as bits

"Arduino boards contain a multichannel, 10-bit analog to digital converter."





## Digital Ramp ADC

This device generates a reference signal (in a step-like fashion). When it equals the input, it registers the digital value.

Arduino board have a similar method known as Successive Approximation ADC

## I.I What we measure

We're measuring bits.

# 2. Digital Output



Instead of making a range of voltages, the digital output works by changing how often 5 V is sent to the output. This is called the duty cycle.

<u>sim</u>

time

The Duty Cycle

# 2.2 On the board



The Two Sides of the board

## Arduino Codes

```
// set up the pins
// our digital PWN output is set to Digital Out 9
const int outPin = 9;
// we start with an output of 0 and declare this variable as an integer
int outputLevel=0;
void setup() {
  //define the pin mode for the digital output
 pinMode(outPin, OUTPUT);
  Serial.begin(9600);
}
void loop() {
 // make an oscillating value
 // output = Sin(omega * t)
  float omega = 2*3.1415;
  outputLevel = 255*sq(sin(millis()*.001*omega));
  // write the outputLevel variable to our digital output pin
  analogWrite(outPin, outputLevel);
  delay(1);
}
```



The Duty Cycle

# 2.3 LED



LED: Light Emitting Diode

Warning: One leg is longer - that goes to the positive voltage

Use a resistor in series to make sure not too much current passes. (220  $\Omega$  is fine)

Connecting an LED

#### 2.4 Power

If current passes through a resistor, there will some energy dissipation.

$$P = IV = I^2 R \tag{1}$$

#### 2.5 Make a heater!

We will use the digital output to send a current to a resister, and then use our thermistor module to measure that change in temperature of the resistor.

To do:

- 1. Make a temperature controller. This will be a potentiometer (essentially a voltage divider)
- 2. Get the value from the controller and use that to set the heater level.
- 3. Connect the resistor to a digital out.
- 4. Measure the temperature with a thermistor (and voltage divider)

Arduino Specific

```
/* LED BRIGHTNESS CONTROL */
// our potentiometer will go to Analog Input 1
const int PotInputPin = A1;
// our digital PWN output is set to Digital Out 9
const int outPin = 9;
// we start with an output of 0 and declare this variable as an integer
int outputLevel=0;
void setup() {
    //define the pin mode for the digital output
    pinMode(outPin, OUTPUT);
}
void loop() {
    int potValue = analogRead(A1);
   // use the map() function to scale the potentiometer input from 0-1023 to 0-255
    outputLevel = map(potValue,0,1023,0,255);
    // write the outputLevel variable to our digital output pin
    analogWrite(outPin, outputLevel);
    delay(1);
}
```