ATMEGA328 – INPUT/OUTPUT I/O pins
https://github.com/teaksoon/lmaewapm

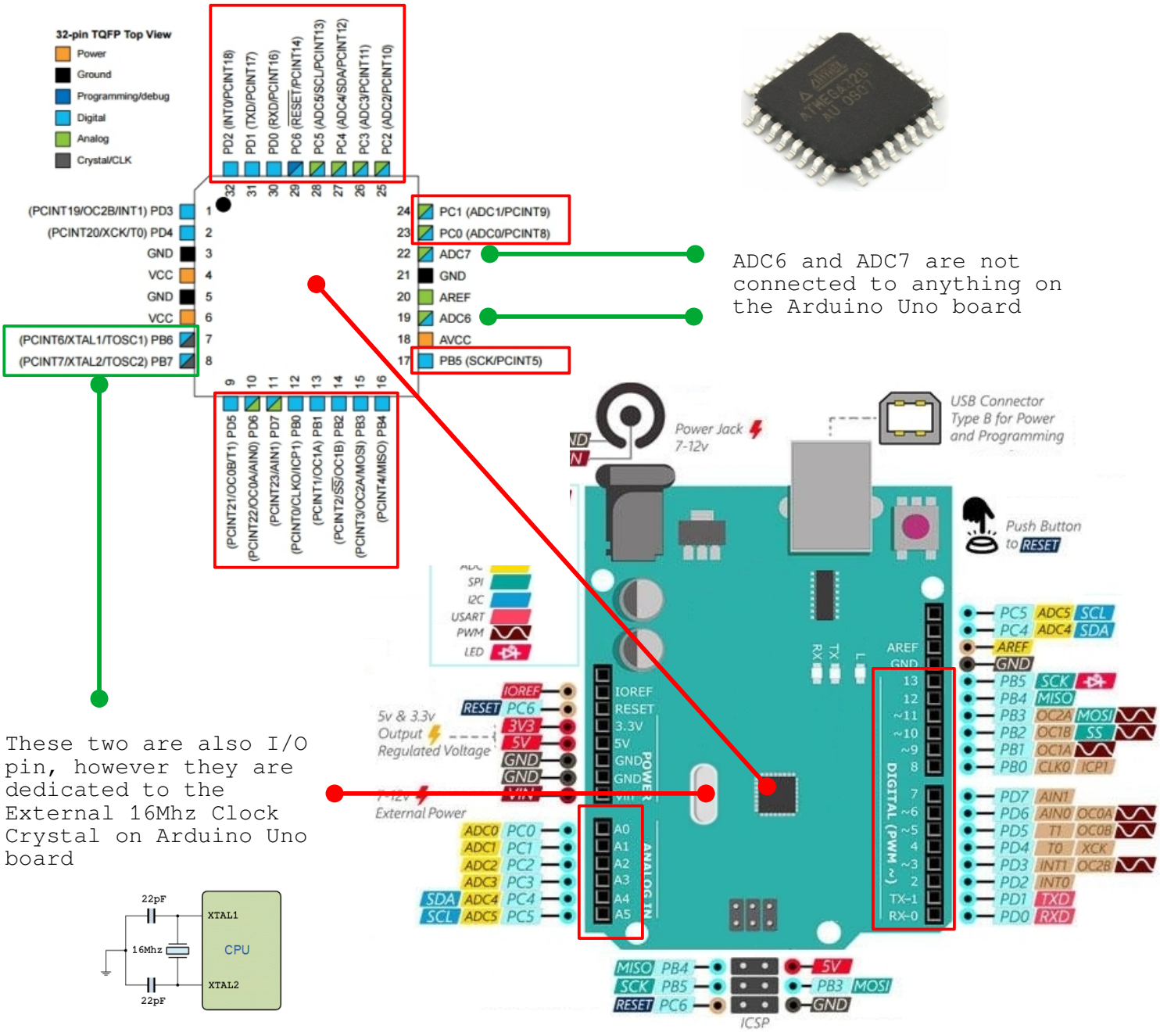
Apart from the **Power Supply Pins (GND, VCC, AVcc)**, the ATMEGA328P micro-controller have many other pins coming out from its physical chip packaging. Those other Pins are known as **INPUT/OUTPUT or I/O Pins**

Each of the ATMEGA328 I/O Pin is connected a female header on the Arduino Uno board(labelled 0 to 13 and A1 to A5), except for

- Pin PB6 and PB7, which are connected to the 16Mhz Clock Crystal
- Pin ADC6 and ADC7, which are not connected to anything on Arduino Uno Board(you have them on the Arduino Nano board)

The I/O Pins are also dealing with the properties of electricty: Current, Voltage and Resistance

What we are interested from the I/O Pins is the "VOLTAGE"



16Mhz Clock Crystal when powered up, will consistently generate "pulse" 16 million times in every one seconds. From there, we get our timed interval. This device is optional, because the ATMEGA328 micro-controller chip has an internal 8Mhz Clock Device. Since we want to run at 16Mhz, so this 16Mhz Clock Crystal is required

The "I/O Pins" can be set to become "INPUT PIN" or "OUTPUT PIN"
We can do it by giving this instruction(Program) to the micro-controller

When I/O Pin is set as "INPUT PIN"

- This pin will "receive" VOLTAGE from the connected external device

- The Voltage "received" from the external device can range from 0V to 5V

Our Program can ask the micro-controller to tell us, how many VOLT is currently supplied by the external device to this Pin

Based on that information(VOLTAGE supplied by external device), we can give other instructions(Program) to our micro-controller in response to that data

When I/O Pin is set as "OUTPUT PIN"

- This pin will "supply" VOLTAGE to the connected external device

- The Voltage "supplied" to the external device can be either 0V or 5V

Our Program can ask the micro-controller to either supply 0V or 5V to this Pin, to be picked up by the external device, which can be...

Permanent – We can just leave the Pin to supply 0V or 5V

Conditional – We can have this Pin supplying 0V or 5V based on certain conditions

Timed – We can have this Pin supplying 0V or 5V for a specific period of time

We can also combine the "Timed" and "Conditional" to do perform more complicated task

A simple example on an INPUT/OUTPUT Pin Programing: (ON/ON Switch):

Pin A is physically connected to a Switch, which can supply 0 or 5V
Pin B is physically connected to a 5V Light Bulb

In our Program, we tell the micro-controller to set **Pin A as INPUT PIN** and **Pin B as OUTPUT PIN.**

Since Pin A is an INPUT PIN, we can ask the micro-controller to get the **VOLTAGE** in Pin A.

if the micro-controller tell us **Pin A has 5V** (means the connected switch has been turned on), since Pin B is an OUTPUT PIN, we ask the micro-controller to **supply 5V to Pin B**, the connected Light Bulb will be turned on.

if the micro-controller tell us **Pin A has 0V** (means the connected switch has been turned off), since Pin B is an OUTPUT PIN, we ask the micro-controller to **supply 0V to Pin B**, the connected Light Bulb will be turned off.

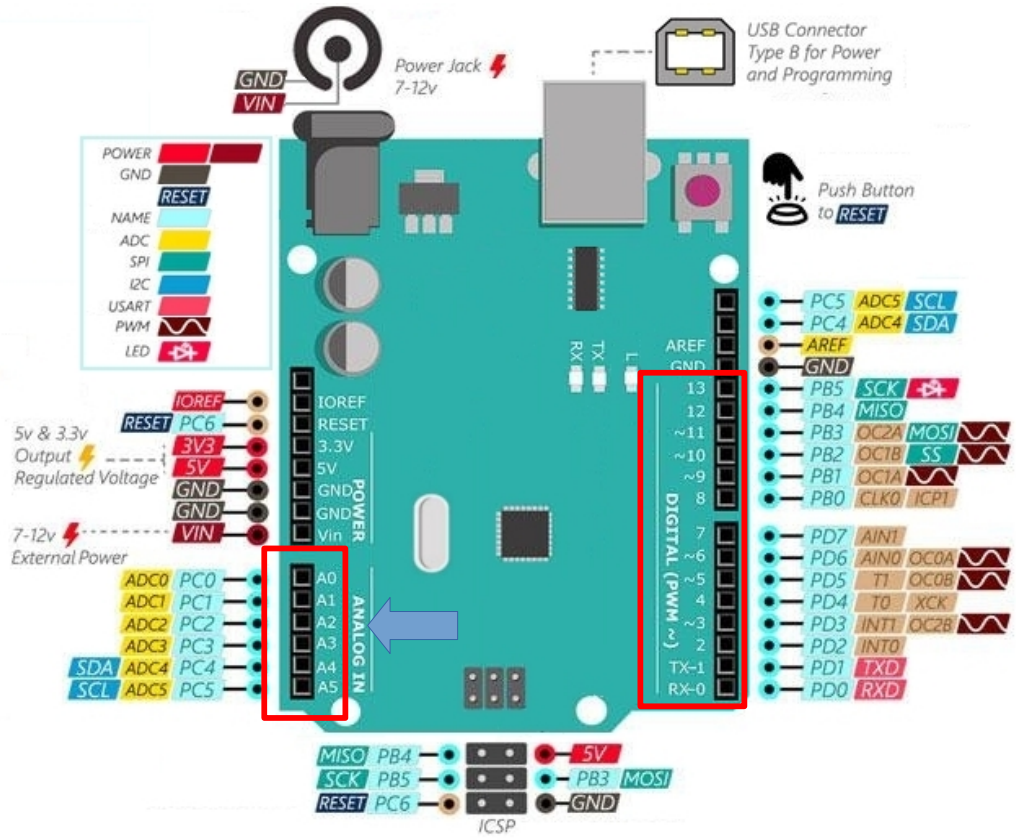
This example does not do much but when we become creative. For example: if we connect an OUTPUT Pin to an Antenna, and starts to turn the VOLTAGE on that OUTPUT Pin, 0V and 5V at an interval with a specific pattern. Guess what we have just done ? We are sending Radio Signals out from our OUTPUT pin.

Robotics, Automation, Artifical Intelligence, IOT, Industrial 4.0, and all the other fanciful names... has roots in this simple reading and setting of “VOLTAGE” on the I/O Pins

From the next lessons onwards, we will be learning how to write Programs to manipulate the “VOLTAGE” from the I/O Pins. We willbe able to see how this simple “VOLTAGE” manipulation can turn “blank” ATMEGA328 micro-controllers into “Smart” Devices

When the I/O Pin is set as INPUT PIN, the micro-controller can tell us whether it is 0V(LOW VOLTAGE) or 5V(HIGH VOLTAGE)

These pin are known as DIGITAL INPUT PINS



There are few pin in the ATMEGA328 micro-controller with special abilities when set as INPUT PIN

The micro-controller has something called "10-BIT ADC" which can tell us the "Actual Voltage" on these Pins instead of just 0V and 5V. On the Arduino Uno board, they are labelled as A0,A1,A2,A3,A4 and A5. The "10-BIT ADC" converts the Actual Voltage on those Pin to a whole number.

0V is represented by 0
5V is represented by 1023 (why 1023? The maximum value for 10-BIT in binary is 1111111111 which is 1023 in decimal)

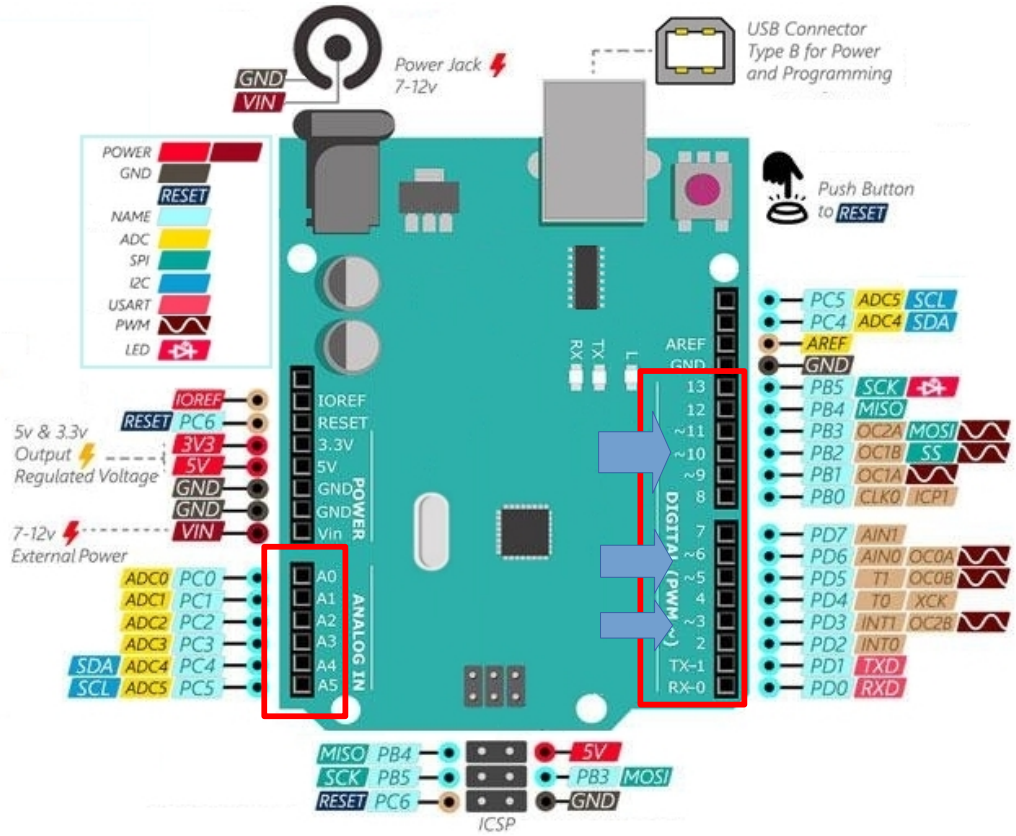
How about 2V ? 2V will be represented by (2*1023)/5 = 409
How about 3V ? 3V will be represented by (3*1023)/5 = 614
and so on...

These pin are known as ANALOG INPUT PINS

Some Analog Sensor device will give us variable Voltage as their readings

When the I/O Pin is set as OUTPUT PIN, the micro-controller can make them to supply either 0V(LOW VOLTAGE) or 5V(HIGH VOLTAGE)

These pin are known as DIGITAL OUTPUT PINS



There are few pin in the ATMEGA328 micro-controller with special abilities when set as OUTPUT PIN

The micro-controller has something called "PWM" or Pulse Wave Modulation on those Pins. On the Arduino Uno board, those pins are labelled with a "~" symbol, ~3,~5,~6,~9,~10 and ~11.

These pin are able to alternate between 0V and 5V with a special pattern based on something called "duty cycle". When the pin is running at,

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 50% duty cycle, will alternate 0V,5V,0V,5V...          (1x0V,1x5V...)
 25% duty cycle, will alternate 0V,0V,5V,0V,0V,5V...    (2x0V,1x5V...)
 75% duty cycle, will alternate 0V,5V,5V,0V,5V,5V...    (1x0V,2x5V...)
100% duty cycle, will alternate 5V,5V,5V...
  0% duty cycle, will alternate 0V,0V,0V...
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This thing will be happening so fast, when the Pin is not at 100% or 0% duty cycle, it "feels like" we are geting a fraction of the VOLTAGE between 0V to 5V.

These pin are known as DIGITAL PWM PINS

Some device use this kind of power supply to perform specific functions