

UNIVERSITY OF TWENTE.

# ARDUINO & ELECTRONICS PRACTICAL

PRACTICAL SESSION 1



Part of **SmartProducts**



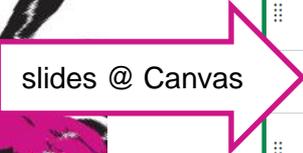
# ARDUINO & ELECTRONICS PRACTICAL

## PRACTICAL SESSION 1

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f.vanslooten@utwente.nl



- Goal: *Become familiar with **Electronics & Arduino***
- 2 practical assignments, 3 afternoon sessions: May 3, 13 & 17
- Introduction to Arduino powered electric circuits
- Practical assignment



⋮	Day 1, May 3
⋮	📄 AppDev Lecture 1 (morning)
⋮	📄 AppDev Assignment 1 13 May   10 pts
⋮	📄 AppDev Practical 1 Intro (afternoon)
⋮	📄 AppDev Practical Assignment 1: build a distance sensor 13 May   10 pts

### Assistants:

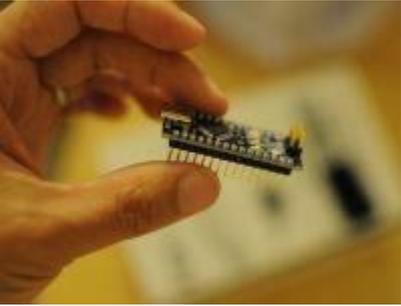
Hilke van den Born  
Tim van der Kooi  
Daniël Kooyman van Guldener  
Filip van der Kroft  
Luc Notenboom  
Jannick Siderius

# ARDUINO NANO

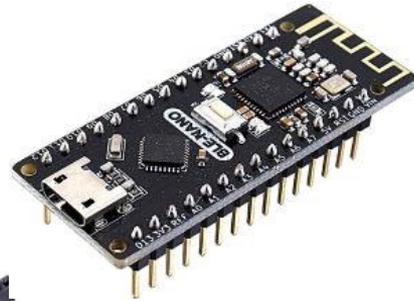
PROGRAMMABLE CIRCUIT BOARD (AKA MICROCONTROLLER)



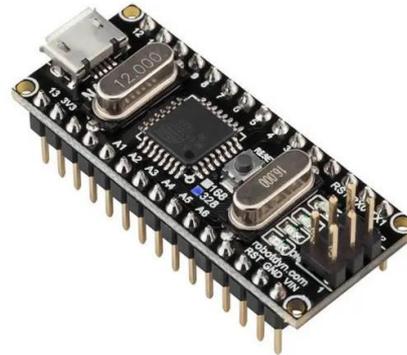
[What is in the Electronics kit?](#)  
[Check it here](#)



Uno



BLE Nano  
with Bluetooth



Nano  
(regular version)



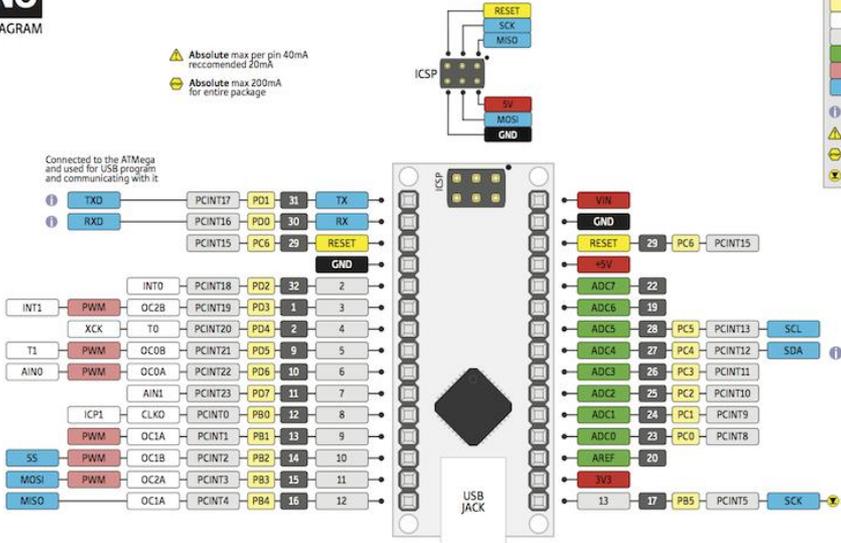
Raspberry Pi  
Pico WH

# PINOUT

THE UNOFFICIAL  
**ARDUINO NANO**  
PINOUT DIAGRAM

⚠ Absolute max per pin 40mA  
recommended 20mA  
⚡ Absolute max 200mA  
for entire package

Connected to the ATmega  
and used for USB program  
and communicating with it

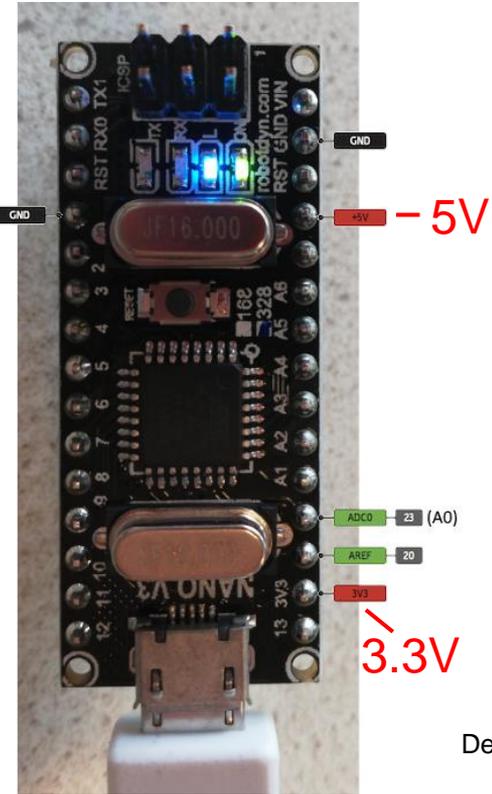


**LEGEND**

- GND
- POWER
- CONTROL
- PHYSICAL PIN
- PORT PIN
- ATMEGA328 PIN FUNC
- DIGITAL PIN
- ANALOG-RELATED PIN
- PWM PIN
- SERIAL PIN

ⓘ General Information  
 ⚠ Pay Attention  
 ⚡ No Really PAY ATTENTION  
 📡 LED

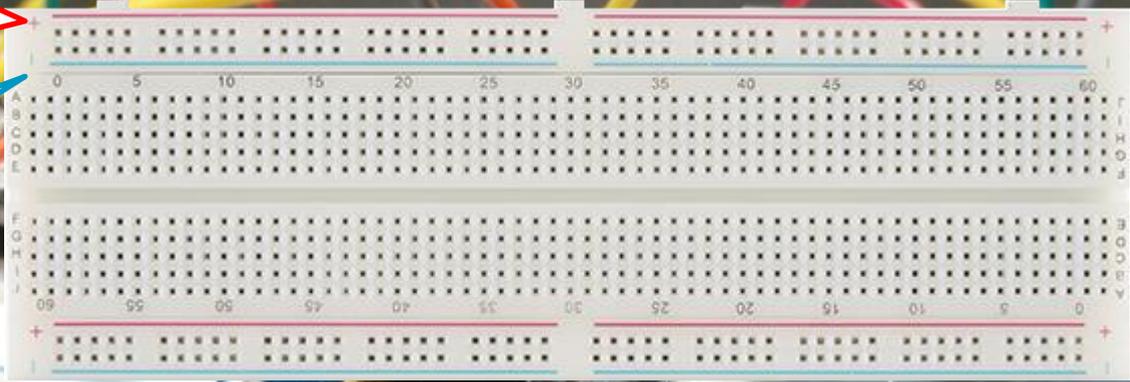
ⓘ On version 2  
Analog Pins are reversed  
e.g. A0 → A7, A7 → A0



# BREADBOARD: PLUGIN ELECTRONIC COMPONENTS

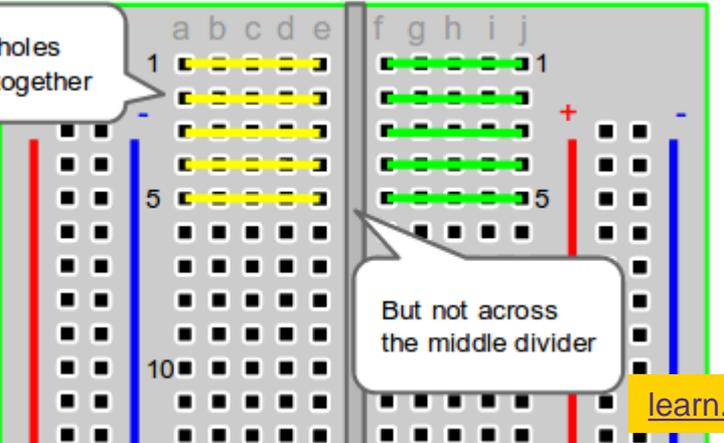
+ track for VCC (power 5 or 3.3V)

- track for GND (ground)



Horizontal holes are linked together

But not across the middle divider



# ARDUINO PROGRAMMING

First time use?  
Choose **Help** >  
**Getting started**

**setup()**: start of  
program, runs once

**loop()**: runs continuously  
after setup()

```
1 void setup() {  
2   // put your setup code here, to run once:  
3  
4 }  
5  
6 void loop() {  
7   // put your main code here, to run repeatedly:  
8  
9 }  
10
```

- Arduino program also called: **sketch**
- Language: C++ (similar to Java)

# ARDUINO PROGRAMMING

## LEARN BY EXAMPLES

Blink | Arduino IDE 2.1.0

File Edit Sketch Tools Help

New Sketch Ctrl+N

New Cloud Sketch Alt+Ctrl+N

Open... Ctrl+O

Open Recent

Sketchbook

Examples

Close Ctrl+W

Save Ctrl+S

Save As... Ctrl+Shift+S

Built-in examples

01.Basics

02.Digital

03.Analog

04.Communication

05.Control

06.Sensors

07.Display

08.Strings

09.USB

10.StarterKit\_BasicKit

AnalogReadSerial

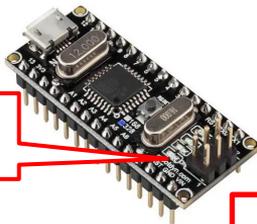
BareMinimum

Blink

DigitalReadSerial

Fade

ReadAnalogVoltage



LED\_BUILTIN is the LED on the board

loop(): turn LED on and off

Blink | Arduino IDE 2.1.0

File Edit Sketch Tools Help

Arduino Nano

Blink.ino

```
12
13
14 modified 8 May 2014
15 by Scott Fitzgerald
16 modified 2 Sep 2016
17 by Arturo Guadalupi
18 modified 8 Sep 2016
19 by Colby Newman
20
21 This example code is in the public domain.
22
23 http://www.arduino.cc/en/Tutorial/Blink
24
25 */
26 // the setup function runs once when you press reset or power the board
27 void setup() {
28   // initialize digital pin LED_BUILTIN as an output.
29   pinMode(LED_BUILTIN, OUTPUT);
30   Serial.begin(9600);
31   Serial.println("Hello world");
32 }
33 // the loop function runs over and over again forever
34 void loop() {
35   digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
36   delay(1000); // wait for a second
37   digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW
38   delay(1000); // wait for a second
39 }
40
```

Output

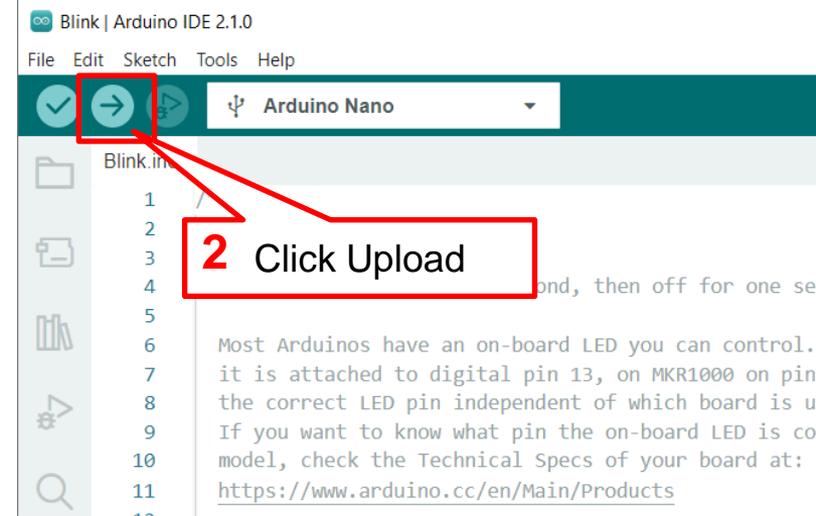
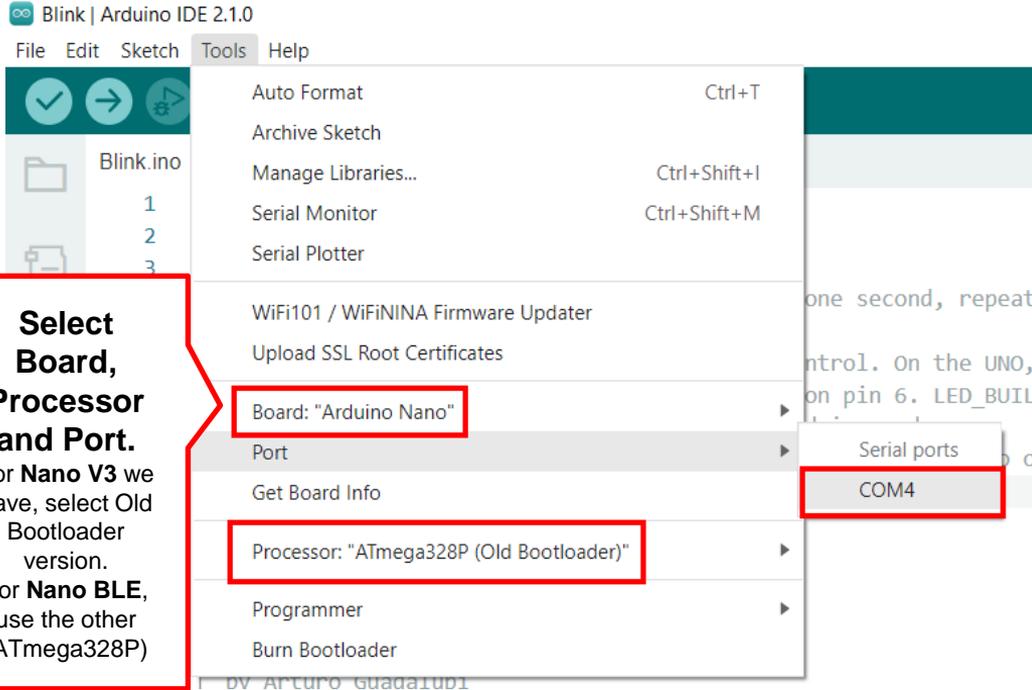
UNIVERSITY OF TWENTE.



# RUN A PROGRAM

## UPLOAD SKETCH TO ARDUINO

Connect USB  
cable first



# TIP: SELECT PROPER PROCESSOR

## TOOLS > PROCESSOR CHOICE FOR ARDUINO NANO

An error occurred while uploading the sketch

```
avrdude: stk500_getsync() attempt 9 of 10: not in sync: resp=0x00
avrdude: stk500_getsync() attempt 10 of 10: not in sync: resp=0x00
An error occurred while uploading the sketch
```

Blink | Arduino 1.8.9

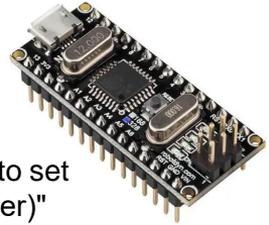
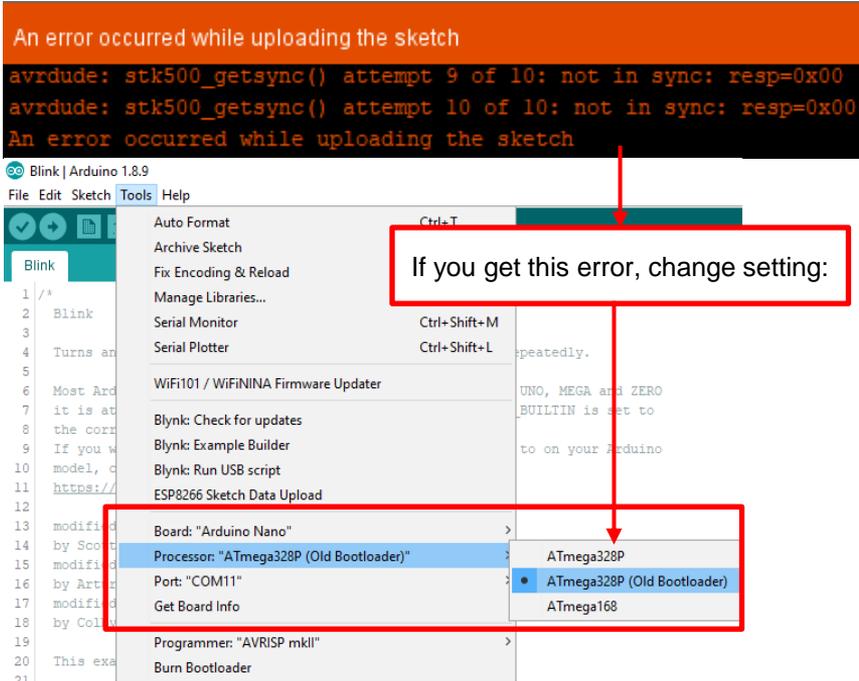
File Edit Sketch Tools Help

Auto Format  
Archive Sketch  
Fix Encoding & Reload  
Manage Libraries...  
Serial Monitor  
Serial Plotter  
WiFi101 / WiFiNINA Firmware Updater  
Blynk: Check for updates  
Blynk: Example Builder  
Blynk: Run USB script  
ESP8266 Sketch Data Upload

Board: "Arduino Nano" >  
Processor: "ATmega328P (Old Bootloader)"  
Port: "COM11"  
Get Board Info  
Programmer: "AVRISP mkII"  
Burn Bootloader

ATmega328P  
● ATmega328P (Old Bootloader)  
ATmega168

If you get this error, change setting:



For regular Nano you need to set Processor to “(Old Bootloader)”

[More troubleshooting tips](#)

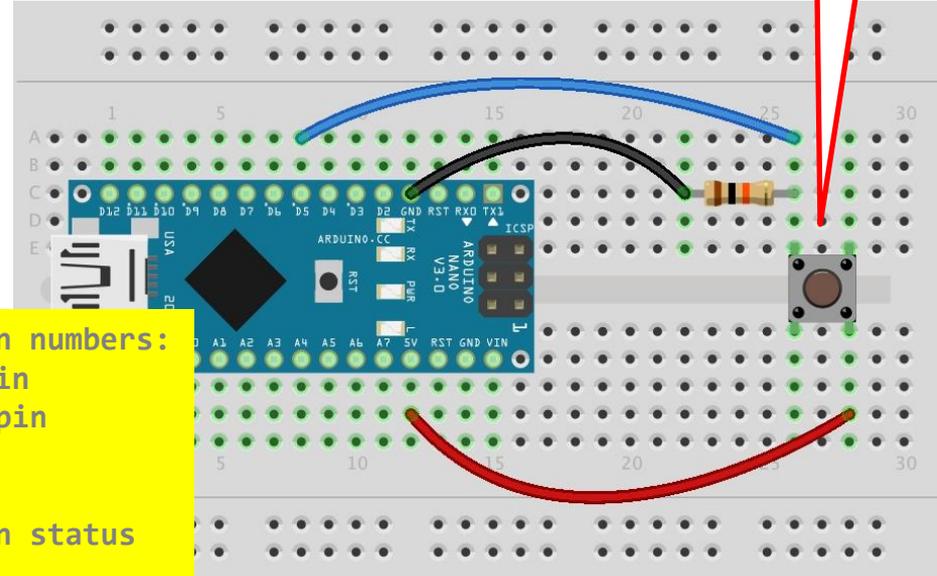
# ARDUINO PROGRAMMING BASICS

*File > Examples > 02.Digital > Button*

```
// constants won't change. They're used here to set pin numbers:
const int buttonPin = 2;    // number of pushbutton pin
const int ledPin = 13;     // number of onboard LED pin

// variables will change:
int buttonState = 0; // variable for reading pushbutton status

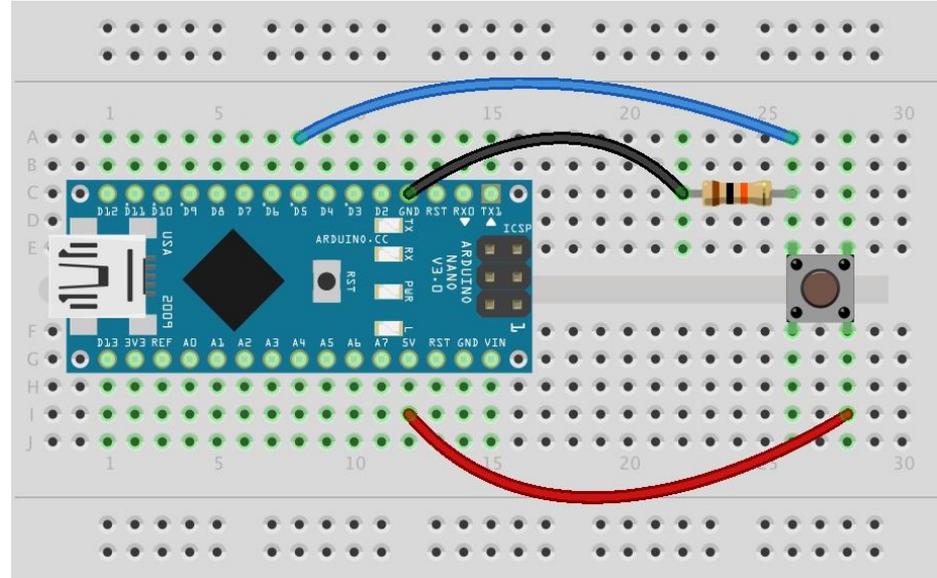
void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}
```



[arduino.cc/en/Tutorial/Button](https://arduino.cc/en/Tutorial/Button)

# ARDUINO PROGRAMMING BASICS

```
void loop() {  
  // read the state of the pushbutton value:  
  buttonState = digitalRead(buttonPin);  
  
  // check if the pushbutton is pressed.  
  // If it is, the buttonState is HIGH:  
  if (buttonState == HIGH) {  
    // turn LED on:  
    digitalWrite(ledPin, HIGH);  
  } else {  
    // turn LED off:  
    digitalWrite(ledPin, LOW);  
  }  
}
```



Does not work as expected...?  
Check out next example: 'debounce'

[arduino.cc/en/Tutorial/Button](https://arduino.cc/en/Tutorial/Button)

[arduino.cc/en/Tutorial/Debounce](https://arduino.cc/en/Tutorial/Debounce)

# USING LIBRARIES

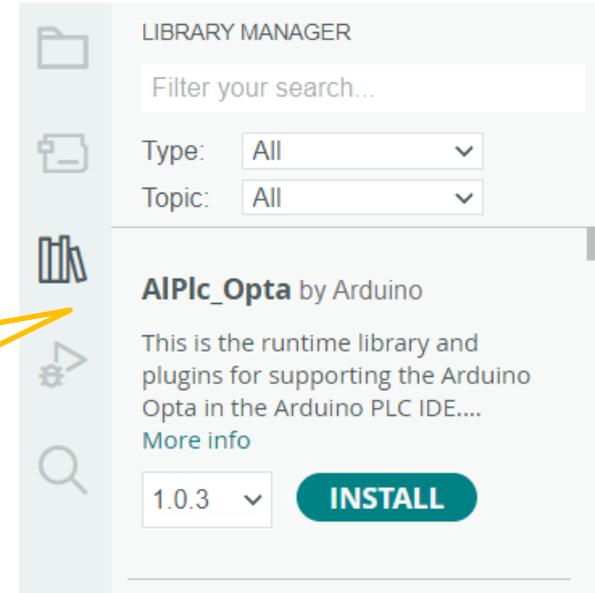
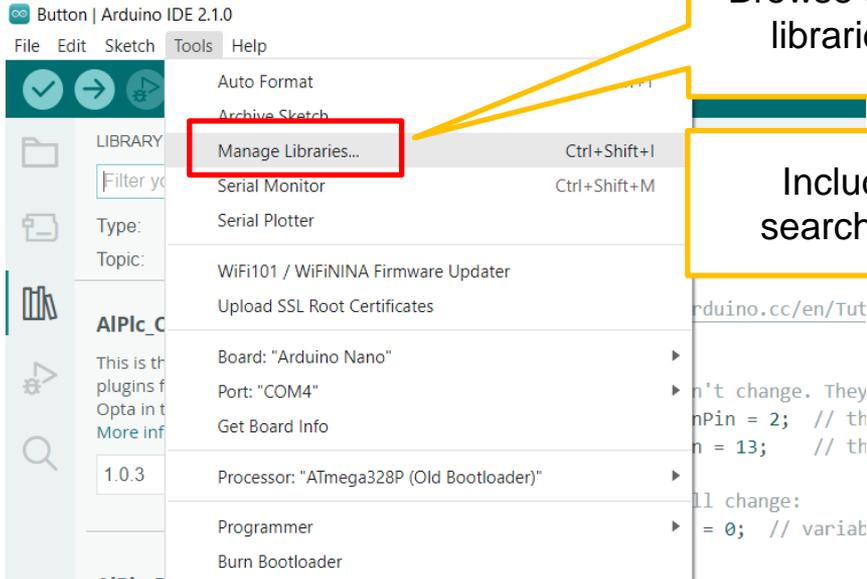
## MAKE PROGRAMMING EASIER

[arduino.cc/en/Main/Libraries](https://arduino.cc/en/Main/Libraries)

- Libraries extend functionality
- Documents\Arduino\libraries** contains folders with libraries

Browse through available libraries (and install)

Include a library by searching & selecting



# GENERAL TIPS

- Always disconnect power (USB cable) if modifying circuit!
- Resistor color codes: [resistorcolorcodecalc.com](https://www.resistorcolorcodecalc.com) (or use multimeter: turn switch to ohm  $\Omega$ )



3 Band 4 Band 5 Band 6 Band

Resistance: 220  $\Omega$   $\pm$ 5%    Minimum: 209  $\Omega$     Maximum: 231  $\Omega$

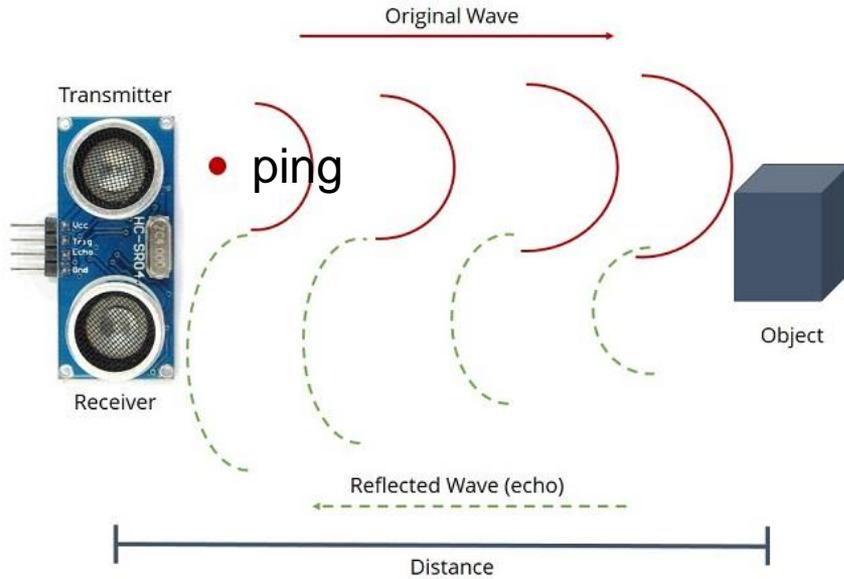
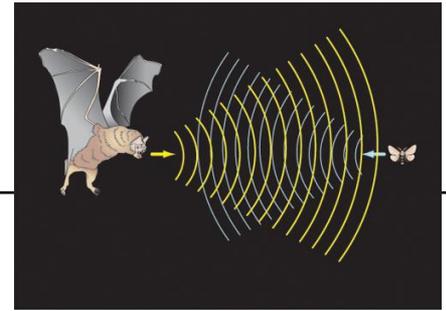
Color	Band 1 1 <sup>st</sup>	Band 2 2 <sup>nd</sup>	Band 3 Multiplier	Band 4 Tolerance
Black		0	$\times 10^0$	
Brown	1	1	$\times 10^1$	$\pm 1\%$
Red	2	2	$\times 10^2$	$\pm 2\%$
Orange	3	3	$\times 10^3$	$\pm 0.05\%$
Yellow	4	4	$\times 10^4$	$\pm 0.02\%$
Green	5	5	$\times 10^5$	$\pm 0.5\%$
Blue	6	6	$\times 10^6$	$\pm 0.25\%$
Violet	7	7	$\times 10^7$	$\pm 0.1\%$
Grey	8	8	$\times 10^8$	$\pm 0.01\%$
White	9	9	$\times 10^9$	
Gold			$\times 10^{-1}$	$\pm 5\%$



[Need help? More tips here](#)

# USE A DISTANCE SENSOR

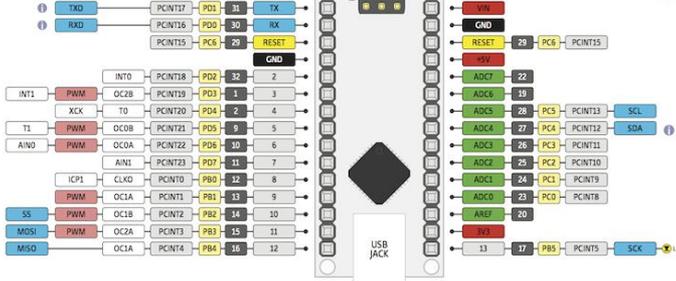
## ULTRASONIC SENSOR



- Uses ultrasonic sound waves to determine range of object (echo-location)
- Range 5-250cm... or more
- Send a 'ping'... wait for return, measure time to get distance
- Library used: 'NewPing'

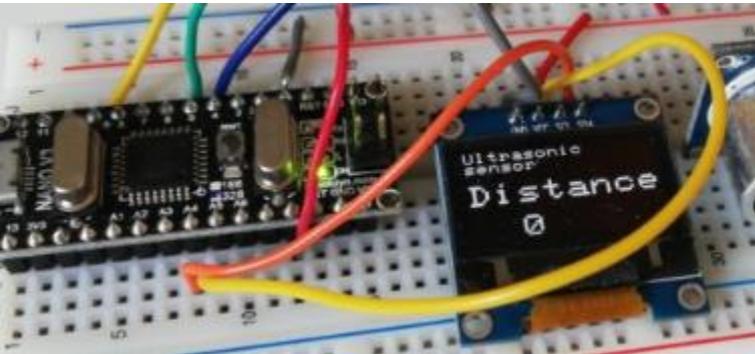
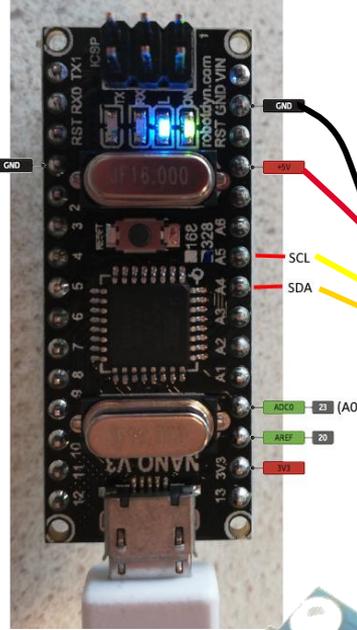
⚠ Absolute max per pin 40mA  
recommended 20mA  
⚠ Absolute max 200mA  
for entire package

Connected to the ATmega and used for USB program and communicating with it



# OLED DISPLAY

- Display text: 8 lines, 16 characters
- Or double font size
- Graphics:



[More about OLED display](#)

# WRITING YOUR FIRST LINES OF CODE

---

- If.. Some condition is *true*
- Do something

```
if ( condition ) { // something nearby?  
    // sound alarm  
}
```

- Example condition:

```
distance < 150
```

# DISTANCE SENSOR WITH ALARM

## EXAMPLE OF USE

---



Distance measurement with alarm built using ultrasonic sensor, controller and buzzer. Can be embedded in a small box.



# ELECTRONICS KIT: CONTENTS

→ to be returned July 5<sup>th</sup>  
→ returning the kit is a condition to receive your grade!

## ■ Check out what is in the kit here

(you do not have to fill in the checklist now, that must be done when you return it)

 Link to more info & tutorials about part

 Link to shop, in case you need to buy more/spare

Hover over parts so see image! →

<b>1 electronics kit, containing:</b>	<a href="#">a transparent box</a> , with the content below.
<a href="#">Arduino Nano</a>  	<input type="checkbox"/> Arduino Nano, can be black or blue board.
<a href="#">Arduino Nano BLE</a>  	<input type="checkbox"/> Arduino Nano with onboard Bluetooth module.
<a href="#">Breadboard</a> 	<input type="checkbox"/> Board with lots of holes in which you can stick components.
<a href="#">Breadboard wires</a> 	<input type="checkbox"/> Small box of breadboard wires.
<a href="#">Various basic components</a> 	<input type="checkbox"/> Resistors, capacitors, LEDs in various colors, at least 6 push buttons etc.
<a href="#">Potmeter</a>  	<input type="checkbox"/> Potentiometer.
<a href="#">Buzzer</a>  	<input type="checkbox"/> Buzzer. Shopping link is to starter kit which contains this.
<a href="#">7-segment display</a>  	<input type="checkbox"/> Small 7-segment LED display (displays a single character).
<a href="#">2 RGB Leds</a>  	<input type="checkbox"/> RGB Led
<a href="#">Ultrasonic sensor module</a>  	<input type="checkbox"/> Ultrasonic distance sensor
<a href="#">OLED Display</a>  	<input type="checkbox"/> 0.96 inch OLED Display 128*64 pixels blue - I2C
<a href="#">Temperature sensor</a>  	<input type="checkbox"/> DHT11 temperature sensor, blue.
<a href="#">MPU-6050 Accelerometer &amp; Gyroscope 3-Axis Module</a>  	<input type="checkbox"/> MPU-6050 Accelerometer and Gyroscope sensor. Warning: version in shop has no headers (you have to solder these yourself, so you need a soldering iron with a fine point and good eyes or a magnifying glass).
<a href="#">Vibration motor module</a>  	<input type="checkbox"/> Vibration motor, like the vibration element in your phone.



# ELECTRONICS KIT: CONTENTS

THERE IS MORE...

→ to be returned July 5<sup>th</sup>  
→ returning the kit is a condition to receive your grade!

## Extra components that can be borrowed

Of some there are only 1 or a few, so make sure to let me know well in advance if you need something! Then I might be able to buy it for you.

- [Mp3 player module with micro-sd card slot](#) [tutorial/more info]
- [Various speakers and buzzers](#) [tutorial/more info]
- [Various stepper motors](#) [tutorial/more info]
- [Lolin32 Lite ESP module](#) (like Arduino Nano, but with Wifi & Bluetooth and much more memory and much faster) [tutorial/more info]
- [Lego Mindstorms](#)
  - [Lego mindstorms kit](#) (approx. 15 kits available) [tutorial/more info]
  - [EV-shield Lego controller shield](#) (Control Lego motors and sensors via Arduino) [tutorial/more info]
- [Various displays and touch screens](#) [tutorial/more info]
- [Joystick module](#) [tutorial/more info]
- [Radio communication](#)
  - [HM10 BLE Bluetooth module](#) (warning: the Arduino Nano BLE which is in the base kit already has Bluetooth build-in) [tutorial/more info]
  - [RF Transceiver 2,4GHz NRF24L01+](#) [tutorial/more info]
- [GPS module Ublox NEO6MV2](#) [tutorial/more info]
- [RFID reader + card & dongle](#) [tutorial/more info]
- [Sensors:](#)
  - [TCS3200 color sensor](#) [tutorial/more info]
  - [Infrared distance sensor](#) [tutorial/more info]
- [Power:](#)
  - [Breadboard power module](#) [tutorial/more info]
  - [9V battery clips](#) [tutorial/more info]
  - [Various battery holders](#) [tutorial/more info]

Tutorials & more info

## Check out what is in the kit here

(you do not have to fill in the checklist now, that must be done when you return it)

Page with electronics kit contents also lists components that can be borrowed!

## Available tools

Apart from the tools available in the workshops and in the Design lab, you may use/borrow the following

- [JBC Weidinger Soldering station BT-2SWA](#), adjustable temperature range 100-450 C



# WHAT ELSE CAN YOU USE?

THERE IS MORE...

→ kit to be returned July 5<sup>th</sup>  
→ returning the kit is a condition to receive your grade!

- [Check out what is in the kit here](#)

(you do not have to fill in the checklist now, that must be done when you return it)

Page with electronics kit contents also lists components that can be borrowed!

- Buy your own components
- Borrow components from Fjodor:
  - **Raspberry PI Pico**
  - Motor's, servos
  - Mp3 module, speakers
  - Various displays

Available in limited numbers!

- And more: [see second half of checklist page of the kit](#)

# GETTING THE ELECTRONICS KIT

---

Do you need a kit?

- Yes: if you are a regular student (doing project + EL + APPDEV courses)
- Yes: if you are repeating or doing (parts) of this module
- **Exceptions: kit **not** needed if you passed\***:
  - Arduino-assignments of APPDEV +
  - Lab-sessions of Electronics +
  - Project

[What is in the Electronics kit?](#)  
[Check it here](#)



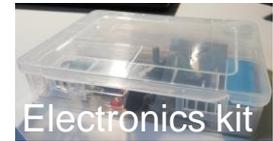
\* Passed means: you did this AND received a sufficient grade for it

# GETTING THE ELECTRONICS KIT

---

- It is strongly recommended to **do today's practical here, in the lecture room:**
- Then you can check components
- Defective or missing? We have replacements!
- Getting help here is easier
  
- **This kit has a value of approx. €60**, please handle it with care and make sure it is returned in good condition at the end of the module!

[What is in the Electronics kit?](#)  
[Check it here](#)



# PRACTICAL ASSIGNMENT

## DISTANCE SENSOR WITH ALARM

- Do assignment today or next session: deadline Friday May 13
- Hand-in Arduino project on Canvas with a video demo
- In the video, demonstrate the circuit you built & the code
- Assignment is a step-by-step tutorial
- It's On Canvas: "AppDev Practical Assignment 1: build a distance sensor"

Practicals count towards the grade just like any other assignment.  
More on grading [in the FAQ](#).



Electronics kit

[Check out what is in the kit here](#)