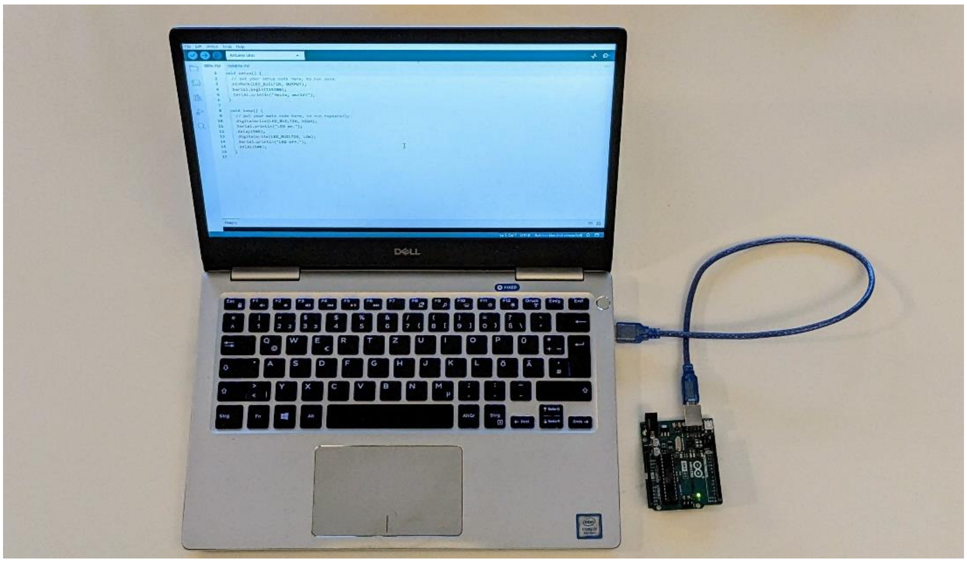
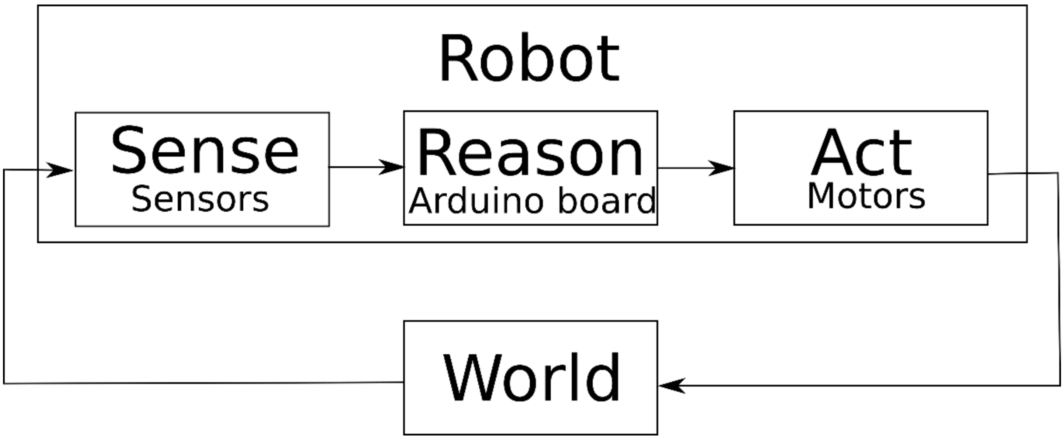
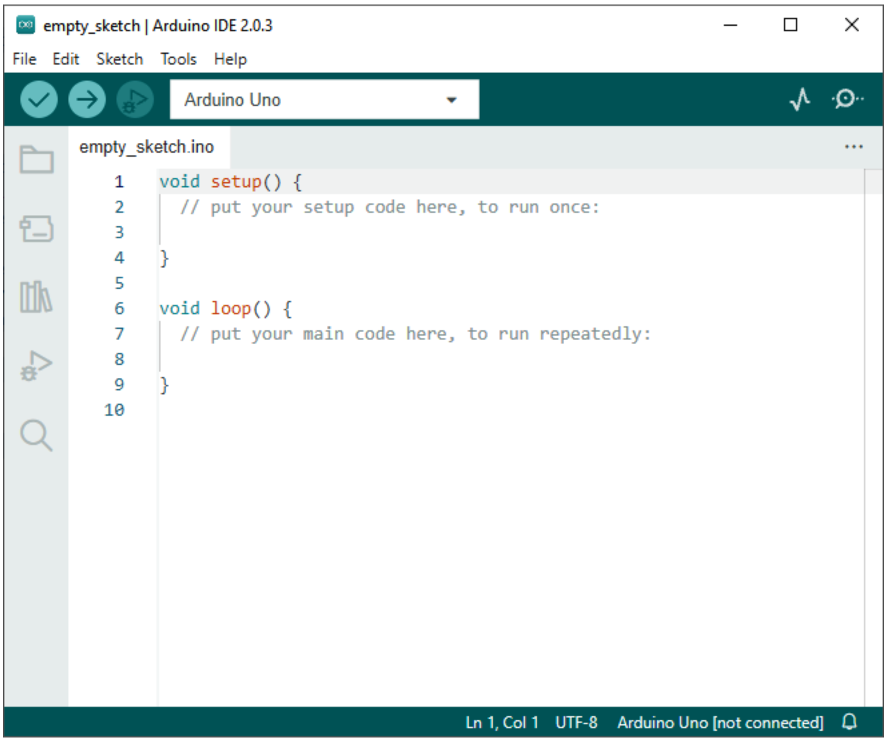
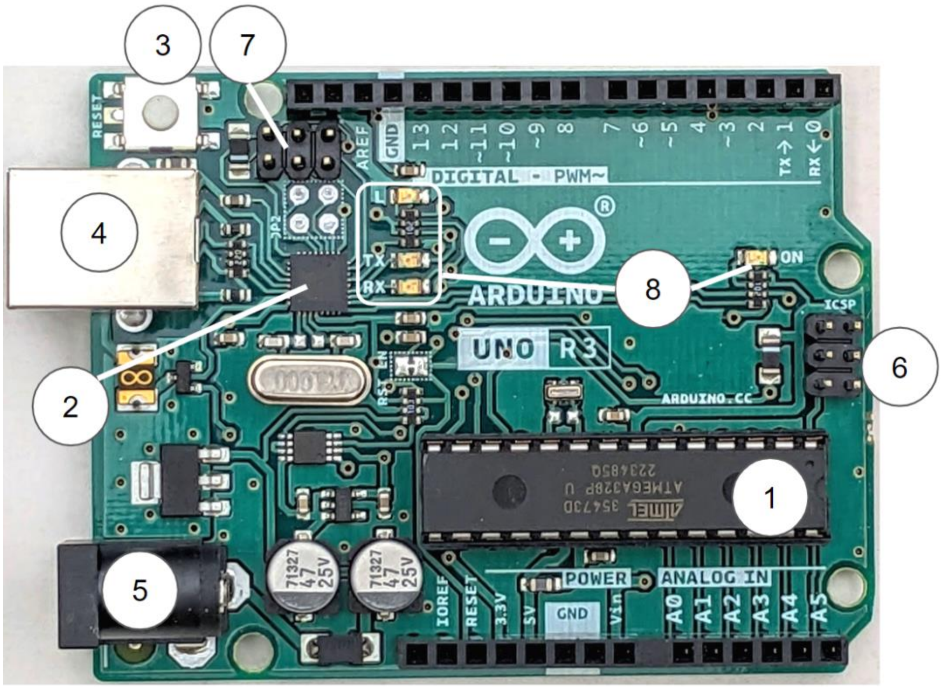
Chapter 1: Introducing Robotics and the Arduino Ecosystem

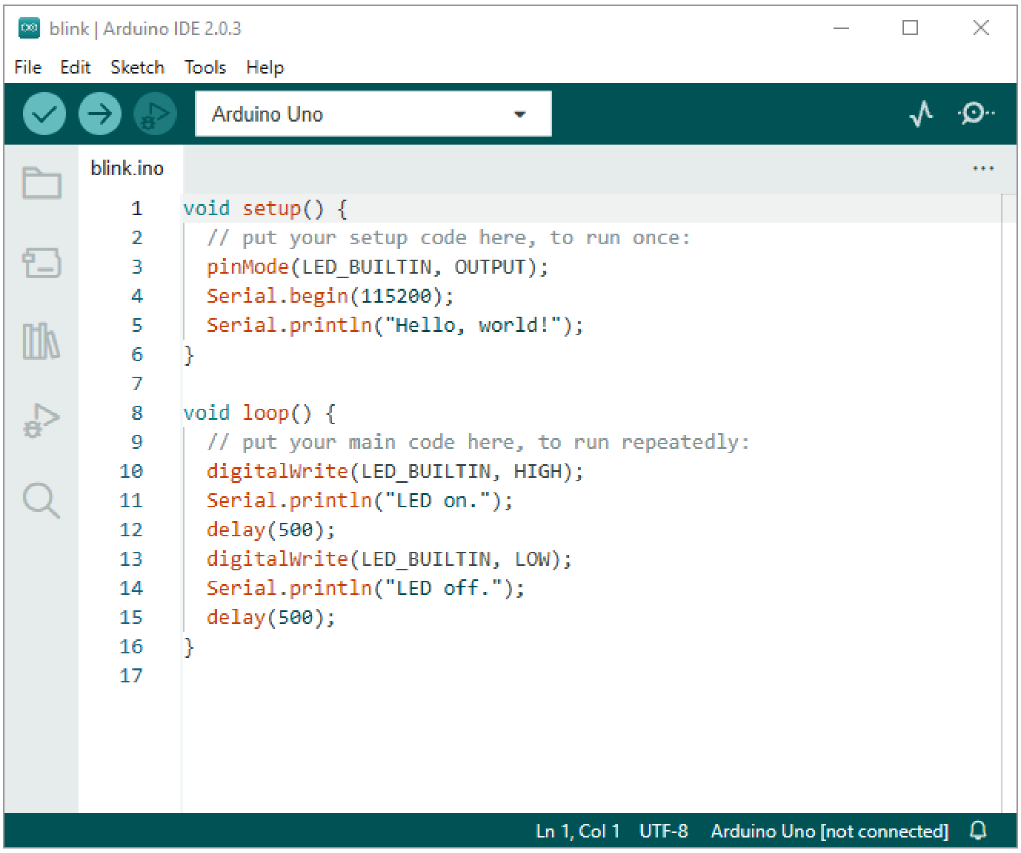




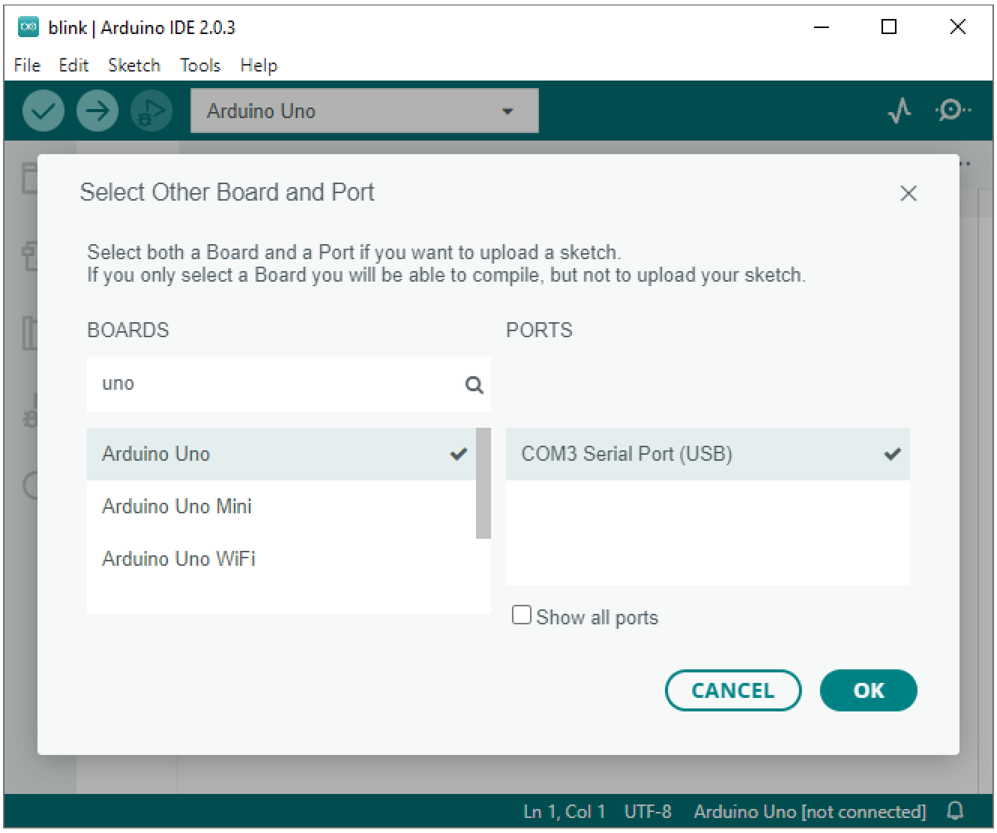

empty_sketch | Arduino IDE 2.0.3
File Edit Sketch Tools Help
Arduino Uno
empty_sketch.ino
Ln 1, Col 1 UTF-8 Arduino Uno [not connected]

```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}

```





```
void setup() {
  // put your setup code here, to run once:
  pinMode(LED_BUILTIN, OUTPUT);
  Serial.begin(115200);
  Serial.println("Hello, world!");
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(LED_BUILTIN, HIGH);
  Serial.println("LED on.");
  delay(500);
  digitalWrite(LED_BUILTIN, LOW);
  Serial.println("LED off.");
  delay(500);
}
```



Select Other Board and Port

Select both a Board and a Port if you want to upload a sketch.
If you only select a Board you will be able to compile, but not to upload your sketch.

BOARDS

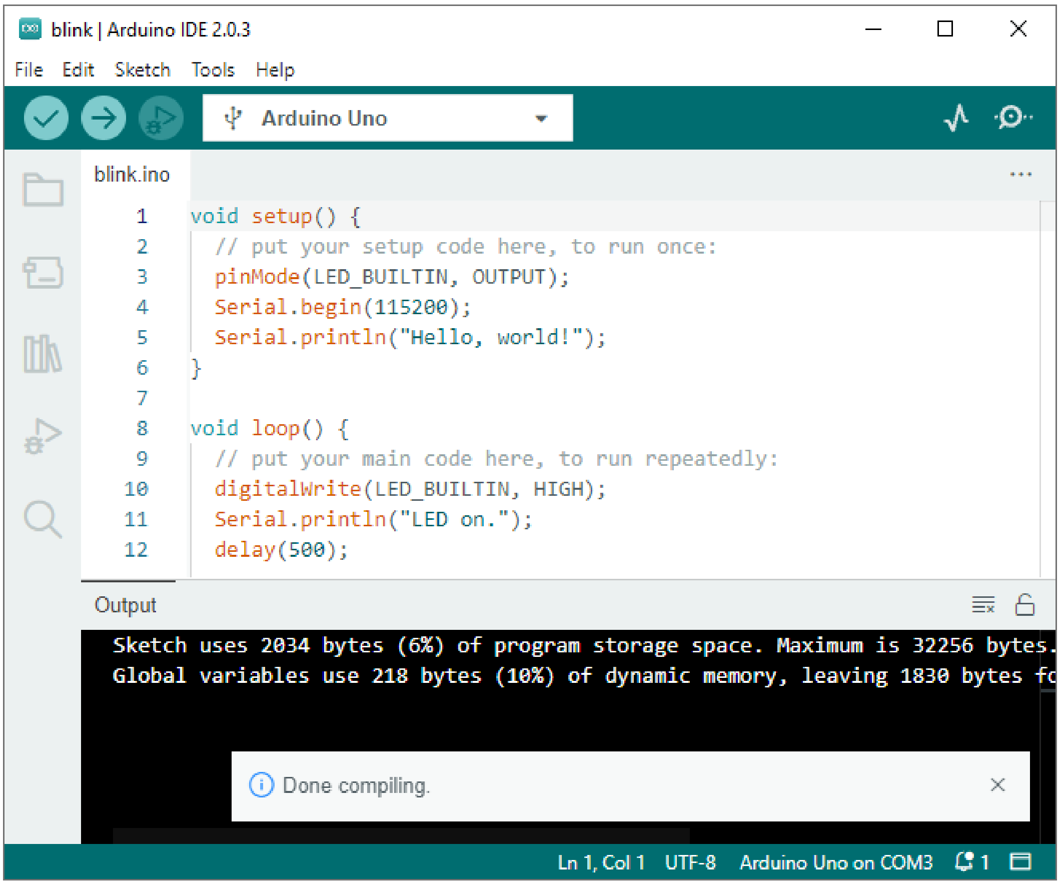
uno

- Arduino Uno ✓
- Arduino Uno Mini
- Arduino Uno WiFi

PORTS

- COM3 Serial Port (USB) ✓

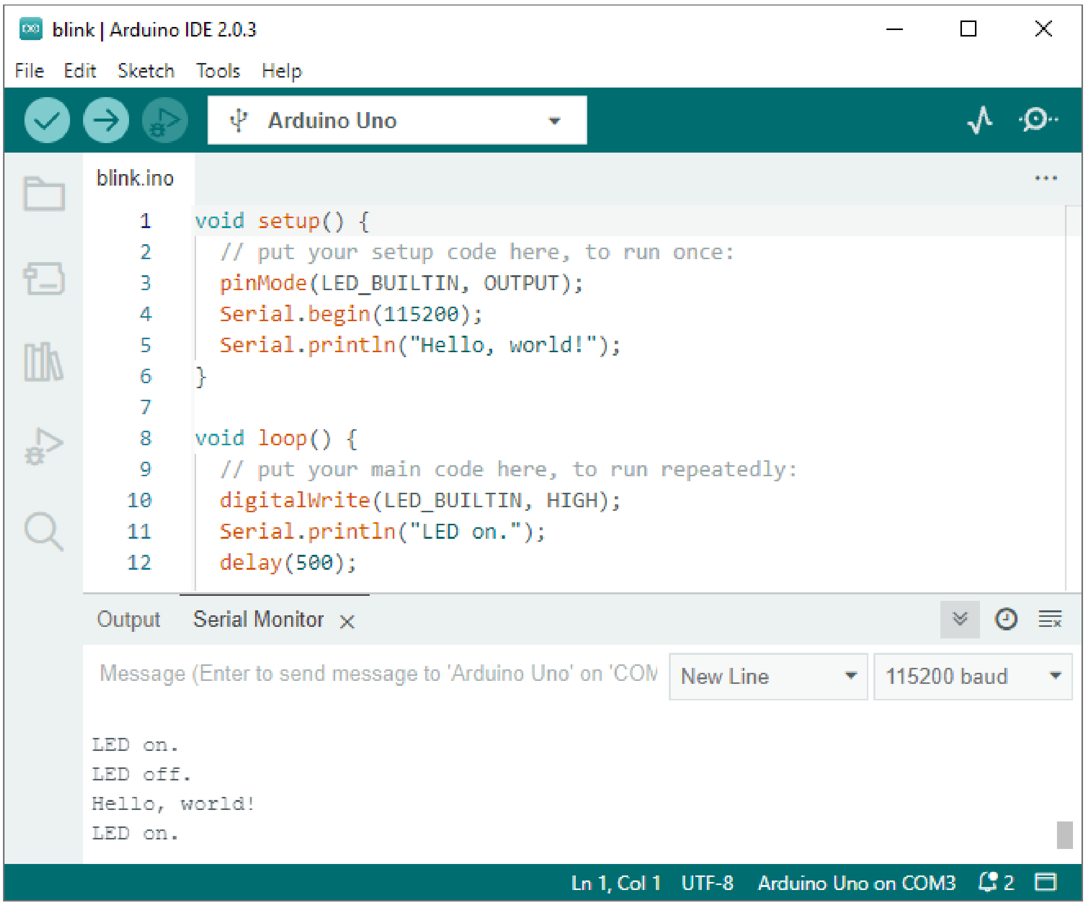
□ Show all ports


blink | Arduino IDE 2.0.3
File Edit Sketch Tools Help
Arduino Uno
blink.ino
Output
Ln 1, Col 1 UTF-8 Arduino Uno on COM3 1

```
void setup() {
  // put your setup code here, to run once:
  pinMode(LED_BUILTIN, OUTPUT);
  Serial.begin(115200);
  Serial.println("Hello, world!");
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(LED_BUILTIN, HIGH);
  Serial.println("LED on.");
  delay(500);
```

```
Sketch uses 2034 bytes (6%) of program storage space. Maximum is 32256 bytes.
Global variables use 218 bytes (10%) of dynamic memory, leaving 1830 bytes fo
```

Done compiling.


blink | Arduino IDE 2.0.3
File Edit Sketch Tools Help
Arduino Uno
blink.ino
Output
Serial Monitor
Ln 1, Col 1 UTF-8 Arduino Uno on COM3 2

```
void setup() {
  // put your setup code here, to run once:
  pinMode(LED_BUILTIN, OUTPUT);
  Serial.begin(115200);
  Serial.println("Hello, world!");
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(LED_BUILTIN, HIGH);
  Serial.println("LED on.");
  delay(500);
```

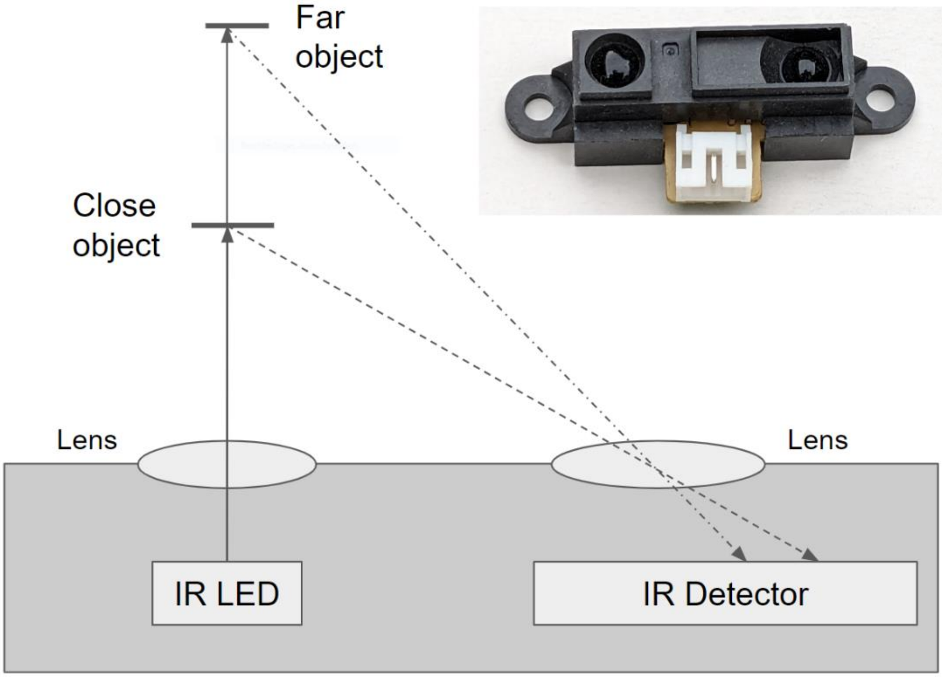
Message (Enter to send message to 'Arduino Uno' on 'COM

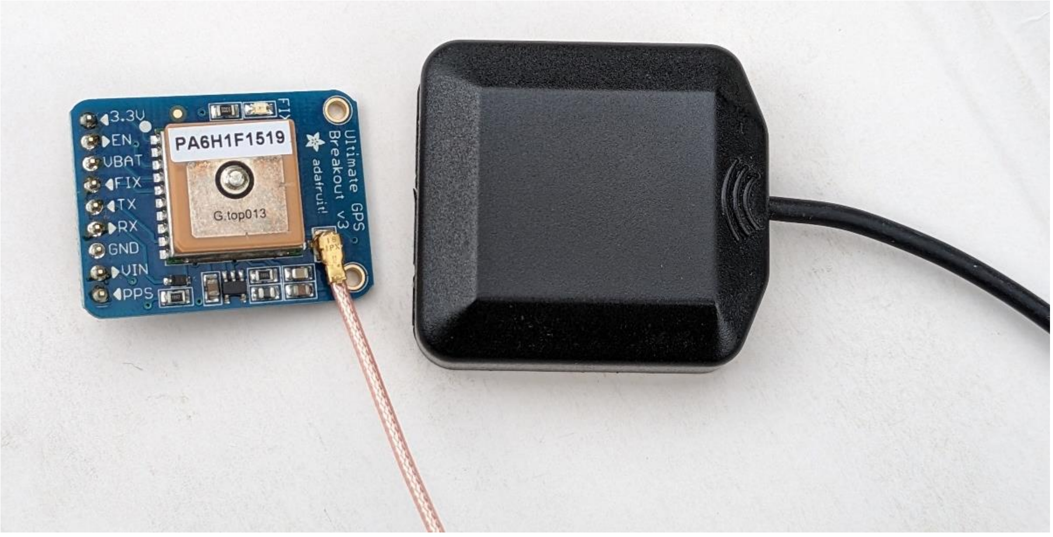
New Line

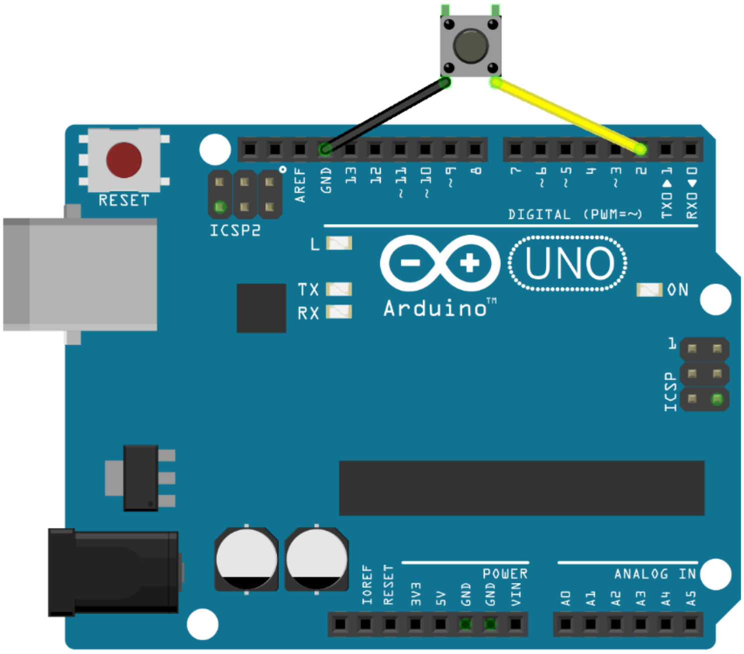
115200 baud

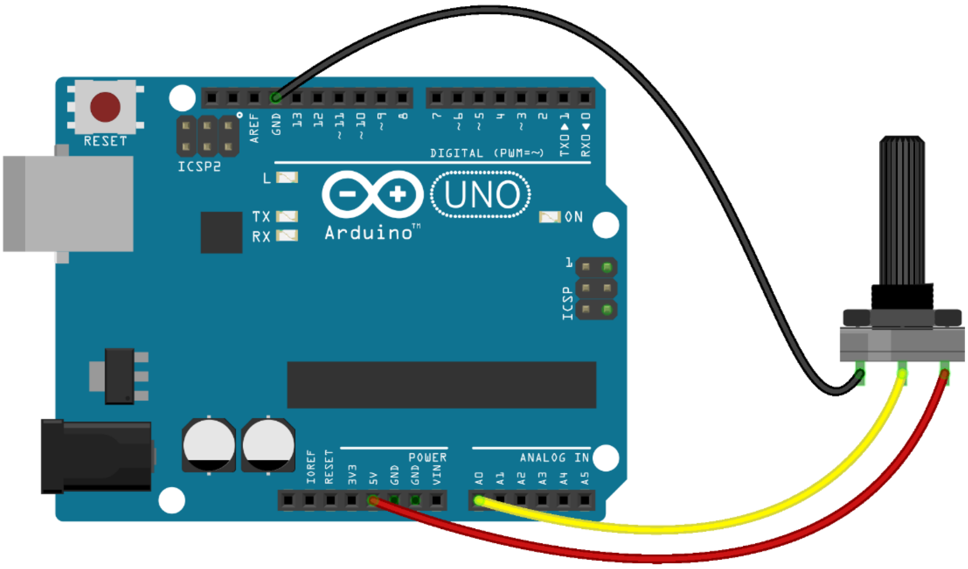
```
LED on.
LED off.
Hello, world!
LED on.
```

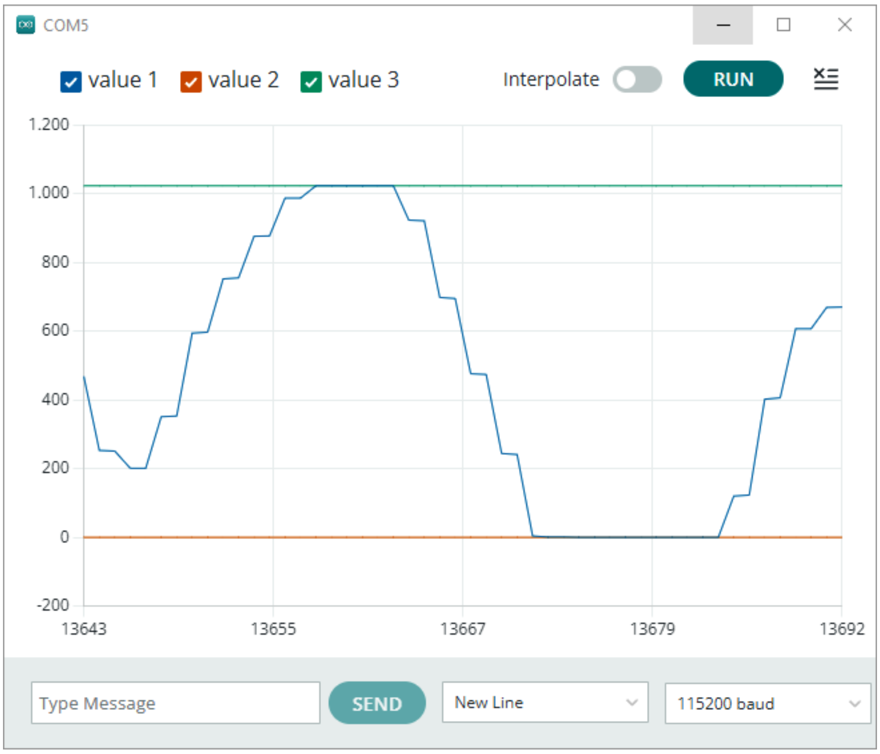
Chapter 2: Making Robots Perceive the World with Sensors

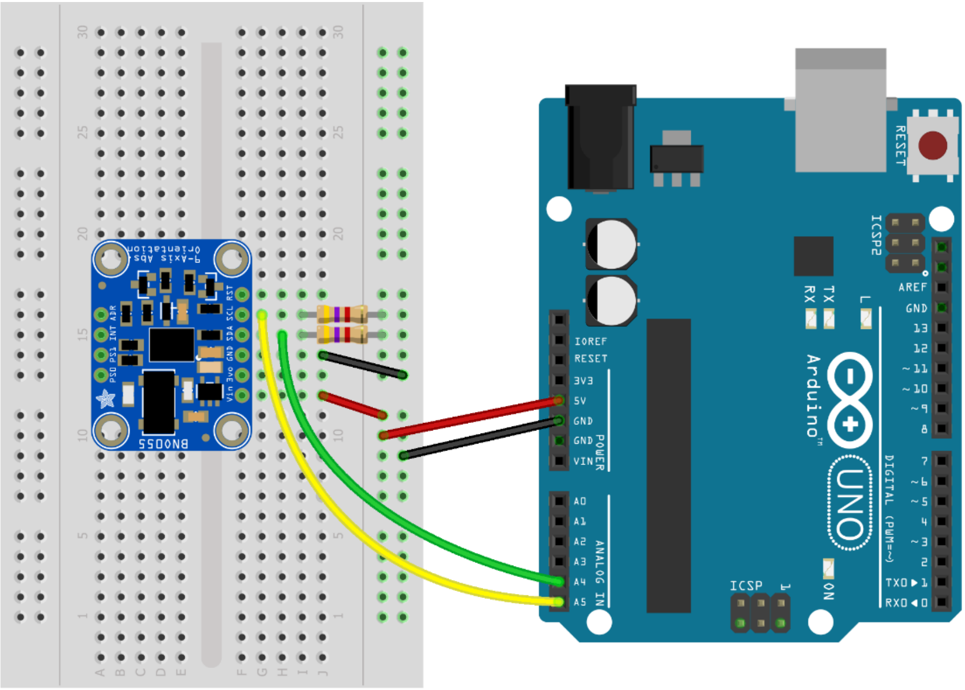


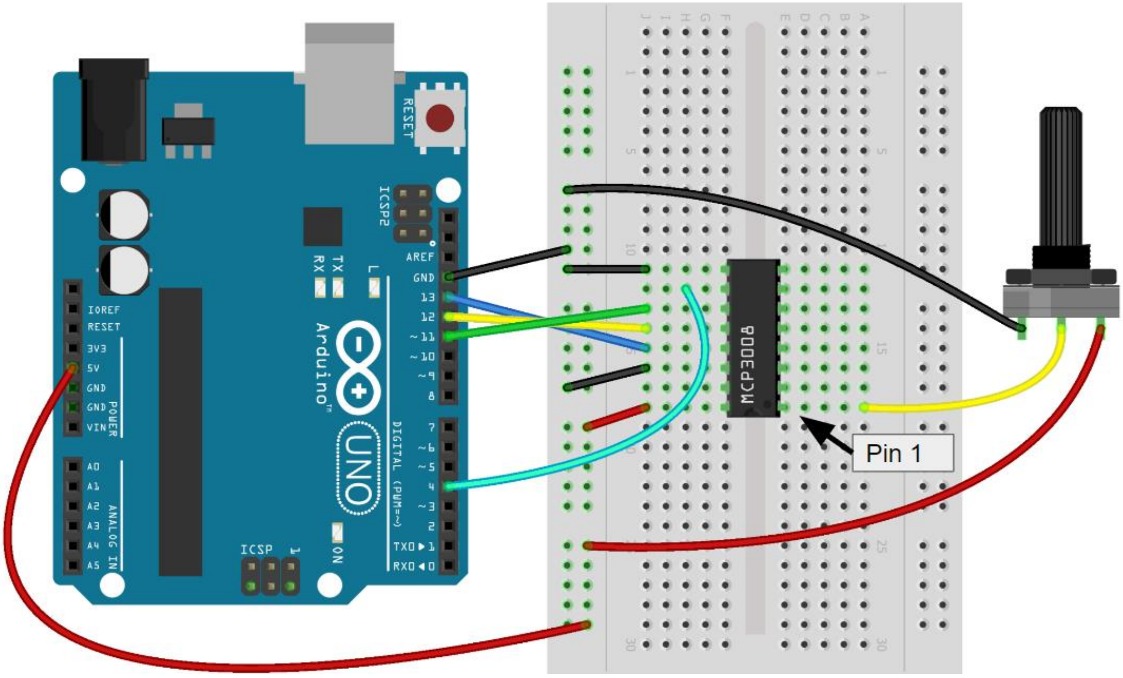


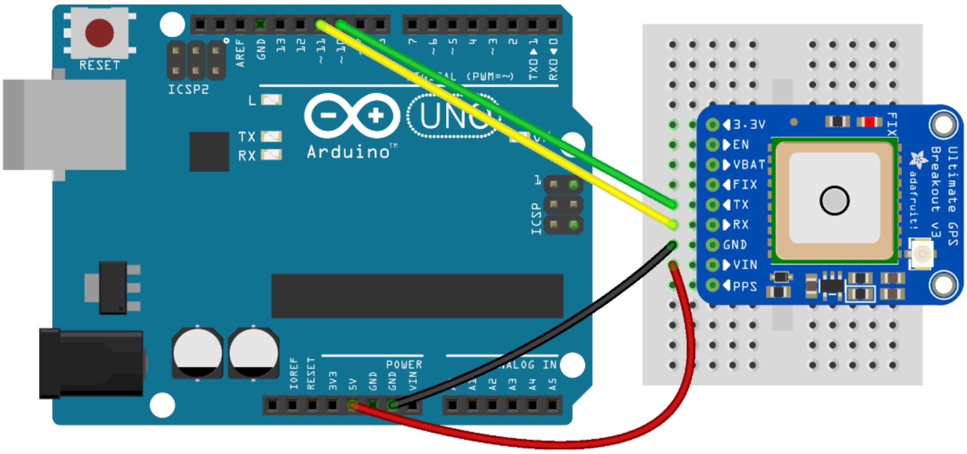

RESET
ICSP2
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX▶1
RX◀0
DIGITAL (PWM=~)
L
TX
RX
Arduino™
UNO
ON
1
ICSP
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
ANALOG IN
A0
A1
A2
A3
A4
A5

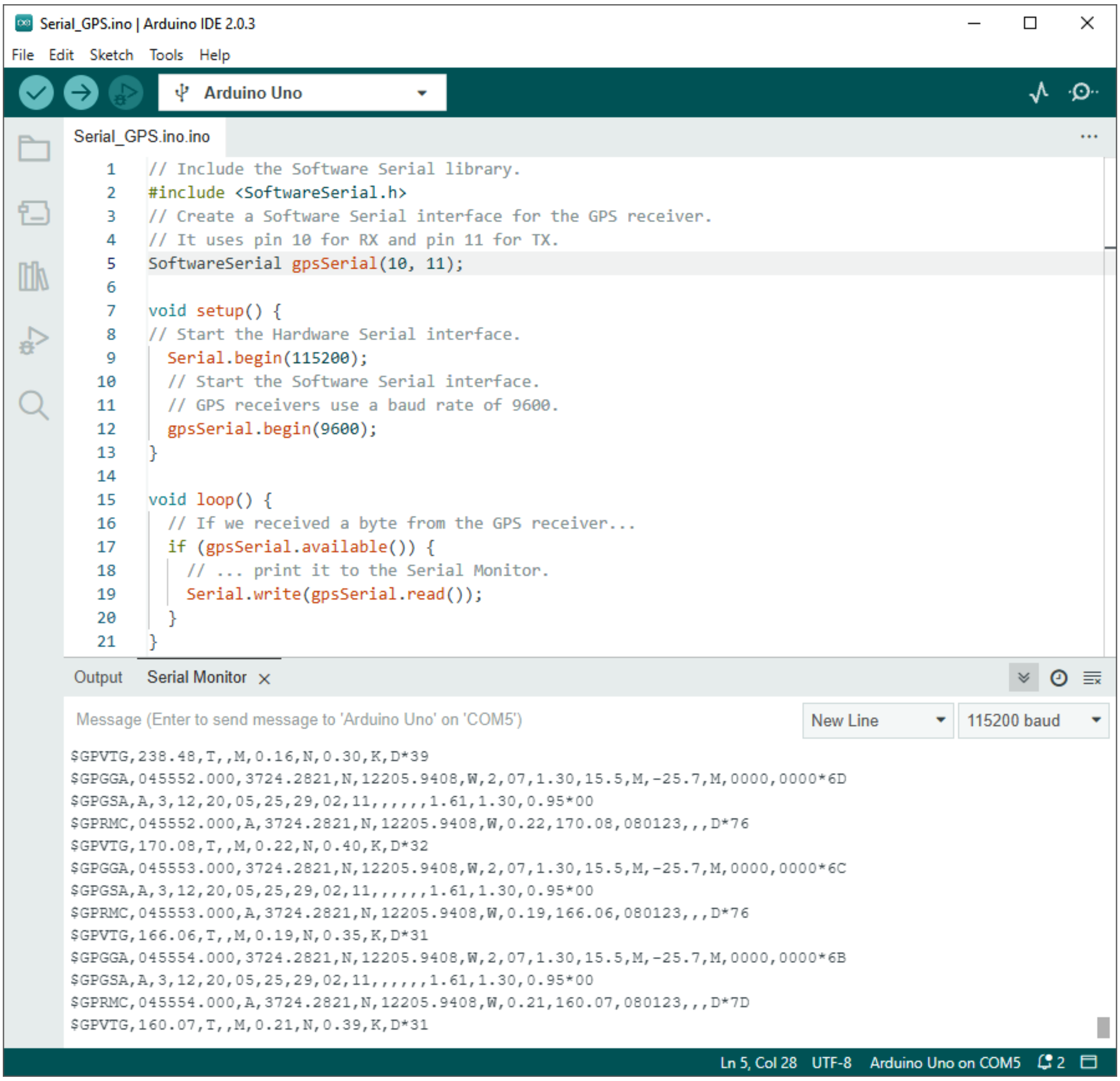

RESET
ICSP2
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX▶1
RX◀0
DIGITAL (PWM=~)
L
TX
RX
Arduino™
UNO
ON
1
ICSP
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
ANALOG IN
A0
A1
A2
A3
A4
A5


COM5
☑ value 1
☑ value 2
☑ value 3
Interpolate
RUN
1.200
1.000
800
600
400
200
0
-200
13643
13655
13667
13679
13692
Type Message
SEND
New Line
115200 baud


9-Axis Abs Orientation
BNO055
Vin 3vo GND SDA SCL RST
PS0 PS1 INT ADR
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
Arduino
UNO
RESET
ICSP2
ICSP
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX▶1
RX◀0
DIGITAL (PWM=~)
TX
RX
L
ON


MCP3008
Pin 1
Arduino
UNO
RESET
ICSP2
AREF
GND
DIGITAL (PWM=~)
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
A0
A1
A2
A3
A4
A5
ANALOG IN
ICSP
ON
TX
RX
L

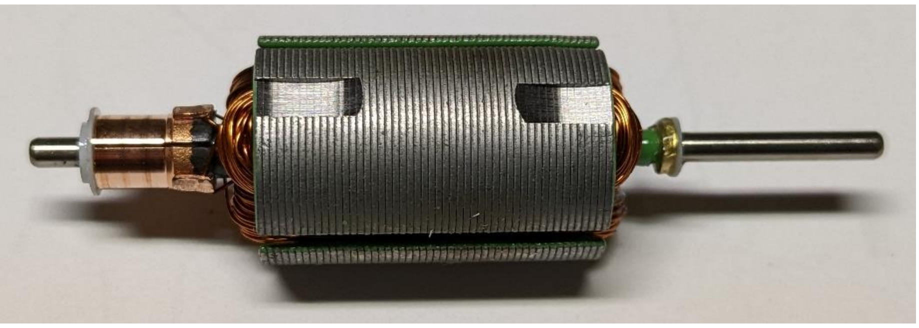

RESET
ICSP2
Arduino
UNO
TX
RX
L
ICSP
POWER
ANALOG IN
3.3V
EN
VBAT
FIX
TX
RX
GND
VIN
PPS
Ultimate GPS Breakout v3
adafruit!

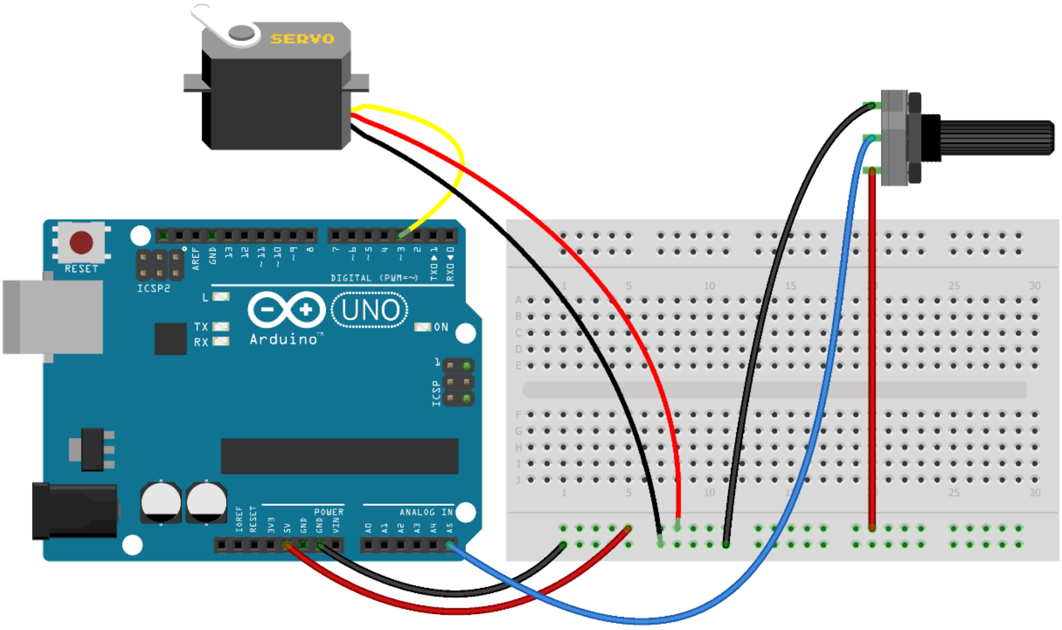


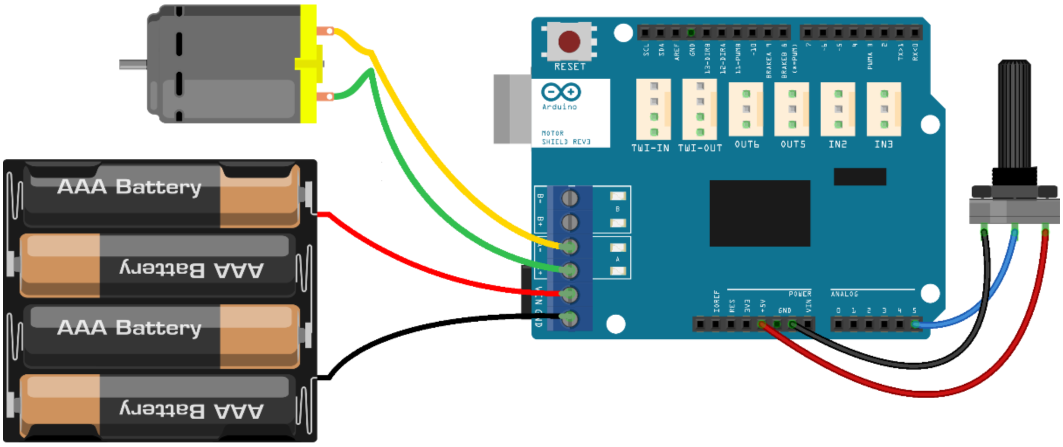
```
// Include the Software Serial library.
#include <SoftwareSerial.h>
// Create a Software Serial interface for the GPS receiver.
// It uses pin 10 for RX and pin 11 for TX.
SoftwareSerial gpsSerial(10, 11);

void setup() {
// Start the Hardware Serial interface.
  Serial.begin(115200);
  // Start the Software Serial interface.
  // GPS receivers use a baud rate of 9600.
  gpsSerial.begin(9600);
}

void loop() {
  // If we received a byte from the GPS receiver...
  if (gpsSerial.available()) {
    // ... print it to the Serial Monitor.
    Serial.write(gpsSerial.read());
  }
}
```

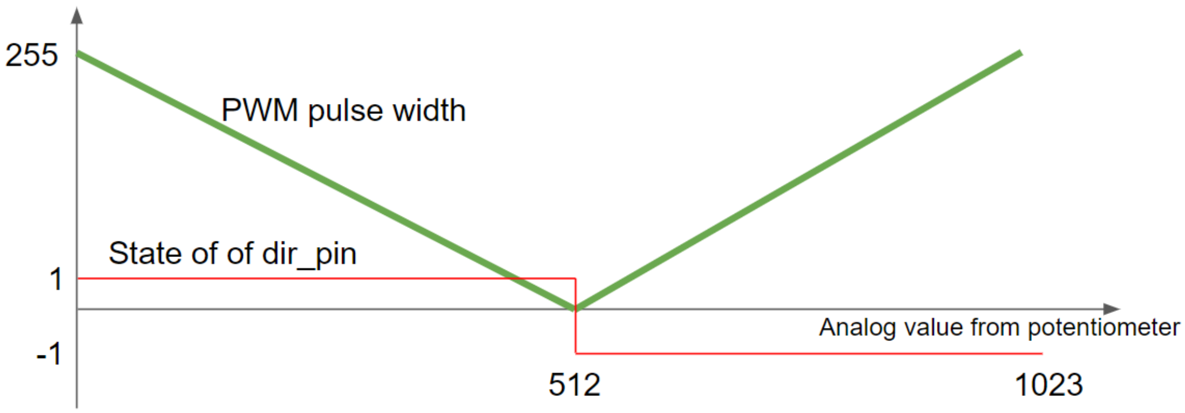
```
$GPVTG,238.48,T,,M,0.16,N,0.30,K,D*39
$GPGGA,045552.000,3724.2821,N,12205.9408,W,2,07,1.30,15.5,M,-25.7,M,0000,0000*6D
$GPGSA,A,3,12,20,05,25,29,02,11,,,,,,1.61,1.30,0.95*00
$GPRMC,045552.000,A,3724.2821,N,12205.9408,W,0.22,170.08,080123,,,D*76
$GPVTG,170.08,T,,M,0.22,N,0.40,K,D*32
$GPGGA,045553.000,3724.2821,N,12205.9408,W,2,07,1.30,15.5,M,-25.7,M,0000,0000*6C
$GPGSA,A,3,12,20,05,25,29,02,11,,,,,,1.61,1.30,0.95*00
$GPRMC,045553.000,A,3724.2821,N,12205.9408,W,0.19,166.06,080123,,,D*76
$GPVTG,166.06,T,,M,0.19,N,0.35,K,D*31
$GPGGA,045554.000,3724.2821,N,12205.9408,W,2,07,1.30,15.5,M,-25.7,M,0000,0000*6B
$GPGSA,A,3,12,20,05,25,29,02,11,,,,,,1.61,1.30,0.95*00
$GPRMC,045554.000,A,3724.2821,N,12205.9408,W,0.21,160.07,080123,,,D*7D
$GPVTG,160.07,T,,M,0.21,N,0.39,K,D*31
```

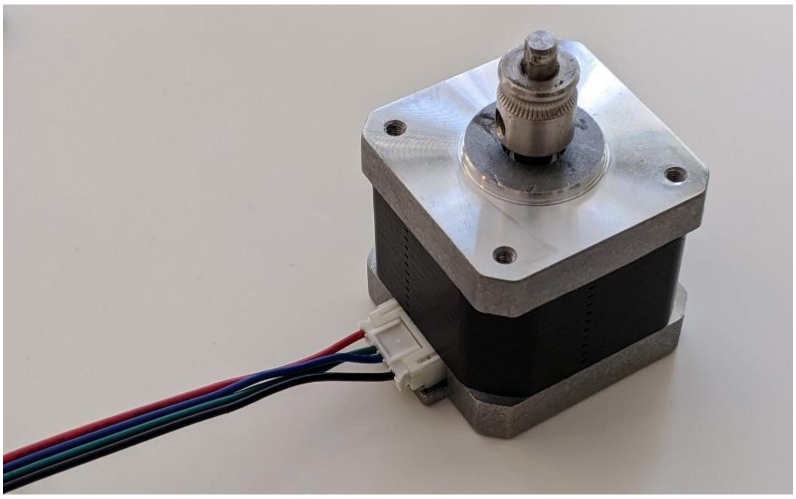
Chapter 3: Making Your Robot Move and Interact with the World with Actuators

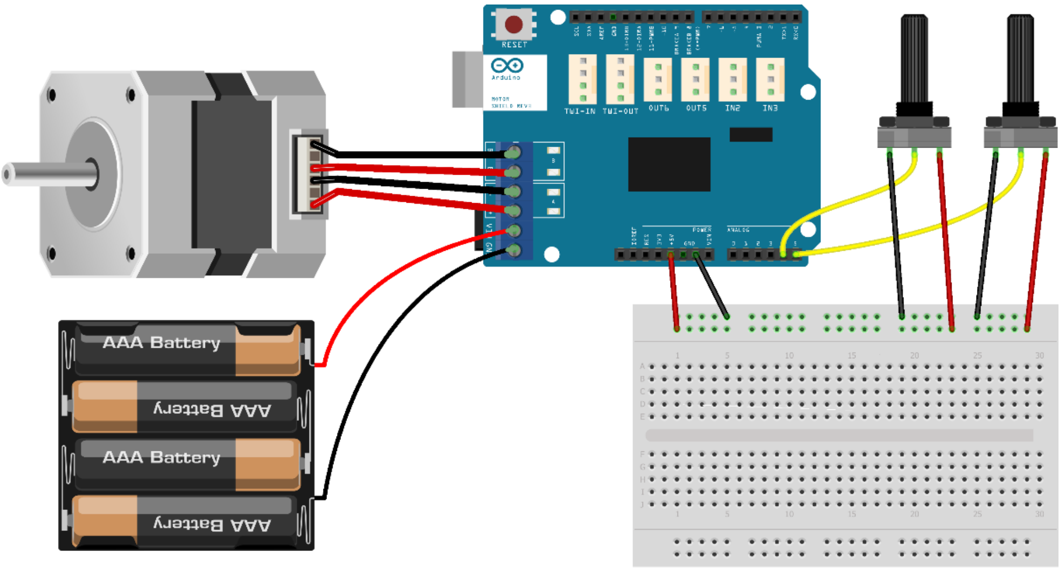


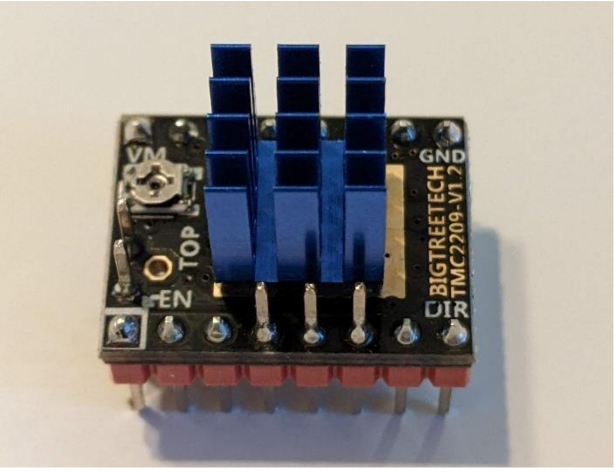




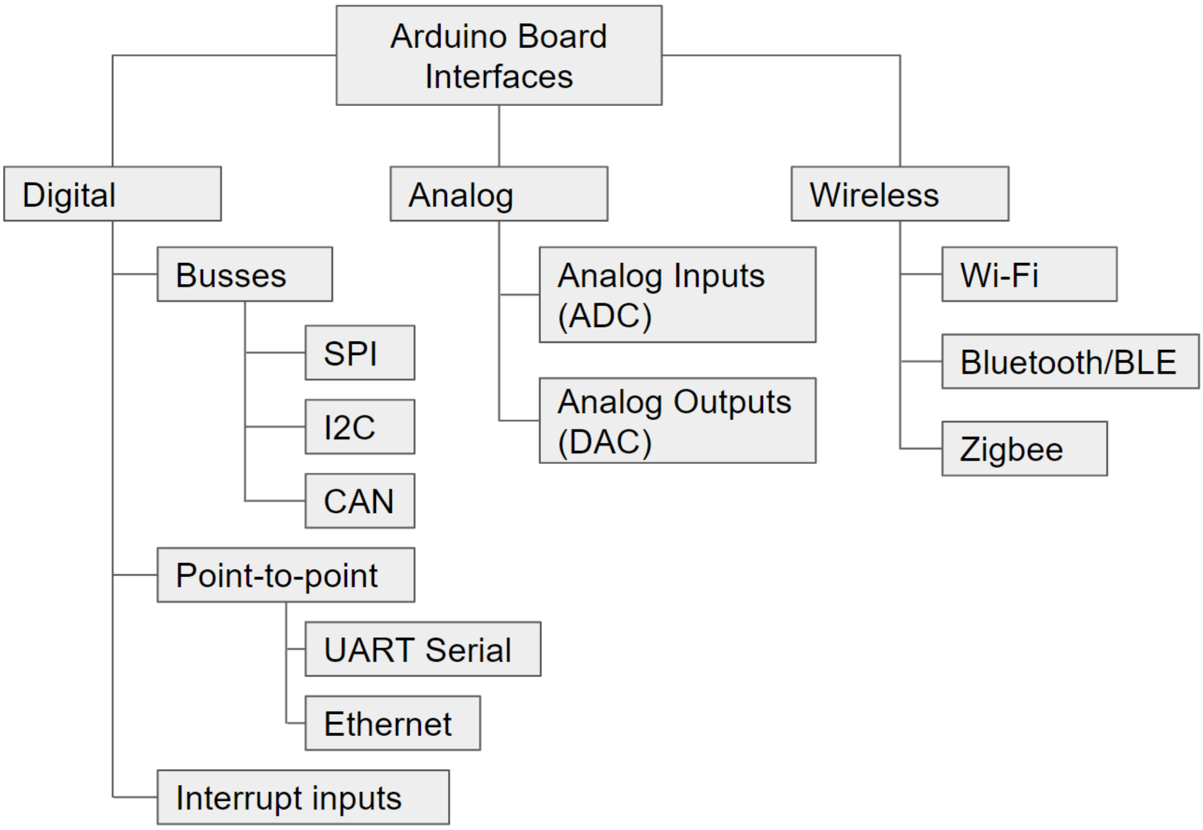

255
PWM pulse width
State of of dir_pin
1
-1
Analog value from potentiometer
512
1023

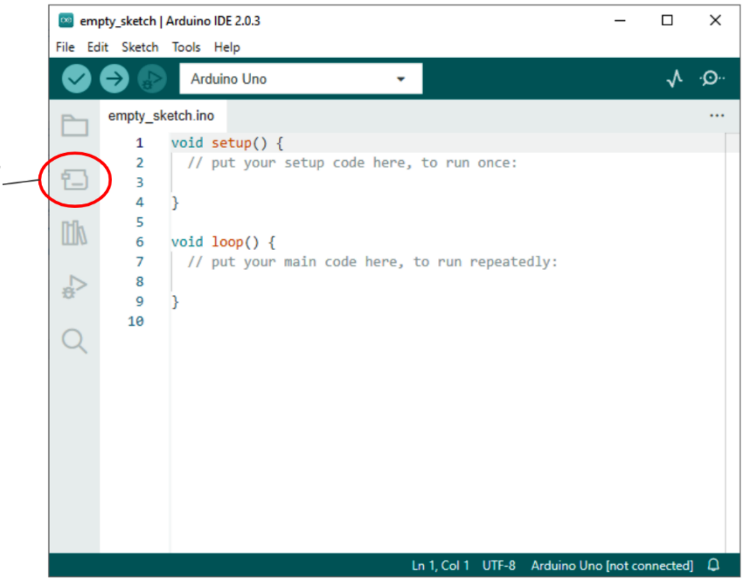



RESET
TWI-IN
TWI-OUT
OUT6
OUT5
IN2
IN3
AAA Battery
AAA Battery
AAA Battery
AAA Battery


VM
TOP
EN
GND
BIGTREETECH
TMC2209-V1.2
DIR

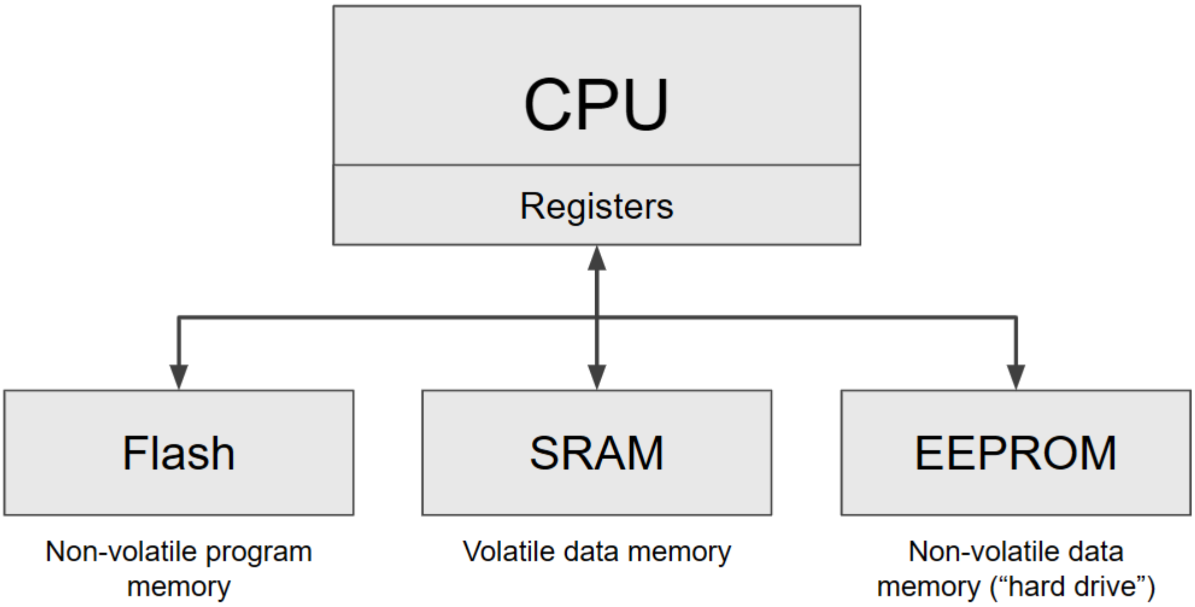
Chapter 4: Selecting the Right Arduino Board for Your Project

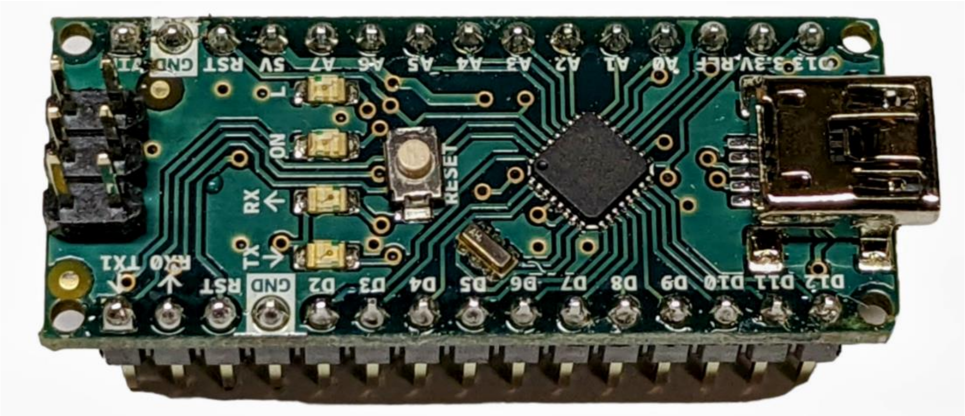


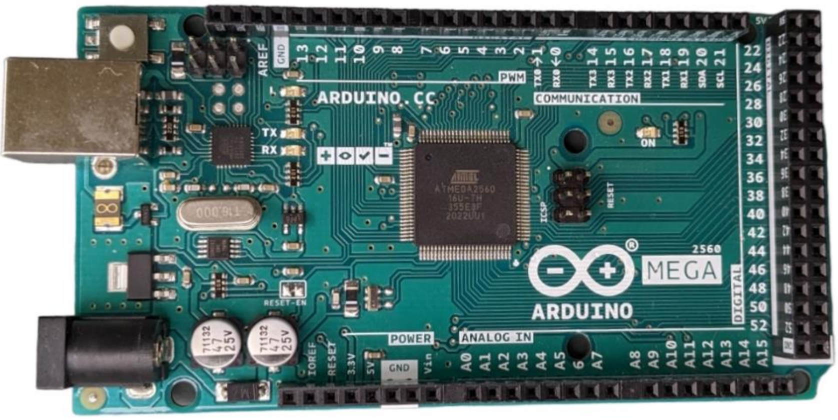

empty_sketch | Arduino IDE 2.0.3
File Edit Sketch Tools Help
Arduino Uno
empty_sketch.ino
Ln 1, Col 1 UTF-8 Arduino Uno [not connected]

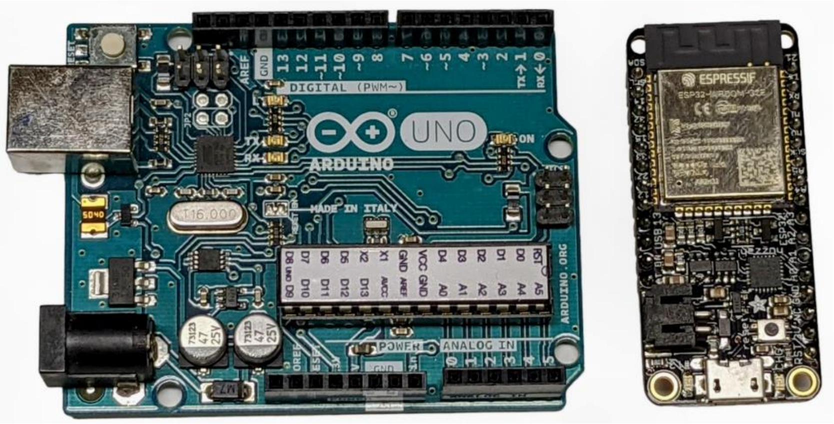
```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

Boards Manager icon


CPU
Registers
Flash
SRAM
EEPROM
Non-volatile program memory
Volatile data memory
Non-volatile data memory ("hard drive")


RESET
ON
RX
TX
L

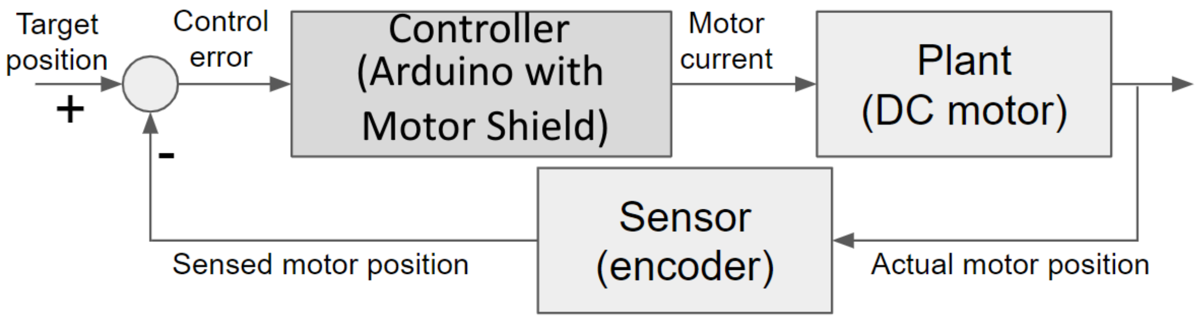

ARDUINO.CC
COMMUNICATION
PWM
ARDUINO
MEGA
2560
POWER
ANALOG IN
DIGITAL

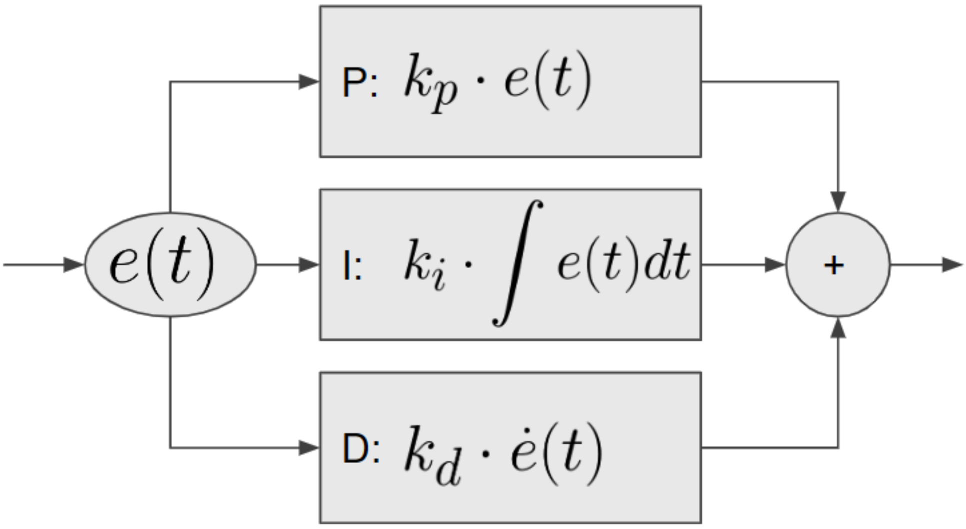


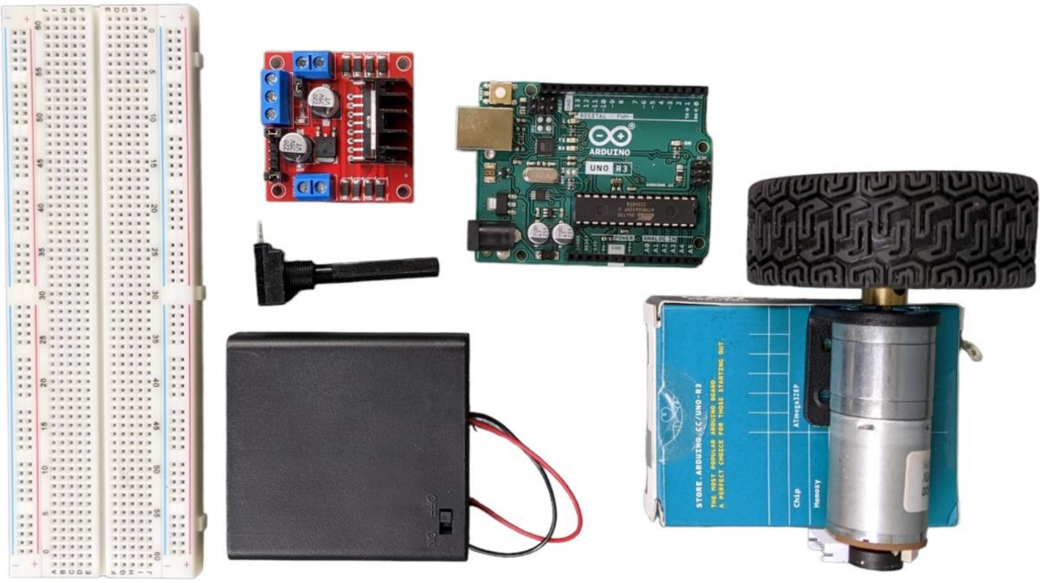
DIGITAL (PWM~)
UNO
ARDUINO
MADE IN ITALY
ARDUINO.ORG
POWER
ANALOG IN
ESPRESSIF

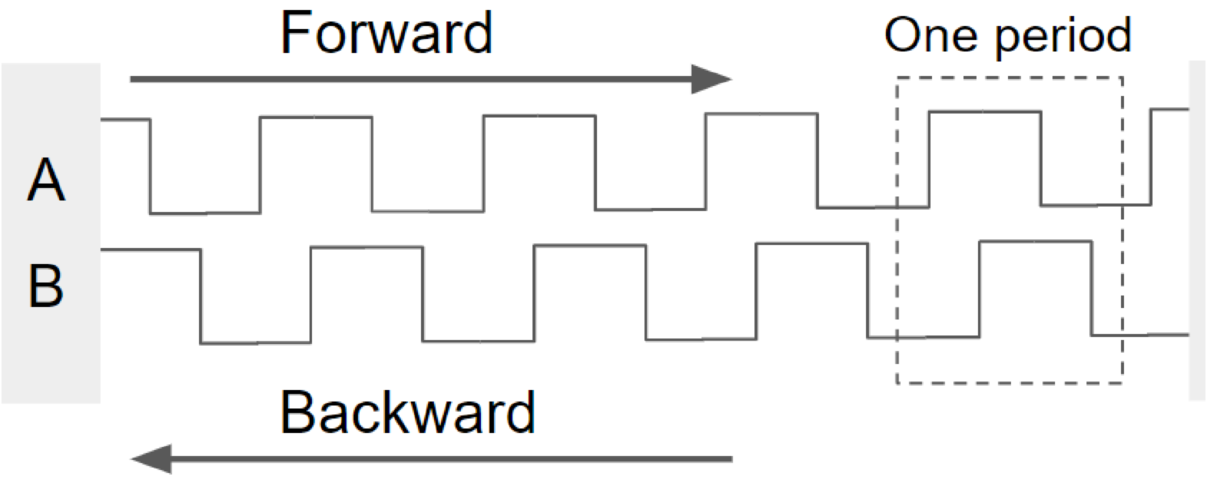
MK66FX1M0VMD18
0N65N
CTBP1952G

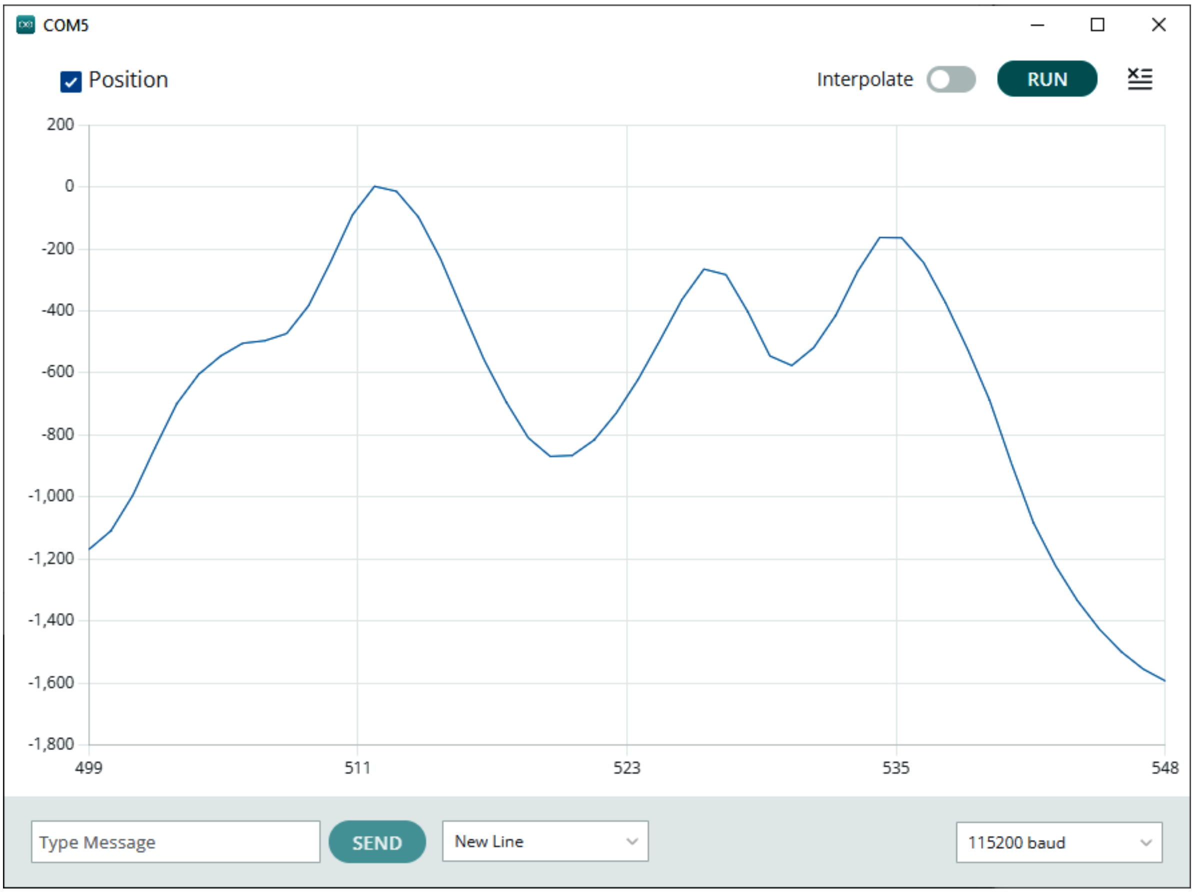
Chapter 5: Getting Started with Robot Programming

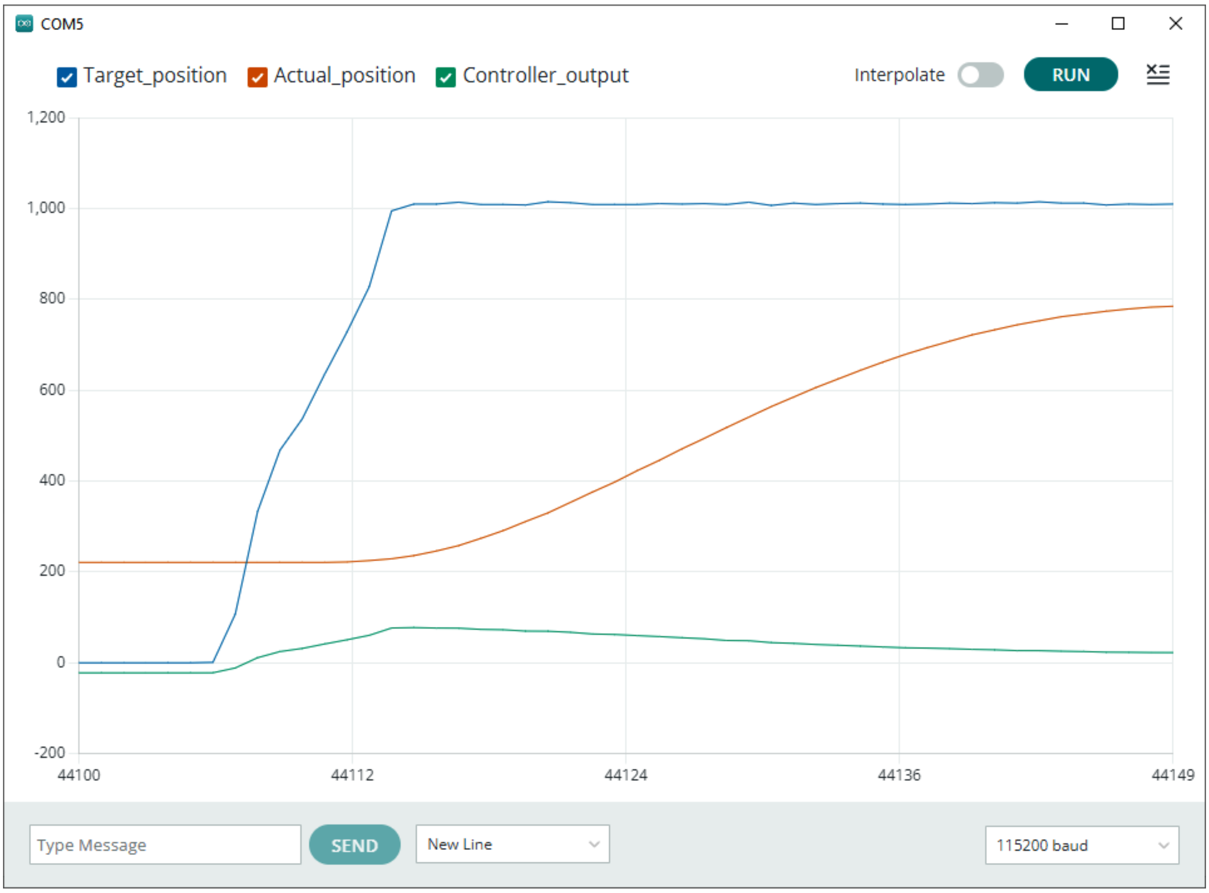


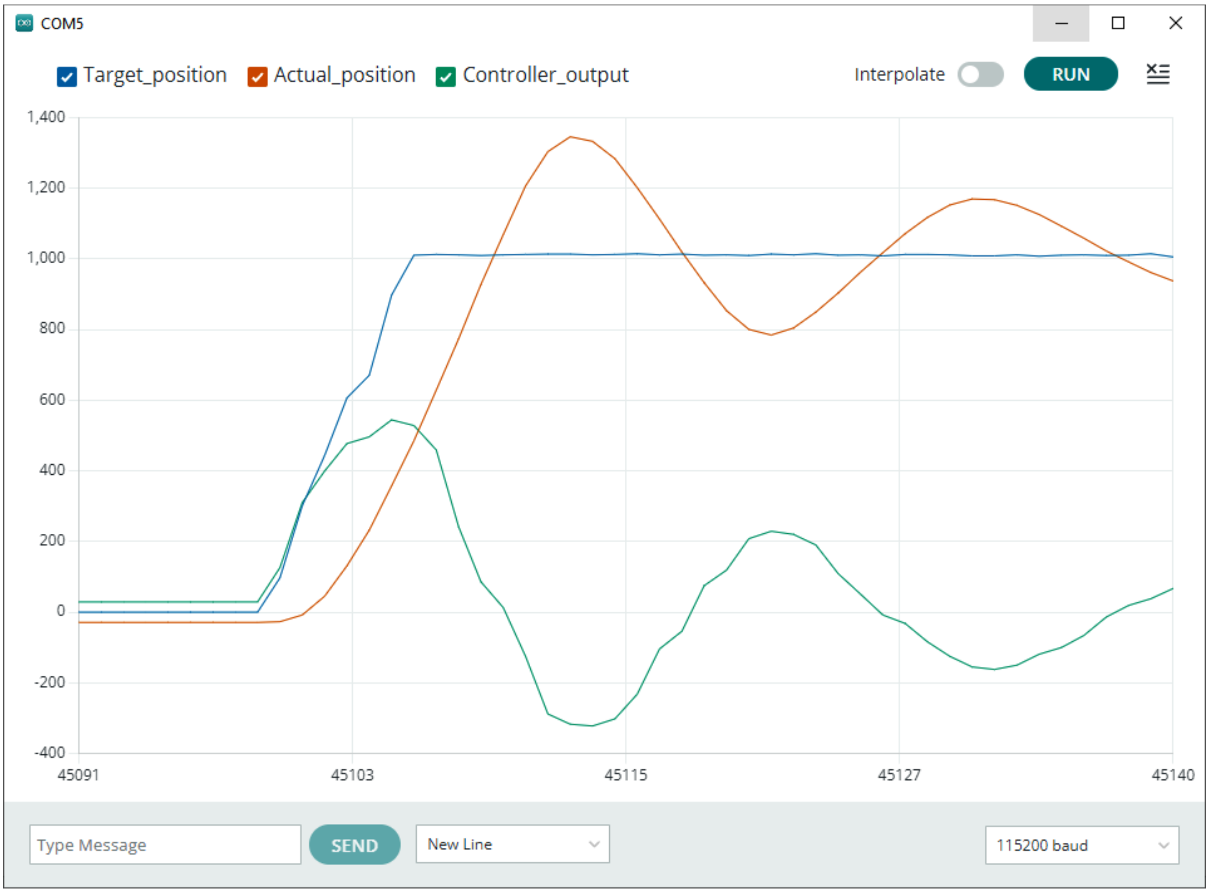


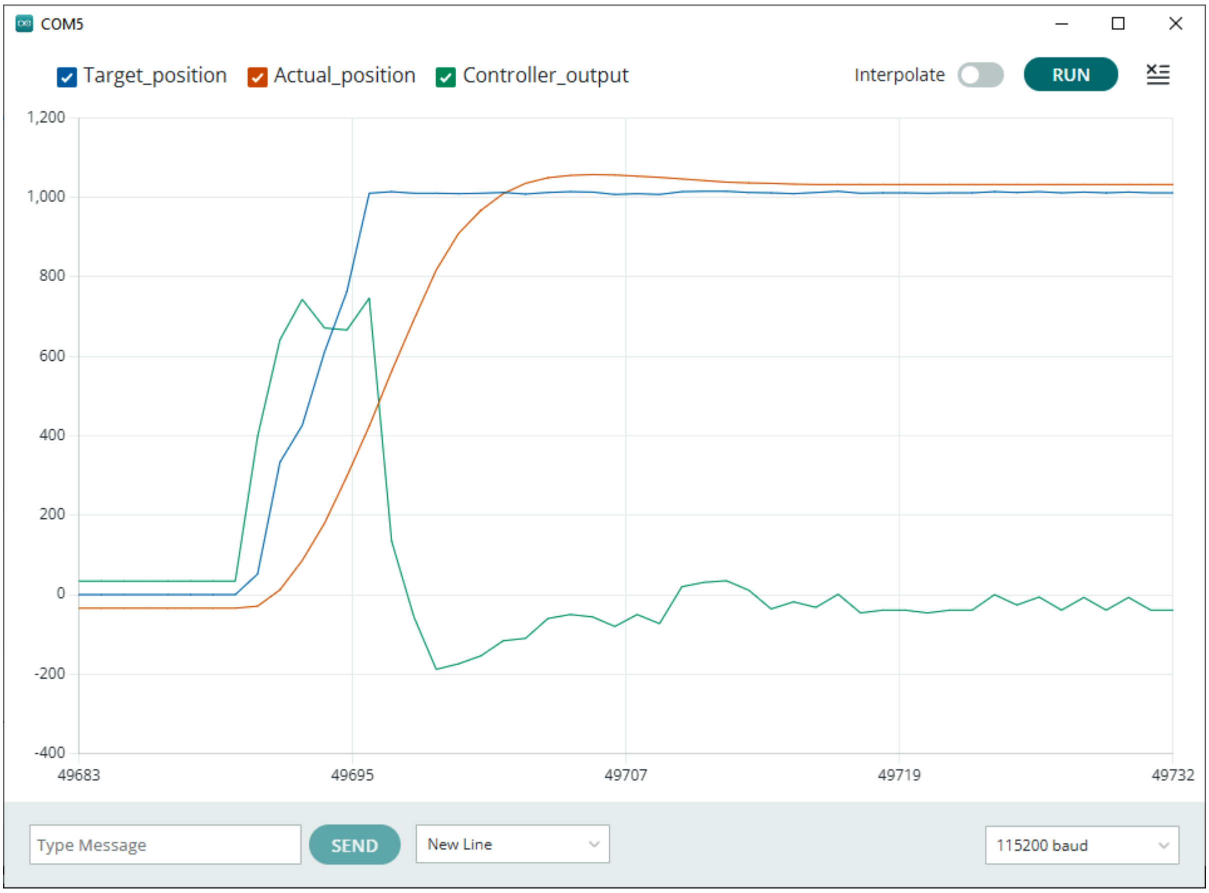



Forward
One period
A
B
Backward


COM5
☑ Position
Interpolate
RUN
200
0
-200
-400
-600
-800
-1,000
-1,200
-1,400
-1,600
-1,800
499
511
523
535
548
Type Message
SEND
New Line
115200 baud


COM5
☑ Target_position
☑ Actual_position
☑ Controller_output
Interpolate
RUN
1,200
1,000
800
600
400
200
0
-200
44100
44112
44124
44136
44149
Type Message
SEND
New Line
115200 baud

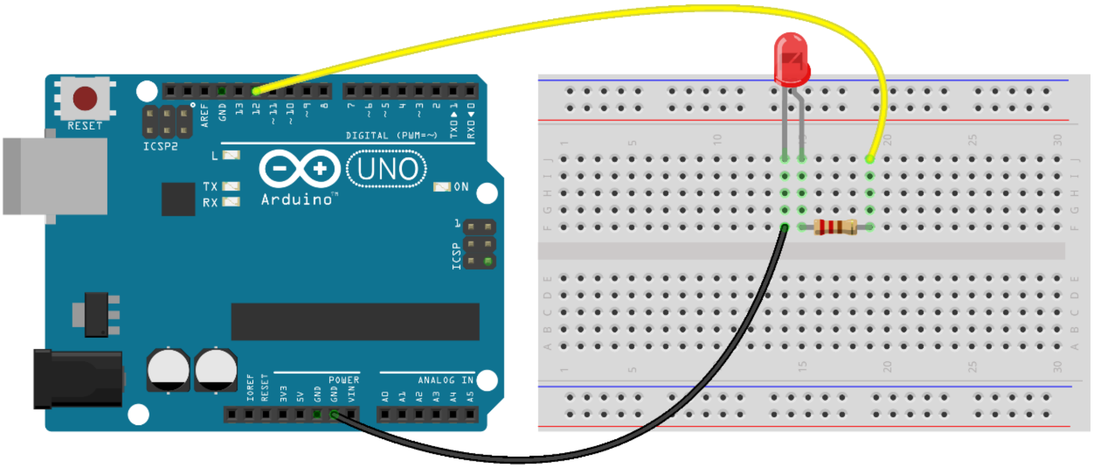

COM5
☑ Target_position
☑ Actual_position
☑ Controller_output
Interpolate
RUN
1,400
1,200
1,000
800
600
400
200
0
-200
-400
45091
45103
45115
45127
45140
Type Message
SEND
New Line
115200 baud

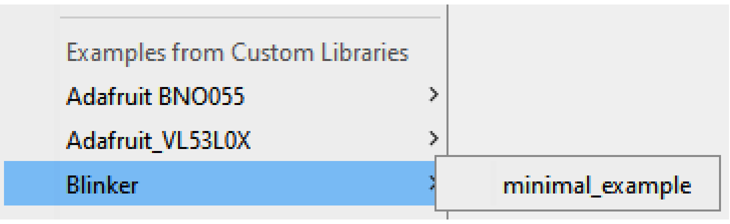


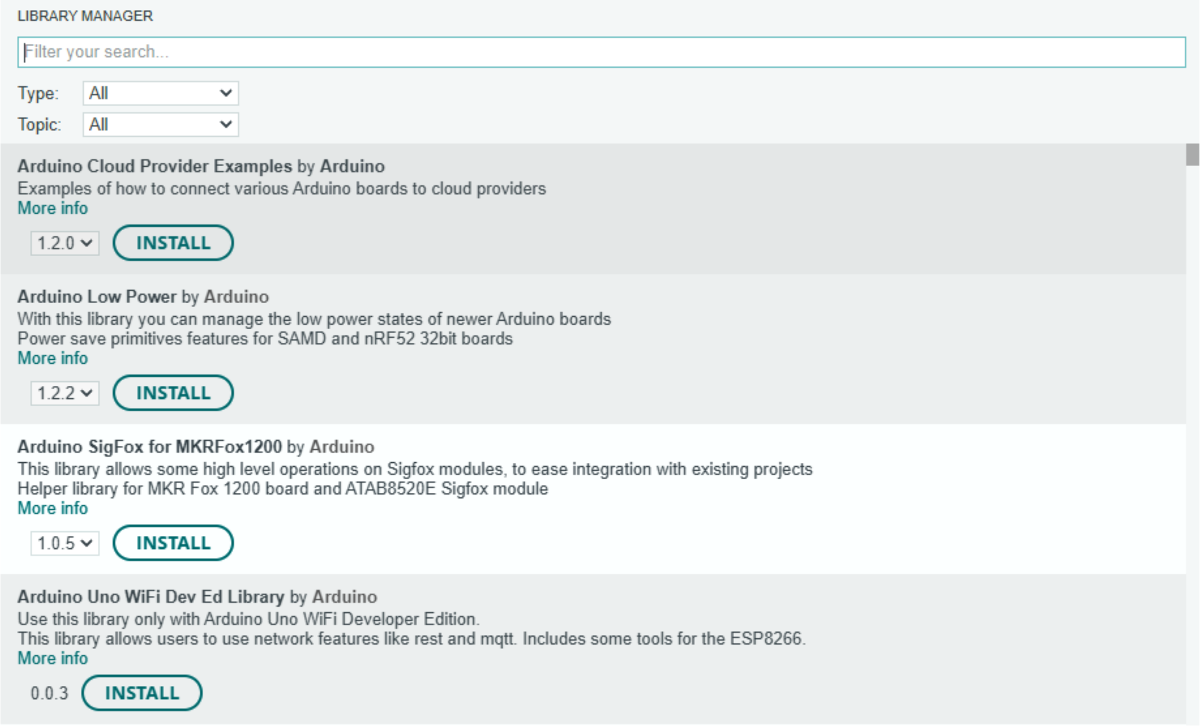
New Line

115200 baud

Chapter 6: Understanding Object-Oriented Programming and Creating Arduino Libraries







LIBRARY MANAGER

Filter your search...

Type: All

Topic: All

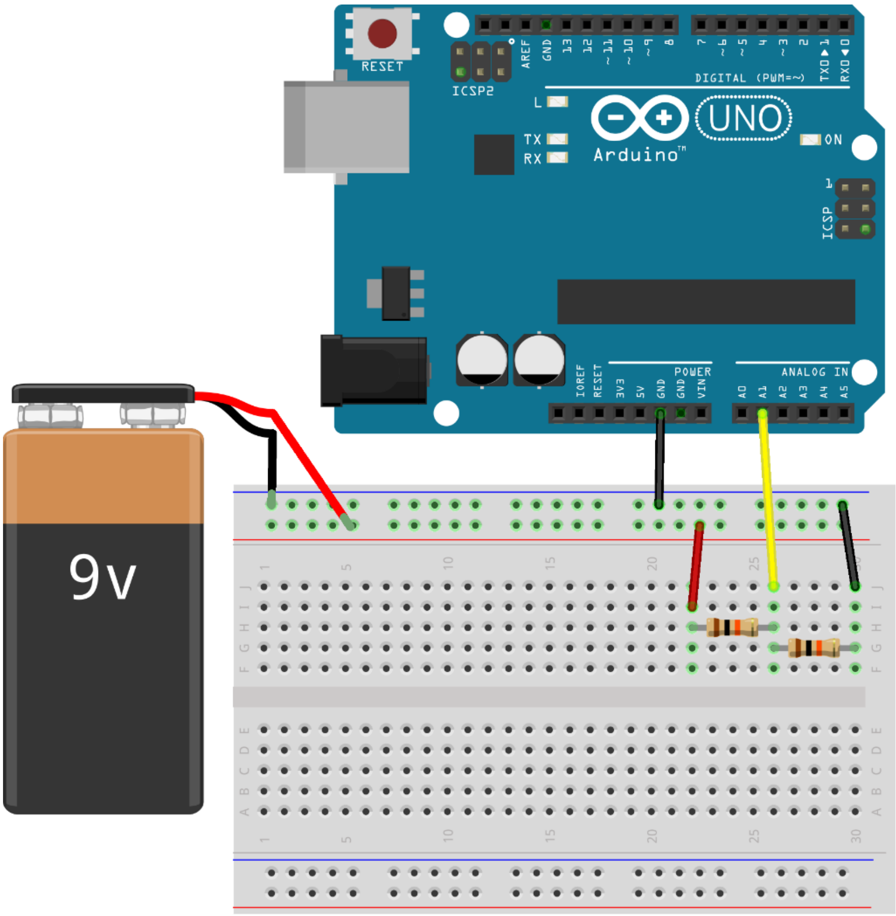
Arduino Cloud Provider Examples by **Arduino**
Examples of how to connect various Arduino boards to cloud providers
More info
1.2.0 INSTALL

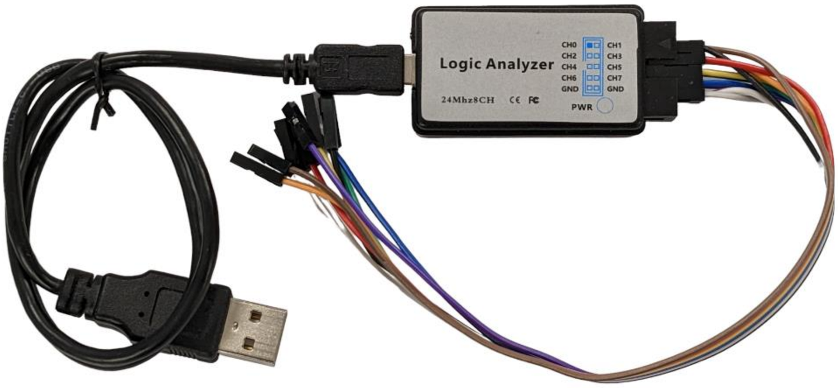
Arduino Low Power by **Arduino**
With this library you can manage the low power states of newer Arduino boards
Power save primitives features for SAMD and nRF52 32bit boards
More info
1.2.2 INSTALL

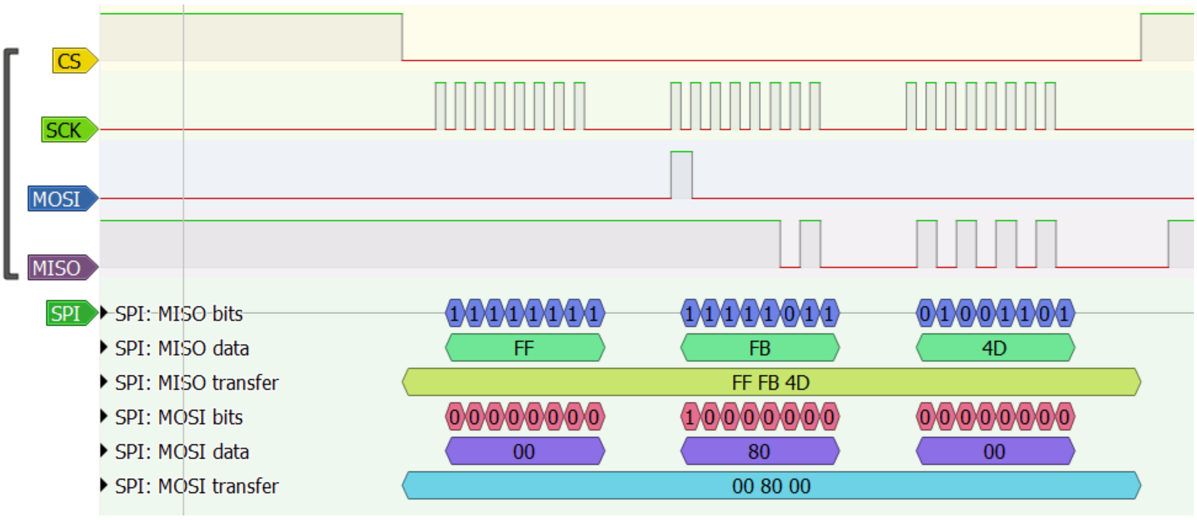
Arduino SigFox for MKRFox1200 by **Arduino**
This library allows some high level operations on Sigfox modules, to ease integration with existing projects
Helper library for MKR Fox 1200 board and ATAB8520E Sigfox module
More info
1.0.5 INSTALL

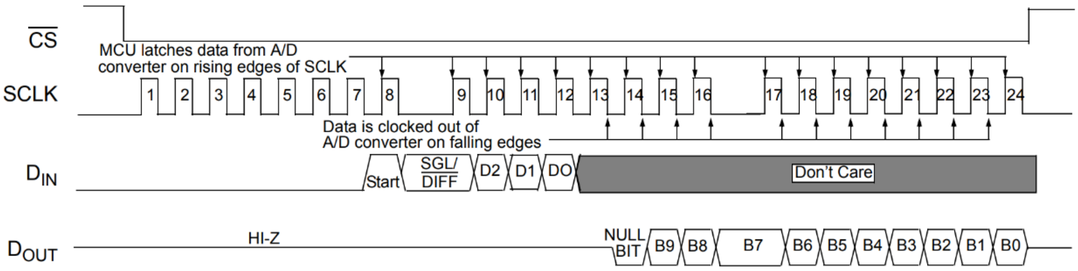
Arduino Uno WiFi Dev Ed Library by **Arduino**
Use this library only with Arduino Uno WiFi Developer Edition.
This library allows users to use network features like rest and mqtt. Includes some tools for the ESP8266.
More info
0.0.3 INSTALL

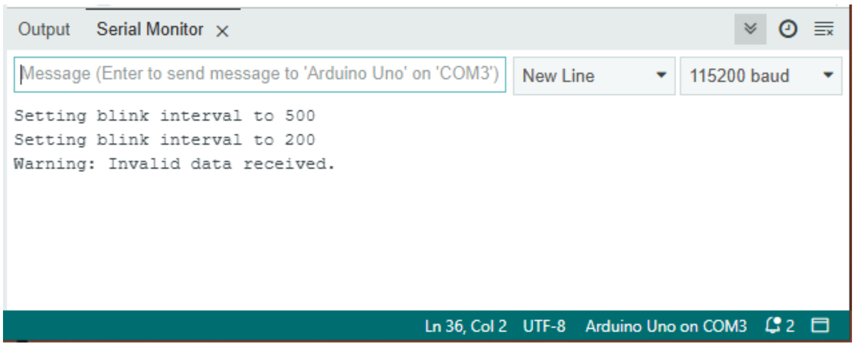
Chapter 7: Testing and Debugging with the Arduino IDE



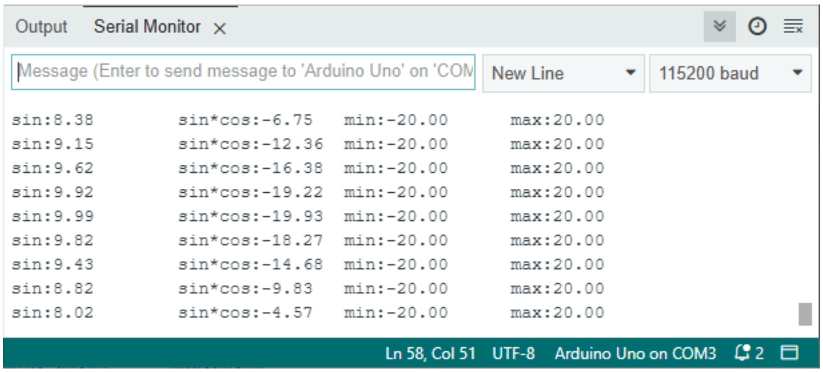




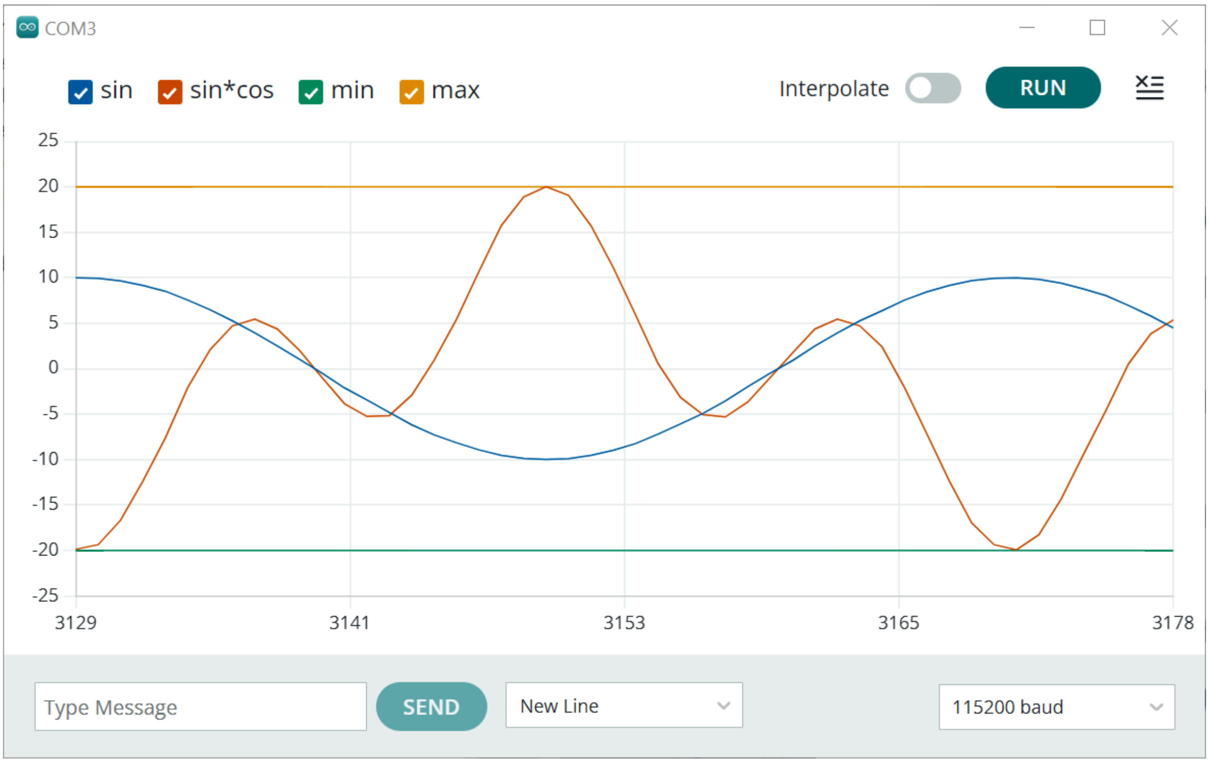




```
Setting blink interval to 500
Setting blink interval to 200
Warning: Invalid data received.
```

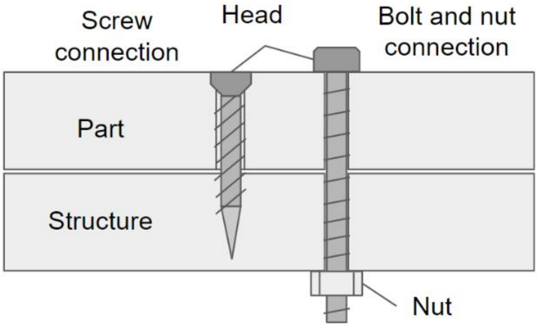


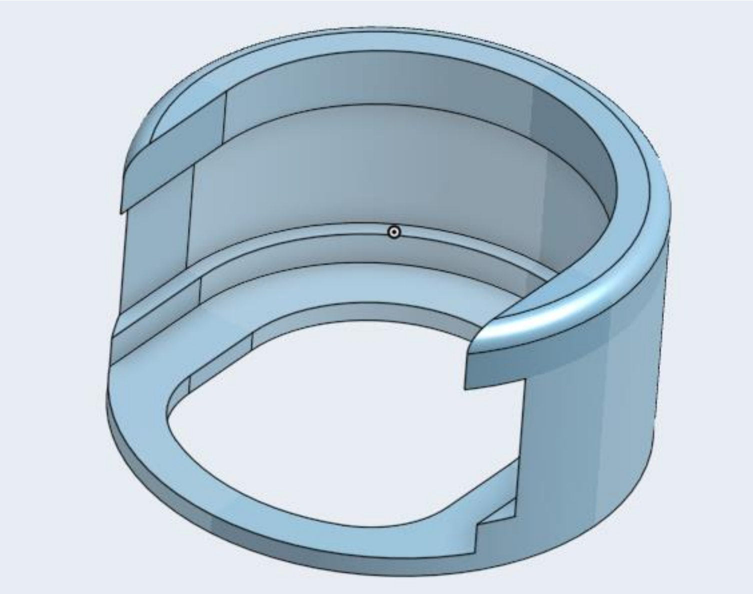
```
sin:8.38        sin*cos:-6.75   min:-20.00      max:20.00
sin:9.15        sin*cos:-12.36  min:-20.00      max:20.00
sin:9.62        sin*cos:-16.38  min:-20.00      max:20.00
sin:9.92        sin*cos:-19.22  min:-20.00      max:20.00
sin:9.99        sin*cos:-19.93  min:-20.00      max:20.00
sin:9.82        sin*cos:-18.27  min:-20.00      max:20.00
sin:9.43        sin*cos:-14.68  min:-20.00      max:20.00
sin:8.82        sin*cos:-9.83   min:-20.00      max:20.00
sin:8.02        sin*cos:-4.57   min:-20.00      max:20.00
```

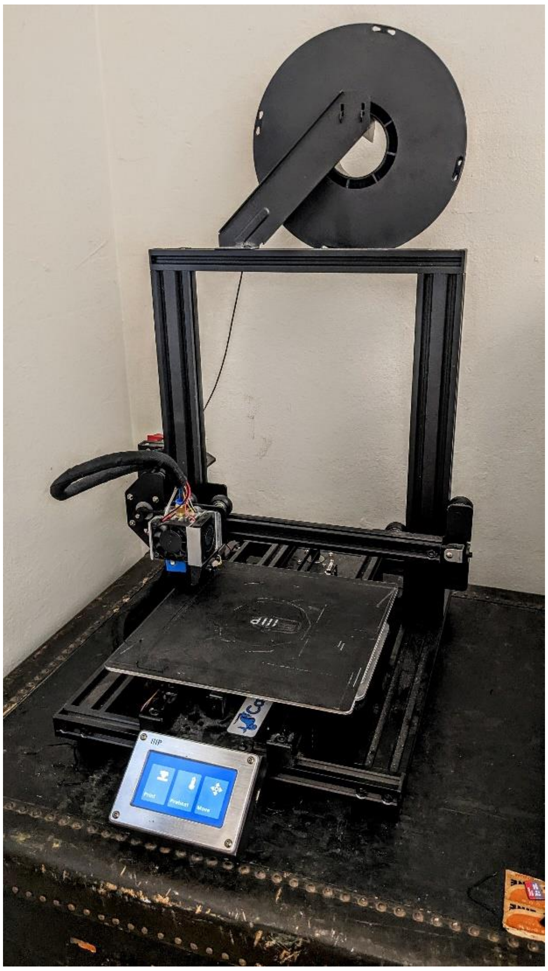


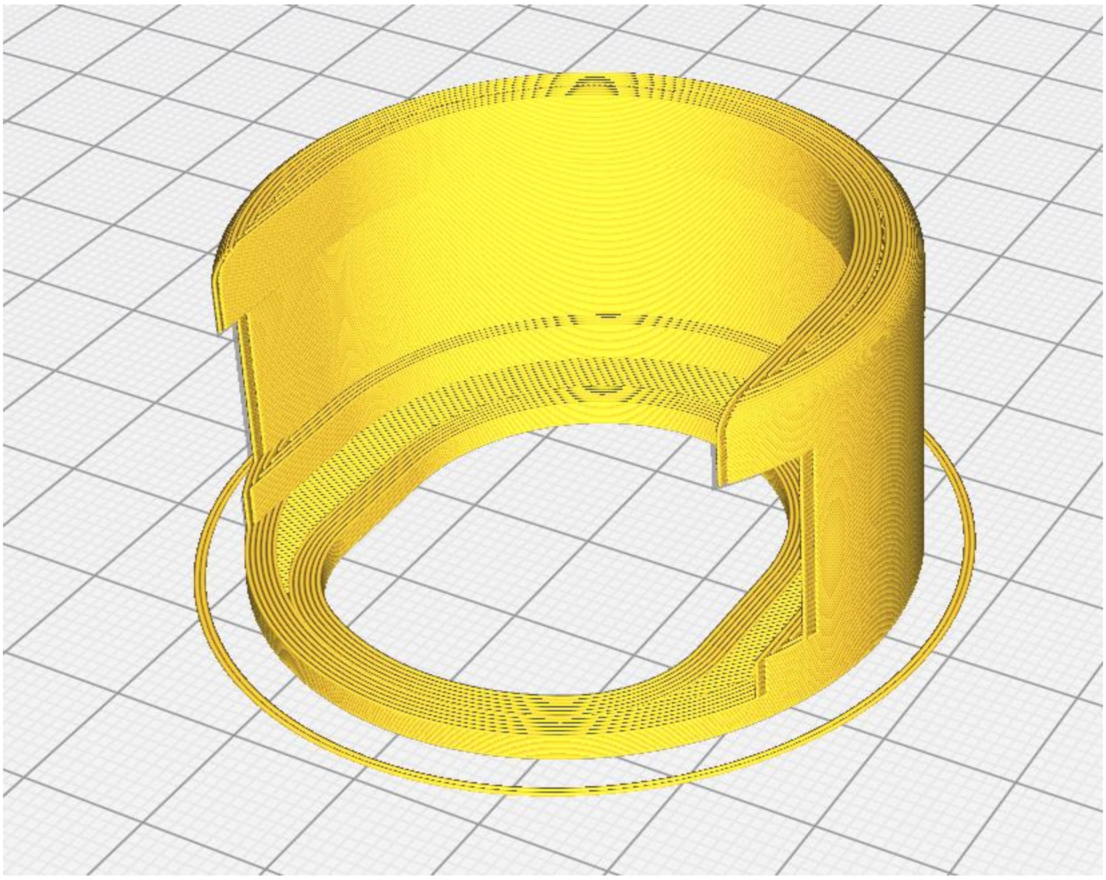
COM3
☑ sin
☑ sin*cos
☑ min
☑ max
Interpolate
RUN
25
20
15
10
5
0
-5
-10
-15
-20
-25
3129
3141
3153
3165
3178
Type Message
SEND
New Line
115200 baud

Chapter 8: Exploring Mechanical Design and the 3D Printing Toolchain

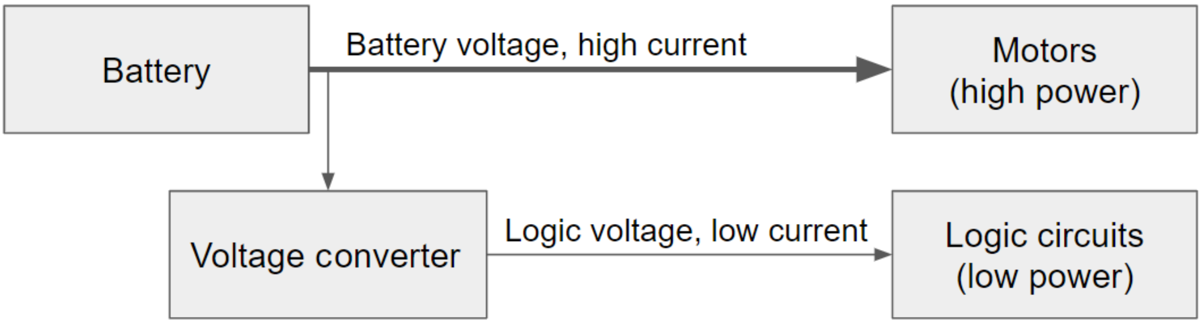


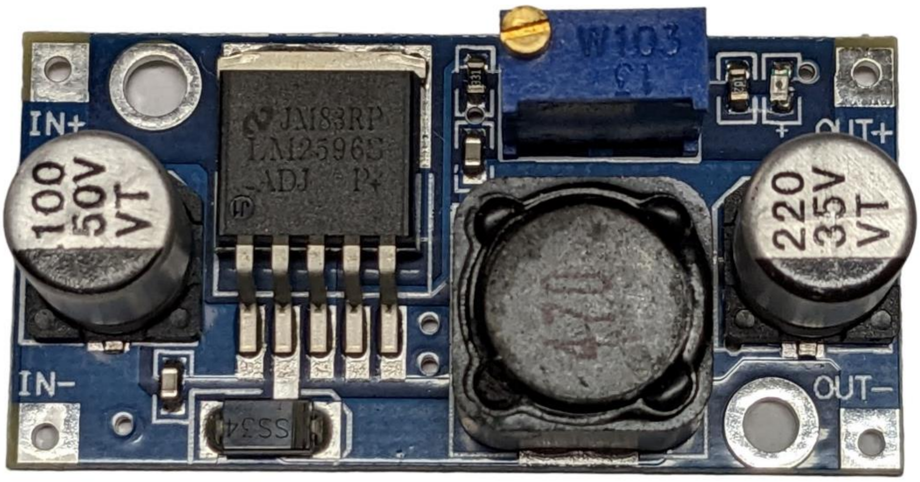


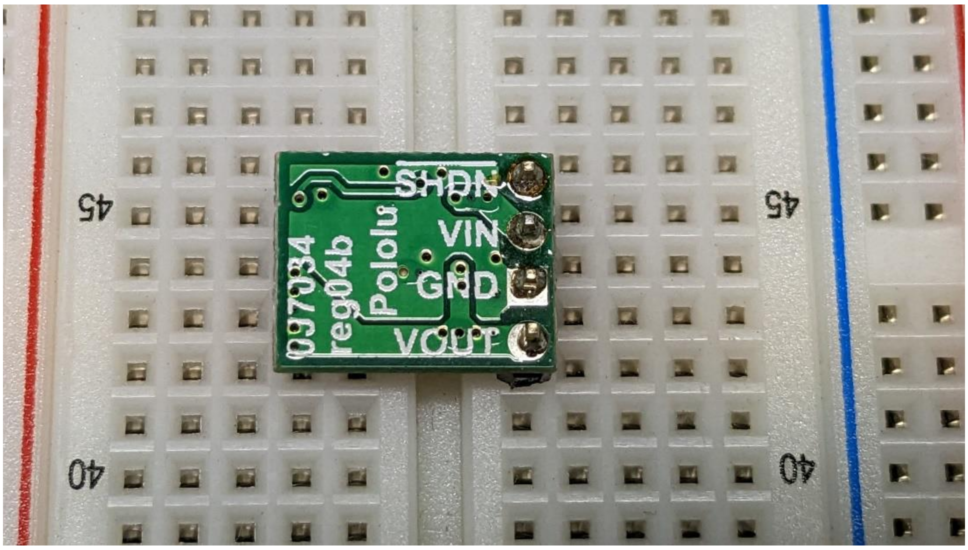

Print
Preheat
More

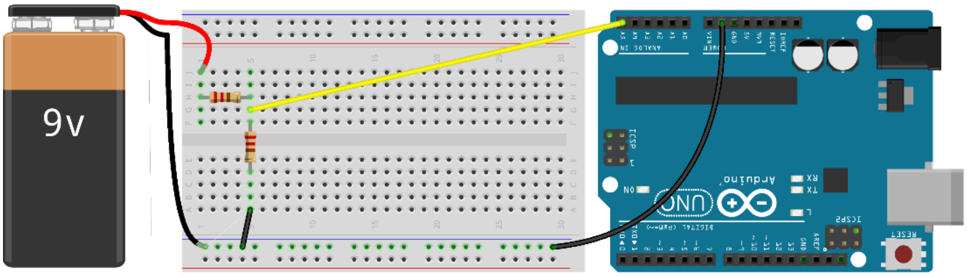


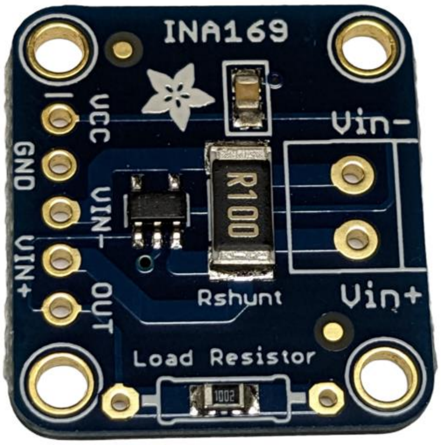
Chapter 9: Designing the Power System of Your Robot

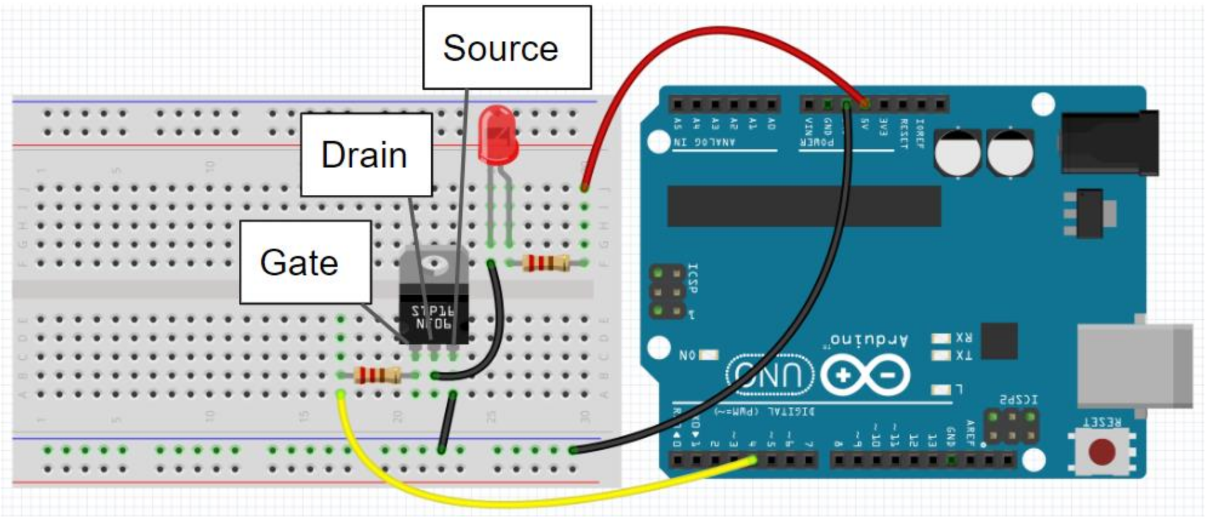

Battery
Battery voltage, high current
Motors (high power)
Voltage converter
Logic voltage, low current
Logic circuits (low power)

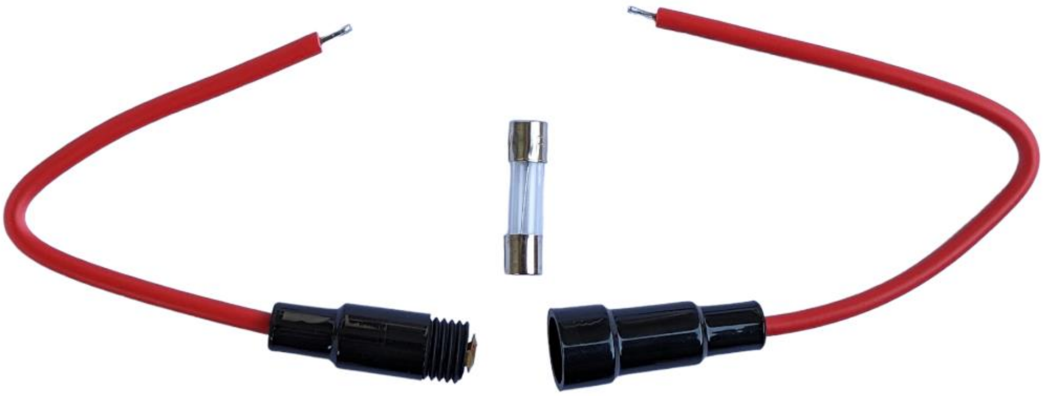


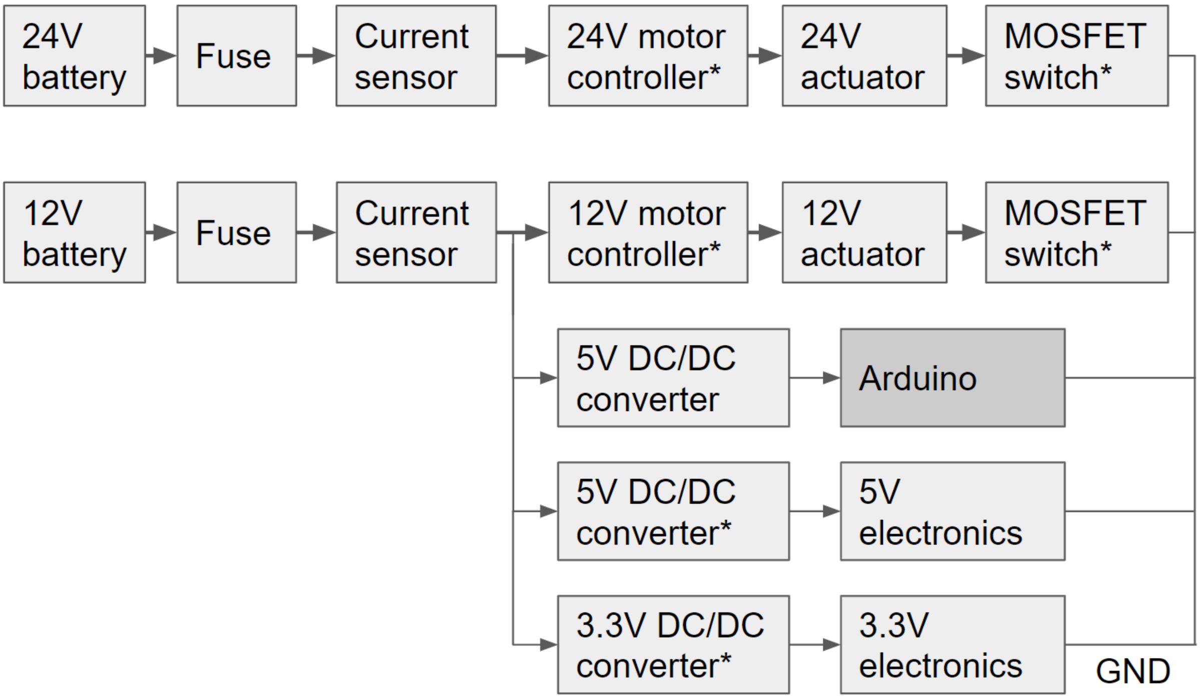

SHDN
VIN
GND
VOUT
Pololu
reg04b
097034
45
45
40
40


9v
Arduino
UNO
RESET
ICSP2
ICSP
ON
TX
RX

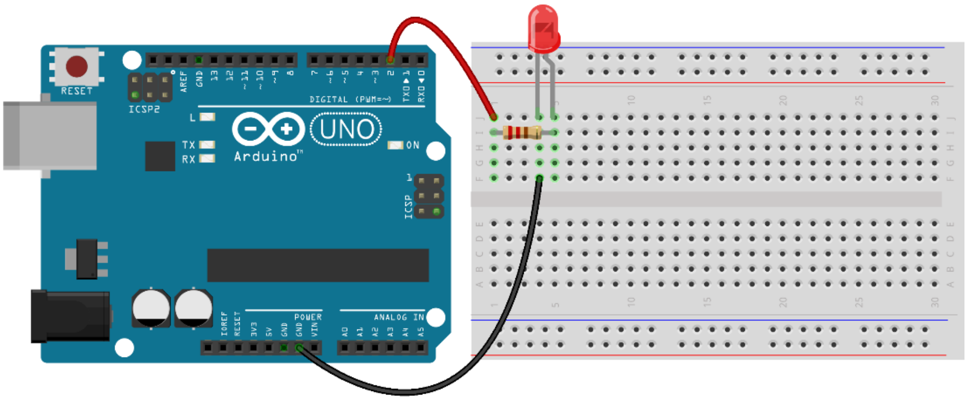

INA169
VCC
GND
VIN-
VIN+
OUT
Vin-
Vin+
R100
Rshunt
Load Resistor
1002

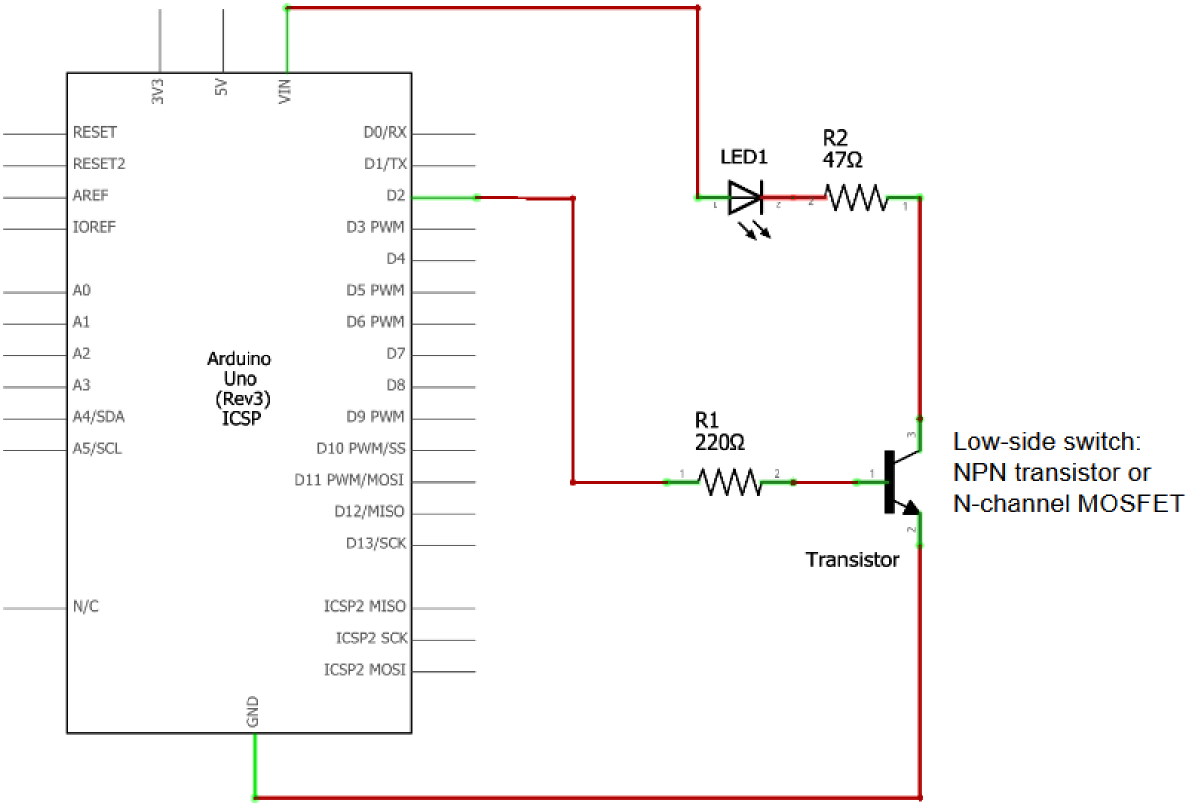

Source
Drain
Gate



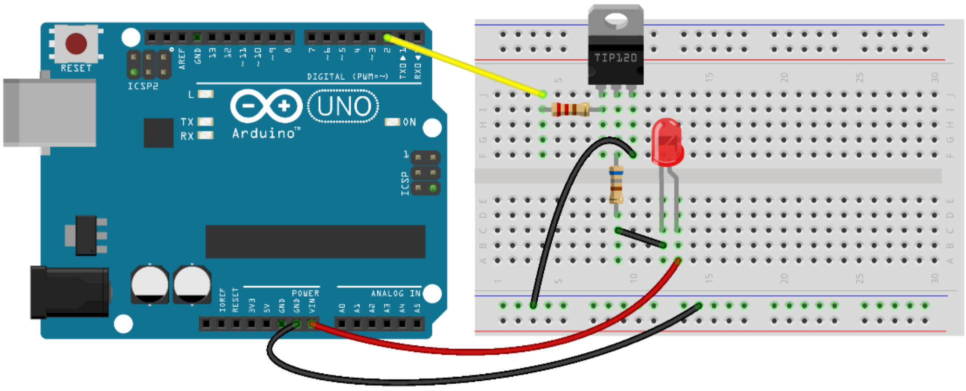

24V battery
Fuse
Current sensor
24V motor controller*
24V actuator
MOSFET switch*
12V battery
Fuse
Current sensor
12V motor controller*
12V actuator
MOSFET switch*
5V DC/DC converter
Arduino
5V DC/DC converter*
5V electronics
3.3V DC/DC converter*
3.3V electronics
GND

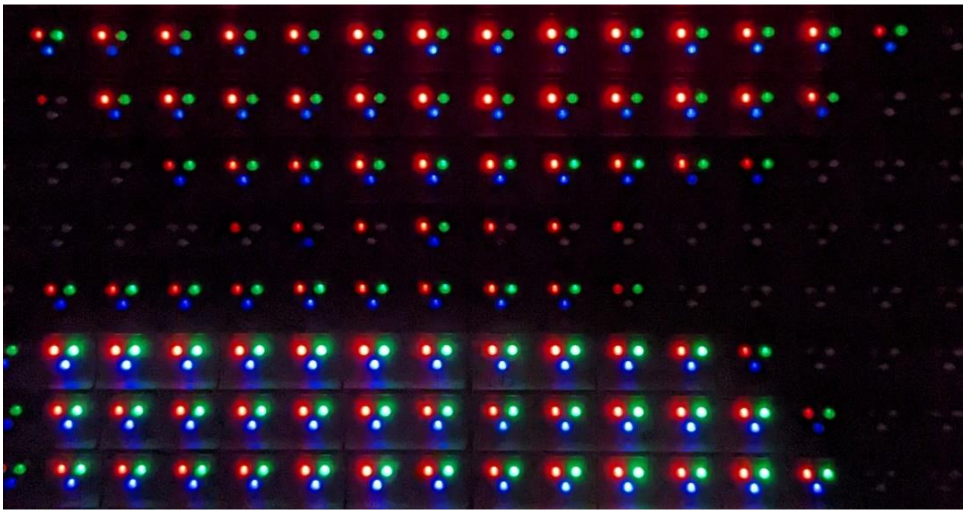
Chapter 10: Working with Displays, LEDs, and Sound

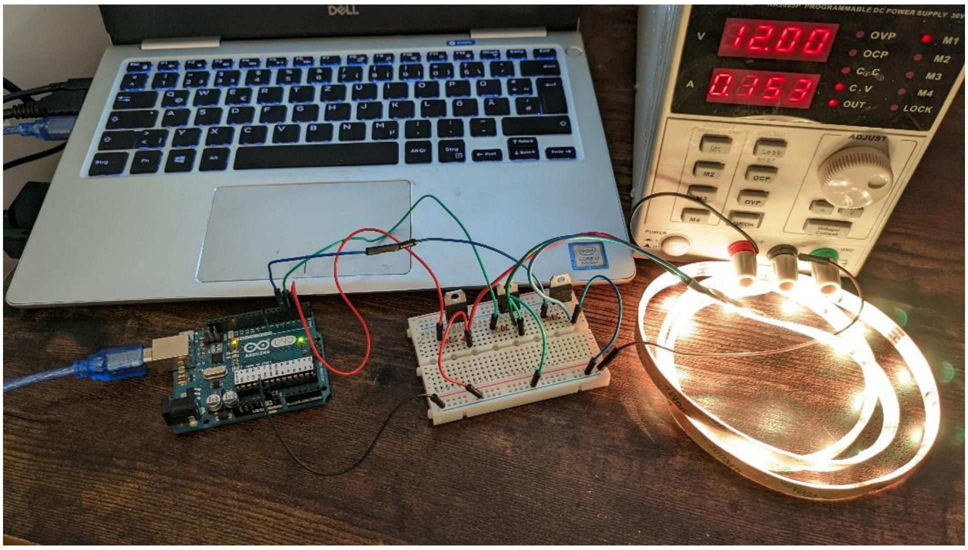


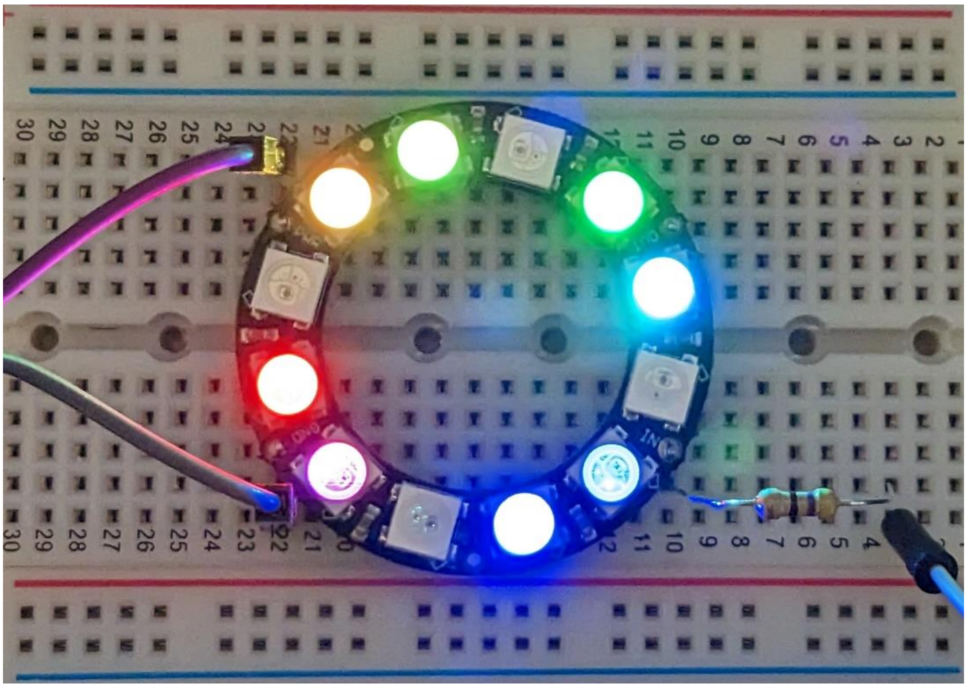


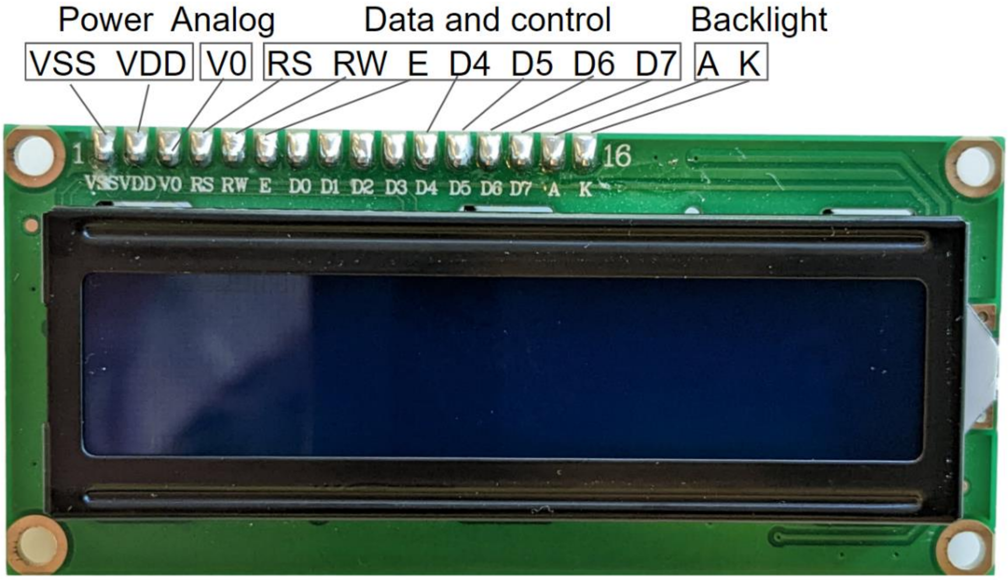
Low-side switch:
NPN transistor or
N-channel MOSFET

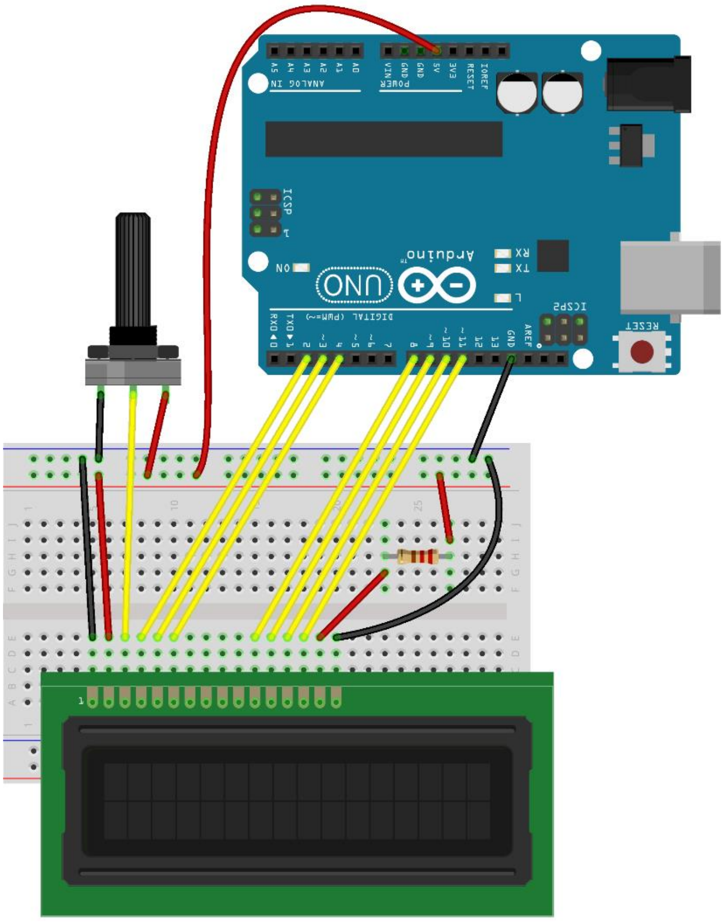

RESET
ICSP2
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX▶1
RX◀0
DIGITAL (PWM=~)
L
TX
RX
UNO
Arduino™
ON
ICSP
1
IOREF
RESET
3V3
5V
GND
GND
VIN
POWER
ANALOG IN
A0
A1
A2
A3
A4
A5
TIP120

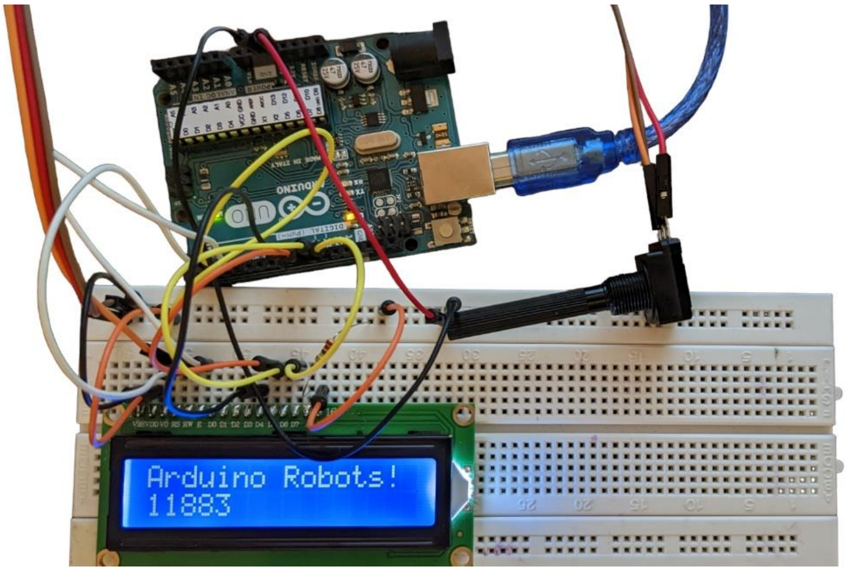


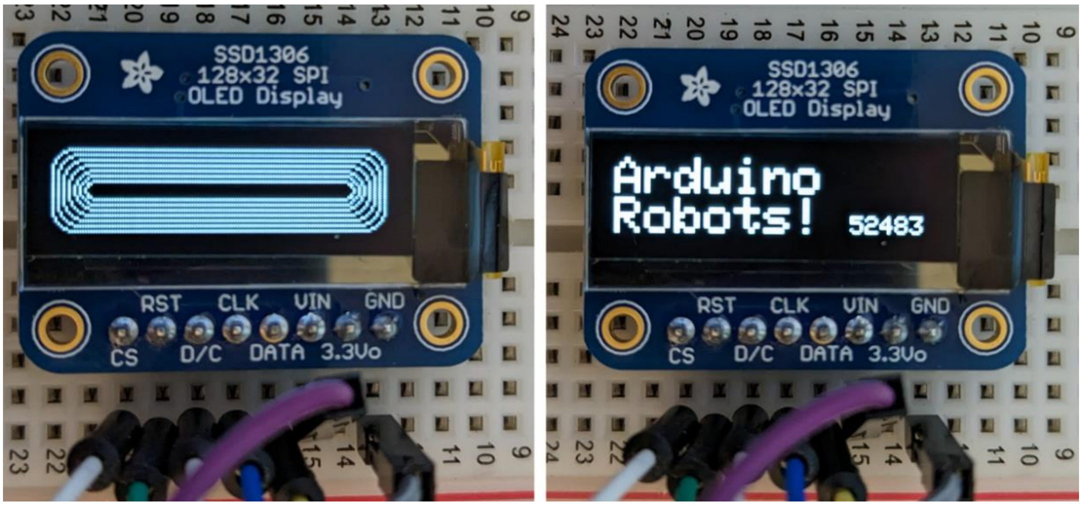

DELL
12.00
0.153
V
A
OVP
OCP
C.V
OUT
M1
M2
M3
M4
LOCK
ADJUST

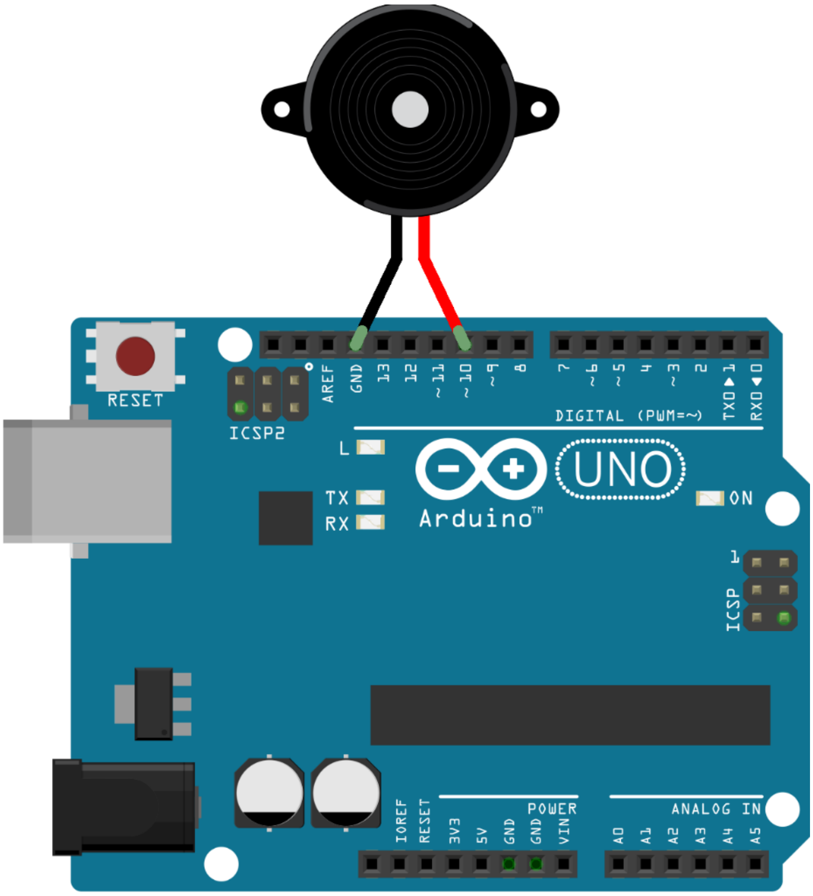



Power
Analog
Data and control
Backlight
VSS VDD
V0
RS RW E D4 D5 D6 D7
A K
1
16
VSS VDD V0 RS RW E D0 D1 D2 D3 D4 D5 D6 D7 A K

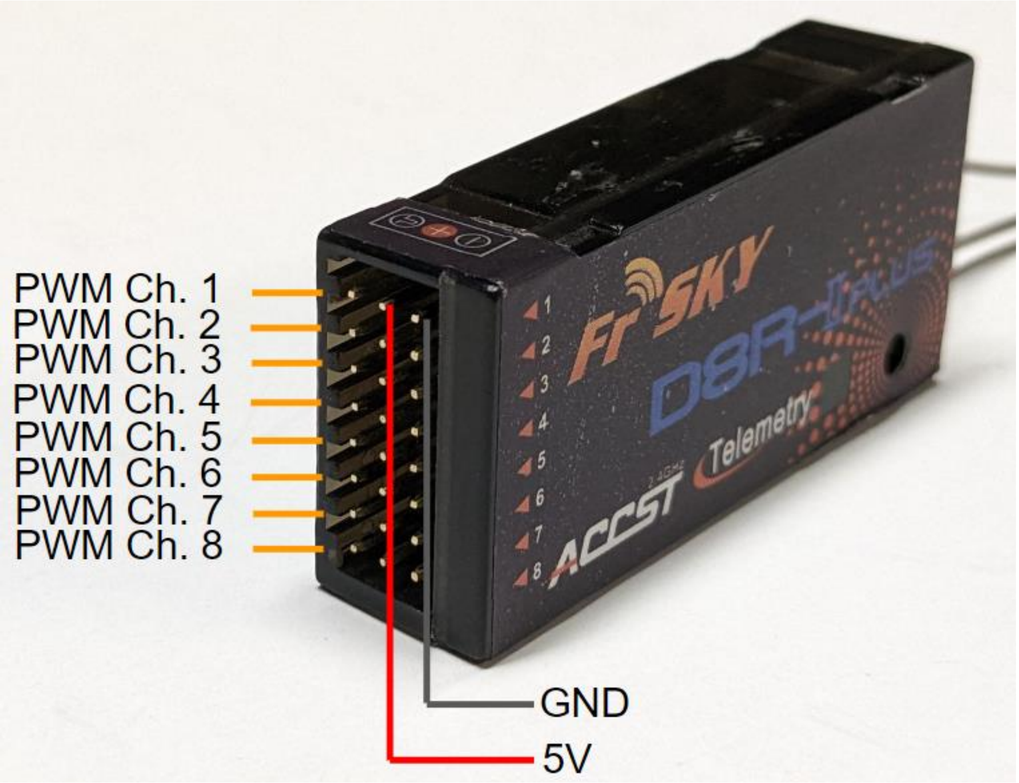


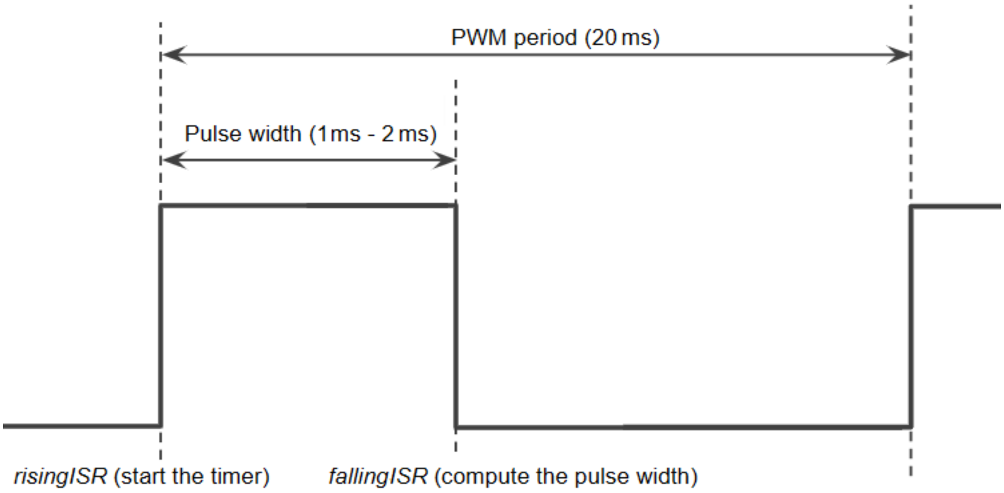

Arduino Robots!
11883

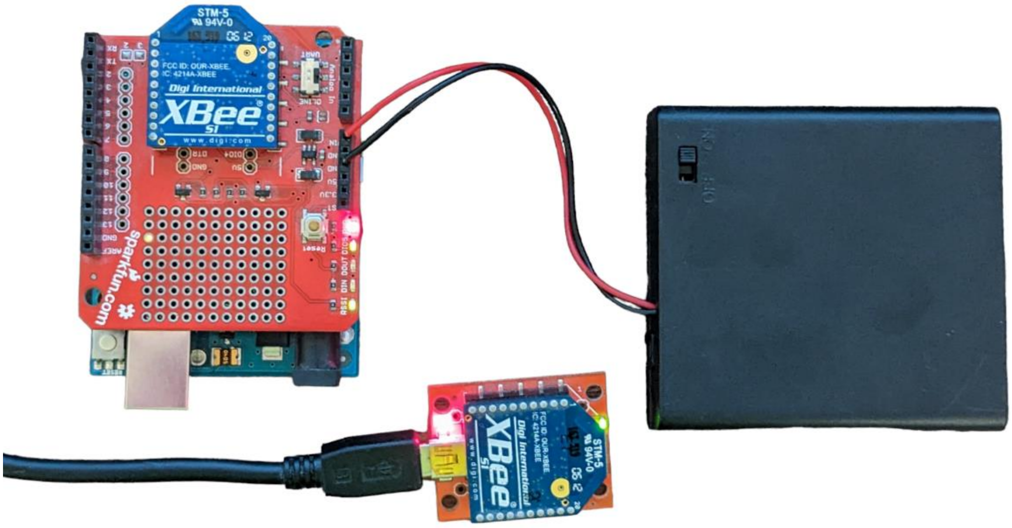

SSD1306
128x32 SPI
OLED Display
RST CLK VIN GND
CS D/C DATA 3.3Vo
Arduino
Robots!
52483

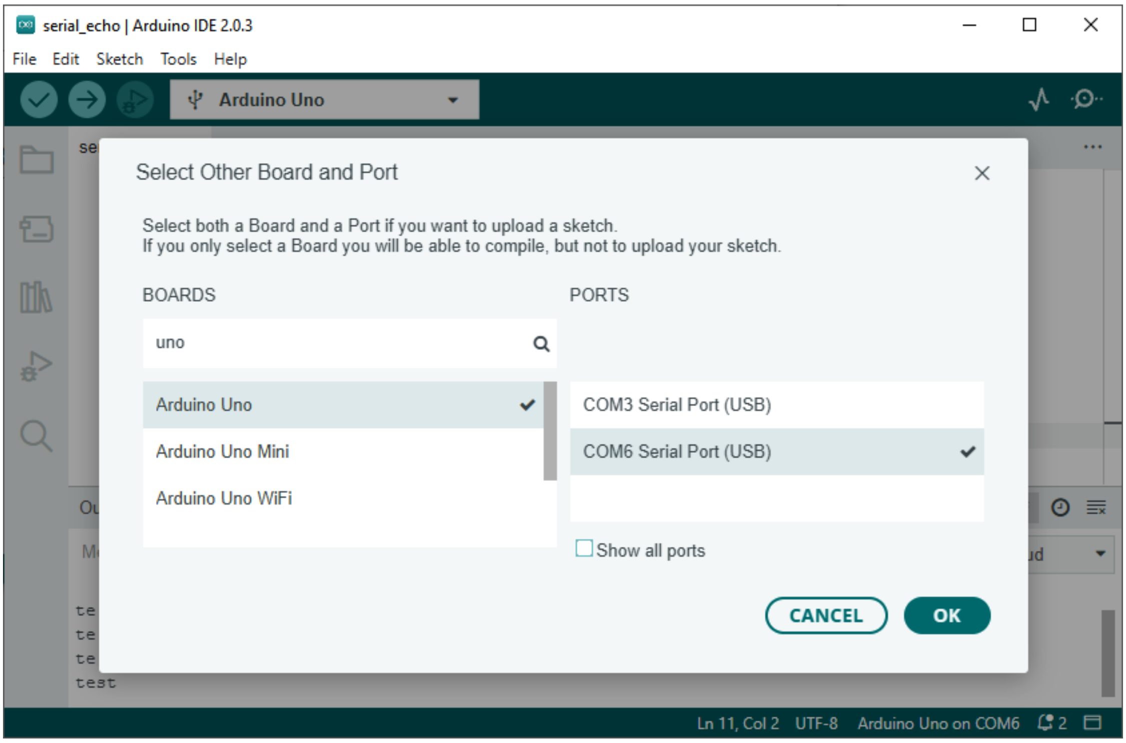

RESET
ICSP2
AREF GND 13 12 ~11 ~10 ~9 8
7 ~6 ~5 4 ~3 2 TX0▶1 RX0◀0
DIGITAL (PWM=~)
L
TX
RX
UNO
Arduino™
ON
ICSP
1
IOREF RESET 3V3 5V GND GND VIN
POWER
ANALOG IN
A0 A1 A2 A3 A4 A5

Chapter 11: Adding Wireless Interfaces to Your Robot




PWM period (20 ms)
Pulse width (1 ms - 2 ms)
risingISR (start the timer)
fallingISR (compute the pulse width)





Select Other Board and Port

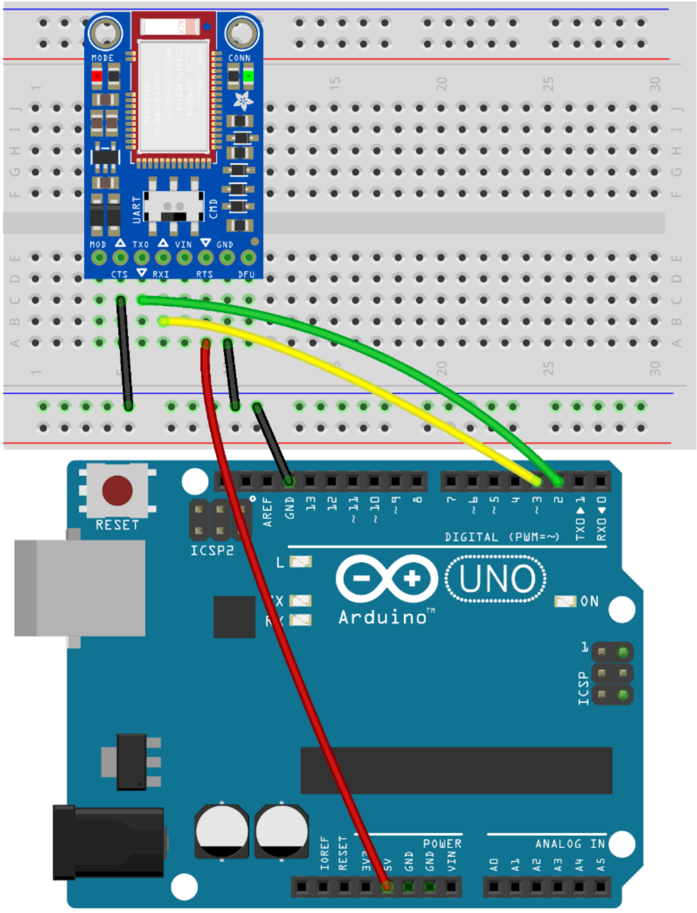
Select both a Board and a Port if you want to upload a sketch.
If you only select a Board you will be able to compile, but not to upload your sketch.

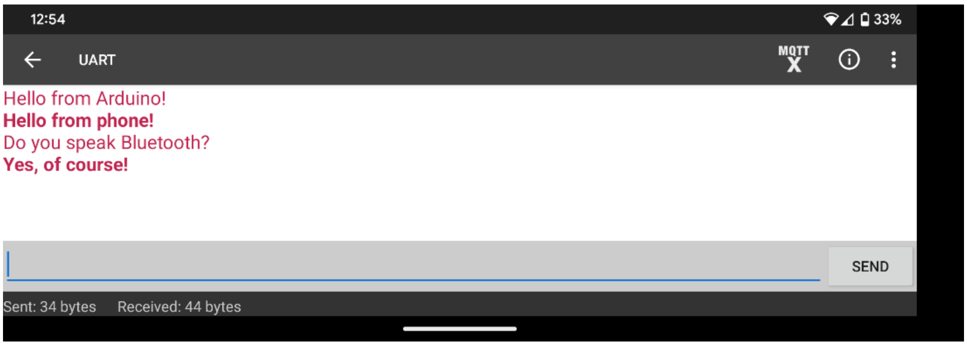
BOARDS	PORTS
uno	
Arduino Uno ✓	COM3 Serial Port (USB)
Arduino Uno Mini	COM6 Serial Port (USB) ✓
Arduino Uno WiFi	

□ Show all ports

```
te
te
te
test
```

Ln 11, Col 2 UTF-8 Arduino Uno on COM6 2





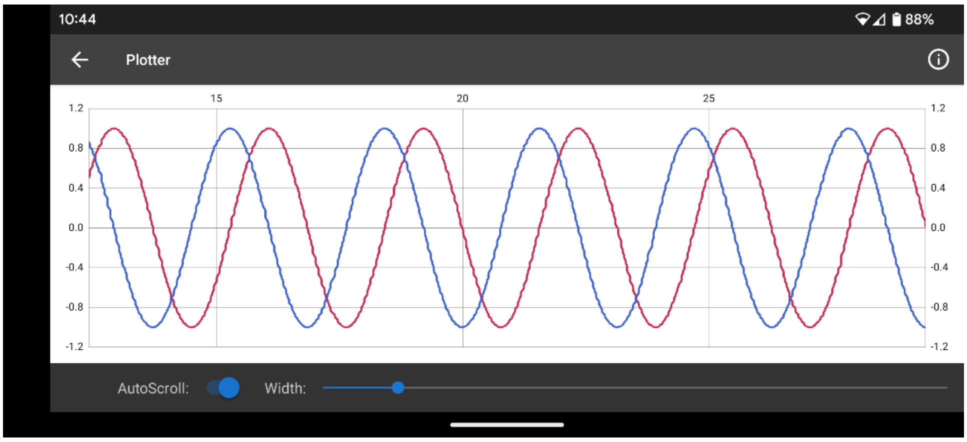
Hello from Arduino!

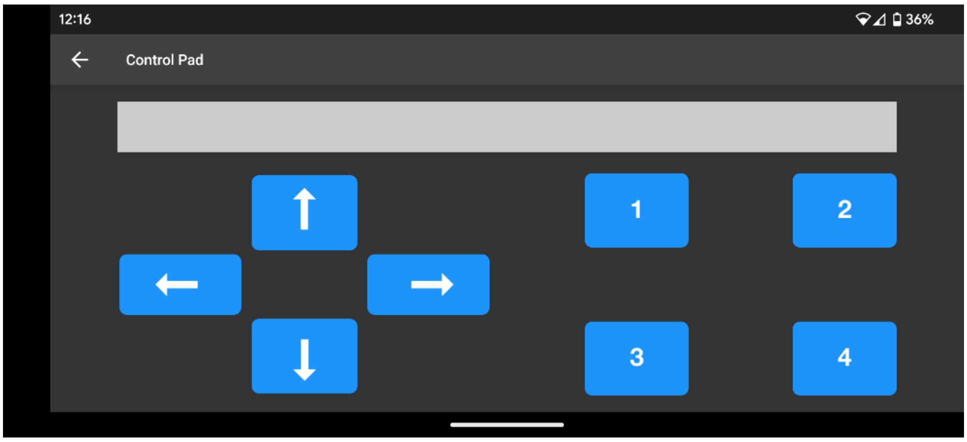
Hello from phone!

Do you speak Bluetooth?

Yes, of course!

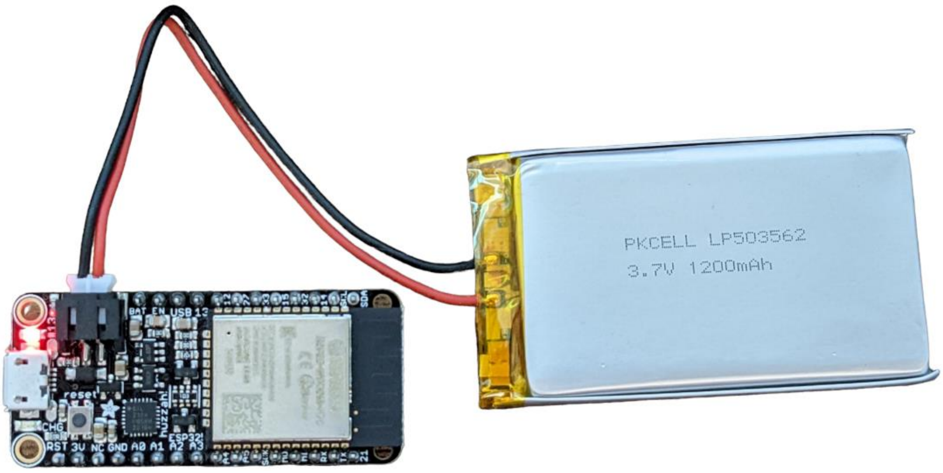
Sent: 34 bytes Received: 44 bytes

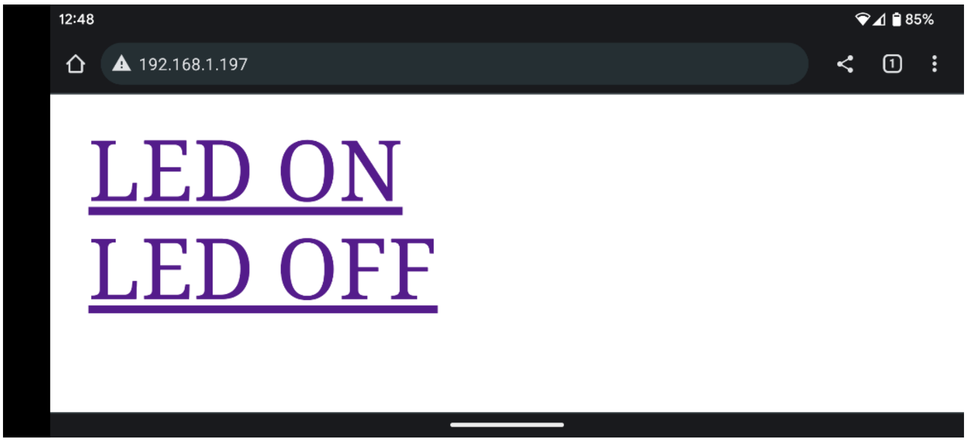



12:16

36%

Control Pad




12:48

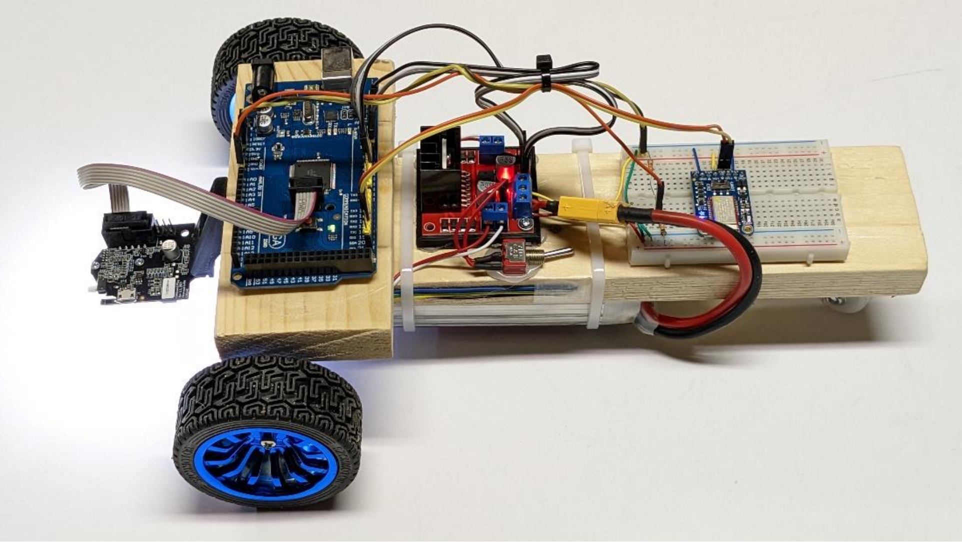
85%

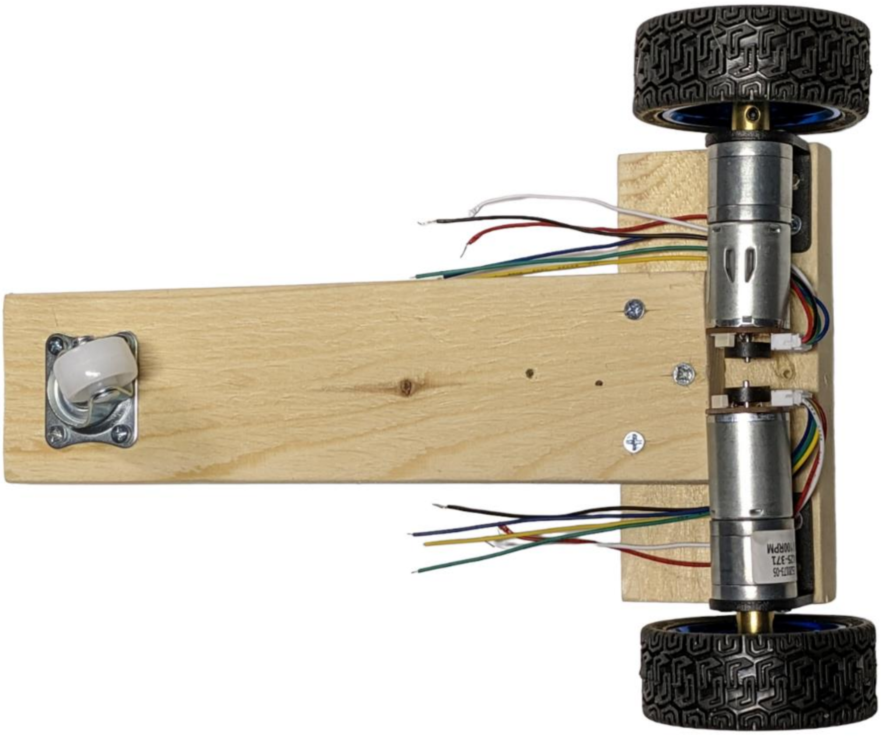
192.168.1.197

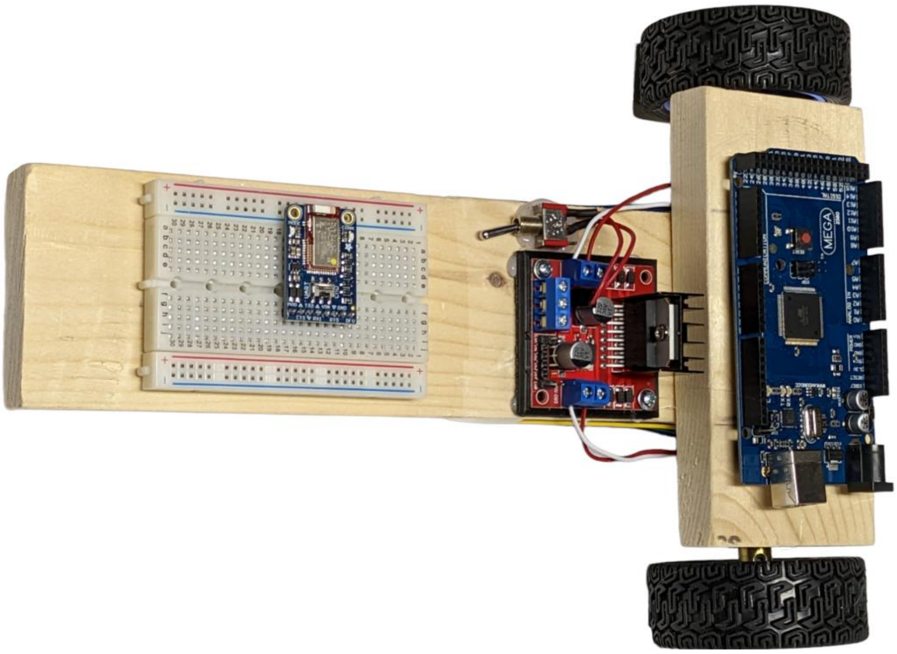
LED ON

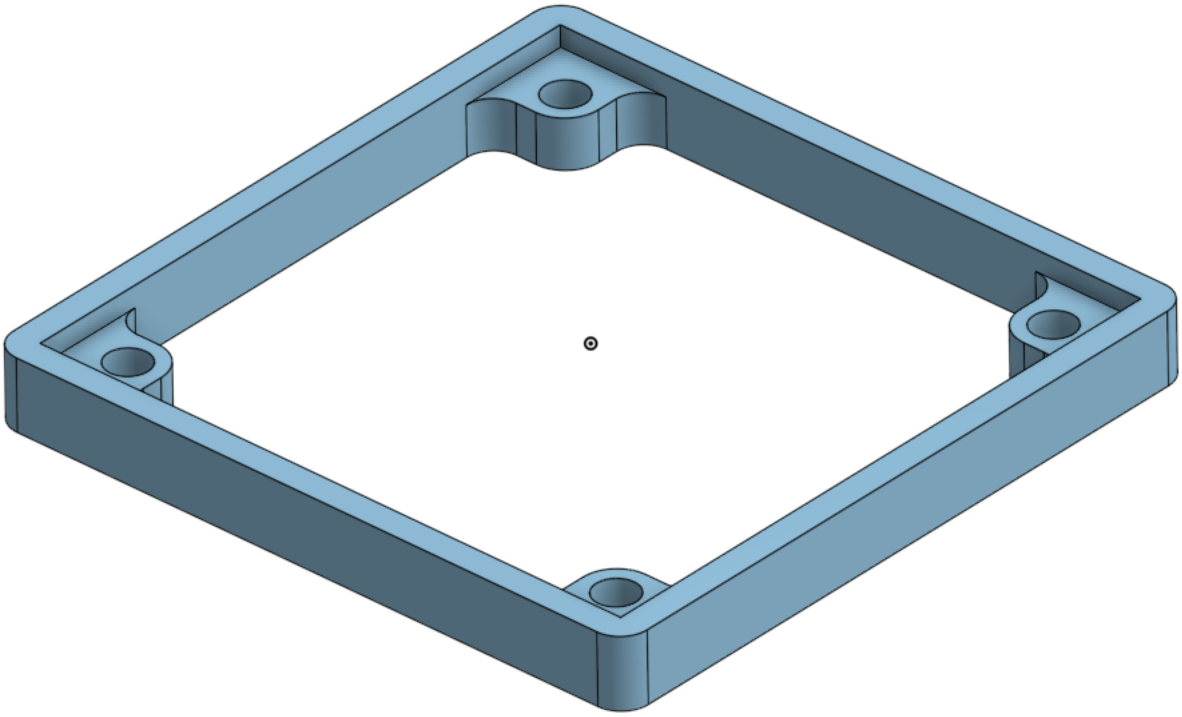
LED OFF

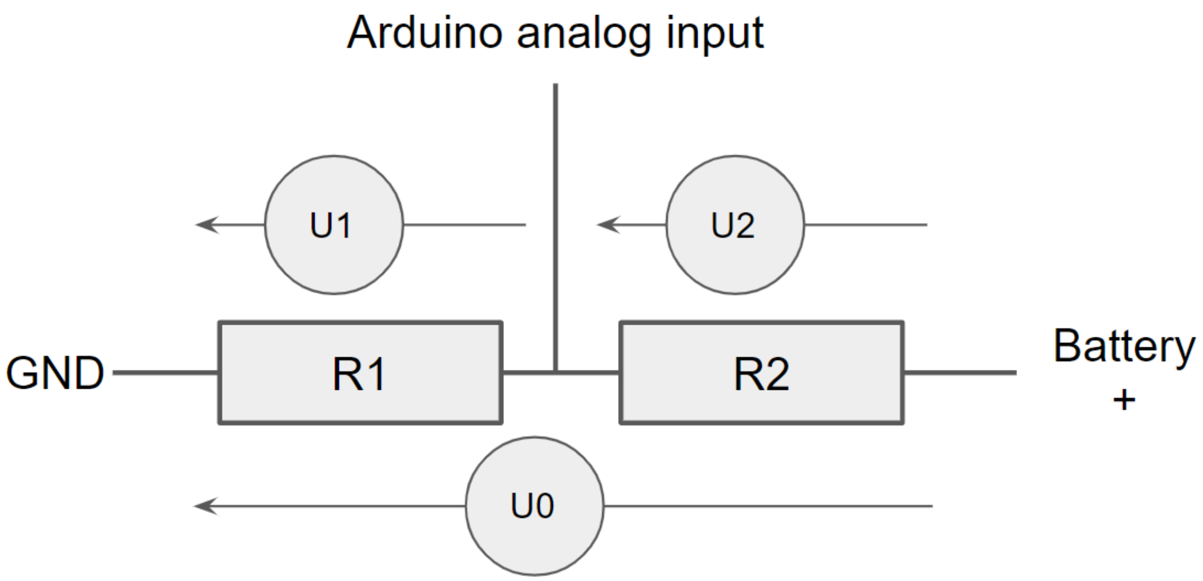
Chapter 12: Building an Advanced Line-Following Robot Using a Camera

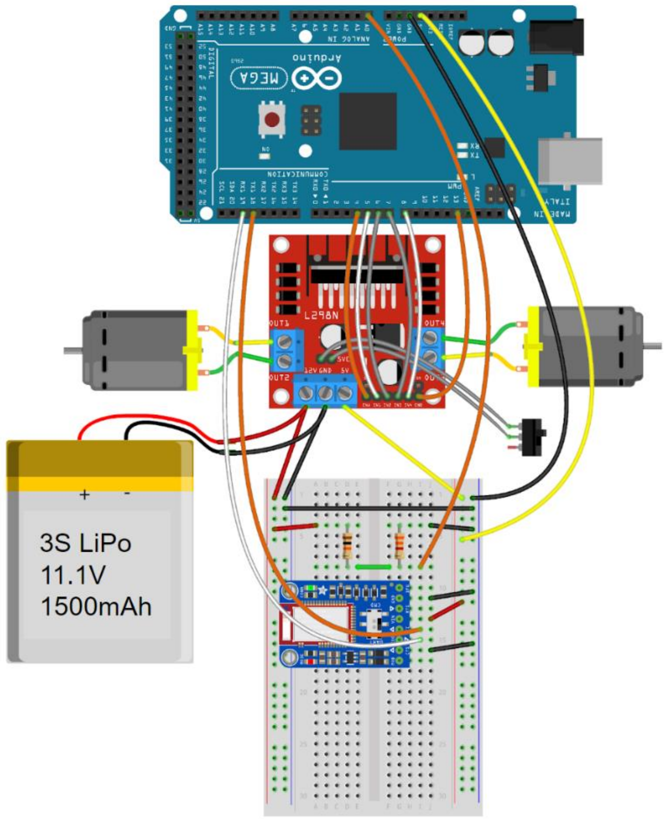


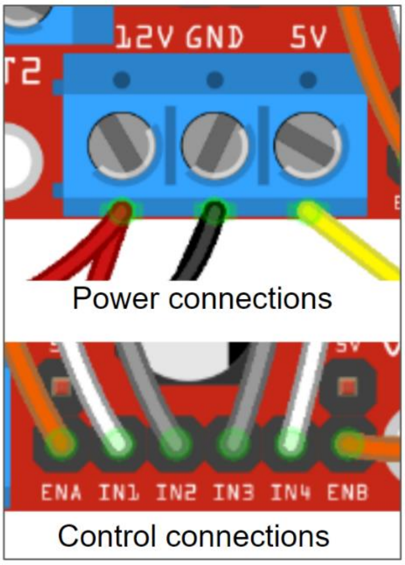


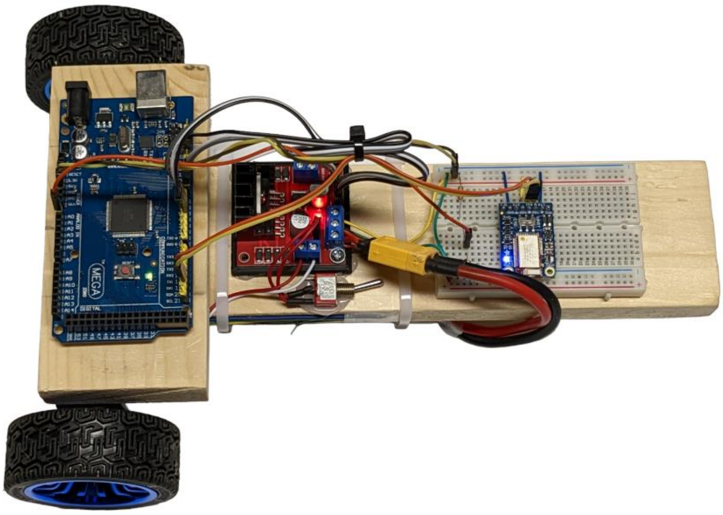


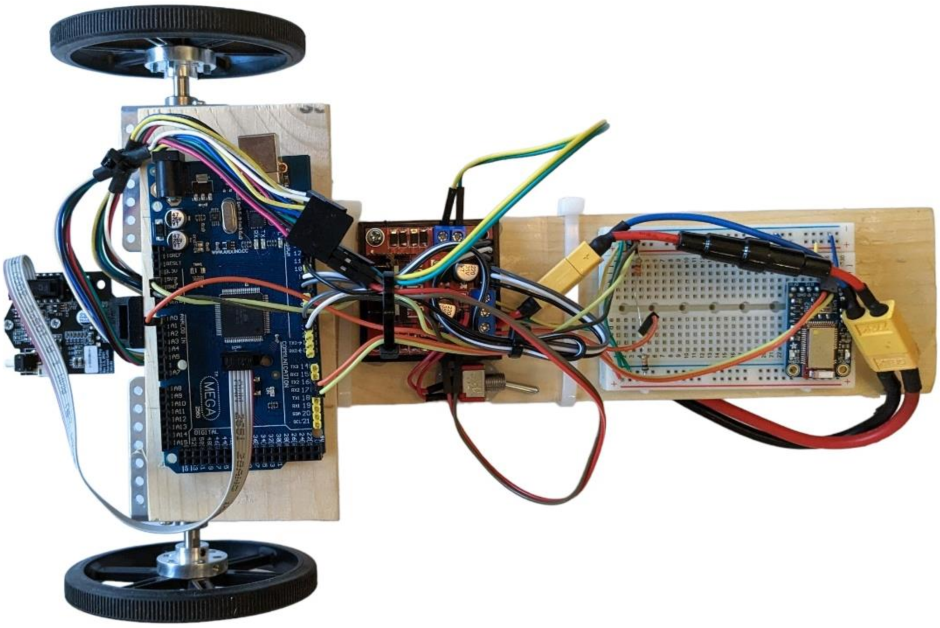


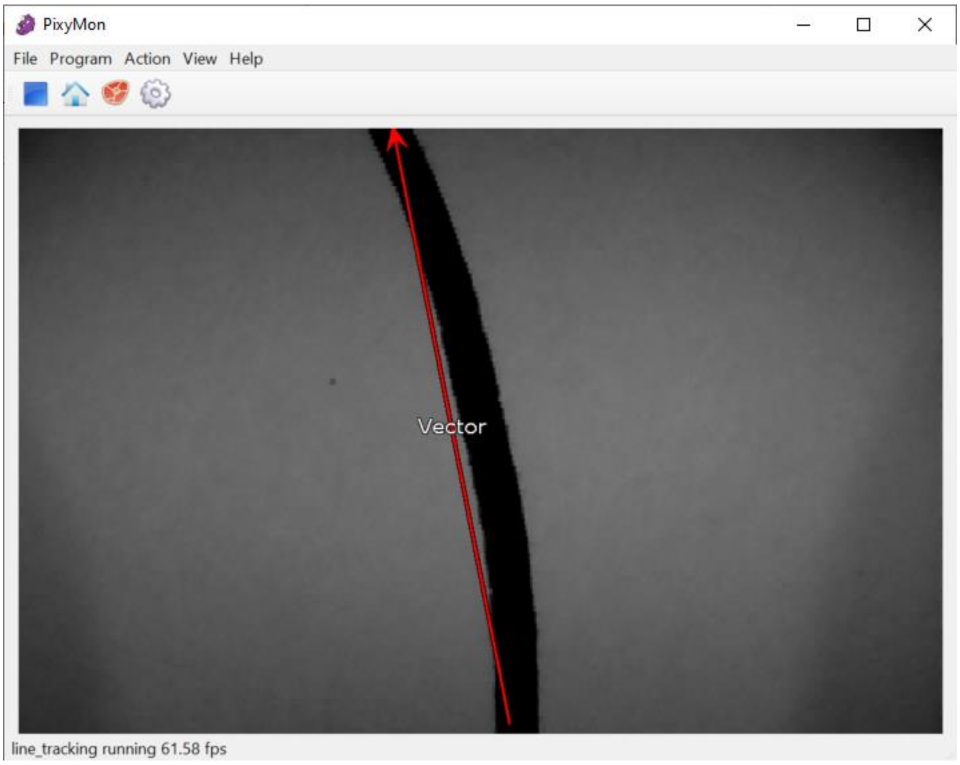

Arduino analog input
U1
U2
GND
R1
R2
Battery
+
U0


+
-
3S LiPo
11.1V
1500mAh

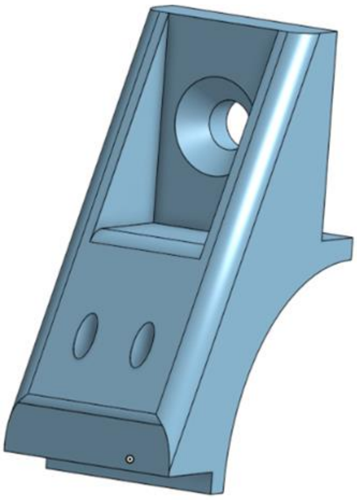

12V GND 5V
Power connections
ENA IN1 IN2 IN3 IN4 ENB
Control connections

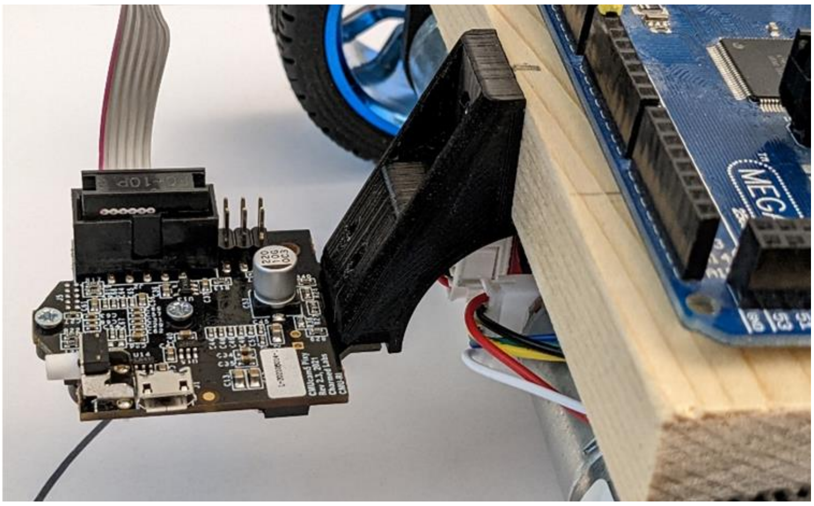




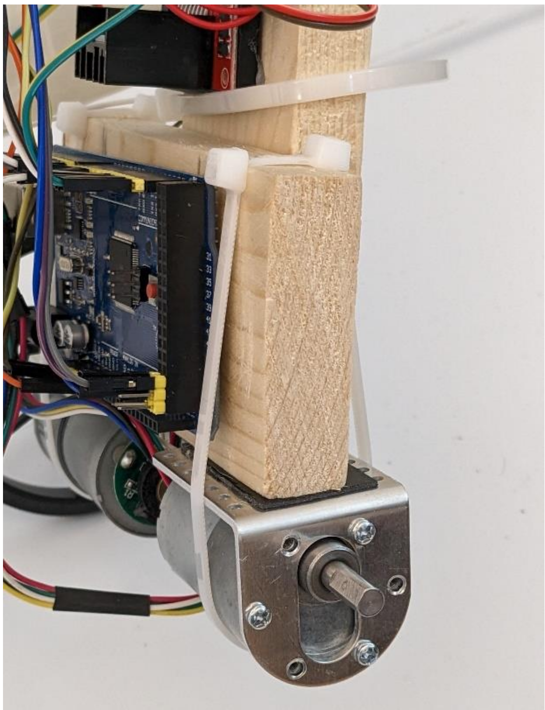


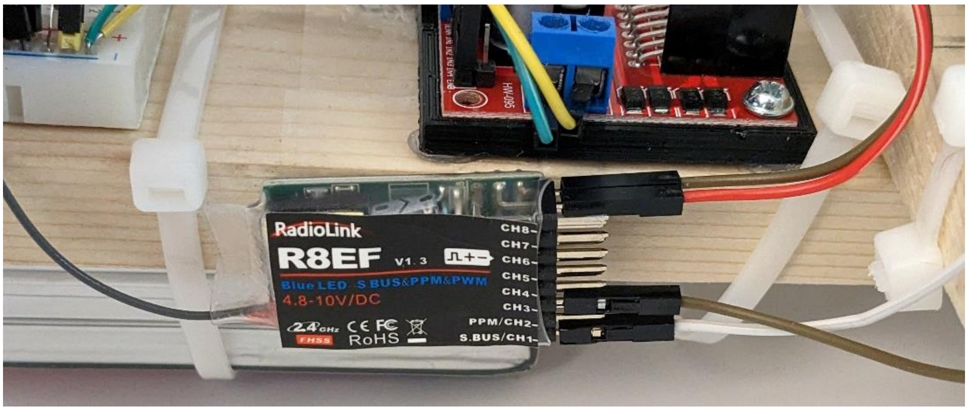
line_tracking running 61.58 fps

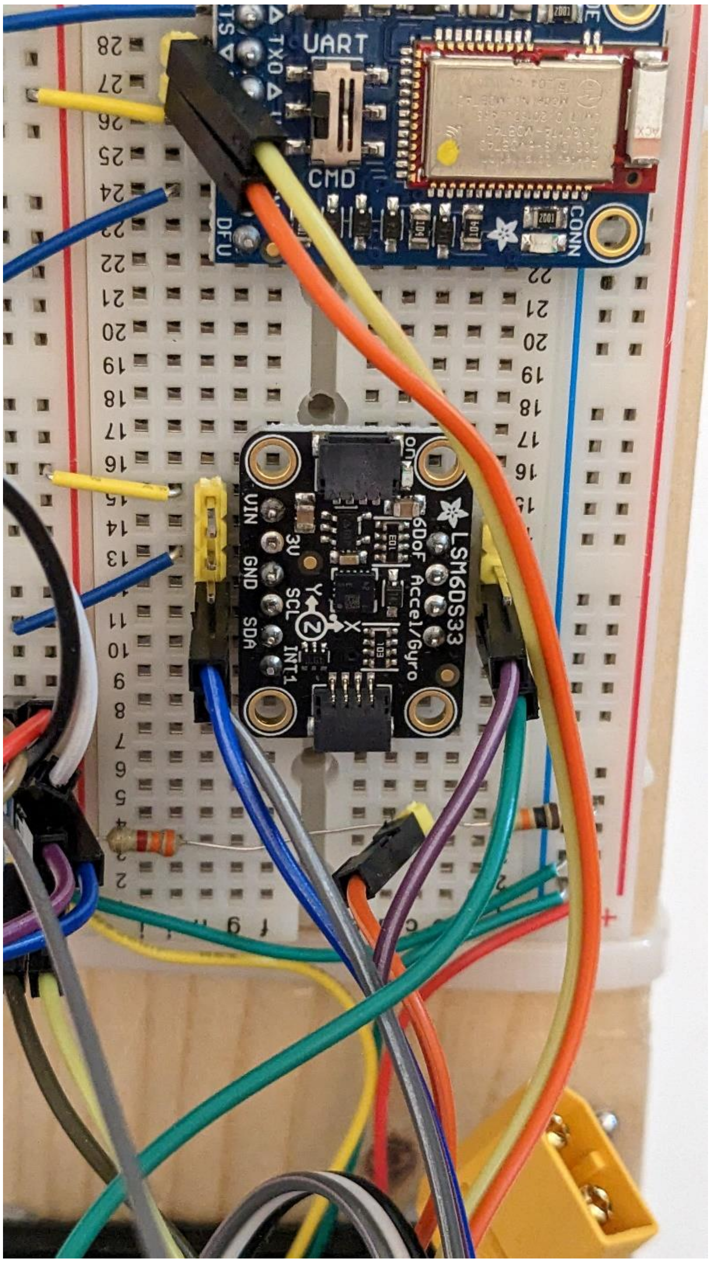


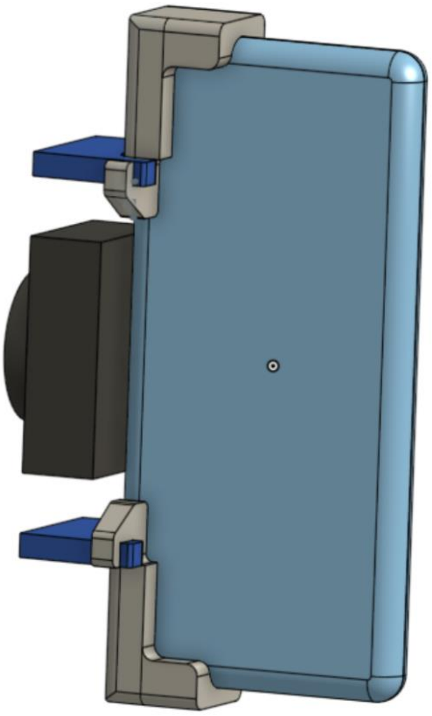


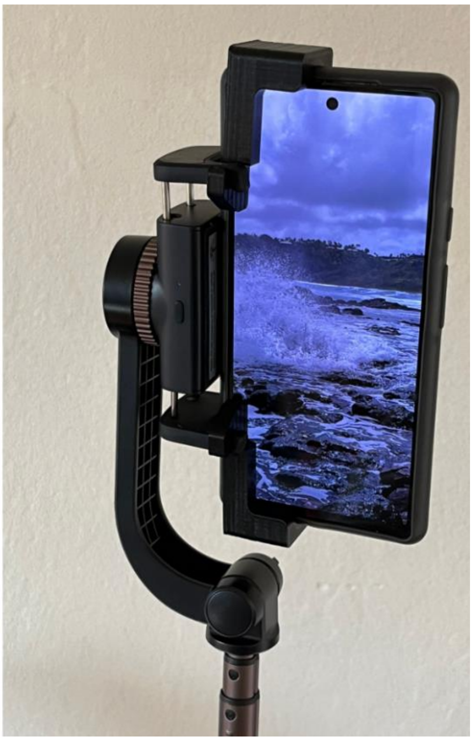
Chapter 13: Building a Self-Balancing, Radio-Controlled Telepresence Robot

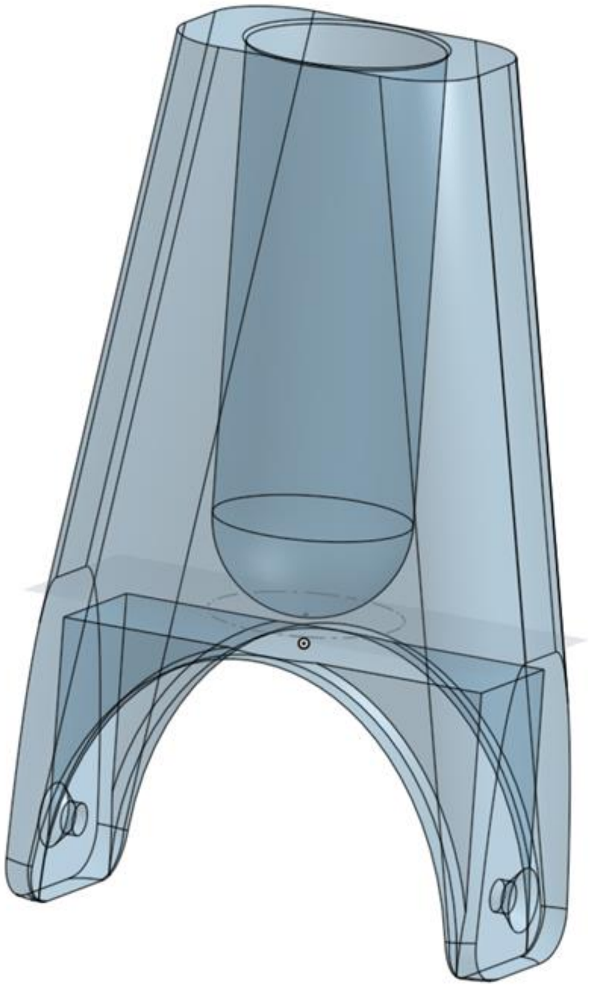


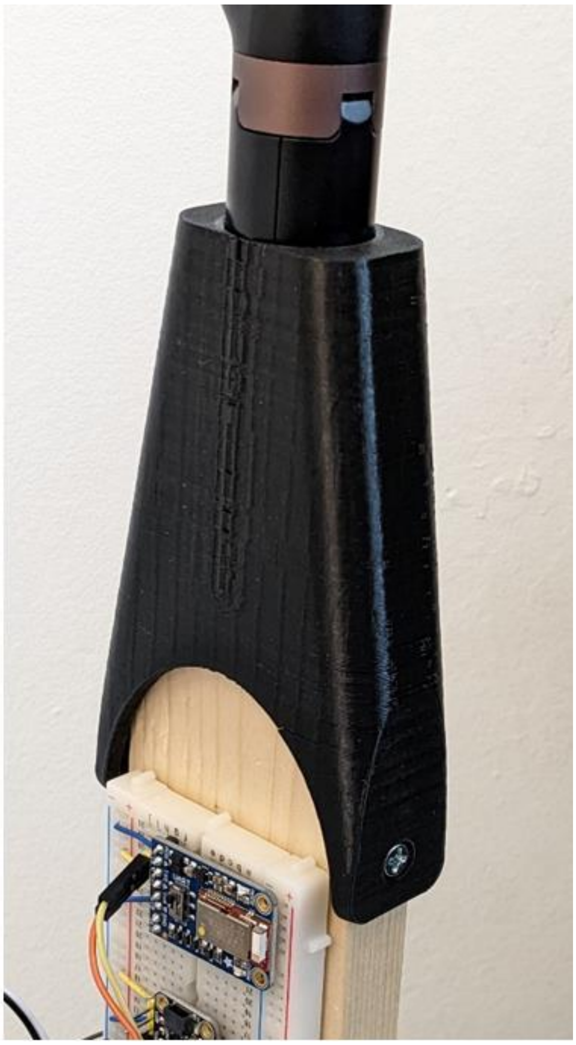


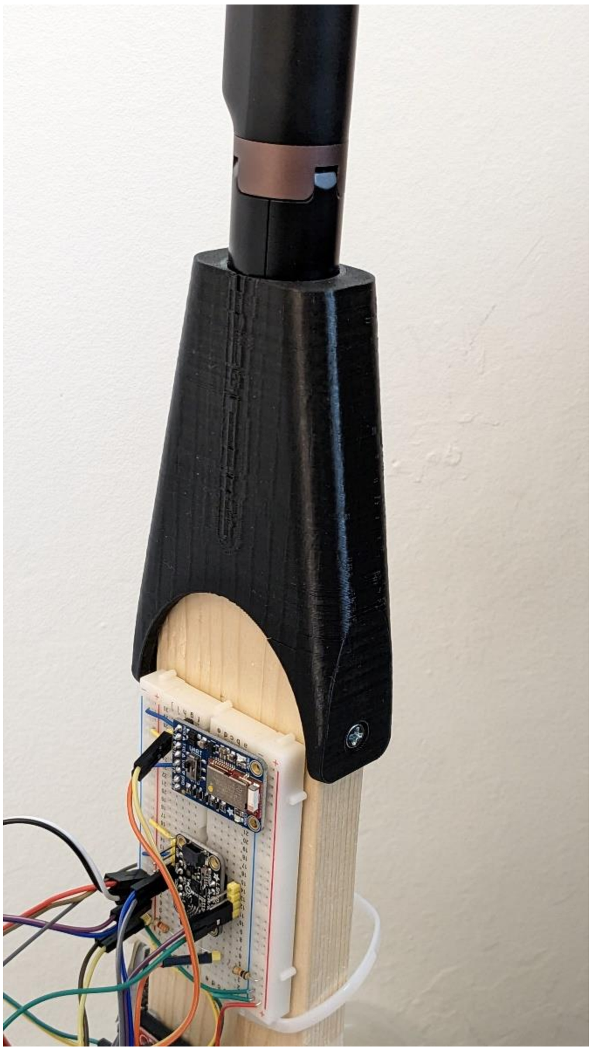

UART
TXO
CMD
DFU
CONN
LSM6DS33
6DoF Accel/Gyro
VIN
3V
GND
SCL
SDA
INT1

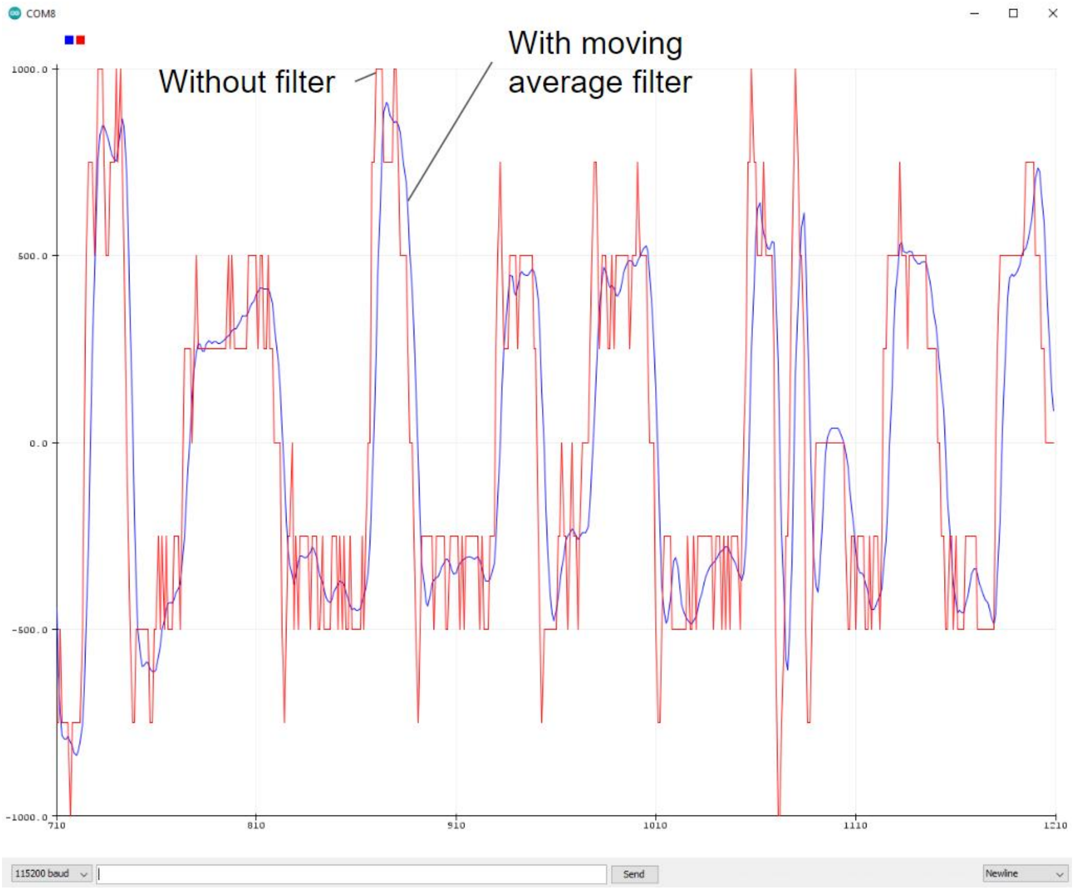






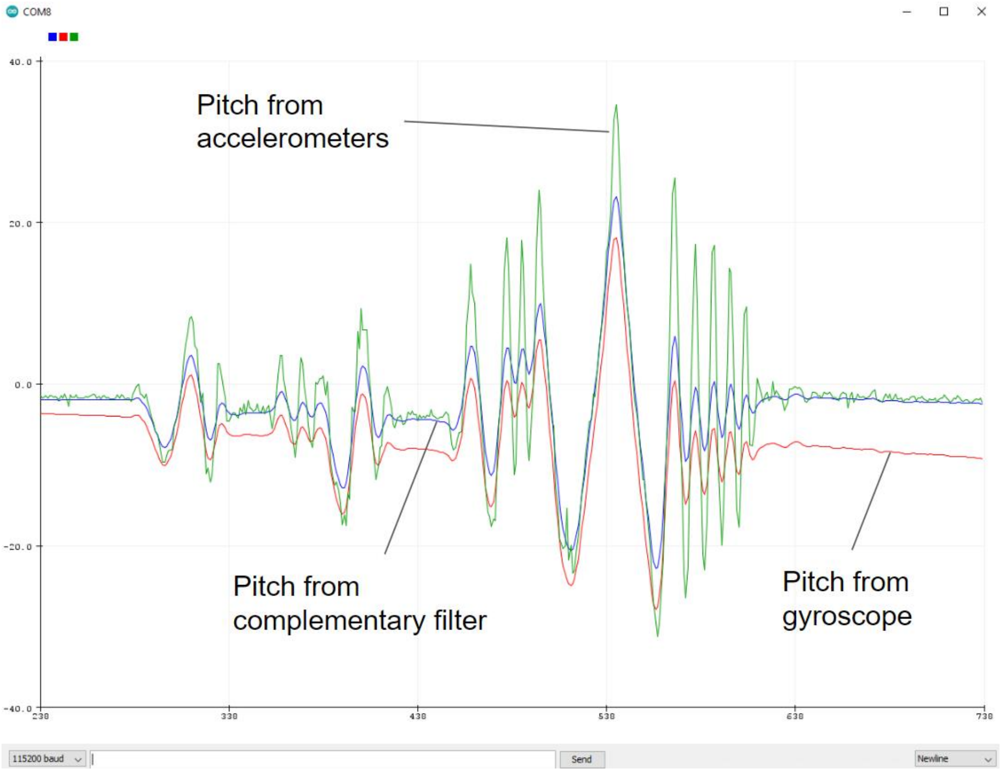






Without filter

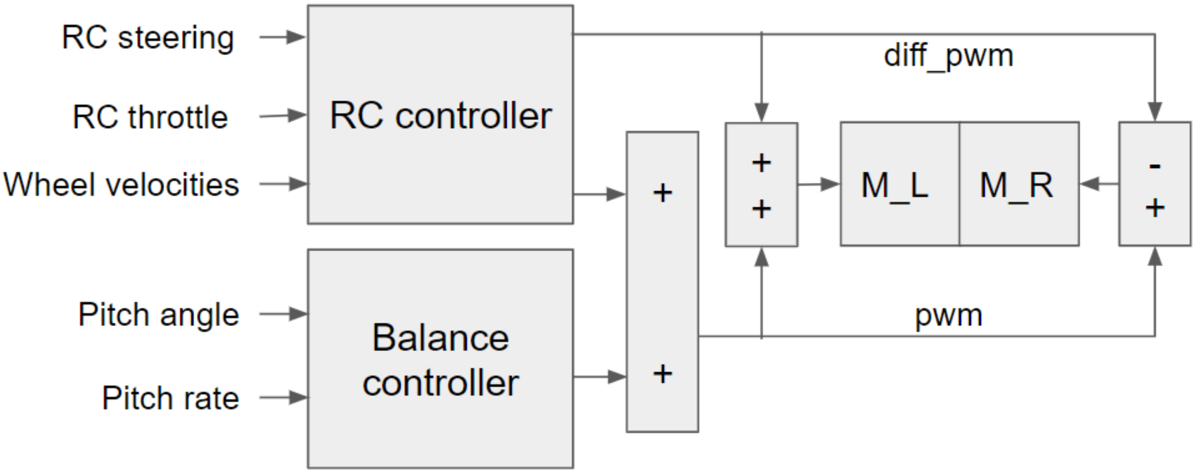
With moving average filter

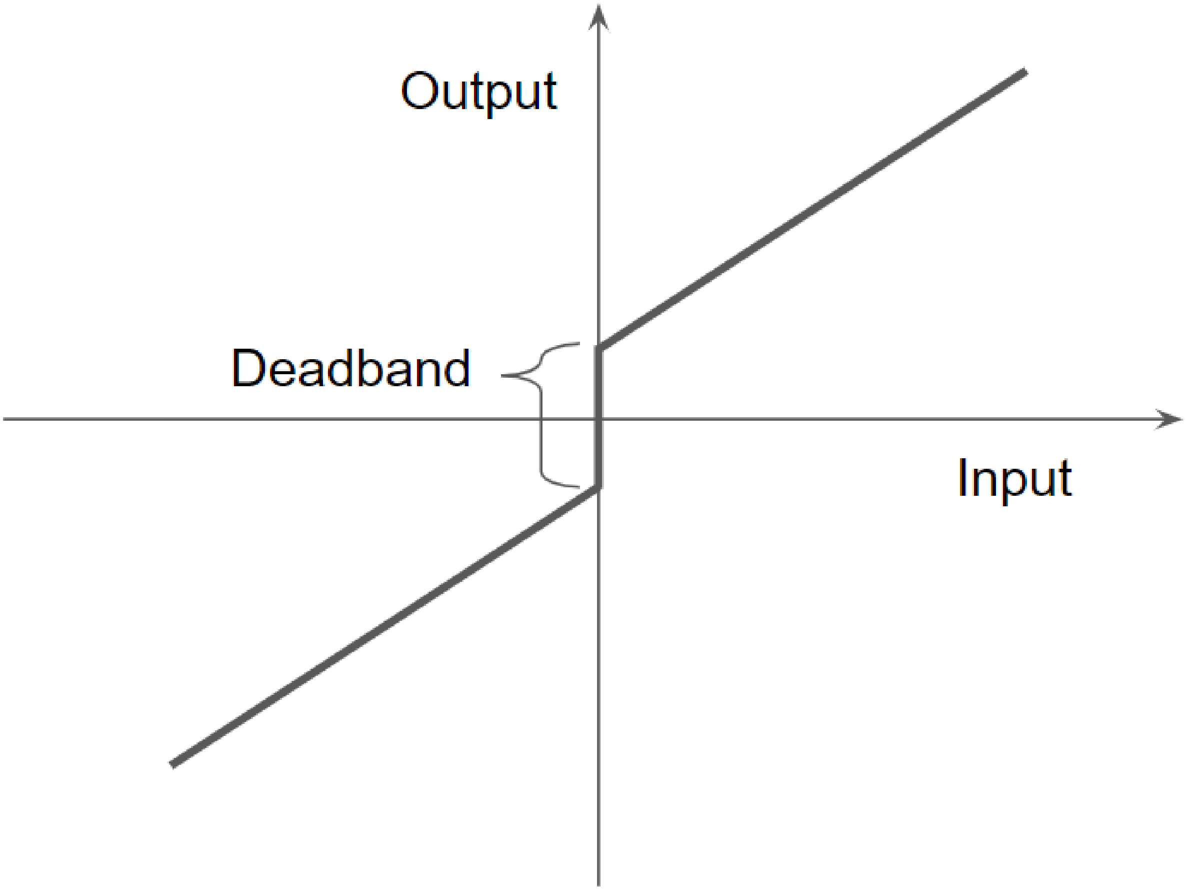


Pitch from accelerometers

Pitch from complementary filter

Pitch from gyroscope


RC steering
RC throttle
Wheel velocities
RC controller
Pitch angle
Pitch rate
Balance controller
+
+
diff_pwm
+
+
M_L
M_R
-
+
pwm


Output
Deadband
Input

Chapter 14: Wrapping Up, Next Steps, and a Look Ahead

No Images