

# Differential Dynamometer for Stroke Rehabilitation

## Build instruction

---

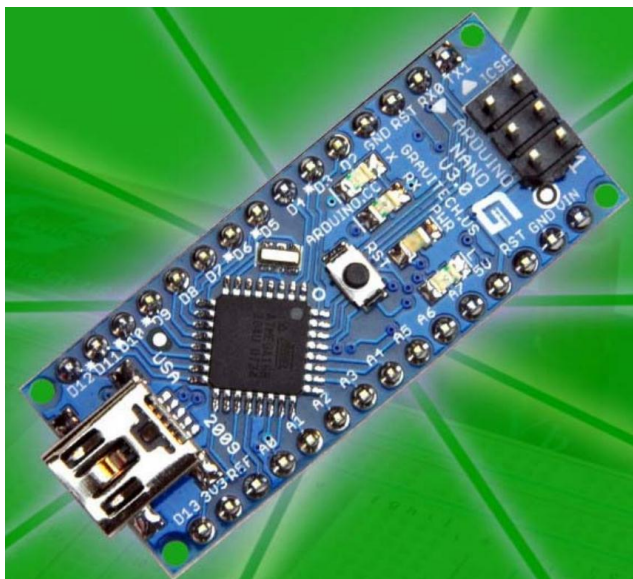
### Bill of Materials

We use in the project the components

1	Controller	Arduino nano R3	1
2	24 bit ADC shield	HX-711 shield	4
3	8 digits LED shield	max7219 0,36"LED shield	2
4	Tenso bridge	Kitchen Scale Sensor 5 kG	4
5	Push button	Any push button	2
6	Box for device	G1168G Gainta	1
7	Sensor mounting base	Plastic cutting board	1
8	Sensor cable connector	DB25f	1
9	Screws M5x25 mm		8
10	Nuts M5		8
11	Washer 5x10x4 mm		8

We make some introduction about it.

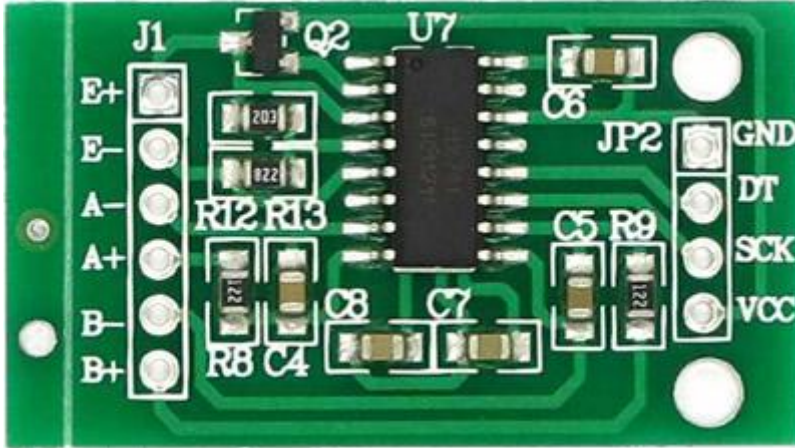
1. Controller Arduino Nano R3.x (992-ARD-NANO30NP) or any Arduino Nano R3.x compatible.



The Arduino IDE code works with any native or compatible PCB.

## 2. 24 bit ADC shield

We use Arduino compatible kitchen scale shield (PCB) with HX-711 chip. The signal from tensobridge is very small, so we need at least 24 bit sigma / delta ADC.



It is possible to use 2 or 4 shields, we use 4 because the chip has a long enough (>80 milliseconds) conversion time.

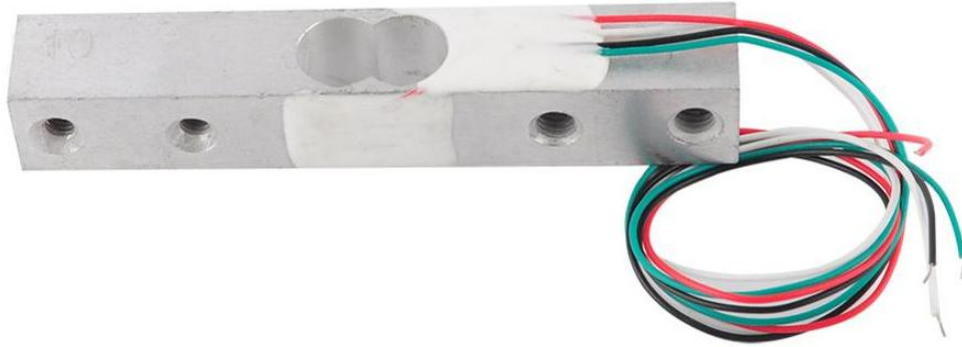
## 3. Max7219 0,36"LED shield

The Shield made using max7219 chips. The shields (two) show the force of fingers press in digital (4 signs in Gramms) or bar views.



## 4. Strain Gauges 5 kG

We recommend to use 5 kG Kitchen Scale Sensor sensors, but You can use any kind of sensors in the range 1 kGramms- 10 kGramms.



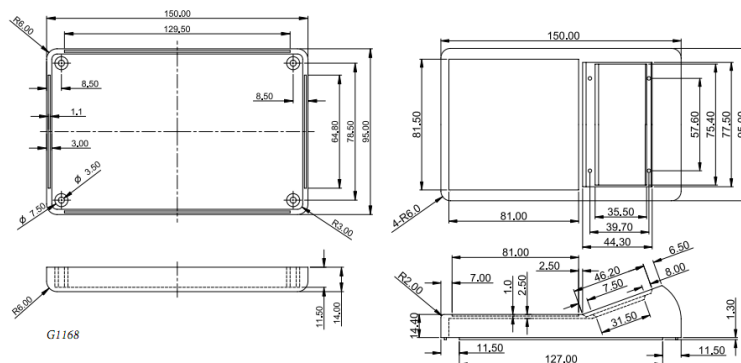
## 5. Push button

You can use one any momentary normal open push button, and one toggle push button.



## 6. Box for device

We use G1168G Gainta box. It is very convenient for display installation.



## 7. Sensor mounting base

We used plastic cutting board, but any flat surface can be used.



#### 8. Sensor cable connector DB25f and DB25m Cable

You can make the device without connectors, with direct cable connections. We suppose that the device with connectors can be used with other sensor board- for foots etc... You can use Mouser 649-DB25P064TXLF. Cable is shown on the figure too.

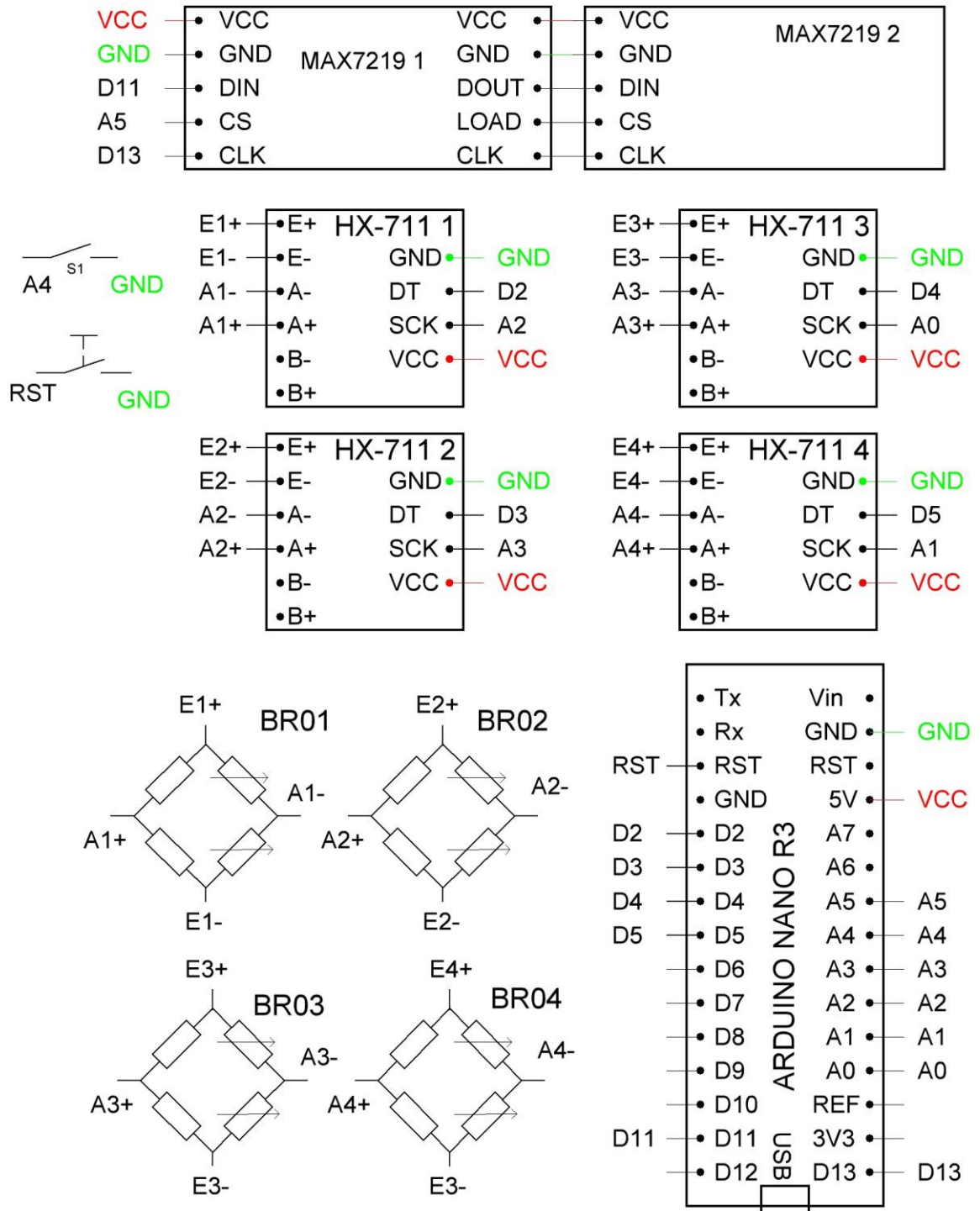


#### 9-11. Nuts, screws and washers

The size of screw-thread depends on screw-thread of strain gauges. 5 and 10 kGramms sensors has M5 (metric 5 mm ) screw-thread, 1-2 kGramms sensors have M4 screw-thread.

## Schematics

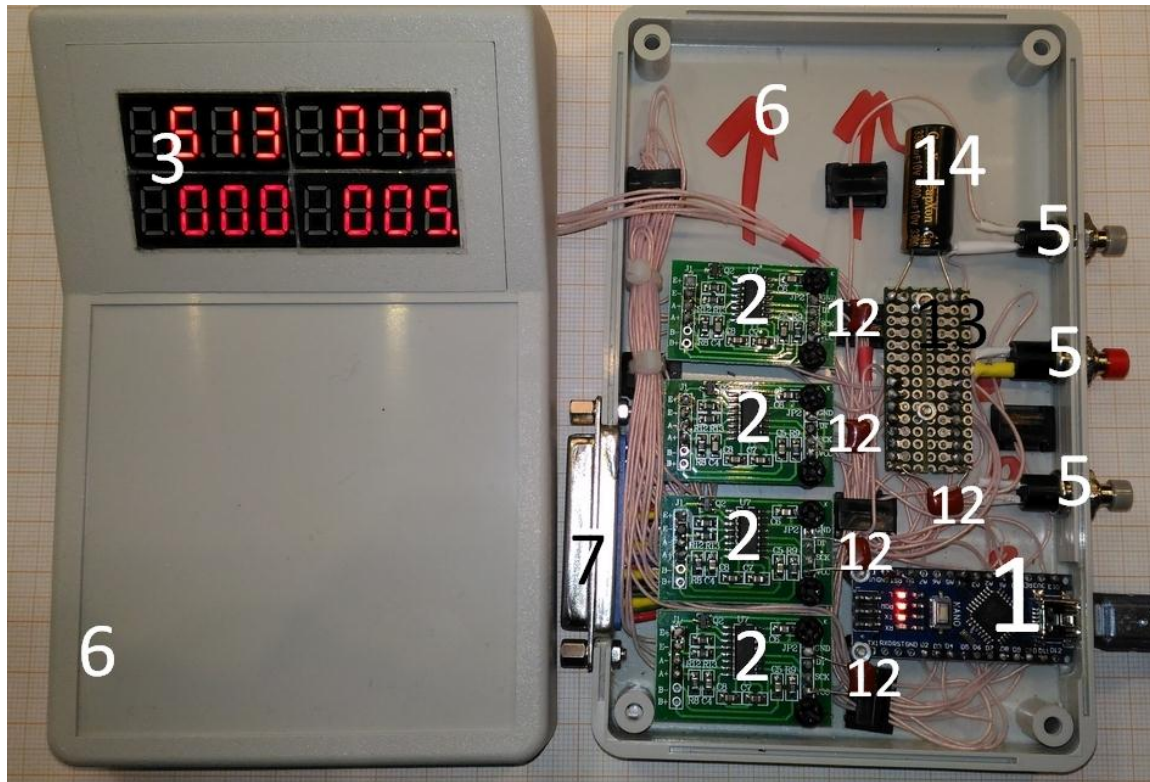
### 4 CHANNEL DIFFERENTIAL DYNAMOMETER LED 8X2



Power supply is over miniUSB connector of Arduino Nano. It is useful to solder some 0.1  $\mu\text{F}$  16 V capacitors on GND and VCC junctions of HX-711 shields, and 3300  $\mu\text{F}$  16 V low ESR capacitor parallel to VCC and GND pins.

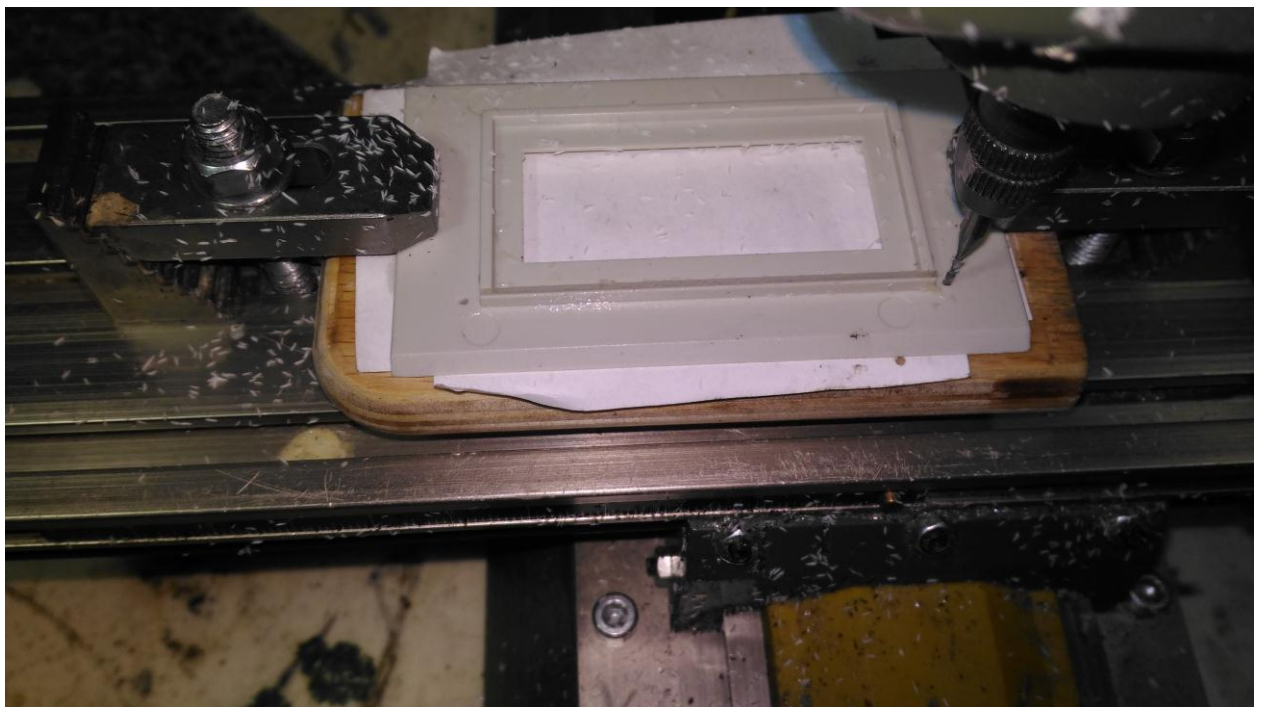
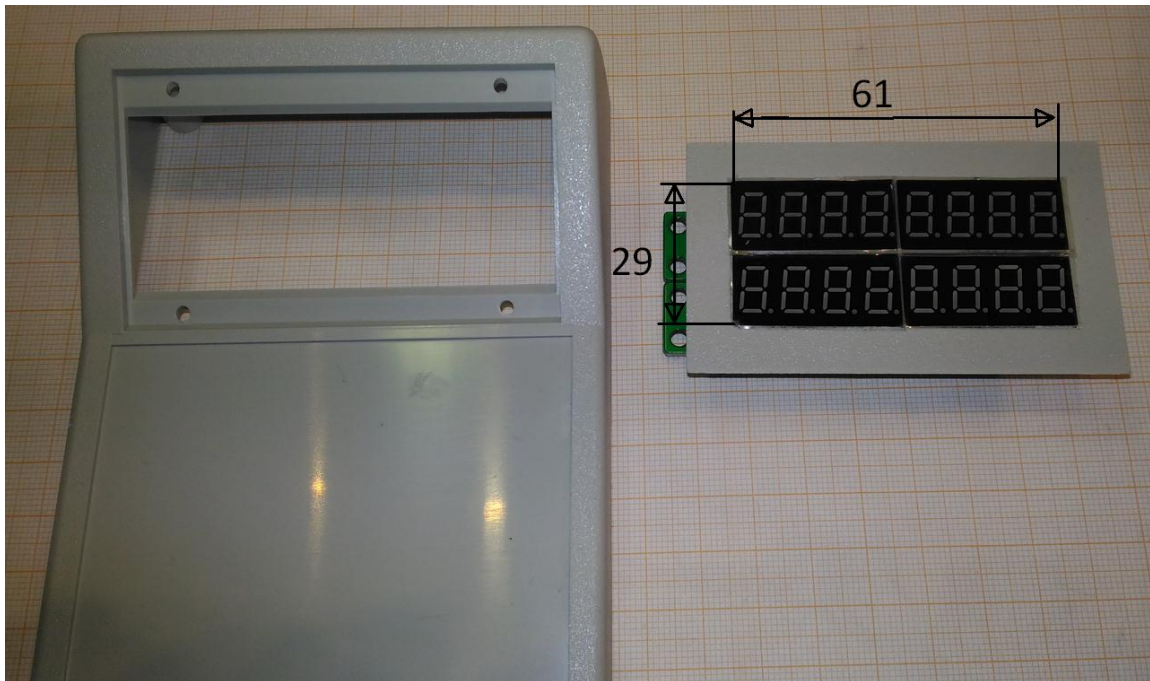
## Mechanical

You have to make holes for push button in any convenient place. We placed it on the right side of box, the DB25F connector- on the left side. You can do the device without connector, with wires soldered direct to HX-711 pins.

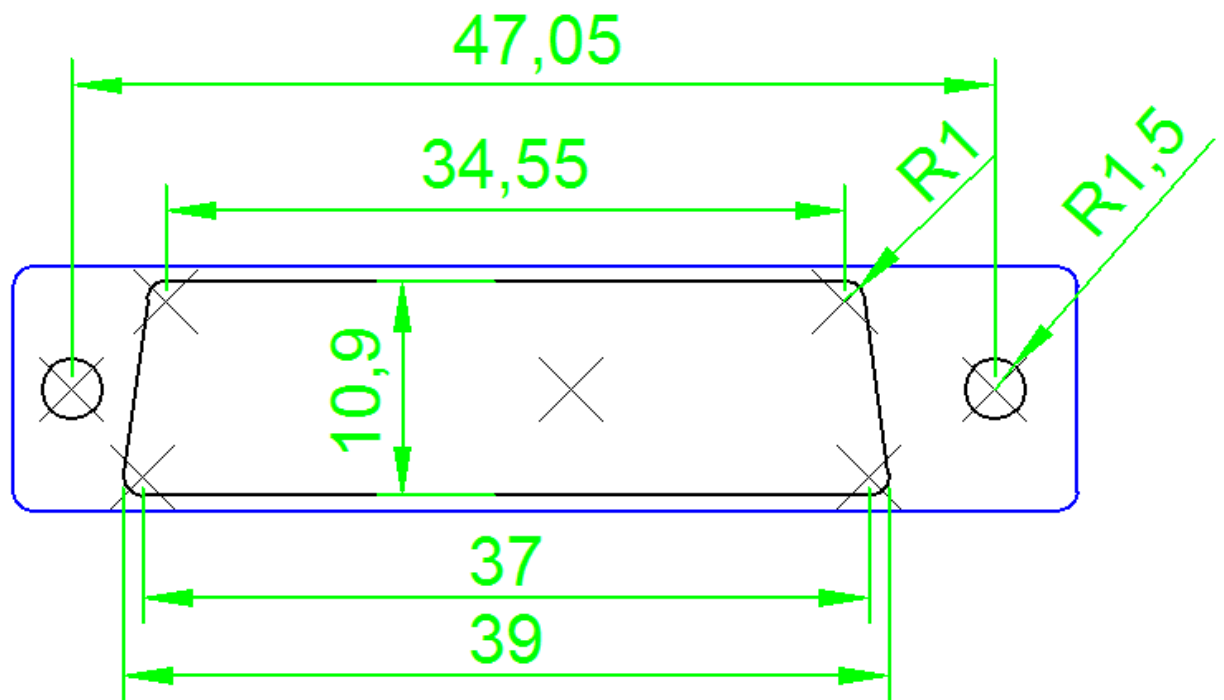


- 1 Controller
- 2 24 bit ADC shields
- 3 8 digits LED shields
- 5 Push button
- 6 Box for device
- 7 DB25F connector
- 8 Sensor cable connector
- 12 0.1 uF 16 V capacitors
- 13 PCB for GND and VCC connections
- 14 3300 uF 16 V low ESR capacitor

It is only one hole in upper box part- rectangular hole for two LED shields. It is good to make a hole with small mill cutter, but it can be done with knife and saw.



Miller cut the window in box top panel.



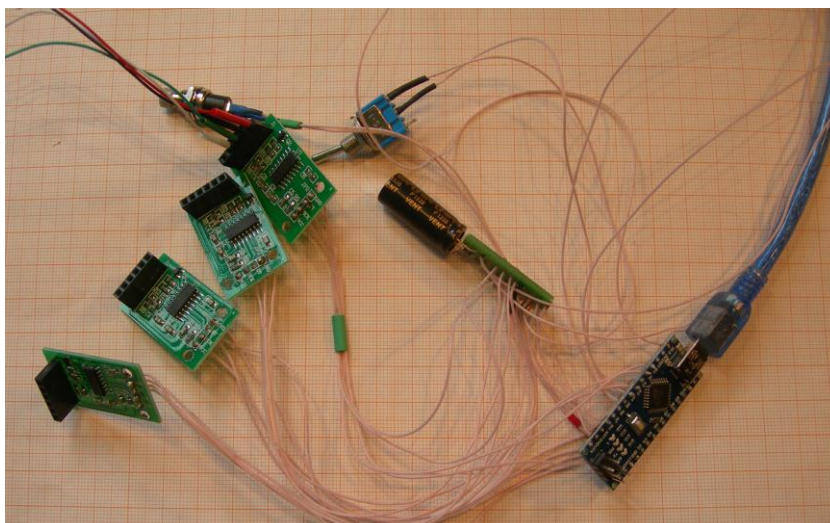
Hole for DB25F connector. Blue- external shield, black- hole , two round holes for screws.

Hole for Arduino USB mini is situated on the right side and has 8x4 mm size.

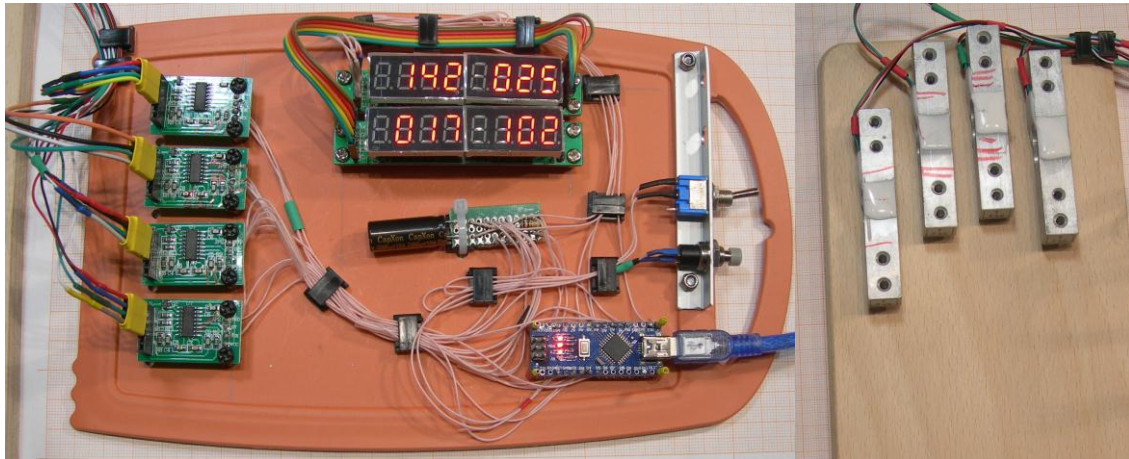
For installation of HX711, power and Arduino PCBs we use nylon PCB standoff (534-1903C) and nylon screws M3 and two M2 (for Arduino).

### Electronics

If You are not experienced in electronics, You can test the device without mount all the PCB and connectors. Here is example of device without box. All the PCBs and sensors are soldered by wires.



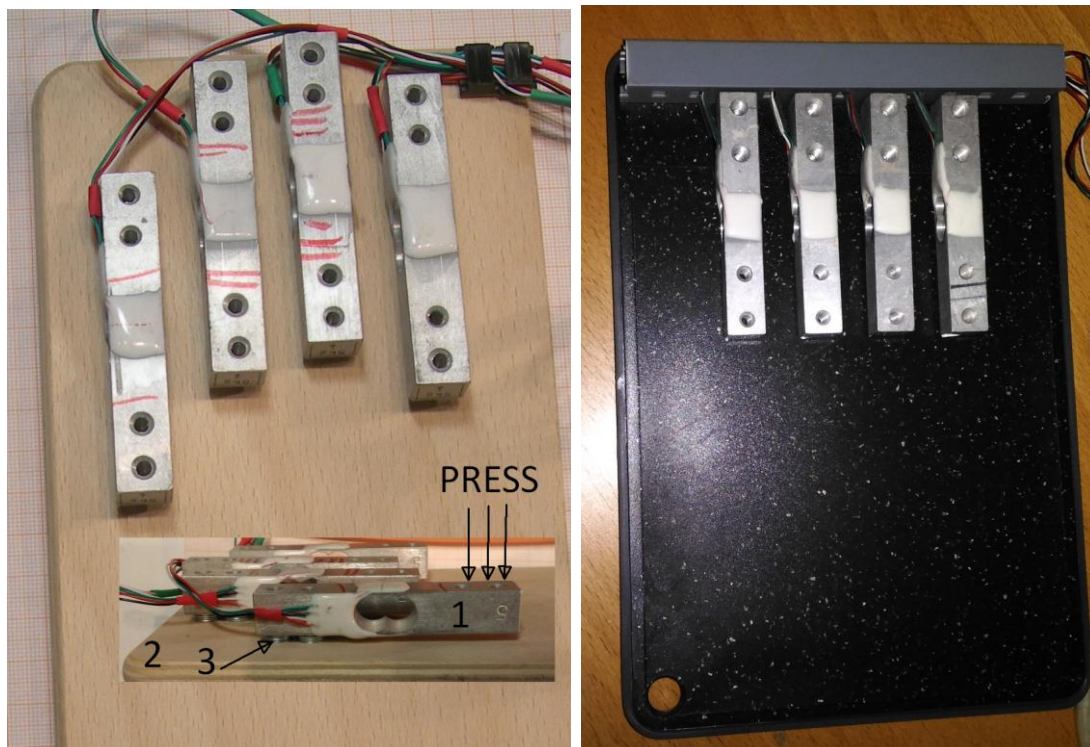
The example of such installation on a tray is shown here, and the sensors on the plywood board for cutting:



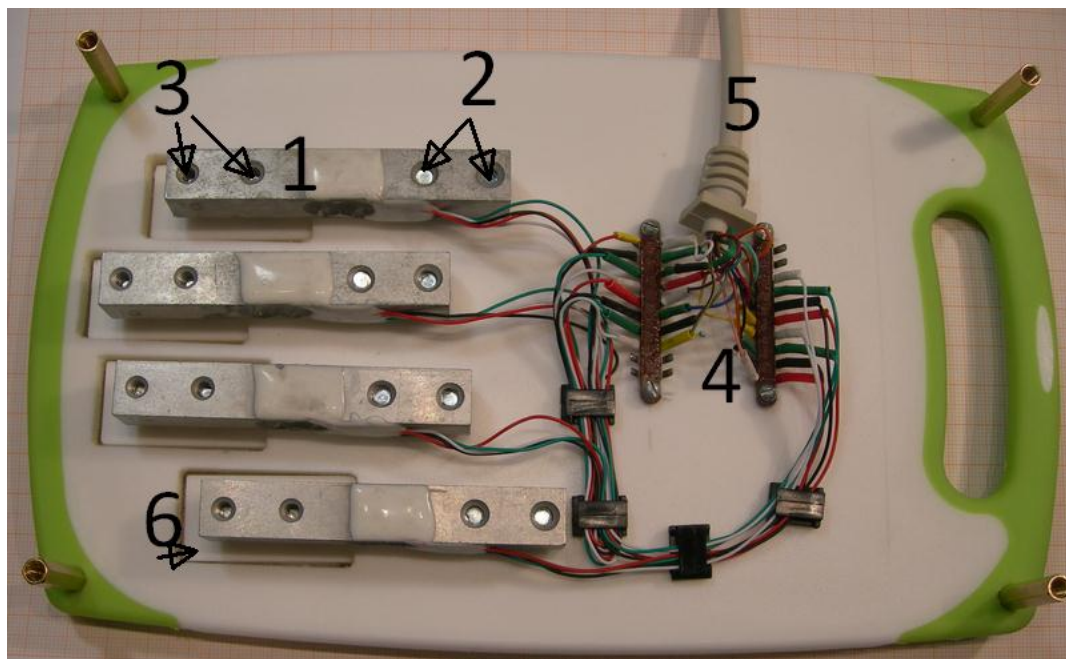
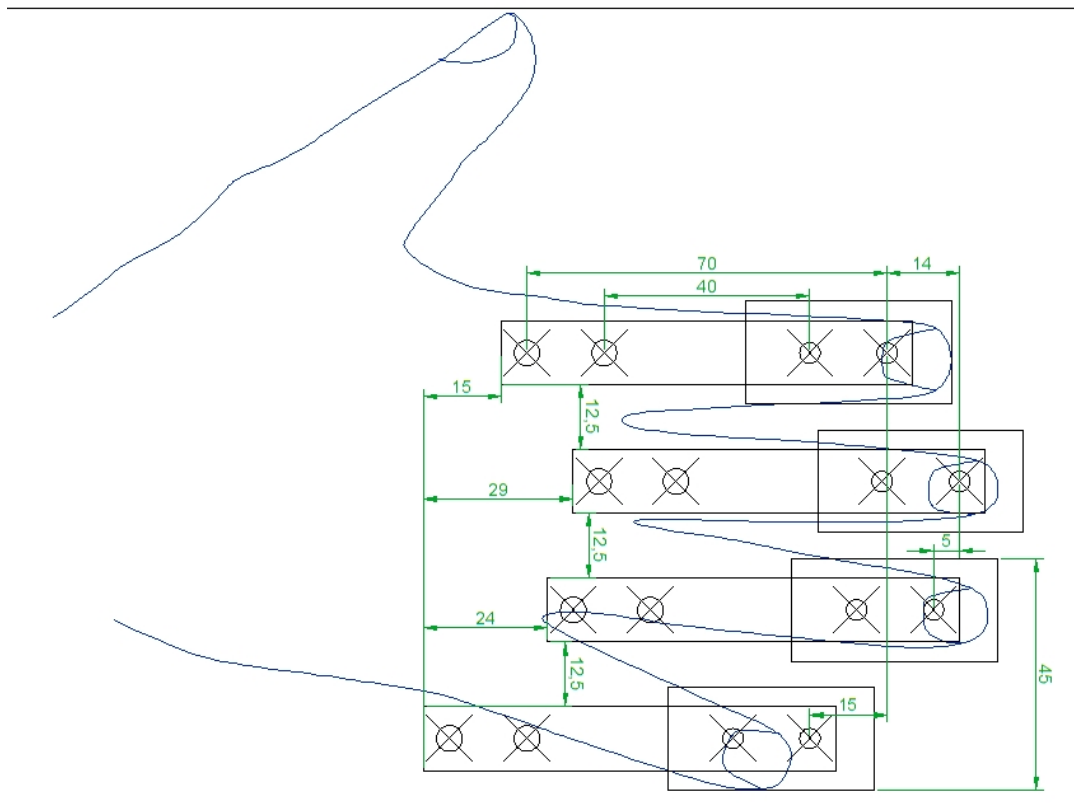
You can assemble all in a box after adjustment and verification.

### Simple Sensor Board

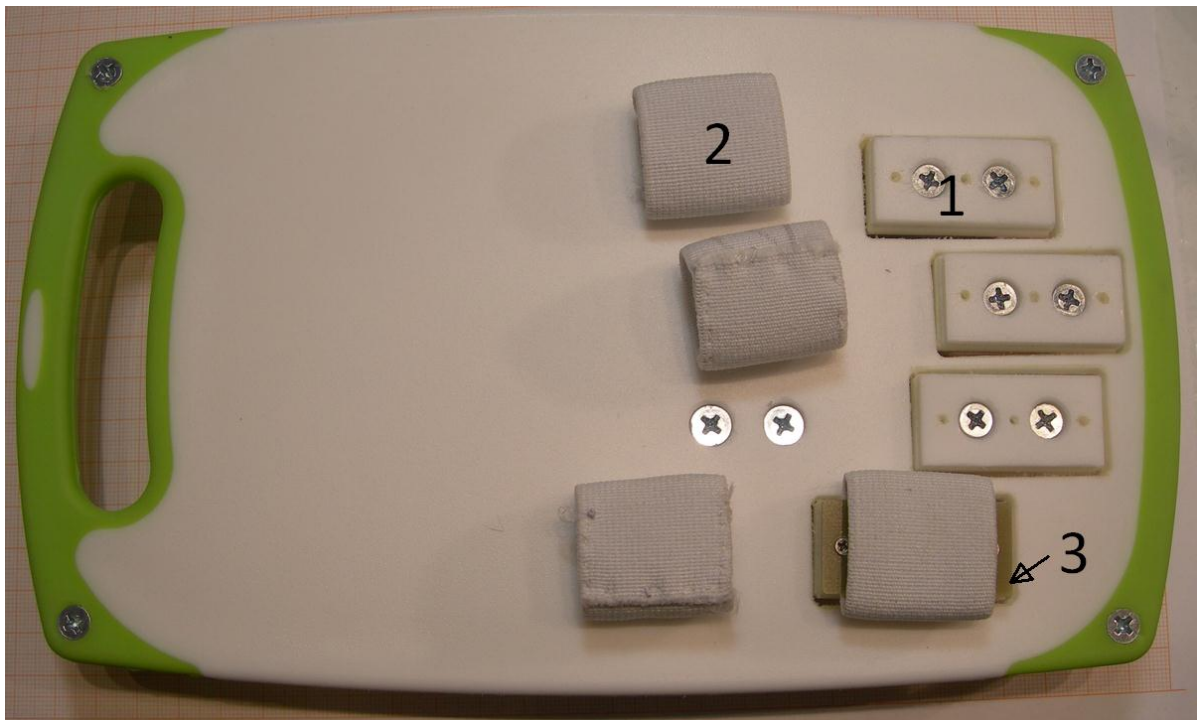
You can make simple Sensor Board, using plastic cutting board or a bit of plywood. The Sensors 1 are attached by means of screws with washers (3) to the plywood plate 2. You can also use plastic plate.



We made sensor board with closed sensors. The sizes of board depends of palm sizes and sensor types. We use 10 kG sensors in this board.



Four sensors (1) are attached with screws 2 with washers to the plate, and four finger plates (6) are attached to the sensors with screws 3. All wires are soldered to the terminals 4. Cable 5 goes to device. The bottom plate is screwed to the four screw racks.



The upper side of board: finger plates 1, ring of fabric band 2, plastic holder 3.



Working position of sensor board.

## Programming

Install (if You have no) Arduino IDE, download \*.ino file from depository <https://github.com/DrOnkel/DifDin.git> and load it to Your Arduino Nano. If You use another sensors, You have to ajust parameters in lines :

```
146 CountW[0] /= 4280L;    // Calibrate 0
```

```
238 CountW[1] /= 4283L; //Calibrate sensor 1
```

```
338 CountW[2] /= 4280L; // Calibrate sensor 2
```

```
424 CountW[3] /= 4283L; // Calibrate sensor 3
```

You can place all the electronics in a box when You check all the connecrions.

Take an interesting experience. Electronics is usefull and interesting.