

**University of Montenegro
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Podgorica**

Laboratorijske vježbe iz predmeta Industrijska elektronika

**Očitavanje temperature i sile na udaljenom Arduinou
(Vježba 1)**

**The measurement of temperature and force using
Arduino and Serial Terminal**

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Grupal (Mirko Kalezić, Tamara Koljenšić, Marija Milinković): Povezivanje temperaturnog senzora na Arduino, prikaz izmjerene temperature na terminal emulatoru i grafičkom monitoru i poredjenje sa alarmnom vrijednošću (kada se pali LED).

Grupall (Vesna Mandić, Ivan Martinović, Danko Petrić): Povezivanje dinamometra na Arduino, prikaz izmjerene vrijednosti sile na terminal emulatoru i grafičkom monitoru i poredjenje sa alarmnom vrijednošću (kada se pali LED).

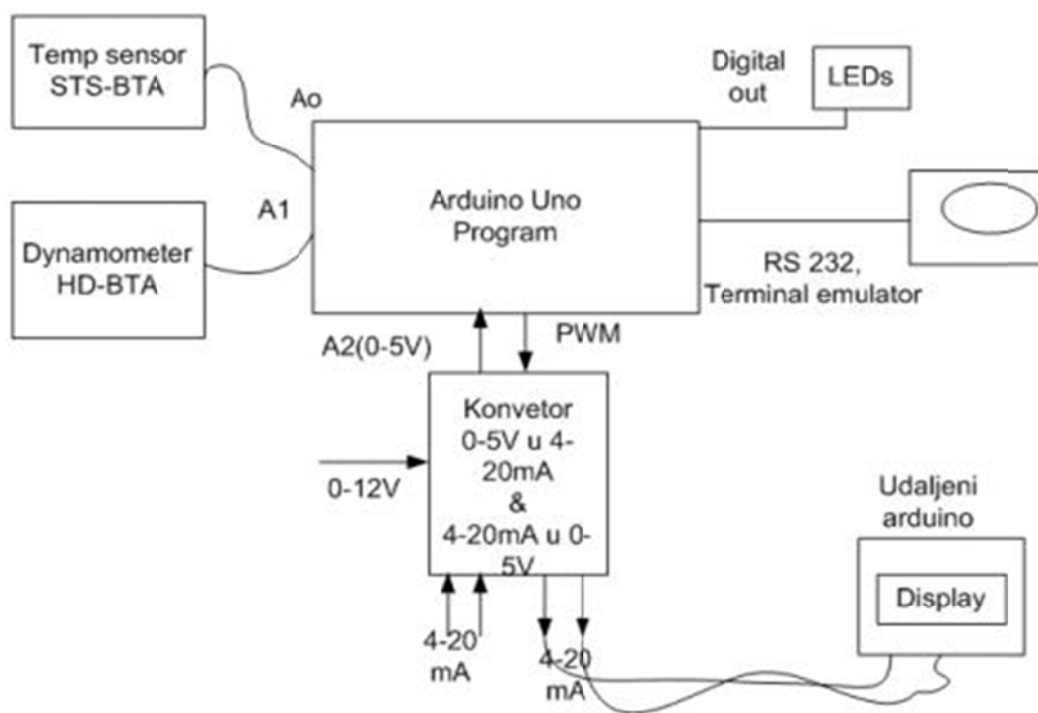
Grupalll (Božidar Andrović, Savo Pejović, Boris Turković): Projektovanje pretvarača naponskog izlaza u strujni i obrnuto (0-5V u 4-20mA i (4-20mA u 0-5V), koristeći operacione pojačavače LM358, LM324. Provjeriti rad temperaturnog senzora sa strujnim izlazom. Na drugom udaljenom Arduinou čitati temperaturu.

Za informaciju o temperaturnom senzoru koristiti:

<https://www.vernier.com/files/manuals/sts-bta/sts-bta.pdf>

Ponoviti gornji primjer za slučaj dinamometra:

<https://www.vernier.com/files/manuals/hdbta/hd-bta.pdf>



Abstract:

We use surface temperature sensor and hand dynamometer to display measured values on Arduino Uno and carry them over long distance.

Surface temperature sensor is used for temperature measurements and it is useful in medicine, industry and commercial purposes.

Hand dynamometer is used to measure force. The most common usage of it is in medicine because it can measure grip and pinch strength.

Measurement results are shown on graphical monitor and terminal emulator of Arduino. Also, LED diode has function of alarm and it is turned on if measured value is above specified.

For showing measured values of both sensors we used the same Arduino code. Given code is uploaded on first Arduino – one on the receiving side, one that sends data about measured temperature and force.

For Arduino to make difference which one sensor is used, we call function Vernier.sensorNumber() that gives information about sensor ID number - different for different sensors. Temperature sensor's ID is 10, and dynamometer's ID is 67.

If measured value is above specified, LED diode is ON (Photo 2). Specified limit value for temperature sensor is 30°C and 250N for dynamometer.

Objašnjenje šeme rešenja:

Za prikazivanje izmjerenih vrijednosti oba senzora koristili smo isti Arduino kod. Ovaj Arduino kod se nalazi na predajnoj strani, tj. na Arduino koji šalje podatke o temperaturi ili sili.

Da bi Arduino razlikovao senzor sa kog prima podatke koristili smo funkciju Vernier.sensorNumber() koja daje podatke o ID broju senzora koji je različit za različite senzore. Za temperaturni senzor ID je jednak 10, a za dinamometar je 67.

Ukoliko vrijednost očitana sa senzora pređe preko specificirane (alarmantne) vrijednosti, pali se LED dioda (slika 2). Alarmantna vrijednost temperaturnog senzora je 30°C, odnosno 250N za dinamometar.

Nakon toga, poslednji dio Arduino koda služi za prikazivanje izmjerenih vrijednosti temperature i sile. Promjene tih vrijednosti smo prikazali grafički (Slika 3. –za temperaturu, Slika 6. –za silu) i na serijskom monitoru (Slika 4. –za temperature, Slika 7. –za silu).

```
#include "VernierLib.h"
VernierLibVernier;
float sensorReading;
int LED=8;
int slanje=3;
int y;
void setup()
{
  pinMode(LED, OUTPUT);
  pinMode(slanje,OUTPUT);
  Serial.begin(9600);
  Vernier.autoID();// this is the routine to do the auto ID
  print SensorInfo();
```

```
}
```

```
void loop()
```

```
{  
  sensorReading = Vernier.readSensor();  
  if(sensorReading <= 0){  
    Serial.print(0);  
  }  
  else{  
    Serial.print(sensorReading);  
  }  
  Serial.print(" ");  
  Serial.println(Vernier.sensorUnits());  
  if(Vernier.sensorNumber() == 10){  
    y = map(sensorReading, -25, 125, 0, 255);  
    analogWrite(slanje, y);  
    delay(10);  
  }  
  else{  
    y = map(sensorReading, 0, 850, 0, 255);  
    analogWrite(slanje, y);  
    delay(1000);  
  }  
  if(Vernier.sensorNumber() == 10 && sensorReading > 30){  
    digitalWrite(LED, HIGH);  
  
  }  
  else if(Vernier.sensorNumber() == 67 && sensorReading > 250){  
    digitalWrite(LED, HIGH);  
    delay(500);  
  }  
  else{  
    digitalWrite(LED, LOW);  
  }  
  delay(500); // half a second  
}
```

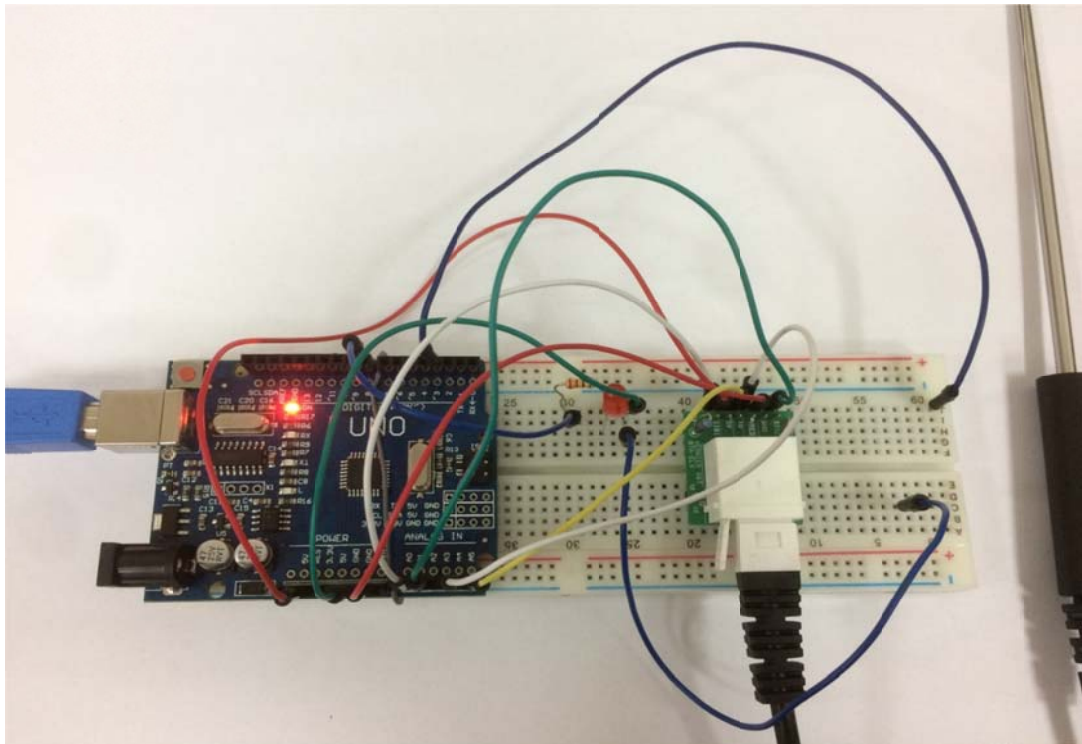
```
void printSensorInfo()
```

```
{  
  // print out information about the sensor found:  
  Serial.println("Sensor Information:");  
  Serial.print("Sensor ID number: ");  
  Serial.print("\t");  
  Serial.println(Vernier.sensorNumber());  
  Serial.print("Sensor Name: ");  
  Serial.print("\t");  
  Serial.println(Vernier.sensorName());  
  Serial.print("Short Name: ");  
  Serial.print("\t");  
  Serial.println(Vernier.shortName());  
  Serial.print("Units: ");  
  Serial.print("\t");  
  Serial.println(Vernier.sensorUnits());  
}
```

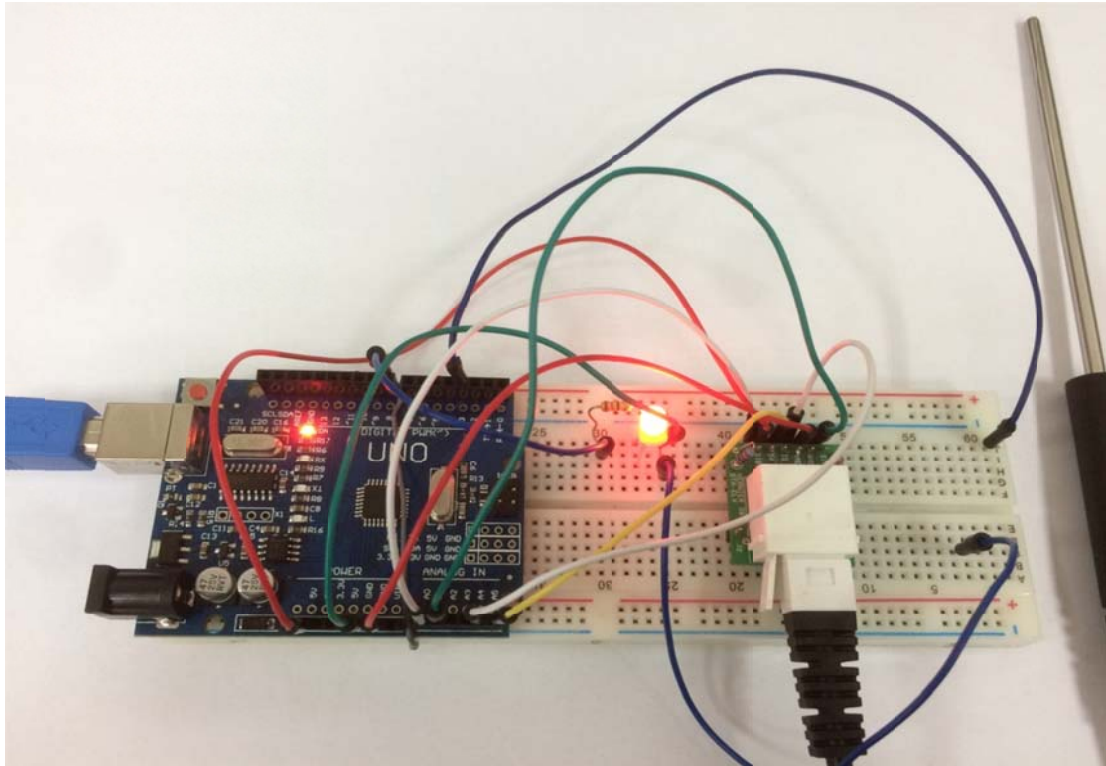
```
Serial.print("ID voltage level: ");
Serial.print("\t");
Serial.println(Vernier.voltageID());
Serial.print("Page: ");
Serial.print("\t");
Serial.println(Vernier.page());
Serial.print("slope: ");
Serial.print("\t");
Serial.println(Vernier.slope());
Serial.print("intercept: ");
Serial.print("\t");
Serial.println(Vernier.intercept());
Serial.print("cFactor:");
Serial.print("\t");
Serial.println(Vernier.cFactor());
Serial.print("calEquationType: ");
Serial.print("\t");
Serial.println(Vernier.calEquationType());
}
```

Spajanje senzora sa Arduinoom se obavlja preko Vernier adaptera. Pinovi su povezani na sledeći način:

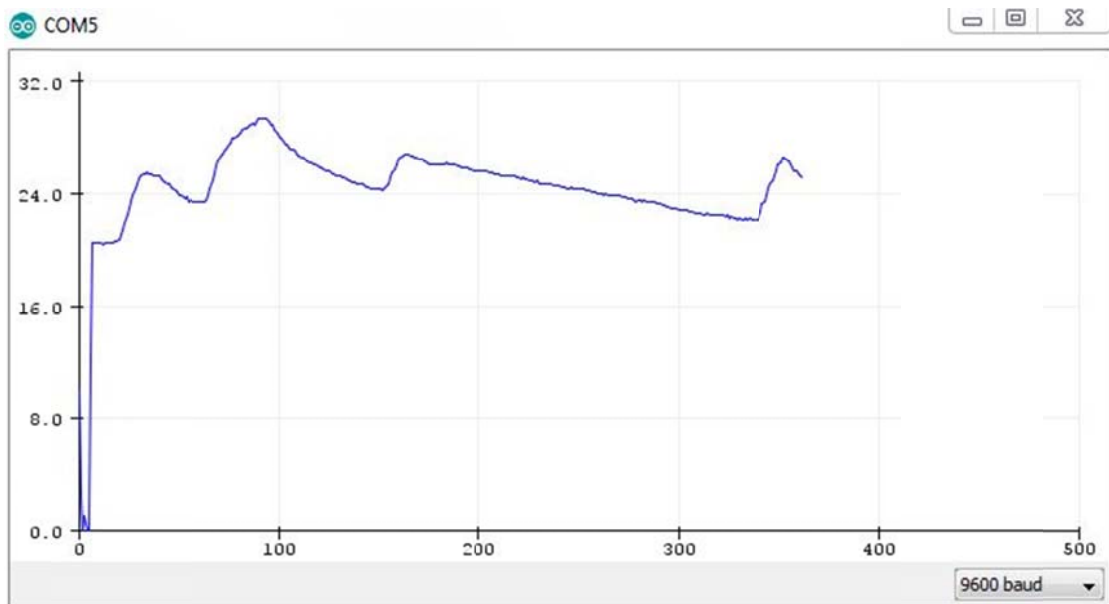
- SIG2 na Arduino pin A1
- GND na Arduino pin GND
- Vres na Arduino pin A4
- ID na Arduino pin A5
- 5V na Arduino pin 5V
- SIG1 na Arduino pin A0



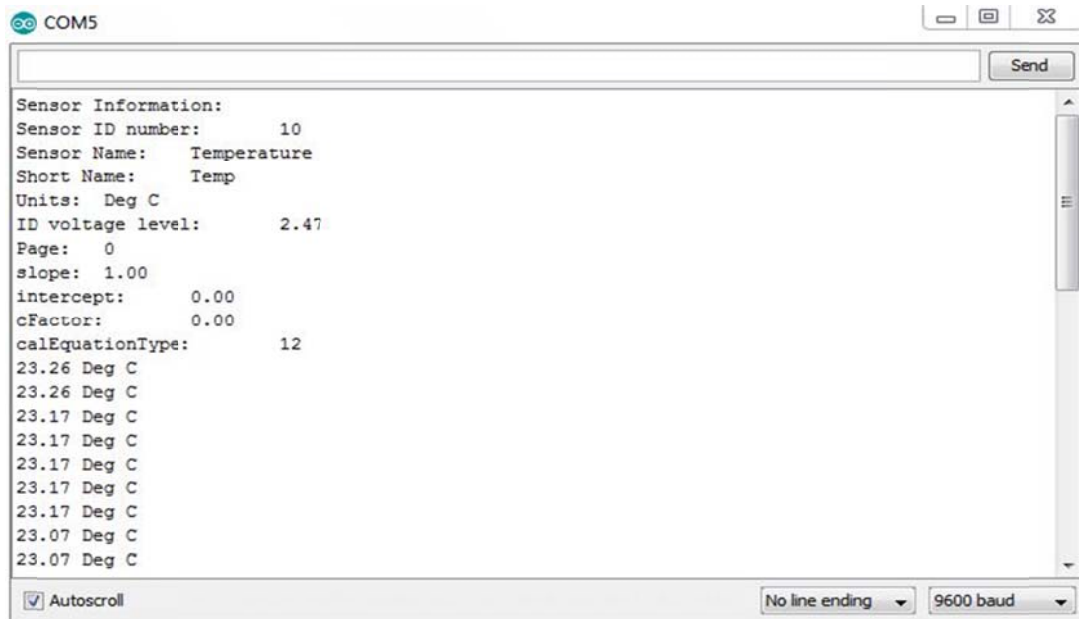
Slika 1. Temperaturni senzor kada je mjerena temperature ispod alarmantne vrijednosti



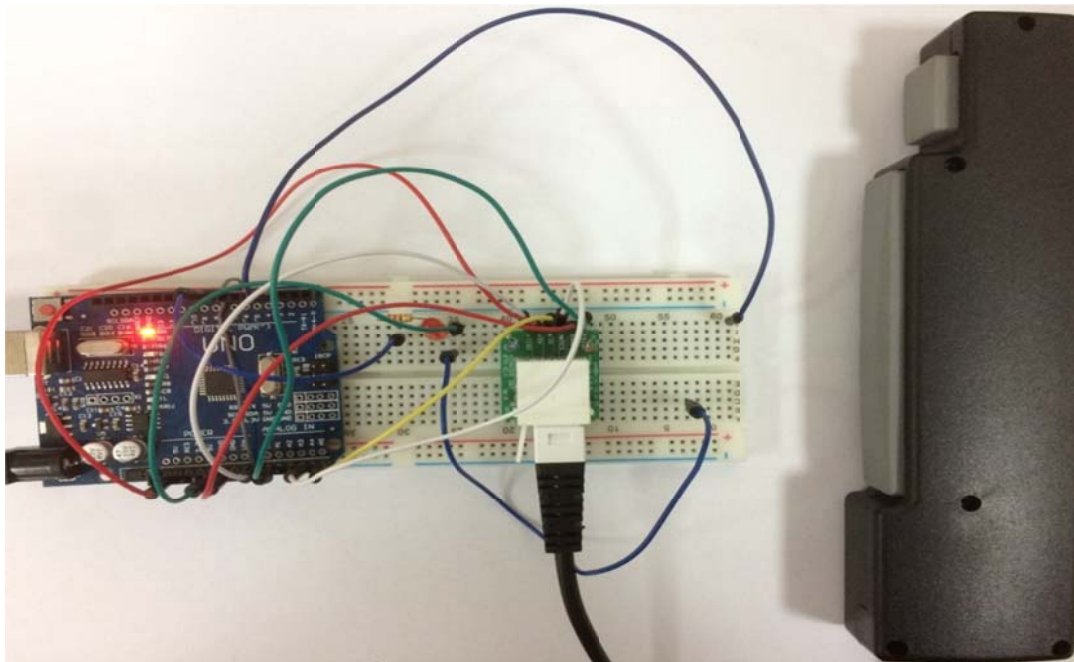
Slika 2. Temperaturni senzor kada je mjerena temperature iznad alarmantne vrijednosti (svijetli LED dioda)



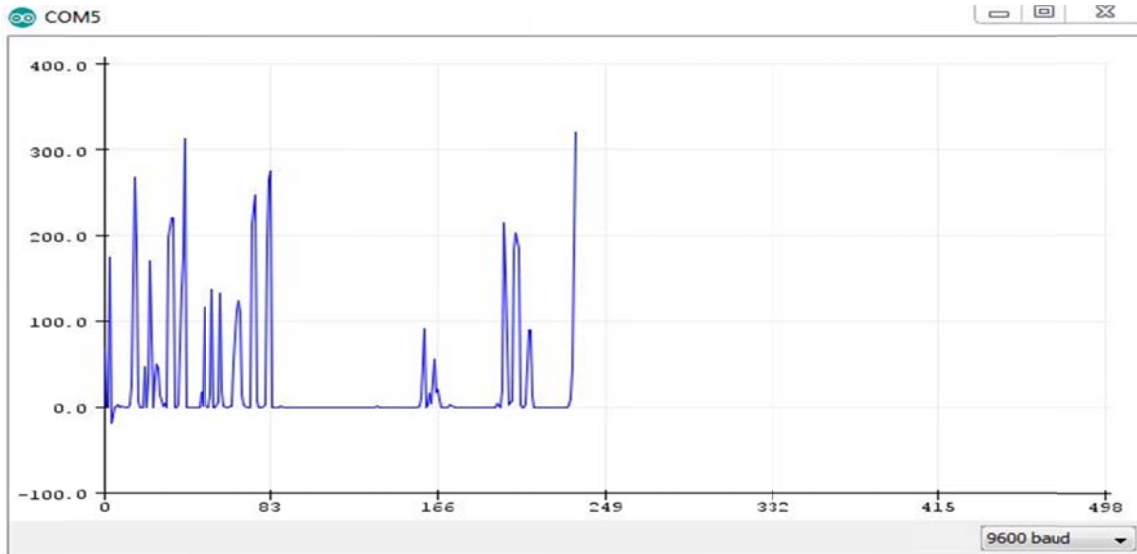
Slika 3. Grafički prikaz promjene temperature



Slika 4. Prikaz promjene temperature na serijskom monitoru



Slika 5. Mjerenje sile pomoću dinamometra



Slika 6. Grafički prikaz promjene sile

The figure shows a text-based output window titled 'COM5'. At the top right is a 'Send' button. The text content is as follows:

```

Sensor Information:
Sensor ID number:      67
Sensor Name:          Force
Short Name:           Force
Units:                (N)
ID voltage level:     -1.00
Page:                 0
slope:                174.70
intercept:            -19.14
cFactor:              0.00
calEquationType:     1
0 (N)
0 (N)
0 (N)
0 (N)
26.07 (N)
3.04 (N)
20.95 (N)
0 (N)
0 (N)
91.75 (N)
0 (N)
33.75 (N)
118.20 (N)
108.81 (N)

```

At the bottom left, there is a checked checkbox for 'Autoscroll'. At the bottom right, there are two dropdown menus: 'No line ending' and '9600 baud'.

Slika 7. Prikaz promjene temperature na serijskom monitoru

Arduino kod na prijemnoj strani:

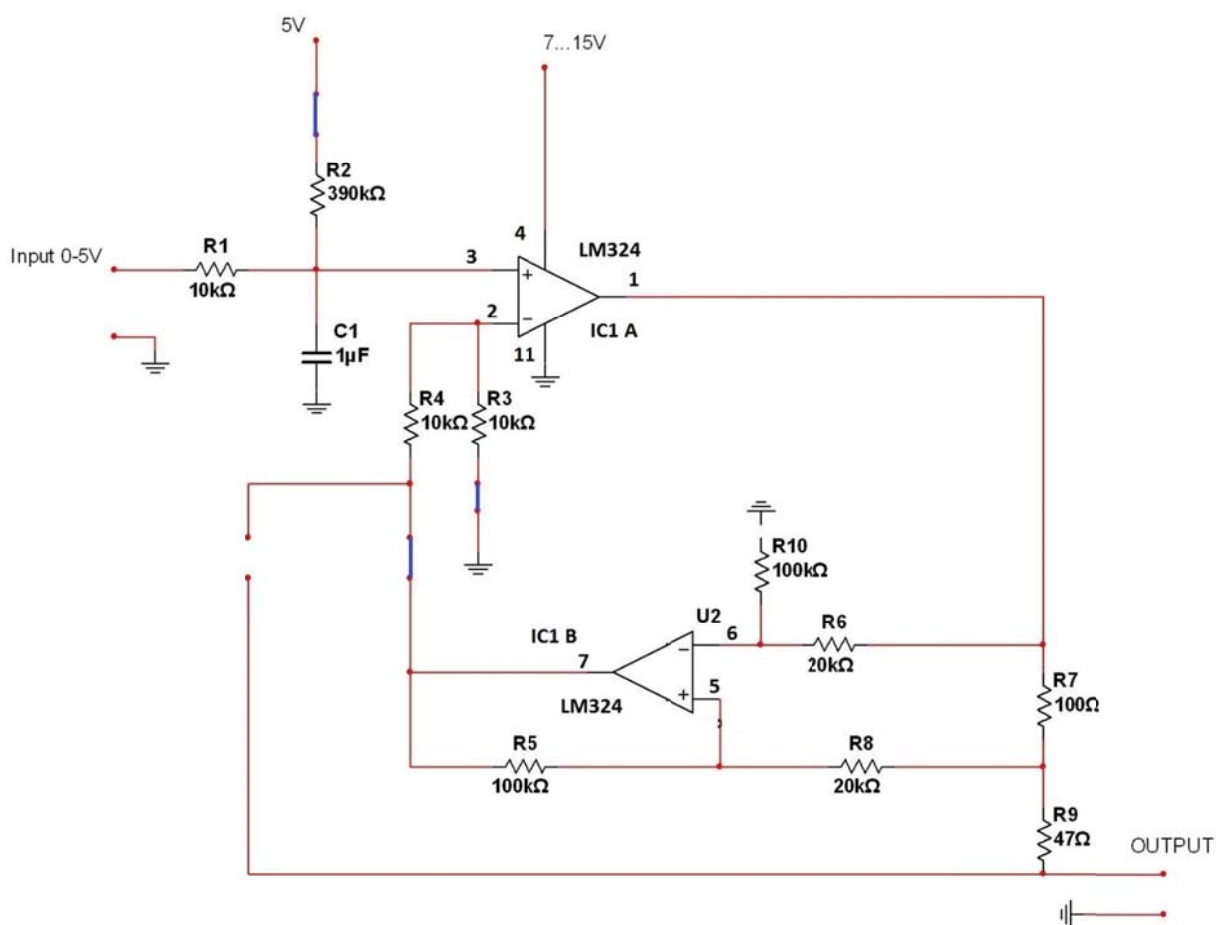
```
float sensorReading;
int prekidac=6;
int LED=8;
floatslanje=A3;
float y;
float k=0;
void setup()
{
  pinMode(LED, OUTPUT);
  pinMode(slanje,INPUT_PULLUP);
  pinMode(prekidac,INPUT_PULLUP);
  Serial.begin(9600);
}

void loop()
{
  if(digitalRead(prekidac)==HIGH){
    k=0;
    for(inti=0;i<10000;i++){
      y = map(analogRead(slanje),102,1023,-25,125);
      k=(k+y);
    }
    k=k/10001;
  }
  else{
    y = map(analogRead(slanje),102,1023,0,850);

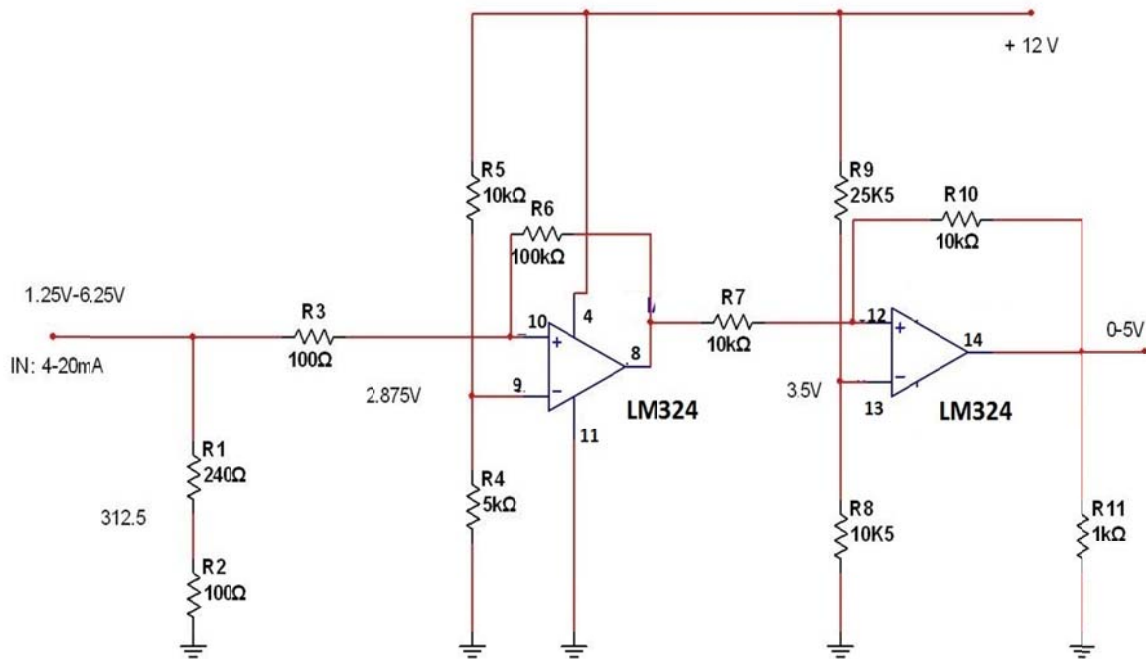
    if(y<=0)
      k=0;
    else
      k=y;
  }

  Serial.println(k);
  delay(1000);
}
```

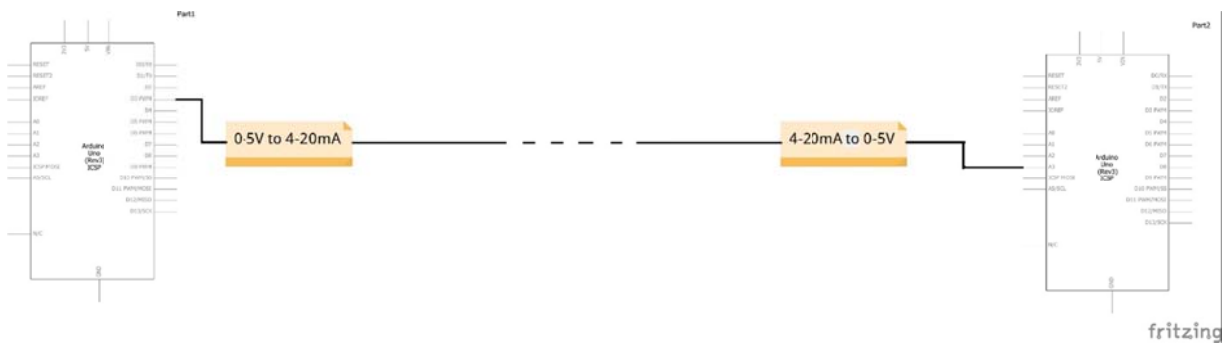
Prenos izmjerenih vrijednosti na udaljeni Arduino se vrši pomoću pretvarača naponskog izlaza u strujni i obrnuto (0-5V u 4-20mA i (4-20mA u 0-5V)). Na predajnoj strani se izlazni napon konvertuje u struju, dalje se struja prenosi da bi se na predajnoj strani struja pretvorila u napon. Signal se prenosi u obliku struje zato što je ona manje osjetljiva na smetnje i šumove koji se mogu javiti u prenosu. Taj napon se dovodi na ulaz Arduina koji očitava izmjerene vrijednosti. Pretvarač napona u struju je realizovan prema kolu u kom su upotrijebljena dva operaciona pojačavača LM324 a kompletna šema je na Slici 8. Slično, pretvarač struje u napon je kolo prikazano na Slici 9.



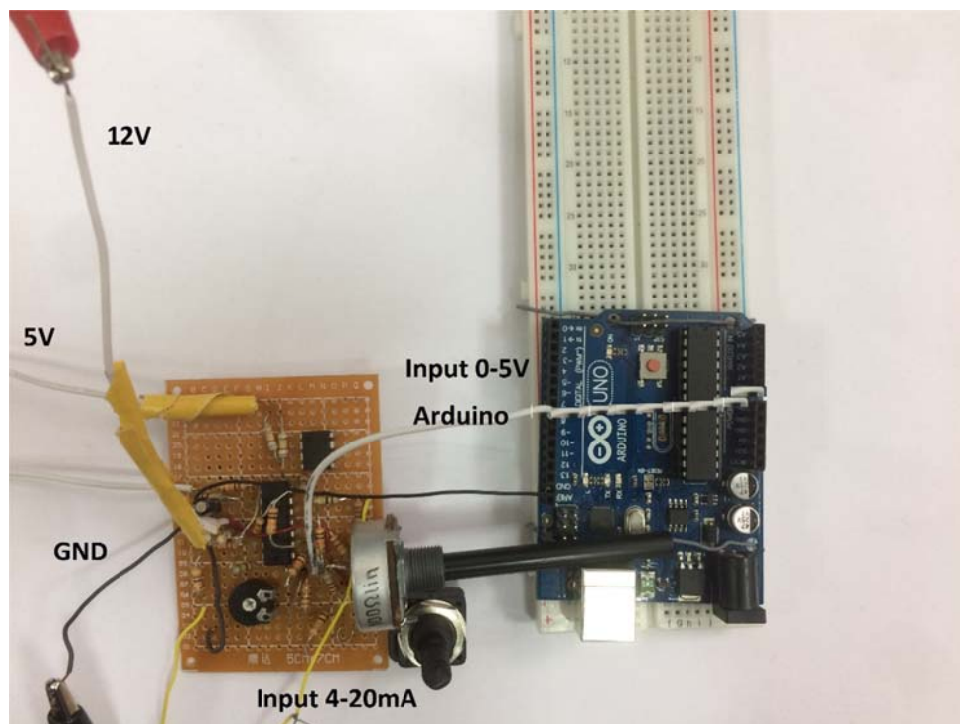
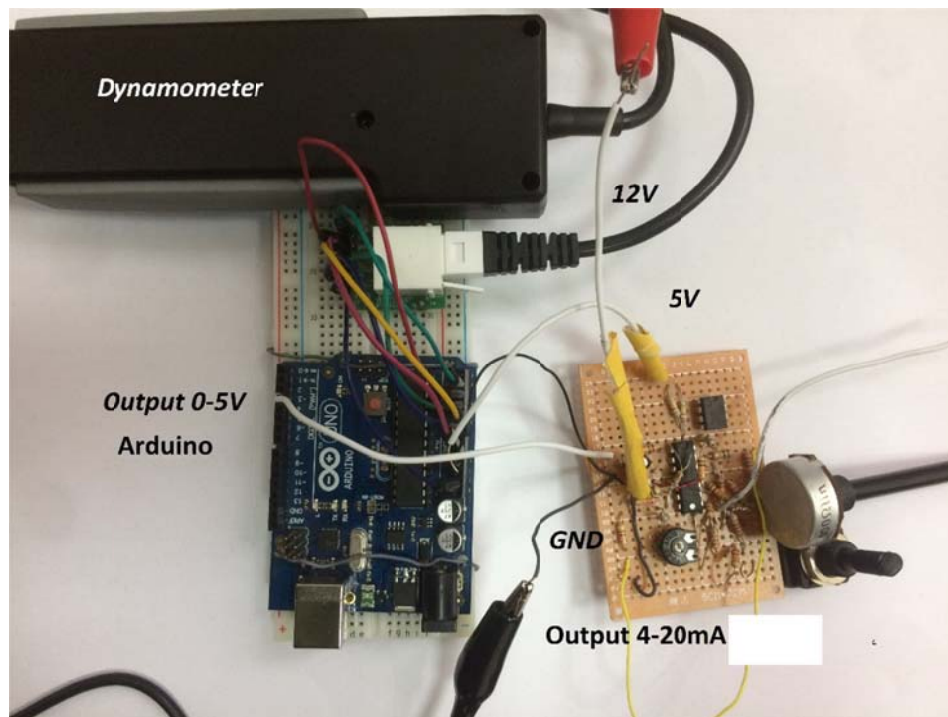
Slika 8. Električna šema pretvarača napona (0-5V) u struju (4-20mA)



Slika 9. Električna šema pretvarača struje (4-20mA) u napon (0-5V)



Slika 10. Blok šema rješenja



Slika 10. Kompletna šema

Literatura:

<https://www.vernier.com/files/manuals/sts-bta/sts-bta.pdf>

<https://www.vernier.com/files/manuals/hdbta/hd-bta.pdf>