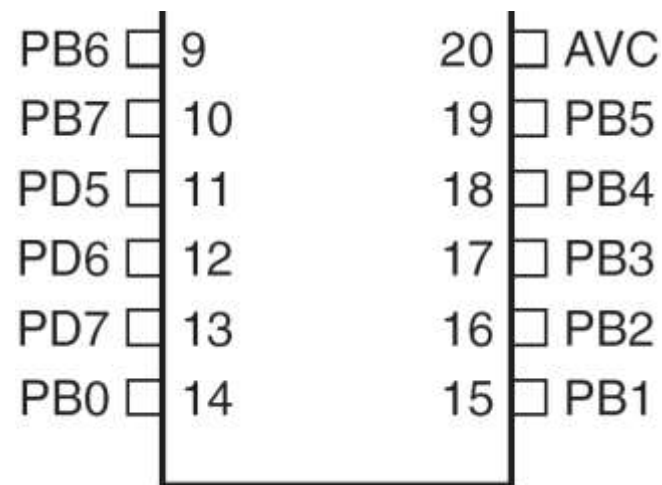


ARDUINO

Izlazni portovi

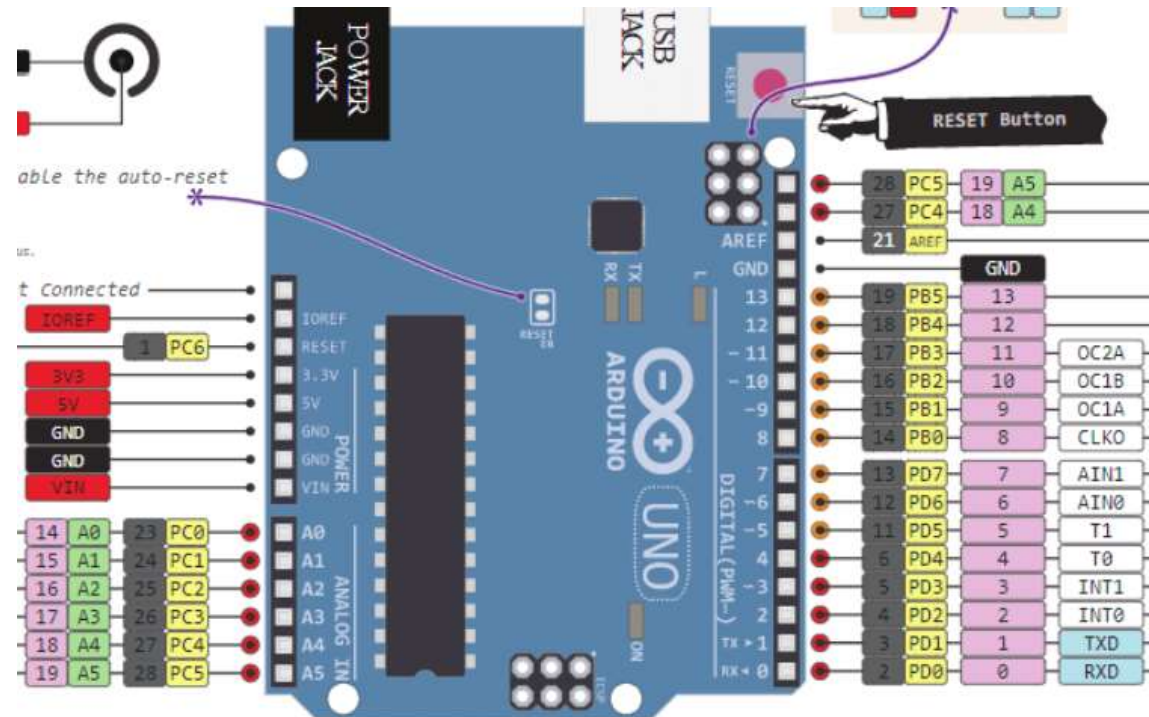
Microcontrolerski portovi i pinovi

- Priključci kroz koje mikrokontroler opšti sa spoljašnjom sredinom
 - Pr. PORTB
 - Pinovi PB0 – PB7
 - Ne moraju biti susjedni
 - Često bi-direcioni



Microcontrolerski portovi i pinovi

(PCINT14/RESET) PC6	1	28	PC5 (ADC5/SCL/PCINT13)
(PCINT16/RXD) PD0	2	27	PC4 (ADC4/SDA/PCINT12)
(PCINT17/TXD) PD1	3	26	PC3 (ADC3/PCINT11)
(PCINT18/INT0) PD2	4	25	PC2 (ADC2/PCINT10)
(PCINT19/OC2B/INT1) PD3	5	24	PC1 (ADC1/PCINT9)
(PCINT20/XCK/T0) PD4	6	23	PC0 (ADC0/PCINT8)
VCC	7	22	GND
GND	8	21	AREF
(PCINT6/XTAL1/TOSC1) PB6	9	20	AVCC
(PCINT7/XTAL2/TOSC2) PB7	10	19	PB5 (SCK/PCINT5)
(PCINT21/OC0B/T1) PD5	11	18	PB4 (MISO/PCINT4)
(PCINT22/OC0A/AIN0) PD6	12	17	PB3 (MOSI/OC2A/PCINT3)
(PCINT23/AIN1) PD7	13	16	PB2 ($\overline{SS}$ /OC1B/PCINT2)
(PCINT0/CLKO/ICP1) PB0	14	15	PB1 (OC1A/PCINT1)

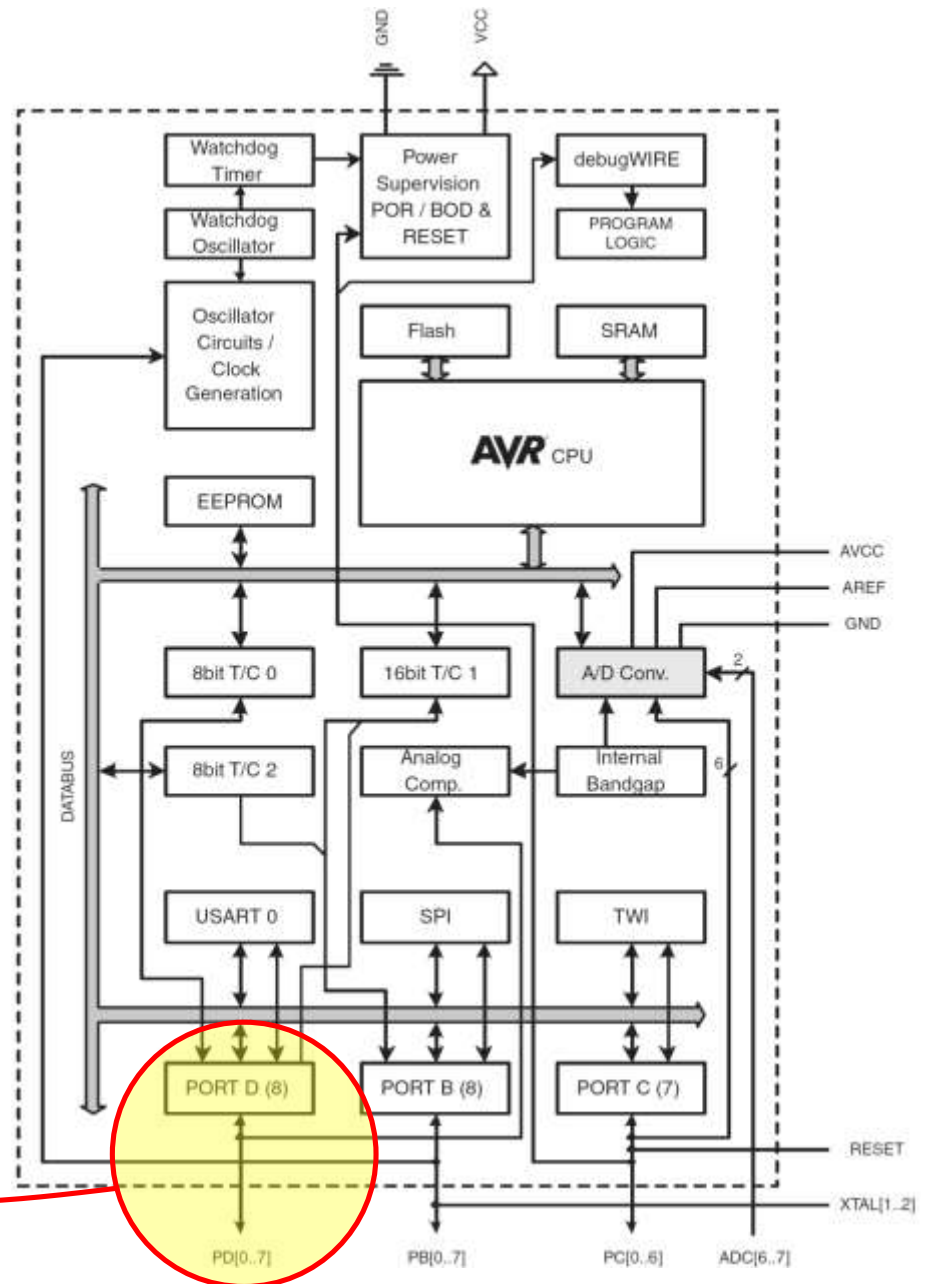
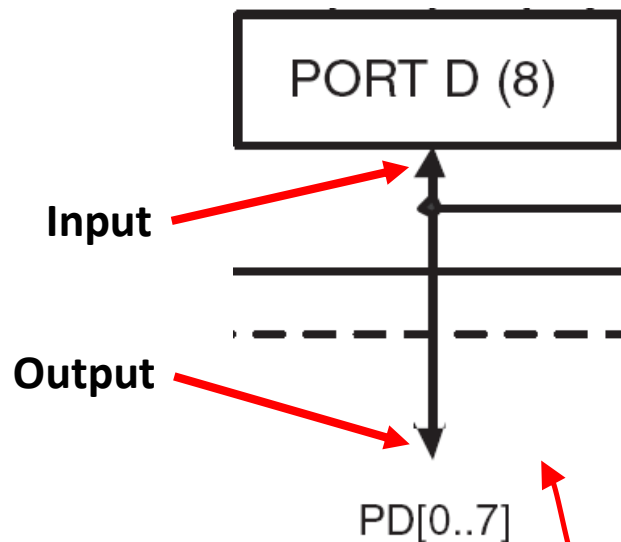


Port Pin – Usmjerenje podataka

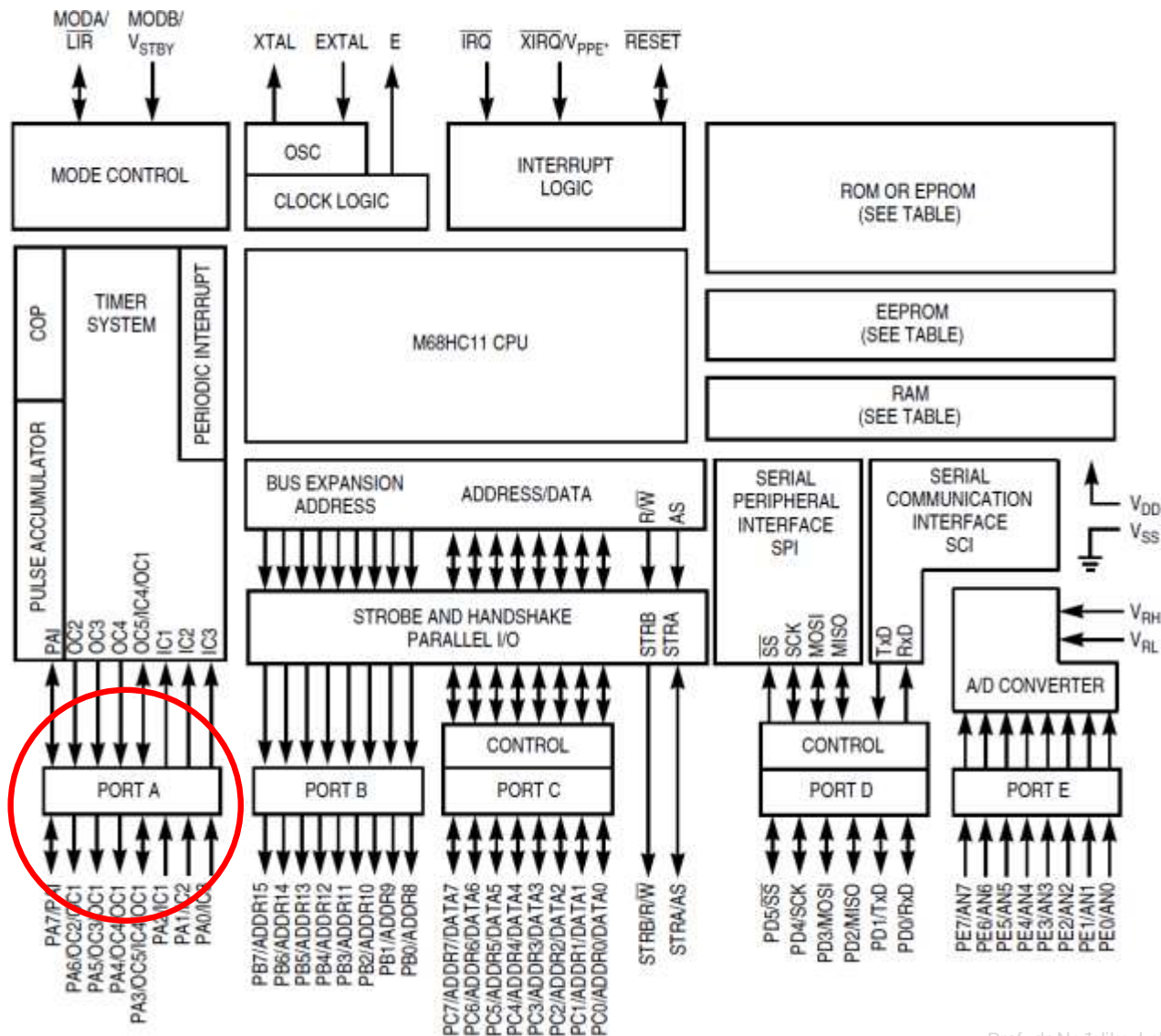
- Ulaz
 - Kada se želi uzeti informacija iz spoljašnjeg svijeta (senzori) u MCU
- Output
 - Kada se želi izmijeniti stanje nečega **izvan** MCU (uključiti ili isključiti motor, itd.) (aktuatori)
- Po uključenju napajanja svi pinovi su ulazni.
- Program može mijenjati usmjerenja podataka za svaki pin u svakom trenutku.

ATmega328

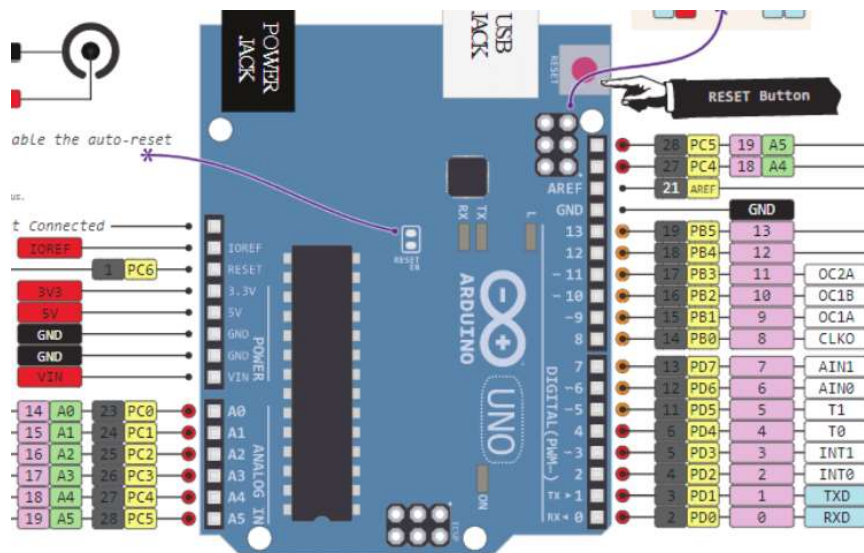
Blok diagram



M68HC11 mikrokontroler



Postavljanje smjera toka podatka za pin



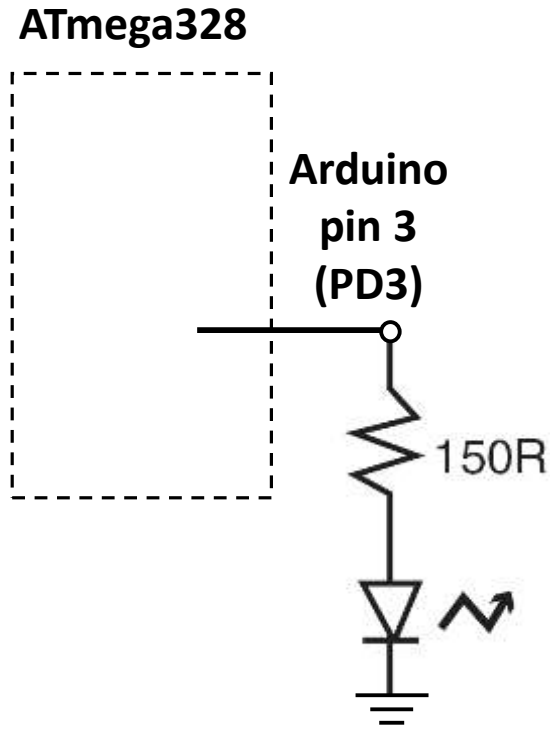
- Arduino
 - `pinMode(pin_no., dir)`
 - Pr. postaviti Arduino pin 3 (PD3) kao izlazni
 - `pinMode(3, OUTPUT);`

Napon na pinu

- Mikrokontroleri su u osnovi ***digitalni*** uređaji.
Za digitalne ulazno/izlazne (IO) pinove:
 - Informacija je ‘kodirana’ u dva diskretna stanja:
 - HIGH or LOW (logic: 1 or 0)
 - Naponi
 - TTL
 - » 5 V (za HIGH)
 - » 0 V (za LOW)
 - 3.3 V CMOS
 - » 3.3 V (za HIGH)
 - » 0 V (za LOW)

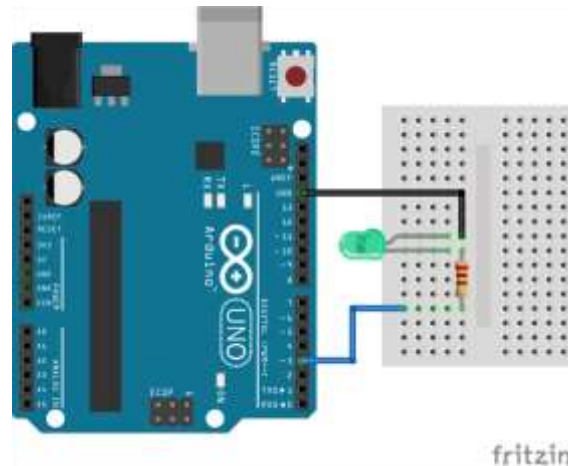
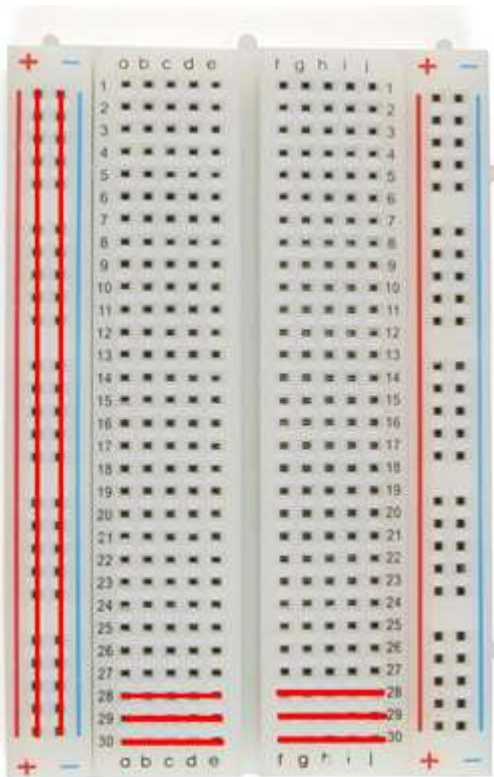
Pin upotrijebljen kao izlazni

- Uključiti LED, koja je povezana na Arduino pin 3 (PD3) (otpornik!)
 - Koji tok podataka treba biti za pin 3 (PD3)?
 - **`pinMode(__3__, __OUTPUT__);`**
 - Uključenje LED
 - **`digitalWrite(3,HIGH);`**
 - Isključenje LED
 - **`digitalWrite(3,LOW);`**

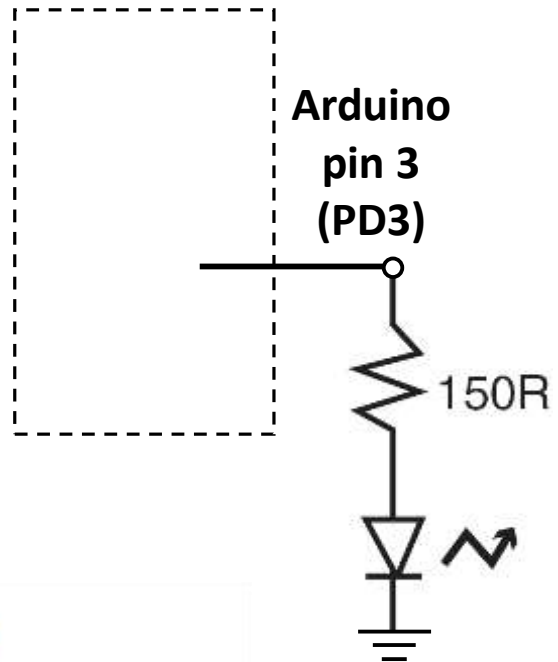


Pin upotrijebljen kao izlazni

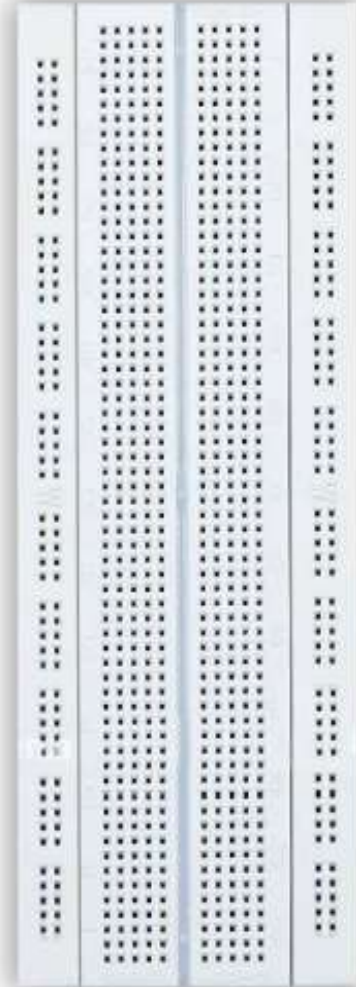
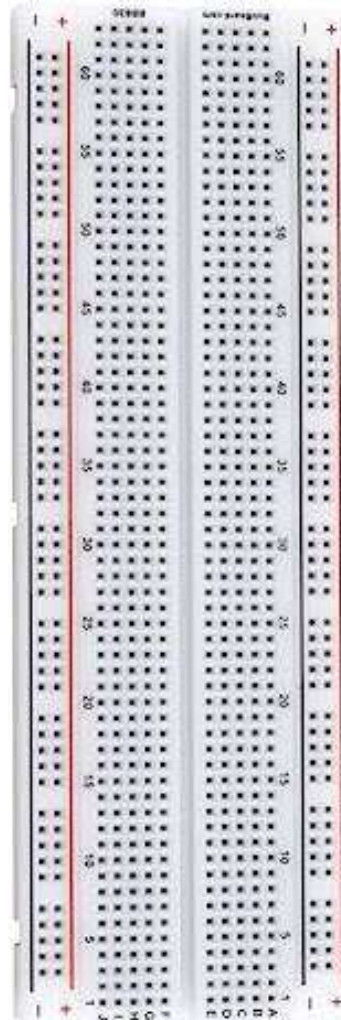
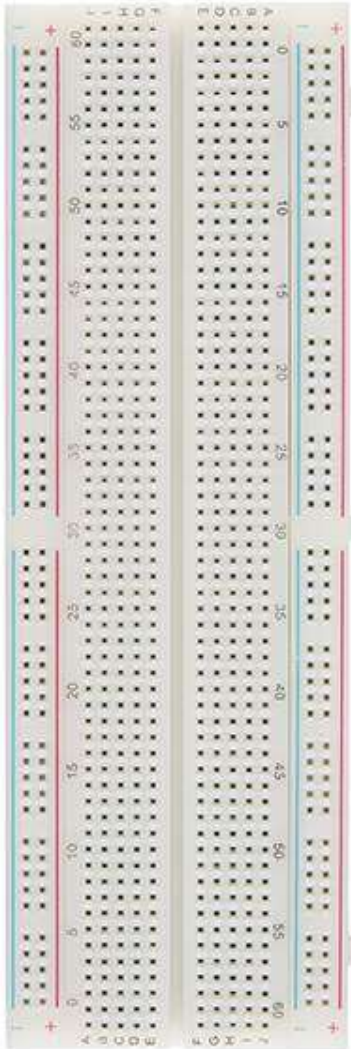
- Uključenje LED
 - `digitalWrite(3,HIGH);`
- Isključenje LED
 - `digitalWrite(3,LOW);`



ATmega328

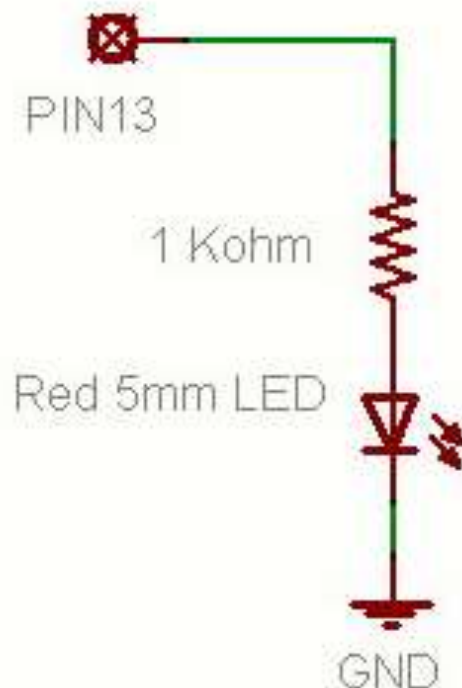


Neke varijante experimentalnih ploča



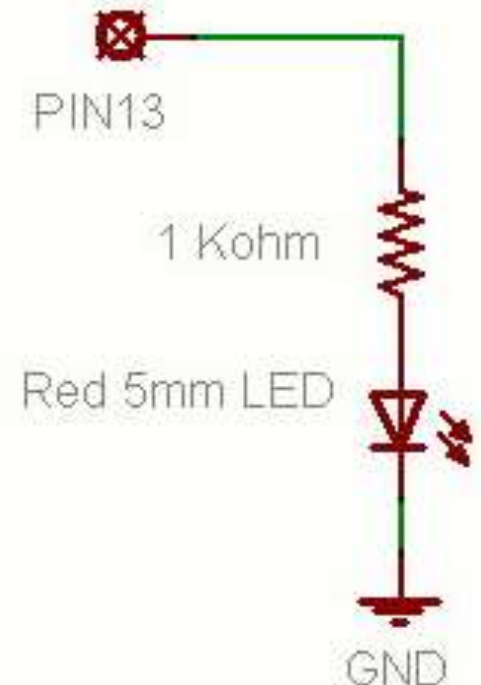
Prosto elektronsko kolo

- Najjednostavniji sklop.
- Uključi/isključi svjetlo.
- Struja teče iz pina (izvora napajanja), kroz potrošač (LED).



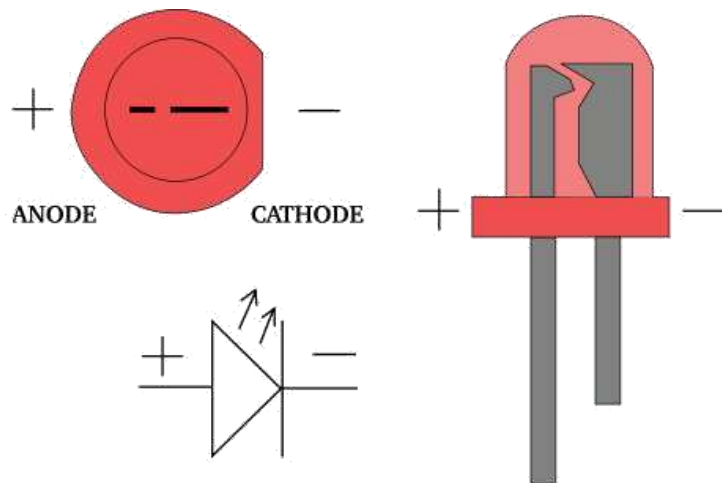
Osnovno LED kolo

- Povežite pin 13 mikrokontrolera na jedan kraj otpornika.
- Drugu nožicu otpornika spojite na dužu nožicu LED.
 - Veća otpornost znači slabije svjetlo.
 - Manja otpornost znači jače svjetlo.
 - Bez otpornosti znači pregorijevanje LED ili preopterećenje porta.
- Kraću nožicu LED spojite na negativni priključak napajanja (masu).



Blink Skeč (Treperenje)

- **File > Examples > Digital > Blink**
- LED ima polaritet
 - Negativni je indikovani zasječenim obodom tijela diode i kraćom nožicom.

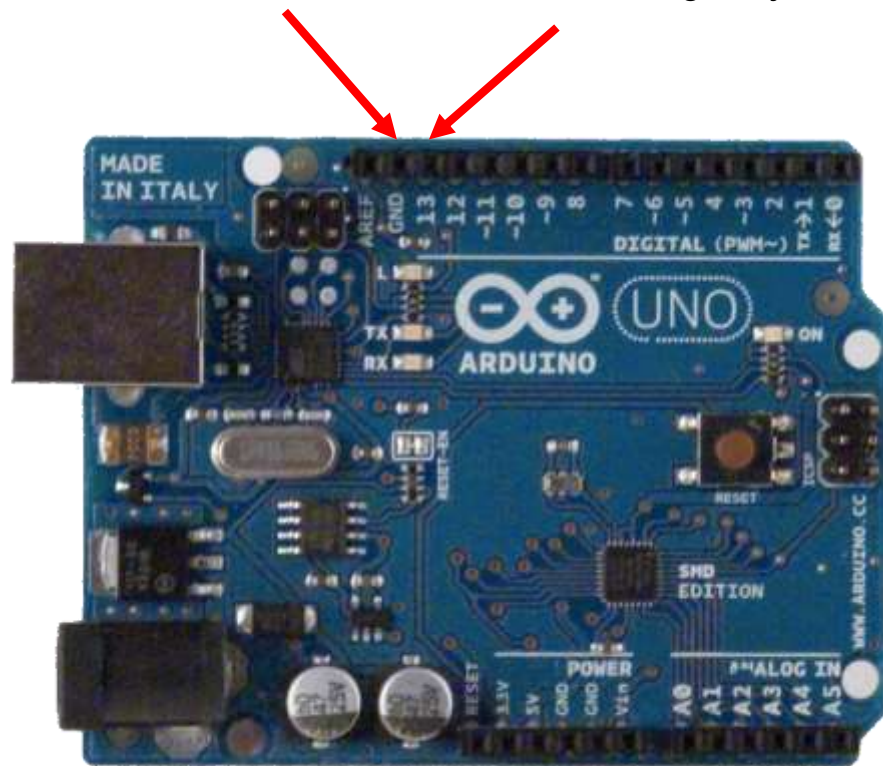


Blink Skeč (Treperenje)

```
void setup( ) {  
    pinMode(13, OUTPUT);  
}  
  
void loop( ) {  
    digitalWrite(13, HIGH);  
    delay(1000);  
    digitalWrite(13, LOW);  
    delay(1000);  
}
```

Povežite jedan kraj kola

Povežite drugi kraj kola



Arduino C je izveden iz C++

■ Ovaj program radi treperenje LED na pinu 13

- avr-libc

```
#include <avr/io.h>
#include <util/delay.h>
```

```
int main(void) {
    while (1) {
        PORTB = 0x20;
        _delay_ms(1000);
        PORTB = 0x00;
        _delay_ms(1000);
    }
    return 1;
}
```

- Arduino C

```
void setup( ) {
    pinMode(13, OUTPUT);
}
```



```
void loop( ) {
    digitalWrite(13, HIGH);
    delay(1000);
    digitalWrite(13, LOW);
    delay(1000);
}
```


Struktura Arduino programa

- Arduino program == 'sketch'
 - Mora imati:
 - `setup()`
 - `loop()`
 - `setup()`
 - Konfiguriše pinove i registre
 - `loop()`
 - Pokreće glavno tijelo programa neprestano
 - Kao `while(1) {...}`
 - Gdje je `main()` ?
 - Arduino uprošćava stavri
 - Odrađuje za Vas

```
/* Blink - turns on an LED for DELAY_ON msec,
then off for DELAY_OFF msec, and repeats
BJ Furman rev. 1.1   Last rev: 22JAN2011
*/
#define LED_PIN 13    // LED on digital pin 13
#define DELAY_ON 1000
#define DELAY_OFF 1000

void setup()
{
    // initialize the digital pin as an output:
    pinMode(LED_PIN, OUTPUT);
}

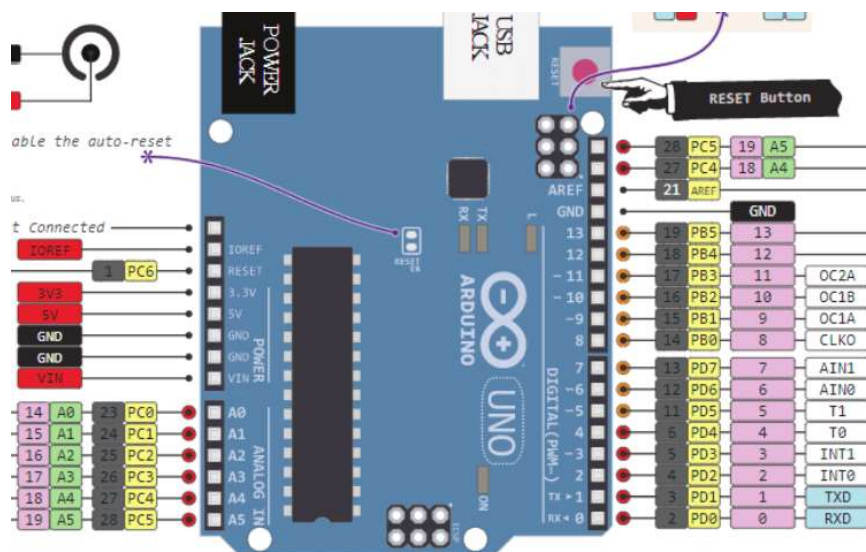
// loop() method runs forever,
// as long as the Arduino has power

void loop()
{
    digitalWrite(LED_PIN, HIGH); // set the LED on
    delay(DELAY_ON); // wait for DELAY_ON msec
    digitalWrite(LED_PIN, LOW); // set the LED off
    delay(DELAY_OFF); // wait for DELAY_OFF msec
}
```

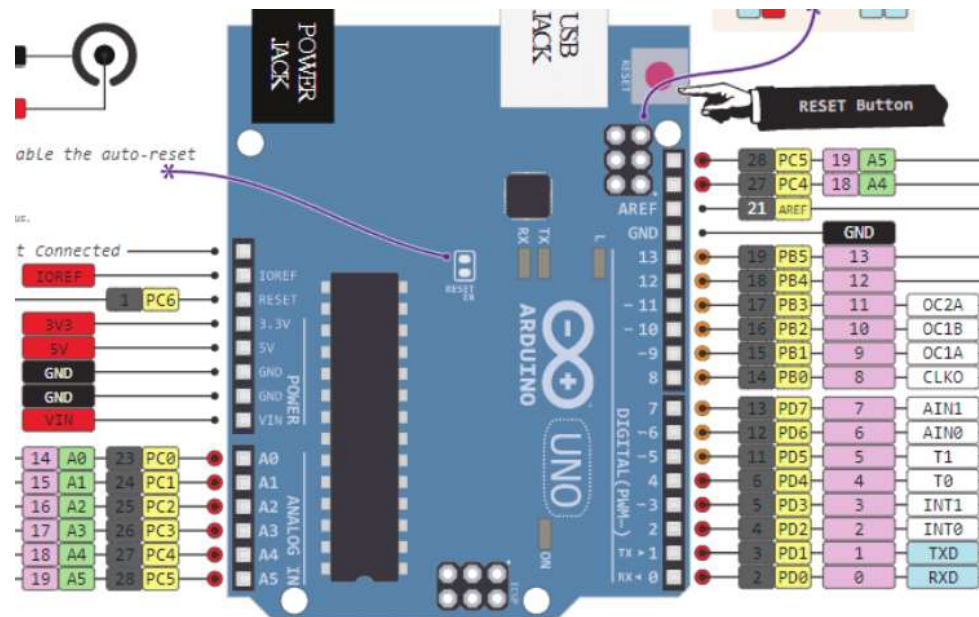
Treperenje 4 LED skeč

```
void setup( ) {  
  pinMode(1, OUTPUT);  
  pinMode(3, OUTPUT);  
  pinMode(5, OUTPUT);  
  pinMode(7, OUTPUT);  
}
```

```
void loop( ) {  
  digitalWrite(1, HIGH);  
  delay (200);  
  digitalWrite(1, LOW);  
  
  digitalWrite(3, HIGH);  
  delay (200);  
  digitalWrite(3, LOW);  
  
  digitalWrite(5, HIGH);  
  delay (200);  
  digitalWrite(5, LOW);  
  
  digitalWrite(7, HIGH);  
  delay (200);  
  digitalWrite(7, LOW);  
}
```



Alternativni pristup



- Pitanje:
 - Postoji li način da se tok podataka postavi za više pinova istovremeno?
- Sav rad na MCU dešava se kroz *registre* (posebne memorijske lokacije)
 - Registri na Atmega328 su dužine 8-bita
- Data direction register (DDRx) upravlja tokom podataka za pinove u PORTx

Bit	7	6	5	4	3	2	1	0	
0x04 (0x24)	DDB7	DDB6	DDB5	DDB4	DDB3	DDB2	DDB1	DDB0	DDRB
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Izvor: http://www.atmel.com/dyn/products/product_card.asp?PN=ATmega328P p. 93

Data Direction Register

- Ako je bit nula -> pin će biti ulazni
 - Postavljenje bita na nulu == ‘**čišćenje bita**’ (‘clearing the bit’)
- Ako je bit jedan -> pin će biti izlazni
 - Postavljenje bit na jedinicu == ‘**postavljanje bita**’ (‘setting the bit’)
- Za istovremenu promjenu toka podataka za više pinova koji pripadaju portu PORTx:
 1. Određivanje koje bitove treba postaviti a koje očistiti u registru DDRx.
 2. Upisati binarni (hex) broj u DDRx.

ATmega328 registri za rad sa portovima

- Vidijeti ATmega328 data sheet, pp. 76-94
- Za digitalne IO, važni registri su:
 - DDRx
 - Data Direction bit u DDRx registru (read/write)
 - PORTx
 - PORTx data registar (read/write)
 - PINx
 - PINx registar (read only)

ATmega328 datasheet, pp. 76-94

The diagram shows a horizontal line representing the I/O pin. On the left, a box labeled 'Pxn' is connected to the line. Below the line, there is a diode pointing down to ground and a capacitor labeled C_{pin} connected to ground. Above the line, there is a diode pointing up. A vertical dashed line separates the pin from the 'Logic' block on the right. Inside the logic block, the pin is connected to a resistor labeled R_{pu} (pull-up resistor) and a MOSFET gate. Below the logic block, text reads 'See Figure "General Digital I/O for Details'.

[illegible]

Bit	7	6	5	4	3	2	1	0	
0x0B (0x2B)	PORTD7	PORTD6	PORTD5	PORTD4	PORTD3	PORTD2	PORTD1	PORTD0	PORTD
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

Bit	7	6	5	4	3	2	1	0	
(Dx)A (Dx)2A	DD07	DD06	DD05	DD04	DD03	DD02	DD01	DD00	DDRD
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

[illegible]

Primjer

- Postaviti Arduino pinove 3, 5, i 7 (PD3, PD5, i PD7) kao izlazne

- Arduino pristup

```
pinMode(3, OUTPUT);  
pinMode(5, OUTPUT);  
pinMode(7, OUTPUT);
```

Ili ako je upotrijebljena me106.h:

```
pinMode(PIN_D3, OUTPUT);  
pinMode(PIN_D5, OUTPUT);  
pinMode(PIN_D7, OUTPUT);
```

- Alternativni pristup

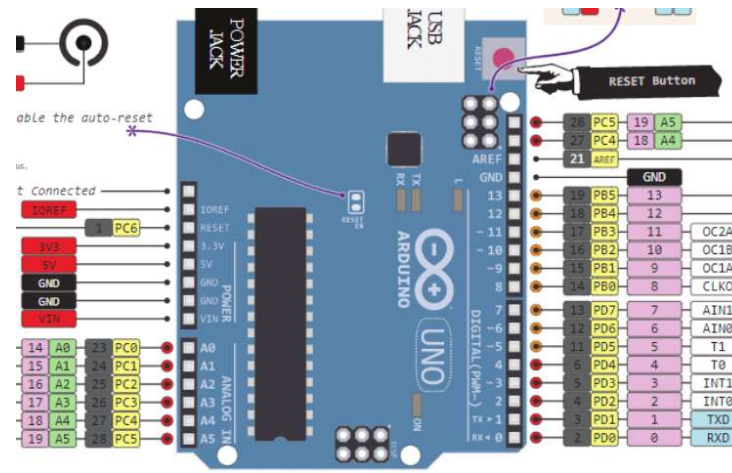
```
DDRD = 0b10101000;
```

ili

```
DDRD = 0xA8;
```

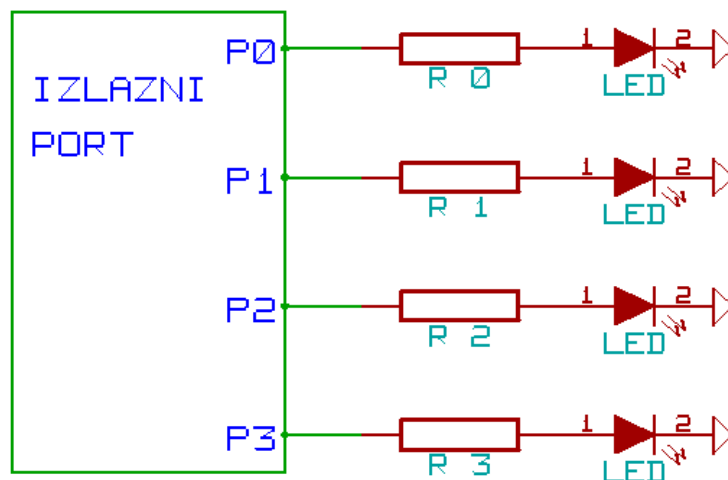
ili

```
DDRD |= 1<<PD7 | 1<<PD5 | 1<<PD3;
```

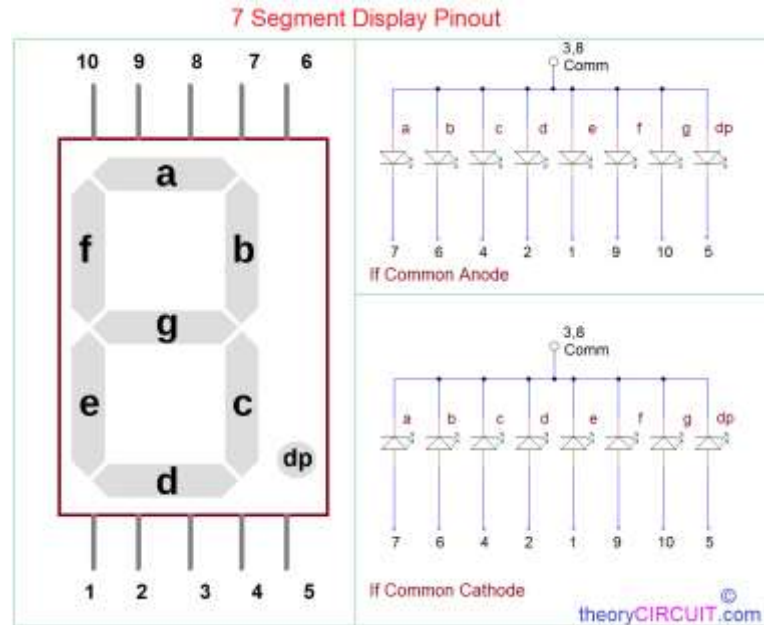
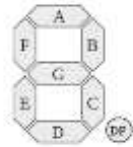
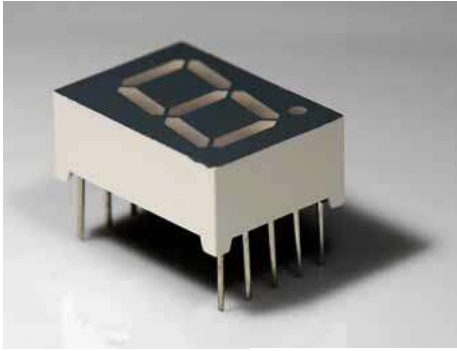


Zadaci za vježbu 1

1. Trcece svjetlo upotrebom 4 LED. Uvijek je samo jedna dioda isključena. **(2-1 poen).**
2. Pomocu 4 LED, u binarnom obliku prikazati vrijednost promjenjive BROJAC. Vrijednost promjenjive brojac se inkrementira svake sekunde. Kada su uključene sve četiri LED, one tri puta trepnu. Tako u krug. **(2-1 poen)**



3. Napisati program koji broji od 0 do F, s ponavljanjem, i prikazuje rezultat na sedmosegmentnom LED displeju. (3-2 poena)



Trasformaciona tabela

Digit	ABCDEFG	A	B	C	D	E	F	G
0	0x7E	on	on	on	on	on	on	off
1	0x30	off	on	on	off	off	off	off
2	0x6D	on	on	off	on	on	off	on
3	0x79	on	on	on	on	off	off	on
4	0x33	off	on	on	off	off	on	on
5	0x5B	on	off	on	on	off	on	on
6	0x5F	on	off	on	on	on	on	on
7	0x70	on	on	on	off	off	off	off
8	0x7F	on	on	on	on	on	on	on
9	0x7B	on	on	on	on	off	on	on

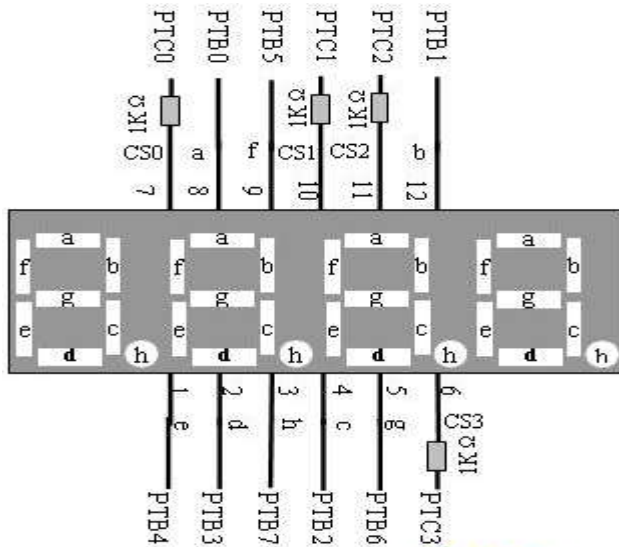
Pomoć:

Razmotrite pisanje funkcije:

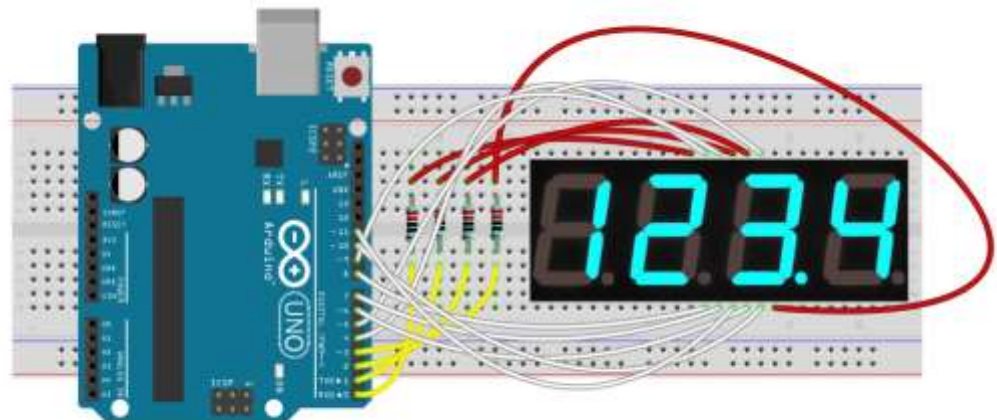
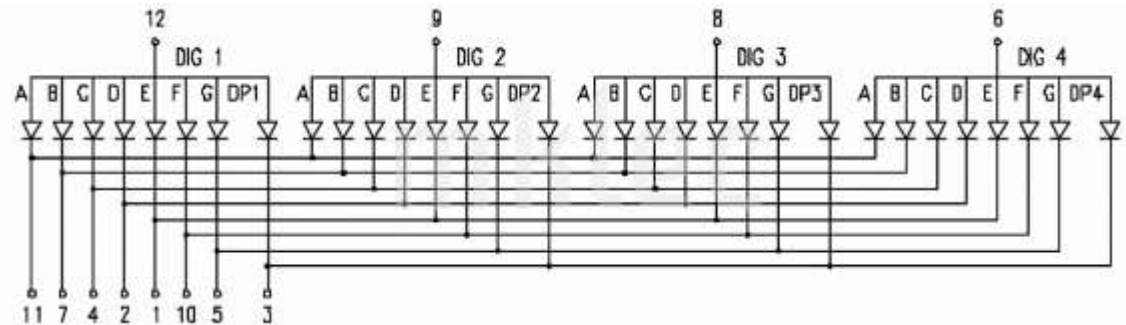
```
void writeDigit(int n)
```

koja ispisuje jednu cifru

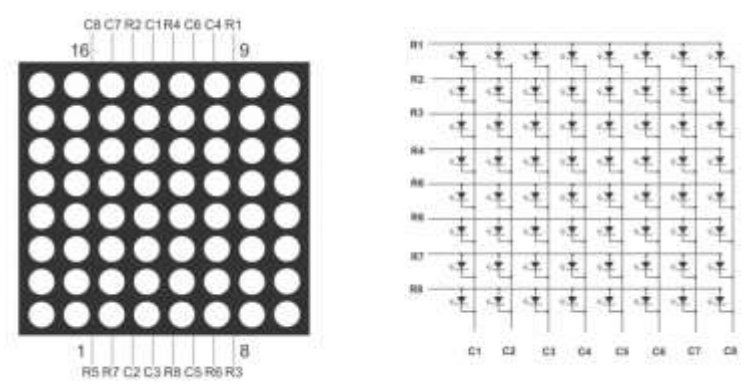
4. Napisati program koji na četvorocifarskom sedmosegmentnom LED displeju ispisaše: '23.02', koji treperi s periodom 3 sekunde. 2.5 sekundi ispis, 0.5 sekundi pauza (nema ispisa na displeju). (4-3 poena)



MCU与4连排8段数码管的连接



5. Napisati program koji na 8X8 matrix LED displeju ispisuje vaše ime i prezime, stalno u krug. Pojedino slovo na displeju se zadržava jednu sekundu. (5-4 poena)



Mogući način povezivanja

