Projekat II

Što je mikrokontroler?

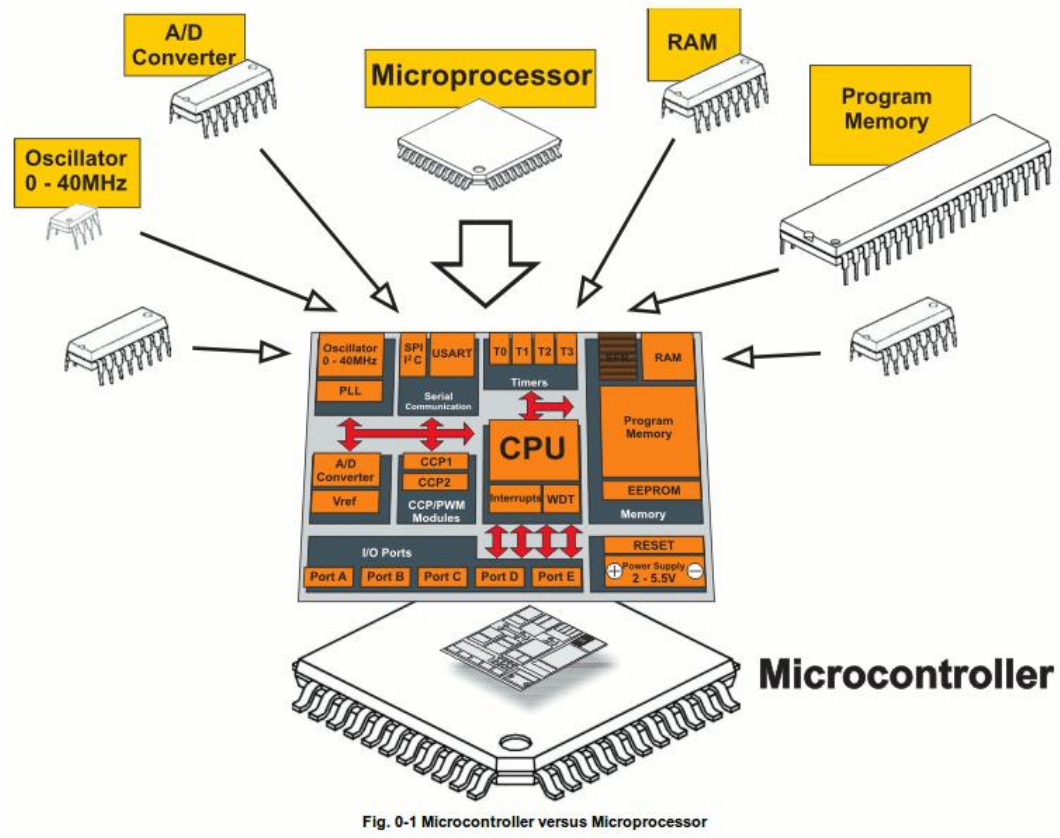
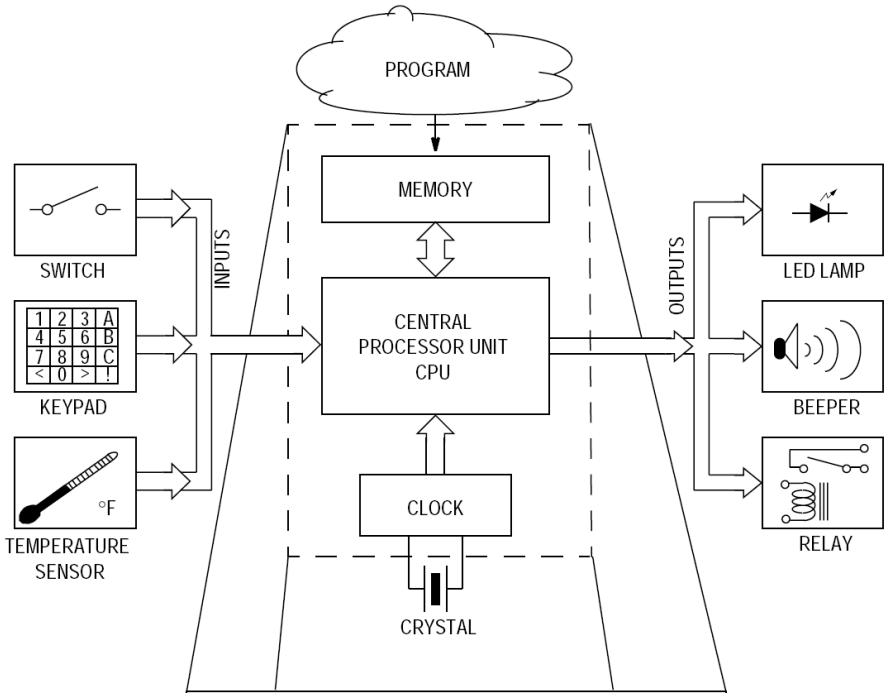
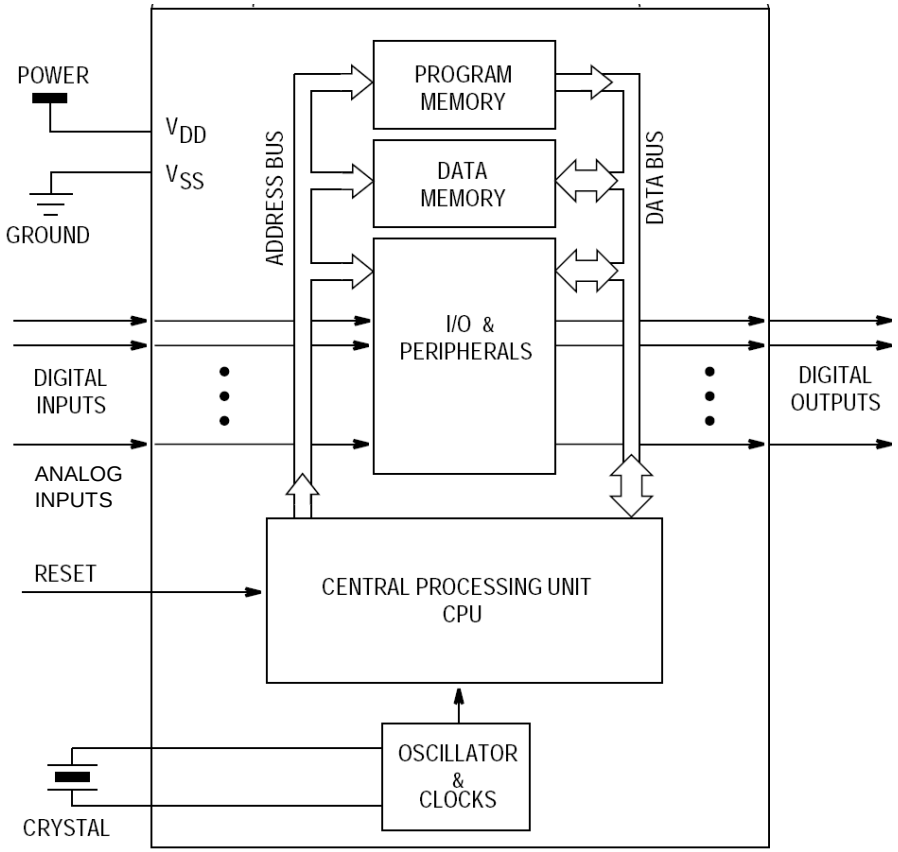


Fig. 0-1 Microcontroller versus Microprocessor

- Mali kompjuter u jednom ļipu
  - Sadrģi procesor, memoriju, i ulaze/izlaze
- Tipiļno je Ă**ugrađen**" unutar nekih ureĽaja i kontroliģe njihov rada
- Mikrokontroler je ļesto mali i jeftin

Što je mikrokontroler?



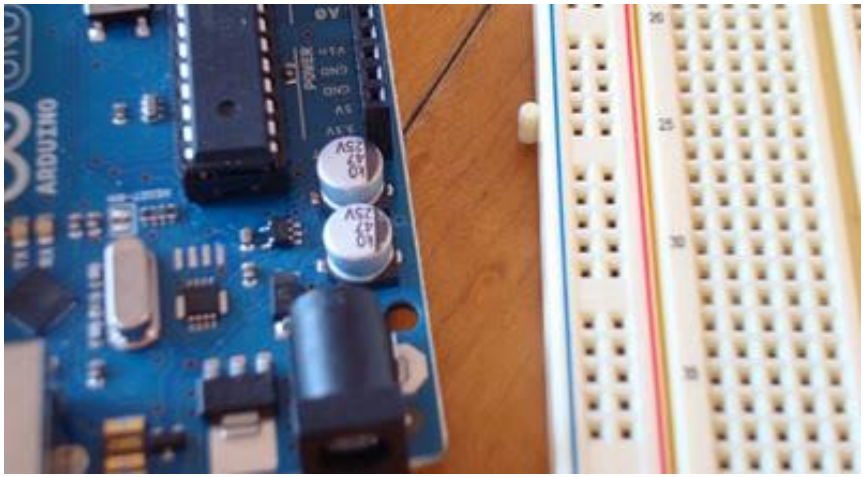


Ġto je razlika izmeĽu ó*Digital* Inputôi ó*Analog* Inputô?

Mikrokontroleri ï definicija

- Programeri rade u virtuelnom svijetu.
- UreĽaji rade u fiziļ kom svijetu.
- Kako povezati vituelni i fiziļ ki svijet?
- Uvedite mikrokontroler.
- Mikrokontroler je u osnovi mali raļ unar koji posjeduje programabilne ulaze i izlaze opġte namjene.
- Ulazi mogu biti upravljani od strane fiziļ kog okruģenja dok izlazi mogu upravljati fiziļ kim okruģenjem.

Što je razvojna ploča?



- Štampana matična ploča dizajnirana da olakša rad sa mikrokontrolerom

- Razvojna ploča tipično uključuje:
  - napojno kolo;
  - programerski interfejs;
  - Lako dostupne ulazno/izlazne pinove.

Arduino – Zvanična definicija

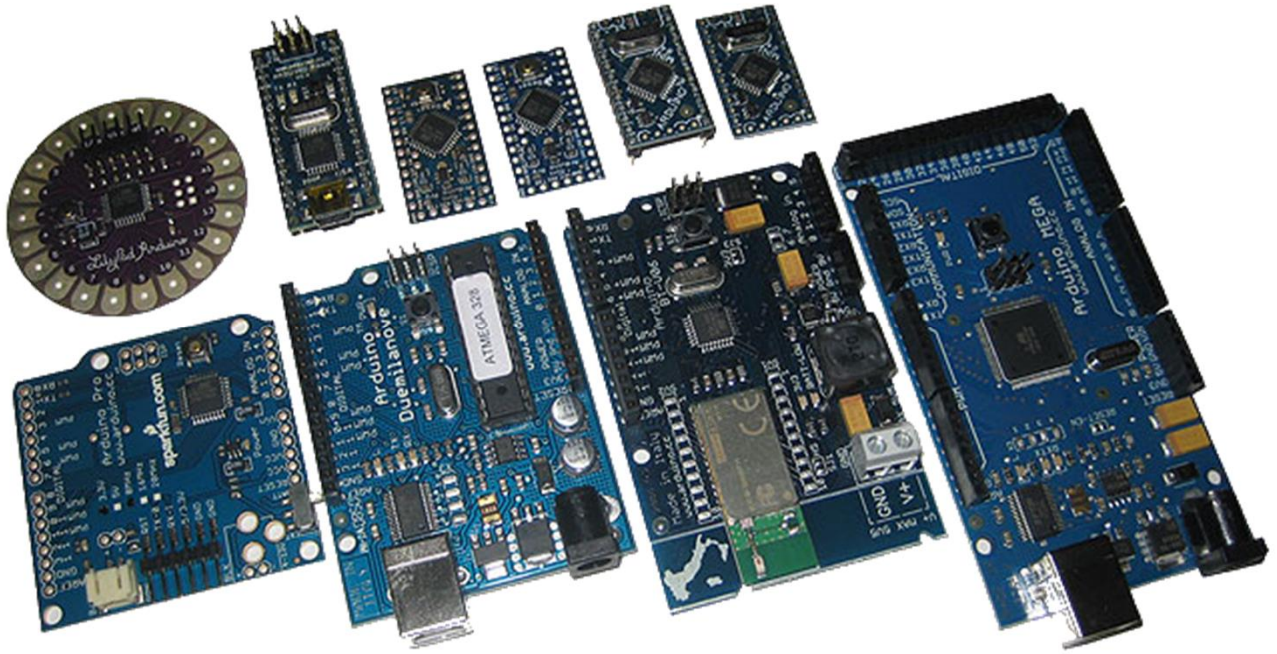
- Uzeto sa zvaničnog web sajta (arduino.cc):
  - Arduino je open-source elektronska prototipna platforma zasnovana na fleksibilnom, jednostavnom za upotrebu, hardveru i softveru.
  - Namijenjen je dizajnerima, hobistima, i svima drugima koji su zainteresovani za kreiranje interaktivnih objekata i okruženja.

Zašto Arduino?

- Bez obzira na razlog, Arduino platforma je postala de fakto standard.
  - Postoji puno realizovanih, dostupnih, projekta koji koriste arduino platformu.
- Teži ravnoteži između jednostavnosti upotrebe i korisnosti.
  - Programski jezici se uglavnom vide kao glavna poteškoća.
  - Arduino C je značajno uproštena verzija C++.
- Nije skup.

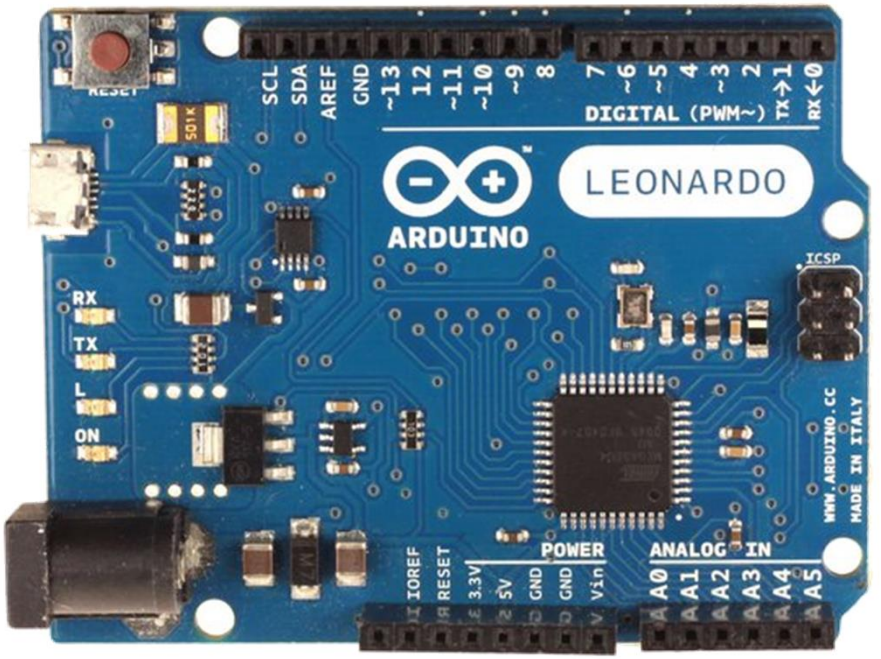
Tipovi Arduino-a

- Više različitih verzija
  - Broj ulaznih/izlaznih kanala
  - Oblik (gabariti)
  - Procesorska snaga
- Leonardo
- Due
- Micro
- LilyPad
- Esplora
- Uno



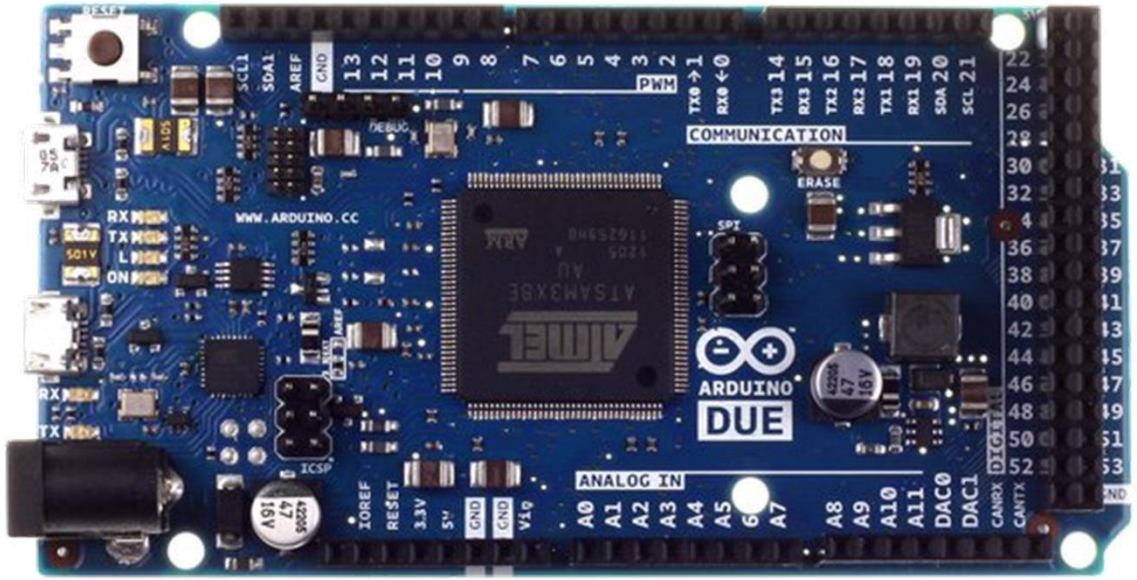
Leonardo

- U poređenju sa Uno, malo unapijedjen.
- Koristi ATmega32u4 mikrokontroler koji ima ugrađenu USB komunikaciju
  - Nema potrebe za dodatnim mikrokontrolerom
  - Može se prikazati PC-u kao miš ili tastatura



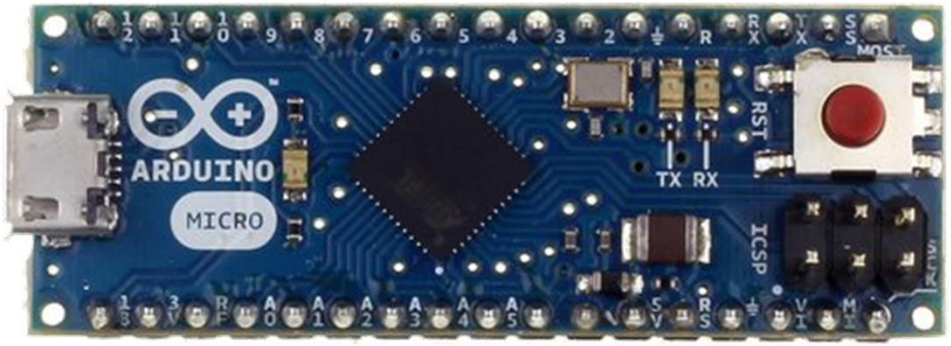
Due

- Mnogo brži procesor, mnogo više pinova
- Radi na 3.3 volta
- Izgledom sličan Mega



Micro

- Kad je veličina važna: Micro, Nano, Mini
- Uključuju sve funkcionalnosti Leonardo-a

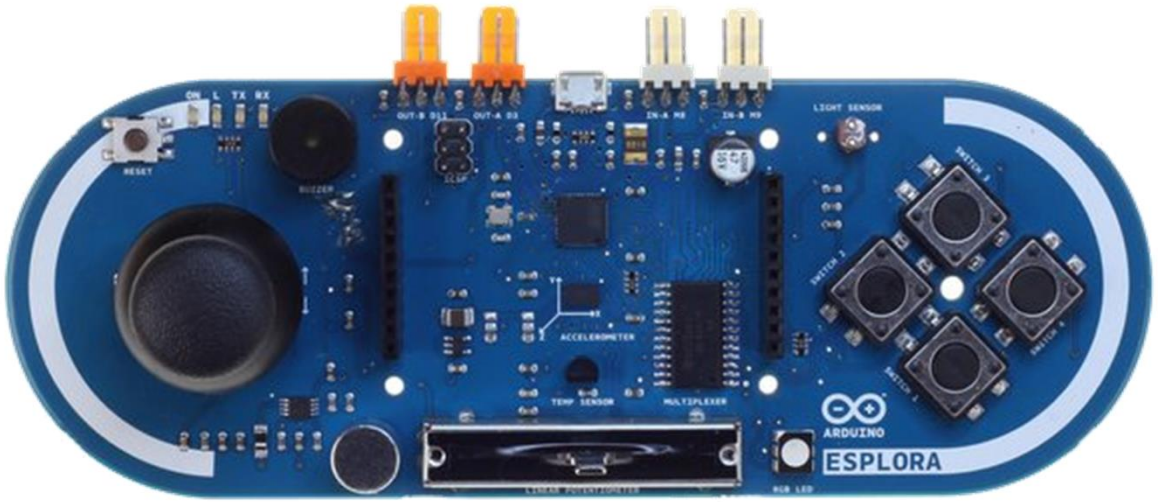


LilyPad

Å LilyPad je pogodan za primjenu na odjeći.

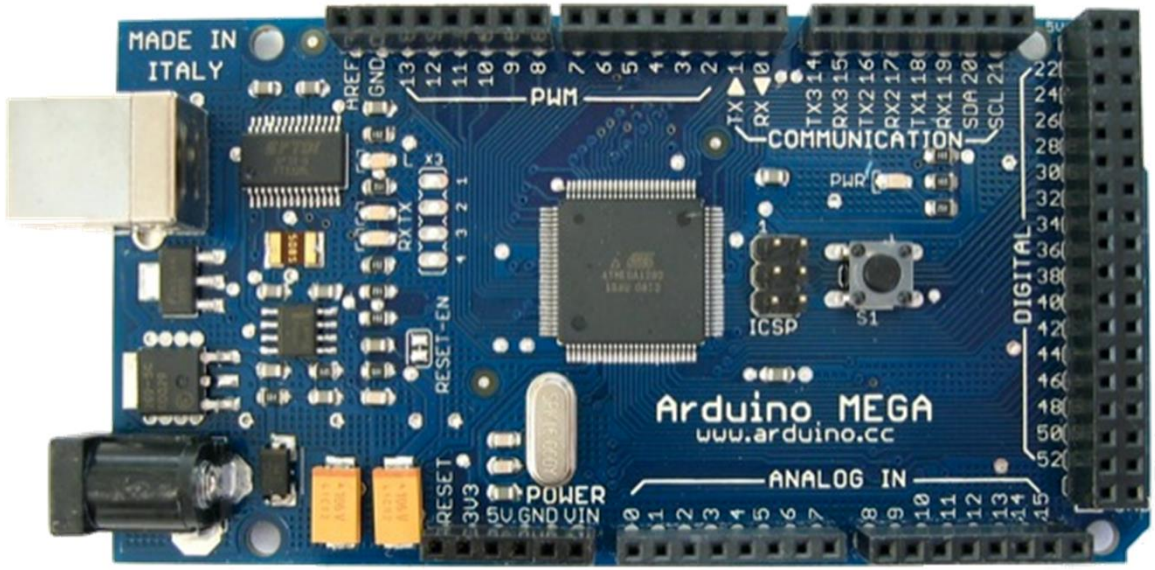
Esplora

- Game controller
- Sadrži džojstik, četiri tastera, linearni poteciometar (klizač), mikrofon, svjetlosni senzor, senzor temperature, tro-osni akceleromatar.
- Nema standardi set IO pinova.



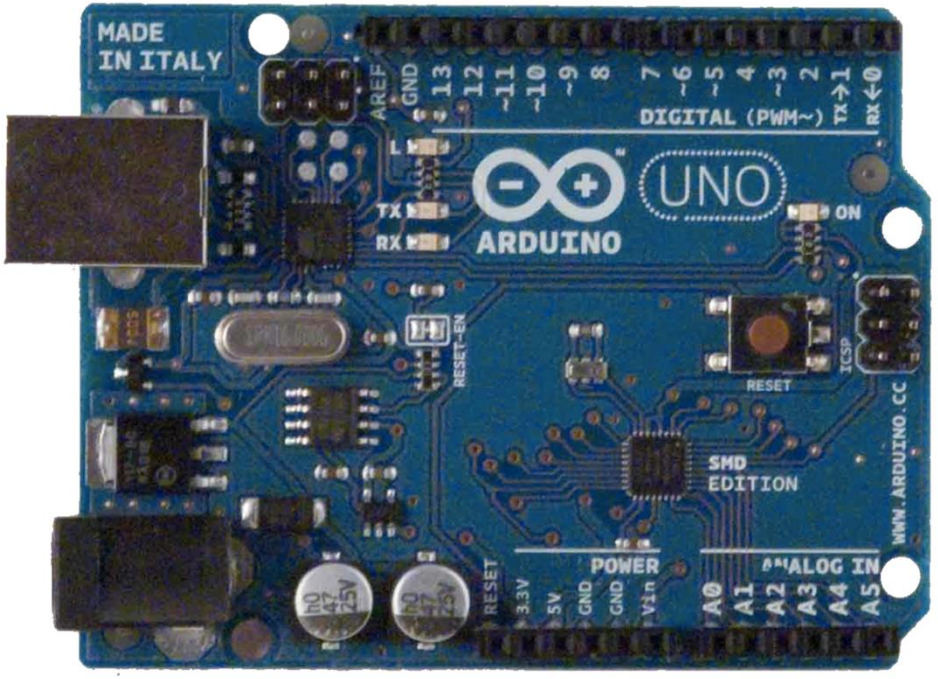
Mega

- U poređenju sa Uno, Mega:
  - Mnogo više komunikacionih pinova
  - Više memorije

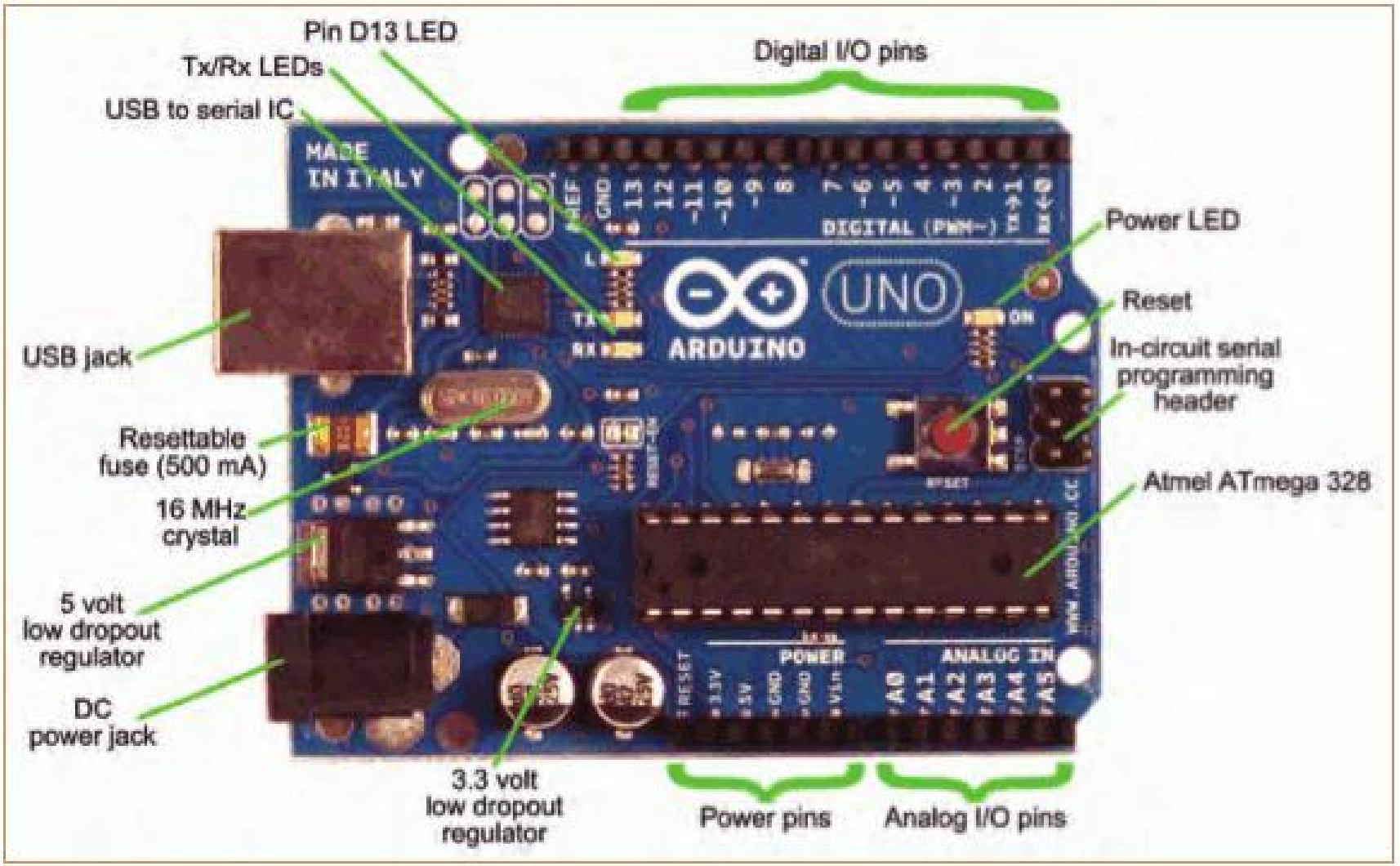


Arduino Uno

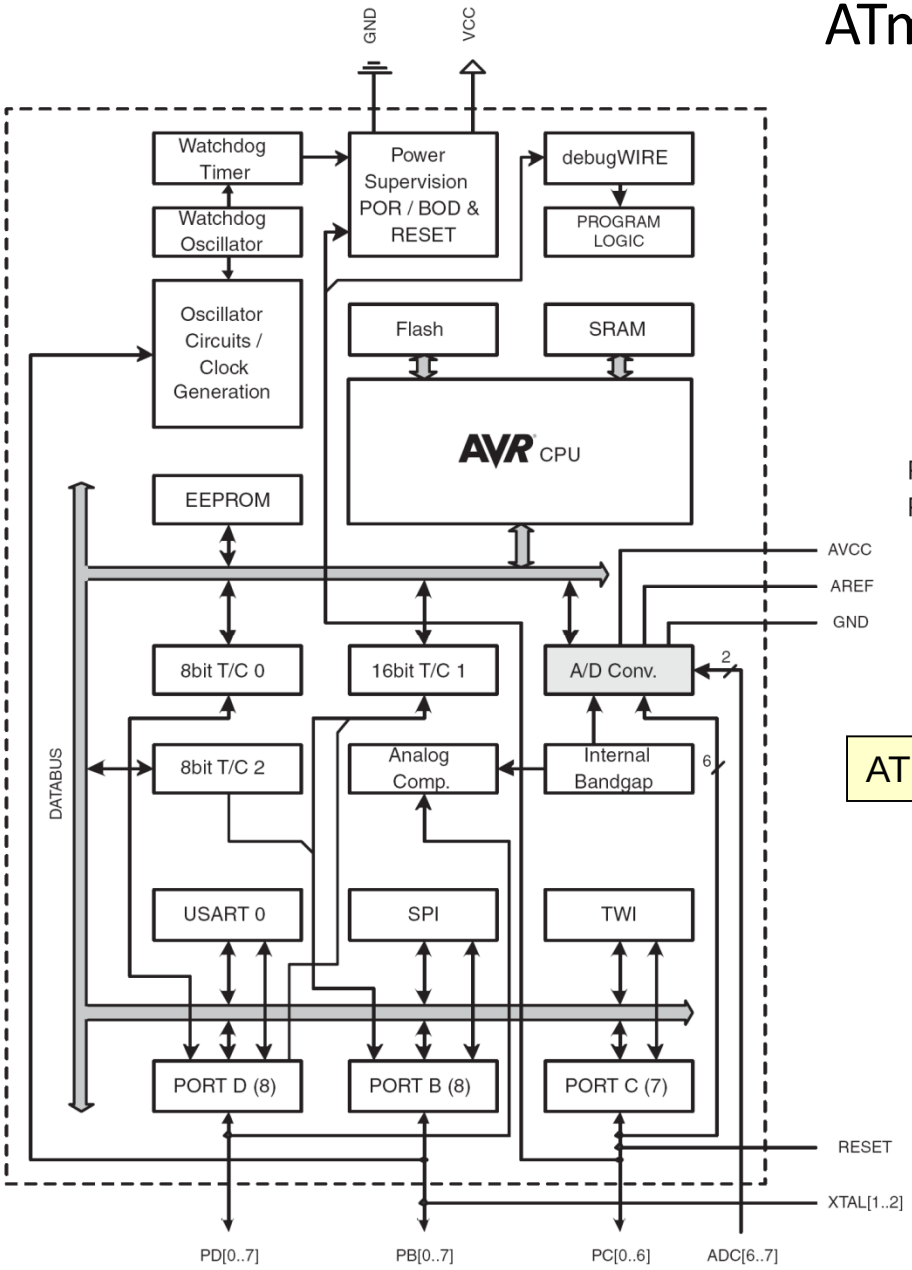
- Pinovi su grupisani u 3 grupe:
  - 14 digitalnih pinova
  - 6 analognih pinova
  - Napajanje
  - Pojavio se 2010

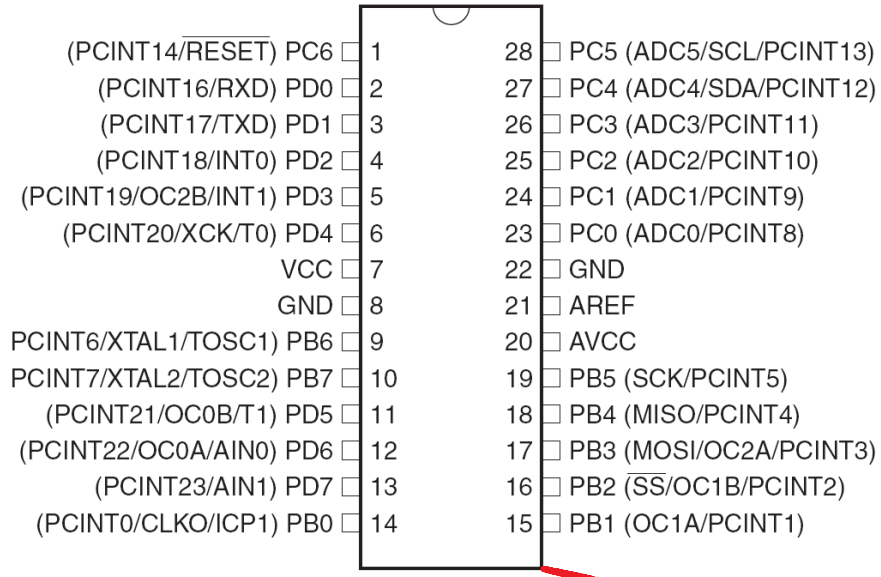


Arduino Uno razvojna ploča

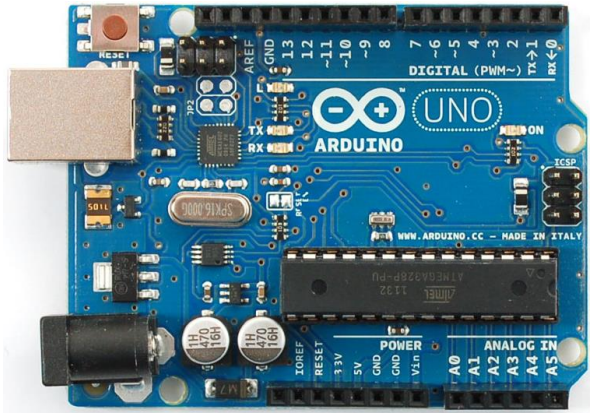


ATmega328 unutrašnja architectura





ATmega328 data sheet pp. 2, 5



Making-robots-with-arduino.pdf

Specification

ATmega328 karakteristike

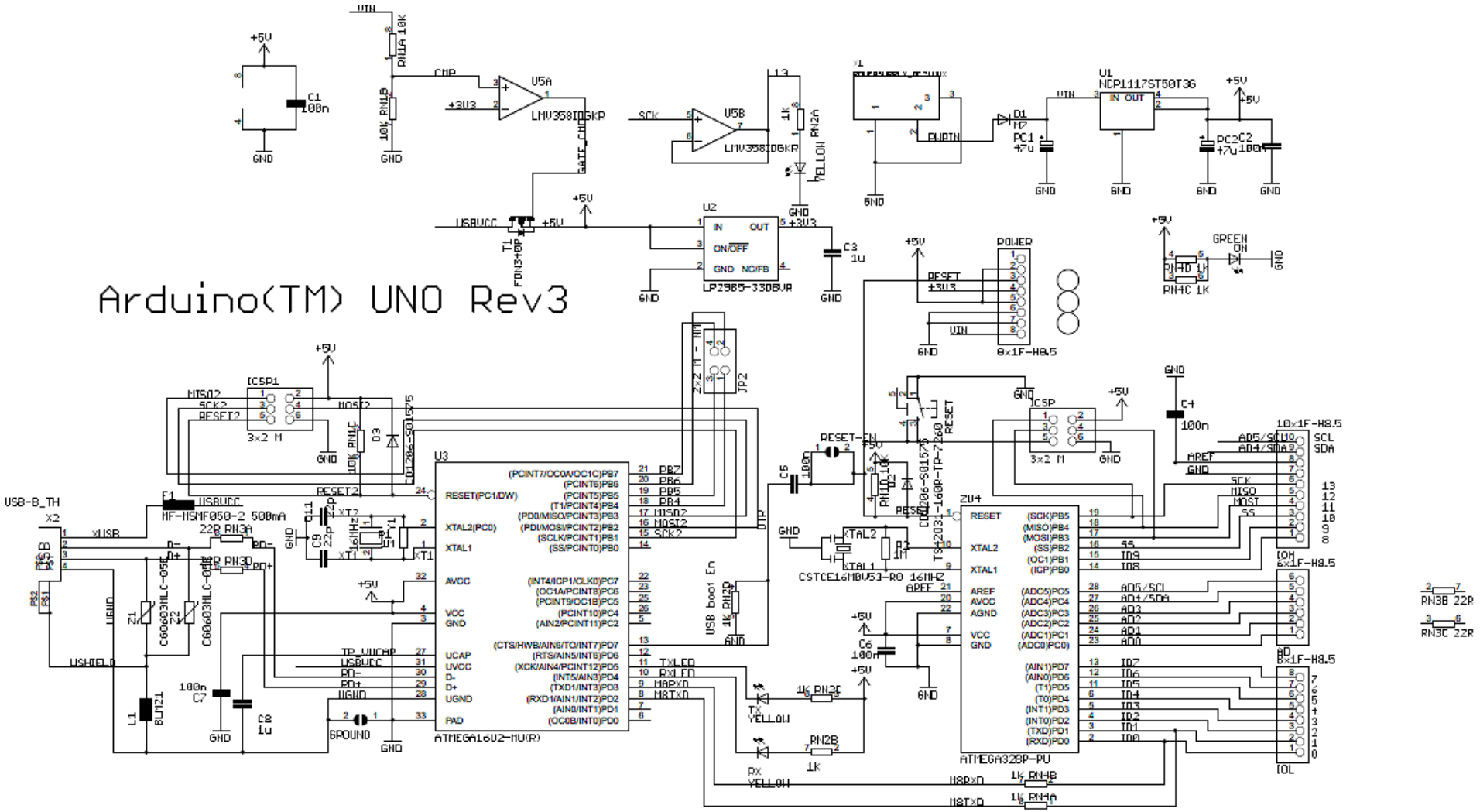
Features

- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
  - 131 Powerful Instructions – Most Single Clock Cycle Execution
  - 32 x 8 General Purpose Working Registers
  - Fully Static Operation
  - Up to 20 MIPS Throughput at 20 MHz
  - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
  - 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory
  - 256/512/512/1K Bytes EEPROM
  - 512/1K/1K/2K Bytes Internal SRAM
  - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
  - Data retention: 20 years at 85°C/100 years at 25°C(1)
  - Optional Boot Code Section with Independent Lock Bits
    - In-System Programming by On-chip Boot Program
    - True Read-While-Write Operation
  - Programming Lock for Software Security
- Peripheral Features
  - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
  - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
  - Real Time Counter with Separate Oscillator
  - Six PWM Channels
  - 8-channel 10-bit ADC in TQFP and QFN/MLF package
    - Temperature Measurement
  - 6-channel 10-bit ADC in PDIP Package
    - Temperature Measurement
  - Programmable Serial USART
  - Master/Slave SPI Serial Interface
  - Byte-oriented 2-wire Serial Interface (Philips I^2C compatible)
  - Programmable Watchdog Timer with Separate On-chip Oscillator
  - On-chip Analog Comparator
  - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
  - Power-on Reset and Programmable Brown-out Detection
  - Internal Calibrated Oscillator
  - External and Internal Interrupt Sources
  - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
  - 23 Programmable I/O Lines
  - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
  - 1.8 - 5.5V
- Temperature Range:
  - -40°C to 85°C
- Speed Grade:
  - 0 - 4 MHz@1.8 - 5.5V, 0 - 10 MHz@2.7 - 5.5.V, 0 - 20 MHz @ 4.5 - 5.5V
- Power Consumption at 1 MHz, 1.8V, 25°C
  - Active Mode: 0.2 mA
  - Power-down Mode: 0.1 µA
  - Power-save Mode: 0.75 µA (Including 32 kHz RTC)

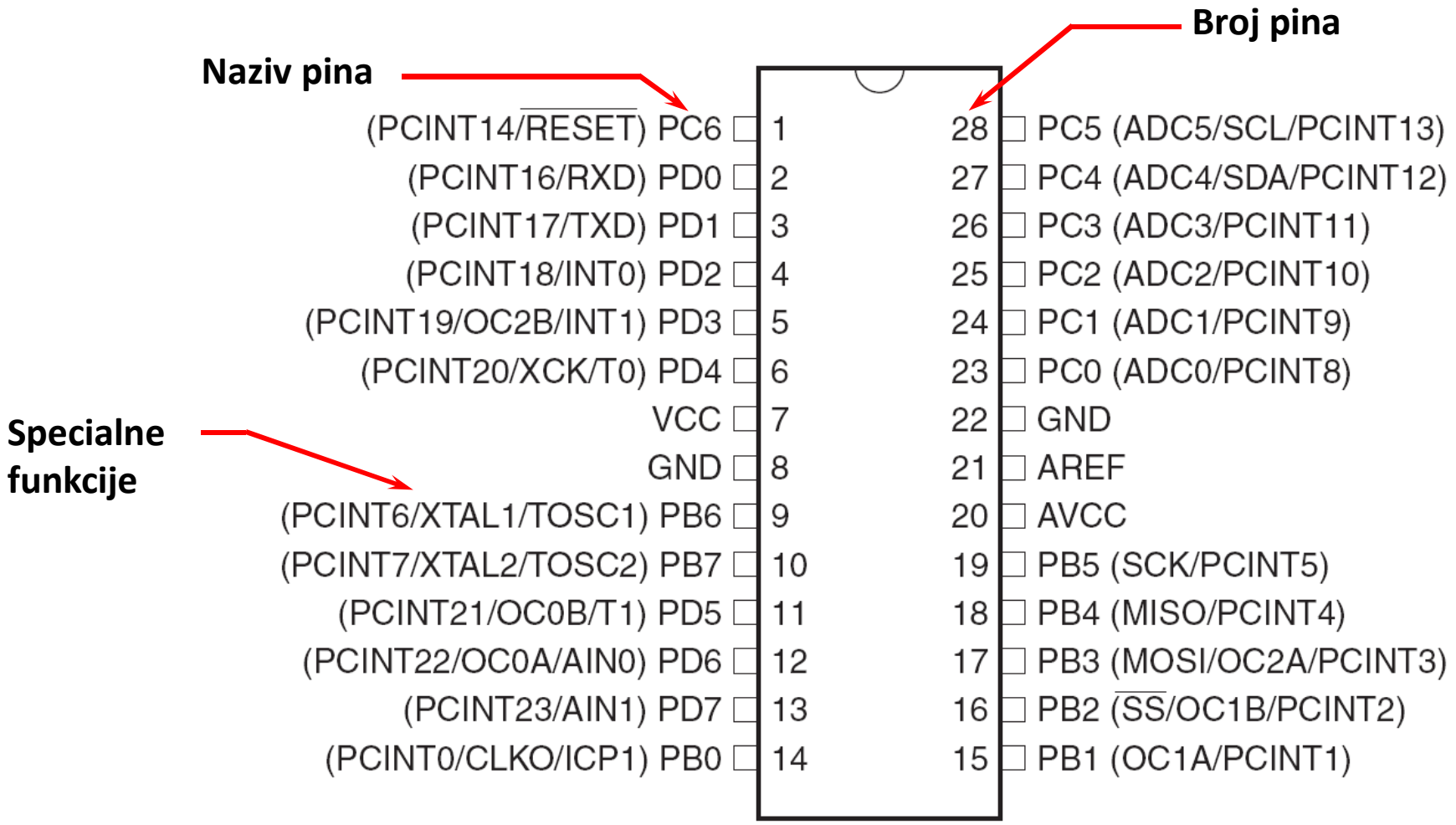
ATmega328 data sheet p. 1

http://www.atmel.com/Images/Atmel-8271-8-bit-AVR-Microcontroller-ATmega48A-48PA-88A-88PA-168A-168PA-328-328P_datasheet.pdf

Arduino Uno – električna šema



ATmega328 Microcontroller



Source:http://www.atmel.com/dyn/products/product_card.asp?PN=ATmega328P

Absolutni maximumi

28.1 Absolute Maximum Ratings*

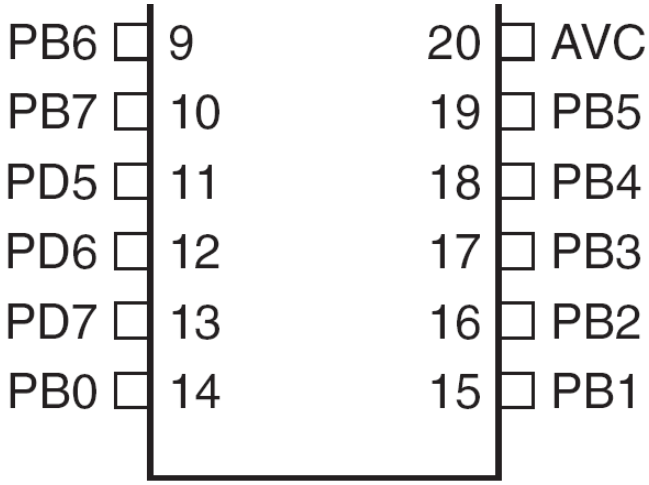
Operating Temperature	-55°C to +125°C
Storage Temperature	-65°C to +150°C
Voltage on any Pin except $\overline{\text{RESET}}$ with respect to Ground	-0.5V to V_{CC}+0.5V
Voltage on $\overline{\text{RESET}}$ with respect to Ground	-0.5V to +13.0V
Maximum Operating Voltage	6.0V
DC Current per I/O Pin	40.0 mA
DC Current V_{CC} and GND Pins	200.0 mA

*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ATmega328 data sheet p. 316

Microcontrolerski portovi i pinovi

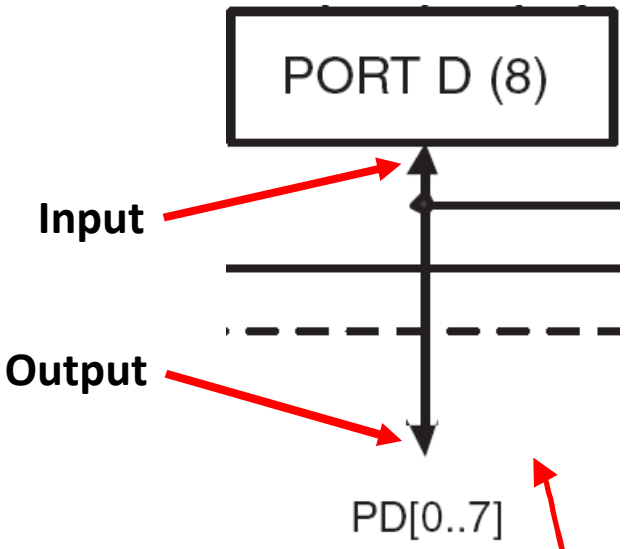
- Priključci kroz koje mikrokontroler opšti sa spoljašnjom sredinom
  - Pr. PORTB
    - Pinovi PB0 – PB7
      - Ne moraju biti susjedni
      - Često bi-*direcioni*

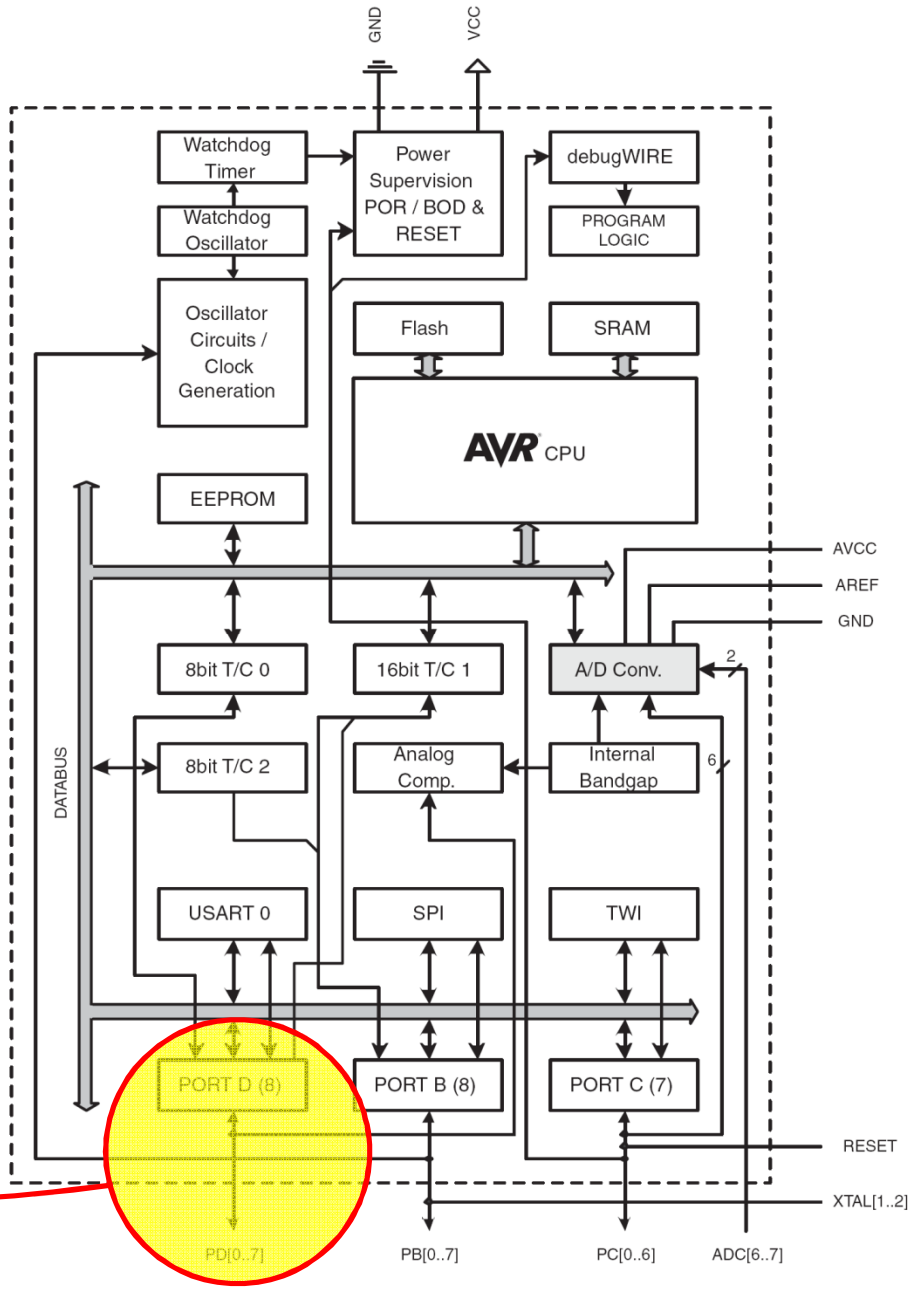


Port Pin – Usmjerenje podataka

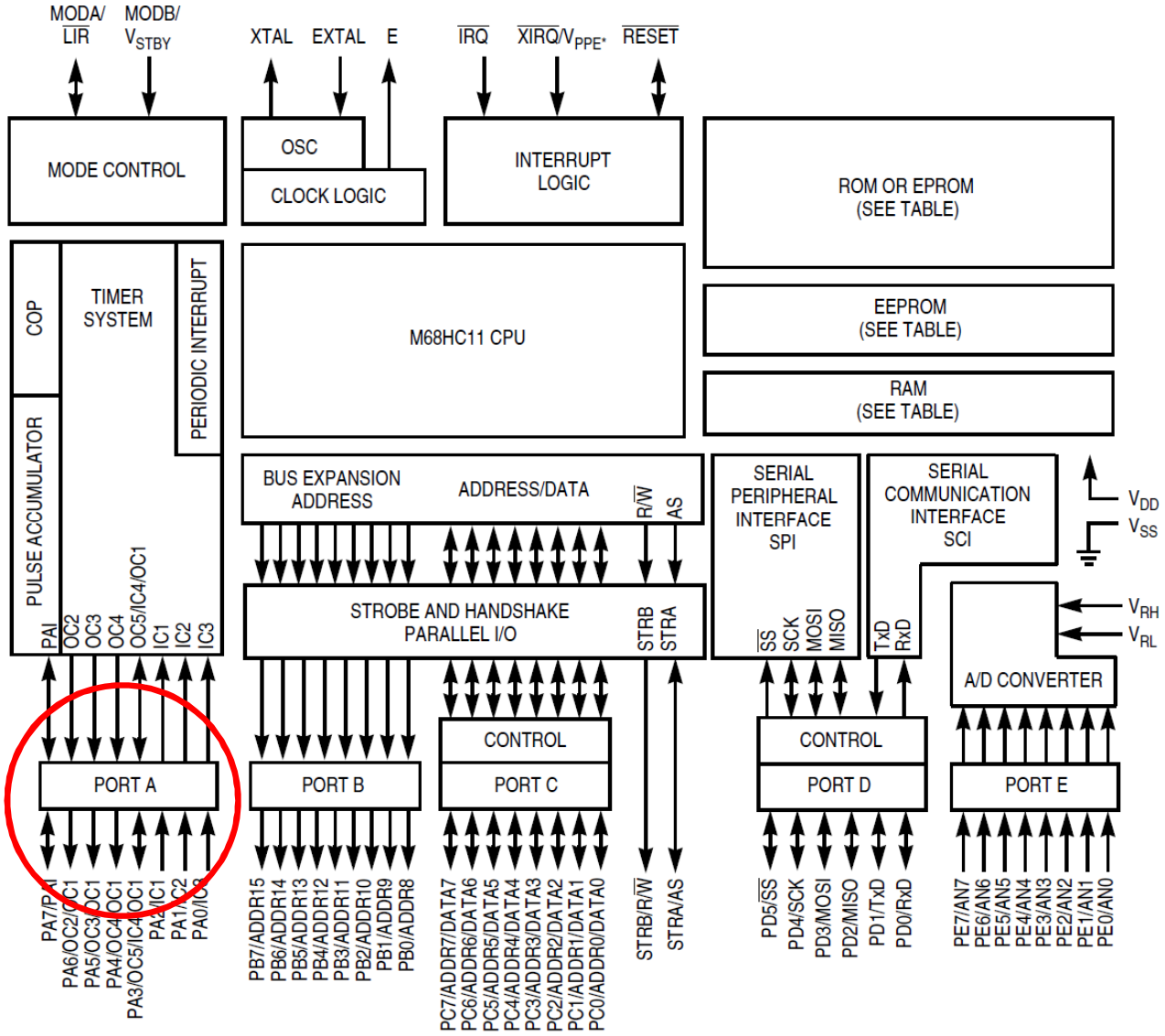
- Ulaz
  - Kada se želi uzeti informacija iz spoljašnjeg svijeta (senzori) **u** MCU
- Output
  - Kada se želi izmijeniti stanje nečega **izvan** MCU (uključiti ili isključiti motor, itd.)
- Po uključenju napajanja svi pinovi su ulazni.
- Program može mijenjati usmjerenja podataka za svaki pin u svakom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

ATmega328
Blok diagram





M68HC11 microkontroler



Postavljenje smjera toka podatka za pin

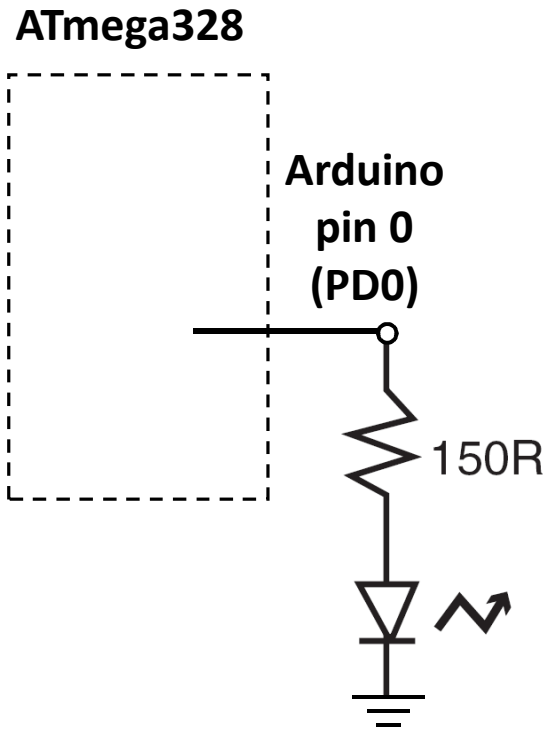
- Arduino
  - pinMode(*pin_no.*, *dir*)
    - Pr. postaviti Arduino pin 3 (PD3) kao izlazni
      - **`pinMode(3, OUTPUT);`**
  - Napomena: jedan pin u jednom trenutku
    - Predpostavimo da se želi postaviti pinove 3, 5, i 7 (PD3, PD5, i PD7) kao izlazne?
    - Postoji li način da se oni postave istovremeno?
      - Da! Kako, slijedi kasnije…

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)

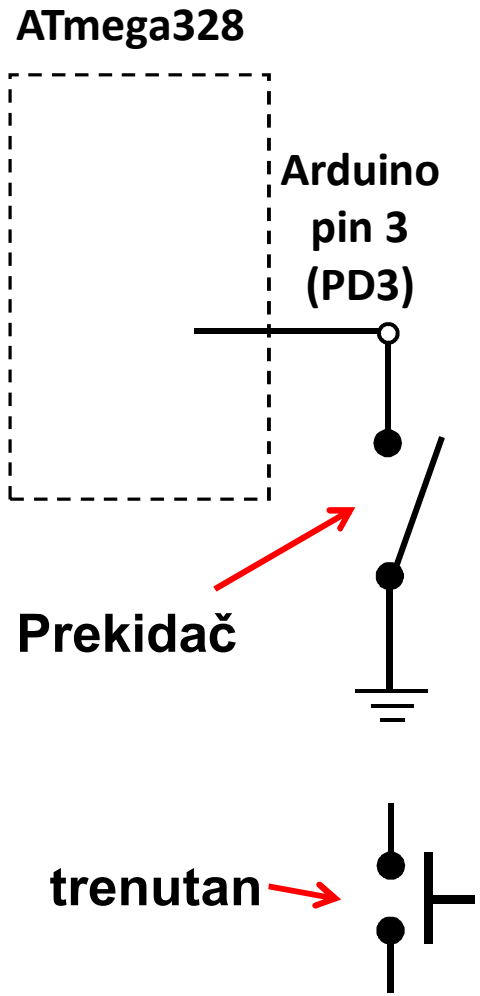
Pin upotrijebljen kao izlazni

- Uključiti LED, koja je povezana na Arduino pin 0 (PD0) (otpornik!)
  - Koji tok podataka treba biti za pin 0 (PD0)?
    - **`pinMode(____, ____);`**
  - Uključenje LED
    - **`digitalWrite(0,HIGH);`**
  - Isključenje LED
    - **`digitalWrite(0,LOW);`**



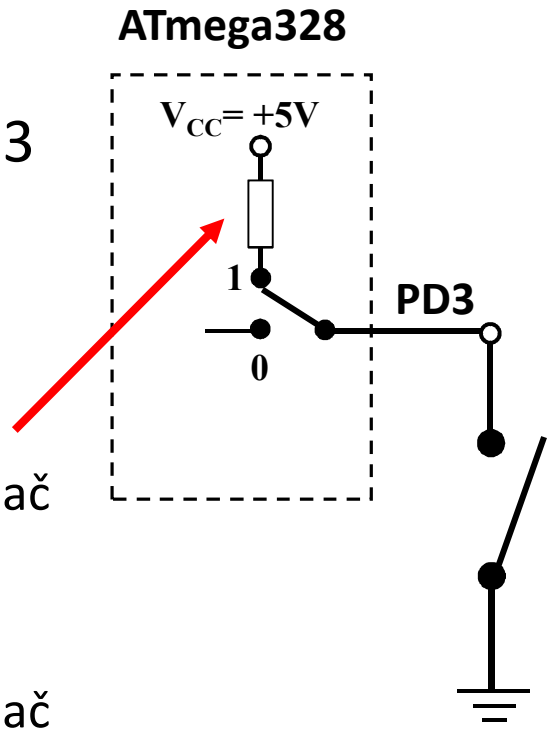
Pin kao ulazni + Pull-up otpornik

- Prekidač kao senzor
  - Pr. Senzor pojasa za sjedište u autu
  - Detekcija ***stanja prekidača***
    - Koji tok podataka treba biti za Arduino pin 3 (PD3)?
    - **`pinMode(____, ____);`**
    - Koji će biti napon na PD3 kada je prekidač zatvoren?
    - Koji će biti napon na PD3 kada je prekidač otvoren?
      - Neodređeno!



Pin kao ulazni + Pull-up otpornik

- Prekidač kao senzor, nastavak.
  - Učinimo napon na pinu poznatim uključenjem pull-up otpornika za PD3
    - Neka je PD3 ulazni port:
      - `digitalWrite(3,HIGH);`
        uključenje "pull-up" otpornika
      - `pinMode(3,INPUT_PULLUP);`
    - Koji će napon biti na PD3 kada je prekidač otvoren?
      - V_{CC}
    - Koji će napon biti na PD3 kada je prekidač zatvoren?

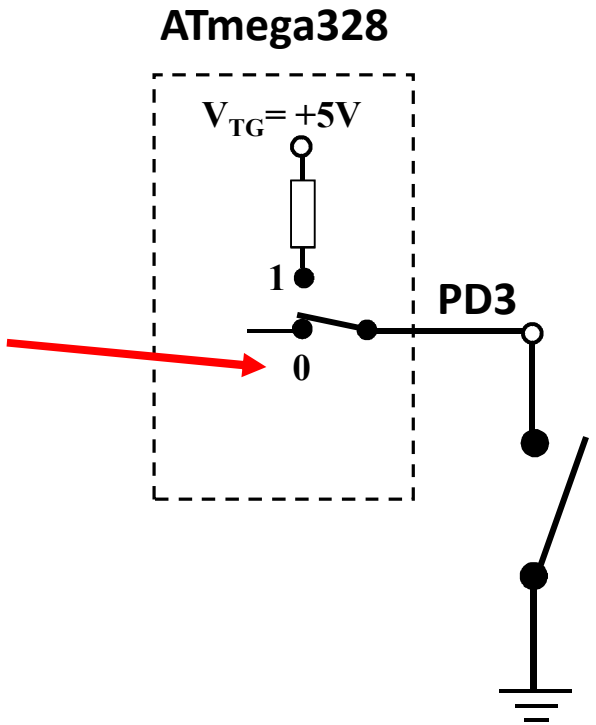


Pin kao ulazni + Pull-up otpornik

- Prekidač kao senzor, nastavak.
  - Za isključenje pull-up otpornika
    - Neka je PD3 ulazni port:

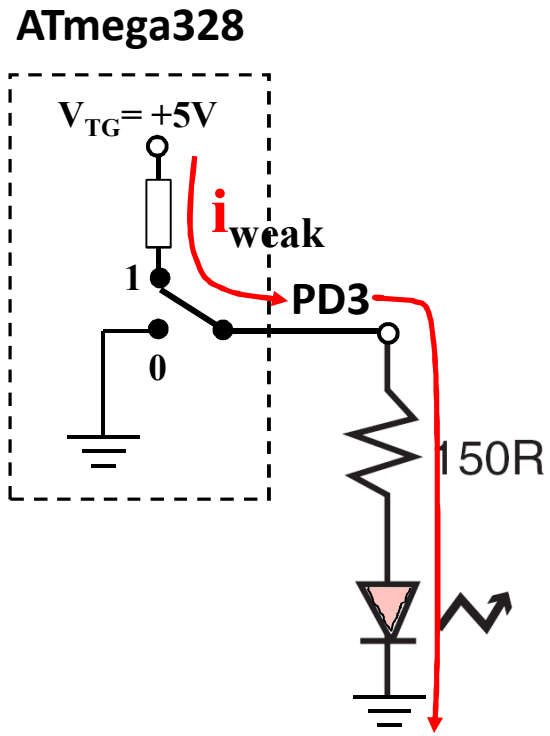
```
digitalWrite(3,LOW);
```

Isključuje “pull-up” otpornik



Pin kao ulazni + Pull-up otpornik

- Mogućnost ‘slabog pogona’ kada je pull-up otpornik uključen
  - Pin koji je postavljen kao ulazni sa uključenim pull-up otpornikom može dati malu struju.
    - Zapamtiti ovo!



I što?

- Pitanje od prije:
  - 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 bit 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 registi su:
  - DDRx
    - Data Direction bit u DDRx registru (read/write)
  - PORTx
    - PORTx data registar (read/write)
  - PINx
    - PINx registar (read only)

PORT Pin i registar detailji

ATmega328 datasheet, pp. 76-94

Figure 13-1. I/O Pin Equivalent Schematic

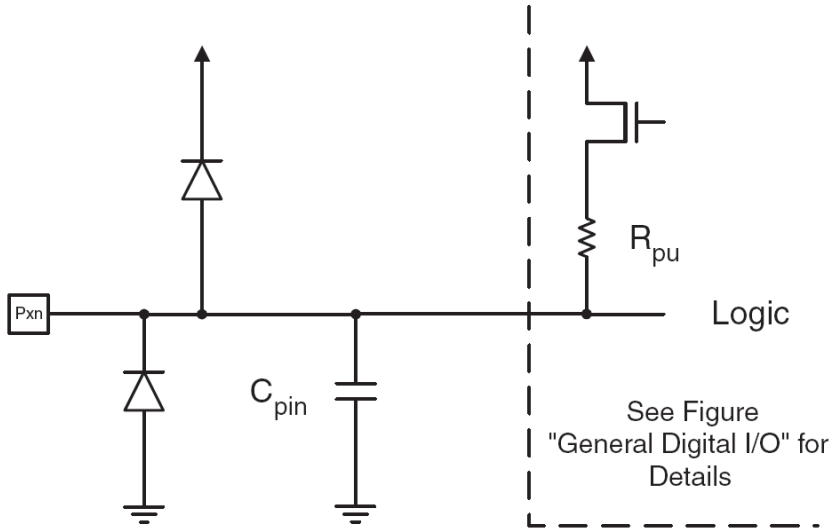
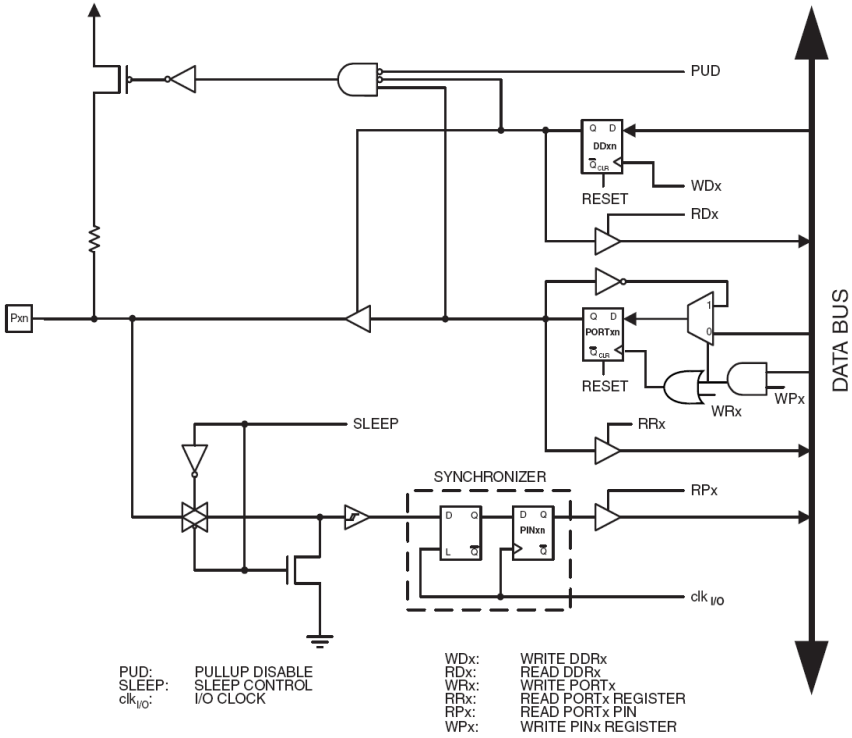


Figure 13-2. General Digital I/O[1]



PORTD – The Port D Data Register

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	

DDRD – The Port D Data Direction Register

Bit	7	6	5	4	3	2	1	0	
0x0A (0x2A)	DDD7	DDD6	DDD5	DDD4	DDD3	DDD2	DDD1	DDD0	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	

PIND – The Port D Input Pins Address

Bit	7	6	5	4	3	2	1	0	
0x09 (0x29)	PIND7	PIND6	PIND5	PIND4	PIND3	PIND2	PIND1	PIND0	PIND
Read/Write	R	R	R	R	R	R	R	R	
Initial Value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Jump to bits

Primjer 1

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

Å Arduino pristup

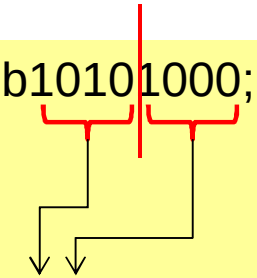
```
pinMode(3, OUTPUT);
pinMode(5, OUTPUT);
pinMode(7, OUTPUT);
```

Ili ako je upotrijebljena me106.h:

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

Å Alternativni pristup

```
DDRD = 0b10101000;

ili

DDRD = 0xA8;

ili

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



Primjer 2

- Postaviti Arduino pinove 0 i 1 (PD0 i PD1) kao ulazne, i uključiti pull-up otpornike

Arduino pristup

```
pinMode(0, INPUT);
pinMode(1, INPUT);
digitalWrite(0, HIGH);
digitalWrite(1, HIGH);
```

Ili ako je upotrijebljena me106.h:

```
pinMode(PIN_D0, INPUT);
pinMode(PIN_D1, INPUT);
digitalWrite(PIN_D0, HIGH);
digitalWrite(PIN_D1, HIGH);
```

Alternativni pristup

```
DDRD = 0; // all PORTD pins inputs
PORTD = 0b00000011;
ili
PORTD = 0x03;
```

Ili još bolje:

```
DDRD & = ~(1<<PD1 | 1<<PD0);
PORTD | = (1<<PD1 | 1<<PD0);
```

Kako startovati?

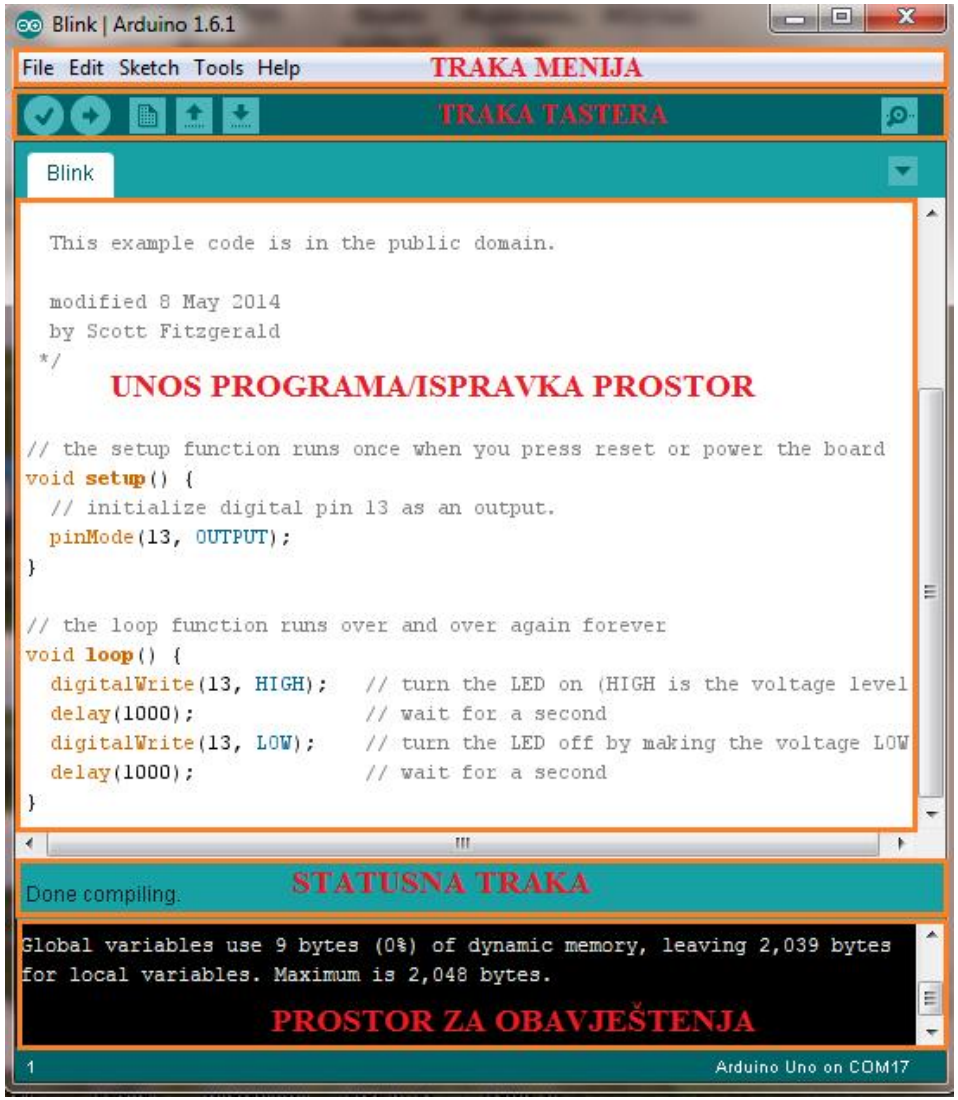
- Posjetite: http://arduino.cc/en/Guide/HomePage

1. Preuzmite & instalirajte Arduino environment (IDE)
2. Povezite ploču sa računarom pomoću USB kabla
3. Ako je potrebno, instalirajte dodatne drajvere
4. Pokrenite Arduino IDE
5. Selektujte razvojnu ploču
6. Selektujte serijski port
7. Otvorite blink primjer
8. Upišite program u razvojnu ploču

...

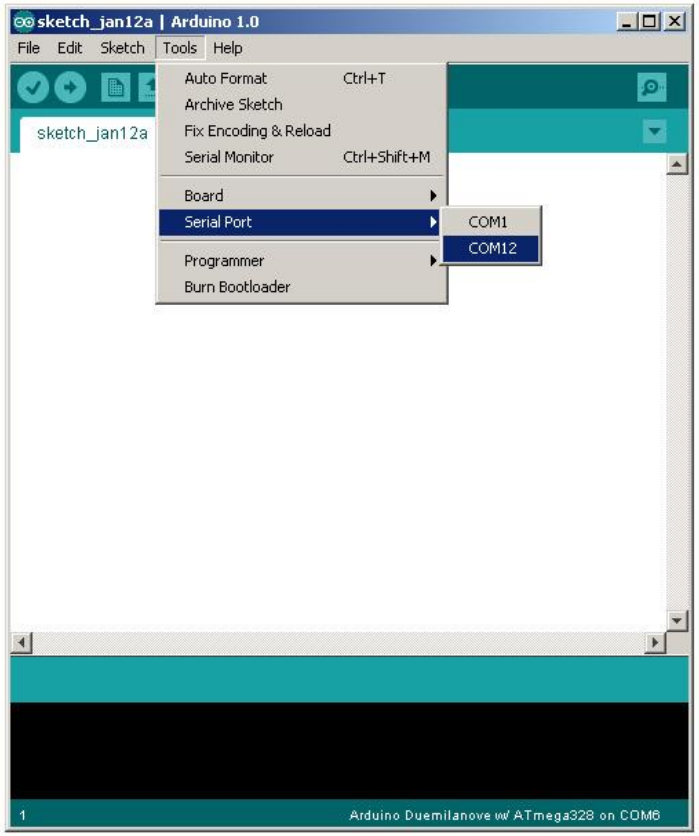
9. Pisanje vlastitog programa
10. Nerviranje/Debagiranje/Primoravanje da radi
11. Oduševljenje i neposredno započinjanje novog projekta
12. (spavanje je za slabiće)

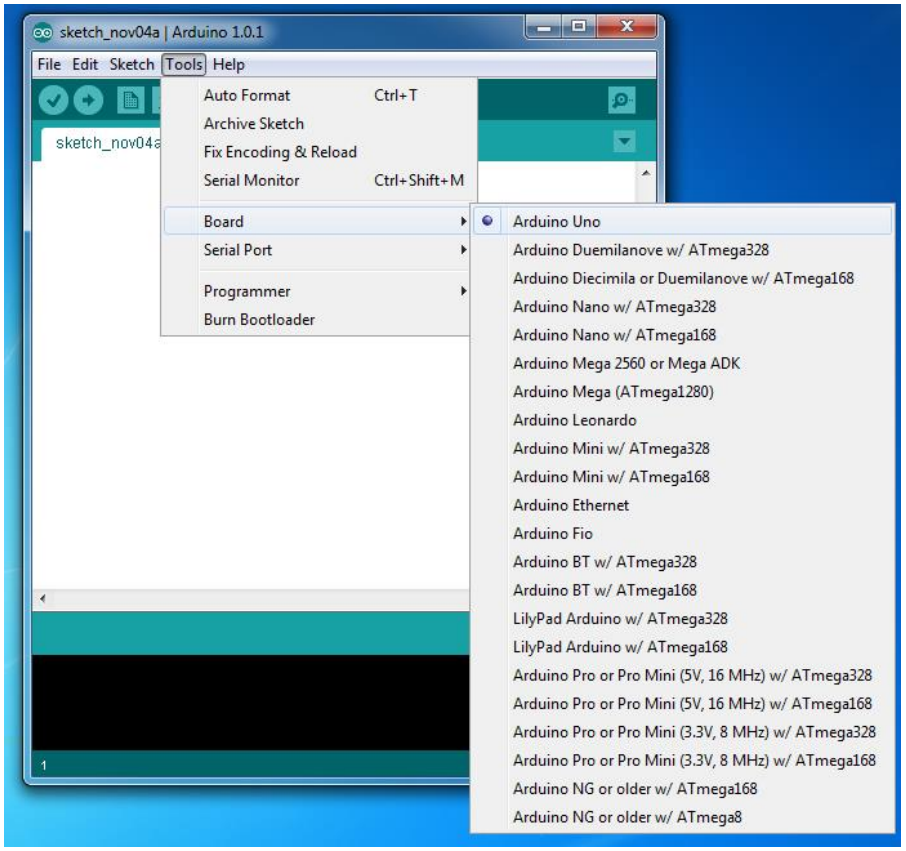
Arduino IDE



Pogledajte: http://arduino.cc/en/Guide/Environment za više informacija

Odaberite serijski port i ploču





Arduino oprema

Keyes RFID Learning Module Set for Arduino

Razvoj Arduino programa

- Zasnovan na C++ bez 80% komandi.
- Pregršt novih komandi.
- Programi se nazivaju 'sketches' (skečevi, skice) .
- Skečevi obevezno sadrže dvije funkcije:
  - void setup( )
  - void loop( )
- setup( ) se pokreće prvi i samo jedanput.
- loop( ) se pokreće neprestano, dok se ne isključi napajanje ili se ne učita novi skeč.

Arduino C

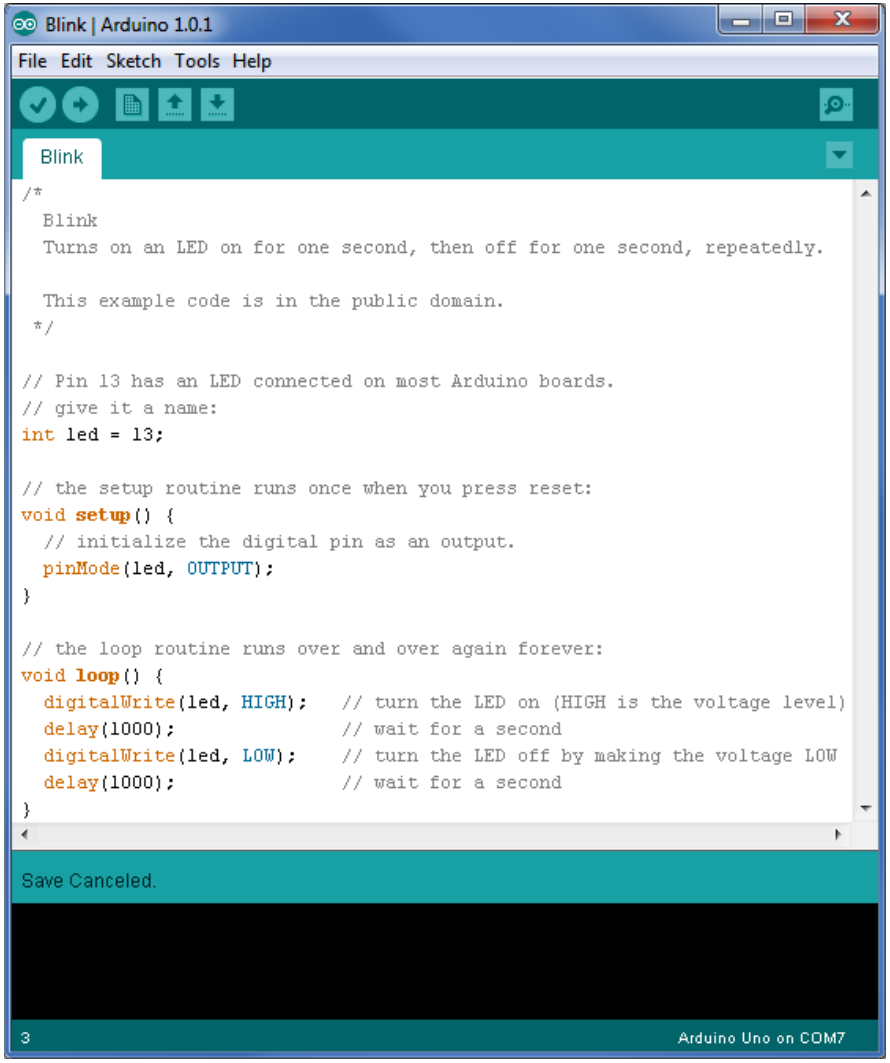
- Arduino skečevi uglavnom upravljaju pinovima na arduino ploči.
- Arduino skečevi su uvijek petlja.
  - void loop( ) {} je isto što i while(1) { }

Arduino tajming

- `delay(`*`ms`*`)`
  - Pauza nekoliko millisekundi
- `delayMicroseconds(`*`us`*`)`
  - Pauza nekoliko mikrosekundi
- Više komandi:
  arduino.cc/en/Reference/HomePage

Osobine kompajlera

- Brojni jednostavni skečevi su uključeni u kompajler
- Nalaze se pod opcijom File, Examples
- Kada je skeč napisan, može se upisati u programsku memoriju mikrokontrolera na Arduino štampanoj ploči kroz opcije File, Upload, ili pritiskom na <Ctrl> U



Arduino C je izveden iz C++

- Ovaj program radi treperenje LED na pinu 13

Å avr-libc

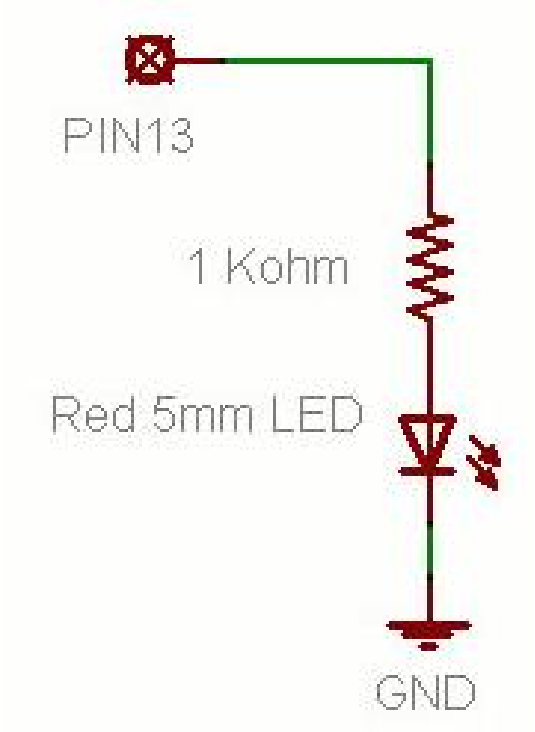
```
#include <avr/io.h>
#include <util/delay.h>

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

Å Arduino C

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

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

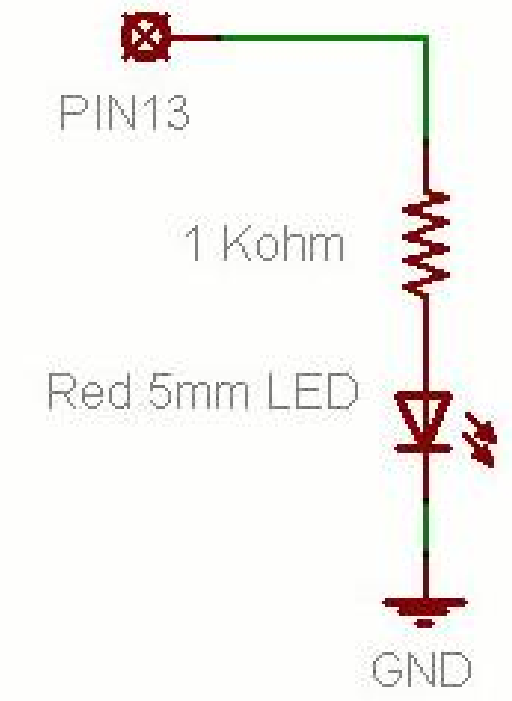
Prosto elektronsko kolo

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



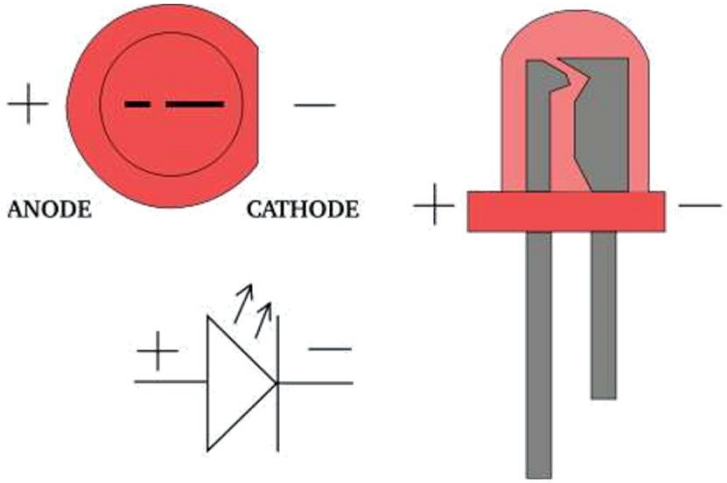
Osnovno LED kolo

- Povežite pin 13 mikrokonrolera 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 port.
- Kraću nožicu LED spojite na negativni priključak napajanja (masu).



Blink Skeč (Treperenje)

- **File > Examples > Digital > Blink**
- LED ima polaritet
  - Negativni je indikovan 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);
}
```

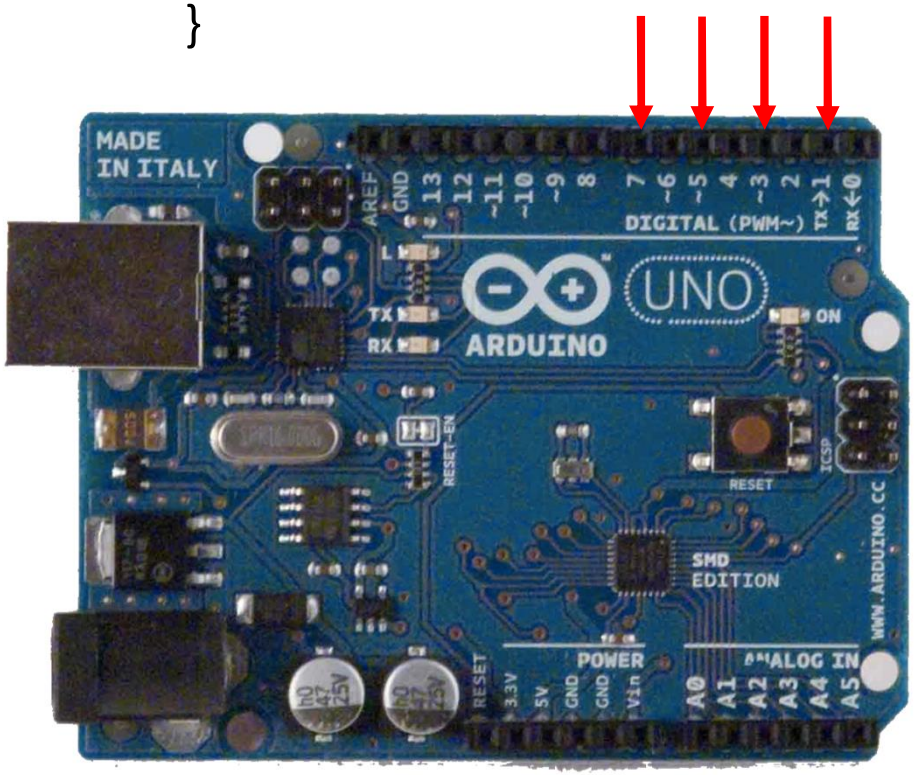
Struktura Arduino programa

- 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);
}
```



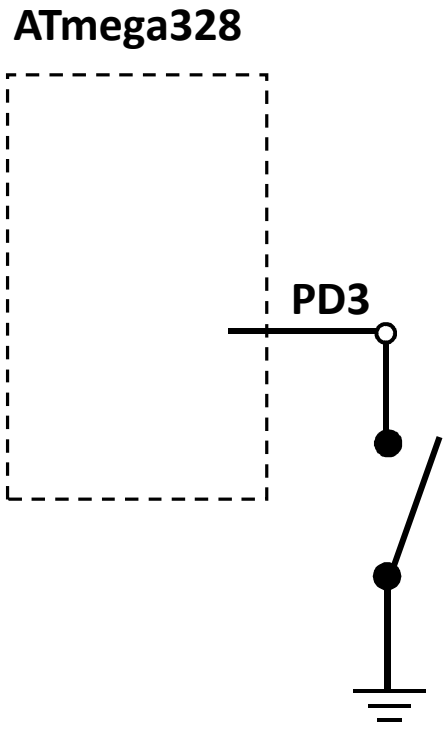

```
void loop( ) {
  digitalWrite(1, HIGH);
  delay (200);
  digitalWrite(1, LOW);

  digitalWrite(3, HIGH);
  delay (200);
  digitalWrite(3, LOW);

  digitalWrite(5, HIGH);
  delay (200);
  digitalWrite(5, LOW);

  digitalWrite(7, HIGH);
  delay (200);
  digitalWrite(7, LOW);
}
```

I što?

- Super. Treperi svjetlo. Ništa posebno.
- Obuhvatili smo samo izlazne postove za sada.
- Možemo li upotrijebiti ulaze za detekciju fizičkih pojava?

Ulazni digitalni pin – Primjer 1

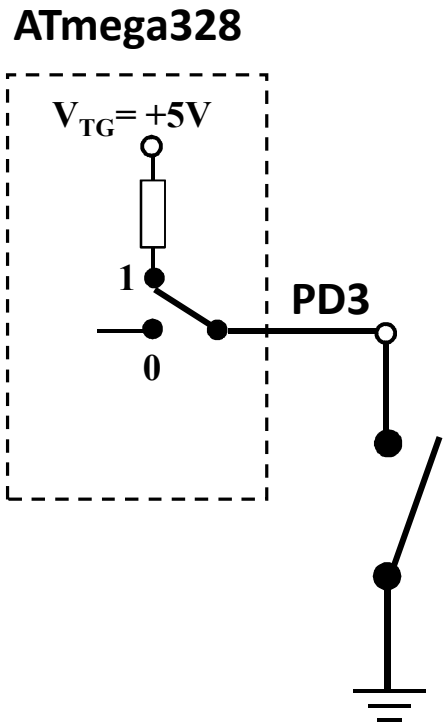
- ‘Očitavanje ulaznog pina’
  - Napisati ćemo nekoliko linija C za Arduino u cilju definisanja načina djelovanja kada je pojas vozača u autu vezan (prekidač zatvoren).
    - Ako je pojas vezan, omogućeno je uključenje auto kroz poziv funkcije start_enable().
    - Ako pojas nije vezan onemogućeno je uključenje auto kroz poziv funkcije start_disable()
  - Napisaćemo najprije psudokod!



Ulazni digitalni pin – Primjer 1

- ‘Očitavanja pina’
  - Pseudokod:

```
Postaviti PD3 kao ulazni
Uključiti PD3 pull-up otpornik
Očitati napon sa Arduino pin 3 (PIN_D3)
IF PIN_D3 napon je LOW (vezan), THEN
        pozovi funkciju start_enable()
ELSE
        pozovi start_disable()
```



Ulazni digitalni pin – Primjer 1

Å ‘Očitavanja pina’

Å Pseudokod:

Postaviti PD3 kao ulazni

Uključiti PD3 pull-up otpornik

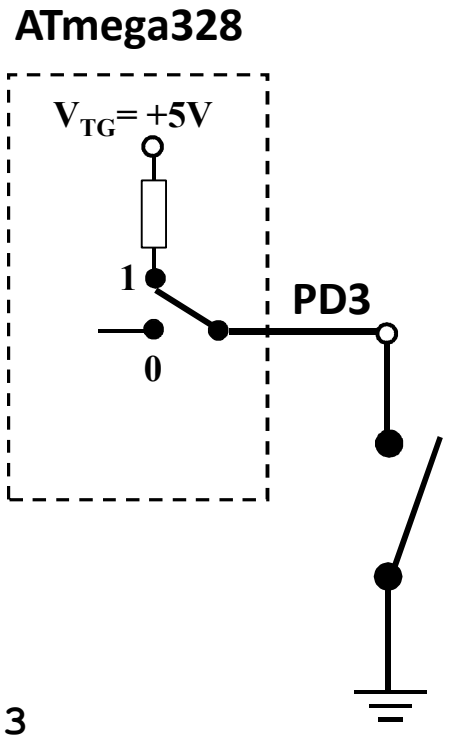
Očitati napon sa Arduino pin 3 (PIN_D3)

IF PIN_D3 napon je LOW (vezan), THEN

pozovi funkciju start_enable()

ELSE

pozovi start_disable()

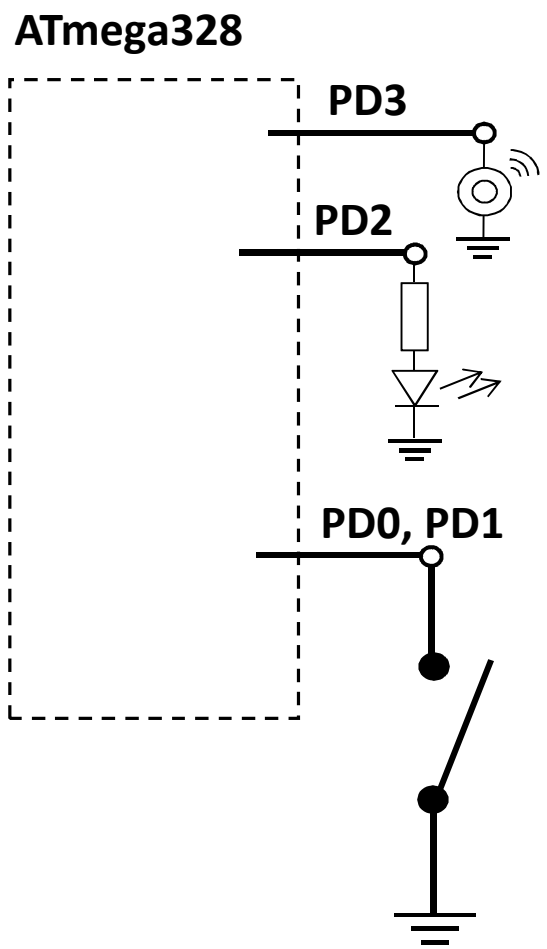


Fragment, nije cijeli program

```
#define PIN_SWITCH 3
#define LATCHED LOW
pinMode(PIN_SWITCH,INPUT_PULLUP);
belt_state = digitalRead(PIN_SWITCH);
if (belt_state == LATCHED)
{ ig_enable(); }
else
{ ig_disabled(); }
```

Ulazni digitalni pin – Primjer 2

- Čitanje sa pina i upisivanje na pin
  - Napisaćemo nekoliko linija C koda za Arduino, s ciljem uključenja LED (PD2) i zvučnog signala (PD3) ako je ključ u bravi (PD0 zatvoren), ali pojas vozača nije vezan (PD1 otvoren)
  - Najprije pseudokod



Ulazni digitalni pin – Primjer 2

Å Pseudokod:

Postavljanje toka podataka za pinove

Postaviti PD0 i PD1 kao ulaze

Uključiti pull-up otpornike za PD0 i PD1

Postaviti PD2 i PD3 kao izlaze

Beskonačna petlja

IF je ključ u bravi THEN

IF ako je pojas vezan, THEN

Isključi zvučni signal

Isključi LED

ELSE

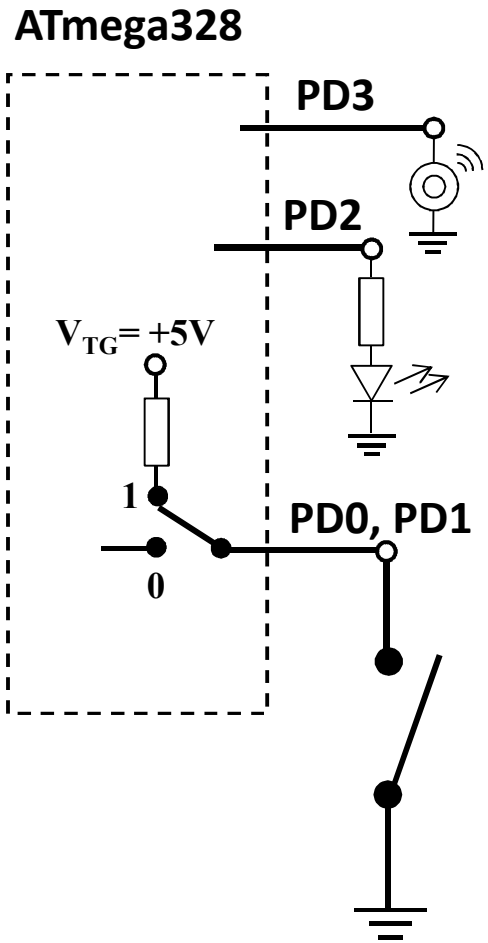
Uključi LED

Uključi zvučni signal

ELSE

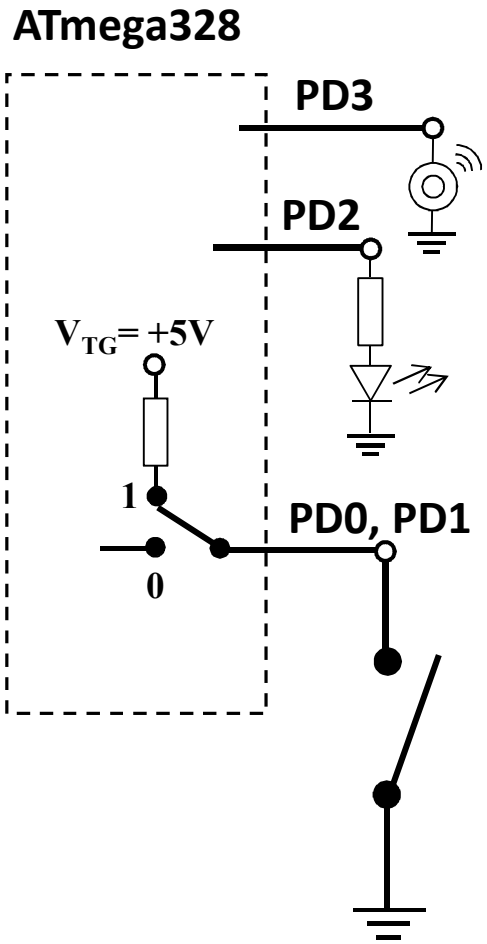
Isključi zvučni signal

Isključi LED



Ulazni digitalni pin – Primjer 2 (Arduino kod)

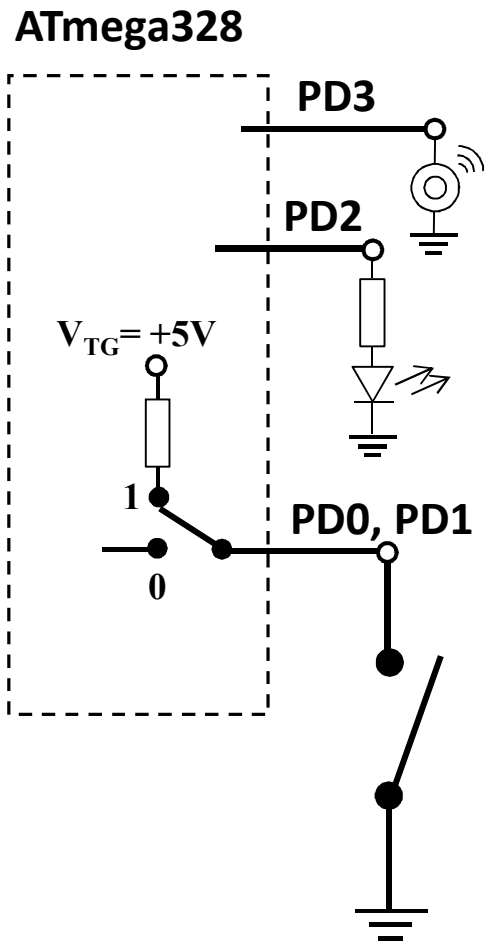
```
#define PIN_IGNITION  0
#define PIN_SEATBELT  1
#define PIN_LED  2
#define PIN_BUZZER  3
#define SEATBELT_LATCHED  LOW
#define KEY_IN_IGNITION LOW
#define LED_ON  HIGH
#define LED_OFF  LOW
#define BUZZER_ON  HIGH
#define BUZZER_OFF  LOW

void setup()
{
  pinMode(PIN_IGNITION, INPUT_PULLUP);  // key switch
  pinMode(PIN_SEATBELT, INPUT_PULLUP); // belt latch switch
  pinMode(PIN_LED, OUTPUT);  // lamp
  pinMode(PIN_BUZZER, OUTPUT);  // buzzer
}
```



/* see next page for code */

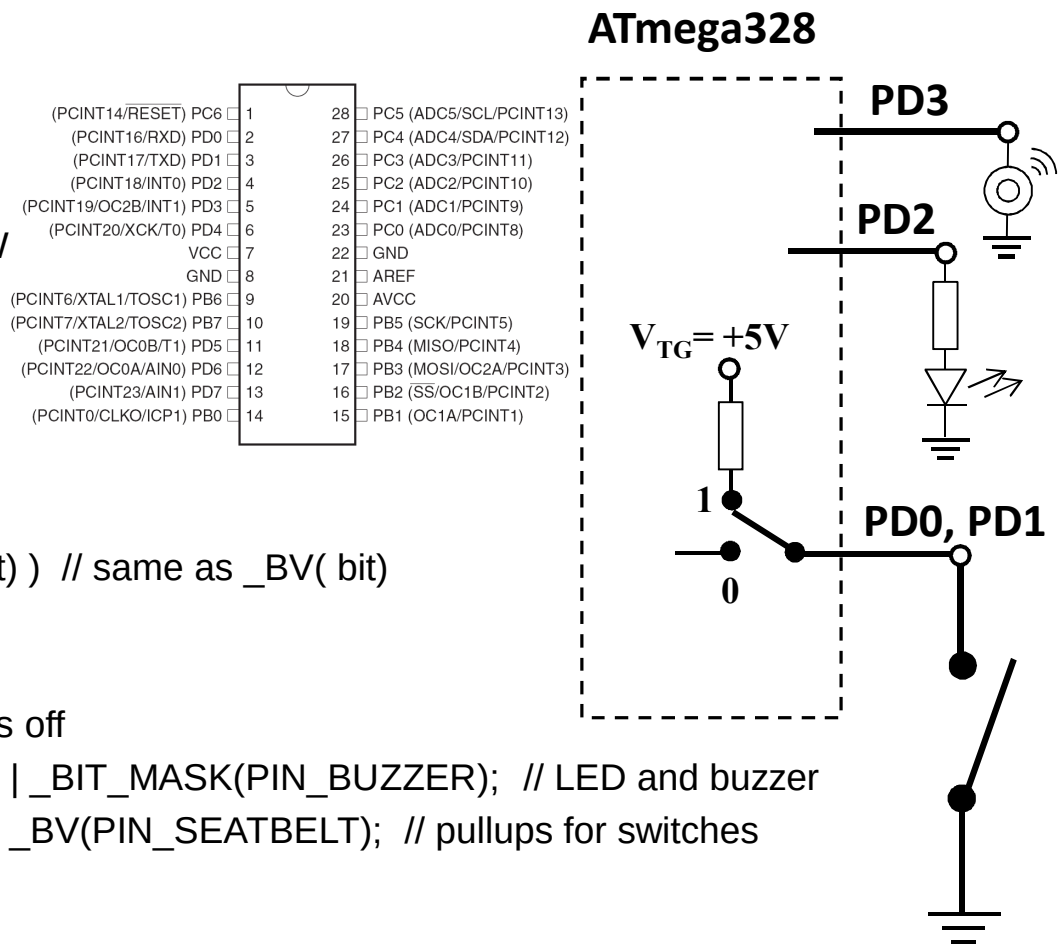
Ulazni digitalni pin – Primjer 2 (Arduino kod)

```
/* see previous page for code before loop() */
void loop()
{
  int key_state = digitalRead(PIN_IGNITION);
  int belt_state = digitalRead(PIN_SEATBELT);
  if (key_state == KEY_IN_IGNITION)
  {
      if (belt_state == SEATBELT_LATCHED)
      {
          digitalWrite(PIN_BUZZER, BUZZER_OFF);
          digitalWrite(PIN_LED, LED_OFF);
      }
      else  // key is in ignition, but seatbelt NOT latched
      {
           digitalWrite(PIN_BUZZER, BUZZER_ON);
           digitalWrite(PIN_LED, LED_ON);
      }
  }
  else  // key is NOT in ignition
  {
        digitalWrite(PIN_BUZZER, BUZZER_OFF);
        digitalWrite(PIN_LED, LED_OFF);
  }
}
```



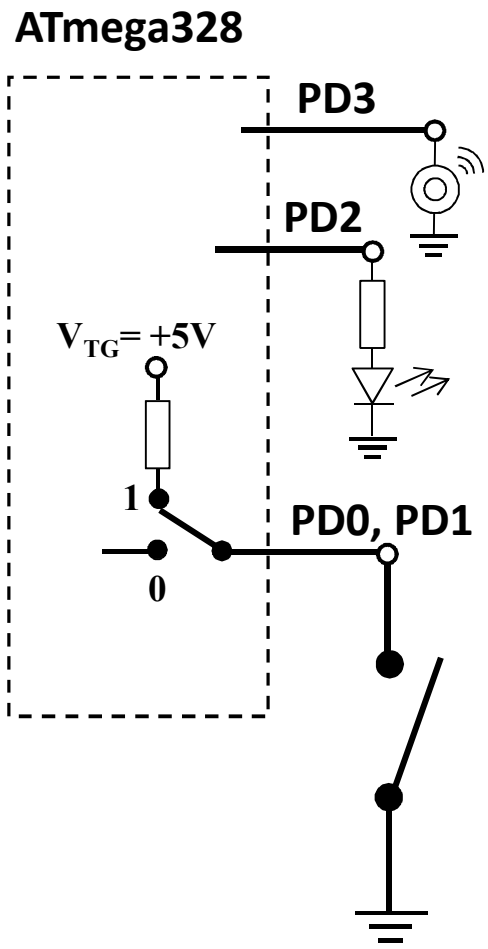
Ulazni digitalni pin – Primjer 2 (Alternativni kod)

```
/* NOTE: #defines use predefined PORT pin numbers  for ATmega328 */
#define PIN_IGNITION  PD0
#define PIN_SEATBELT  PD1
#define PIN_LED  PD2
#define PIN_BUZZER  PD3
#define SEATBELT_LATCHED  LOW
#define KEY_IN_IGNITION LOW
#define LED_ON  HIGH
#define LED_OFF  LOW
#define BUZZER_ON  HIGH
#define BUZZER_OFF  LOW
#define  _BIT_MASK( bit )  ( 1 << (bit) )  // same as _BV( bit)
void setup()
{
    PORTD = 0;  // all  PORTD pullups off
    DDRD  = _BIT_MASK(PIN_LED)  | _BIT_MASK(PIN_BUZZER);  // LED and buzzer
    PORTD | = _BV(PIN_IGNITION) | _BV(PIN_SEATBELT);  // pullups for switches
}

/* See next page for loop() code */
```



Ulazni digitalni pin – Primjer 2 (Arduino kod)

```
/* see previous page for setup() code */
void loop()
{
    uint8_t current_PORTD_state, key_state, belt_state;
    current_PORTD_state = PIND;  // snapshot of PORTD pins
    key_state = current_PORTD_state  &  _BV(PIN_IGNITION);
    belt_state = current_PORTD_state  &  _BV(PIN_SEATBELT);
    if (key_state  == KEY_IN_IGNITION)
    {
        if (belt_state == SEATBELT_LATCHED)
        {
          PORTD &=  ~( _BV(PIN_LED)  |  _BV(PIN_BUZZER) );
        }
        else
        {
          PORTD |=  ( _BV(PIN_LED)  |  _BV(PIN_BUZZER) );
        }
    }
    else
    {
      PORTD  & = ~( _BV(PIN_LED)  |  _BV(PIN_BUZZER) );
    }
}
```



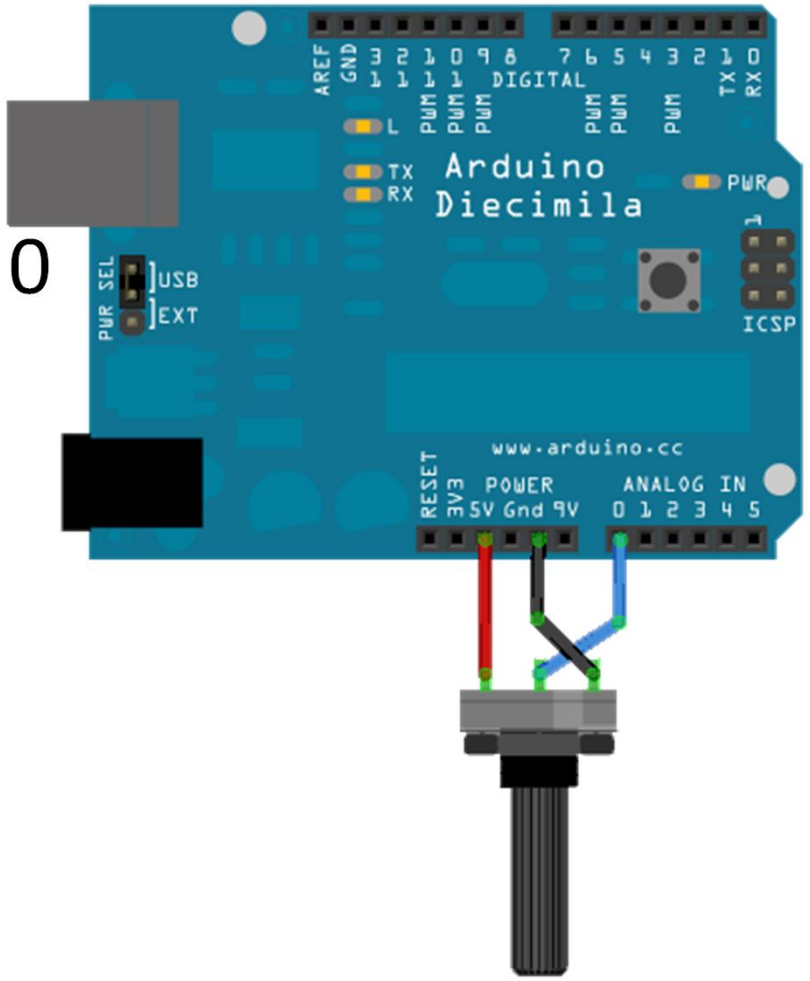
Analogni ulazi

Analogni ulazi Arduina se mogu očitati kao opseg brojeva, u zavisnosti od elektičnih karakteristika kola.

- 0 to 1023
- .0049 V per digit (4.9 mV)
- Vrijeme očitanja je 100µs (10,000 puti u secondi)

Analogni ulaz

- Potenciometar (promjenjivi otpornik) priključen je na analogni pin 0 Arduina.
- Vrijednost napona na pinu 0 veoma zavisi od otpornosti potenciometra, odnosno pozicije klizača.



Analogni ulazi-primjene

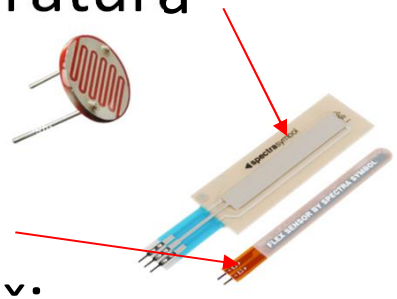
- Promjenljivi otpornik se može zamijeniti sa senzorom.
- Na primjer foto-otpornik.
  - Zavisno od nivoa osvjetljaja foto otpornik može:
    - Uključiti LED
    - Pojačati ili smanjti intezitet sijanja LED (ili LED niza)
- Mnogi senzori su jednostavno promjenljivi otpornici. Otpornost im se mijenja sa promjenom nekih fizičkih karakteristika okoline.

Senzori

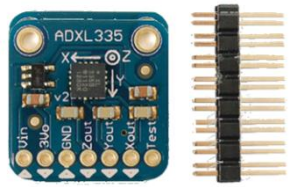
- Senzori mogu biti digitalni ili analogni.
- Obično, senzori koji mjere opseg vrijednosti mijenjaju svoju otpornost.
- Arduino može senzorisati samo napon, ne otpornost.
- U cilju obezbjedjenja napona Arduinu, senzori koji mijernjaju svoju otpornost zahtijevaju dodatno, često naponski djelilac.

Razni sensori

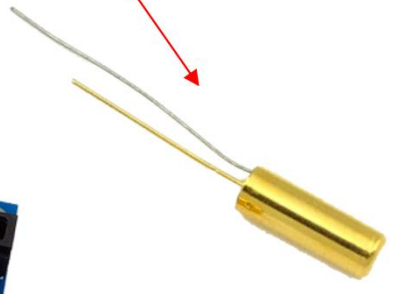
- Dials on a radio are simply potentiometers
- Temperatura
- Svjetlo
- Ugao



- Pekidači
  - Je li korisnik zatvorio prekidač ili pritisnuo taster?
- Akcelerometar



- Infrared senzor & svjetlost
- Hall effect senzor
- Ball tilt sensor (za mjerenje orjentacije)
- Sila



“Konkurencija” Arduinu

- Alternative Arduino platformi
  - Pinguino – PIC kontroler
  - MSP430 – Texas Instruments;
  - Drugi: korisnički, Teensy, itd.
- Netduino
- Računari
  - Raspberry Pi
  - BeagleBones – TI; ima računar i kontroler

Netduino

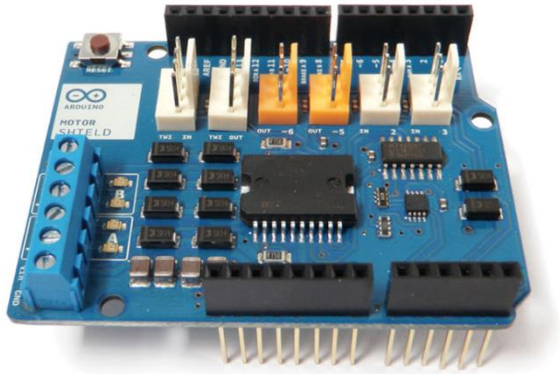
- Microkontroler i razvojno okruženje kreirano od strane Microsoft za rad sa .NET Micro Framework.
- DALEKO moćnije razvojno okruženje.
- Razlike
  - Pinovi na Netduino su 3.3V (not 5).
  - Netduino ima mnogo brži procesor
  - 60K RAM-a (naspram Uno-vih 2K).
- U velikoj mjeri kompatibilan sa Arduino-om, ali nije potpuno izmjenjiv.

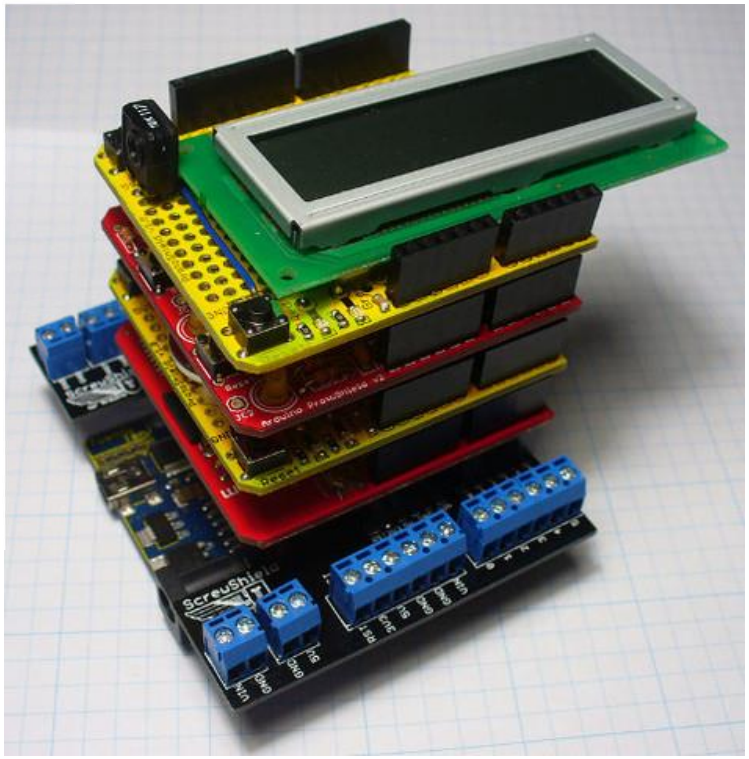
Raspberry Pi

- Pojednostavljeni računar, ne kontroler
- Koristi Debian Linux
  - Arch Linux ARM, Fedora, FreeBSD, Slackware…
- Programiran sa Python-om
  - BBC BASIC, C, Perl
- Kako je u pitanju računar (ime operativni sistem), ima drugačiju ulogu u projektima.
- Hijararhija: računar upravlja kontrolerima, kontroleri upravljaju hardverom.

Šildovi (Dodaci)

- Šildovi su ploče koje se dodaju na Arduino ploču.
- Oni proširuju mogućnosti Arduina.
- Primjeri:
  - Ethernet
  - GPS
  - Motor
  - Prototip
- shieldlist.org





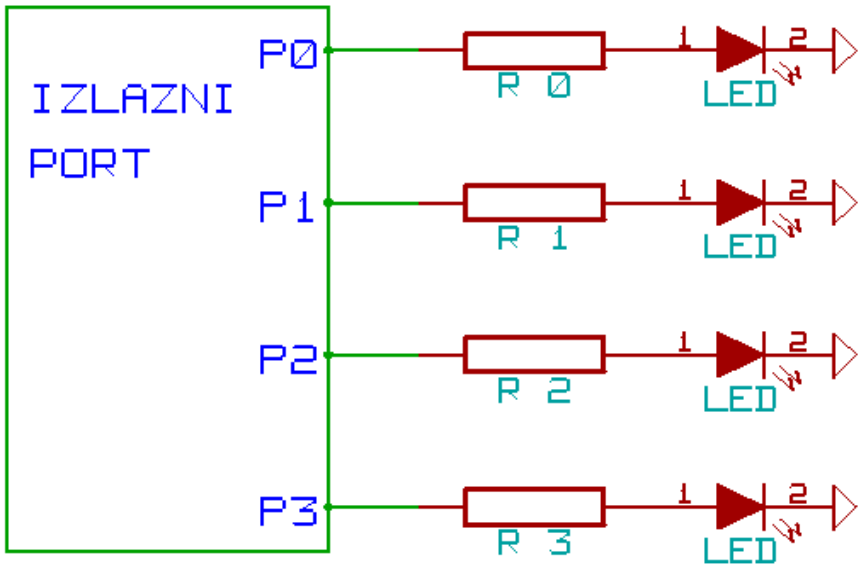
Zaključak

- Arduino platforma predstavlja jeftin način da se uđe u svijet robotike.
- Arduino ima:
  - Brojne korisnike
  - Bogatu online biblioteku kodova i projekata

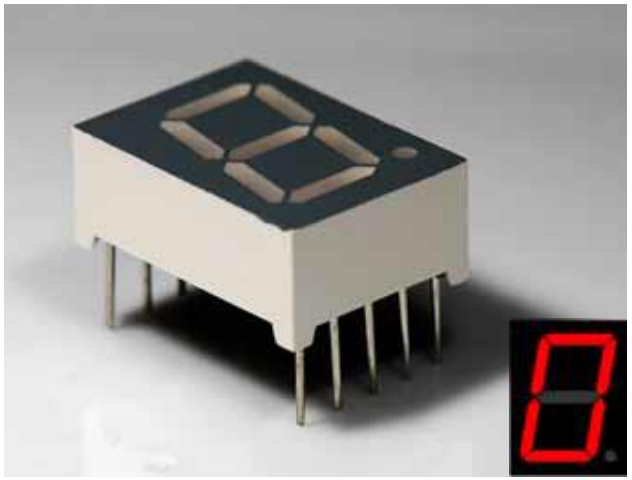
Zadaci za vježbu 1

1. Pomocu 4 LED, u binarnom obliku prikazati vrijednost promjenjive BROJAC. Vrijednost promjenjive brojac se inkrementira svake sekunde. **(2 poena)**

2. Trcece svjetlo upotrebom 4 LED. Uvijek je samo jedna dioda uključ ena. **(3 poena)**



3. Napisati program koji broji od 0 do 9, s ponavljanjem, i prikazuje rezultat na sedmosegmentnom LED displeju. (**4 poena**)



Pomoć :

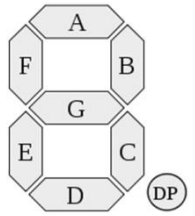
Razmotrite pisanje funkcije:

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

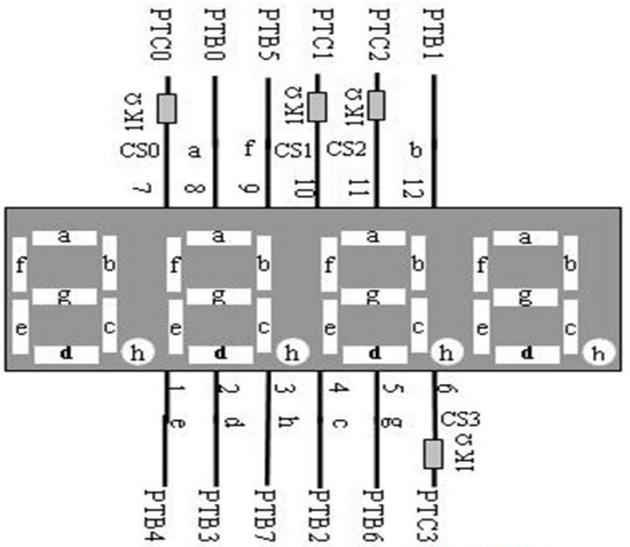
koja ispisuje jednu cifru

Trasformaciona tebela

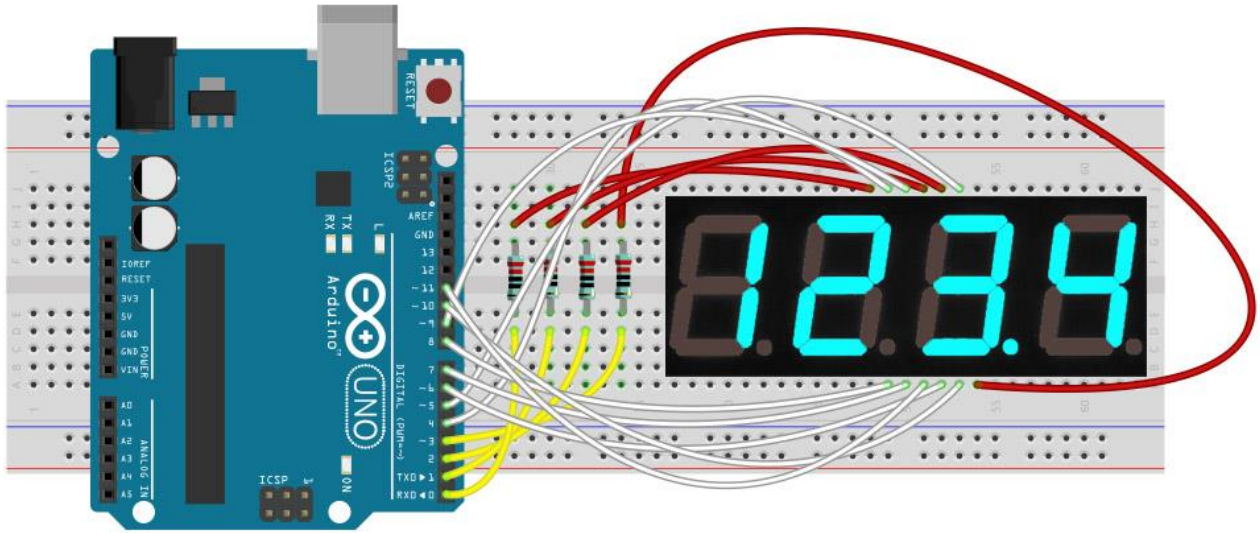
Digit	ABCDEFG	A	B	C	D	E	F	G
0	0×7E	on	on	on	on	on	on	off
1	0×30	off	on	on	off	off	off	off
2	0×6D	on	on	off	on	on	off	on
3	0×79	on	on	on	on	off	off	on
4	0×33	off	on	on	off	off	on	on
5	0×5B	on	off	on	on	off	on	on
6	0×5F	on	off	on	on	on	on	on
7	0×70	on	on	on	off	off	off	off
8	0×7F	on	on	on	on	on	on	on
9	0×7B	on	on	on	on	off	on	on



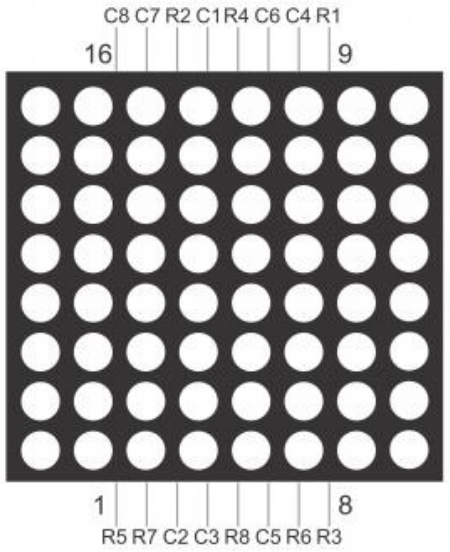
4. Napisati program koji na ļ etvorocifarskom sedmosegmentnom LED displeju ispisuje: ð123.4ô (**6 poena**)

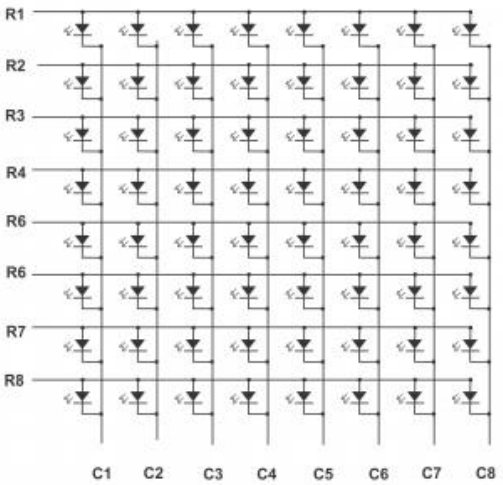


MCU与4连排8段数码管的连接



5. Napisati program koji na 8X8 matrix LED displeju ispisuje kvadrate koji se skupljaju i ģire naizmjeniļ no ili srce koje kuca (odnosno pojavljuje se i nestaje). (**8 poena**)






Kraj