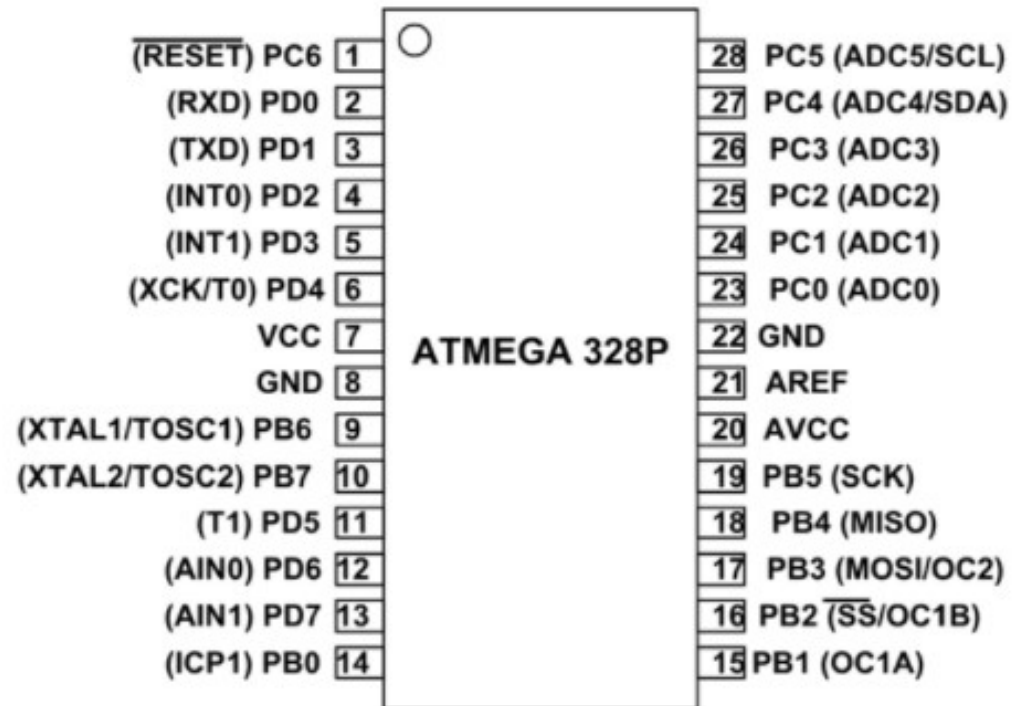# AVR Interfacing

IO Ports

Agenda

- I/O Ports.

- I/O Ports Programming.

- Interfacing with Switches and Leds.

- Interfacing with 7-Segment.

- Interfacing with DC-Motor.

- Interfacing with LCD.

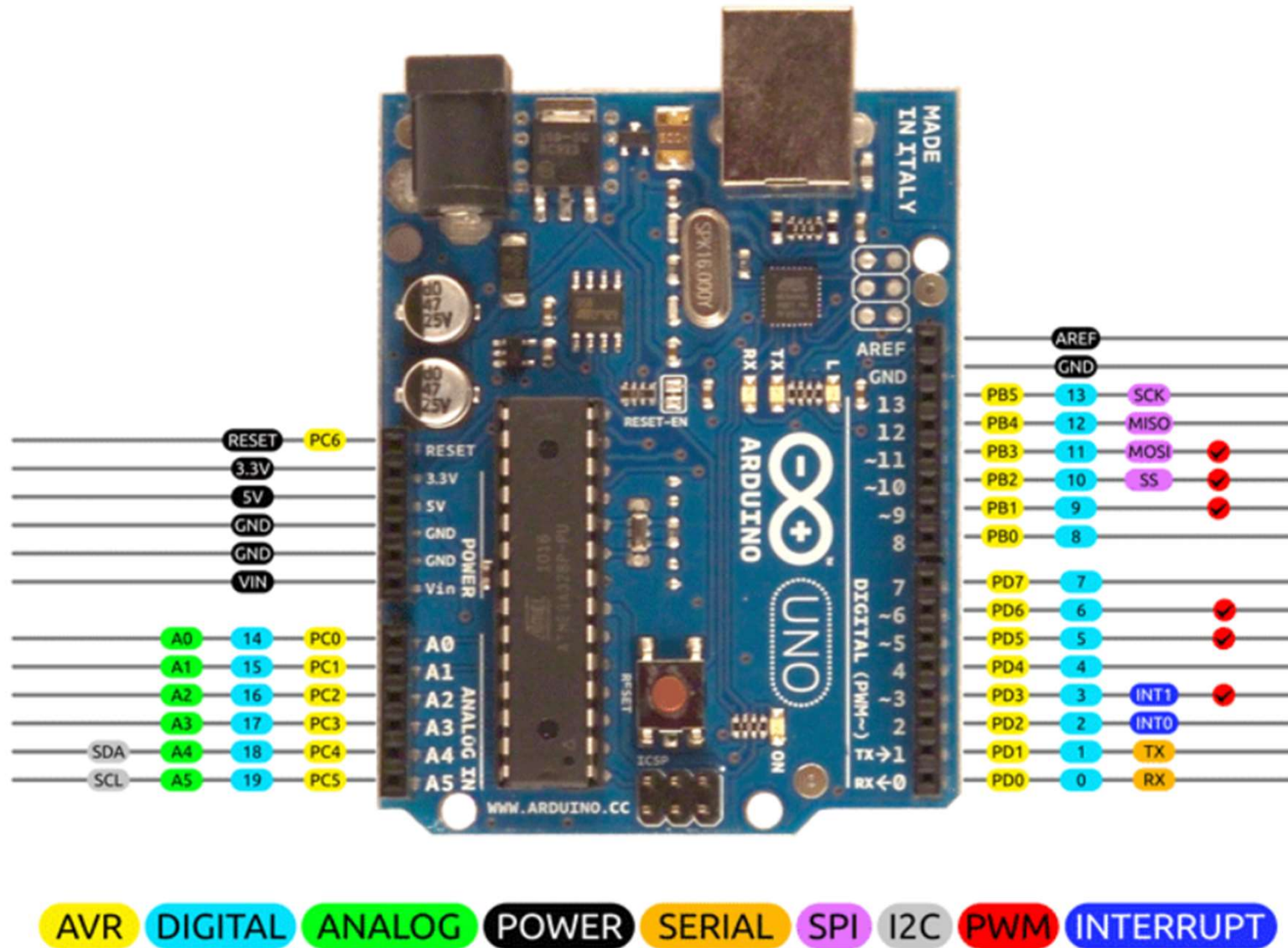- Interfacing with Keypad.

I/O Ports

- **ATmega328p has programmable I/O lines divided into:**
  - PORTB(PB7………PB0)
  - PORTC(PC6………PC0)
  - PORTD(PD7……..PD0)

- **Each PORT is controlled by 3 registers:**
  - **DDRx** :
    Data Direction Register to set the pin either output or input pin.
  - **PORTx**
    Output Register to assign a value to the port (from **µC** to interface).
  - **PINx:**
    Input Register where it holds the input value from interface.

  Note: Most pins in µC make more than one function (multiplexed functions)

I/O Ports

I/O Ports

I/O Ports

Port A Data Register – PORTA

Bit	7	6	5	4	3	2	1	0	
	PORTA7	PORTA6	PORTA5	PORTA4	PORTA3	PORTA2	PORTA1	PORTA0	PORTA
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	

Port A Data Direction Register – DDRA

Bit	7	6	5	4	3	2	1	0	
	DDA7	DDA6	DDA5	DDA4	DDA3	DDA2	DDA1	DDA0	DDRA
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	

Port A Input Pins Address – PINA

Bit	7	6	5	4	3	2	1	0	
	PINA7	PINA6	PINA5	PINA4	PINA3	PINA2	PINA1	PINA0	PINA
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	

I/O Ports Programming

- **To decided which Port is input and which is output:**
  - ➢ Configure the port direction use register **DDRX**
    1 ➔ for Output.
    0 ➔ for Input.
- **To Read(input case) :**
  - ➢ Use register **PINx**

- **To Write(output case) :**
  - ➢ Use register **PORTx**.

  Note:
  In case you set any PIN as **input** you can activate the **internal pull up** resistor by setting the corresponding bit in **PORTX** register.

I/O Ports Programming

- **How to set values in registers**
  - DDRA=5; /*(decimal)mean I activate pin 0 and pin 2 as output and the rest as input pins */

  - DDRB=0x14; /*(hexadecimal)mean I activate pin 2 and pin 4 as output and the rest as input pins */

  - DDRC=0b00000011; /*(binary)mean I activate pin 0 and pin 1 as output pins and the rest as input pins */

- **How to deal with a specific pin with conserving other pins**
  - **To set specified bit in register**
    Make OR operation on the register with The pin number.
    - ❑ For example if we want to set pin number 5 in PORTA
    $$PORTA = PORTA \,|\, (1 << PA5);$$
  - **To clear specified bit in register**
    Make AND operation on the register with (NOT) The pin number.
    - ❑ For example if we want to set pin number 3 in PORTB
    $$PORTB = PORTB \,\&\, (\,\sim(1 << PB3)\,);$$

I/O Ports Programming

➢ **To toggle specified bit in register**
Make XOR operation on the register with The pin number
❑ For example if we want to toggle pin number 2 in PORTC
$$PORTC = PORTC \char94 (1 << PC2);$$

• **Example:**
➢ To set the pin 2 in PORTB as input pin and use the internal pull up resistor of this pin.
$$DDRB = DDRB \& (\sim(1 \ll PB2))$$
$$PORTB = PORTB \mid (1 \ll PB2)$$

I/O Ports Programming

```
DDRA = 0xFF;  //initialize portA as output
DDRB = 0x00;  //initialize portB as input

if ((PINB & 0b00000001) == 1) //read a switch on PB0
{
    PORTA = 0xFF;        //All LEDs on
}
else
    PORTA = 0x00;        //All LEDs off
```

I/O Ports Programming

I/O Port applications

- **As Output**
  - LED and 7-Segemnt
  - LCD display
  - Motors.
  - Buzzer.
  - Signal to another μC.
  - Output to PC through PC Serial Port.
- **As Input**
  - Switches(push button, keypad etc.)
  - Analog/Digital sensors.
  - Signal from another μC.
  - Input from PC through PC Serial Port.

Interfacing with Switches and Leds
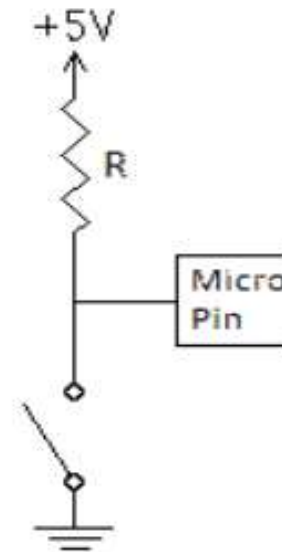
LED Configuration

Negative Logic
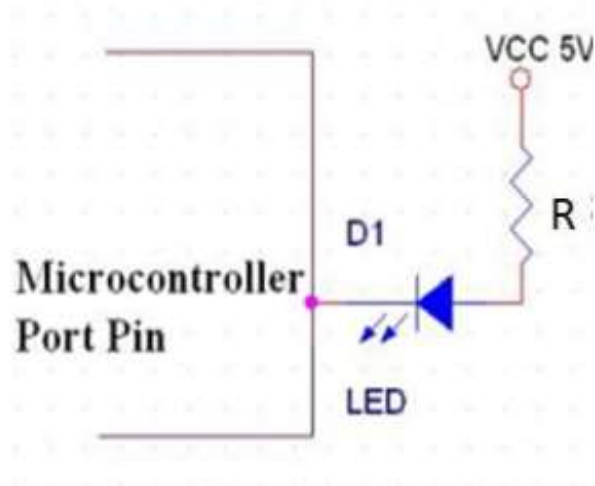
Positive Logic
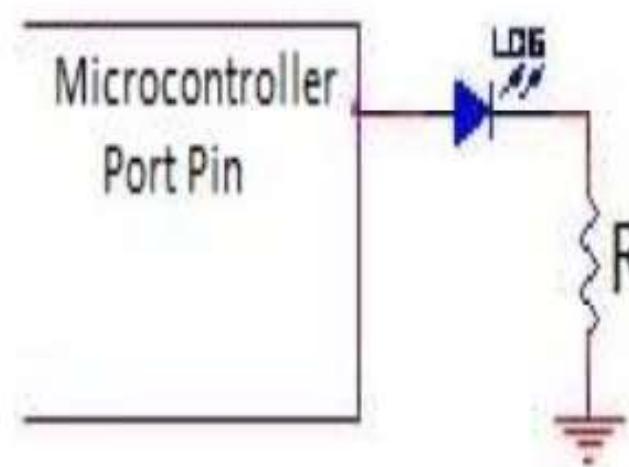
Interfacing with Switches and Leds

Switch Configuration

Pull Down Resistor
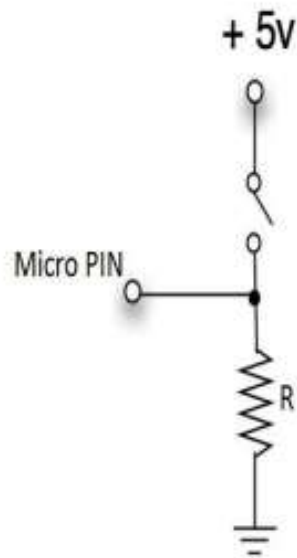

Pull UP Resistor

Interfacing with Switches and Leds
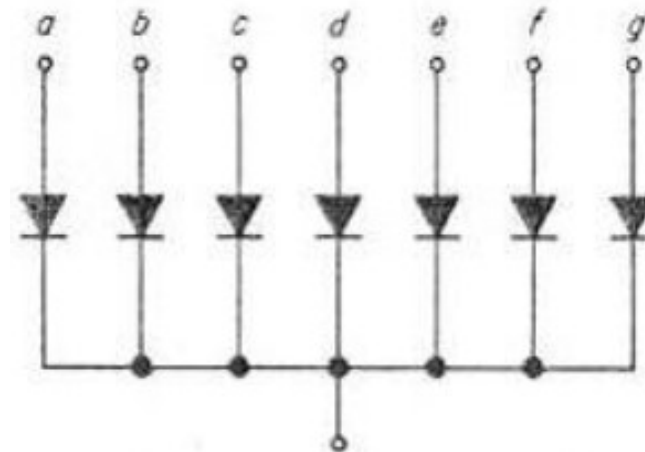
Switch de-bounce problem
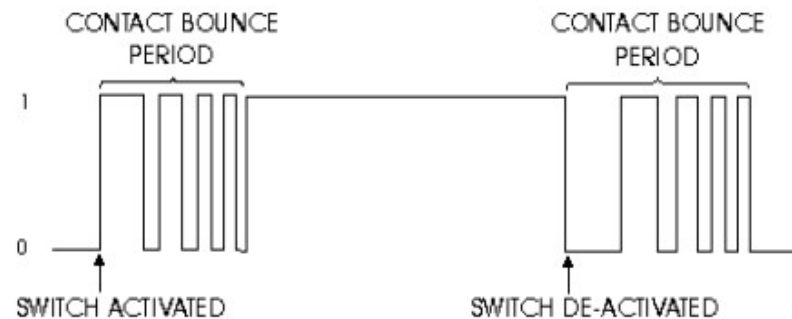
- Could be handled using software or hardware.
- It relies on the fact that bouncing takes a maximum period of 20-30 ms.
- The basic idea is to implement a delay after the first detected edge, during which no scanning for the switch is done. after the delay period is finished, scanning can proceed (Exercise 3).
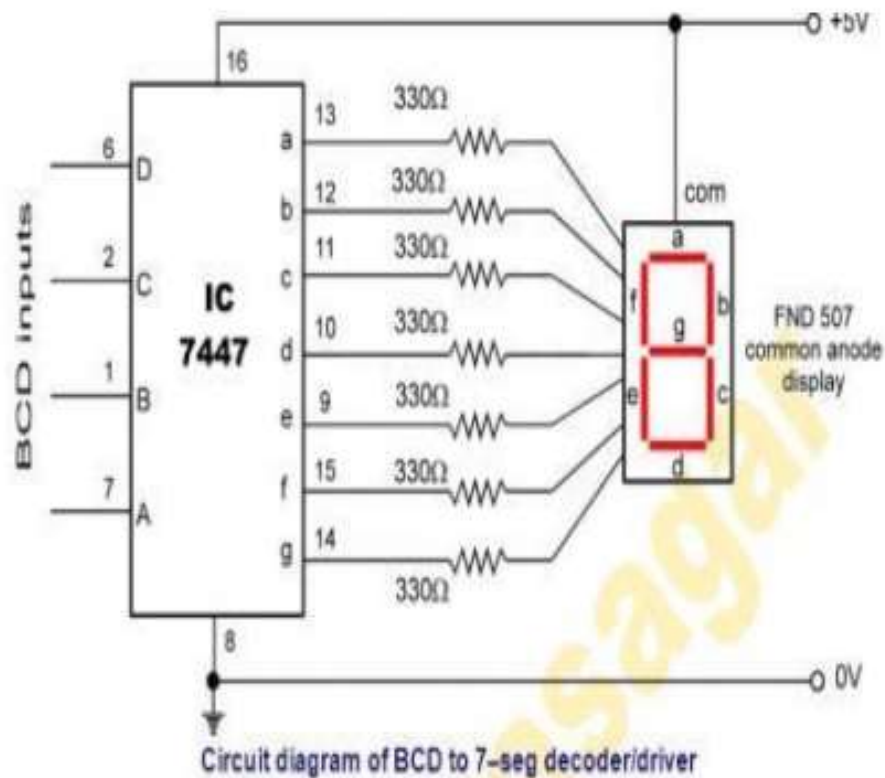
Interfacing with 7-Segment
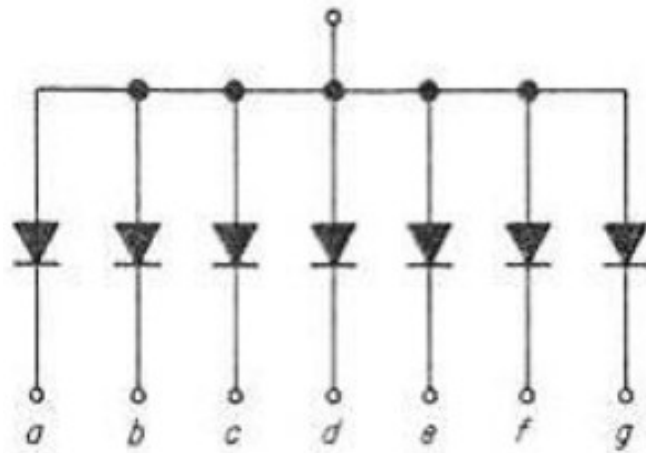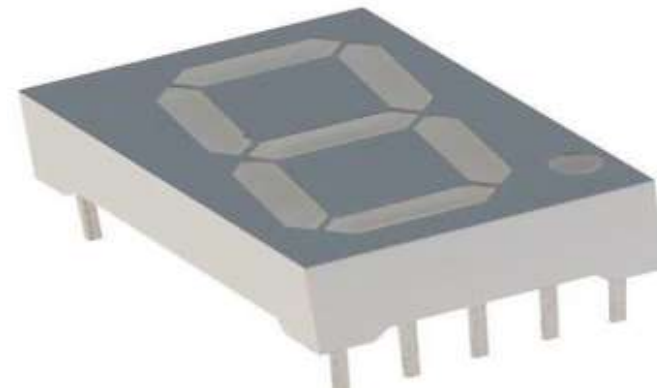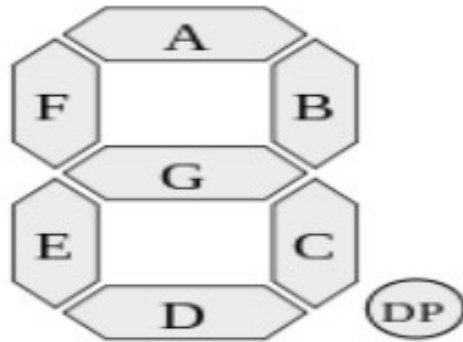
Common Anode

Common Cathode

Interfacing with 7-Segment

In order to reduce the number of pins can be used to interface the 7 segment, we use decoder connected and follows;

Circuit diagram of BCD to 7–seg decoder/driver

Digit	Decoder inputs			
	C3	C2	C1	C0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1