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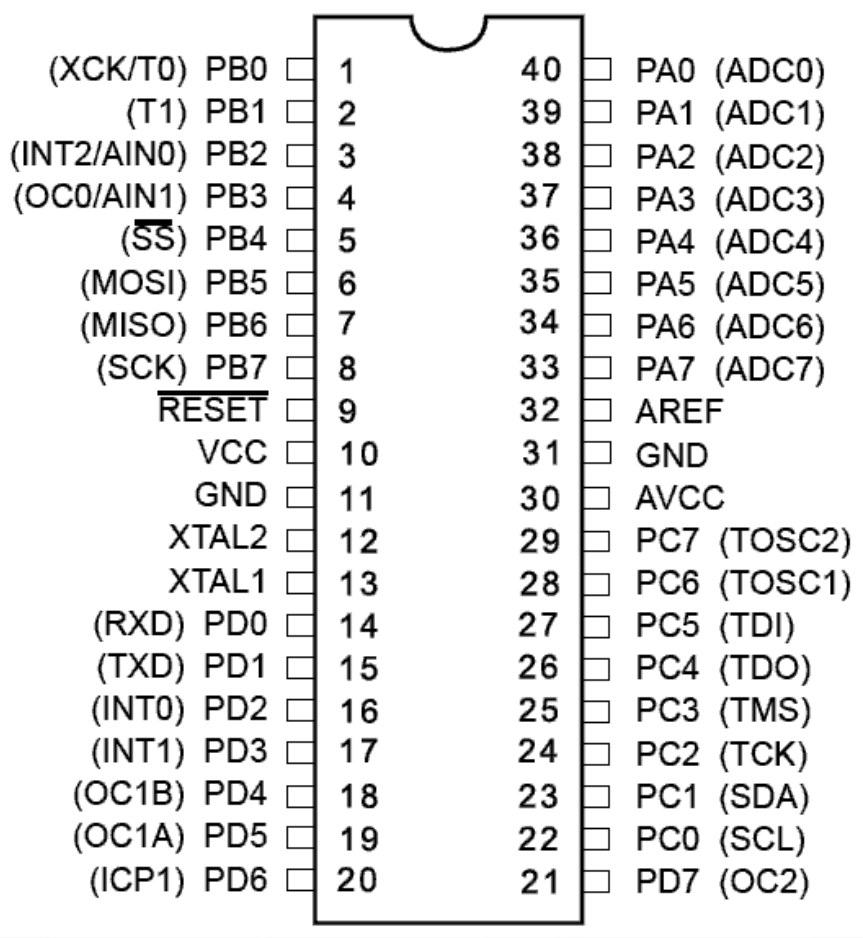
Micro-controllers

A **microcontroller** is a small computer on a single circuit containing a processor core, memory, and programmable I/O peripherals. It is one of the main components of modern embedded systems.
For our use we will using one of the basic µC IC named Atmel Atmega 16. Its pin diagram is shown below:



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Overview of the IC

- It contains 40 pins numbered 1 to 40.
- Out of which 32 pins are divided into 4 groups containing 8 pins each. These are numbered from PA0-PA7, PB0-PB7, PC0-PC7 and PD0-PD7. These pins are the I/O pins of Atmega 16. They can be configured to act either as input or output. How? We will see below. Some of them are also used to program the microcontroller.
- Rest of the 8 pins are reserved.

Configuring I/O pins

- Input/output is controlled through special variables called "**registers**".
- Registers are actual hardware memory locations inside the µCs with predefined names and sizes.
- Assigning a value to these registers in the program changes the corresponding hardware configuration. And, these values can be altered multiple number of time at any point in the program.
- There are 3 registers that control the I/O pins: **DDR, PORT and PIN**.
- Each group has its own registers. Hence, **DDRA, PORTA, PINA** registers for group A; **DDRB, PORTB, PINB** for group B and likewise.

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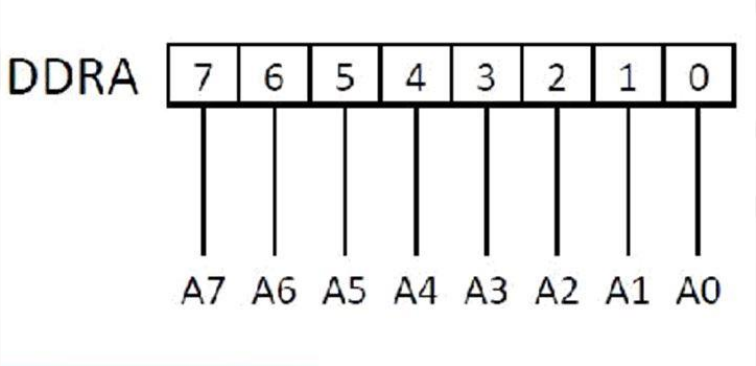
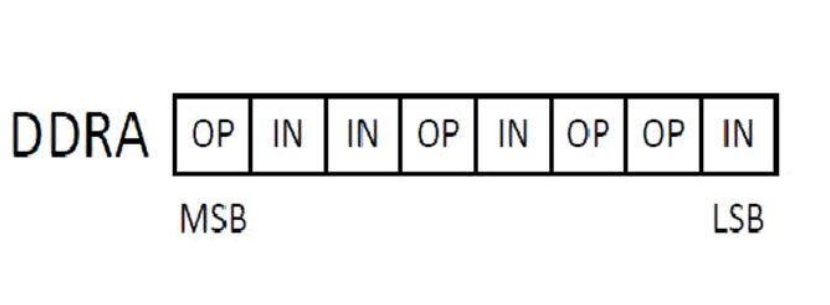
Data Direction Register (DDR)

- Decides whether the pin is Input or Output
- DDR is an 8 bit register. Each bit corresponds to a particular pin on the associated groups (often called ports).
- If a bit on the DDR register is 0, then the corresponding pin on the associated port is set as input.
- Similarly, if the bit is 1, then the pin is set as output.
- If a pin is configured as input, then it has some floating voltage unless an external voltage is applied.
- For an output pin, the voltage is fixed to a particular value.



- MSB of DDRA corresponds to the pin A7.
- If DDRA = 0b10010110, then:



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PORT Register

- PORT is also an 8 bit register. The bits on the PORT register correspond to the pins of the associated port in the same manner as in the case of the DDR register.
- PORT is used to set the **output** value.
- If the pin is set as **output**, then a PORT value of 1 will set voltage at that pin to 5V, and PORT value 0 sets the voltage to 0V.
- If the pin is configured as an **input,** PORT values serves the purpose of **pull up** or **pull down.**

PIN Register

- PIN is a register whose value can be read, but cannot be changed inside the program.
- It gives the value of the actual voltage at a particular pin: 1, if the value at the corresponding pin is 5V and 0 for 0V.

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Summary

DDR = 0		DDR = 1	
PORT = 0	PORT = 1	PORT = 0	PORT = 1
Pin is input. If unconnected, **PIN** is 0.	Pin is input. If unconnected, **PIN** is 1.	Pin is output, value is 0. **PIN** is always equal to **PORT**	Pin is output, value is 5V. **PIN** is always equal to **PORT**

Software Needed

- **CVAVR**: **For** editing and compiling the code.
- **AVR Studio**: **For** transferring the code to Atmega.
- A circuit simulator if needed.

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Example Code

Coding is done in C. The following code toggles the output value of port A pins after regular interval of 1000 ms.

```
#include <avr/io.h>
#include <util/delay.h>
int main(){
        DDRA = 0xFF;
        while(1)  {
                PORTA = 0xAA;
                _delay_ms(1000); //Delays all the work for 1000ms
                PORTA = 0x55;
                _delay_ms(1000);
              }
        return 0;
    }
```

As you can see coding is very simple.

Links

Links for additional details:

students.iitk.ac.in/eclub/assets/lectures/techkriti13/Introduction_to_mcu.pptx

students.iitk.ac.in/eclub/assets/lectures/techkriti13/Timers_and_Interrupts.pptx