INTRODUCTION TO MICROCONTROLLERS

BINARY CELL

- A binary cell is a memory element that can store one bit of information.

- Binary cell storing logic 1:   1
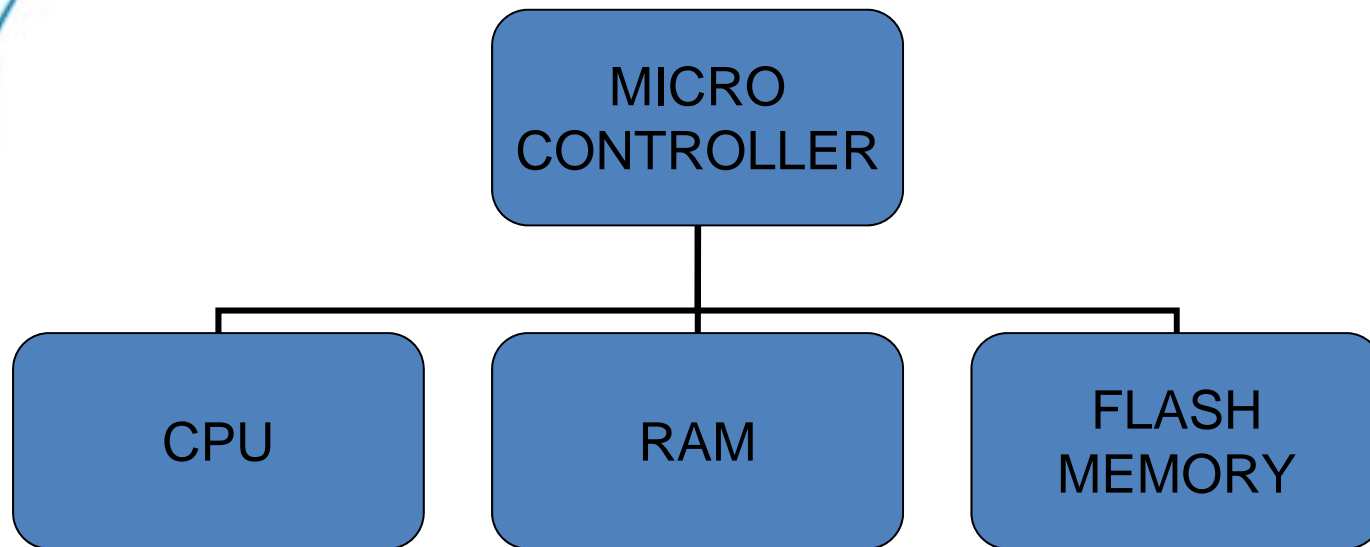
- Binary cell storing logic 0:   0

REGISTER

- A group of binary cells is called a Register.
- Every register is characterized by:

  1. Name of the register.

  2. The number of binary cells in the register.

X

1	0	1	0	0	1	1	0

MICRO CONTROLLER

CPU

RAM

FLASH MEMORY

- The CPU is interfaced to the RAM and Flash memory.

- We feed our program into the flash memory.

- When we turn ON the microcontroller, CPU accesses the instructions from RAM which in turn accesses our code from the Flash memory.

RAM and FLASH MEMORY

- RAM consists of several registers.
- Configuring the registers of RAM is the core job of the programmer.

- The code that we write is stored in the Flash Memory.

ATmega 16 pin configuration

(XCK/T0) PB0	1	40	PA0 (ADC0)
(T1) PB1	2	39	PA1 (ADC1)
(INT2/AIN0) PB2	3	38	PA2 (ADC2)
(OC0/AIN1) PB3	4	37	PA3 (ADC3)
($\overline{SS}$) PB4	5	36	PA4 (ADC4)
(MOSI) PB5	6	35	PA5 (ADC5)
(MISO) PB6	7	34	PA6 (ADC6)
(SCK) PB7	8	33	PA7 (ADC7)
$\overline{RESET}$	9	32	AREF
VCC	10	31	GND
GND	11	30	AVCC
XTAL2	12	29	PC7 (TOSC2)
XTAL1	13	28	PC6 (TOSC1)
(RXD) PD0	14	27	PC5 (TDI)
(TXD) PD1	15	26	PC4 (TDO)
(INT0) PD2	16	25	PC3 (TMS)
(INT1) PD3	17	24	PC2 (TCK)
(OC1B) PD4	18	23	PC1 (SDA)
(OC1A) PD5	19	22	PC0 (SCL)
(ICP1) PD6	20	21	PD7 (OC2)

Flash memory of ATmega 16 is 16KB. Hence the name.

PORT

- A 'port' is a set of 8 I/O pins.

- There are four ports in ATmega 16.

- Hence there are 32 bidirectional pins.

- The four ports are named as: A , B , C and D.

- Our first job while writing a program is to configure which ports are input ports and which ports are output ports.

PROGRAMMING

- The program is written in C in AVR Studio 4.
- The first statement SHOULD be :
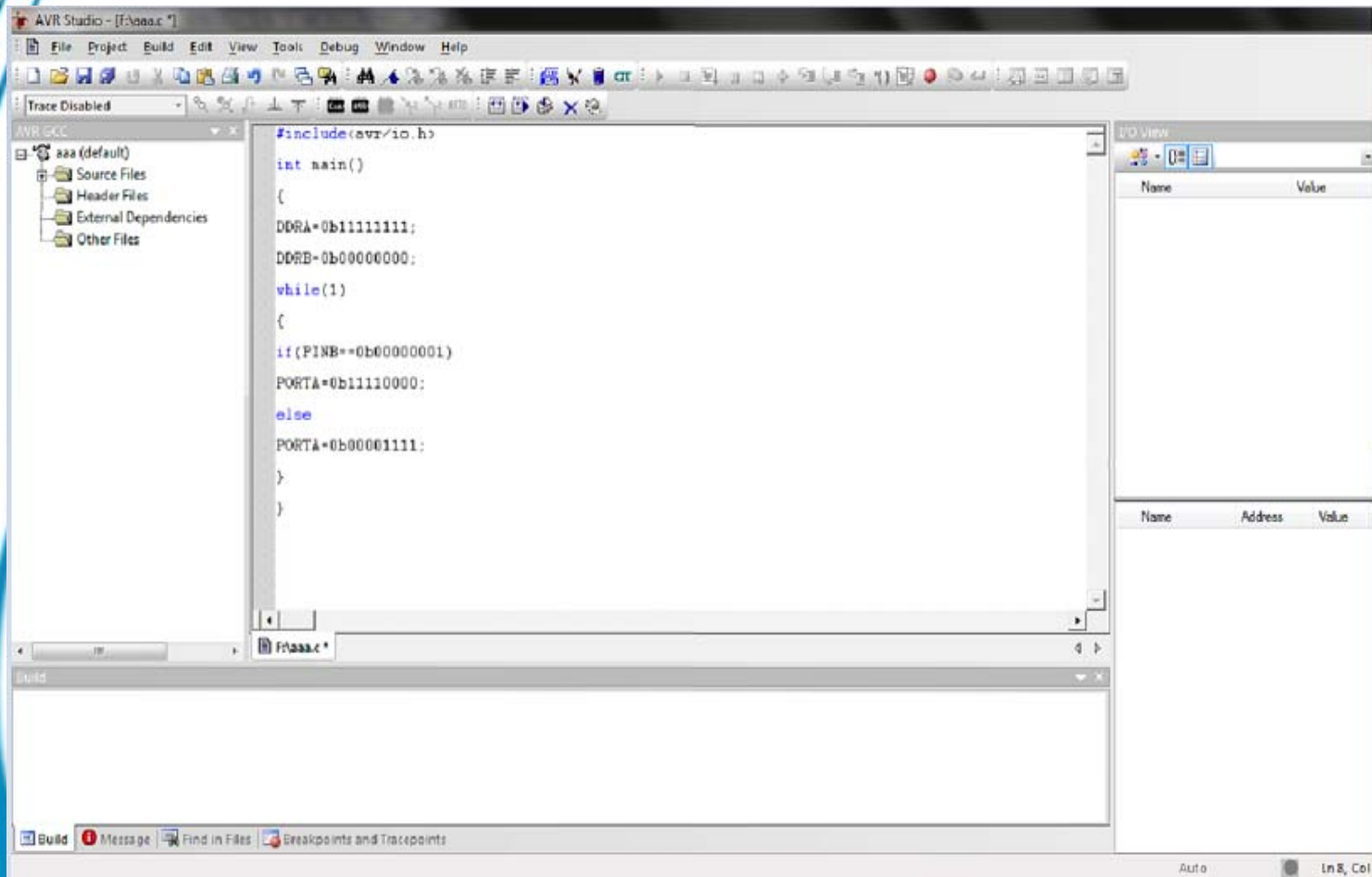
    #include<avr/io.h>

- Open the main() function.
- Complete the code.
- Close the main() function.
- Compile the program.

SAMPLE CODE

```c
#include<avr/io.h>
int main()
{
DDRA=0b11111111;
DDRB=0b00000000;
while(1)
{
if(PINB==0b00000001)
PORTA=0b11110000;
else
PORTA=0b00001111;
}
}
```

AVR Studio 4 screen shot

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Integrating Knowledge...

SAMPLE CODE WITH COMMENTS

```
#include<avr/io.h>            // header file
int main()
{
DDRA=0b11111111;          // To set entire port A as output port
DDRB=0b00000000;          // To set entire port B as input port
while(1)
{
if(PINB==0b00000001)              // if PB0 is at logic HIGH
PORTA=0b11110000;    // pins PA7...4 give logic 1(5 V) as output, PA3...0 give 0V
else
PORTA=0b00001111;    // PA3...0 give logic 1 as output, PA7...4 give logic 0(0 V).
}
}
```

DDR – DATA DIRECTION REGISTER

- There is a data direction register for each port.
- Setting a bit in the DDR register to logic 1 will make the corresponding pin an output pin.
- Setting a bit in the DDR register to logic 0 will make the corresponding pin an input pin.
- To make the first four pins(PA0...3) as input pins and the other four pins(PA4...7) as output pins, the statement should be

DDRA=0b11110000;

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	

PIN REGISTER

- There is a PIN register for every port.
- If the port is configured as an input port, the inputs at each pin of the port are stored in the corresponding bits of the PIN register.

Bit	7	6	5	4	3	2	1	0	
	PINB7	PINB6	PINB5	PINB4	PINB3	PINB2	PINB1	PINB0	PINB
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	

PORT REGISTER

- There is a PORT register for every port.

- If the port is configured as an output port, setting the bits of the PORT register to logic 1 or logic 0 would set the corresponding pins to logic 1 or logic 0.

- To put logic 1 in the first six pins and logic 0 in the next two pins of port A, the statement should be

    PORTA=0b00111111;

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	

- By using the three registers

  - DDR

  - PIN

  - PORT

  we can write the code for basic bots like line follower, obstacle avoider etc using simple if else statements.

- The more number of registers you know, the more complex applications you can make.

GOING FURTHER

- For more information on various other registers of ATmega 16, download its datasheet (pdf) from

  www.atmel.com

Visit

www.extremeelectronics.co.in

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