Introduction to Microcontrollers

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Things to be covered today...

- Embedded System – Introduction, Examples
- Microcontrollers - basic features
- Input and output from a micro-controller
- Programming a micro-controller
- Interfacing Character LCD with Micro-controller
- How to use Infrared – Tsop sensor ?

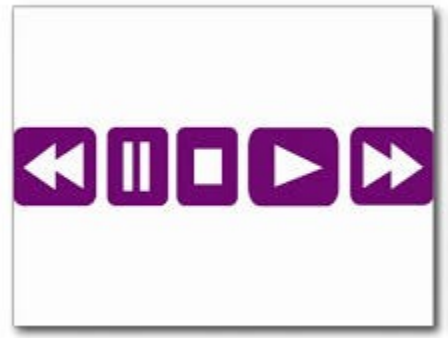
Embedded Systems

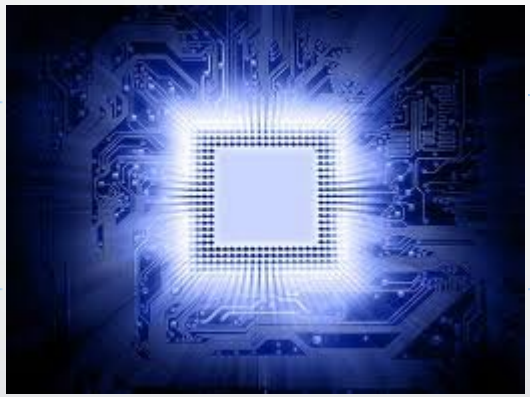
- Gadgets and devices
- Self controlled devices
- Contains I/O devices, storage devices and a central ‘controller’

Example: Music player

Output

Input



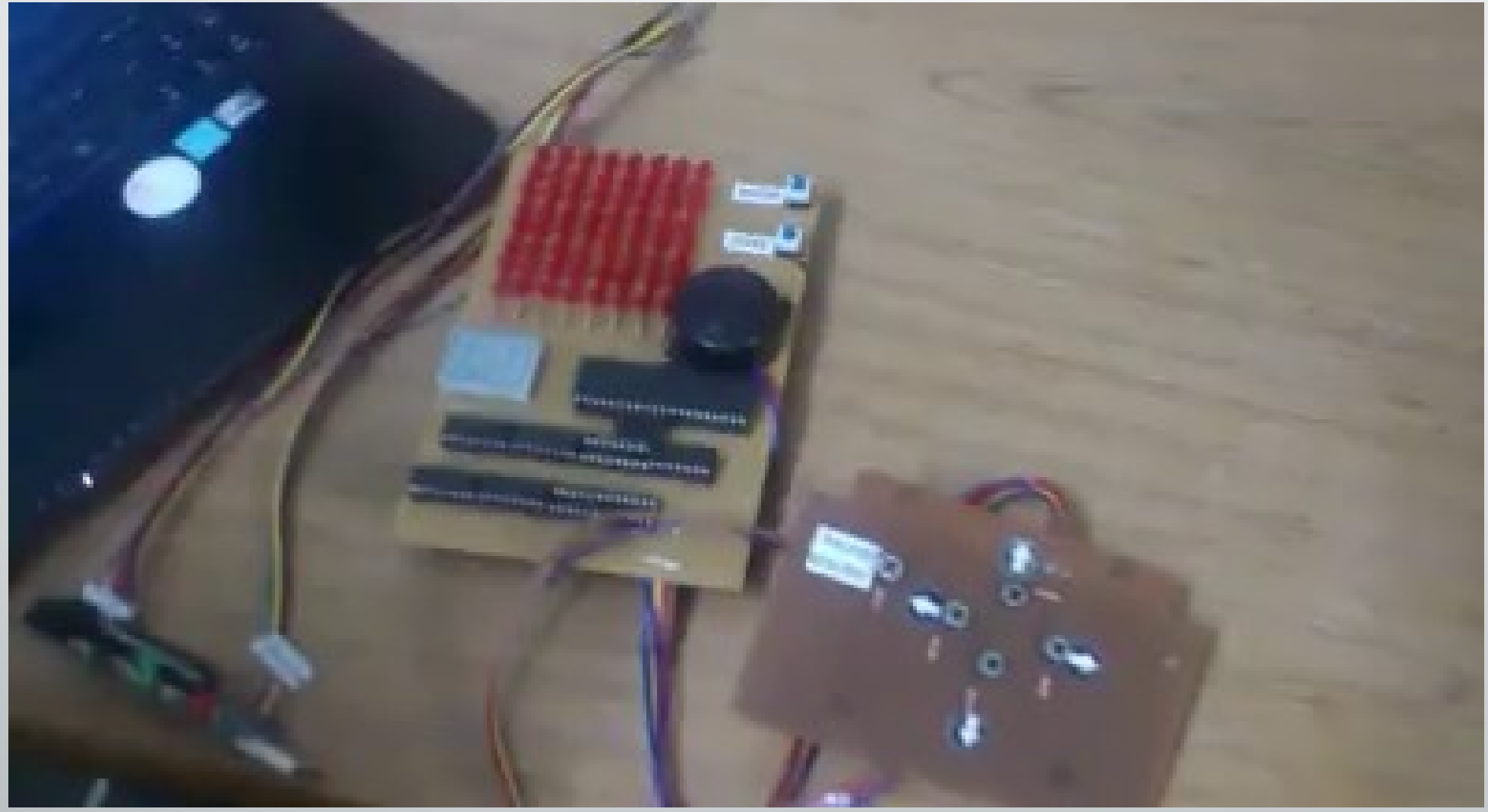


Controller

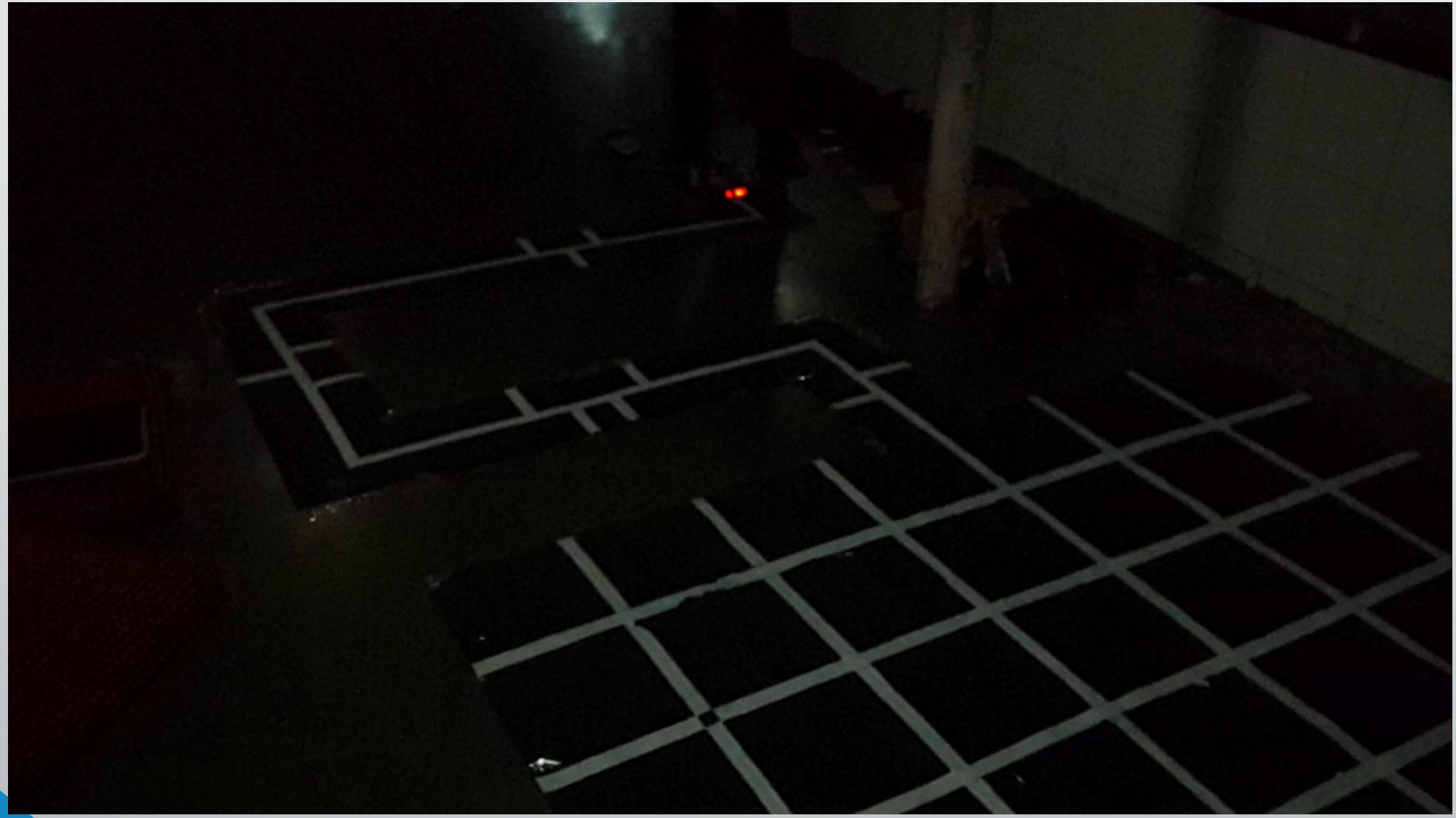
Output

Storage Device

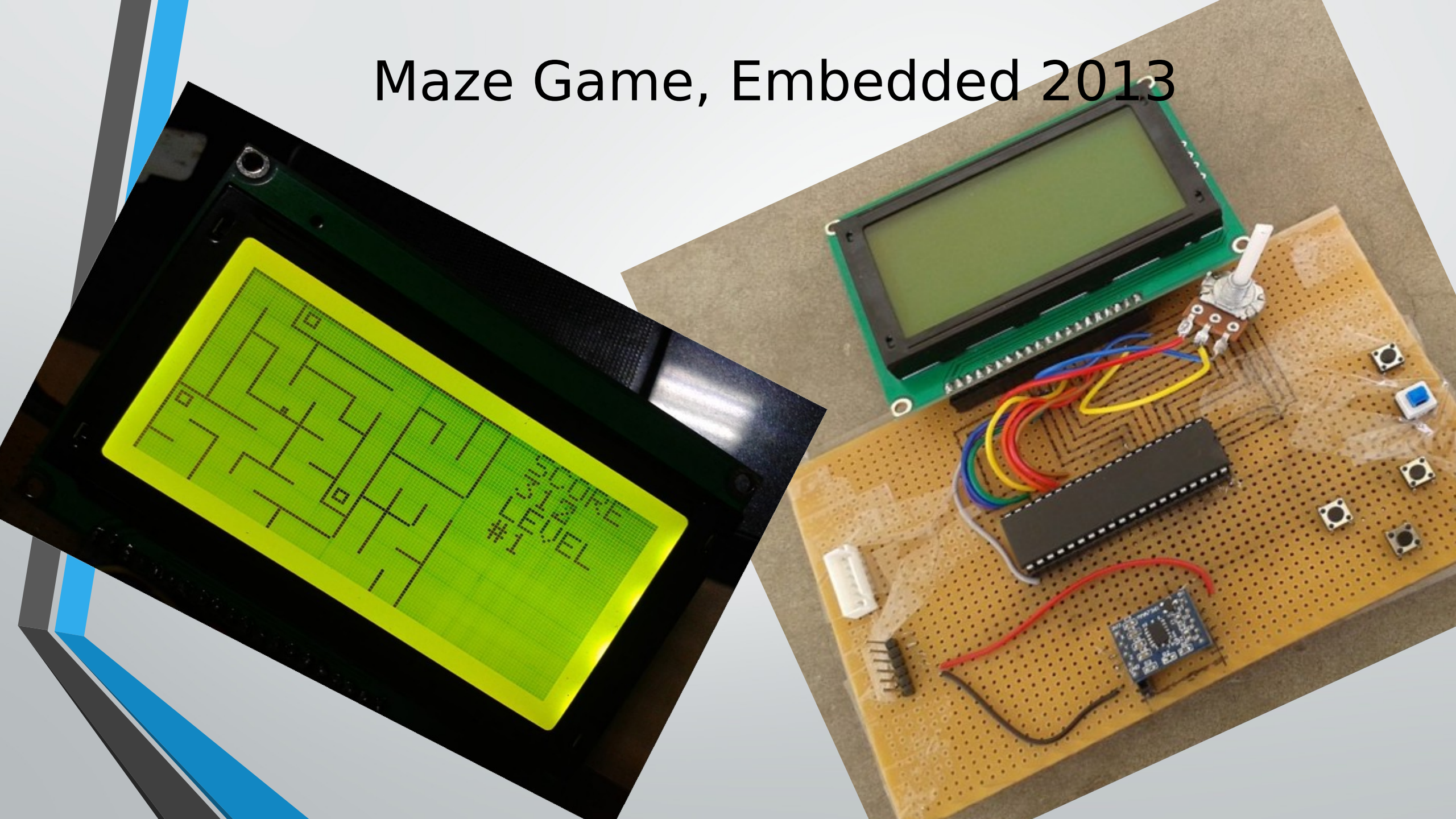
Snake Game, Electromania 2013



Line Following Bot, Techfest 2014



Maze Game, Embedded 2013



Micro-Controllers

- Why “micro”? Larger controllers are available too: processors that run computers
- Out of several available vendors like Atmel, Intel, ARM, Cypress, etc. We will use Atmel ATmega microcontrollers
- Like computers they execute programs. We will use C as the coding language

ATMEGA 8

- 28 pin IC
- 23 pins for I/O
- 5 pins reserved
- I/O pins divided into 3 groups of 8* pins, ca
- Ports labelled as B, C and D

I/O Registers

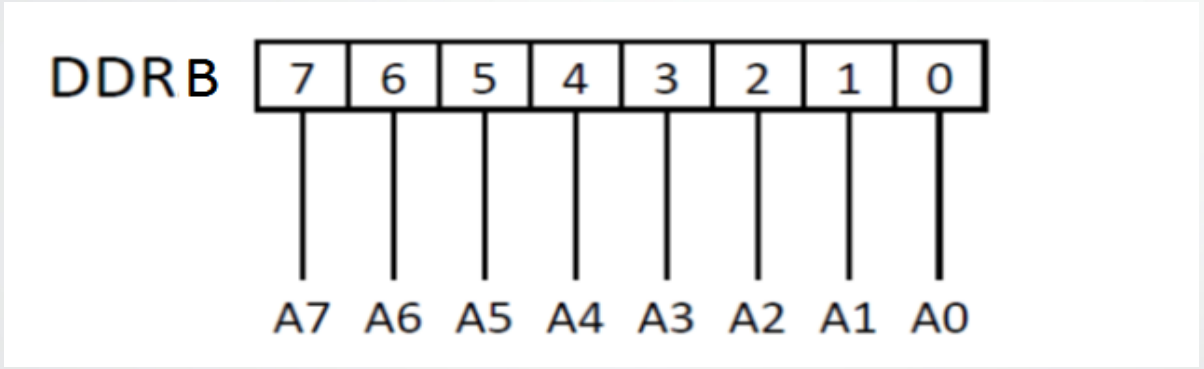
- Input / Output is controlled through special variables called “**registers**”
- Registers are actual hardware memory locations inside the µCs with predefined names and sizes
- Assigning a value to these registers in the program changes the corresponding hardware configuration. And, these values can 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 port has it’s own registers. Hence, **DDRC, PORTC, PINC** registers for port C; **DDRB, PORTB, PINB** for port B and likewise

DDR(Data Direction Register)

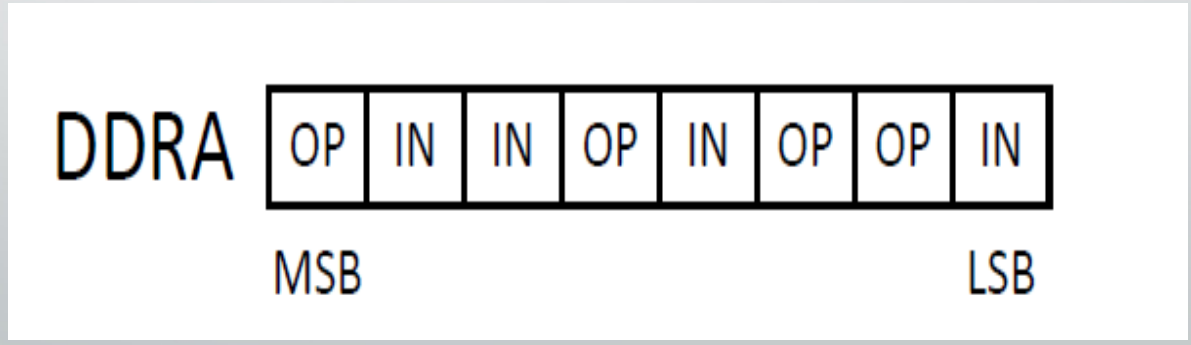
- Decides whether the pin is Input or Output
- DDR is an 8 bit register. Each bit corresponds to a particular pin on the associated port
- If a bit on the DDR register is 0, then the corresponding pin on the associated port is set as input
- Similarly, if the bit is 1, then the pin is set as output
- 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

Setting Register Values

- MSB of DDRB corresponds to the pin A7



- If DDRA = 0b10010110, then:



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 value 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 required pin is 5V and 0 for 0V.

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**

Some C concepts

- | is bitwise OR. Eg. 10100111 | 11000101 = 11100111
- & is bitwise AND. Eg. 10100111 & 11000101 = 10000101
- ~ is bitwise NOT. Eg. ~10100110 = 01011001
- << is shift left. >> is shift right

Simplest C program for a micro-controller

```
int main(){
return 0;
}
```

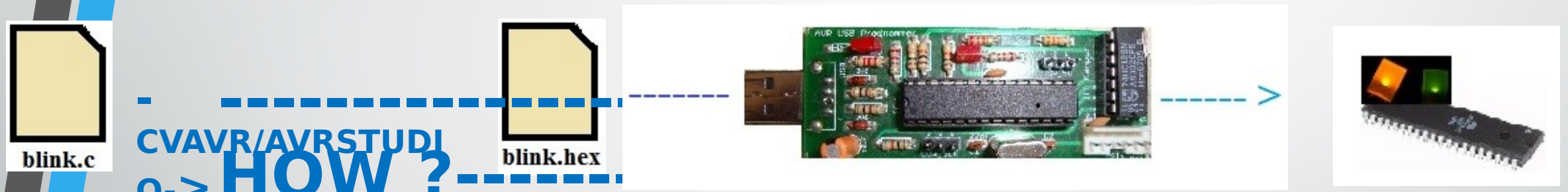
Example Program 1

```
#include <avr/io.h>
int main(){
DDRA = 0b11111111; // or 255 or 0xFF
while(1){
PORTA = PINC;
}
return 0;
}
```

Example Program 2

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

How to Program MCU?

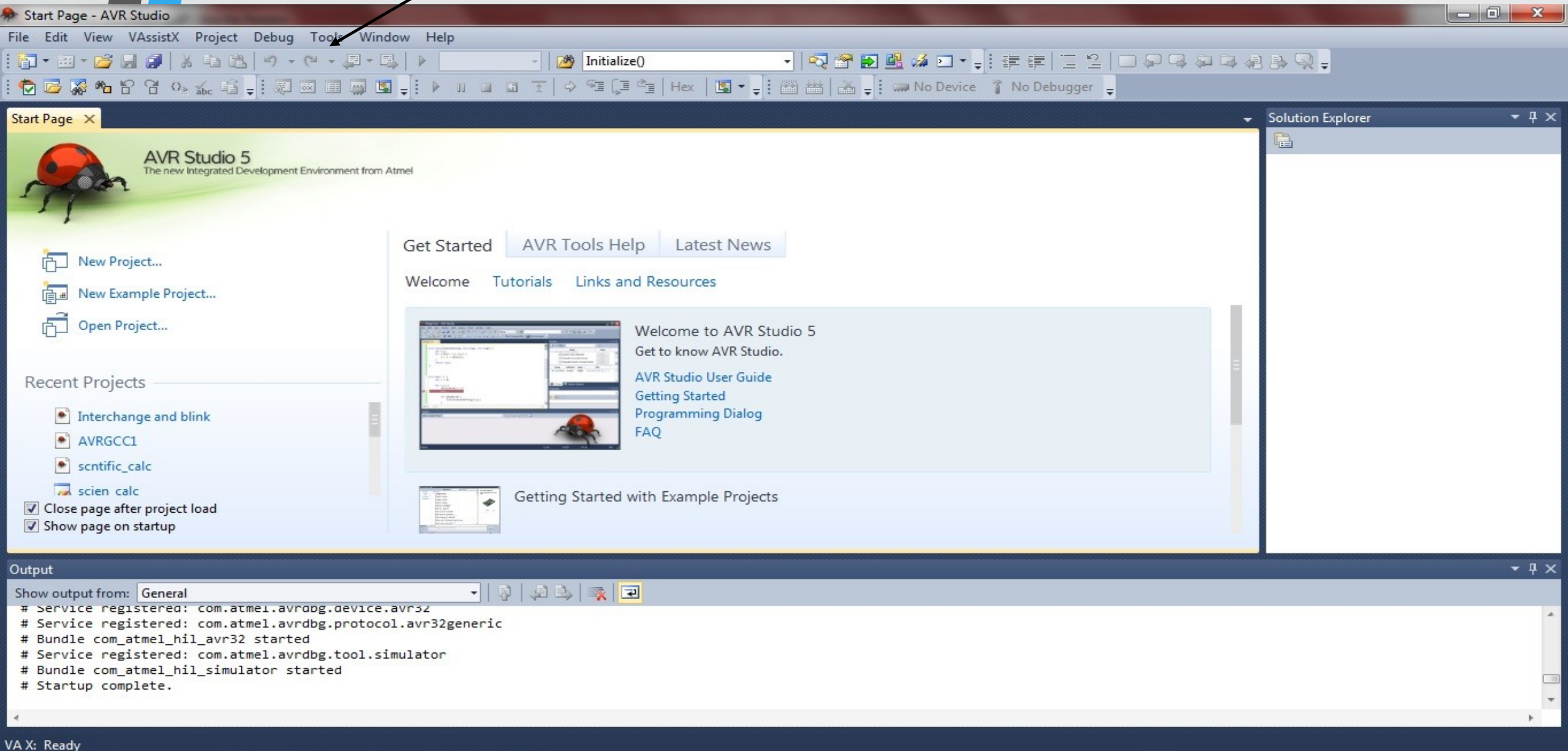


#Problem: What kind of files MCU can execute ?

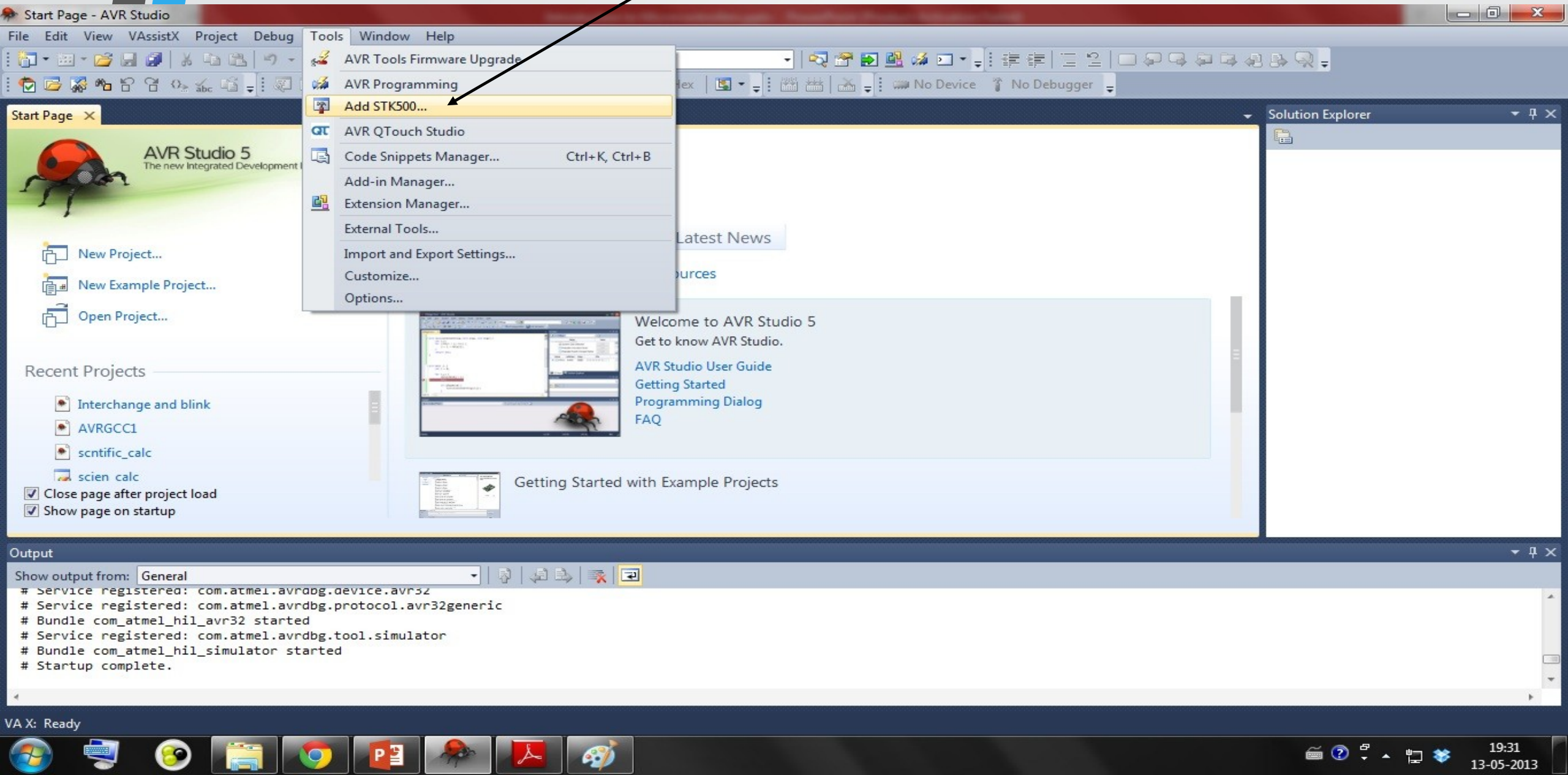
#Problem: How to transfer that file to MCU ?

AVR Studio

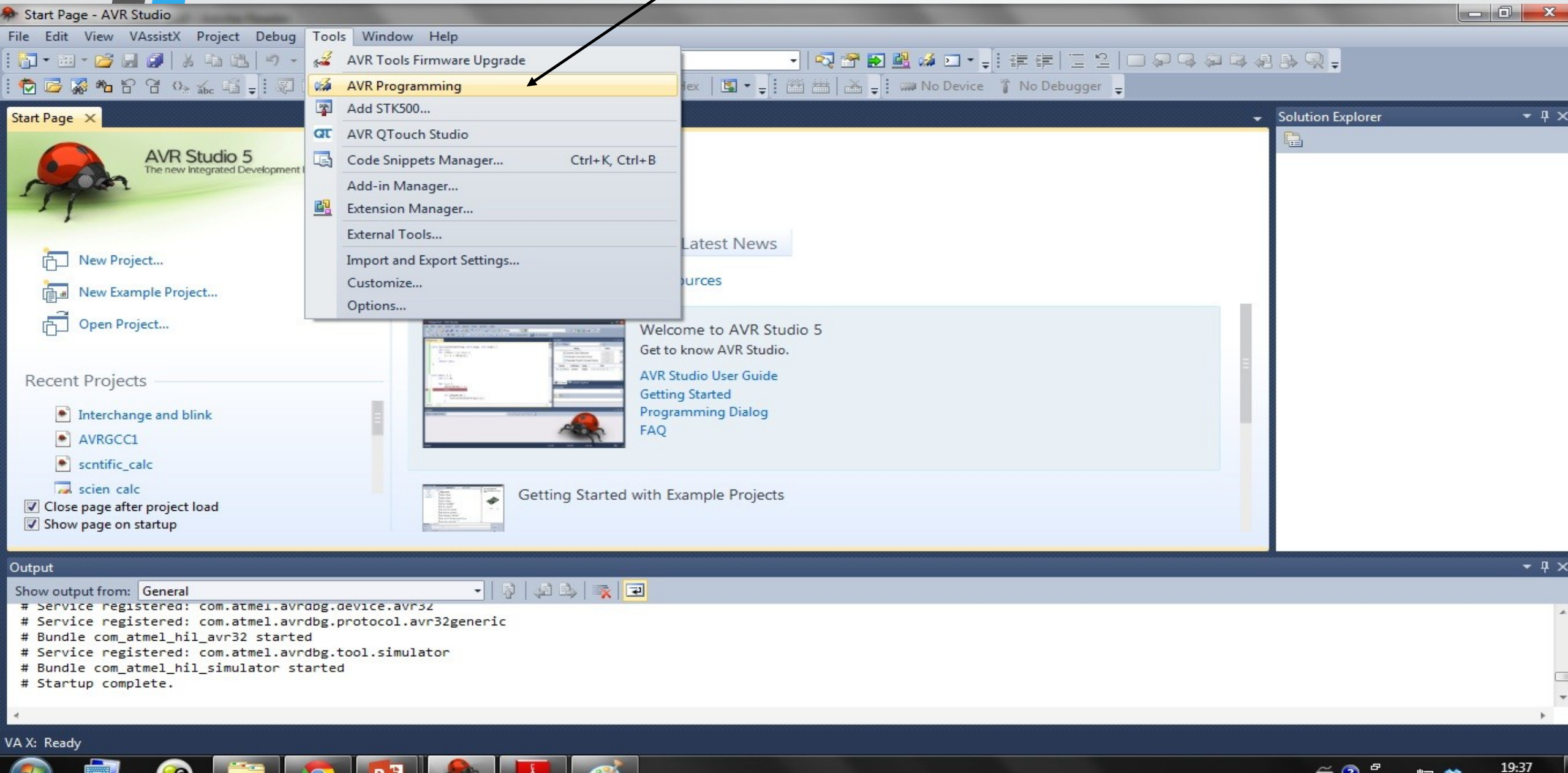
Select Tools



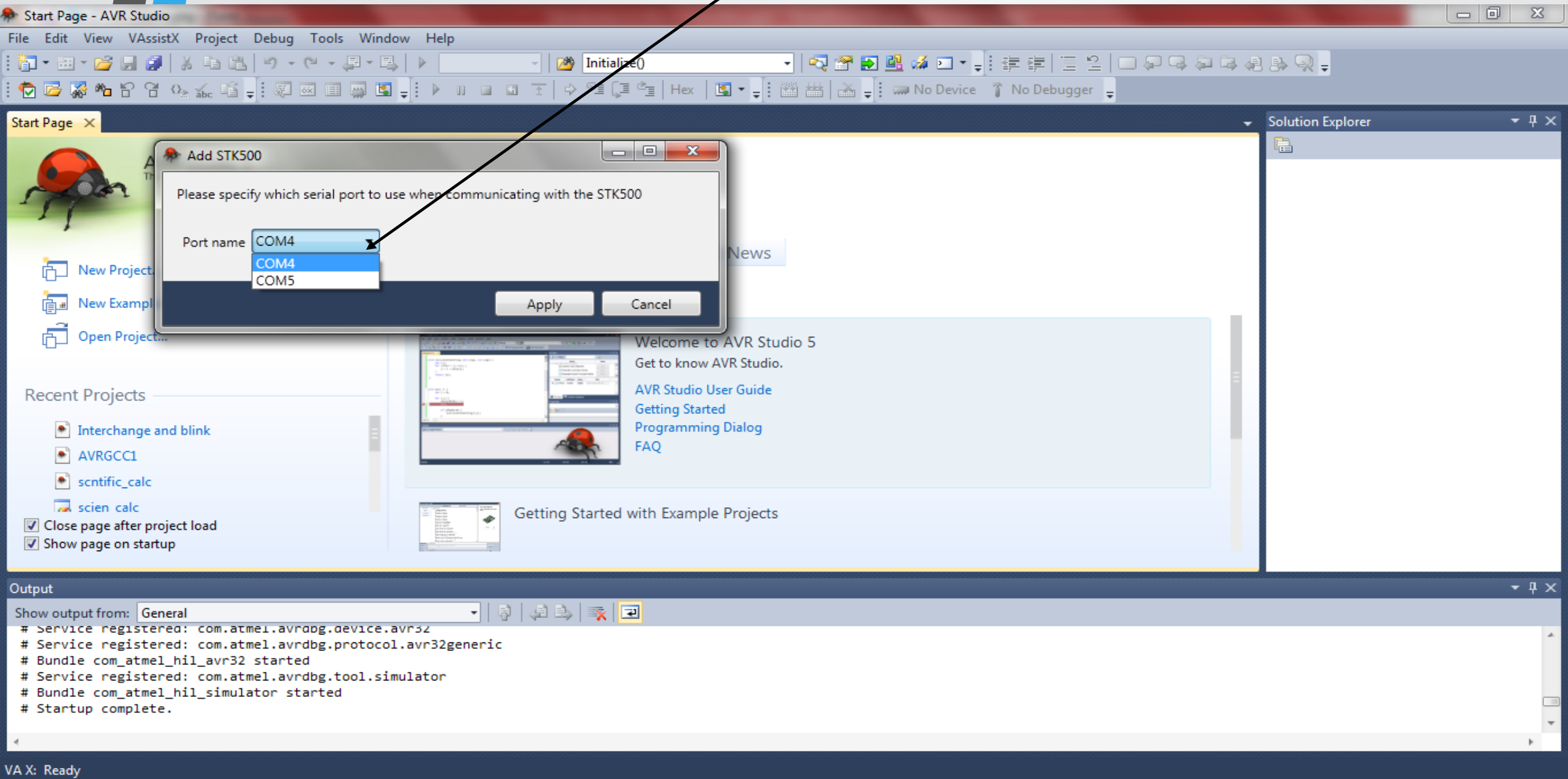
Select Add STK500



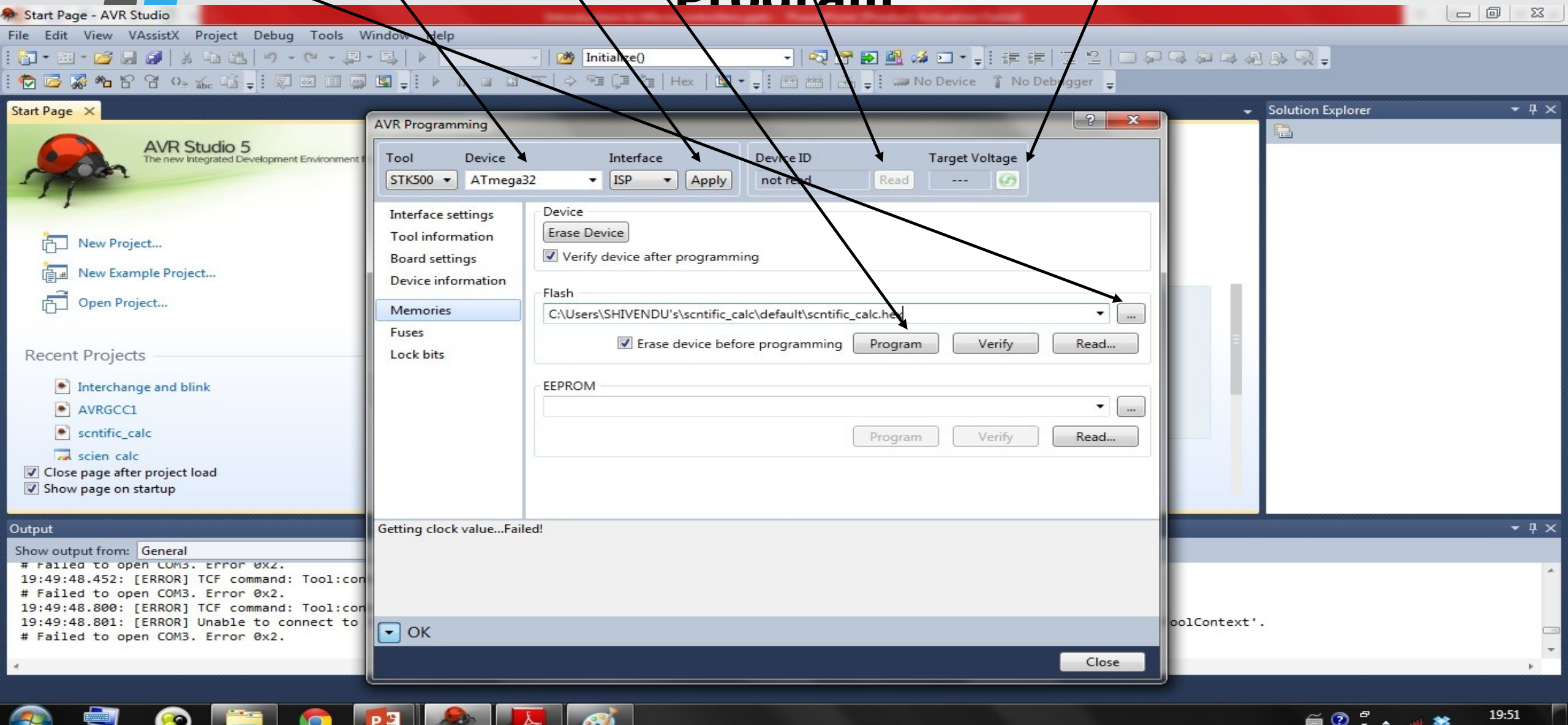
Select AVR programming

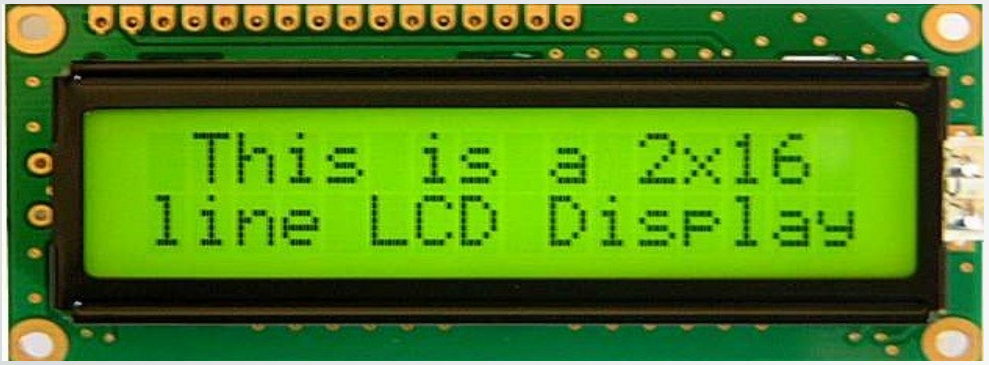


Select COM port

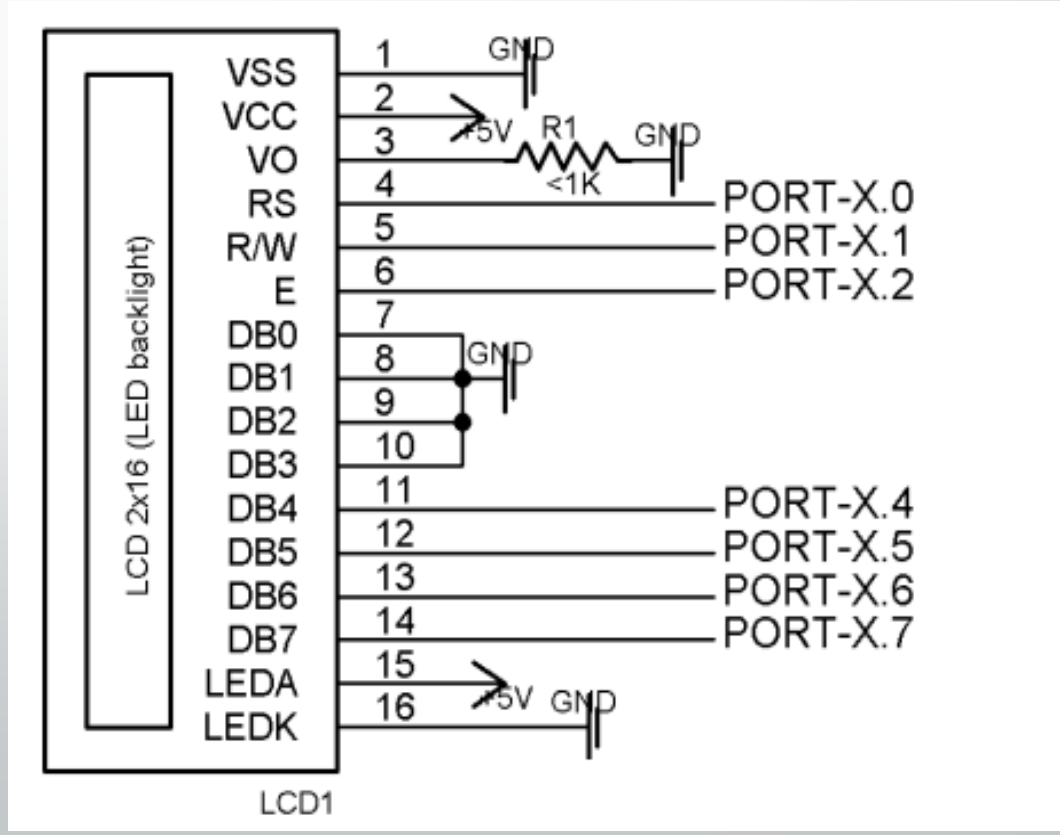


Select Device -> Click Apply -> Read Device ID -> Read target Voltage -> Choose Hex File -> Then Program





- We interface an LCD to our microcontroller so that we can display messages, outputs, etc.
- Sometimes using an LCD becomes almost inevitable for debugging and calibrating the sensors
- We will use the 16x2 LCD, which means it has two rows of 16 characters each. Hence in total we can display 32 characters



IR - TSOP Pair!

Just Think Over!

- TSOP sensor detects the presence of light from the Infrared LED
- How will it distinguish from other Infrared light already present
- Should we use some kind of encoding ?
- TSOP sensor detects Infrared light only at 38 KHz
- How do we generate light at 38KHz?
- Timers and Interrupts… we will talk in the next lecture

Thanks ”

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