JTAGAVRU1

JTAG AVR Emulator through USB

Main Features

- AVR Studio Compatible
- Supports AVR Devices with JTAG Interface
- Emulates Digital and Analog On-Chip Functions
- Data and Program Memory Breakpoints
- Supports Assembler and HLL Source Level Debugging
- Programming interface to flash, eeprom, fuses and lock bits.
- Upgradeable to Support Future Devices
- Rescue clock – where the fuse bits do not match the hardware
- Operates at Target Voltages from 1.8V to 5.5V
- USB Interface to PC for Debugging, Programming and Control
- Powered from PC through USB does not require external power supply

1. Introduction

The JTAGAVRU1 from ERE (www.ere.co.th) is compatible JTAG ICE from Atmel and it works with AVR Studio a complete tool for doing On-Chip Debugging on AVR 8-bit RISC microcontrollers with the JTAG interface.

The JTAG interface is a 4 wire Test Access Port (TAP) controller that is compliant with the IEEE 1149.1 standard. The IEEE standard was developed to enable a standard way to efficiently test circuit board connectivity (Boundary Scan). Atmel AVR devices have extended this functionality to include full Programming and On-Chip Debugging support.

The JTAGAVRU1 uses the standard JTAG interface to enable the user to do real time emulation of the microcontroller while it is running in the target system.

The AVROCD (AVR On-Chip Debug) protocol gives the user complete control of the internal resources of the AVR microcontroller. The JTAGAVRU1 gives perfect emulation at a fraction of the cost of traditional emulators.

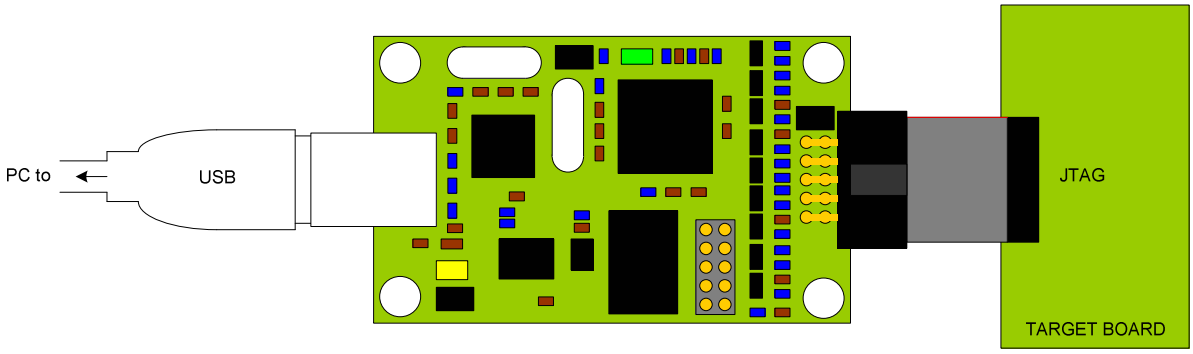

Figure 1. JTAGAVRU1 application

The JTAGAVRU1 is supported by AVR Studio. Updated versions of AVR Studio is found on www.atmel.com

2. Device Support

The JTAGAVRU1 supports AVR 8-bit RISC Microcontrollers with integrated JTAG functionality. Support for new devices will be added through AVR Studio. Latest version of AVR Studio is always available from www.atmel.com.

AVR Studio will automatically prompt the user if it is discovered that the firmware in the JTAGAVRU1 is outdated.

The JTAGAVRU1 supports AVR devices operate at target voltage from 1.8V to 5.5V.

Currently the JTAGAVRU1 supports the following devices:

	ATmega16L	ATmega16
ATmega162V		ATmega162
ATmega169V	ATmega169L	ATmega169
	ATmega32L	ATmega32
	ATmega323L	ATmega323
	ATmega64L	ATmega64
	ATmega128L	ATmega128
		AT90CAN128

Table 1. Device support

The list is updated as new versions are released. Please check www.atmel.com for the latest information.

3. Getting Start

3.1 System Requirements

The minimum software and hardware requirements are:

- Pentium processor (Pentium II and above is recommended)
- 64 MB of RAM
- 100 MB of free hard disk space
- Windows 98/ME/2K/XP/2003
- USB port, bus-powered

3.2 The beginner

- Plug JTAGAVRU1 to PC through USB port
- Install USB driver after new hardware is found by operating system
- Connect the emulator to target board then run the AVR Studio
- Re-boot the PC or re-plug the USB if the AVR Studio can not find the emulator

4. Hardware Description

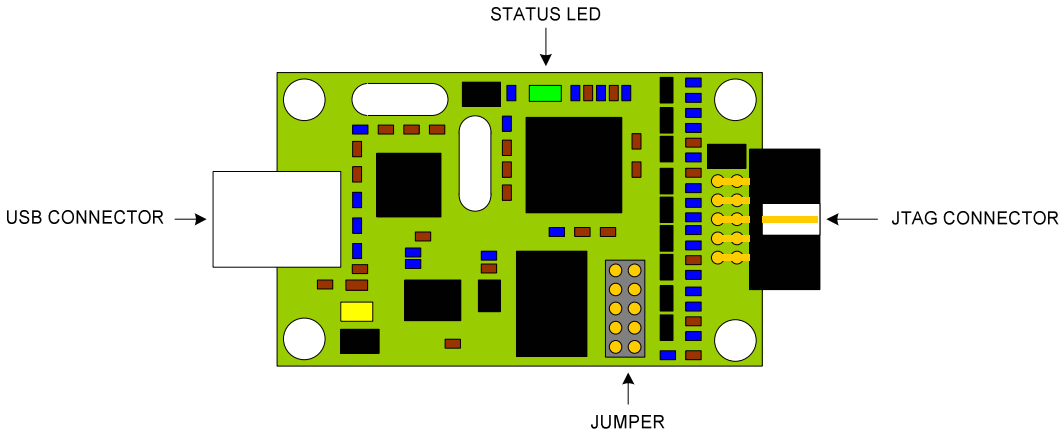

Figure 2. JTAGAVRU1 structure

4.1. General Board Description

A block diagram of JTAGAVRU1 is shown below. The emulator can be divided in to 4 sections: USB interface, Control Section, Voltage converter and JTAG cable. In this section a brief overview of different blocks will be given.

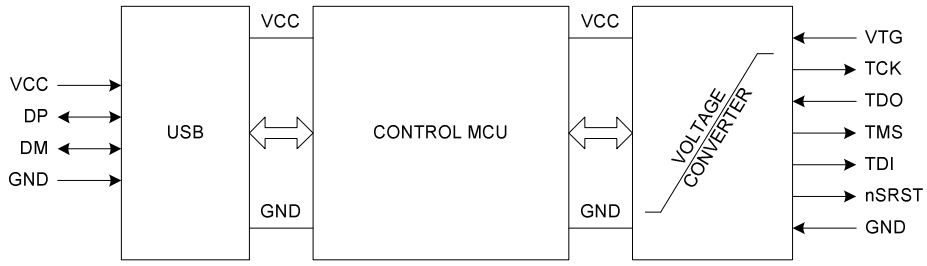

Figure 2. Block diagram of JTAGAVRU

- **USB Interface**

The emulator uses USB port for communication via VCP driver of COM port. Connect the USB cable between the emulator and a free USB port on the PC. AVR Studio will automatically search through the available COM ports and detect supported tools.

If there are other devices taking control over the COM ports, these have to be shut down before starting AVR Studio. AVR Studio cannot force control over a COM port if other resources have control of the port (eg. Modem, IrDA, PDA etc.)

- **Control Section**

The control MCU handles all communication between the target AVR and front-end software. The emulator is completely software controlled from AVR Studio. No manual configuration of JTAG is needed. One LED on board is use to show status of communicating, debugging and programming.

- **Voltage Converter**

The emulator operates at 5VDC under USB power supply. Also it can debug and program the target AVR voltage from 1.8V to 5.5V. So the voltage converter converts the target voltage to 5V. However you need to supply the target voltage to VTref pin.

- **JTAG Interface cable**

The emulator supports 10-pin JTAG connector pin out. A 1 foot of 10-pin flat cable is carried together the board.

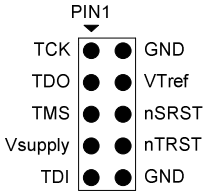

Figure 3. JTAG connector

Pin	Signal	I/O	Description
1	TCK	Output	Test Clock, clock signal from JTAGAVRU1 to target JTAG port.
2	GND	-	Ground
3	TDO	Input	Test Data Output, data signal from target JTAG port to JTAGAVRU1.
4	VTref	Input	Target reference voltage. VCC from target used to control logic-level converter. This pin is connected to Vsupply on board.
5	TMS	Output	Test Mode Select, mode select signal from JTAGAVRU1 to target JTAG port.
6	nSRST	Output	Output from adapter to the target system reset.
7	Vsupply	Input	Supply voltage, this is a target voltage. It is connected to VTref.
8	nTRST	NC	Not connected, reserved for compatibility with other equipment (JTAG port reset).
9	TDI	Output	Test Data Input, data signal from JTAGAVRU1 to target JTAG port.
10	GND	-	Ground

Table 2. Connector descriptions

A minimum of 6 wires is required to connect JTAGAVRU1 to the target board. These Signals are TCK, TDO, TDI, TMS, VTref and GND.

Optional lines are: Vsupply and the nSRST. The nTRST signal is not used, and is reserved for compatibility with other equipment.

- Vsupply and VTref are used for target board is supplying target voltage to the JTAGAVRU1
- nSRST in JTAGAVRU1 is only used to control the target reset line. Does not monitor the reset line. This is however not necessary for correct emulation. But if the application code sets the JTD bit in the MCUCSR, the JTAG Interface will be disabled. To enable the JTAGAVRU1 to reprogram the target AVR, it will need to have control of the Reset Pin.

In application code, please do not set the JTD bit in the MCUSCR register because the JTAG interface will be disabled.

The following text and descriptions will assume a 6-wire connection between target and the emulator.

The figure below shows which JTAG lines should be connected to the target AVR to ensure correct operation. To avoid drive contention on the lines it is recommended that series resistors are placed between the JTAG lines and external circuitry. The value of the resistor should be chosen so that the external circuitry and the AVR do not exceed their maximum ratings (i.e. sinks or sources to much current). For more details see JTAG ICE online help in AVR Studio.

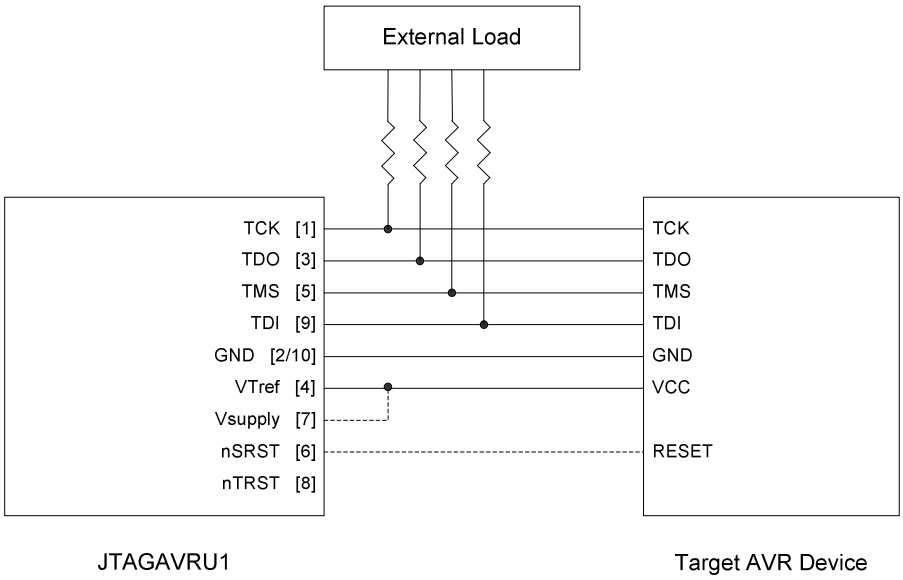

Figure 4. Connection

5. USB Driver

5.1 Installing Driver

Driver for JTAGAVRU1 is not directly control USB port. It is USB Visual COM Driver that can be used with JTAG ICE software from Atmel which use RS232 (COM) to interface to device. Therefore it need 2 times for installing. The first installing is Visual COM Driver installation and other is JTAGAVRU1's driver installation. To install the driver see step below. However in this manual the driver name is **JTAGAVRU1_R2176**. The name of driver may be changed if new version of driver is released.

- Plug the USB cable to PC and JTAGAVRU1.

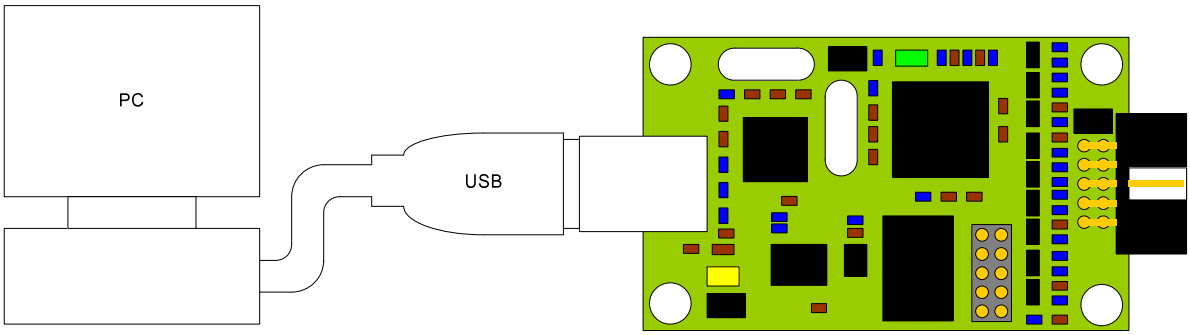

Figure 5. Plug USB cable

- Wait a moment, Windows will detect new USB hardware.
- In this process the OS found new USB Visual COM Driver for JTAGAVRU1. This process is Visual COM Driver installation.

Figure 6. OS found USB Visual COM Driver

- Select **"Install from a list or specific location (Advanced)"** radio button then click **"Next"** button.

Figure 7. Select installing type

- Click **"Browse"** button to browse driver.

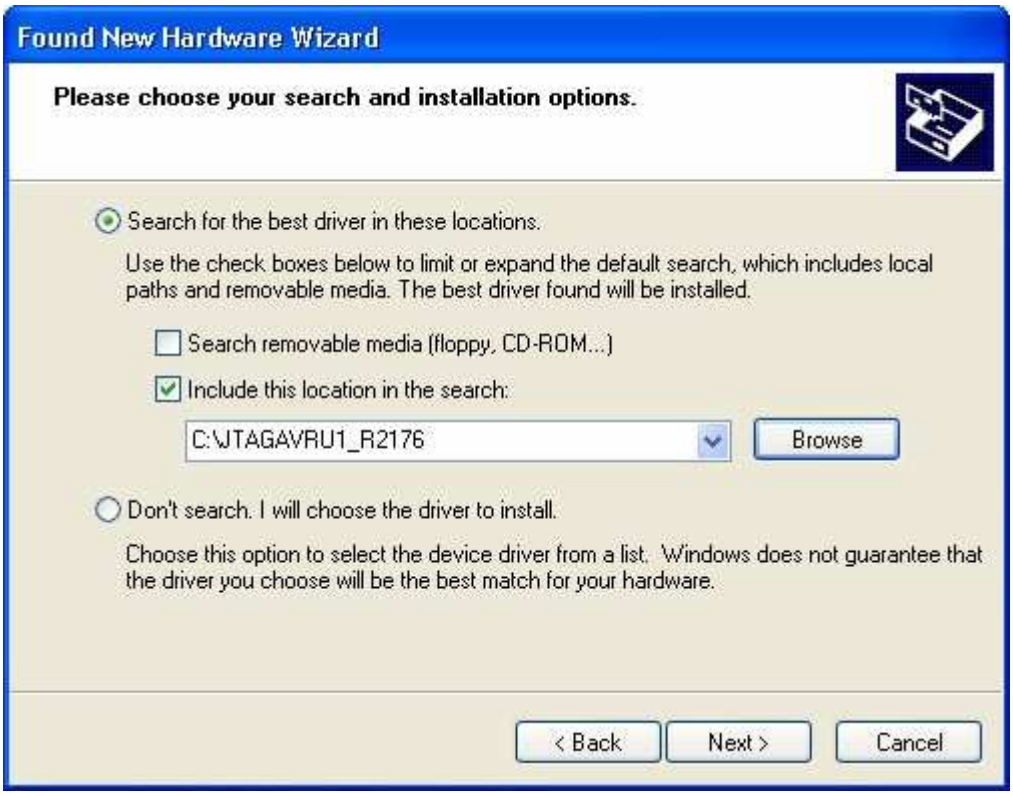

Figure 8. Browse driver

- Specify the driver then click **"OK"** button.

Figure 9. Select the driver

- The Visual COM Driver start installing.

Figure 10. Start installing Visual COM Driver

- If the following dialog box is shown, click the **"Continue Anyway"** button.

Figure 11. Continue Anyway

- Wait for this process.

Figure 12. Installs the driver

- Then click **"Finish"** button.

Figure 13. The Visual COM Driver installed

- The Visual COM Driver is installed completely.
- The OS found new hardware again that is the JTAGAVRU1, after the Visual COM Driver is installed completely.

Figure 14. OS found JTAGAVRU1

- Select **"Install from a list or specific location(Advanced)"** then click **"Next"** button again.

Figure 15. Select installing type

- Click **"Next"** button.

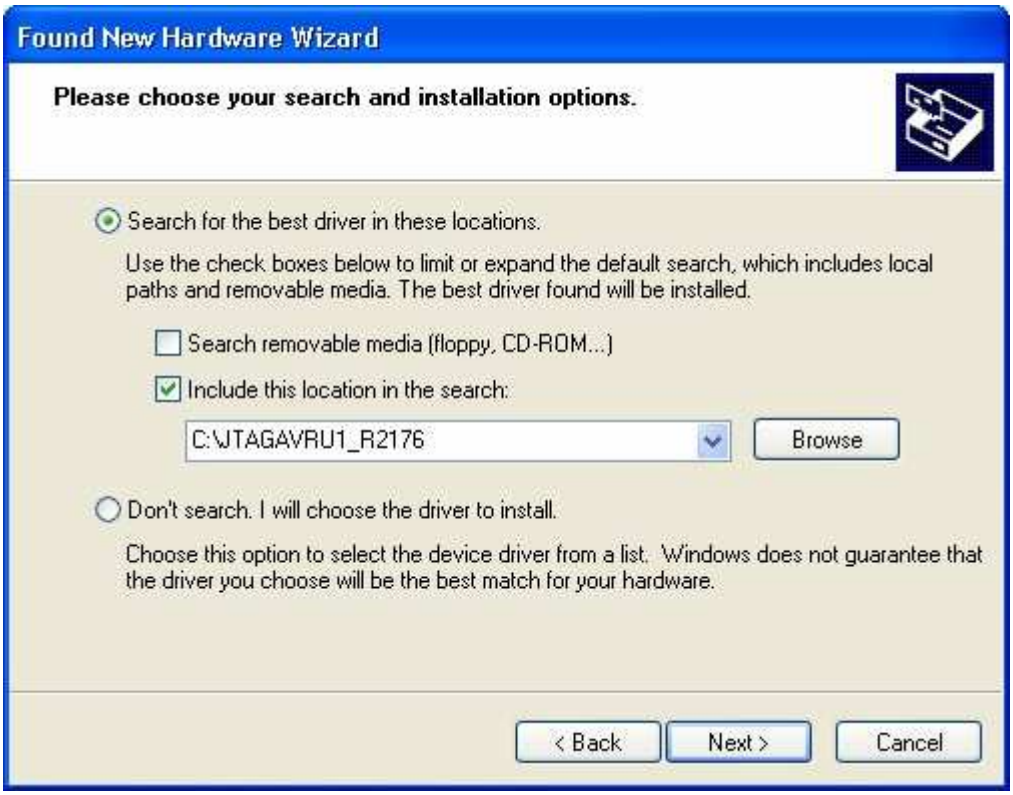

Figure 16. Browse driver

- Click **"Browse"** button to browse the driver.

Figure 17. Select the driver

- In the **"Browse For Folder"** dialog box, Select the driver then click **"OK"** button.

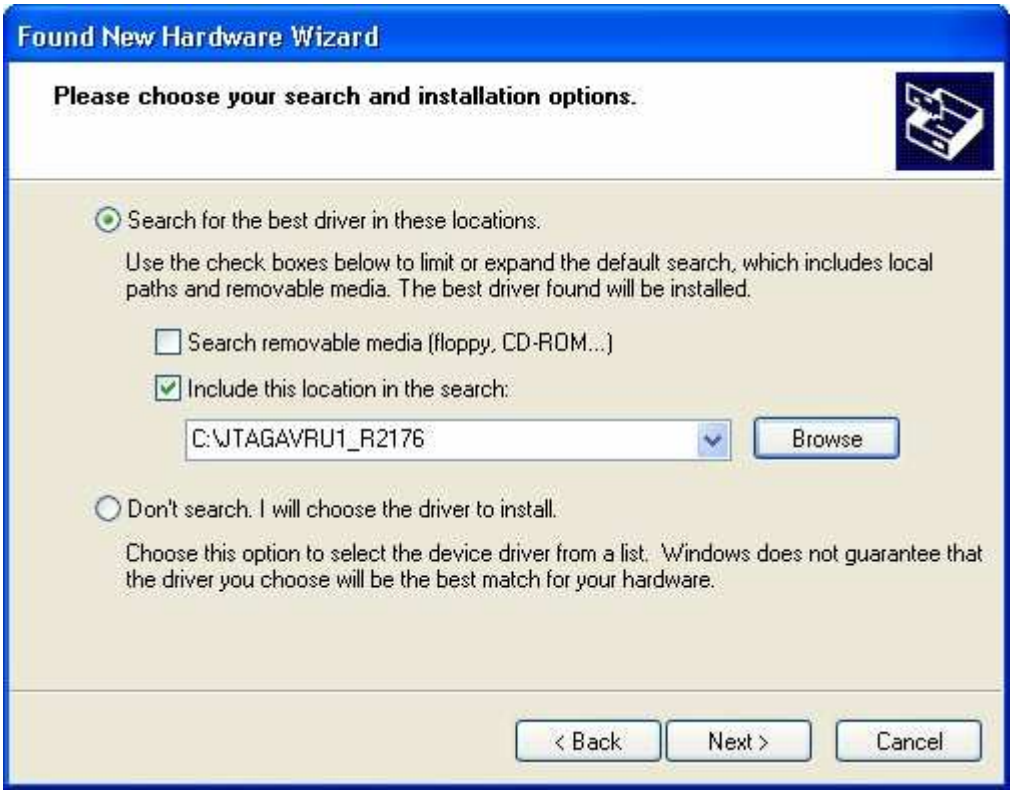

Figure 18. Driver is ready to install

- Click "**Next"** button to continue installing. And click **"Continue Anyway"** when a warning dialog box is shown.

Figure 19. Continue Anyway

- Wait for this process.

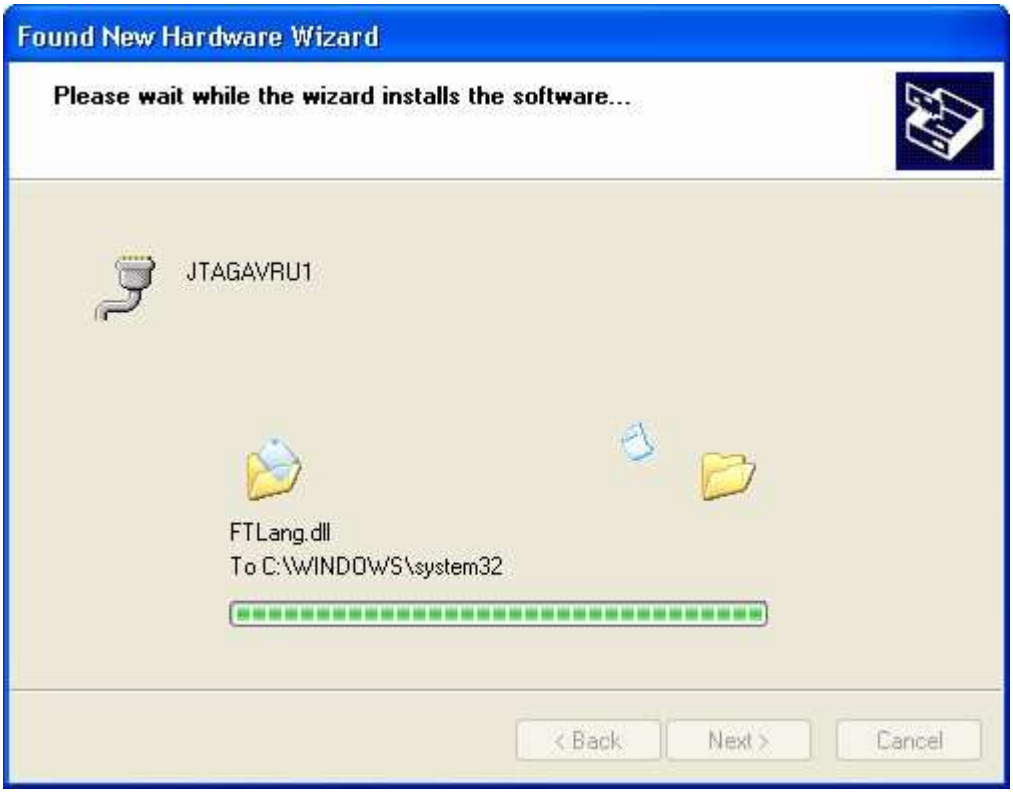

Figure 20. Installing the driver

- When process is finished, click **"Finish"** button.

Figure 21. Completing

- The driver of the JTAGAVRU1 is now installed and the programmer is ready for usage.

5.2 Checking driver

After the driver is installed on PC you can view it as the following method.

- Plug the USB cable to the JTAGAVRU1, LED is light.
- The emulator is shown by select **"Control Panel > Performance and Maintenance > System"** then you will see as below when you click on **"Hardware"** tab.

Figure 22. Hardware tab

- Click **"Device Manager"** button.

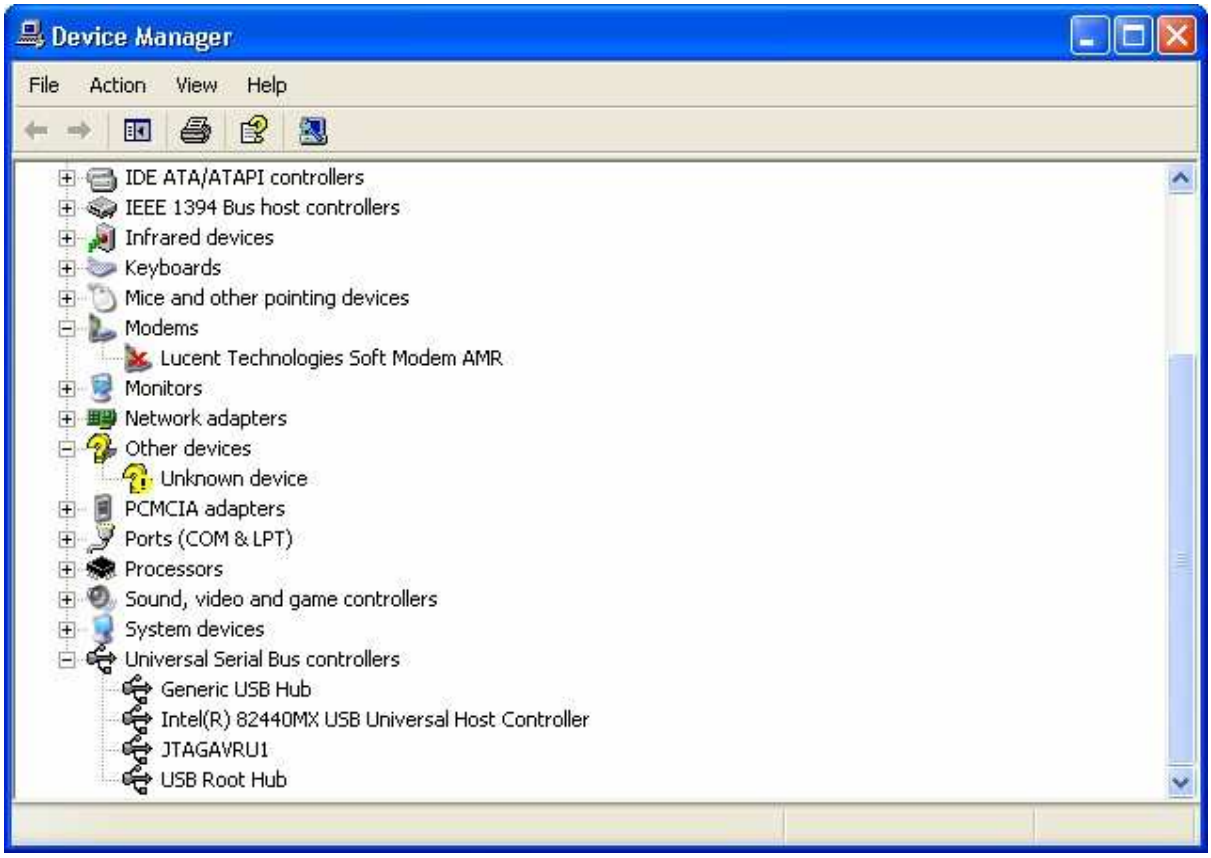

Figure 23. View JTAGAVRU1

- You can see the JTAGAVRU1 by click on **"+"** sign of **"Universal Serial Bus controller"** tree as shown above.
- Also you can see that what is COM port the JTAGAVRU1 using, by click on the **"+"** sign of **"Ports (COM & LPT)"** tree as show below . In the below figure the JTAGAVRU1 is using COM3.

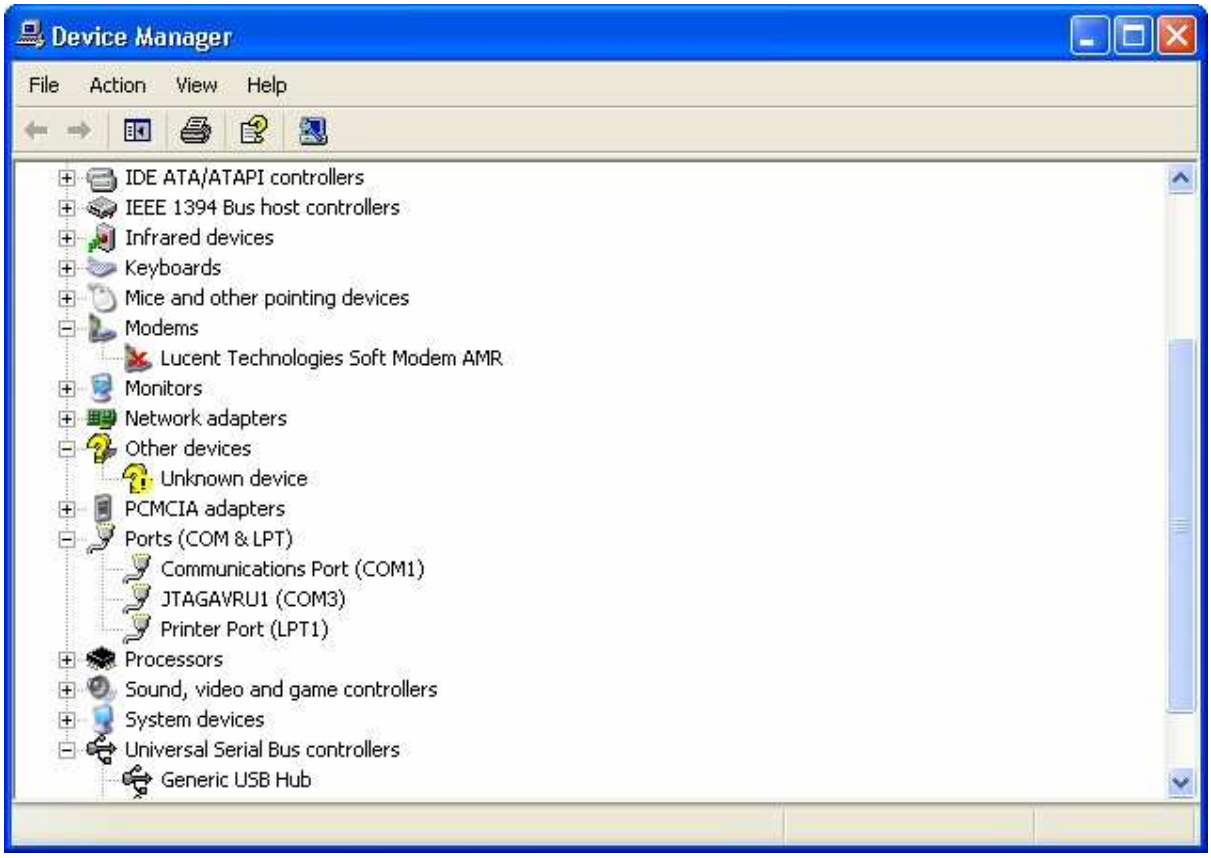

Figure 24. View COM port

! The JTAGAVRU1 must be installed on COM1 to COM4.

5.3 Changing COM port

You don't follow of this item if your emulator is installed on COM1 to COM4.

The "Avr Prog" can use COM1 to COM4. The "Avr Prog" will not start unless JTAGAVRU1 is installed on COM1 to COM4. Changing COM port is needed for this reason if your emulator is not installed on COM1 to COM4.

- Plug the USB cable to the emulator, LED is light.
- The programmer is shown by select **"Control Panel > Performance and Maintenance > System"** then you will see as below when you click on **"Hardware"** tab.

Figure 25. Hardware tab

- Click **"Device Manager"** button.

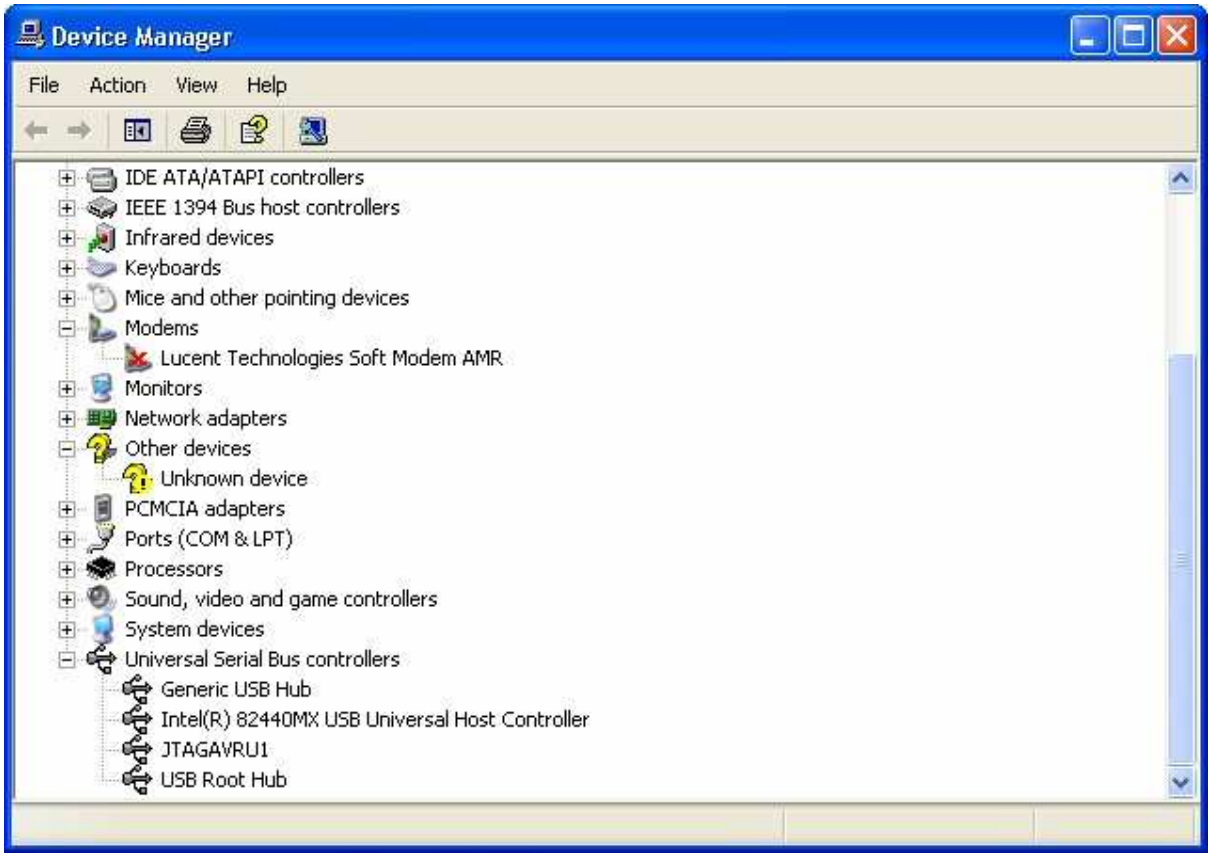

Figure 26. View JTAGAVRU1

- Click on the **"+"** sign of **"Ports (COM & LPT)"** tree as show below. It show COM8 for JTAGAVRU1 which cannot be used for "Avr Prog".

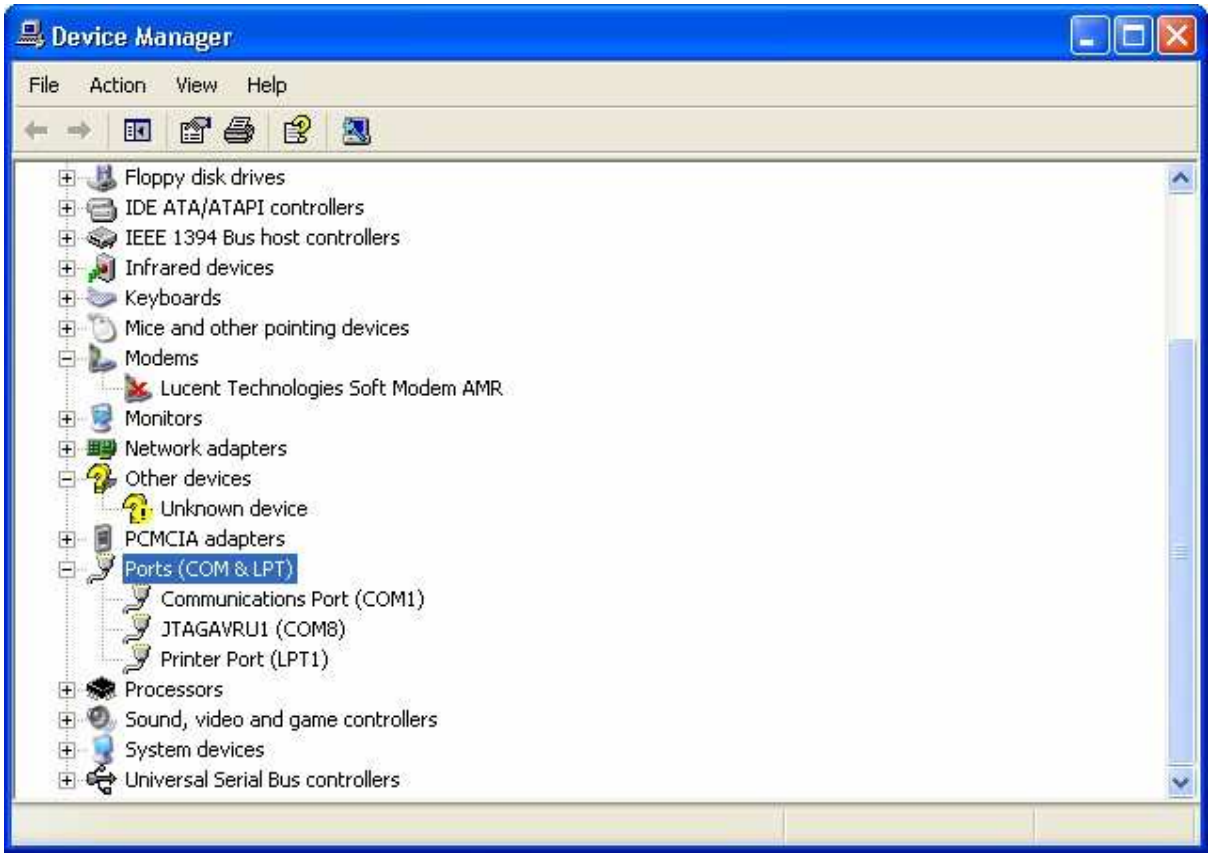

Figure 27. View COM port

- Double-clicking on **"JTAGAVRU1(COM8)"** or right-clicking then select **"Properties"** then you will see **"JTAGAVRU1 (COM8) Properties**" dialog box.

Figure 28. JTAGAVRU1 properties

- Click on **"Port Settings"** tab

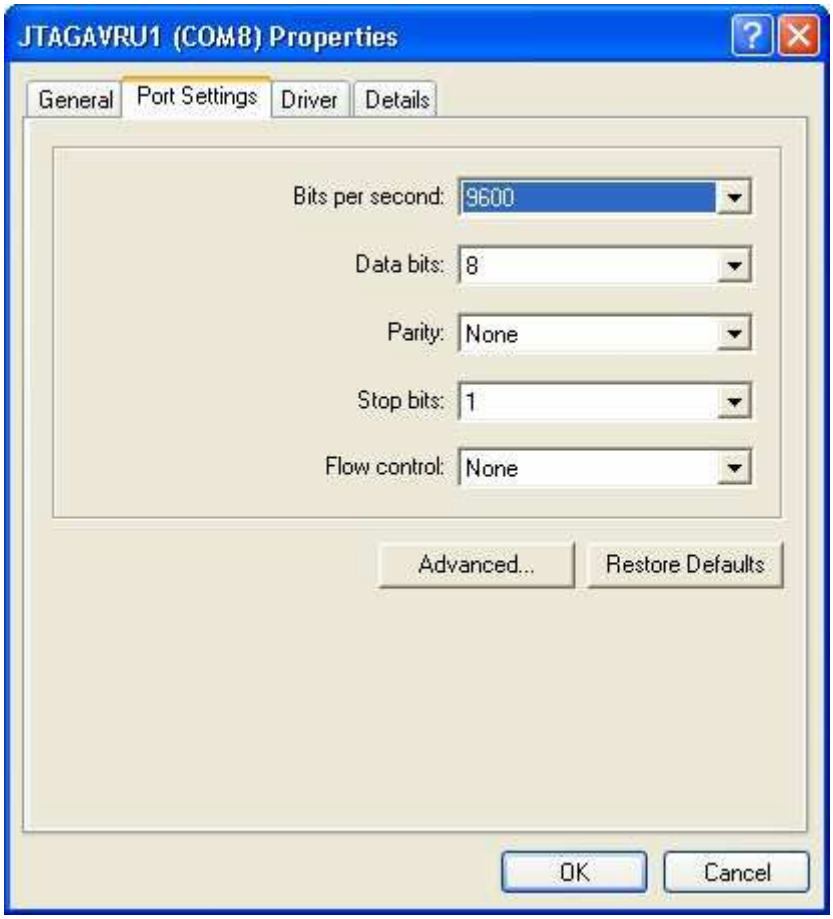

Figure 29. Port settings

- Click on **"Advanced"** button.

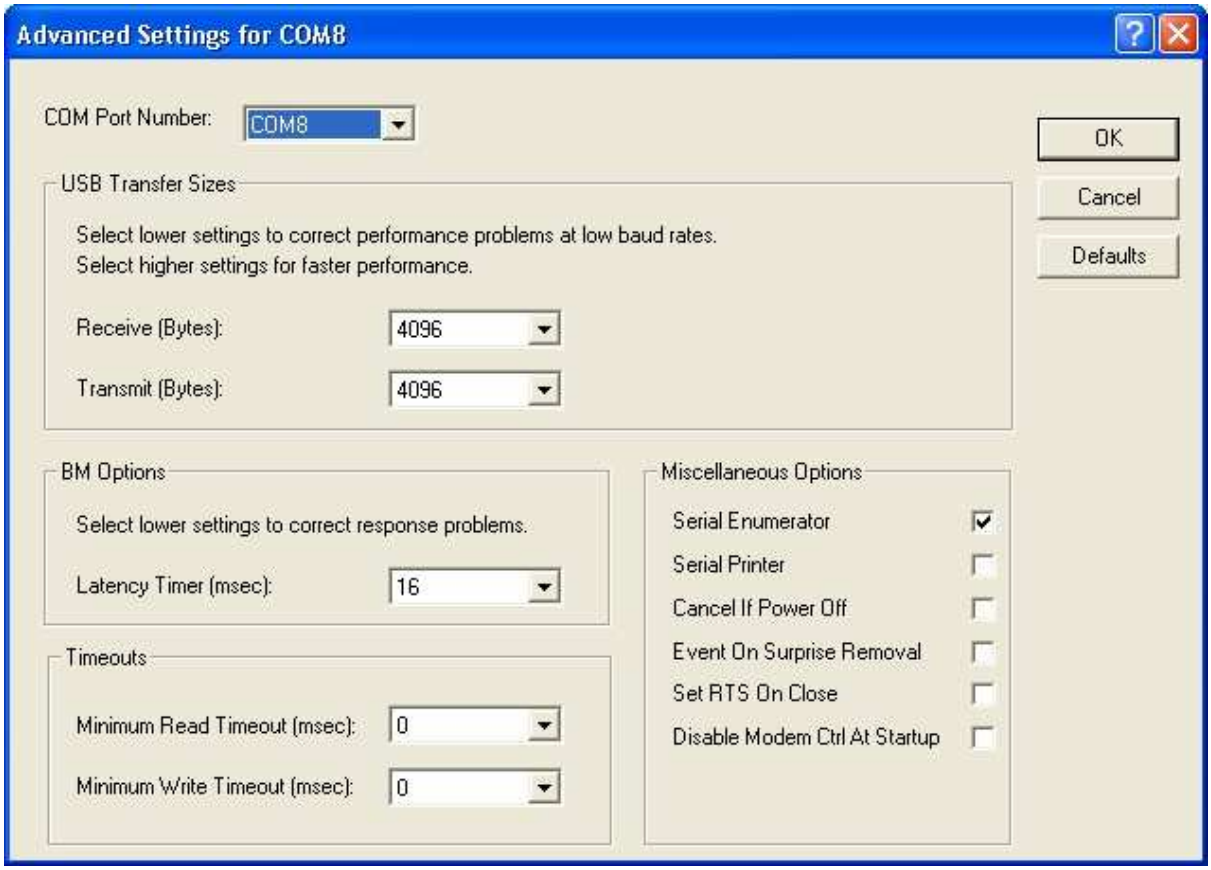

Figure 30. Advanced settings

- Selecting other COM port (COM1 to COM4) in **"COM Port Number"**. In this case we change to COM3.

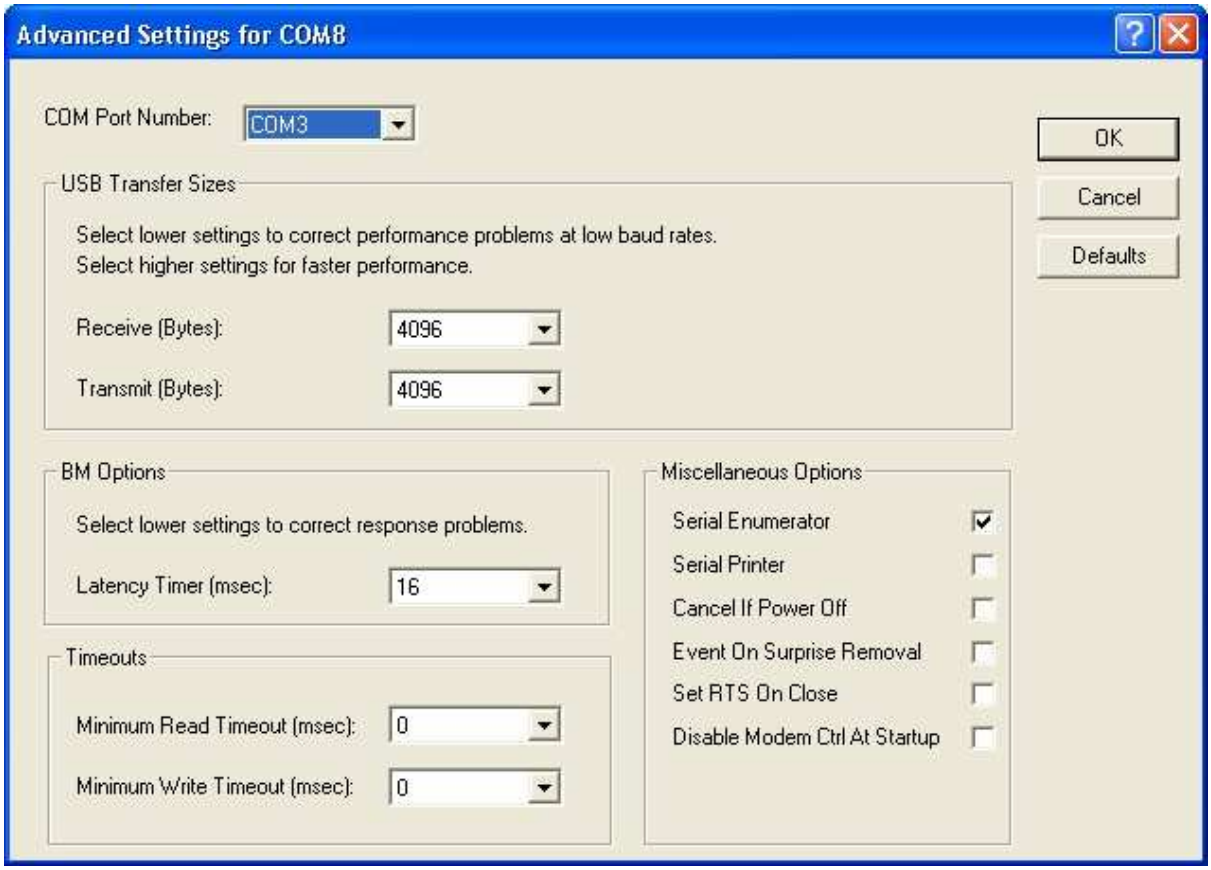

Figure 31. Change new COM port

- Click **"OK"** button on top-right of this dialog box.

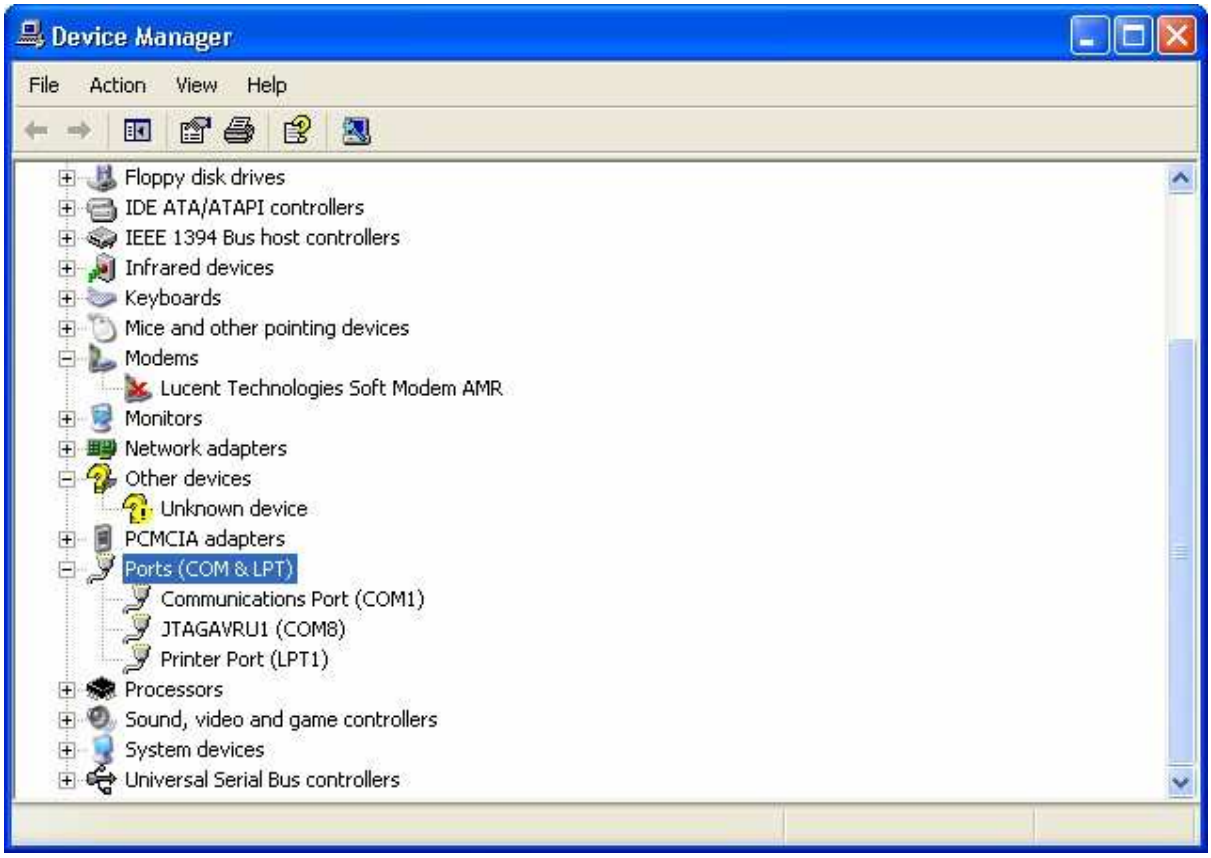

Figure 32. Changing completely

- Re-connect the driver by re-connect USB cable to JTAGAVRU1 (un-plug and re-plug) then you will see JTAGAVRU1 on new COM port as below, this is COM3.

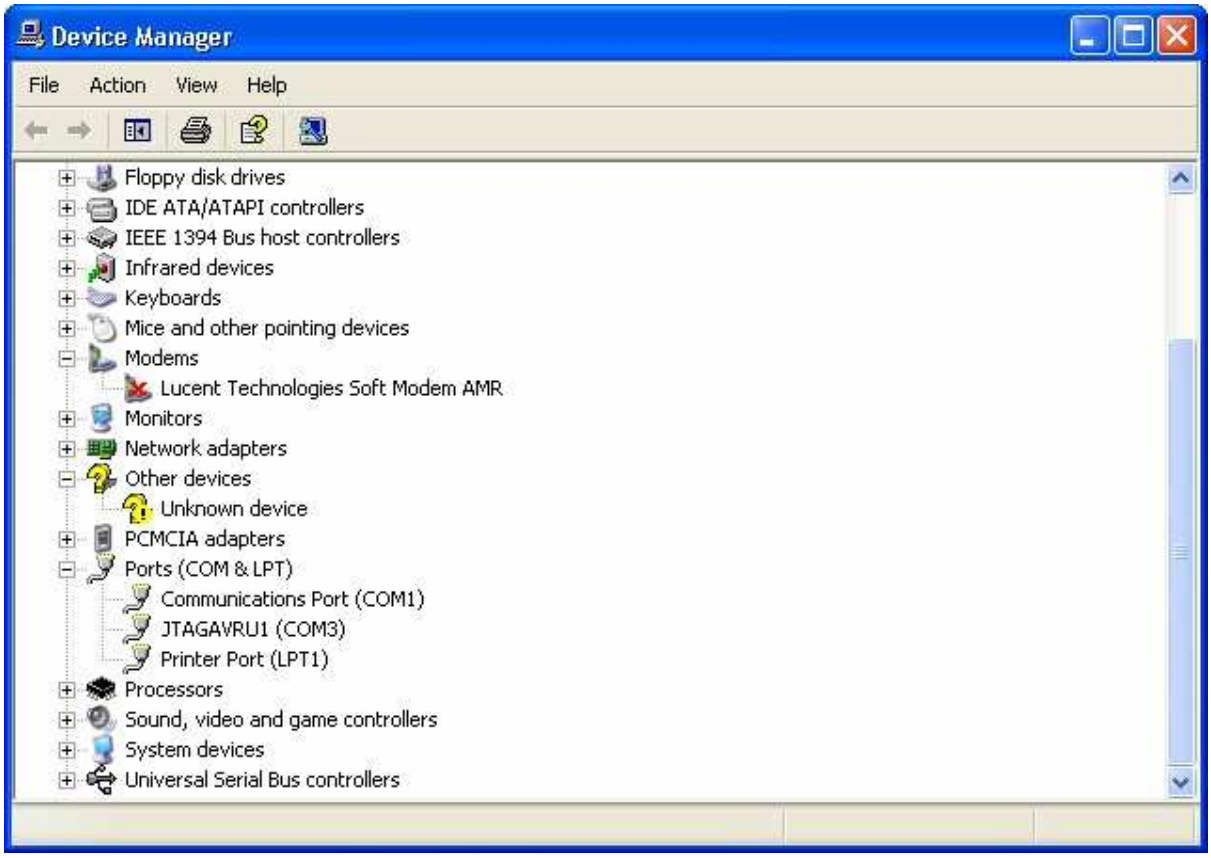

Figure 33. New COM port

6. Frontend Software

This section cover some special features and considerations when On-Chip Debugging with AVR Studio and JTAGAVRU1. General AVR Studio topics are covered in the AVR Studio online help system.

AVR Studio with its Integrated Development Environment (IDE) is the ideal software for all AVR development. It has an editor, an assembler, and a debugger and is the front-end for all AVR emulators and the JTAG ICE (JTAGAVRU1).

- AVR Studio version 4.12 or later is required for JTAGAVRU1 support.

The newest release of AVR Studio can be found in the AVR section of the Atmel website, www.atmel.com

It is assumed that the reader has general knowledge of how to use the AVR Studio software. For more information on general use of AVR Studio, please look in the interactive help system supplied with AVR Studio. This section covers JTAG ICE (JTAGAVRU1) specific topics only.

When the system is correctly connected and powered up, AVR Studio should be launched. Open a project and AVR Studio will search the COM ports for the JTAG ICE (JTAGAVRU1).

Note that AVR Studio searches through the COM ports in a sequential manner. If other Atmel tools are connected to COM ports, make sure that these are switched off, or disconnected, as AVR studio will look for supported AVR tool, and connect to the first tool it finds.

- Make sure no other devices or applications have control of the selected COM port.

The JTAGAVRU1 will then try to detect if there is power on the target board. If there is power then the JTAGAVRU1 will try to read the JTAG ID (Identification Number) on the target AVR. In the JTAGAVRU1 fails to read the JTAG ID it could be that:

1. The target AVR is not connected to the JTAGAVRU1.
   Solution: Verify that the JTAGAVRU1 is correctly connected to the target AVR.

2. The JTAG Interface fuse is not enabled on the target AVR.
   Solution: Use another interface (e.g. ISP) to verify that the JTAG enable fuse is set.

3. The JTAG Interface fuse is enabled, but the existing application on the target AVR has set the JTD (JTAG Disable) bit in the MCUCSR register.
   Solution: Holding the target AVR in Reset will prevent the JTD bit from being set by the application code.

When the JTAG ID is read successfully the JTAGAVRU1 will read the lock bit settings. If the lock bits are set the emulator has to do a chip erase on the target AVR before proceeding.

The emulator will then automatically enable the OCD (On-Chip Debug) fuse on the target AVR. Note that the emulator also can automatically disable the OCD fuse, when the debugging session is finished and the project is closed. Based on the JTAG ID from the target AVR, AVR Studio will configure the correct IO view and settings accordingly.

- **On-Chip Debugger Option**

To access the On-Chip Debugger Options while debugging use the menu option: **Debug -> JTAG ICE Options**.

Figure 34. JTAG options

- **Connection Dialog**

To ensure proper communication between the emulator and the target AVR, the OCD communication frequency from the emulator must be less than 1/4 of the target AVR frequency. If the emulator communicates at a higher speed then the target AVR can handle; communication will fail. If

you on the other hand specify an OCD frequency that is too low, communication will still work, but unnecessary delays are introduced.

"COM Port Baud Rate". Allows the user to select the preferred communication speed. Lower the baud rate if communication problems occur.

For more details about JTAG ICE (JTAGAVRU1) options can see in JTAG ICE online help in Avr Studio help.

7. Programming with JTAGAVRU1

In addition to using the JTAGAVRU1 as an On-Chip Debugger, it can also be used as a programmer. Activate the menu option **Tools -> Program AVR** to display the AVR Programmer selection dialog. This will display the dialog below.

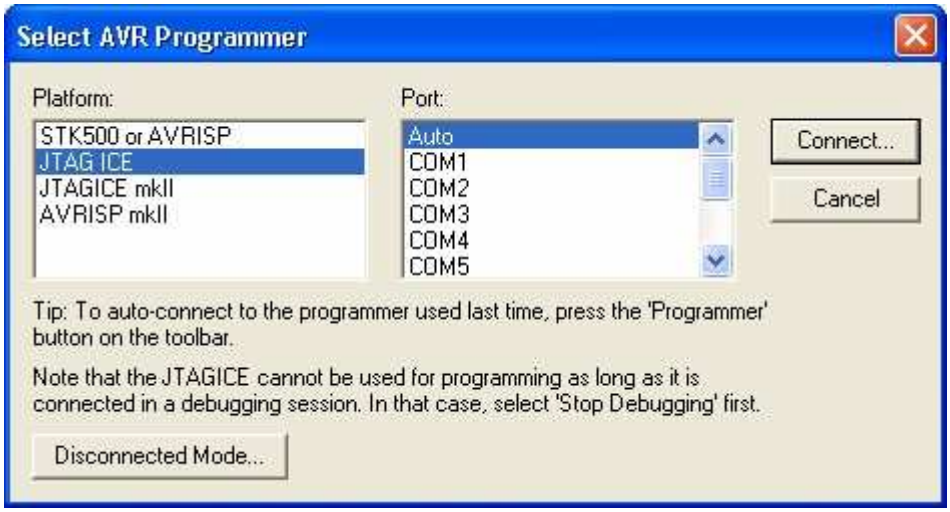

Figure 35. Auto Connecting

Select **"JTAG ICE"** in the Platform list and click "Connect...". If "Auto" is selected in the port list, AVR Studio will search all COM ports for the JTAG ICE (JTAGAVRU1). If a specific port is selected, AVR Studio will only try to connect to the given port.

If there are problems connecting to the JTAGAVRU1, make sure no other device or application has control of the selected COM port, and that there are no active debugging sessions using the JTAGAVRU1.

Important: If you disable the JTAG Enable fuse you will not be able to communicate with the target AVR with the JTAGAVRU1.

To ensure correct programming when using the JTAG interface, you must perform a chip erase before programming the Flash or EEPROM. Remember to disable the **"Preserve EEPROM"** fuse if you intend to reprogram the EEPROM.

8. Special Considerations

When using the JTAGAVRU1 some special considerations should be noted.

- **JTAG Port Frequency**

  Always set the JTAGAVRU1 port frequency to 1/4 or less than the target device frequency. When using a device that support system clock division, the lowest system frequency used must be considered when choosing the JTAGAVRU1 port frequency.

! More of other special considerations can be found in online help in Avr Studio help.

9. Rescue Clock

Where the fuse bits do not match the hardware (i.e. when the target AVR is programmed for external clock but it should be programmed for external x'tal) cause the target AVR can not run and is not talked by the programmer. A rescue clock signal is available at the rescue clock pin on JTAGAVRU1 can correct this cause by connect this pin to the XTAL1 pin of target AVR. Then uses

the programmer programs correct fuse bits which match the hardware. The LC cable (www.ere.co.th) is advice for rescue clock wire. The rescue clock signal is 5V TTL.

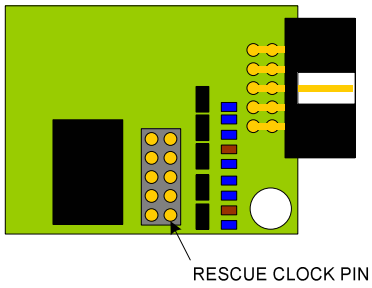

Figure 36. Rescue clock pin

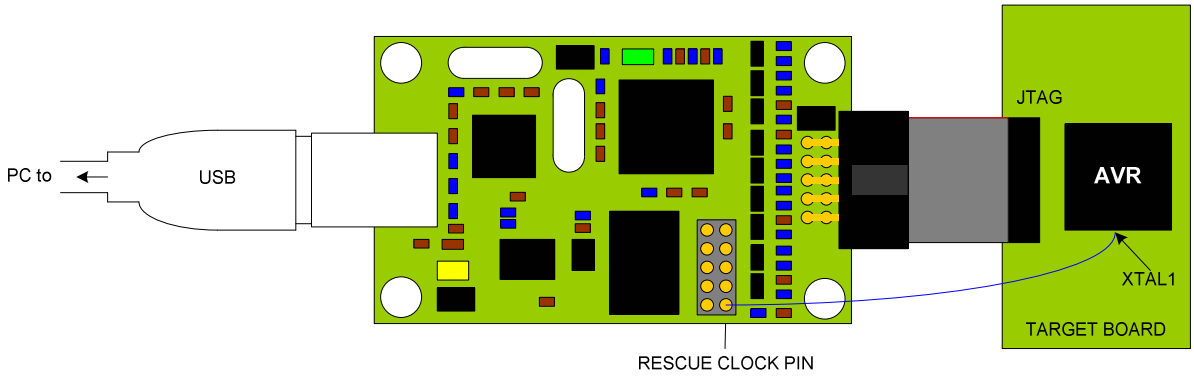

Figure 37. Rescue clock application

10. JTAGAVRU1 Firmware Upgrade

AVR Studio will detect that the firmware distributed with AVR Studio is newer that the firmware present in JTAGAVRU1. Following is a procedure on how to manually upgrade the firmware of emulator when its firmware is older or some parts of firmware are failed.

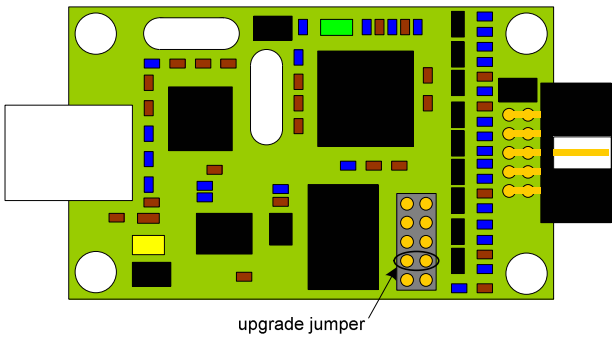

Figure 38. A jumper for upgrade

- Power off the emulator by un-plug the USB cable.

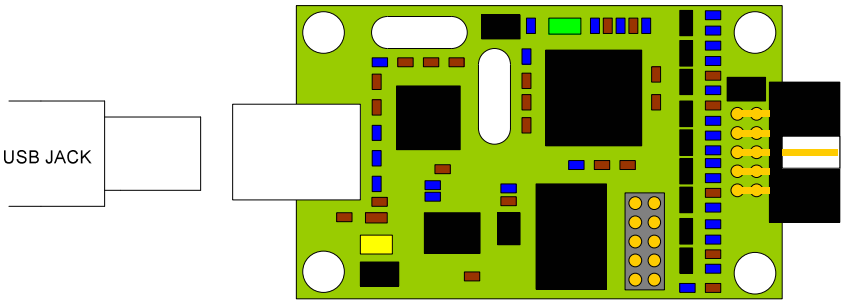

Figure 39. Power off the emulator

- Close the upgrade jumper.

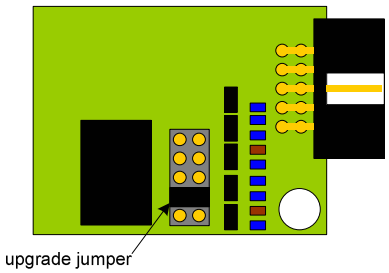

Figure 40. Close the upgrade jumper

- Power on the emulator by re-plug the USB cable.

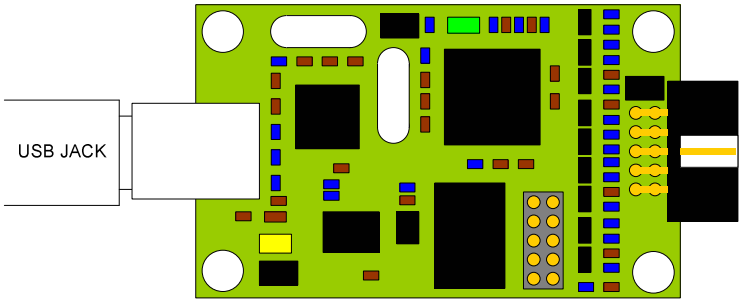

Figure 41. Power on the emulator

- Wait for a moment.
- Start AVR Studio.

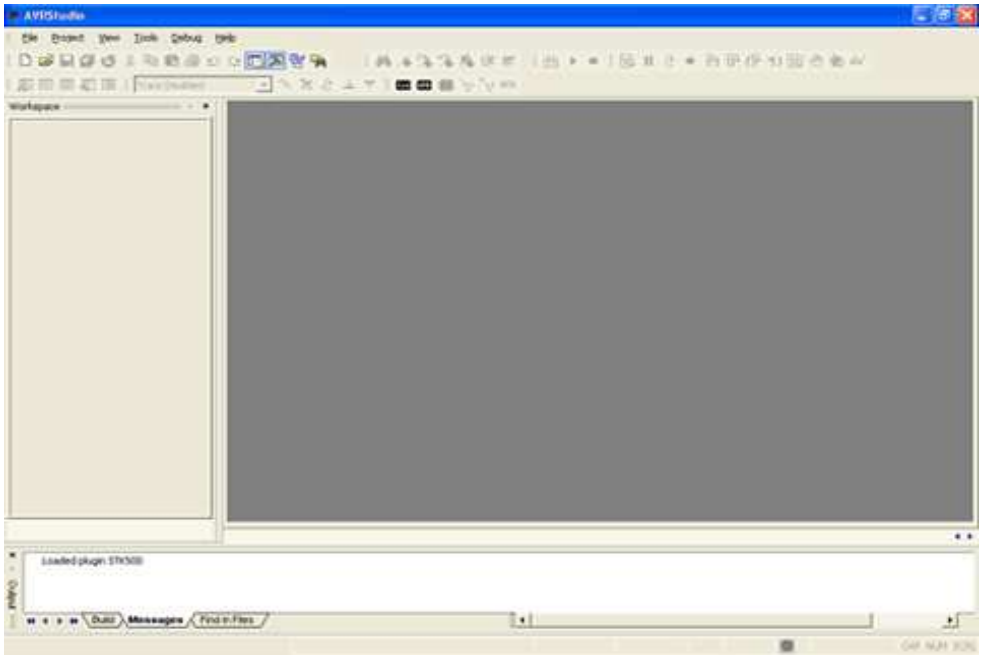

Figure 42. AVR Studio

- Start the application "AVR Prog" located in the **Tools** menu of AVR Studio.

The "Avr Prog" will not start unless JTAGAVRU1 is installed on COM1-4 !!!

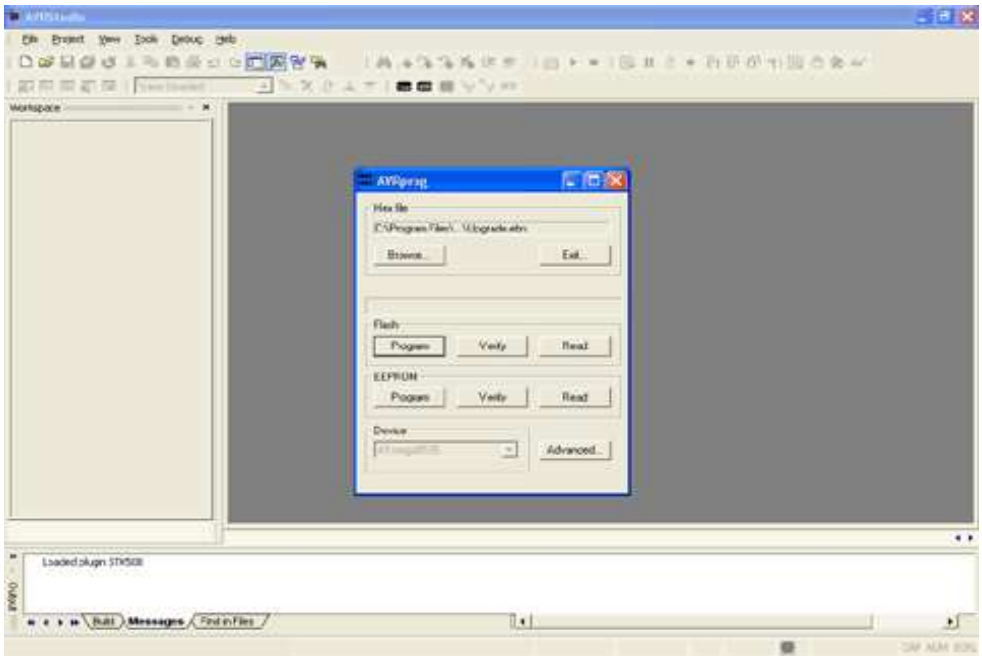

Figure 43. Start AVR Prog

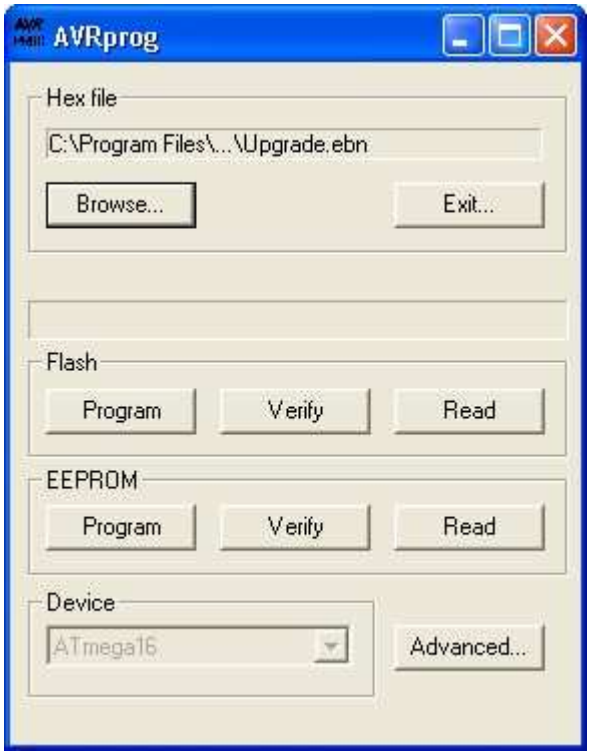

Figure 44. AVR Prog

- Click **"Browse"** button in Hex file window. Locate and select the **"Upgrade.ebn"** in the AVR Studio subfolder named JTAGICE. Typical path is "C:\Program Files\Atmel\AVR Tools\JTAGICE" in AVR Studio 4.x .

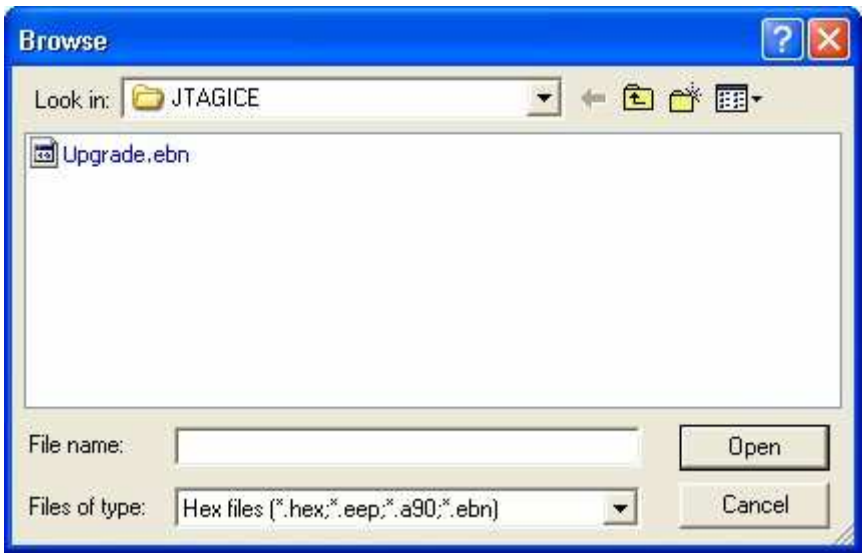

Figure 45. Browse the Upgrade.ebn

- Click **"Program"** button in Flash window on AVR Prog dialog box.
- Close "AVR Prog" after Programming and verification is completed.
- Power off the emulator by un-plug USB cable.
- Open the upgrade jumper.

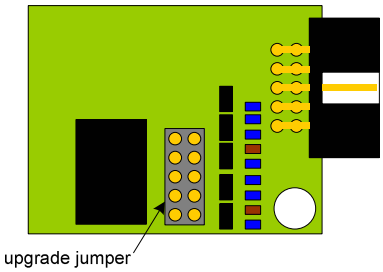

Figure 46. Open the upgrade jumper

- The firmware of the emulator is now upgraded and the debugger is ready for usage.

10. Troubleshooting Guide

Problem	Reason	Solution
JTAG Emulation Start out ok, then suddenly it fails.	Synchronization is lost.	Power cycle the emulator and target board. Decreasing the communication speed between the PC and the emulator may be required.
	The JTAG port frequency is set to high.	Always set the emulator port frequency to 1/4 or less than the target device frequency. When using a device that support system clock division, the lowest system frequency used must be considered when choosing the emulator port frequency.
	The JTAG Disable bit in the MCUCSR register has been inadvertently written by the application.	Hold reset low to regain control and change the code so that the JTAG Disable bit is not written.
When I start debugging, the led starts blinking, and the emulator never start.	The JTAGAVRU1 starts directly in Run Mode	Place a Breakpoint on the first instruction in the main function.
After Uning the JTAGAVRU1 to download code to the device, the emulator no longer work.	The JTAG ENABLE fuse has been disabled.	Program the JTAG ENABLE fuse.
	The programming interface is still active. It is not possible to use both OCD and programming at the same time.	Close the Programming interface, then enter emulation mode.
JTAGAVRU1 is detected by AVR Studio or other software front-end, but it will not connect to target device.	JTAG ENABLE Fuse is not programmed	Use an other programming interface to program the JTAG ENABLE Fuse.
AVR Prog cannot detect JTAGAVRU1	JTAGAVRU1 does not install on COM1 to COM4	Re-install JTAGAVRU1 on COM1 to COM4
AVR Studio does not find JTAGAVRU1	Old version of AVR Studio	Download AVR Studio newer version from Atmel's website
	Other Device or service controls the USB port	Disable other drivers.
	USB power supply is lower than 4.3 V	Use other USB port, disconnect other USB device.
	Driver is disconnected	Re-boot computer.

Table 3. Troubleshooting Guide

! You can see more troubleshooting in online help in AVR Studio

11.1 Measuring USB power supply

For protect emulator's code are erased when power supply voltage is changed. So the emulator will be reset where the power supply voltage of USB is lower than 4.3 V. For make sure, we recommend higher 4.7 V for USB power supply, due to 10% error of power supply. The following is a sample for measuring power supply voltage of USB port where the emulator connecting to both USB port and target board.

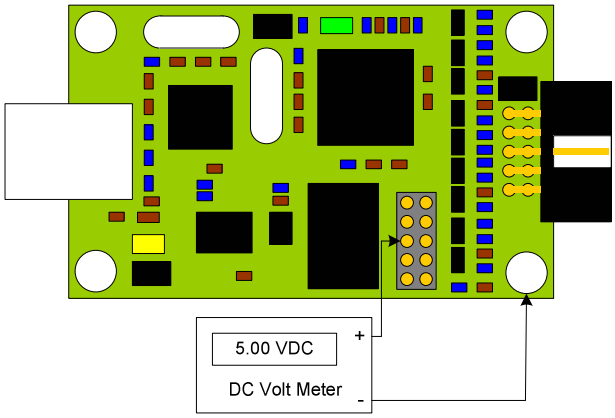

Figure 47. Measuring voltage of USB power supply