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ATmega162
ATmega169
ATmega32
ATmega323
ATmega64
ATmega128
AT90CAN128

Order Codes
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JTAGAVRU
STK200ICE
STK200ICEU
STK300ICE
STK300ICEU

AVR JTAG ICE

Complete Debugging for AVR Microcontrollers

Introduction

Newer AVR devices have a JTAG interface built-in. The JTAGAVR tool uses this JTAG port for On-chip Debugging. This is real time emulation whilst the chip is running in the target system. It can also use the JTAG interface for programming operations.

The JTAGAVR works in conjunction with Atmel's AVR Studio® software (version 4.05 or later). AVR Studio® is a superb integrated development environment with editors, assemblers, support for C compilers, Simulator and support for hardware ICE such as JTAGAVR. So, JTAGAVR acts as a hardware interface between AVR Studio and your target system, which makes it simple to setup and use. It also means that you can debug assembler or high level languages such as C.

The JTAG interface header recommended by Atmel is used by the JTAGAVR. This header is described later. However your target system may not have this interface e.g. STK200, STK300 or STK500, because they use the standard Kanda ISP header layout. Therefore, we have included port adapters in the kit that allow you to plug the JTAGAVR directly onto the port headers on these boards. This means that you can include JTAGAVR in your existing development system without having to mess around with wires and soldering irons - hassle free integration.

The JTAGAVR gives you instant In Circuit Emulation at the lowest possible cost, with the added bonus of device programming using the same hardware. We also supply JTAGAVR with an STK200 or STK300 Kit if you do not already have any development hardware. USB versions are also available.

What is On-chip Debugging (OCD)?

The JTAGAVR differs from a traditional In-Circuit Emulator (ICE) because the JTAGAVR uses On-Chip Debugging (OCD). A traditional Emulator is a device built to emulate the behaviour of a single device or a group of devices, whereas the JTAGAVR interfaces to the internal On-Chip Debug system inside the target AVR. This provides an interface and a method for monitoring and controlling code execution in a physical AVR device through the JTAG interface.

This OCD logic can be used to control the execution of code in the device. So while a traditional Emulator emulates device behaviour, the JTAGAVR will take control of the device and execute the code on the actual device. Using the OCD system, exact electrical and timing characteristics are achieved. The JTAGAVR can operate from 3 volt to 5 volt, which enables the JTAGAVR to emulate all AVR devices with the JTAG interface.

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Contents

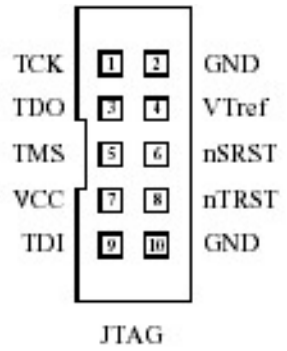
- JTAGAVR tool with JTAG port interface
- JTAGAVR firmware update interface
- STK200/300/500 interface adapters (2)
- Serial or USB lead
- CD with user manual, AVR Studio and device datasheets
- USB Interface - JTAGAVRU only

Interfaces

Atmel JTAG Interface

The JTAGAVR tool uses the standard JTAG interface pictured here. This interface is present on some development boards eg STK501.

If your target system has this interface, simply plug in the JTAG tool without any adapters.

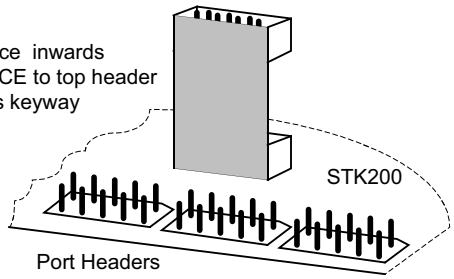


JTAG

STK200/STK300 and STK500 Interface

Two interface adapters are supplied to allow the JTAGICE to be connected directly to the port headers on these boards. Different AVR devices have the JTAG port on different device port pins, which is why two interfaces are supplied type A and B. The adapters correctly route the JTAG signals, GND and VCC pins so that you just need to connect the adapter to the correct port header on the STK200, STK300 or STK500 and plug-in the JTAGICE.

Adapter:
Box Headers face inwards
Connect JTAGICE to top header
Top Header has keyway



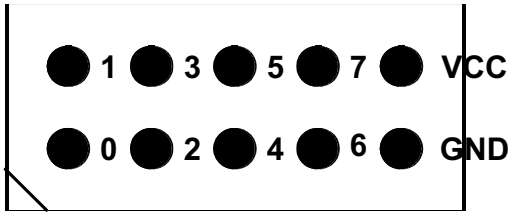
AVR Type1	JTAG Interface	Connection
ATmega128 ATmega64 ATmega169 ATmega165 ATmega325/625 ATmega3250/6250	TDI - PF7 TDO - PF6 TMS - PF5 TCK - PF4	Connect **Adapter A** to **Port F header** on STK200/STK300 or STK500. Also called Analog header on STK300.

AVR Type2	JTAG Interface	Connection
ATmega32 ATmega323 ATmega16	TDI - PC5 TDO - PC4 TMS - PC3 TCK - PC2	Connect **Adapter B** to **Port C header** on STK200/STK300 or STK500.

AVR Type3	JTAG Interface	Connection
ATmega162	TDI - PC7 TDO - PC6 TMS - PC5 TCK - PC4	Connect **Adapter A** to **Port C header** on STK200/STK300 or STK500.

Edge of STK200/300/500

Layout of port headers on STK200, STK300 and STK500 is shown in this diagram. The adapter routes the JTAG signals to the correct pin on the AVR device. You just need to connect the right adapter to the JTAGAVR and plug it into the right port header on the board.



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Custom User Interface

If you want to create your own interface, please note the following points:

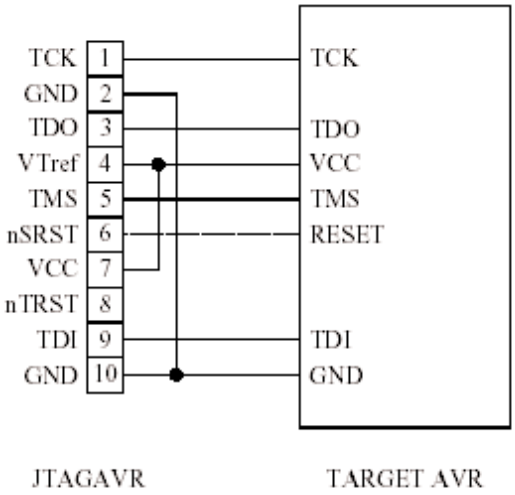
- A minimum of 6 wires is required to connect the JTAGAVR to the target board.
- These signal are TCK,TDO,TDI,TMS,VTref (or VCC) and GND.

- The VCC is connected to VTref on the JTAGAVR board because the JTAGAVR requires a power supply from target board

- nTRST signal is not used for debug or program mode but it is used for upgrading firmware.

- The nSRST is used to control and monitor the target reset line. This is however not necessary for correct emulation. But if the application code sets the JID bit in the MCUCSR, the JTAG Interface will be disabled. To enable the JTAGAVR to reprogram the target AVR, it will need to have control of the Reset pin.

This picture shows the lines that should be connected from the target AVR to the JTAGAVR.

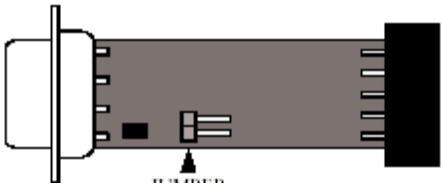


Connecting to PC

The JTAGAVR uses a standard RS-232 port for communication with AVR Studio, or a Virtual serial port on the USB version.

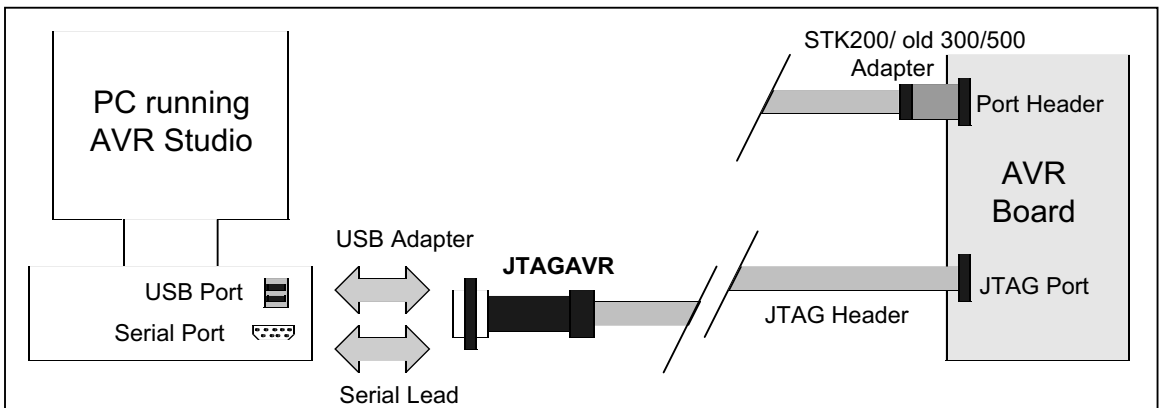
1. Connect the DB9 connector on the JTAGAVR to RS232 (serial) port of computer, using the serial lead supplied, or with the USB version, connect it to the DB9 connector on the USB adapter and plug in to USB port.

2. Plug JTAGAVR cable onto the JTAG header on a target board if available, or use the adapters supplied to connect to the port headers on a STK200, old STK300 or STK500.



3. Ensure that the jumper on the bottom of the JTAGAVR is open as shown. The jumper is only closed when performing firmware updates.

When the connection has been made, apply power to the target board and the POWER LED on the JTAGAVR should light. The ACTIVE LED will light when a communication is made between AVR Studio and the JTAGAVR.



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Running JTAGAVR

Once the JTAGAVR is connected and powered up, as described above, then run AVR Studio. Open a project, and AVR Studio will search for the JTAGICE.

Note: Disconnect or power down any other AVR Studio compatable tools or Studio may find them first.

If JTAGAVR finds a powered board, it will attempt to read the device ID. If no ID can be read, then check the following:

1. The target AVR is not connected to the JTAGAVR
   Solution: Verify that the JTAGAVR 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. AVRISP) 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.If the Reset line on the target AVR is connected to the JTAGAVR, the JTAGAVR can hold the Reset line during the reprogramming as long as the Hold Reset option is selected.

4. JTAG frequency is too high for target frquency.
   Solution:Choose Debug Menu->JTAG ICE Options and reduce JTAG frequency to one quarter of target board frequency.

When the JTAG ID is read successfully the JTAGAVR will read the lock bit setting. If the lock bits are set, the JTAGAVR will do a chip erase on the target AVR before proceeding.
The JTAGAVR will then automatically enable the OCD(On-Chip Debug) fuse on the target AVR.

Note that the JTAGAVR will also 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 setting accordingly.

Breakpoints

Hardware Breakpoints
Unlike other Atmel AVR emulators, the JTAGAVR has a limited amount of hardware breakpoints. 3 general-purpose (GP) hardware breakpoints are available. In addition there is a special “break on change of program flow” option, which can be enabled.

The 3 GP hardware breakpoints can be used as:
- 3 general-purpose breakpoints
- 2 general-puspose breakpoints and 1 data break point
- 1 general-purpose breakpoints and 2 data breakpoint
- 1 general-purpose breakpoints and 1 masked SRAM breakpoint
- 1 general-purpose breakpoints and 1 masked Flash breakpoint

Break on change of program flow can be enabled or disabled regardless of which other break point options are used. AVR Studio will keep track of which modes are used, and will give a warning if too many breakpoints are used.

* The JTAG documentation states that 4 GP breakpoints are available. This is correct, but in the JTAGAVR one breakpoint is permanently used for internal JTAGAVR usage. The three other are freely available.

Software Breakpoints
Note that software breakpoints are not supported in this release (Firmware from AVR Studio version 4.10 Build356).

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Breakpoints - continued

Breakpoint Instructions
Some AVR devices support break point instructions. Using break instructions means that the actual instruction is replaced by a break instruction in the Flash memory during debugging. By using break instructions an unlimited number of breakpoint can be used. Since the actual instruction is replaced by a break instruction, the flash page has to be re-programmed when adding or removing a breakpoint. The break instructions are thus slower to use than hardware breakpoints. AVR Studio controls the breakpoints and full instructions are given in our user manual.

JTAG Programming

In addition to using the JTAGAVR as an On-Chip Debugger, it can also be used as a programmer. The JTAG programming interface is launched from AVR Studio. Activate the menu option Tools -> STK500 to open the programming interface. AVR Studio will search the COM ports for the JTAGAVR. Note that AVR Studio searches through the COM ports in a sequential order, so make sure any other AVR Tools are switched off or disconnected,as AVR studio will look for all supported AVR tools and connect to the first tool it finds. Note that the programming interface also support JTAG Daisy Chain.
Make sure no other device or application has control of the selected COM port, and that there are no active debugging sessions using JTAGAVR.
Caution:
1. If you disable the JTAG Enable fuse you will not be able to communicate with the target AVR using the JTAGAVR.
2. To ensure correct programming when using the JTAG interface, you must perform a chip erase before programming the Flash or EEPROM.
3. Remember to disable the “Preserve EEPROM” fuse if you intend to reprogram the EEPROM.

Full Development Kits

The JTAGAVR is also available with the STK200 and STK300 kits - see below for part numbers. With these options, you get a full development kit with:

- JTAGAVR In Circuit Emulator, with adapters
- STK200 or STK300 Board with AVR device (ATmega162 or ATmega128L)
- AVRISP-U USB Port Programmer
- Programming lead, LED and Socket leads
- On CD:
  - Programming software
  - Application Builder
  - User Manuals
  - Code Examples
  - Board schematics
  - Device datasheets
  - Atmel AVR Studio3 and 4 (distributed under licence conditions of Atmel Corp.©)
  - AVREdit IDE/Editor (© Hae-Kwon Hwang) with AVRGCC 3.2 C Compiler

Order Codes

Order Codes	Description
JTAGAVR	JTAGAVR Interface plus adapters and serial lead
JTAGAVRU	JTAGAVR Interface plus adapters and USB adapter
STK200ICE	USB JTAGAVR plus adapters, STK200 Board, C Compiler etc.
STK300ICE	USB JTAGAVR plus adapters, STK300 Board, C Compiler etc.

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Using JTAGAVR with STK200, STK300, STK500

Connect the JTAGAVR to the PC as described above.

Choose the correct adapter (A or B - marked on front of board) depending on the AVR device selected - see table on page 2

Plug the adapter into the end of the JTAGAVR lead - it can only be inserted the right way round.

Plug the adapter onto the correct port header on the STK board - Port C or Port F (Port F is called Analog header on STK300). Again this depends on the device being used as listed on Page 2.

STK200ICE - supplied with ATmega162, so use Adapter B and connect to Port C
STK300ICE - supplied with ATmega128, so use adapter A on Port F (Analog)

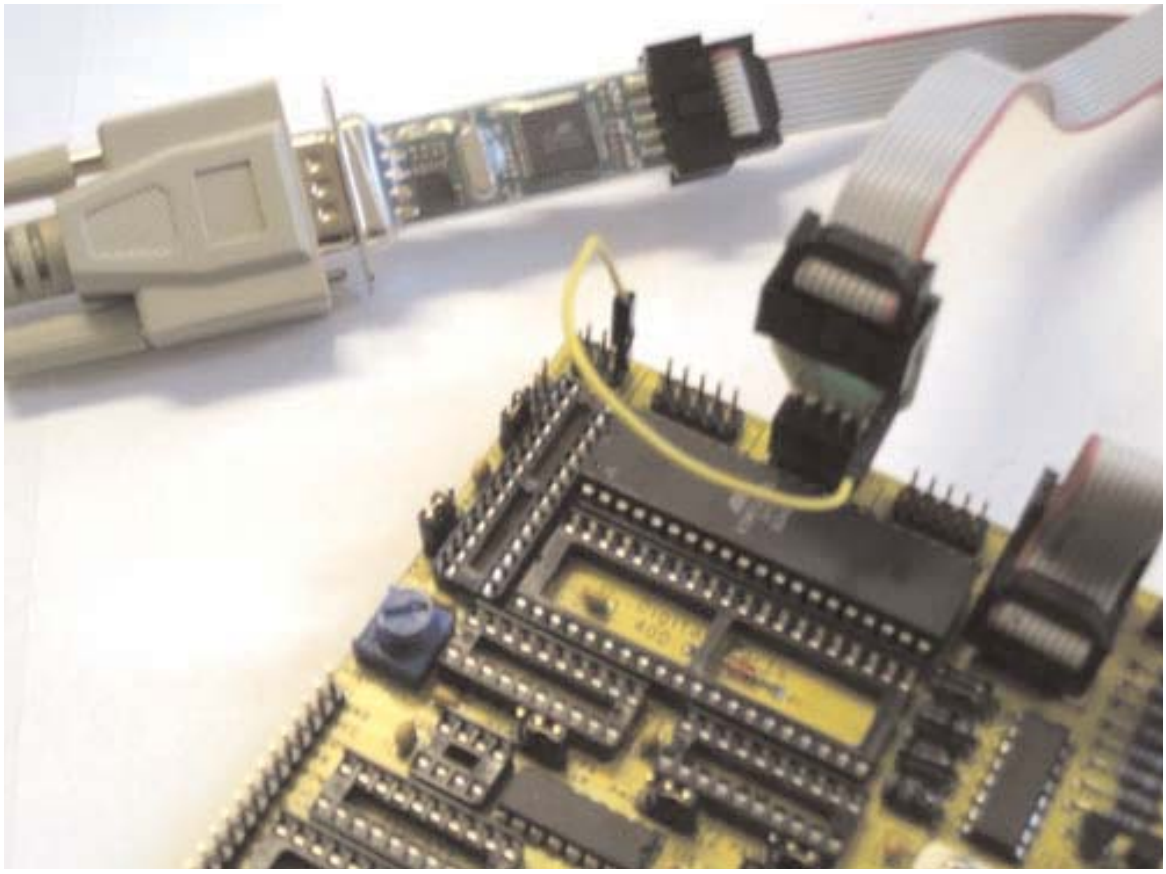
The adapter is connected with solder side out as shown in picture below.

Reset Lead

A reset lead is supplied to enable JTAGAVR to control Reset Line. This does NOT have to be connected, unless the Device has JTAG Disable Fuse set.

The reset pin on the STK200 is the middle pin on the outside of the 6-way header, marked Reset. Connect the cable supplied from Reset Pin of adapter to this reset pin.

On STK300, Reset is the middle outside pin of MISC header



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