Programming the AVR with ATMEL AVR Studio 4 and the JTAG ICE

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The JTAG ICE

The AVR JTAG ICE from Atmel is a powerful development tool for On-chip Debugging of all AVR® 8-bit RISC microcontrollers with IEEE 1149.1 compliant JTAG interface. The JTAG ICE and the AVR Studio® user interface give the user complete control of the internal resources of the microcontroller, helping to reduce development time by making debugging easier. The JTAG ICE performs real-time emulation of the microcontroller while it is running in a target system.

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. Atmel AVR devices have extended this functionality to include full Programming and On-chip Debugging support. The JTAG ICE 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 AVR On-chip Debug protocol (AVROCD) gives the user complete control of the internal resources of the AVR microcontroller.

Connecting the JTAG ICE

Before starting AVR Studio, the JTAG ICE must be connected to the front-end PC and target board. All connections must be made before starting AVR Studio to ensure correct auto-detection by AVR Studio. JTAG ICE uses a standard RS-232 port for communication. Connect the RS-232 cable between the JTAG ICE and a free COM port on the PC. AVR Studio will automatically search through the available COM ports and detect supported tools. If other devices control the COM ports, they may need to be shut down before starting the AVR Studio to ensure that the JTAG ICE is detected.
Connecting JTAG ICE to Target Board

A minimum of 6 wires are required to connect JTAG ICE to the target board. These signals are TCK, TDO, TDI, TMS, VTref and GND. The nSRST is used to control and monitor the target reset line. However, this is not necessary for emulation. If the application code sets the JTD bit in the MCUCSR, the JTAG Interface will be disabled. To enable the JTAG ICE to reprogram the target AVR, it will need to control of the Reset Pin. The MegaAVR Development board from Progressive Resources LLC is equipped with an appropriate mating connection through P2 and is shown below in figure 3. This allows the JTAG ICE to be easily connected to the development board.

![Figure 3. MegaAVR Development JTAG Interface](image)

Connecting Power

The JTAG ICE power supply can operate using either an external power supply, or it can be supplied directly from the target board. The MegaAVR Development board from PRLLC does not supply the JTAG ICE with power; therefore an external power supply must be used. The external supply must be in the range of +9 to +15 VDC at 50 to 60mA. For most lab applications, the JTAG ICE power connection can be made in parallel with the raw power supply for the development board.

The status LEDs indicate the operational state of the JTAG ICE. The significance of each color is denoted below in table 1.

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Indicates Target Power</td>
</tr>
<tr>
<td>Red</td>
<td>JTAG ICE Power indicator</td>
</tr>
<tr>
<td>Yellow</td>
<td>Indicates data communication over the JTAG interface</td>
</tr>
</tbody>
</table>

Table 1. Status LED Indication

*Note:* When running from external power (9 - 15VDC), both red and green LEDs light.
Using the AVR Studio

When the JTAG ICE is connected the PC and target board, power may be turned on. The following power up sequence is recommended to ensure proper communication between target AVR, JTAG ICE and AVR Studio.

1. Power up Target board
2. Power up JTAG ICE
3. Start up AVR Studio

The equipment will not be harmed using a different power up sequence, but communication problems between AVR Studio and the JTAG ICE may occur. If this happens use the recommended power up sequence.

When the system is correctly connected and powered up, AVR Studio should be launched. The AVR Studio is capable of programming the target AVR device, debugging the target AVR software, and simulating the AVR software. Only one of these options can be performed at a time. For instance, the target AVR cannot be reprogrammed while the AVR Studio is being used to debug the target device. The debugging session must be closed first, and then the device can be re-programmed. Likewise, the debugger cannot be used while the AVR Studio is in programmer mode.
Make sure no other device or application controls the selected COM port, and that there are no active debugging sessions using the JTAG ICE. To close a debugging session, click on the File pull-down menu and then select Close from the list. Select the Program Chip icon shown in figure 4 to activate the programming session. The programming interface shown below in figure 5 will be displayed. The message area at the bottom should indicate that the JTAG ICE has been located. Select the target AVR device type using the pull-down menu. Once the device type has been selected, click on the Fuses Tab.

Figure 5. The JTAG Programming Interface
JTAG Relevant Fuse Settings

When the Fuses Tab is selected, the JTAG ICE will enter the programming mode and read the current Fuse bit settings. If these settings do not match those listed below, the fits bits must be changed.

There are 2 fuses that must be set for the JTAG ICE to function correctly. This is the JTAG enable fuse and the OCD enable fuse. These fuses are enabled by default when shipped from the factory. If the JTAG Enable fuse is unintentionally disabled, the user can enable the fuse by using one of the other programming interfaces (e.g., ISP). In addition to these two fuse bits, the two Brown-out detection bits should be set.

1. Message Area

2. Enable On-chip Debug

3. Enable JTAG Interface

4. Select Boot Flash Size

5. Select Brown-out Level

6. Enable the Brown-Out detection

7. Scroll down to see additional fuse bits

Once the above fuses have been set, scroll down to the bottom of the list using the scroll bar located on the right side. Select the external clock fuse bit when using the MegaAVR Development board. This tells the microcontroller to use the external oscillator instead of the internal RC oscillator (see figure 7 located on the next page). After these fuse bits are all selected, program them into the microcontroller by selecting the Program Button.
Once the Fuse bits have been programmed, click on the Lock Bits tab and ensure that no protection is selected.
Programming the Microcontroller

Once the device type, fuse bits, and lock bits have been selected, return to the Program Tab. Select the browse button to locate and select the hex file to be programmed into the AVR target. Once located, select the proper hex file. The file can be loaded by double-clicking on the file name or by clicking on the Open button.

Once the hex file has been loaded, select the Program button to actually send the program to the target AVR. The message area at the bottom of the programming window will update with the status (see figure 10 located on the next page).
The target AVR microcontroller is now programmed and freely running the selected software. Close the programmer to allow the JTAG ICE to be used for other procedures by clicking on the close window button.
References:


Images are taken from AVR Studio 4. Program is available for download from the Atmel Web Site located at www.atmel.com.