

AT12615: Getting Started with ATmega48PB/88PB/168PB

APPLICATION NOTE

Description

This application note aims at getting started with the Atmel® ATmega48PB/88PB/168PB AVR® based microcontroller.

Features

- Getting started with the ATmega48PB/88PB/168PB microcontroller and tools
- Getting started with Atmel ATmega168PB Xplained Mini Kit and Atmel Studio 6.2

This application note contains a list of all necessary tools required to start the work and points to where to look for additional information.

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1. Key Features

- AVR (Harvard) Architecture
- Single level pipelining.
- In-System Reprogrammable Flash memory
- Separate EEPROM section available
- Optional Boot Code Section with Independent Lock Bits
- RWW – Read While Write support
- 20MIPS @ 20MHz
- Most Single Clock Cycle Execution
- Low power microcontroller with various sleep modes
- High Code Density (Advanced RISC Instruction Set)
- On-Chip Hardware Multiplier
- Short Interrupt Latency 4 Clock Cycles
- Factory Calibrated Internal RC Oscillator
- Security with Fuses and Lock Bits
- Atmel QTouch® Library support
- Compatibility between devices (Portability)

Note: For detailed information (like AVR architecture, flash size, number of pins, operating voltage range, number of peripheral channels, module description etc.) refer to the ATmega48PB/88PB/168PB datasheet.

2. Device Related Website Links

The product overview webpage for each device is available at the following link

ATmega48PB:

<http://www.atmel.com/devices/ATMEGA48PB.aspx?tab=overview>

ATmega88PB:

<http://www.atmel.com/devices/ATMEGA88PB.aspx?tab=overview>

ATmega168PB:

<http://www.atmel.com/devices/ATMEGA168PB.aspx?tab=overview>

Note: For demonstration purpose, in this document ATmega168PB device is used as reference. But the features, example application explained in this document will be applicable for ATmega48PB and ATmega88PB devices also. Since the ATmega48PB and ATmega88PB device doesn't have Xplained Mini Kit like ATmega168PB device, STK®600 Kit can be used along with appropriate routing card and socket card to run the application given in this document.

3. Getting Started with Atmel ATmega168PB

3.1. Device Related Website Links

The ATmega168PB product overview webpage (as shown in the figure below) is available at:

<http://www.atmel.com/devices/ATMEGA168PB.aspx>

Figure 3-1 Device Webpage

Home > Products > Microcontrollers > AVR 8- and 32-bit MCUs > megaAVR MCUs

ATmega168PB

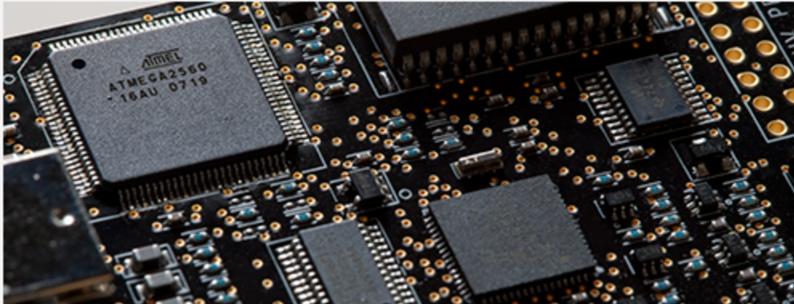
Overview ▾

Parameters

Tools

Documents

Applications



Buy Now

Datasheet

PDF **Software** **Description**

 **ATmega48PB/88PB/168PB Preliminary Summary**
(file size: 634KB, 24 pages, revision C, updated: 03/2015)

 **ATmega48PB/88PB/168PB Complete**
(file size: 5.8MB, 360 pages, revision C, updated: 03/2015)

[More Documents...](#)

The high-performance Atmel® picoPower® 8-bit AVR® RISC-based microcontroller combines 16KB ISP flash memory with read-write capabilities, 512B EEPROM, 1KB SRAM, 27 general purpose I/O lines, 32 general-purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, USART with wake-up on start of transmission, a byte-oriented 2-wire serial interface, SPI serial port, 8-channel 10-bit A/D converter, programmable watchdog timer with internal oscillator, a 9 byte unique serial number and five software selectable power-saving modes. The device operates between 1.8-5.5 volts.

By executing powerful instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed.

Key Parameters

Parameter	Value
Flash (Kbytes):	16 Kbytes
Pin Count:	32
Max. Operating Freq. (MHz):	20 MHz
CPU:	8-bit AVR
# of Touch Channels:	16
Hardware QTouch Acquisition:	No
...	...

In the **Parameters** tab, the configuration parameter details (like flash size, number of peripheral channels, number of I/O pins, etc.) for this device can be found.

<http://www.atmel.com/devices/ATMEGA168PB.aspx?tab=parameters>

In the **Documents** tab, all the related documents (like datasheet and application notes) for this device can be found.

<http://www.atmel.com/devices/ATMEGA168PB.aspx?tab=documents>

In the Datasheet section under the **Documents** tab today there are two documents:

1. Preliminary / Complete version (includes all peripheral descriptions and electrical characteristics).
2. Preliminary Summary / Summary version (includes Ordering Information, pin out, and Packaging Information).

The device related application notes (like e.g. hardware design considerations) and its associated firmware (if any) are also available under the **Documents** tab.

In the **Applications** tab, the recommended application areas (not limited to) for this device can be found.

<http://www.atmel.com/devices/ATMEGA168PB.aspx?tab=applications>

In the **Tools** tab, all the related tools (like IDE, programmer, debugger, evaluation kits, BSDL files) for this device can be found.

<http://www.atmel.com/devices/ATMEGA168PB.aspx?tab=tools>

The ATmega168PB Xplained Mini kit's webpage can be viewed by clicking the ATmega168PB Xplained Mini available in the following link:

<http://www.atmel.com/devices/ATMEGA168PB.aspx?tab=tools>

3.2. ATmega168PB Xplained Mini Kit

The kit can be ordered online by clicking **Add to Cart** in the following link:

<http://www.atmel.com/tools/MEGA168PB-XMINI.aspx>

Figure 3-2 ATmega168PB Xplained Mini Webpage

Home > Products > Microcontrollers > AVR 8- and 32-bit MCUs > megaAVR MCUs

ATmega168PB Xplained Mini

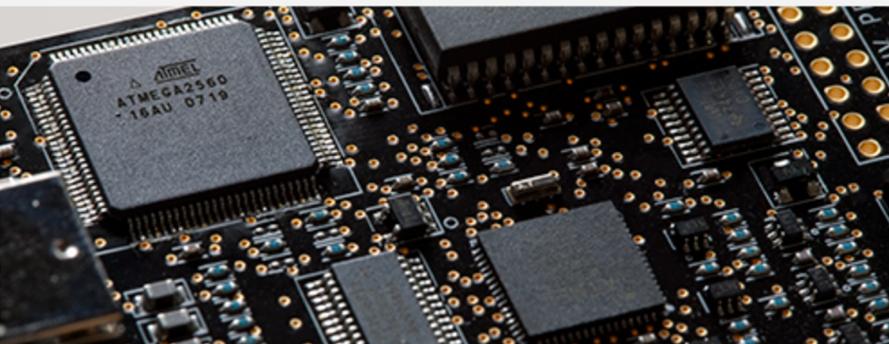
Overview ▾

Devices

Documents

Applications

Related Tools



Get Started

We'll tell you all you need to know to start evaluating and working with this product.

» Start Now

» Contact Sales

» Request Samples

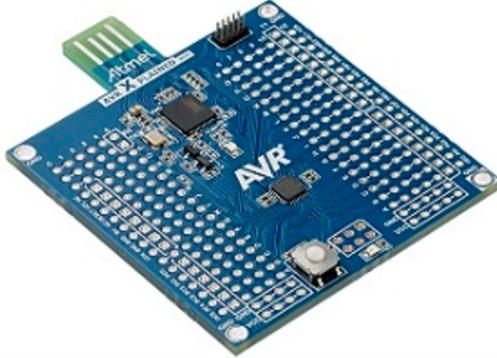
» Sign-up for News

Buy Now

The Atmel ATmega168PB Xplained Mini evaluation kit is a hardware platform for evaluating the Atmel ATmega168PB microcontroller. The evaluation kit comes with a fully-integrated debugger that provides seamless integration with Atmel Studio 6.2 or later. The kit provides access to the features of the ATmega168PB enabling easy integration of the device in a custom design.

Key Features

- On-board debugger with full source-level debugging support in Atmel Studio
- Auto-ID for board identification in Atmel Studio 6.2
- Access to all signals on target MCU
- One green status LED
- One mechanical user pushbutton
- Virtual COM port (CDC)
- 16MHz target clk
- USB-powered
- Arduino shield-compatible foot prints
- Target SPI bus header foot print
- Xplained Pro extension headers can easily be strapped in
- Supported with application examples published on Atmel Space



Related Items

» Third Party Support

» University Program

» AVR Knowledge Base

» Technical Support

» What's Changed

» Mature Devices

Ordering Information

Ordering Code	Atmel Store Availability¹	Unit Price (USD)²	Buy Online
ATMEGA168PB-XMINI	4	1 @ USD 9.71 each	<input type="button" value="Add to Cart"/>

¹Backlog orders can be placed for items currently not available.
²Suggested retail price per unit for budgetary use only.

In the **Documents** tab, all the kit related documents like schematics and user guide can be found.

<http://www.atmel.com/tools/MEGA168PB-XMINI.aspx?tab=documents>

Note: For detailed information like header and connections, refer to the ATmega48PB/88PB/168PB Xplained Mini User Guide, which is available at the under the **Documents** tab.

3.3. Atmel Studio

3.3.1. Atmel Studio Webpage

The Atmel Studio installer (free IDE) is available at:

<http://www.atmel.com/tools/ATMELSTUDIO.aspx>

3.3.2. Atmel Studio Microsite

To learn more about Atmel Studio, refer to the following microsite:

http://www.atmel.com/microsite/atmel_studio6/

Figure 3-3 Atmel Studio Microsite Webpage

The screenshot shows the homepage of the Atmel Studio 6 microsite. At the top, there's a navigation bar with tabs: Overview (which is selected), Software Library, QTouch Tools, C/C++ Compiler/Editor, Debugging/Simulation, and Videos. A red banner on the left says "Version 6.2 Released for Production". The main title is "ATMEL STUDIO 6" with the subtitle "One Collaborative Studio With Integrated App Store and Shared Workspace". Below this is a "DOWNLOAD NOW" button. To the right, there's a 3D-style illustration of a studio environment featuring a ladybug, a window, and a computer monitor displaying code. A code snippet is also shown on the monitor. On the left side of the main content area, there's a section titled "Atmel Studio 6 - The Studio to Design All Embedded Systems" with links to "What's New in Atmel Studio 6.2", "Atmel introduces the latest Xplained Mini development kit", "Develop and Debug Atmel applications in a single, integrated environment with Atmel-ICE", "Studio 6.2 support for the new Atmel-ICE probe provides advanced programming and debugs connectivity for Atmel ARM- and AVR-based MCUs, including the ability to capture data trace information", "Accelerate Your Time to Market with Percepio Trace™", and a list of features for Percepio Trace. On the right side, there are three video thumbnails: "Atmel Gallery Overview", "ASF Design (1 of 5): Starting with a board, XMEGA-A3BU Xplained", and "Atmel Studio training".

In the **Videos** tab the getting started videos (like editor, creating a new C (GCC) project, debugging AVR applications, debugging ARM® applications, etc.) can be found.

http://www.atmel.com/microsite/atmel_studio6/videos.aspx

3.3.3. Connecting the ATmega168PB Xplained Mini kit

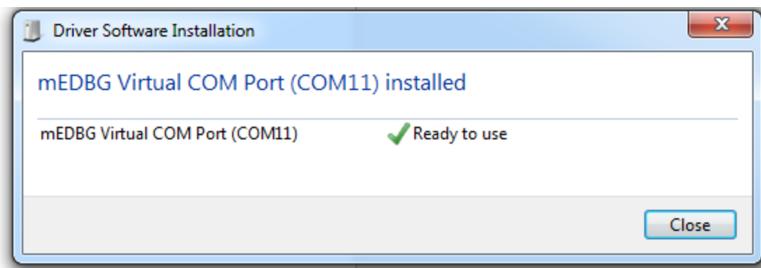
This section helps user to connect the ATmega168PB Xplained Mini with Atmel Studio 6.2.

1. Download and install [Atmel Studio](#) version 6.2 SP2 (6.2.1563) or later versions.
2. Launch Atmel Studio.
3. Connect the ATmega168PB Xplained Mini to the USB port and it will be visible in Atmel Studio.

3.3.3.1. Auto Board Identification of Xplained Mini Kit

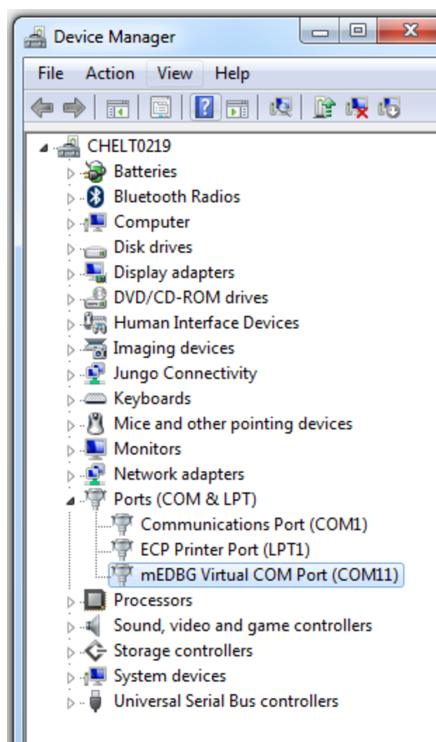
- Once the ATmega168PB Xplained Mini kit is connected to the PC, the Windows® Task bar will pop-up a message as shown in [Figure 3-4 ATmega168PB Xplained Mini Driver Installation](#) on page 10.

Figure 3-4 ATmega168PB Xplained Mini Driver Installation



- If the driver installation is proper, EDBG will be listed in the Device Manager as shown in [Figure 3-5 Successful mEDBG Driver Installation](#) on page 10

Figure 3-5 Successful mEDBG Driver Installation



- Open Atmel Studio 6.2, go to **View → Available Atmel Tools**. The EDBG should get listed in the tools as mEDBG and the tool status should display as "Connected". This indicates that the tool is communicating properly with the Atmel Studio.

Figure 3-6 mEDBG under Available Atmel Tools

Available Tools		X
Tools and Simulators	Status	
mEDBG (ATML2523010200000007)	Connected	
Simulator	Connected	

3.3.3.2. Connect the ATmega168PB Xplained Mini UART to the mEDBG COM Port

1. Connect the mEDBG USB to the PC.
2. Use the Device Manager to find the COM port number.
3. Default COM port settings are 9600 baud N 8 1. The COM port settings can be changed by using the Device Manager.

3.4. Programming and Debugging

This section helps to program and debug the ATmega168PBXplained Mini kit by using mEDBG.

3.4.1. Programming the ATmega168PB Xplained Mini by using mEDBG

1. Connect the mEDBG USB to the PC.
2. Go to the Atmel Studio: Click **Tools**, select **Device Programming**, and then select the connected mEDBG as **Tool with Device** as ATmega168PB and **Interface** as ISP, click **Apply**.
3. Select **Memories** and locate the source .hex or .elf file and then click **Program**.
4. If the source contains fuse settings, go to **Production file** and upload the .elf file and program the fuses.

Note: If ISP programming fails it could be because the debugWIRE is enabled. See [debugging section](#) on how to disable debugWIRE mode.

3.4.2. Debugging the ATmega168PB Xplained Mini by using mEDBG

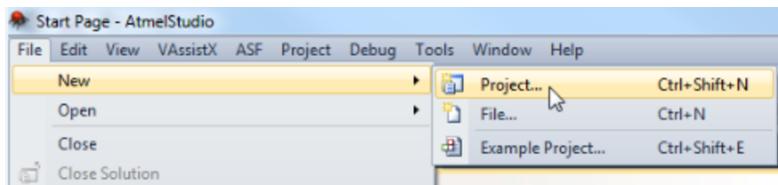
1. Start **Atmel Studio**.
2. Connect the mEDBG USB to the PC.
3. Open your project.
4. In the **Project** menu select the project properties page. Select the **Tools** tab and select mEDBG as debugger and debugWIRE as interface.
5. In the **Debug** menu click **Start Debugging and Break**.
6. Atmel Studio will display an error message if the DWEN fuse in the ATmega168PB is not enabled, click YES to make Studio set the fuse using the ISP interface.
7. A debug session is started with a break in main. Debugging can start.
8. When exiting debug mode select **Disable debugWIRE and Close** in the **Debug** menu, this will disable the DWEN fuse.

Note: If the debug mode is not exited by selecting **Disable debugWIRE and Close** in the **Debug** menu, the DWEN fuse will be enabled and the target will still be in debug mode, i.e. it will not be possible to program the target by using the SPI (ISP) interface.

4. Creating an Example Application in Atmel Studio

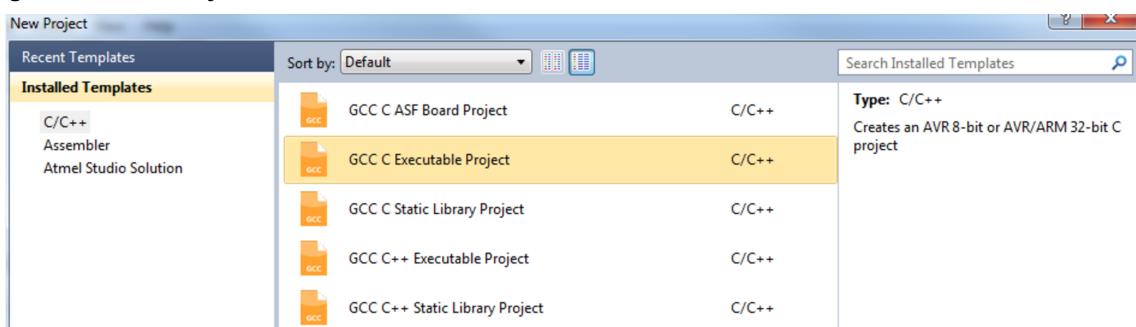
1. After connecting the board, to create a new project in Atmel Studio go to **File** → **New** and click on **Project** (as shown in [Figure 4-1 Creating New Project in Atmel Studio](#) on page 12).

Figure 4-1 Creating New Project in Atmel Studio



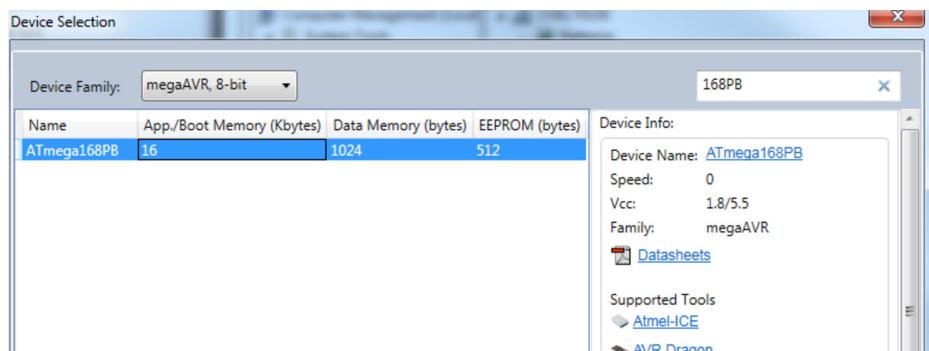
2. The New Project wizard will display as shown in [Figure 4-2 New Project Wizard](#) on page 12. Select the **GCC C executable Project** template, name the project and click **OK** to get the device selection wizard.

Figure 4-2 New Project Wizard



3. The Device Selection wizard will display as shown in [Figure 4-3 Device Selection Wizard](#) on page 12. Select the ATmega168PB device from megaAVR® device family and click **OK**.

Figure 4-3 Device Selection Wizard



4. The new project and the .c file will be created as shown in [Figure 4-4 Project Window](#) on page 13.

Add the following code snippet (LED control using push button) in the .c file.

```
int main(void) {
    /* configure LED pin as output */
    DDRB |= 1<<DDRB5;
    while(1) {
        /* check the button status (press - 0 , release - 1 ) */
        if(!(PINB & (1<<PINB7))) {
            /*switch off (0) the LED until key is pressed */
            PORTB &= ~(1<<PORTB5);
```

```

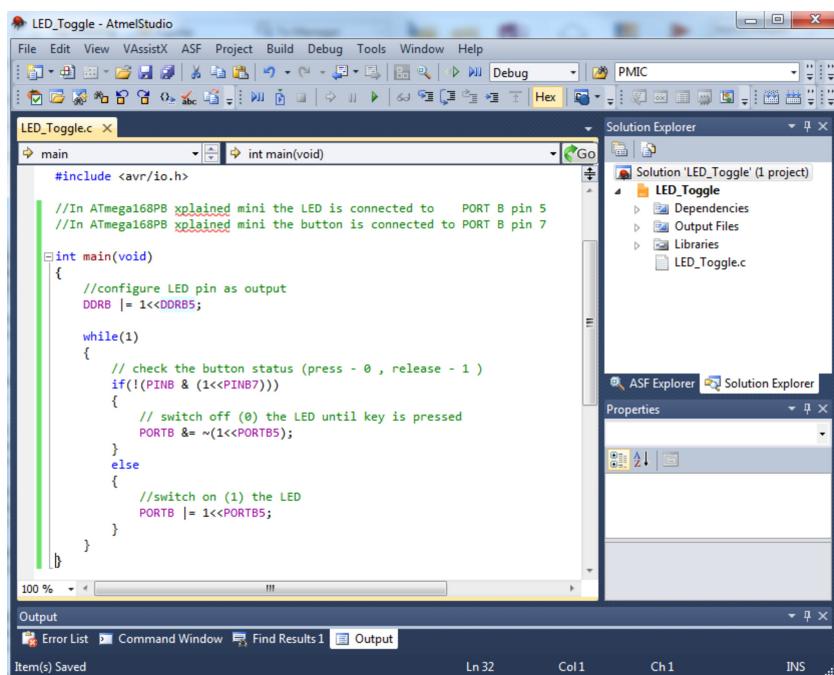
        } else {
            /* switch on (1) the LED*/
            PORTB |= 1<<PORTB5;
        }
    }
}

```

5. Code explanation:

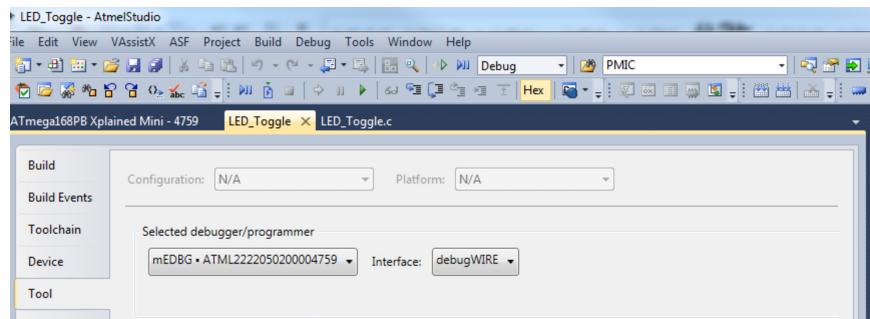
- Each PORT has three registers DDRx, PORTx, and PINx
- The DDRx register is used to configure the port pin direction. 1 - Output; 0 - Input.
- If one pin is configured as output pin and if the respective bit in PORTx is written logic one, the respective port pin is driven high. If the same bit is written logic zero, the pin will be driven low.
- The PINx register is used to return the logic level available on the port pin
- In this example code the PB7 Button is used as input and the PB5 LED0 as output
- Here the LED0 is controlled based on the pushbutton status
- As long the button is in pressed state (0) the LED0 will not glow (0)
- On releasing the button (1) the LED0 will glow (1 - default)

Figure 4-4 Project Window



6. In order to debug this project, configure the Tool and Interface in the Project properties. To open the project properties, go to **Project** menu → **Properties**. In the project properties, go to **Tool** tab → Under the **Selected Debugger/Programmer**, select the tool as mEDBG and interface as debugWIRE as shown in [Figure 4-5 Tool and Interface Settings](#) on page 14 Tool and Interface Settings.

Figure 4-5 Tool and Interface Settings



7. To program and execute the application, there are two options:
 - Start a debug session on the board, where the user will be able to program and debug
 - Program the generated .hex file into the controller and execute the application

Both these options can be configured on ATmega168PB Xplained Mini as shown in [Figure 4-6 Start without Debugging](#) on page 14 and [Figure 4-7 Start Debugging and Break](#) on page 14.

Figure 4-6 Start without Debugging

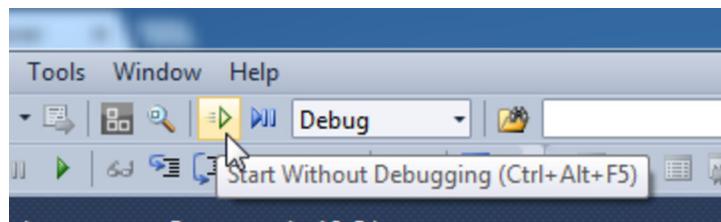
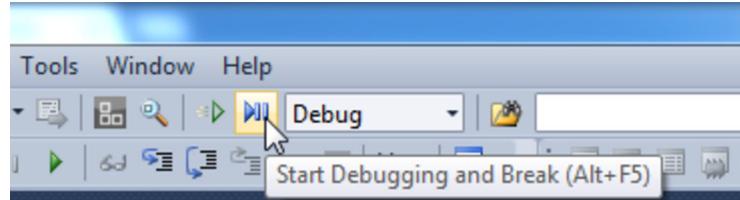


Figure 4-7 Start Debugging and Break



Note: If the debug mode is not exited by selecting **Disable debugWIRE** and **Close** in the **Debug** menu, the DWEN fuse will be enabled and the target will still be in debug mode, i.e. it will not be possible to program the target by using the SPI .

5. What's next?

- Atmel Studio videos

http://www.atmel.com/microsite/atmel_studio6/videos.aspx

- Atmel Studio online help

<http://www.atmel.com/webdoc/atmelstudio/>

- Atmel Studio offline help (After installing Atmel Studio)

In Atmel Studio

Help → View Help (Ctrl+F1) → Atmel Studio

- ASF (Atmel Software framework) Getting Started and ASF Reference manual

<http://www.atmel.com/tools/AVRSOFTWAREFRAMEWORK.aspx?tab=documents>

- ASF online documentation

<http://ASF.atmel.com/docs/latest/>

- Technical documentation for various products

<http://www.atmel.com/webdoc/>

- Atmel Gallery

<https://gallery.atmel.com/>

- Production Selection Guide

Atmel MCU Selector on <http://www.atmel.com/>

- Ordering Samples and Buying evaluation board and kits:

<http://www.atmel.com/> → Buy → 'Atmel store'

- Technical Documentation

<http://www.atmel.com/design-support/documentation/default.aspx>

- Knowledge Base and Technical Support/Design Support

<http://www.atmel.com/design-support/>

- Collaborative workspace

<http://spaces.atmel.com>

- AVR Freaks® community

<http://www.avrfreaks.net/>

6. Revision History

Doc. Rev.	Date	Comments
42422B	08/2015	Added the content related with ATmega48PB and ATmega88PB device.
42422A	03/2015	Initial document release.



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