Atmel AVR 8-bit Microcontrollers

AT12075: ATmega328PB Xplained Mini Demo

APPLICATION NOTE

Introduction

This application note describes how to control the brightness of LED (USER LED on the ATmega328PB Xplained Mini kit) by using the Peripheral Touch Controller (PTC) module of the Atmel® AVR® ATmega328PB device. The PTC module is used for position sensing of the capacitive touch slider present on the Xplained Mini kit. The slider position is used to vary the PWM duty cycle hence control the brightness of the USER LED. The source code is available for download along with this application note. An ATmega328PB Xplained Mini kit is used to demonstrate the application.

Features

- Low-power, high-sensitivity, environmentally robust capacitive touch buttons, sliders, wheels, and proximity sensing
- Minimal external components

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1. Abbreviation

COM	Communication Port
GPIO	General Purpose Input/Output Pins
ITO	Indium Tin Oxide
IDP	Integrated Development Platform
LED	Light Emitting Diode
MCU	Micro Controller Unit
mEDBG	Mini Embedded Debugger
PC	Personal Computer
PCB	Printed Circuit Board
PTC	Peripheral Touch Controller
PWM	Pulse Width Modulation
USB	Universal Serial Bus

2. Pre-requisties

The solution discussed in this document requires:

- Atmel Studio 7.0 or later
- ATmega328PB Xplained Mini kit
- Example Source Code available for download with this application note

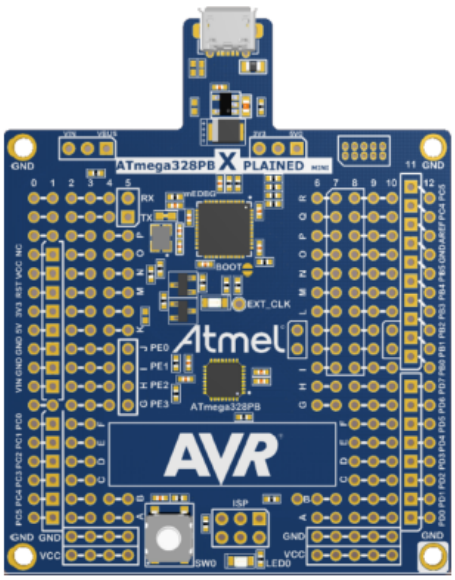
3. ATmega328PB Xplained Mini

3.1. Board Overview

The ATmega328PB Xplained Mini evaluation kit is a hardware platform to evaluate the Atmel ATmega328PB microcontroller. The evaluation kit comes with a fully integrated debugger that provides seamless integration with Atmel Studio 6.2 (and later version). The kit provides access to the features of the ATmega328PB enabling easy integration of the device in a custom design.

For more details about this kit, refer the Atmel ATmega328PB Xplained Mini user guide available at http://www.atmel.com/Images/Atmel-42469-ATmega328PB-Xplained-Mini_User-Guide.pdf

Figure 3-1. ATmega328PB Xplained Mini Kit



3.2. Enumeration and Detection

When the ATmega328PB Xplained Mini kit is connected to the PC, Windows will enumerate the device and install appropriate driver. If the driver installed successfully, mEDBG will be listed in the Device Manager as mEDBG Virtual COM port under Ports as shown in the following screenshots.

Figure 3-2. Tool Enumeration

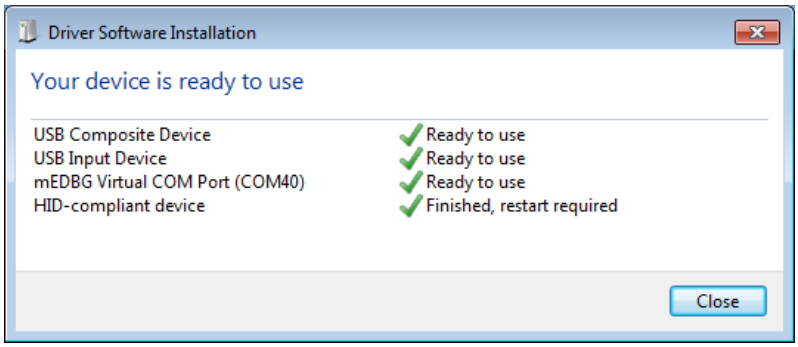
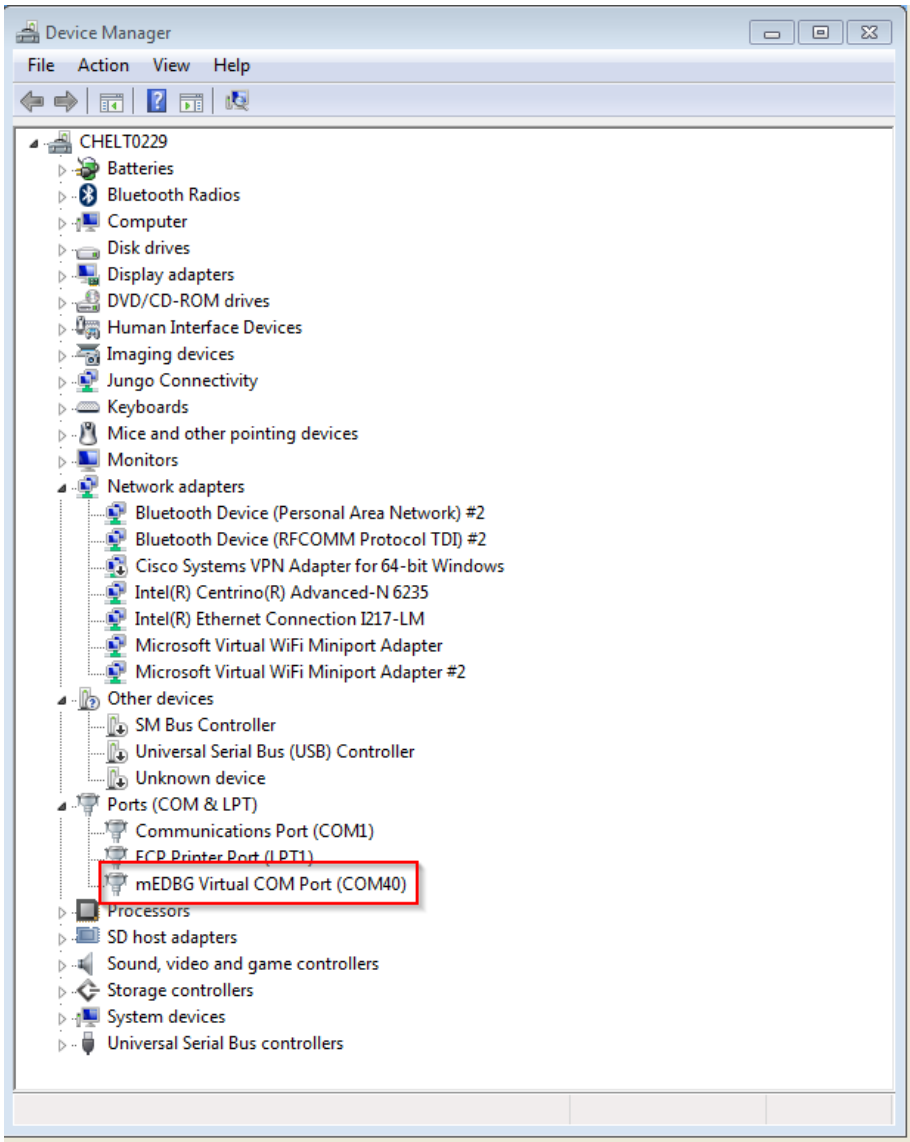


Figure 3-3. Successful mEDBG Driver Installation



4. PTC - Peripheral Touch Controller

4.1. Overview

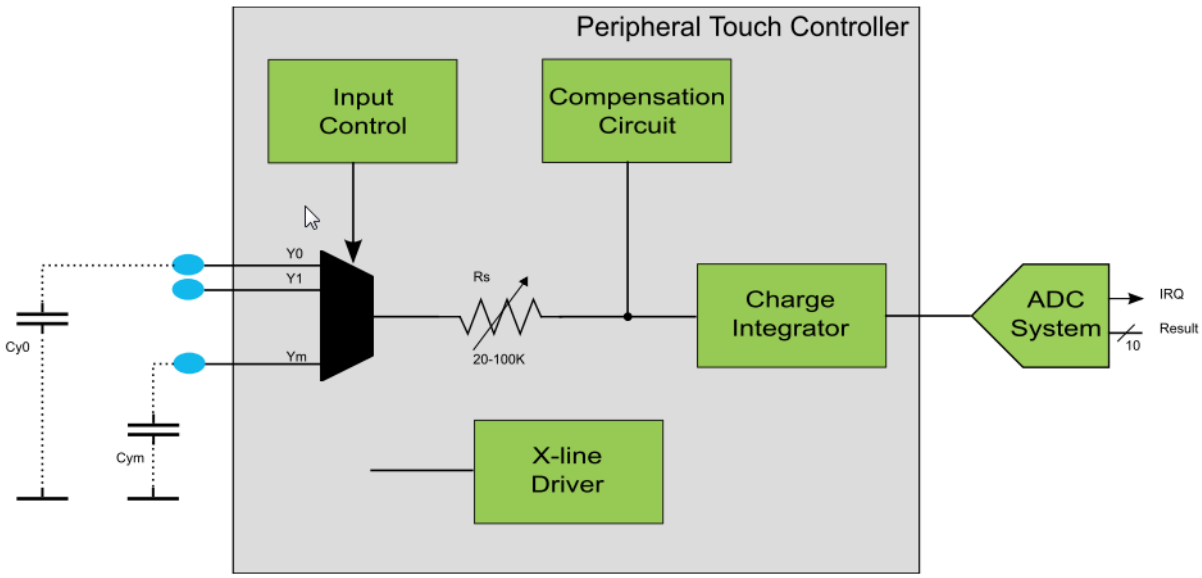
Atmel QTouch® Peripheral Touch Controller (PTC) offers built-in hardware for capacitive touch measurement on sensors that function as buttons, sliders, and wheels. The PTC supports both mutual and self-capacitance measurement without the need for any external component. It offers high sensitivity and noise tolerance, as well as self-calibration, and minimizes the sensitivity tuning effort by the user.

The PTC is intended for autonomously performing capacitive touch sensor measurements. The external capacitive touch sensor is typically formed on a PCB, and the sensor electrodes are connected to the analog charge integrator of the PTC using the device I/O pins. The PTC supports mutual capacitance sensors organized as capacitive touch matrices in different X-Y configurations, including Indium Tin Oxide (ITO) sensor grids. In mutual capacitance mode, the PTC requires one pin per X-line (drive line) and one pin per Y-line (sense line). In self-capacitance mode, the PTC requires only one pin with a Y-line driver for each self-capacitance sensor.

This application note uses self-capacitance mode to detect touch on capacitive sensors.

For more details on the PTC module, refer the ATmega328PB datasheet.

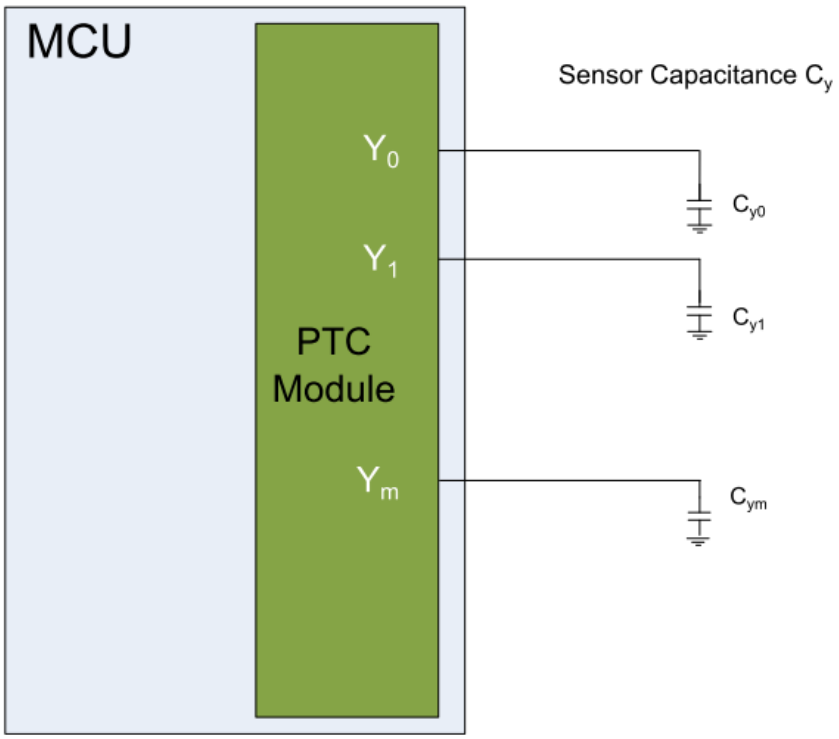
Figure 4-1. PTC Block Diagram Self-capacitance



4.2. Self-capacitance Sensor Arrangement

The self-capacitance sensor is connected to a single pin on the Peripheral Touch Controller through the Y electrode for receiving the signal. The sense electrode capacitance is measured by the Peripheral Touch Controller.

Figure 4-2. Self-capacitance Sensor Arrangement

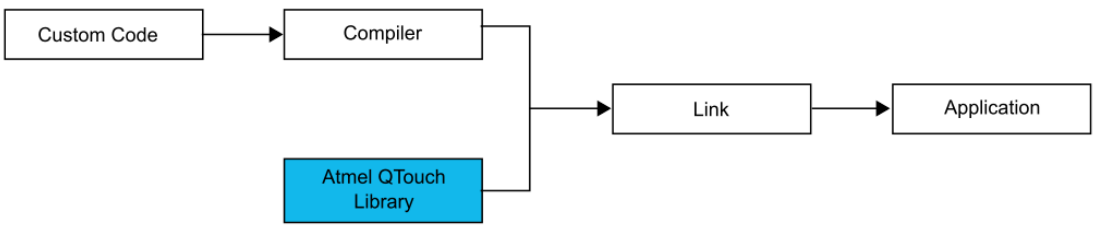


For more information about designing the touch sensor, refer to Buttons, Sliders, and Wheels Touch Sensor Design Guide on http://www.atmel.com.

4.3. Functional Description

In order to access the PTC, the user must use the QTouch Composer tool to configure and link the QTouch Library firmware with the application code. QTouch Library can be used to implement buttons, sliders, wheels, and proximity sensor in a variety of combinations on a single interface.

Figure 4-3. QTouch Library Usage



For more information about QTouch Library, refer to the Atmel QTouch Library Peripheral Touch Controller User Guide available at http://www.atmel.com/images/atmel-42195-qtouch-library-peripheral-touch-controller_user-guide.pdf.

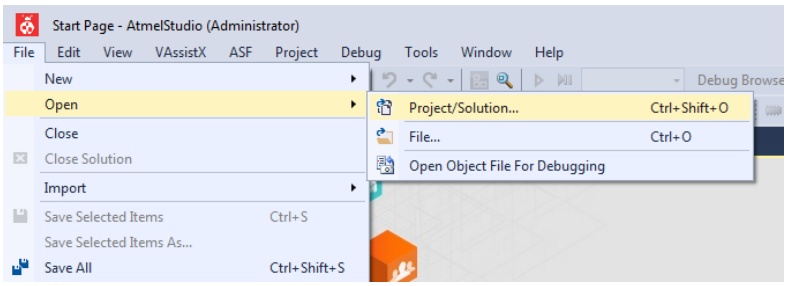
5. Demo Project

The demo code associated with this application note is available as compressed zip file in Atmel Website.

To load the code in the Atmel Studio,

1. Extract the zip file to get the project and associated source code.
2. Start Atmel Studio, go to **File** > **Open** and click on **Project/Solution**. The shortcut key is (CTRL + Shift + O).

Figure 5-1. Opening Example Project in Atmel Studio



3. **Open Project** Dialog box will appear.
4. Select the Example project solution file (`.atsln`) and click **Open**.
5. Alternate method is to double click the (`.atsln`) file from the extracted folder, this action will start Atmel Studio and then load the project.

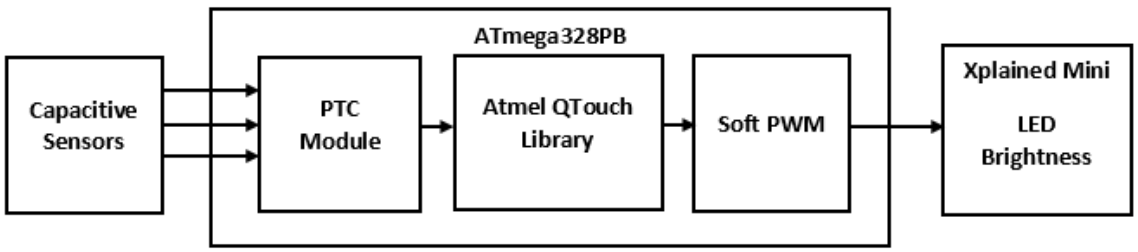
5.1. Application Overview

The demo application consists of following two components:

1. The Atmel QTouch Library.
2. The demo code which controls the duty cycle of timer based software PWM.

The QTouch Library is used by the Demo application to sense capacitive touch slider position using built-in hardware capacitive touch sense module (PTC), the application uses this slider position to vary the duty cycle of the software PWM, which controls the brightness of the USER LED connected to PORT PB5. For more details, refer section Software PWM on page 9.

Figure 5-2. Application Block Diagram



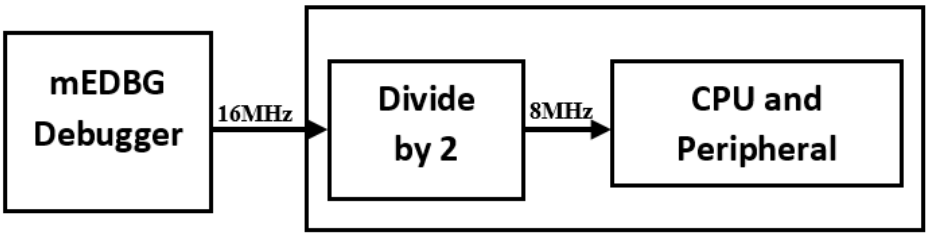
5.1.1. Software PWM

PWM waveform generated using manual setting/clearing of GPIO in periodic manner using a Timer is called software PWM.

5.2. Configuration

The ATmega328PB Xplained Mini board contains an on-chip mEDBG debugger(ATmega32U4) which provides 16MHz clock to the target ATmega328PB device. The target device prescales it by 2 to generate 8MHz device clock.

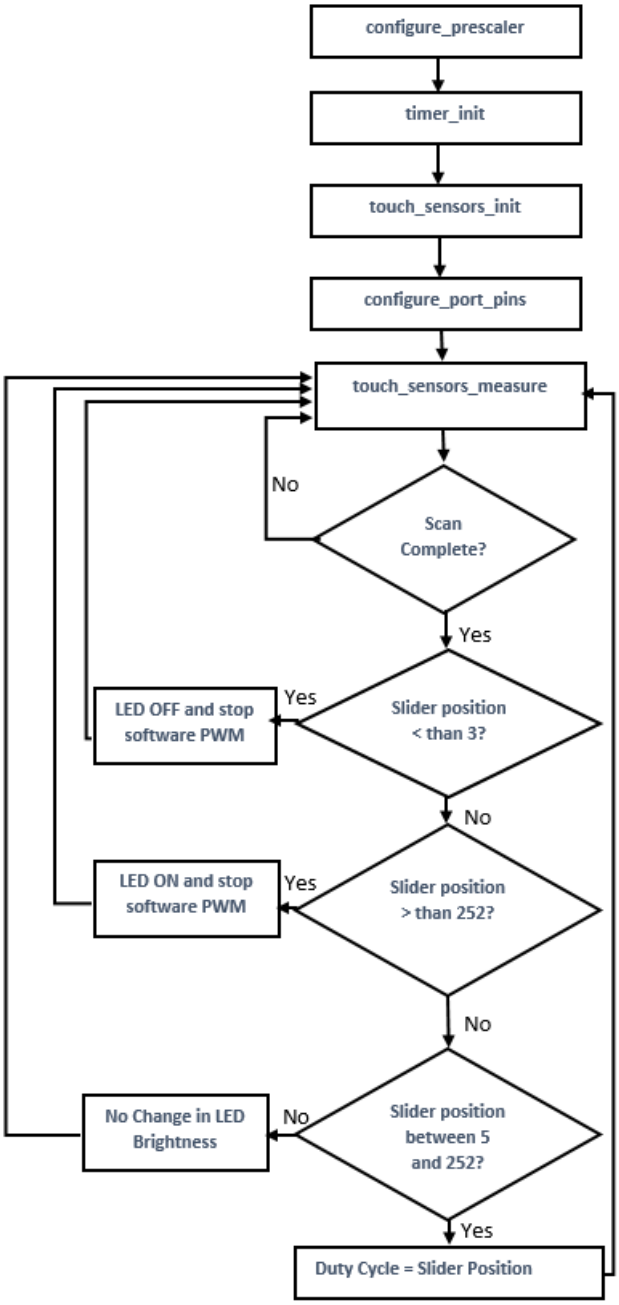
Figure 5-3. Clock Configuration



The modules used by this demo application are:

- **Timer0:** Used to generate Software PWM output on GPIO to control LED brightness.
- **Timer2:** Used to time the QTouch Library.
- **PTC:** Used to scan capacitive touch sensors.

5.3. Flowchart



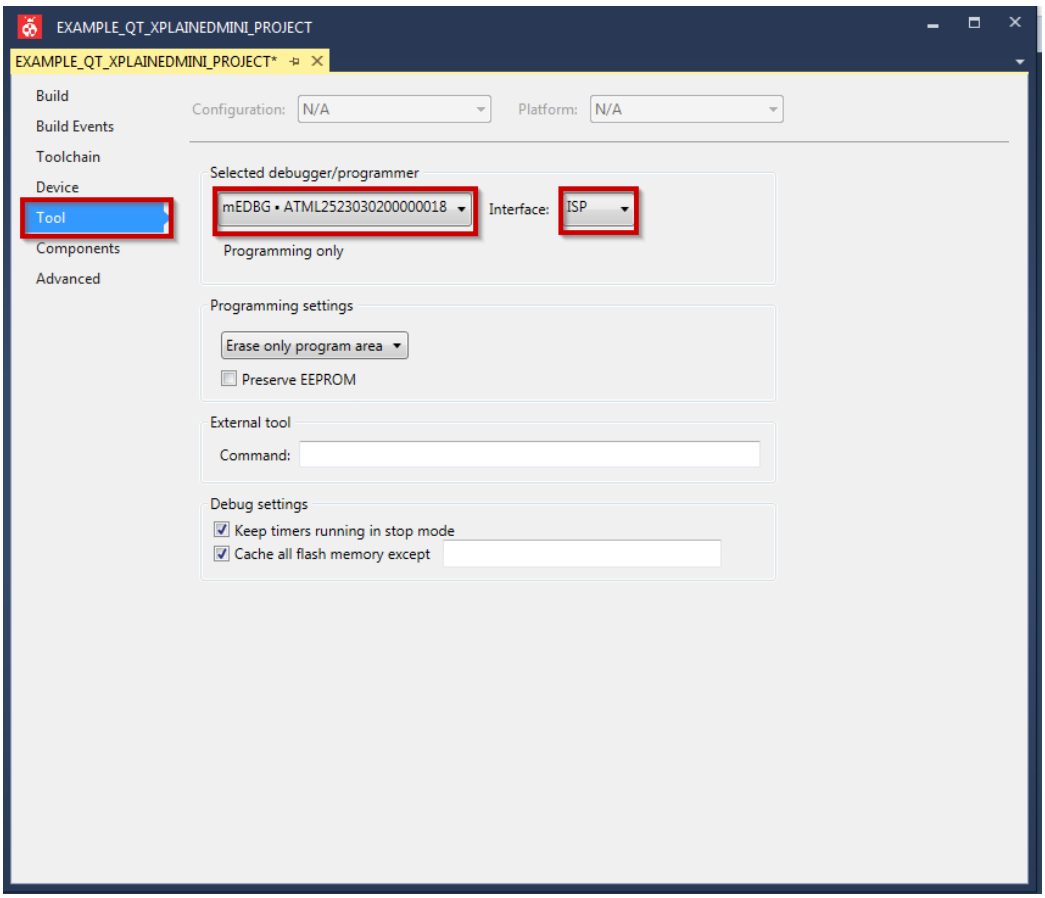
- **configure_prescaler:** This function configures the prescaler to divides the 16MHz clock provided by the mEDBG debugger by 2 to generate 8MHz system clock.
- **timer_init:** Initializes Timer0 for software PWM and Timer2 for timing QTouch Library.
- **touch_sensors_init:** Initializes QTouch library and configures touch sensors.
- **configure_port_pins:** Configures USER LED pin as output.
- **touch_sensors_measure:** Measures the capacitive touch sensors.

5.4. Downloading and Executing the Application

The firmware corresponding to this application note is available at www.atmel.com. The following steps will explain how to program and execute this application.

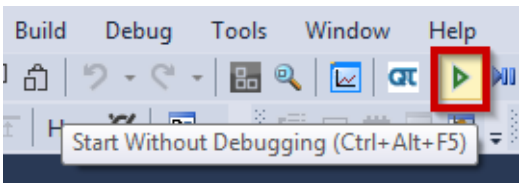
1. Open the project in Atmel Studio and compile it. Refer section Demo Project on page 9 for more information on how to open the solution in Atmel Studio.
2. To program the target device, go to **Project > Project Properties**>**Tools** tab. Select the tool as **mEDBG** and interface as **debugWire** as shown in the following image.

Figure 5-4. Tool and Interface Configuration for Programming



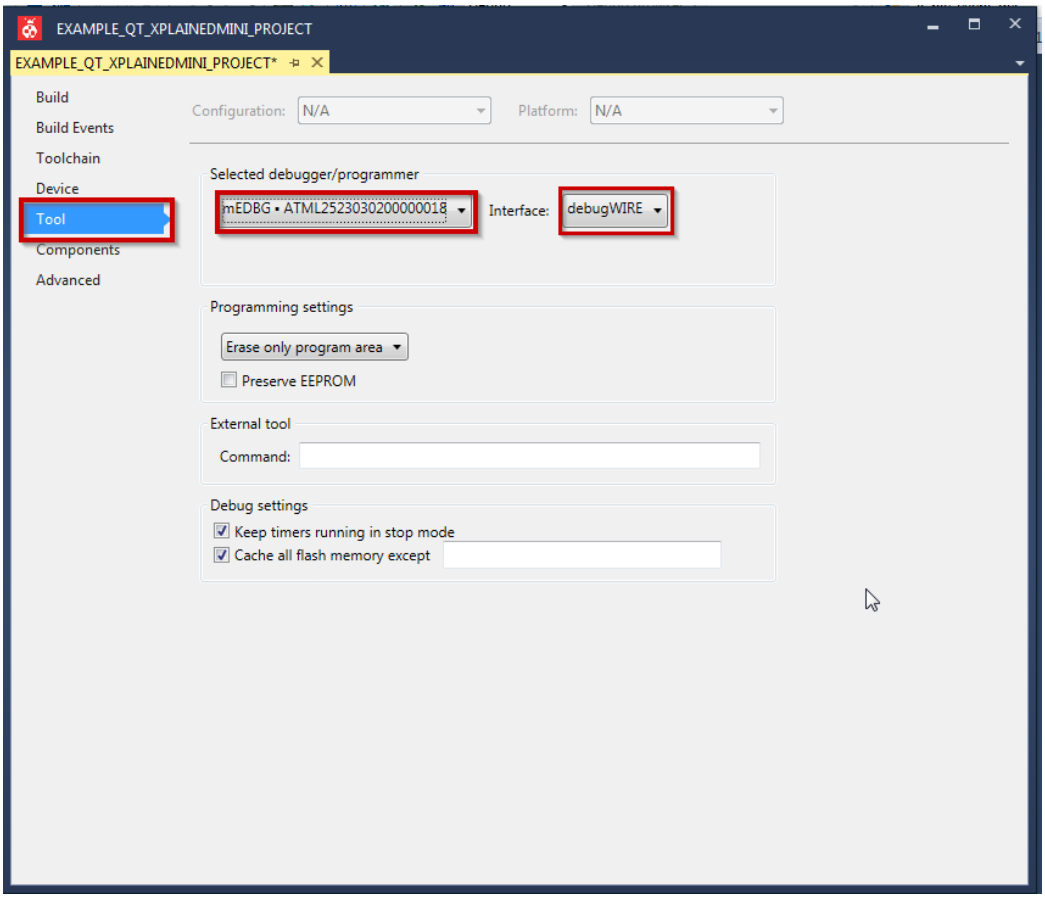
3. To begin programming, click **Start Without Debugging** in the toolbar as shown in the following image.

Figure 5-5. Programming the Device



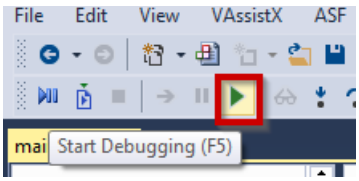
4. To debug the code, go to **Tools** tab. Select **mEDBG** as Debugger/Programmer with **debugWire** Interface as in shown in the following image.

Figure 5-6. Tool and Interface Configuration for Debugging



5. To start debugging, click **Start Debugging** in the toolbar as shown in the following image.

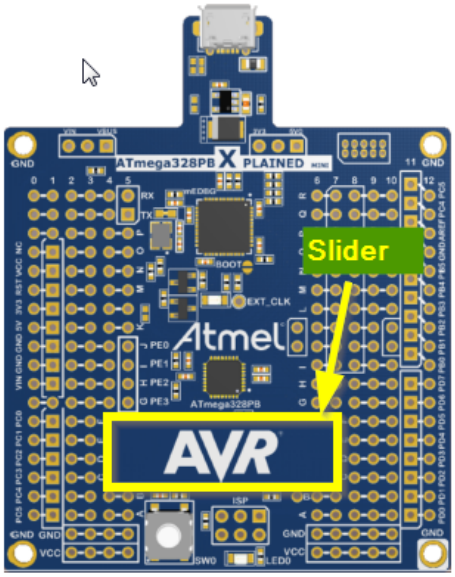
Figure 5-7. Debugging the Device



5.5. Procedure and Result

When the application is programmed in to the device in Xplained Mini kit, slowly slide the finger on the capacitive touch slider and the brightness of the LED will increase when sliding slowly from left to right and brightness will decrease when sliding right to left.

Figure 5-8. Slider Location in ATmega328PB Xplained Mini kit



6. References

- Atmel QTouch Library Peripheral Touch Controller User Guide (http://www.atmel.com/images/atmel-42195-qtouch-library-peripheral-touch-controller_user-guide.pdf)
- ATmega328PB datasheet (http://www.atmel.com/devices/ATMEGA328PB.aspx)
- ATmega328PB Xplained Mini kit (http://www.atmel.com/tools/MEGA328PB-XMINI.aspx)

7. Revision History

Doc Rev.	Date	Comments
42652A	02/2016	Initial document release.

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Atmel Corporation 1600 Technology Drive, San Jose, CA 95110 USA **T:** (+1)(408) 441.0311 **F:** (+1)(408) 436.4200 | **www.atmel.com**

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