APPLICATION NOTE

AT08801: Single Key Configurator - User Guide

Atmel QTouch

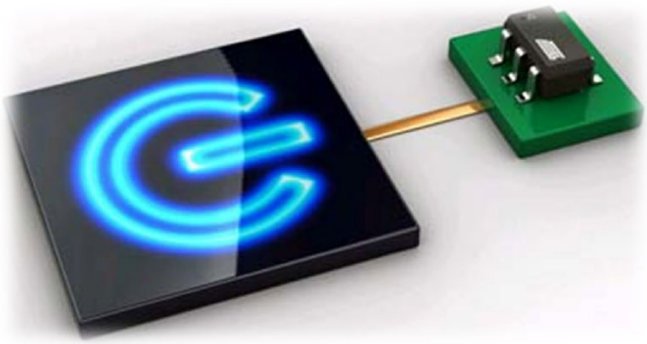
Features

- Single QTouch® key configuration
- QTouch and QTouchADC acquisition methods
- Operating modes (ON/OFF, Toggle, Debug)
- Discrete output pin configuration
- Configure sensor specific and global parameters
- Support for touch data streaming

Description

Atmel® offers single key QTouch solutions the form of application specific devices such as AT42QT1010, AT42QT1011, and AT42QT1012. These devices are configured for fixed settings and can meet the requirements of most applications for single touch key.

The Single Key Configurator Tool has been designed to support user configurable settings. The tool is capable of generating a binary file (Hex format) based on the selected configuration. The user can program the generated .hex file into the Atmel ATtiny10 device to have a customized single QTouch key solution suited for their end application. This document describes the different features, operating modes, and configurable parameters supported by the Single Key Configurator Tool. The tool is designed to support ATtiny10 devices only. The Single Key Configurator Tool is available in Atmel QTouch Library 5.0 release.



Contents

1 Single Key Configurator Tool

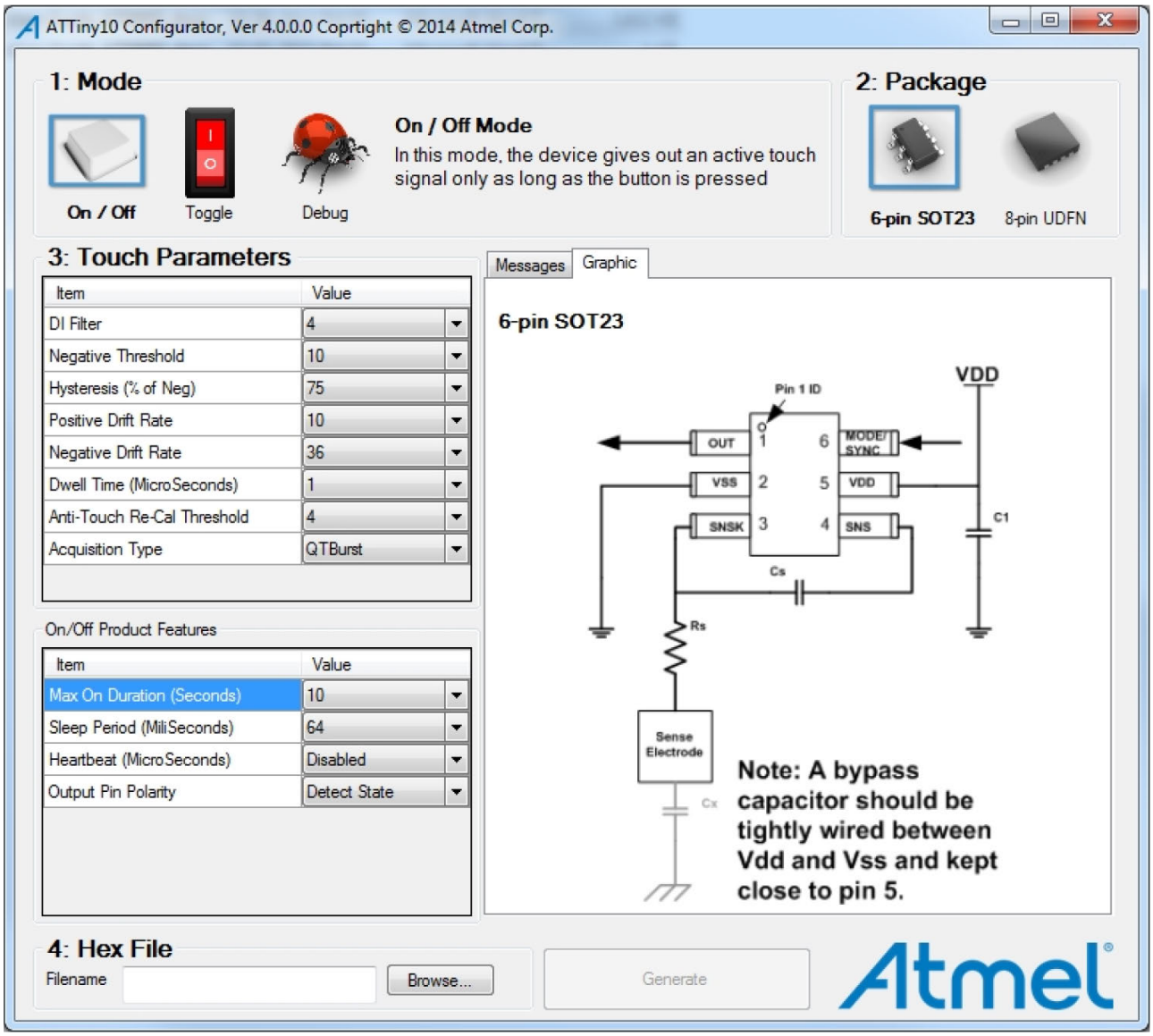
The Single Key Configurator Tool for ATtiny10 devices supports three modes of operation:

- On/Off mode
- Toggle Mode
- Debug Mode

The Single Key Configurator Tool can be set in any of the above three modes by clicking and selecting the appropriate “Mode” in the GUI.

The On/Off and Toggle modes provides several ways of configuring device output state to a sensor detect event. Debug mode supports streaming of touch data and sensor status information.

Figure 1-1. Single Key Configurator Tool View



The Single Key Configurator Tool consists of several configurable parameters. They are available under QTouch Parameters and Product Features option. QTouch Parameters consist of sensor specific and global parameters related to the touch acquisition mechanism. Product Features consists of parameters which are specific to the mode of operation and have no relation to touch acquisition.

More description about the modes and sensor configurable parameters are provided in the following sections.

After downloading the QTouch Library 5.0, you can choose to install it in any convenient location on your system. You can find the Single Key Configurator tool in the following location *Atmel_QTouch_Libraries_5.0* > *Atmel_QTouch_Libraries_5.0* > *Device_Specific_Libraries* > *AVR_Tiny_Mega_XMEGA* > *ATtiny10*

1.1 On/Off Mode

In the On/Off mode, the device output will remain Active High/Active Low (depending upon output pin polarity) for the duration of the touch detection. In the On/Off mode, the appropriate acquisition method has to be selected from the “Acquisition Type” menu under QTouch Parameters to support a single QTouch key or QTouchADC key.

QTouch and QTouchADC are two different capacitive touch acquisition methods from Atmel. Both methods are of self-capacitance type but differ in the way the charge transfer takes place.

The QTouch method works on the principle of charge transfer. This uses a switched capacitor technique to assess relative changes in a sensor’s capacitance as it is touched. Charge transfer works by applying a voltage pulse in series connection of the sensor capacitance Cx and sampling capacitor Cs. By repeating the pulse multiple times, a high resolution technique is realized that can detect changes in capacitance.

The QTouchADC method is implemented by oversampling a standard ADC and requires only one pin per channel. This method works by sharing charge between the ADC’s internal sample and hold capacitor and the sensor capacitance Cx.

Table 1-1. Differences between QTouch and QTouchADC

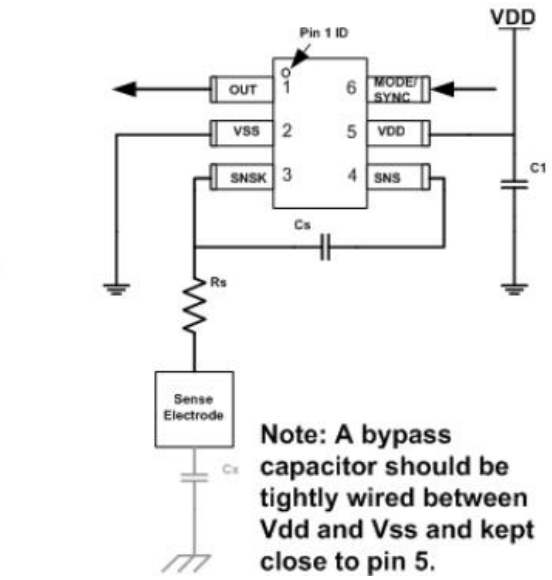
	QTouch	QTouchADC
Number of pins per channel	2	1
MCU peripheral used	GPIO	ADC
Sampling capacitor (Cs)	External	Internal
Sensitivity tuning	Depends on Cs value placed in the hardware	Depends on Oversampling and Scaling values in firmware
Signal value on touch	Decreases	Increases

The Single Key Configurator tool describes the pin-out and circuit for QTouch and QTouchADC methods under the Graphic window. User can select the appropriate package type, either 6-pin SOT23 or 8-pin UDFN.

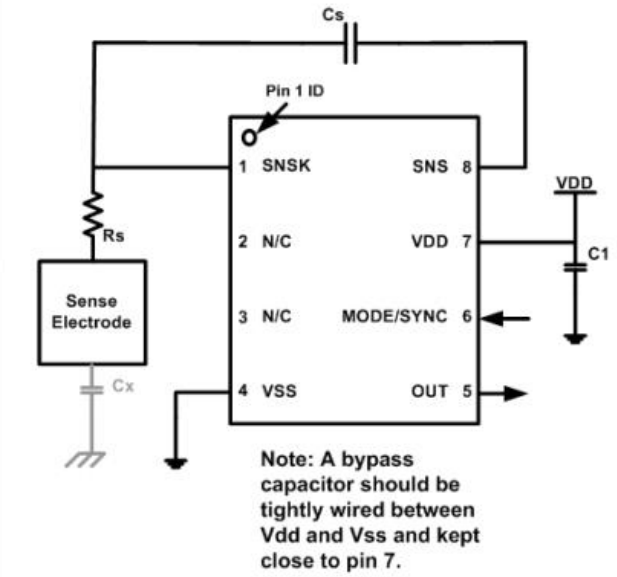
Figure 1-2. ATtiny10 Pin Configuration

QTouch Method

6-pin SOT23

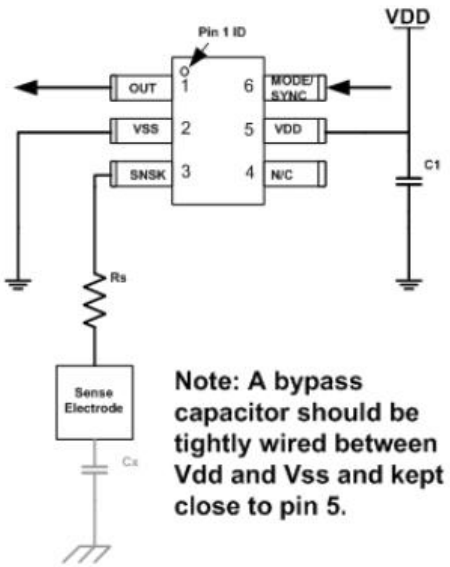


8-pin UDFN

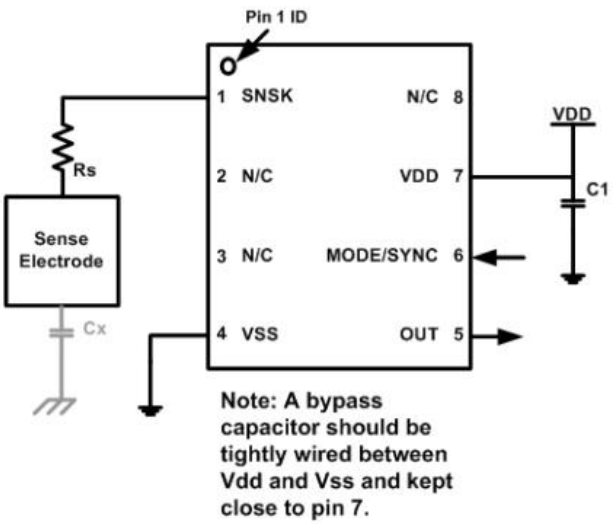


QTouchADC Method

6-pin SOT23



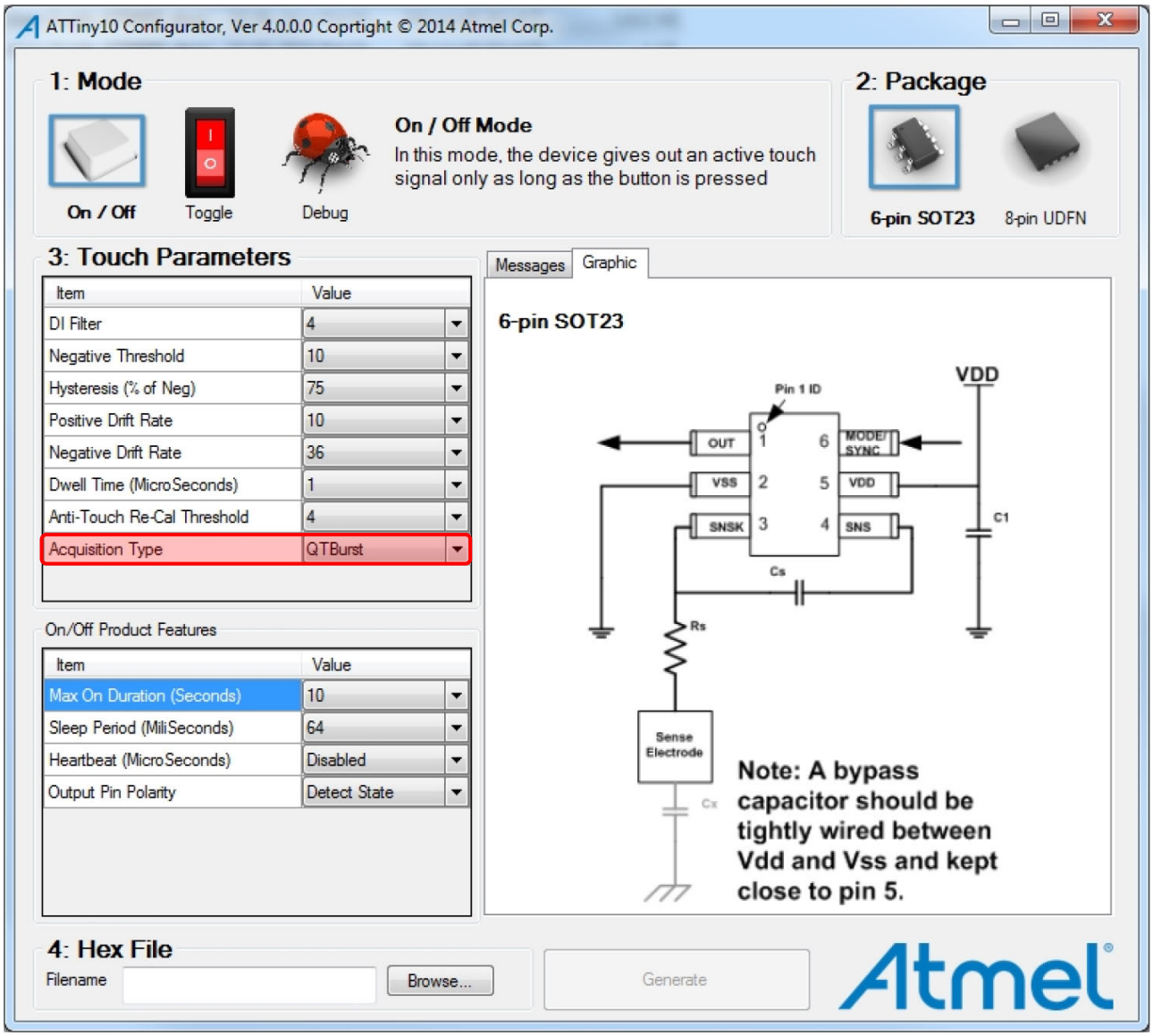
8-pin UDFN



1.1.2 QTouch Key Configuration

Selecting the *QTBurst* option in “Acquisition Type” menu allows configuration of the QTouch key.

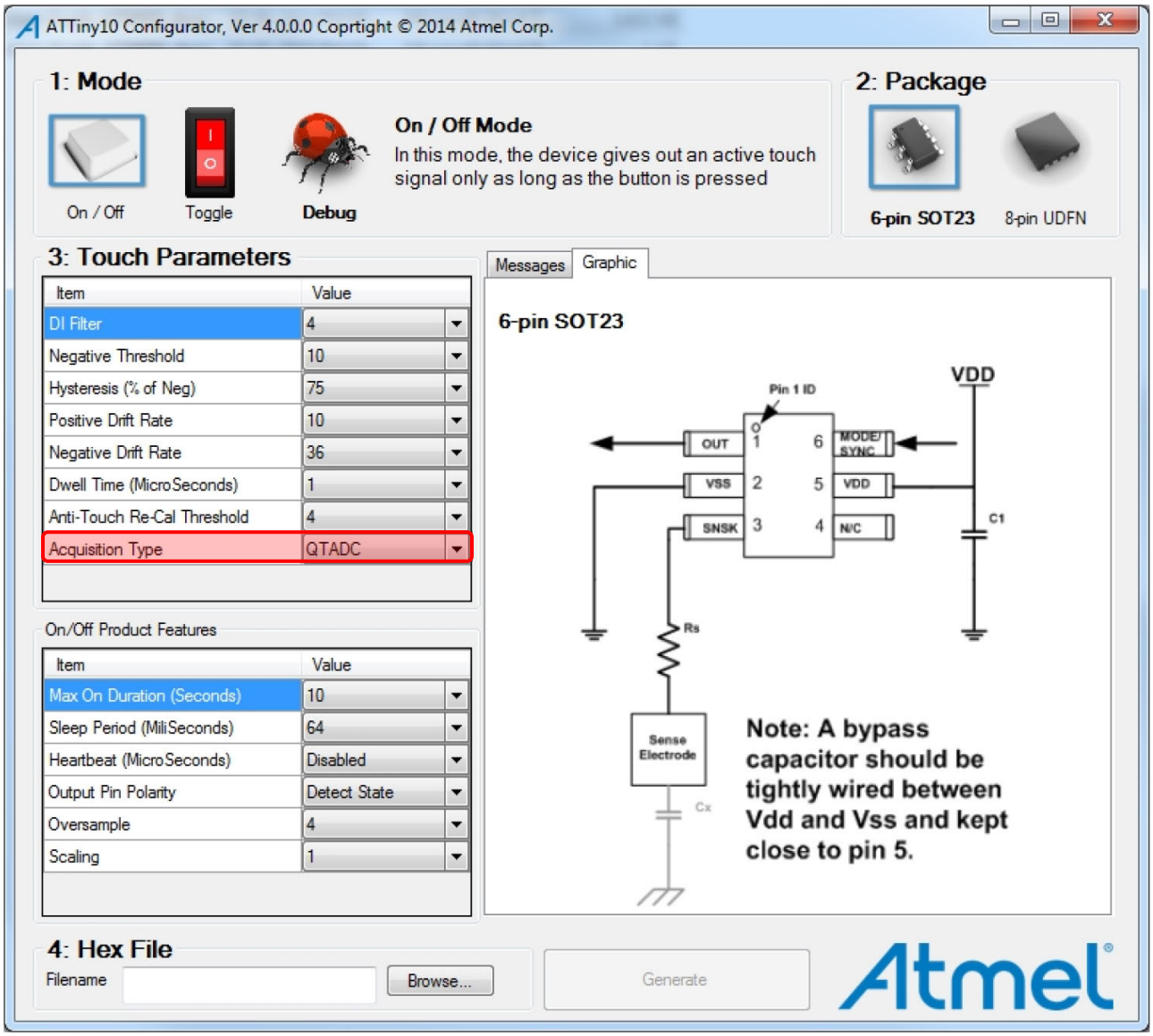
Figure 1-3. On/Off Mode – QTouch Method



1.1.3 QTouchADC Key Configuration

Selecting the *QTADC* option in “Acquisition Type” menu allows configuration of the QTouchADC key.

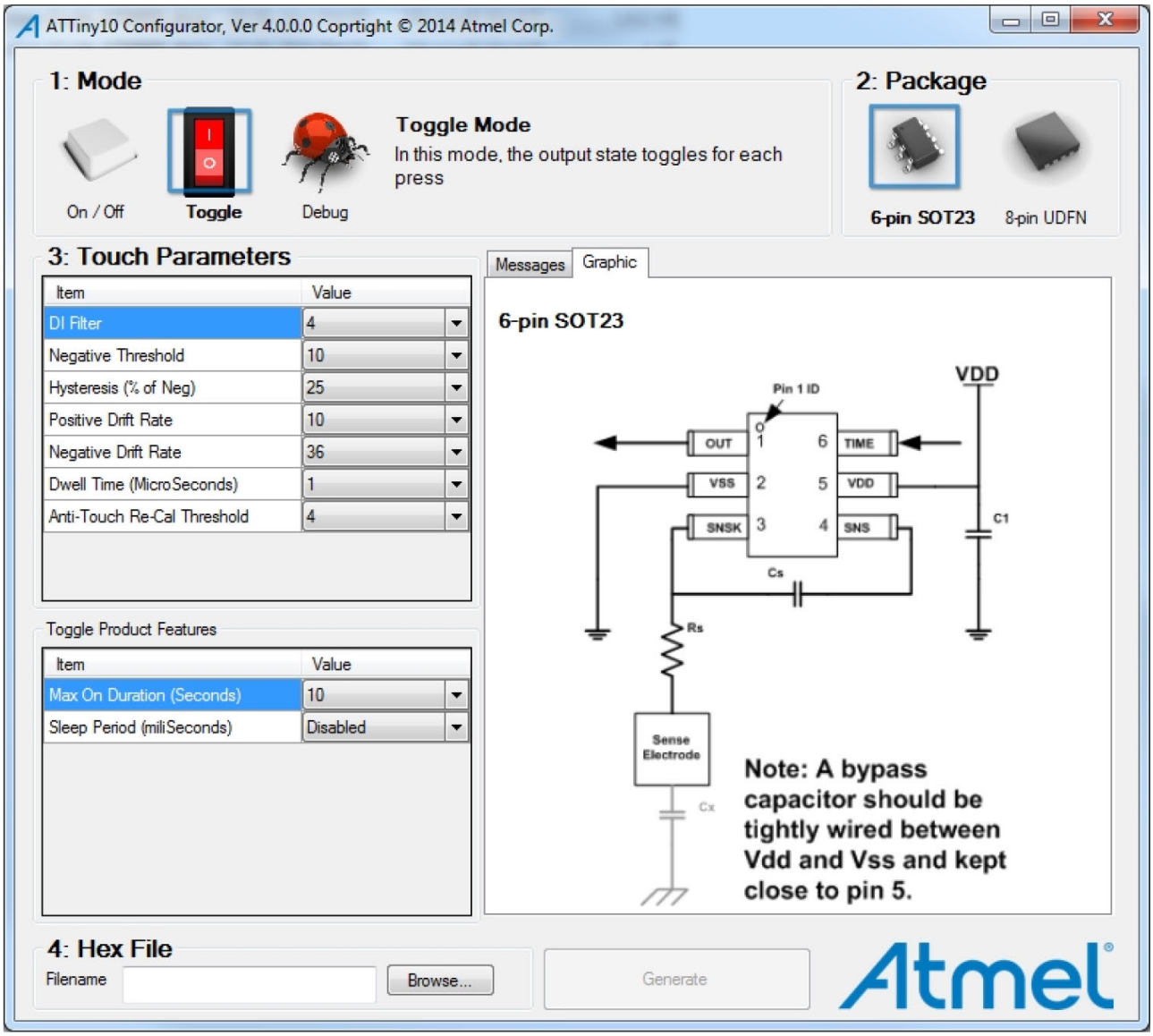
Figure 1-4. On/Off Mode – QTouchADC Method



1.2 Toggle Mode

In toggle mode, the device output status toggles between Active High and Active Low for each touch detection. The toggle mode supports configuration of a single QTouch key only.

Figure 1-5. Toggle Mode

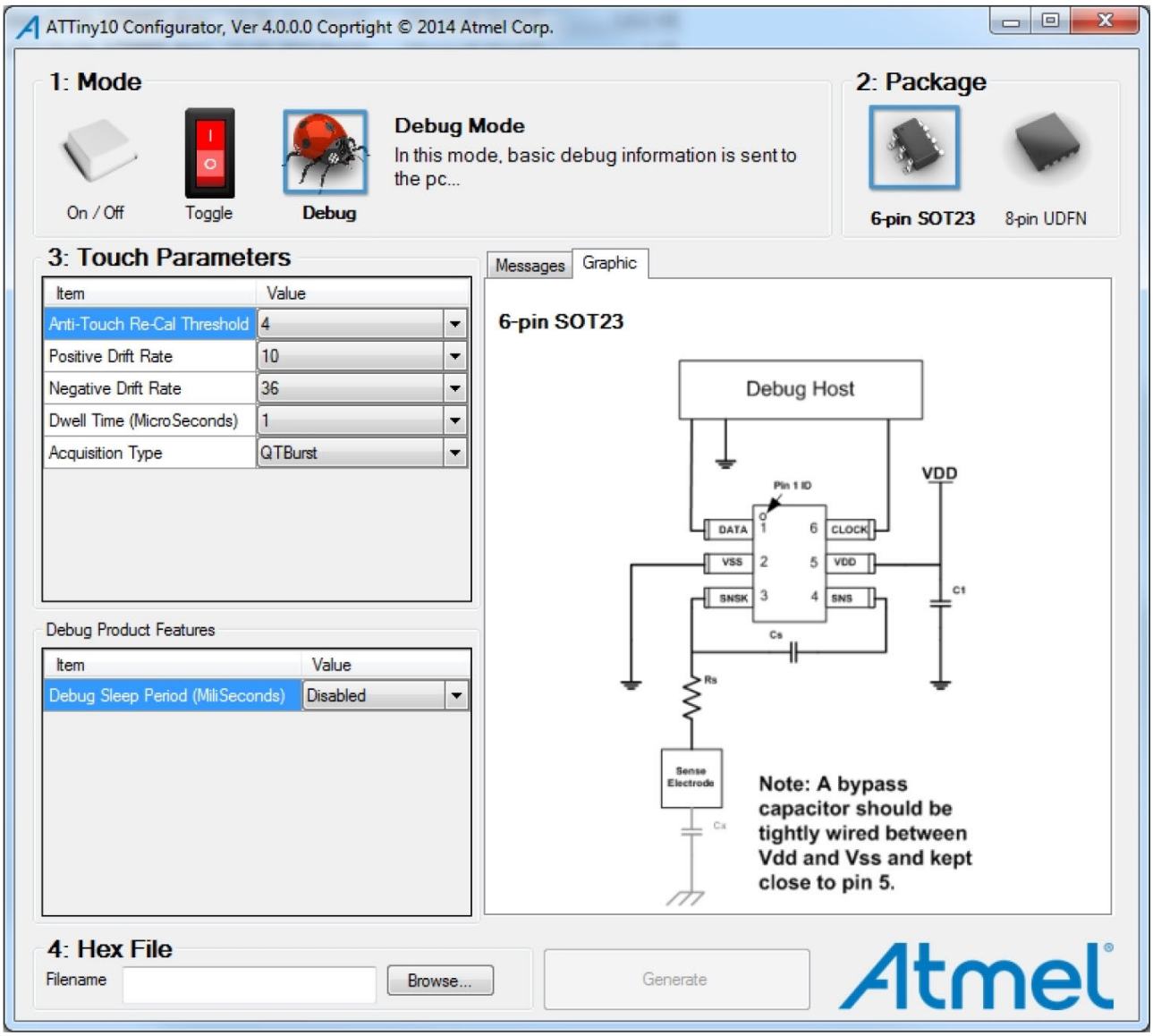


1.3 Debug Mode

The Single Key Configurator Tool includes a debug mode which may be used for observing several internal operating variables in real-time. The debug interface provides a useful aid during the product development and uses two pins, one for clock and one for data, to stream data out of the part.

In the debug mode the device can be configured to stream touch data for either QTouch or QTouchADC key configuration. The signal, reference, and delta values can be sent using the one-way Bit-Bang SPI interface. It is possible to transmit this touch data using an USB bridge interface to PC.

Figure 1-6. Debug Mode



IMPORTANT

In debug mode, RESET pin (Pin PB3) would be used as debug clock pin. So it has to be configured as I/O pin. To configure RESET pin as I/O pin, CHECK the RSTDISBL option in device fuse settings. Refer to Chapter 5 Device Programming for details.

1.3.2 Description of the Debug Interface

In the Debug mode 13 bytes of data is sent by the MCU in a frame. Each frame is transmitted after a key scan. This data provides the real-time signal measurements occurring in the device. This mode is useful to analyze and tune sensitivity of the touch system. The details of the data transmitted are provided in Table 1-2 and Table 1-3.

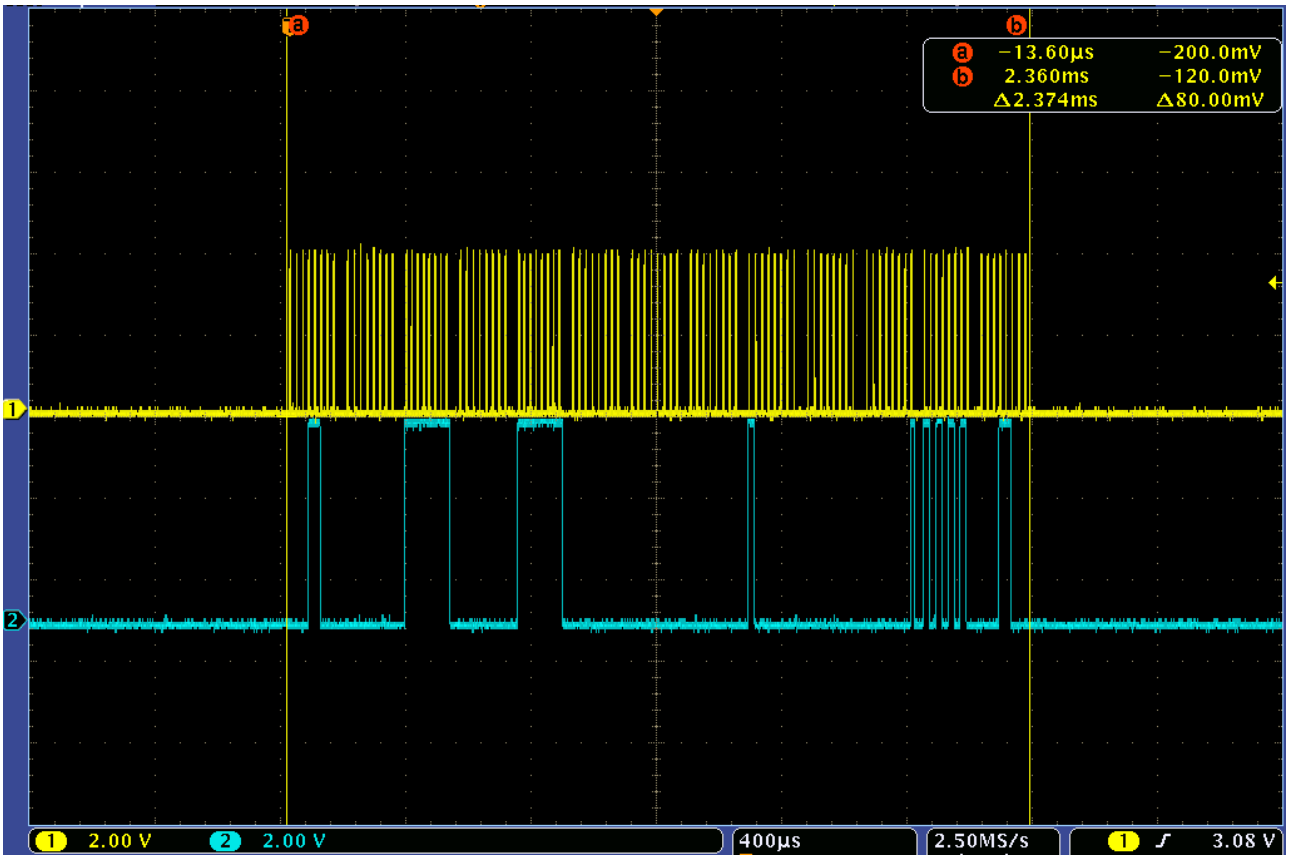
Table 1-2. Debug Interface Details

Interface Element	Description
Debug clock output	Pin 6 - PB3 (DBG CLK)
Debug data output	Pin 1 – PB0 (DBG DATA)
Data valid	Clock High
Data changing	Clock Low
Clock frequency	Approximately 500kHz
Blank time between byte transmissions	40µs
Frame transmission time	2.4ms
Frame length	13 bytes
Byte transmission order	Most Significant Bit (MSB) First

Table 1-3. Debug Output Data Frame

Frame Byte #	Data Type	Description of Data Byte
0	unsigned 8-bit	Time-stamp
1	unsigned 16-bit	Current Signal for the key_H
2		Current Signal for the key_L
3	unsigned 16-bit	Reference Signal for the key_H
4		Reference Signal for the key_L
5	signed 16-bit	Signal Delta for the key_H
6		Signal Delta for the key_L
7	unsigned 8-bit	SW_Timer_H
8	unsigned 8-bit	SW_Timer_L
9	unsigned 8-bit	Detect Integration
10	unsigned 8-bit	Detect State
11	unsigned 8-bit	Burst Value
12	unsigned 8-bit	Time-stamp

Figure 1-7. Output Data Frame as Seen on an Oscilloscope



2 QTouch Parameters

This chapter describes the sensor specific and global parameters, which can be configured by the user. These parameters could be fine-tuned to improve the touch sensitivity, noise immunity, and moisture tolerance of the touch sensor.

2.1 Detect Integration Filter

The detect integration (DI) is a counter acting as a signal filter to suppress false detections caused by spurious events like electrical noise.

Parameter	Unit	Minimum	Maximum	Typical
DI	Cycles	1	16	4

Possible values: 1, 2, 4, 6, 8, 16.

2.2 Negative Threshold

The negative threshold or detect threshold parameter is used to determine key touch when crossed by a negative-going signal swing after having been filtered by the detection integration.

Parameter	Unit	Minimum	Maximum	Typical
Negative Threshold	Counts	10	250	10

Possible values: 10, 15, 20, 50, 60, 70, 80, 90, 100, 110, 150, 200, 250.

2.3 Positive Threshold

The positive threshold or hysteresis parameter adds stickiness to the touch detection algorithm. It is expressed as a percentage of the sensor's negative threshold value. For a sensor which is in in-detect state, the touch delta count must go below the negative threshold minus hysteresis to update its status as out of detect.

Once a sensor goes into detect state, its negative threshold level is reduced by the hysteresis value in order to avoid the sensor dither in and out of detect when the signal level is close to original threshold level.

Parameter	Unit	Minimum	Maximum	Typical
Positive Threshold	% of negative threshold	25	75	25

Setting of 25 = 25% of negative threshold.

Setting of 50 = 50% of negative threshold.

Setting of 75 = 75% of negative threshold.

Possible values: 25, 50, 75.

2.4 Positive Drift Rate

The rate at which sensor's reference level is increased to compensate the increase in signal level (due to temperature effect on physical sensor characteristics) is called positive drift rate.

Parameter	Unit	Minimum	Maximum	Typical
Positive Drift Rate	200ms	1	60	10

Possible values: 1, 2, 3, …, 60.

Drift mechanism works only while there is no detection in effect.

The positive drift rate should be set at a higher rate than the typical value to compensate the increasing signal level. A conductive object over the sensor which does not cause detection and for which the sensor has already made full allowance (over some period of time), it could suddenly be removed leaving the sensor with an artificially suppressed reference level and thus become insensitive to touch. Here, in this case, the sensor should compensate for the object's removal by raising the reference level relatively quickly.

2.5 Negative Drift Rate

The rate at which the sensor's reference level is decreased to compensate the drop in signal level (due to temperature effect on physical sensor characteristics) is called negative drift rate. Decreasing signal level should not be compensated quickly, as an approaching finger could be compensated for partially or entirely before even touching the sensor. Thus negative drift rate has to be set very cautiously.

Parameter	Unit	Minimum	Maximum	Typical
Negative Drift Rate	200ms	1	60	36

Possible values: 1, 2, 3, 4, 5, …, 60.

2.6 Dwell Time

The dwell time is the duration for which charge is captured on a sensor electrode during touch acquisition. Dwell time parameter allows the acquisition pulses to have varying charge capture durations.

Longer dwell times permit the use of higher series resistor on the sense line to improve immunity of the system against conducted and radiated noise without compromising sensor gain.

Parameter	Unit	Minimum	Maximum	Typical
Dwell time	micro seconds	1	101	1

Possible values: 1, 5, 9, 13, 17, 21, 25, 29, 33, 37, 41, 45, 49, 53, 57, 61, 65, 69, 73, 77, 81, 85, 89, 93, 97, 101.

2.7 Anti-Touch Recalibration Threshold

Anti-touch recalibration threshold is the threshold level for a rapid positively moving (i.e. above its reference level) sensor signal, above which automatic recalibration occurs. This condition is not normal, and usually happens only after a recalibration when a conductive object is lying on the sensor and is subsequently removed. Recalibration threshold helps to recover from these events quickly.

Parameter	Unit	Minimum	Maximum	Typical
Anti-Touch Re-cal Threshold	Counts	4	20	4

Possible values: 4, 5, 6, 7, …, 20.

3 Product Features

This chapter explains the product output features which are specific to a particular mode. These features help to configure the output of the Atmel ATtiny10 device. The device output state changes upon the touch detection event.

3.1 Max On Duration

The Max on duration feature monitors continuous sensor detections and if touch detection exceeds the period set in max on duration parameter, then the sensor performs a full recalibration.

Presence of any conductive object near a sensor may alter the signal level enough to report a touch detection event. If a conductive object unintentionally contacts a sensor resulting in touch detection for a prolonged interval, then it is usually desirable to recalibrate the sensor in order to restore its function. The max on duration timer monitors such detections and performs recalibration after a time delay of few seconds. After a recalibration has taken place, the sensor once again functions normally even if it still in contact with the foreign object.

Parameter	Unit	Minimum	Maximum	Typical
Maximum On Duration	Seconds	10	120	10

Possible values: 10, 20, 30, 40, 50, 60, 70, 80, 90, 120.

The Maximum On Duration feature can be turned off/ disabled by selecting “Infinity” value.

3.1.1 Infinite Max On Duration without Battery Tracking Feature

In the QTouch method, the sensor signal value varies with change in operating voltage. The Single Key Configurator Tool supports the salient feature called battery tracking. This feature is suitable for battery powered applications where the device battery power level is being monitored continuously. If there are any changes in the voltage level when the sensor is in detect state, the sensor reference would be shifted accordingly to compensate signal deviations. The shift in reference level helps to maintain sufficient delta for touch without affecting the sensor state.

The battery tracking feature is enabled by default when the max on duration parameter is set. It can be disabled by selecting “Infinity W/O Track” value.

The QTouchADC method is resilient to supply voltage changes. So, gradual drop in power supply level does not affect the signal value and thus the sensor state.

3.2 Sleep Period

The device performs touch measurement periodically after every few milliseconds as set in the sleep period parameter. The sleep period parameter allows the device to sleep at the end of each burst when there is no touch event. On detecting a possible touch event, the device does burst continuously until the touch event is resolved and afterwards the device goes to sleep.

Parameter	Unit	Minimum	Maximum	Typical
Sleep Period	milliseconds	64	8192	64

Possible values: 64, 128, 256, 512, 1024, 2048, 4096, 8192.

In a touch system, with longer sleep duration between touch measurements it is possible to achieve lower power consumption values, but it slows the device response time to a touch event. So, the appropriate sleep period has to be set in the application to get good trade-off between power consumption and response time.

3.3 HeartBeat

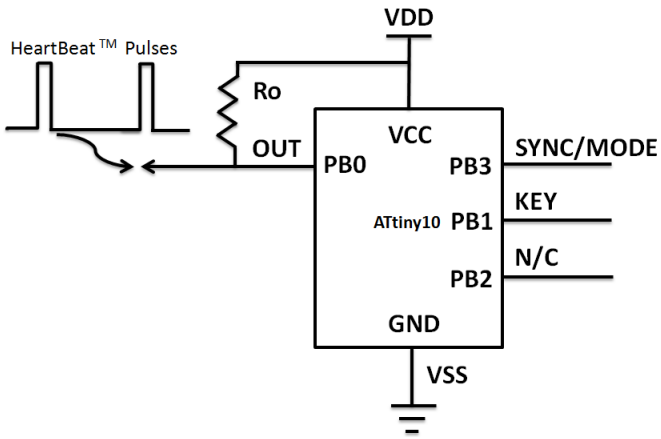
The On/Off mode of the Single Key Configurator provides the HeartBeat health indicator for the device output. The HeartBeat pulse will be visible as long as the device is powered and the touch measurements are running. The device generates pulse once before each burst event by taking the output pin into a tri state mode. The duration of the pulse is of the order of few microseconds and is configurable in the Single Key Configurator Tool.

The HeartBeat pulse can optionally be used to determine the device is operating normally. The HeartBeat indicator can be sampled by using a pull-up resistor on the output pin as shown in Figure 3-1.

Parameter	Unit	Minimum	Maximum	Default
HeartBeat	Microseconds	5	51	Disabled

Possible values: 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51.

Figure 3-1. HeartBeat Pulses with a Pull-up Resistor



3.4 Output Pin Polarity

In the On/Off mode, the state of the output pin for the touch detection event can be configured to have either Active High or Active Low. Selecting detect state option for output pin polarity parameter enables Active High state on output pin upon touch detection. The detect state inverted option for the output pin polarity parameter enables Active Low state on the output pin upon touch detection.

3.5 Oversample

In the QTouchADC method, oversampling is useful to increase signal resolution, which in turn helps in enhancing the touch sensitivity. Each acquisition cycle consists of signal accumulation and signal averaging. Changing the oversampling rate alters the number of measurements accumulated. Higher oversampling values are useful for proximity sensor designs but require longer acquisition times.

Parameter	Minimum	Maximum	Typical
Oversample	4	4096	4

Possible values: 4, 16, 64, 256, 512, 1024, 2048, 4096.

3.6 Scaling

The Scaling parameter relates to signal averaging in the QTouchADC acquisition cycle. Changing the scaling parameter alters the average factor of the accumulated signal.

Increasing the scaling factor helps to get good signal-to-noise (SNR) ratio. Depending upon the application requirements, appropriate oversample and scaling factors can be used.

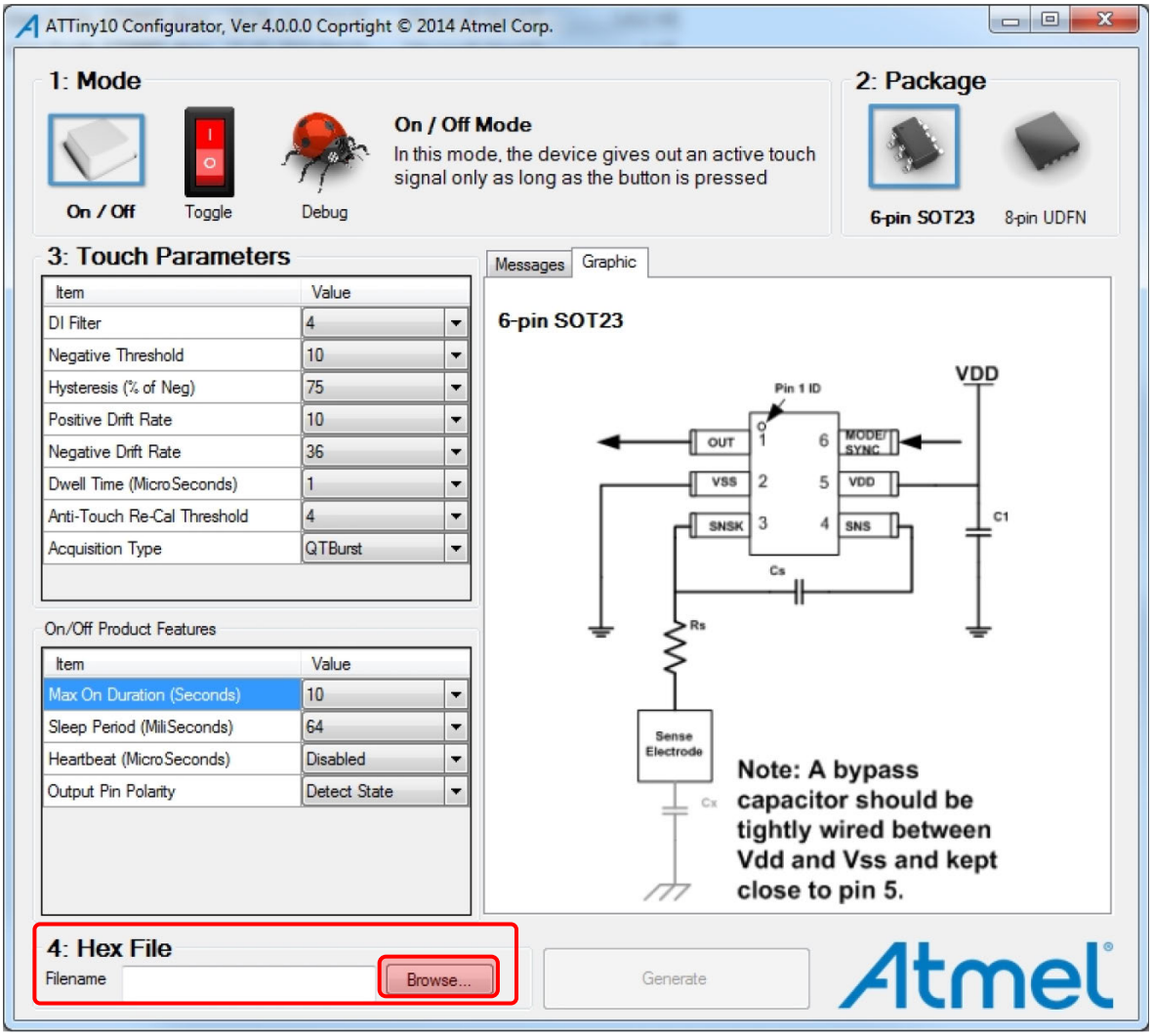
Parameter	Minimum	Maximum	Typical
Scaling	1	8	1

Possible values: 1, 2, 3, …, 8.

4 Output .hex File Generation

The following steps are to be followed to generate the .hex file, which can be programmed to ATtiny10 MCU.

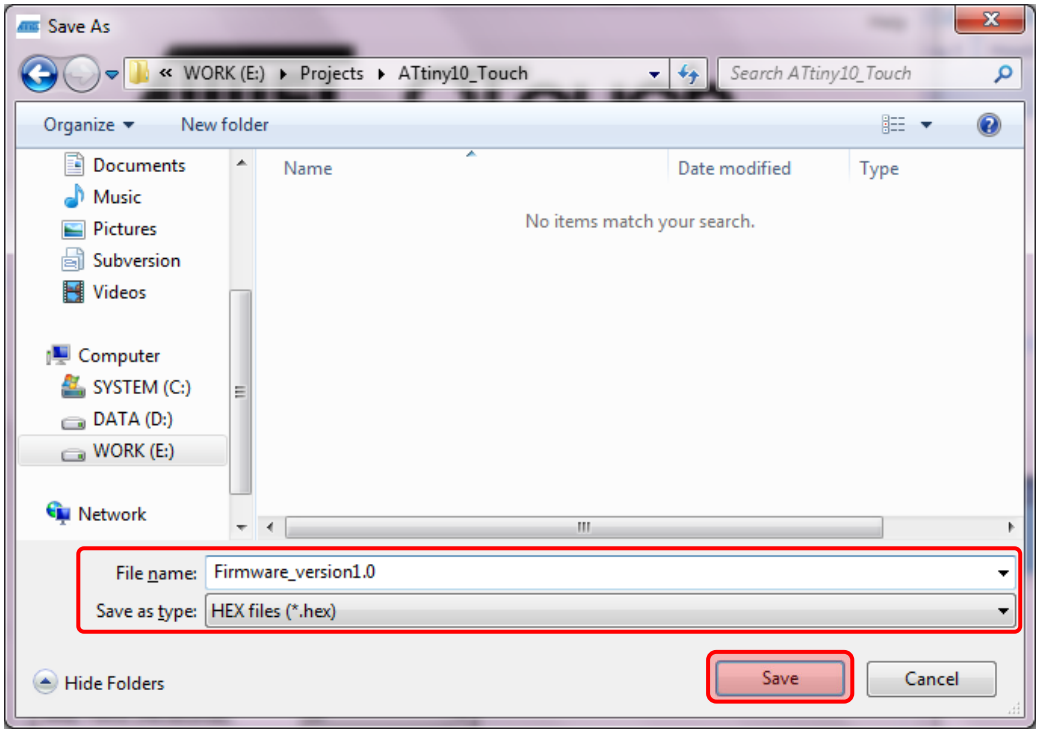
- Click on *Browse* under the *Hex File Options*



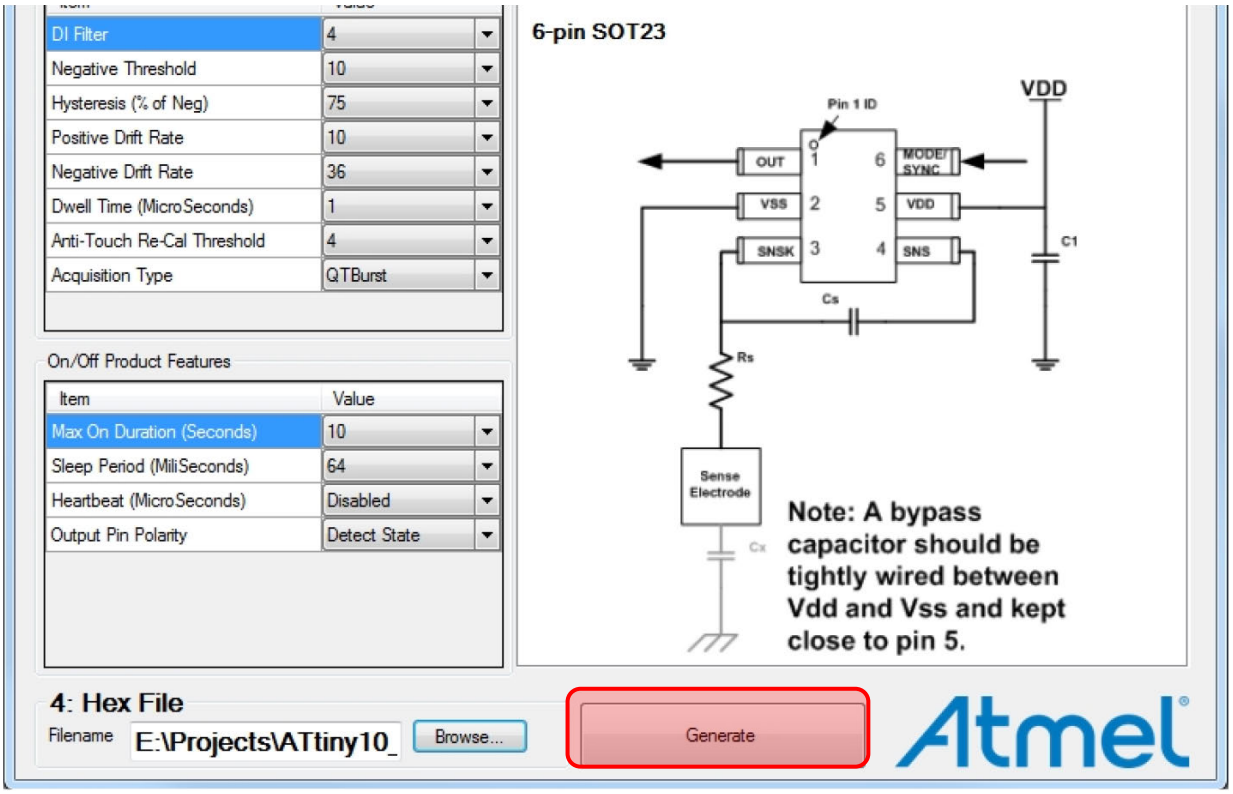
IMPORTANT

Before output .hex file generation, select the appropriate mode from the drop down menu “Mode”. Also configure all sensor specific and global parameters in QTouch Parameters and Product Features options.

- Now the “Save as” window pops up. Choose the appropriate location to save the file and then provide the desired file name. Click on the Save option.



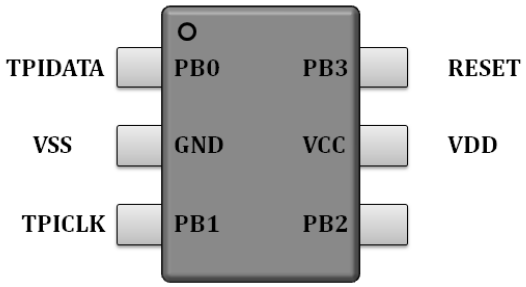
- As a final step, click on the *Generate* icon to generate the .hex file



5 Device Programming

The ATtiny10 MCU is programmed using TPI (Tiny Programming Interface). TPI programming requires three lines, namely TPIDATA, TPICLOCK, and RESET.

Figure 5-1. TPI Pin Configuration for ATtiny10



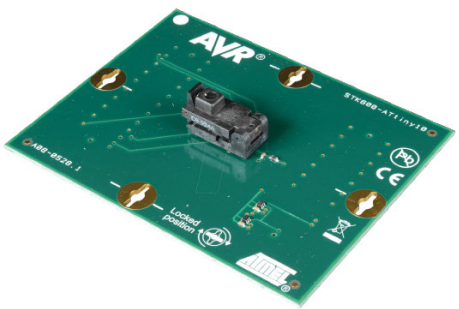
There are three programmers available which support TPI programming.

Figure 5-2. Supported Atmel Programmer for TPI Programming

Atmel ICE

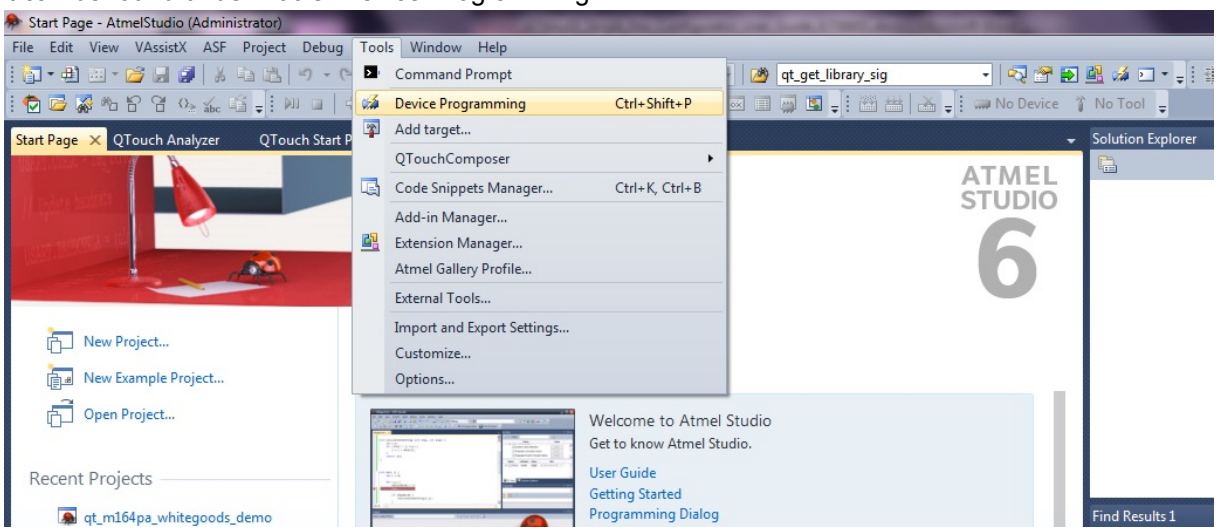
AVRISP mkII

STK600 and ATtiny10 Socket Card

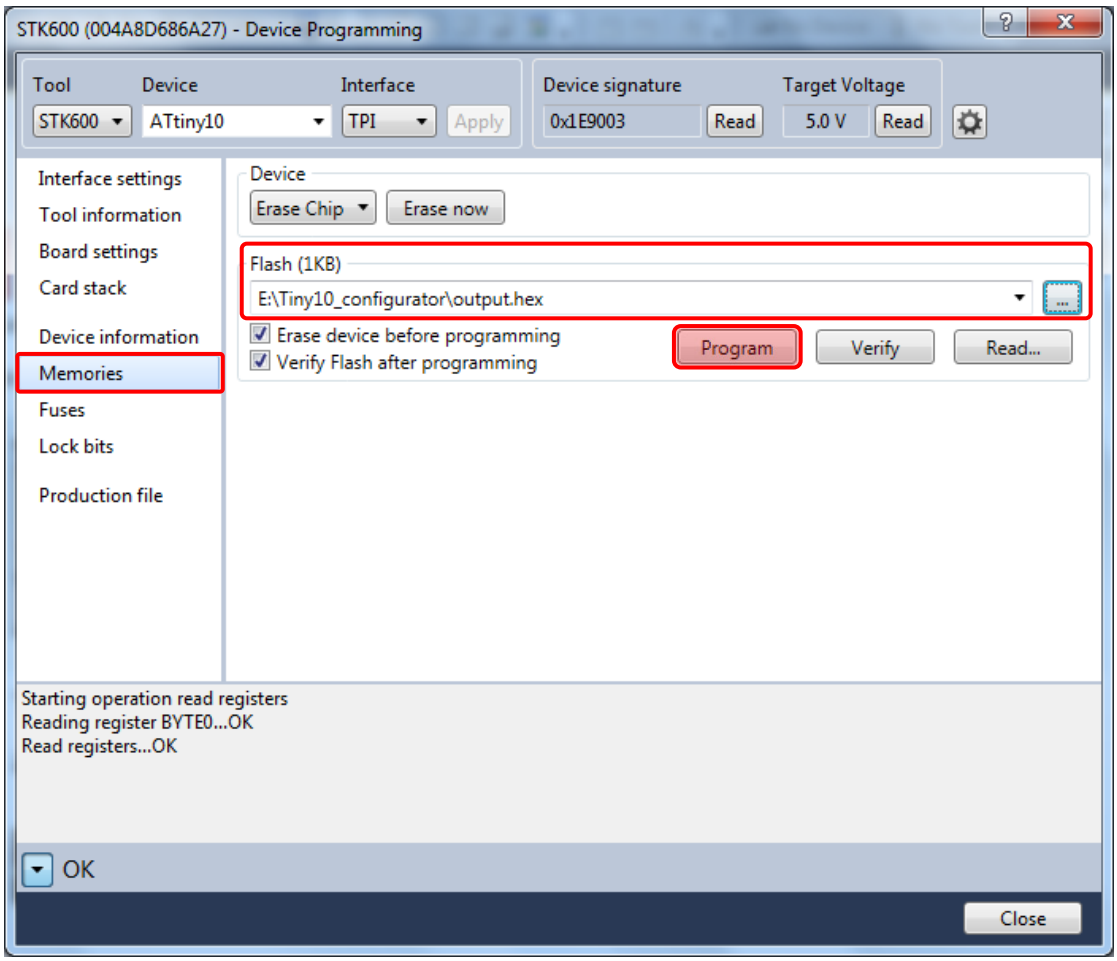


The following steps are to be followed to program the generated firmware file into the ATtiny10.

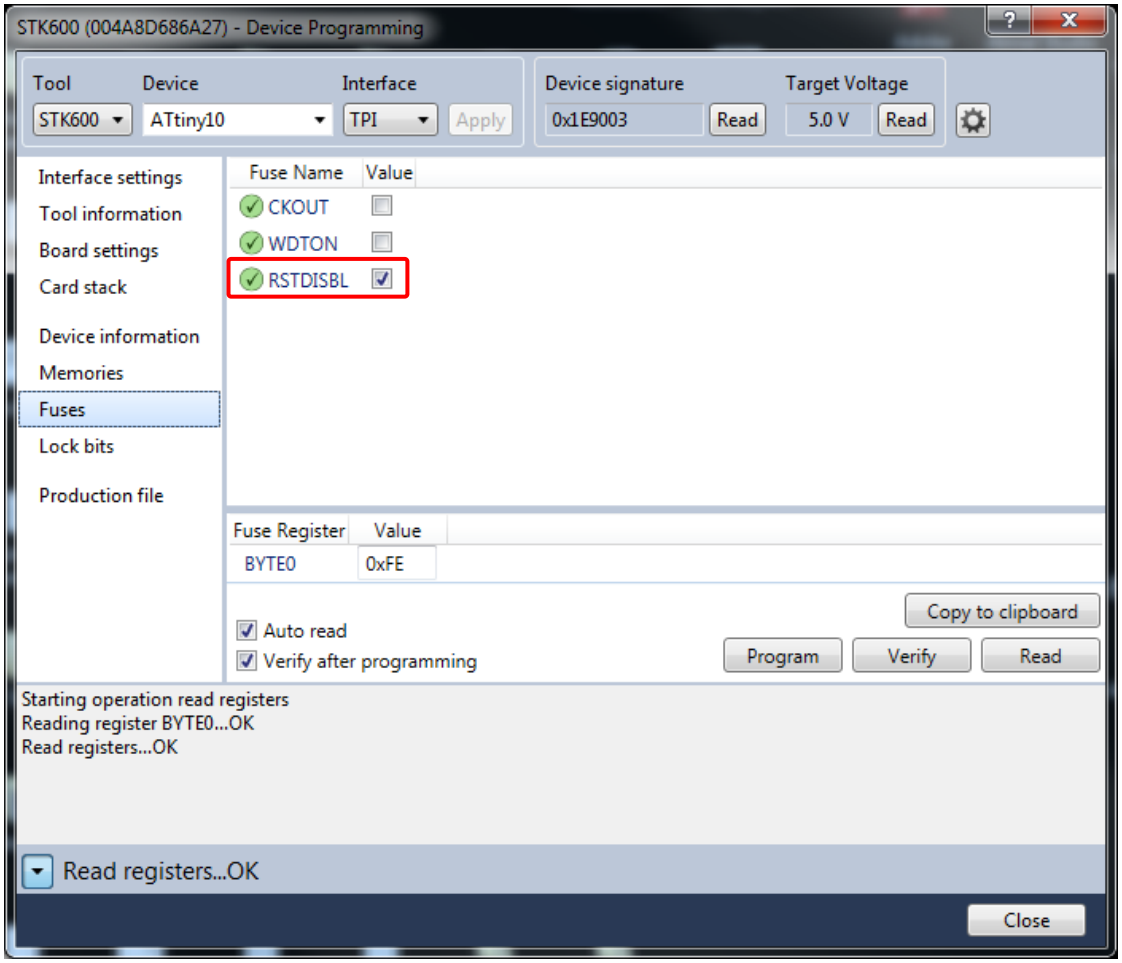
- Launch Atmel Studio IDE and open the Device Programming dialog box.
  It can be found under Tools>Device Programming.



- To load the ATtiny10 device with generated output .hex file, provide the path of the output file in Memories settings. Click on the Program button to download the firmware.



- The RESET Pin is used as Mode Pin in this application. Hence in the fuse settings RSTDISBL fuse bit is to be enabled.



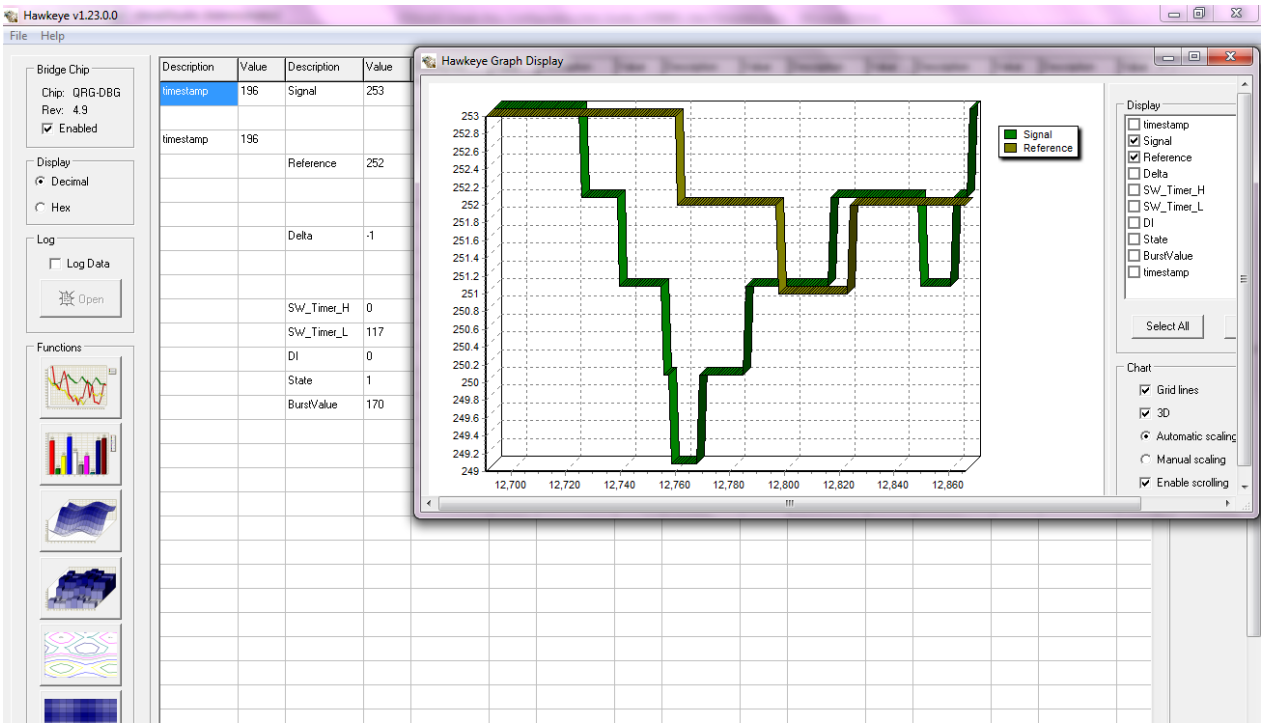
CAUTION

Once the RSTDISBL fuse bit is enabled, the ATtiny10 device can be re-programmed only by using High-Voltage TPI programming. Only STK®600 can perform High-Voltage programming.

Appendix A DEBUG Output

If the DEBUG firmware is programmed the ATtiny10 MCU streams a multi-byte frame of data out of the two debug pins after each key scan cycle. The transmission format is compatible with the Atmel Plug-in USB card and the data can be viewed using the Atmel Hawkeye PC software (contact Atmel for information).

A.1 Hawkeye PC Software



A.2 Debug Mode Hardware Configuration

The capacitive measurement data transmitted by the ATtiny10 device can be viewed in the PC by using the Hawkeye PC software. The USB Bridge is used to connect the ATtiny10 device with Hawkeye.

Figure A-1. USB Bridge Hardware

USB PCB 80146

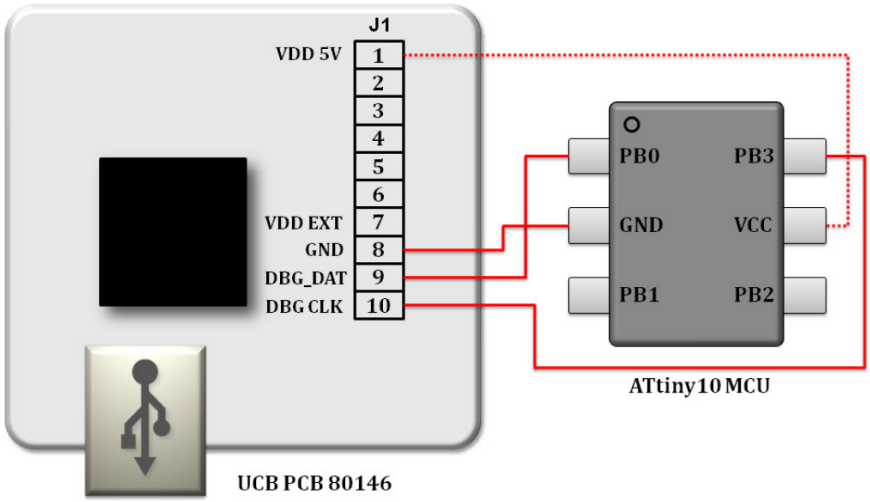
The USB Bridge is powered from the PC by using the attached USB cable. The bridge acts as a simple converter which converts the debug data packets to USB compatible data packets.

In the Debug Mode the MCU can be powered either from the USB Bridge or from an external power supply. It is recommended to keep the MCU at the operating voltage level of the final application. The 9206 USB Plug-in card supports 5V and 3.3V whereas the USB PCB 80146 can provide 1.8V, 2.8V, 3.3V, and 5V.

Table 1. Pin Connections Between ATtiny10 and USB Bridge

ATtiny10 MCU	USB Bridge
PB0	DBG DATA
PB3	DBG CLOCK
GND	GND
VCC	VCC (optional)

Figure A-2. Circuit Diagram for Connection with USB PCB 80146



Appendix B Revision History

Doc Rev.	Date	Comments
42326A	02/2015	Initial document release.

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