Thermo Click - Cross-Platform Development Quick Start Guide

Overview

This document explains how to use the MikroElektronika Themo Click board as an accessory to the following host development platforms (microcontrollers):

- Atmel's SAMA5D3 Xplained
- Beaglebone Black
- RIoTboard

The SHT11 Clickboard contains a thermocouple-to-digital converter (sensor) allowing users to take accurate temperature measurements which can be used by an application program for a variety of custom applications. Sample C programs for each platform are presented.

Thermo Click Hardware

The board connects to the host platform via the mikroBUS connector. Temperature data are read with a simple synchronous serial peripheral interface (SPI) bus. The details for the sensor are found at http://datasheets.maximintegrated.com/en/ds/MAX31855.pdf.

Schematics for the SHT11 Click board are found at http://www.mikroe.com/downloads/get/1879/thermo_click_manual.pdf.

Regardless of the host platform, connecting the board requires five connections.

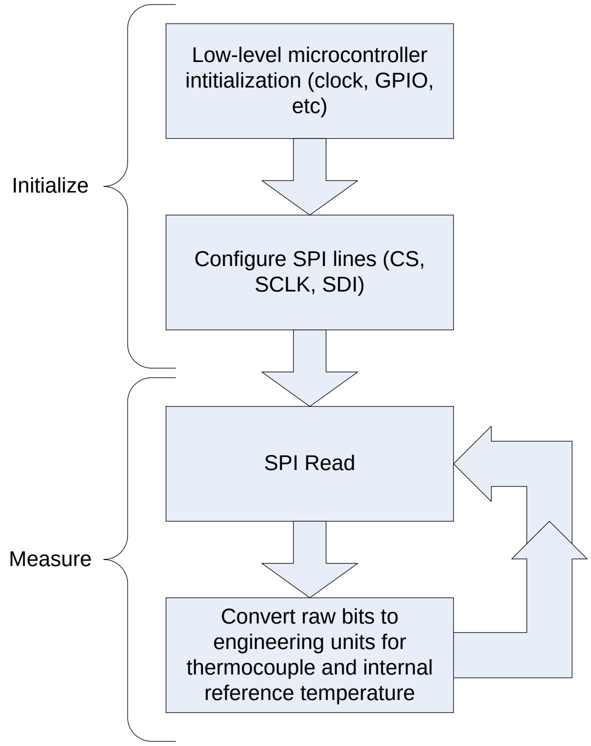
Click Board	Host Platform
VCC 3.3V	3.3V source
GND	GND
#CS (chip select input, active low)	#CS (chip select output, active low)
SCK (serial clock input)	SCK (serial clock output)
SDO (serial data output)	SDI (serial data input)

Note that the serial interface is read-only.

When running the example software, be sure to have the included thermocouple connected.

Software

For any microcontroller, the software for reading the temperature data follows the same basic flow. The example program listed below follow this flow and are designed to be the most simple utilization of the hardware.


Initialize
Low-level microcontroller intitialization (clock, GPIO, etc)
Configure SPI lines (CS, SCLK, SDI)
Measure
SPI Read
Convert raw bits to engineering units for thermocouple and internal reference temperature

The sections below describe the specifics for connections the board to various specific host platform boards.

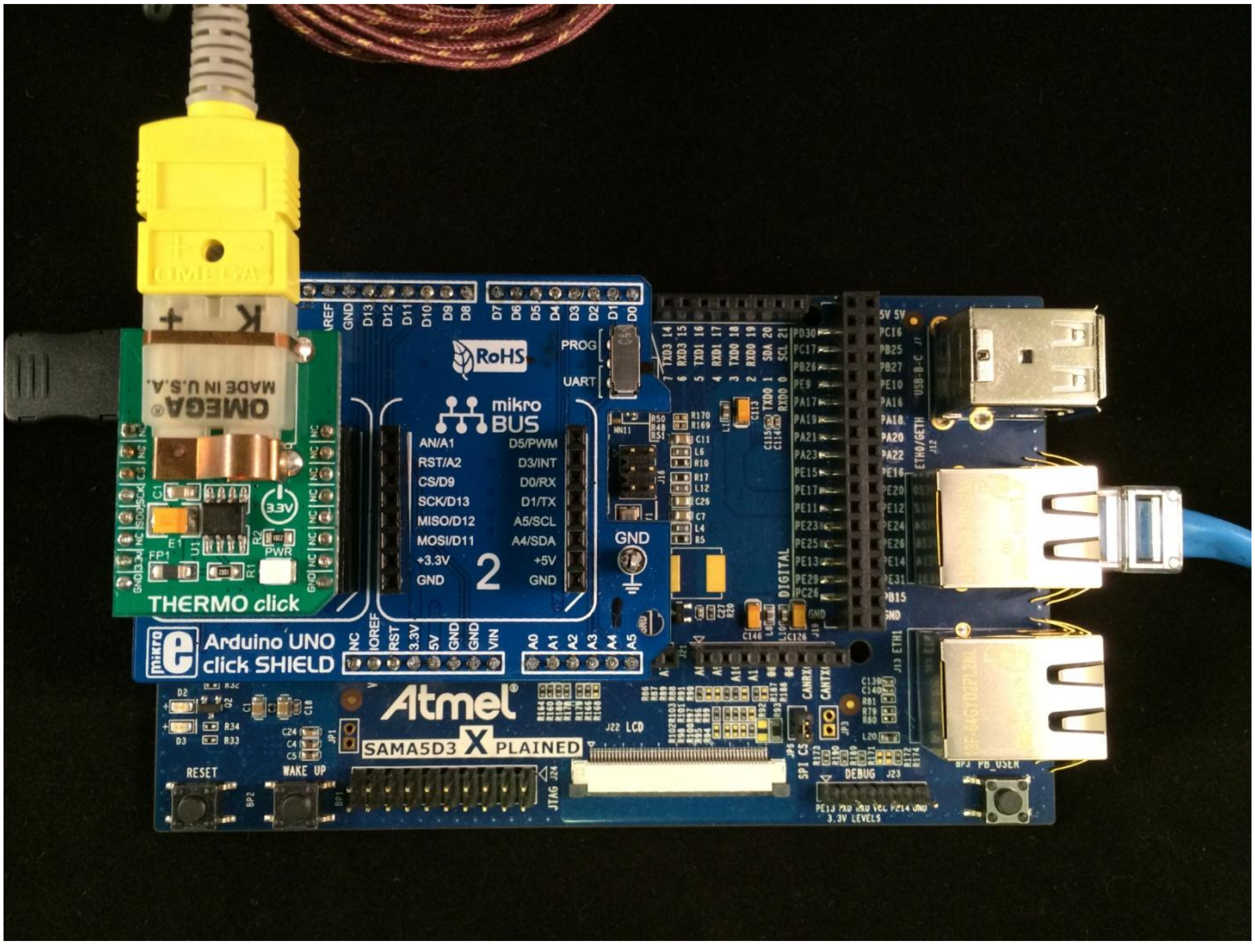
Connecting the Thermo Click to the SAMA5D3 XPlained Board

Connecting the Thermo Click board to the SAMA5D3 XPlained board requires using the Arduino UNO click shield adapter board http://www.element14.com/community/docs/DOC-66846. The adapter board makes the following connections:

SAMA5 XPlained Pin	SAMA5 XPlained Pin Configuration	Arduino UNO Click Shield Pin	Thermo Click Pin
3.3V		3.3V	3.3V
Gnd		Gnd	Gnd
PC25	Output	PB2/SPI-SS	CS Bus 1
PC24	Output	PB5/SPI-SCK	SCK
PC22	Input	PB4/SPI-MISO	MISO (master In / slave out data)

The example code assumes that the Click Board is installed on the Arduino UNO Click Shield Adapter Bus 1.

The example assumes that the SAMA5 Xplained board is running the factory-installed Poky Linux firmware.



Compile and Run the Example Program

1. The example code requires a PC running Linux in order to cross-compile and install the program. The instructions for building the cross-compile toolchain can be found at http://www.at91.com/linux4sam/bin/view/Linux4SAM/PokyBuild#How_to_build_Poky_for_AT91. Build the toolchain.
2. Connect the SAMA5 XPlained board to an Ethernet connection and power-on the board. Using the serial port connection, connect to the SAMA5 board. From the shell, get the IP address of the SAMA5 board:
   ```
   # ifconfig eth0
   ```
3. Download the example code from http://www.element14.com/community/docs/DOC-68827#cdownloads and extract the files to convenient location.
4. Edit the makefile to use the actual IP address of the SAMA5 board.
5. Setup the build environment by running the following:

```
# source /opt/poky/1.5.1/environment-setup-cortexa5hf-vfp-poky-linux-gnueabi
```

6. From the directory of the example program, compile the source code with make:
   ```
   # make sama5
   ```
7. Install the program into the target's file system at /home/root
   ```
   #make install_sama5
   ```
8. Run the program. In the SAMA5 shell, run
   ```
   #  cd /home/root
   # ./sam_thermo_click
   ```
9. The shell terminal should display the raw ADC values for the connected thermocouple and internal sensor temperatures, followed by the actual temperature values in degrees Celcius.

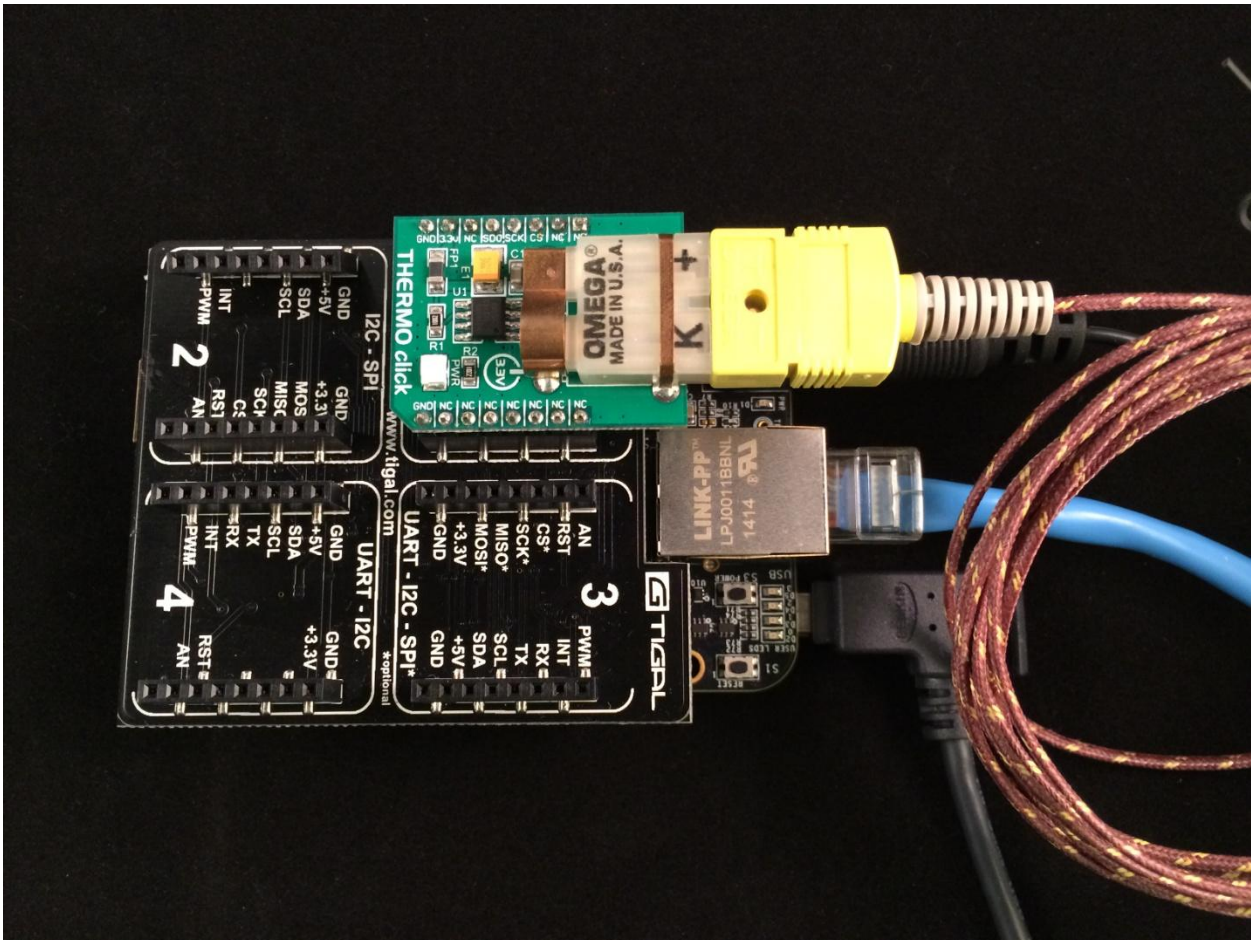
Connecting the Thermo Click to the Beaglebone Black

Connecting the Thermo Click board to the Beaglebone Black requires using the Tigal BeagleBone mikroBUS Cape adapter board http://www.element14.com/community/docs/DOC-66837. The adapter board makes the following connections:

Beaglebone Black Pin	**Beaglebone Black Pin Configuration**	**BeagleBone mikroBUS Cape Adapter Pin**	**Thermo Click Pin**
VDD_3V3EXP		3.3V	3.3V
GND		GND	GND
SPI1_CS (P9.28)	Output	CS	CS
SPI1_SCLK (P9.31)	Output	SCK	SCK
SPI1_D0 (P9.29)	Input	MISO	MISO (master In / slave Out data)

The example code assumes that the Click Board is installed on the BeagleBone mikroBUS Cape Adapter Host 1.

The example assumes that the Beaglebone Black is running the factory-installed Linux (Debian) firmware.



Compile and Run the Example Program

1. Download the example code from http://www.element14.com/community/docs/DOC-68827#cdownloads and extract the files to convenient location.
2. The example code requires gcc, BB-SPIDEV1-00A0.dtbo or BB-MIKROBUS-01-00A1.dtbo, and root access.
    a. Instructions to download BB-MIKROBUS-01-00A1.dtbo can be found at http://elinux.org/Tigal:BeagleBone_mikrobuscape
        i. When using this method, and you have more than one cape installed, you need to ensure that this cape does not have the same address assigned to this cape as the other capes currently installed on the board. You can change the address of this board by changing the dip switch positions found on the bottom of the board. You can refer to the above site for an image of where the dip switchs are located (It will be under Product Images, Bottom image). You can also refer to this site, https://www.tigal.com/wiki/doku.php?id=tigalcapes:bb_mikrobus_cape
            1. On this site they will also explain how to install the overlay and use it, along with other helpful information.

   b. If you are using this cape then you do not need to enable the SPI pins to use this click. If not then you will need to enable the SPI pins.

3. To enable the SPI pins first you need to disable the HDMI pins, so go to /boot/uboot/uEnv.txt and uncomment the line below Disable HDMI, and reboot the system.
4. Next go to /sys/devices/bone_capemgr.9/
   a. This directory can differ depending on the OS you are running.
5. Enter in the following command echo BB-SPIDEV1 > slots
6. Now you can enter in the following command to see that BB-SPIDEV1 has been loaded correctly, cat slots.
   a. The output should look something like this:

```
0: 54:PF---
1: 55:PF---
2: 56:PF---
4: ff:P-O-- Bone-LT-eMMC-2G,00A0,Texas Instrument,BB-BONE-EMMC-2G
5: ff:P-O-- Bone-Black-HDMI,00A0,Texas Instrument,BB-BONELT-HDMI
6: ff:P-O-- Bone-Black-HDMIN,00A0,Texas Instrument,BB-BONELT-HDMIN
7: ff:P-O-L Override Board Name,00A0,Override Manuf,BB-SPIDEV1
```

   b. To remove this BB-SPIDEV1 enter in the following command -7 > slots.
   c. We enter in 7 since that is the number that BB_SPIDEV1 was assigned in our case.
      i. WARNING: The above command to unload the overlay may crash your system depending on the version you currently have installed.
      ii. The overlay will not be loaded when you reboot your system, unless you set it to load at boot at the /boot/uboot/uEnv.txt.
7. Compile the code using "gcc –Wall ThermoClick.c –o ThermoClick.out"
   a. –Wall enables all warnings
   b. –o Specify the output filename
   c. Technically you do not need either of these two flags to compile the sample code. They are just nice to have.
8. To execute the code ./ThermoClick.out (Or the output filename)
9. The shell terminal should display the raw ADC values for the connected thermocouple and internal sensor temperatures, followed by the actual temperature values in degrees Celcius.

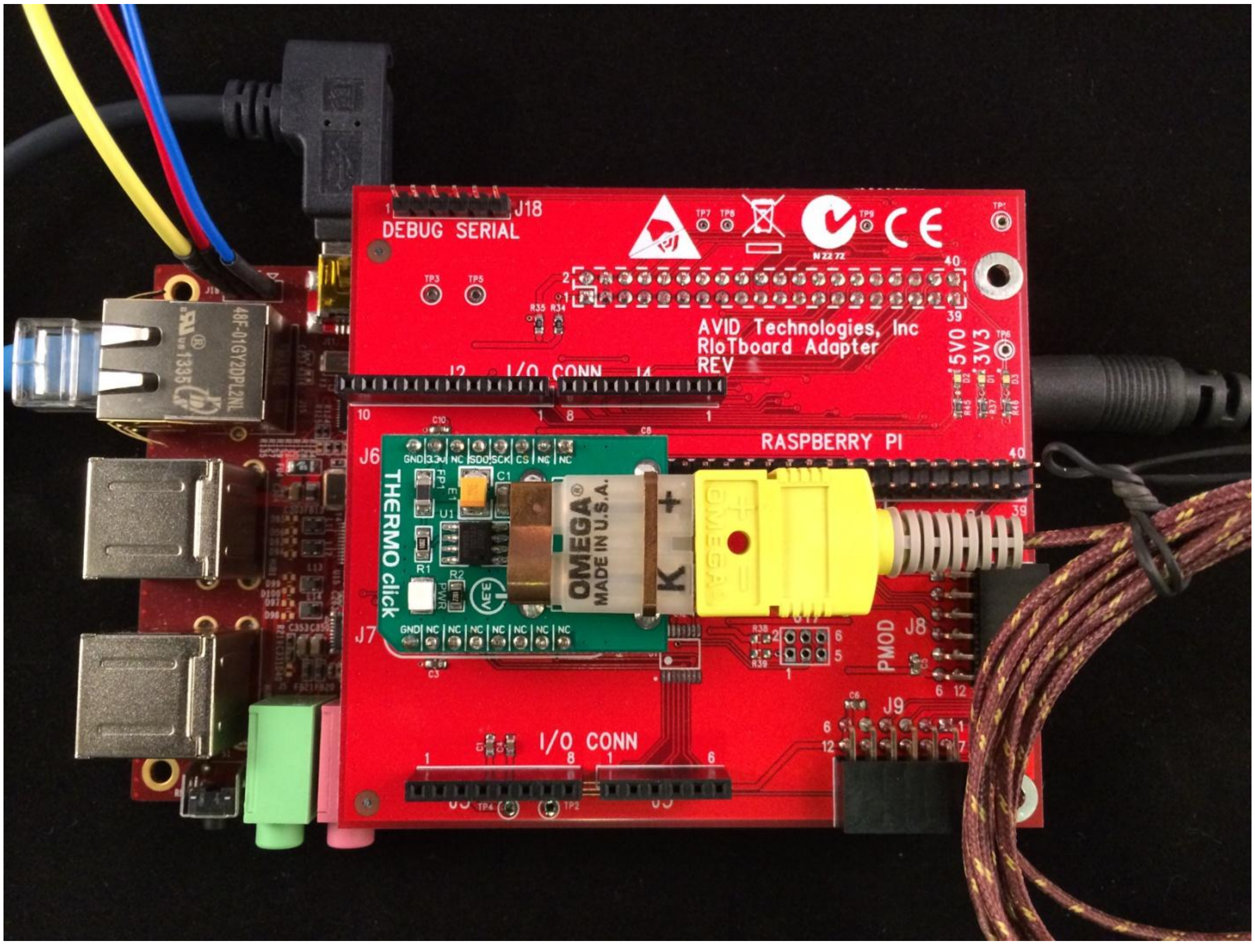
Connecting the Thermo Click to the RIoTboard

Connecting the Thermo Click board to the RIoTboard requires the use of the RIoTboard Adapter board http://www.element14.com/community/docs/DOC-68821 . The adapter board makes the following connections:

RIoTboard Pin	RIoTboard Pin Configuration	RIoTboard Adapter Pin	Thermo Click Pin
3.3V		3.3V	3.3V

GND		GND	GND
CSPI2_CS0 / GPIO5_12	Output	CSPI2_CS0, MB_CS	CS
CSPI2_SCLK / GPIO5_13	Output	CSPI2_SCLK, MB_SCL	SCK
CSPI2_MISO / GPIO5_11	Input	CSPI2_MISO, MB_MISO	MISO (master In / slave Out data)

The example assumes that the RIoTboard is running the factory-installed Android firmware.



Compile and Run the Example Program

1. *The example code requires the installation of the following tools on the development PC:
    a. Android Software Development Kit (SDK)
    b. Android Native Development Kit (NDK)
    c. Java Development Kit (JDK)
    d. gcc and make tools (which can be installed by mingw MinGW)
    e. Cygwin
    f. A terminal emulator such as Putty.
2. Download the example code from http://www.element14.com/community/docs/DOC-68827#cdownloads and extract the files to convenient location.

3. From the command line, change the jni directory in the example code.
4. Build the software with the ndk build tool:
   ```
   > ndk-build
   ```
5. Install the software onto the RIoT Board:
   ```
   > adb push libs/armeabi/thermo /data/local/tmp
   ```
6. Open a terminal connection (e.g. with Putty) to the target platform.
7. Change directories to the install location (/data/local/tmp)
   ```
   # cd /data/local/tmp
   ```
8. Make the file executable:
   ```
   # chmod 777 thermo
   ```
9. Run the program
   ```
   ./thermo
   ```
10. The shell terminal should display the raw ADC values for the connected thermocouple and internal sensor temperatures, followed by the actual temperature values in degrees Celsius.