EK-TM4C1294XL-BOOSTXL-SENSHUB Firmware Development Package

USER'S GUIDE

SW-EK-TM4C1294XL-BOOSTXL-SENSHUB-UG-2.1.0.12573

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Texas Instruments
108 Wild Basin, Suite 350
Austin, TX 78746
www.ti.com/tiva-c

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1 Introduction

The Texas Instruments® Tiva™ EK-TM4C1294XL-BOOSTXL-SENSHUB evaluation board (Tiva C Series TM4C1294 Connected LaunchPad) is a low cost platform that can be used for software development and prototyping a hardware design. A variety of BoosterPacks are available to quickly extend the LaunchPad's features.

The EK-TM4C1294XL-BOOSTXL-SENSHUB includes a Tiva ARM® Cortex™-M4-based microcontroller and the following features:

- Tiva™ TM4C1294NCPDT microcontroller
- Ethernet connector
- USB OTG connector
- 2 user buttons
- 4 User LEDs
- 2 booster pack connectors
- On-board In-Circuit Debug Interface (ICDI)
- Power supply option from USB ICDI connection, USB OTG connection or external power connection
- Shunt jumper for microcontroller current consumption measurement

This document describes the example applications that are provided for the EK-TM4C1294XL when paired with the BOOSTXL-SENSHUB BoosterPack. This BoosterPack provides a variety of motion and environmental sensors. It also provides an EM expansion option for attachement of additional peripherals such as the CC2533EMK or CC4000EMK. These examples utilize the TivaWare™ for C Series Sensor Library to extract and process information from the BOOSTXL-SENSHUB.

2 Example Applications

The example applications show how to utilize features of the EK-TM4C1294XL development board. Examples are included to show how to use many of the general features of the Tiva microcontroller, as well as the feature that are unique to this development board.

A number of drivers are provided to make it easier to use the features of the EK-TM4C1294XL. These drivers also contain low-level code that make use of the TivaWare peripheral driver library and utilities.

There is an IAR workspace file (`ek-tm4c1294xl-boostxl-senshub.eww`) that contains the peripheral driver library project, along with all of the board example projects, in a single, easy-to-use workspace for use with Embedded Workbench

There is a Keil multi-project workspace file (`ek-tm4c1294xl-boostxl-senshub.mpw`) that contains the peripheral driver library project, along with all of the board example projects, in a single, easy-to-use workspace for use with uVision.

All of these examples reside in the `examples/boards/ek-tm4c1294xl-boostxl-senshub` subdirectory of the firmware development package source distribution.

2.1 Nine Axis Sensor Fusion with the MPU9150 and Complimentary-Filtered DCM (compdcm_mpu9150)

This example demonstrates the basic use of the Sensor Library, TM4C1294 LaunchPad and SensHub BoosterPack to obtain nine axis motion measurements from the MPU9150. The example fuses the nine axis measurements into a set of Euler angles: roll, pitch and yaw. It also produces the rotation quaternions. The fusion mechanism demonstrated is a complimentary-filtered direct cosine matrix (DCM) algorithm. The algorithm is provided as part of the Sensor Library.

This example requires that the BOOSTXL-SENSHUB be installed on BoosterPack 1 interface headers. See code comments for instructions on how to use BoosterPack 2 interface.

Connect a serial terminal program to the LaunchPad's ICDI virtual serial port at 115,200 baud. Use eight bits per byte, no parity and one stop bit. The raw sensor measurements, Euler angles and quaternions are printed to the terminal. An LED begins to blink at 1Hz after initialization is completed and the example application is running.

2.2 Humidity Measurement with the SHT21 (humidity_sht21)

This example demonstrates the basic use of the Sensoror Library, TM4C1294XL LaunchPad and SensHub BoosterPack to obtain temperature and relative humidity of the environment using the Sensirion SHT21 sensor.

This example requires that the SensHub BoosterPack is installed on BoosterPack 1 interface headers on the LaunchPad. See the code comments for information on porting this to use BoosterPack 2.

Connect a serial terminal program to the LaunchPad's ICDI virtual serial port at 115,200 baud. Use eight bits per byte, no parity and one stop bit. The humidity and temperature as measured by the SHT21 is printed to the terminal. An LED will blink to indicate the application is running.

2.3 Light Measurement with the ISL29023 (light_isl29023)

This example demonstrates the basic use of the Sensor Library, TM4C1294 Connected LaunchPad and the SensHub BoosterPack to obtain ambient and infrared light measurements with the ISL29023 sensor.

The SensHub BoosterPack must be installed on BoosterPack 1 interface. See code comments for changes needed to use BoosterPack 2 interface.

Connect a serial terminal program to the LaunchPad's ICDI virtual serial port at 115,200 baud. Use eight bits per byte, no parity and one stop bit. The raw sensor measurements are printed to the terminal. An LED blinks at 1Hz once the initialization is complete and the example is running.

The code automatically adjusts the dynamic range of the sensor when the intensity reaches a min or max threshold within the current range setting.

2.4 Pressure Measurement with the BMP180 (pressure_bmp180)

This example demonstrates the basic use of the Sensor Library, the EK-TM4C1294XL LaunchPad, and the SensHub BoosterPack to obtain air pressure and temperature measurements with the BMP180 sensor.

SensHub BoosterPack (BOOSTXL-SENSHUB) must be installed on BoosterPack 1 interface headers.

Instructions for use of SensorHub on BoosterPack 2 headers are in the code comments.

Connect a serial terminal program to the LaunchPad's ICDI virtual serial port at 115,200 baud. Use eight bits per byte, no parity and one stop bit. The raw sensor measurements are printed to the terminal. The LED blinks at 1 Hz once the initialization is complete and the example is running.

2.5 SensHub Internet of Things Example (senshub_iot)

This application uses FreeRTOS to manage multiple sensor tasks and aggregate sensor data to be published to a cloud server. The senshub_iot.c file contains the main function and perform task init before handing control over to the FreeRTOS scheduler.

The tasks and their responsibilities are as follows:

- cloud_task.c is a manager of the cloud interface. It gathers the sensor data and builds it into a packet for transmission to the cloud.
- command_task.c is a manager of the UART virtual com port connection to a local PC. This interface allows advanced commands and data.

- isl29023_task.c is a task to manage the interface to the isl29023 light sensor. It collects data from the sensor and makes it available to other tasks.
- tmp006_task.c is a task that manages the tmp006 temperature sensor. It gathers data from the temperature sensor and makes it available to other tasks.
- bmp180_task.c is a task that manages the bmp180 pressure sensor. It gathers data from the sensor and makes it available to other tasks.
- compdcm_task.c is a task that manages data from the MPU9150. It performs complimentary direct cosine matrix filter on the data to determine roll, pitch and yaw as well as quaternions. This data is made available to other tasks.
- sht21_task.c is a task that manages the SHT21 humidity and temperature sensor. It collects data from the sensor and makes it available to other tasks.

In addition to the tasks, this application also uses the following FreeRTOS resources:

- Queues enable information transfer between tasks.
- Mutex Semaphores guard resources such as the UART from access by multiple tasks at the same time.
- Binary Semaphores synchronize events between interrupts and task contexts.
- A FreeRTOS Delay to put the tasks in blocked state when they have nothing to do.
- A Software timer to regulate the timing of cloud sync events.
- The FreeRTOS run time stats feature to show CPU usage of each task at run time.

For additional details on FreeRTOS, refer to the FreeRTOS web page at: `http://www.freertos.org/`

2.6 Temperature Measurement with the TMP006 (temperature_tmp006)

This example demonstrates the basic use of the Sensor Library, TM4C1294 Connected LaunchPad and the SensHub BoosterPack to obtain ambient and object temperature measurements with the Texas Instruments TMP006 sensor.

SensHub BoosterPack (BOOSTXL-SENSHUB) Must be installed on BoosterPack 1 interface headers.

Connect a serial terminal program to the LaunchPad's ICDI virtual serial port at 115,200 baud. Use eight bits per byte, no parity and one stop bit. The raw sensor measurements are printed to the terminal. An LED blinks at 1Hz once the initialization is complete and the example is running.

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