SYNOPSYS®

Temperature Sensor demo

Application Note

ARC EM Starter kit

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Version 1.0

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Revision History

Version	Date	Note
1.0	23 August 2013	Initial release
1.1	8 Ocober 2013	Updated for EMSK 2.0

Contents

1 Introduction 5
2 Build demo setup 5
2.1 Temperature sensor 5
2.2 LCD display 5
2.3 ARC EM Starter kit 7
2.4 Assembling the demo setup 8
3 Temp sensor application 9
3.1 Application architecture 9
3.2 Flow chart 11
3.3 Project tree 12
3.4 Compiling the application 12
3.5 Running the application 13
4 Useful References 14

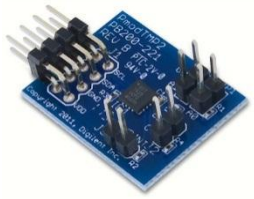
1 Introduction

This document outlines the steps required to create a digital thermometer based on the ARC EM starter kit board and two peripheral module (Pmod) extension boards for measurement and visualization. The demo application for the thermometer is called *temp_demo* and is available in the baremetal package. This application is compatible with the Metaware Development toolkit.

2 Build demo setup

This section outlines the steps required to build a hardware setup for temperature measurement and display of results. Pmod boards are available to purchase from Digilent (www.digilentinc.com) or one of its distributors.

2.1 Temperature sensor



The temperature sensor used in this demo is called **PmodTMP2.**

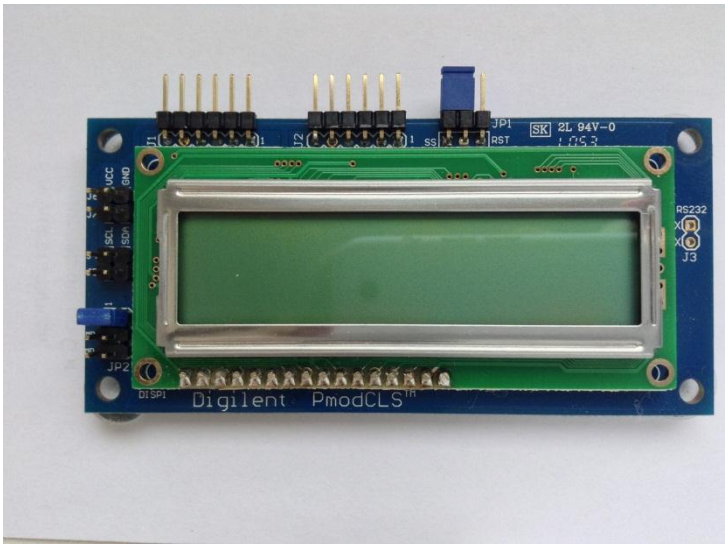
The PmodTMP2 is a temperature sensor and thermostat control board built around the **Analog Devices ADT7420.**
The PmodTMP2 uses an 8-pin connector that allows for communication via I2C, and provides pins to daisy-chain the PmodTMP2 to other I2C devices. The PmodTMP2 also provides two 2-pin headers for selecting the I2C address of the chip, and two 2-pin headers for controlling external devices based upon temperature thresholds defined by the user in software.

All jumpers on the PmodTMP2 board should be opened in order to work with the *temp_sensor* application.

2.2 LCD display

The LCD display used in this demo is called Digilent **PmodCLS**. This module includes a 2x16 character LCD screen and provides the following interfaces for communication: UART, SPI or TWI (I2C compatible). The temperature sensor application uses the SPI interface. There are a few revisions of this board available; this document describes all settings for rev.E.

The figure below shows the board along with the required jumper settings for the *temp_sensor* application, as detailed in the table below.



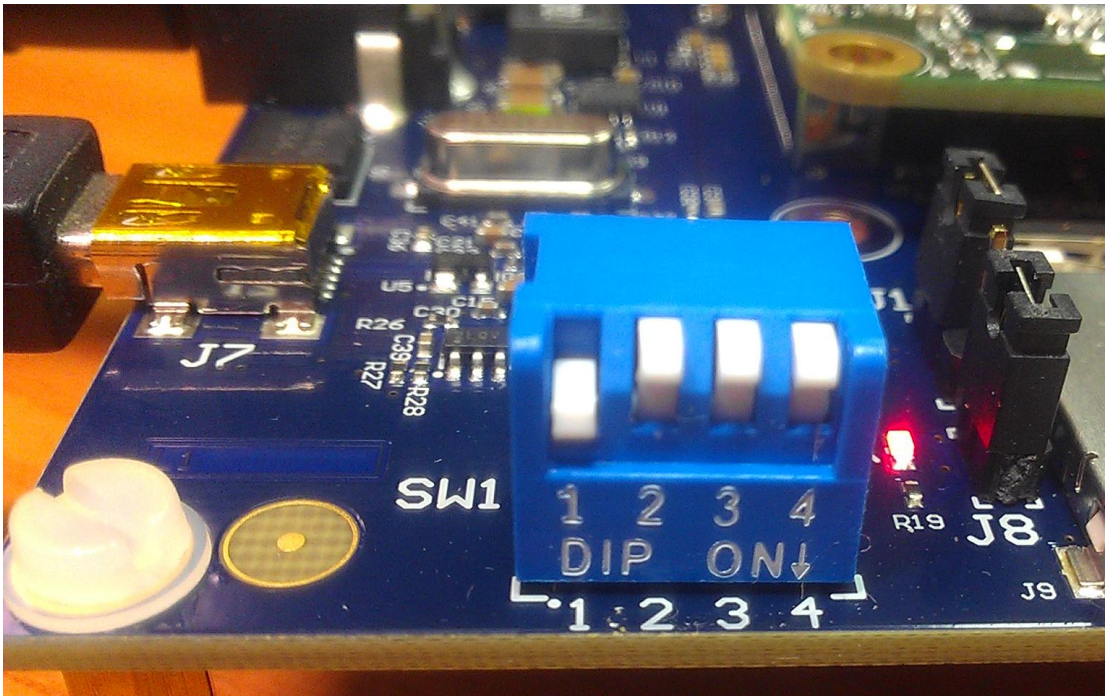
PmodCLS showing required jumper settings

The following jumper settings should be set for the temperature sensor application:

Jumpers	*value*	*comment*
MD0	0 (set)	SPI protocol
MD1	1 (empty)	
MD2	1 (empty)	
JP1	1-2	SS line selected

2.3 ARC EM Starter kit

The ARC EM Starter kit board includes an SPI flash storage device that is pre-programmed with four FPGA images containing different configurations of DesignWare® ARC EM cores: ARC EM5D, ARC EM7D, and ARC EM7DFPU. The FPGA image is selected with pins 1 and 2 of the SW1 DIP switch on the base board as shown on the figure below:



SW1 DIP switch

The definition of bits 1 and 2 are described in the table below:

Table 1 Selecting the configuration

Bit 1	Bit 2	Configuration
OFF	OFF	*ARC EM5D*
ON	OFF	*ARC EM7D*
OFF	ON	*ARC EM7DFPU* This is ARC_EM7D with Floating Point Unit
ON	ON	*Reserved*

A predefined configuration is downloaded from an on-board SPI flash device automatically after power on or after the press of the FPGA configuration button located above the letter “C” of ARC logo on the base board. The loading process takes up to 20 seconds and a green LED on the FPGA module is on during this period. After that, the ARC EM processor optionally performs a self-test and/or starts a user application. This action depends on position of bits 3 and 4 of SW1 as described in the databook.

2.4 Assembling the demo hardware

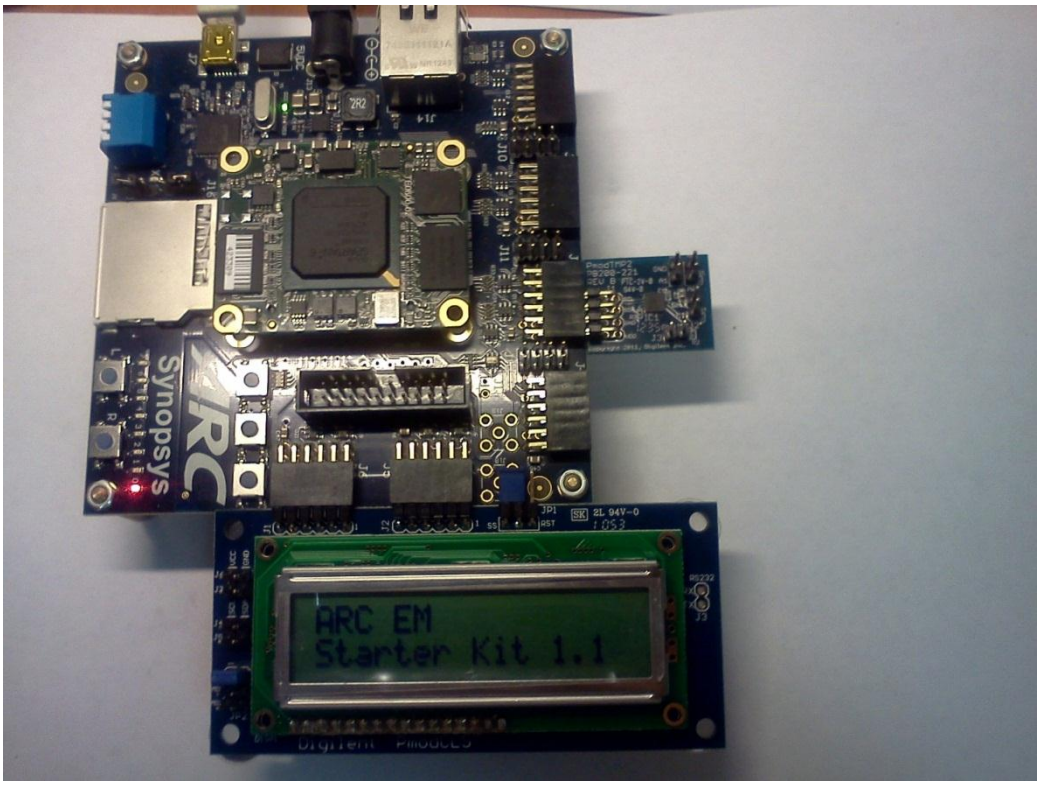
The application running on this setup expects that the base board is connected to specific Pmods.

Pmod3 – temperature sensor

Pmod6 – LCD display. Note! The LCD display should be connected to the upper line of Pmod6 (J6) either by using a cable or directly. The board also uses the Pmod5 (J5) connector, but only for mechanical support. Therefore, make sure J5 is configured as a GPIO port (the default setting) to avoid board damage. This is controlled via the *PMOD_MUX_CTRL* register and the default state is 0. The *temp_sensor* software does not change this, so it is only a concern if you make changes to the software.

Pmod1 – configured as external UART. It can be used to connect a remote terminal or Bluetooth module. Note that this is not part of the *temp_sensor* application.

The board's connections are illustrated below:



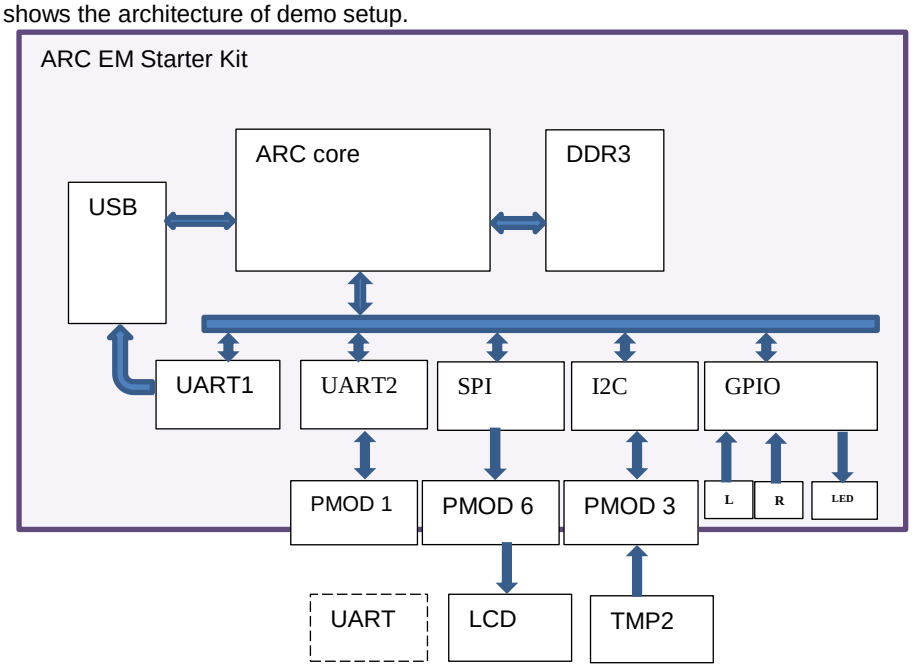
3 Temp sensor application

This chapter describes software part of the temperature sensor demo.

3.1 Application architecture

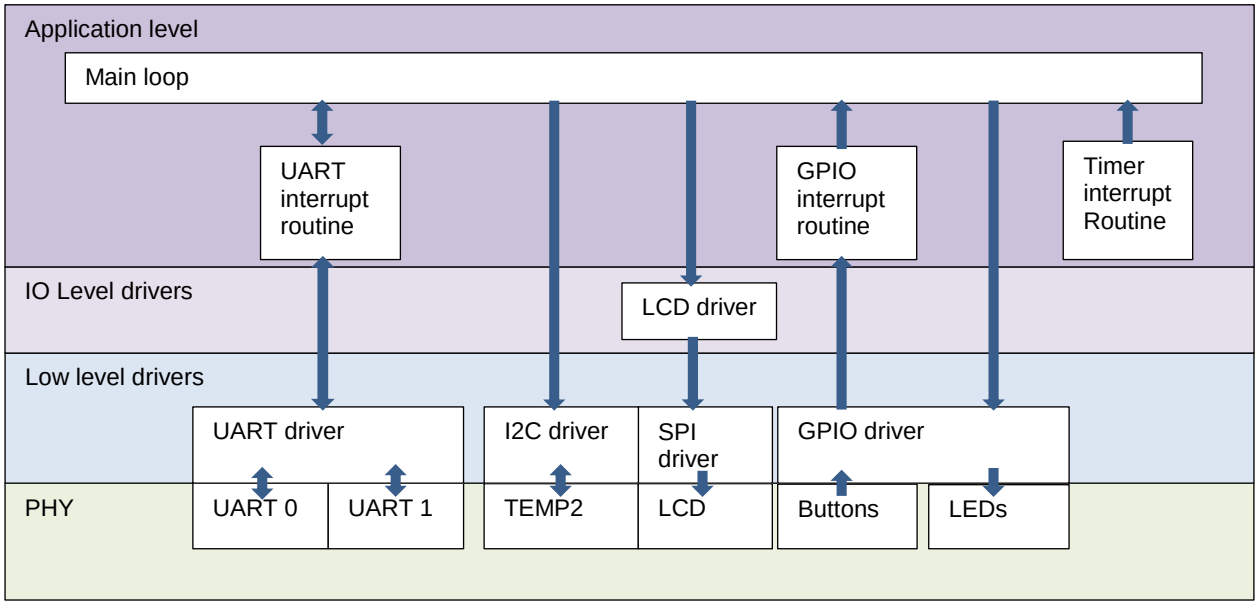
The temperature sensor demo uses all peripheral controllers available on the ARC EM Starter kit: UART, I2C, SPI and GPIO.

The figure below shows the architecture of demo setup.

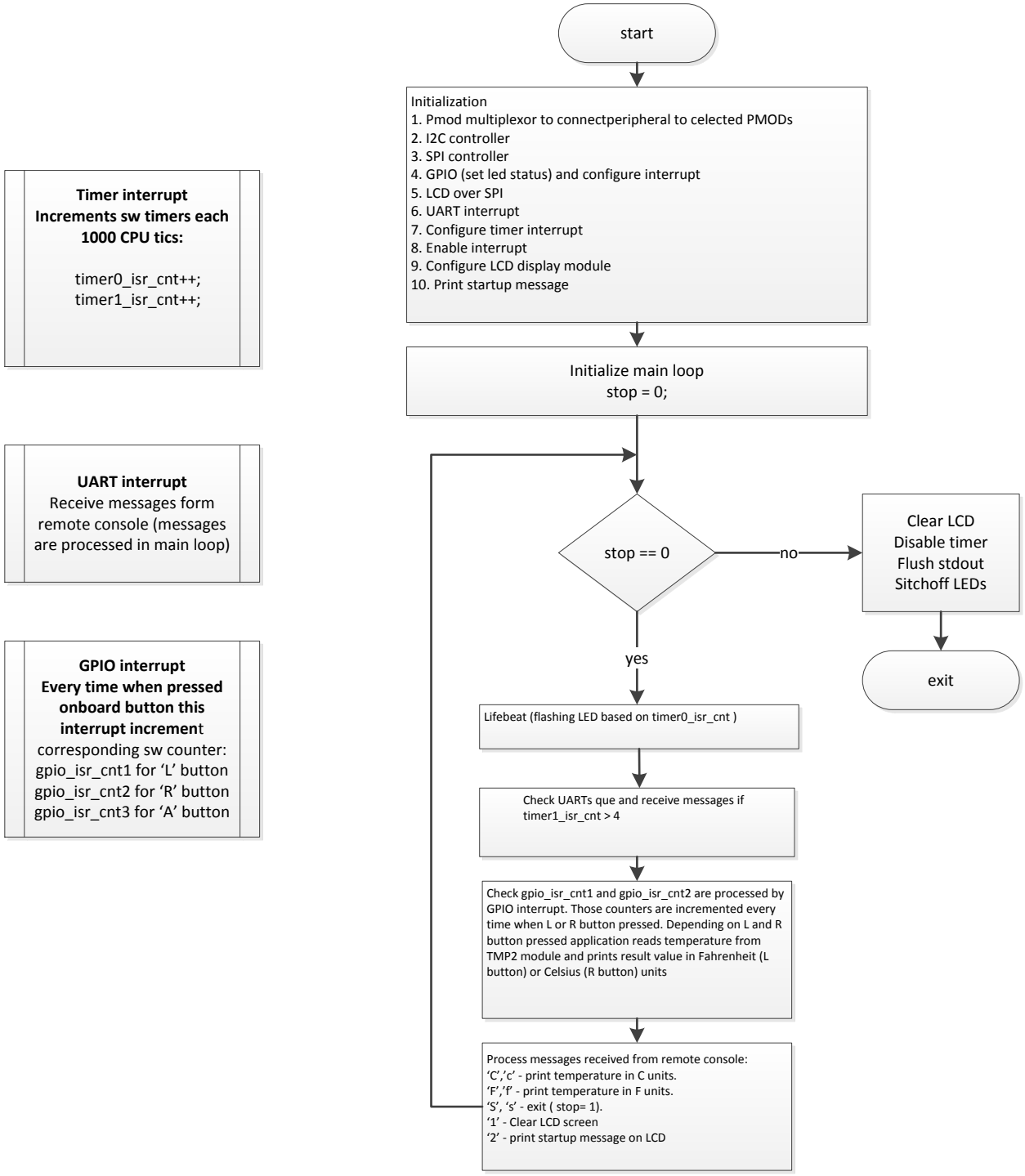


Two UART channels are used as a console, one of which is routed via the USB connector. Messages on the LCD display go through the SPI interface, measured temperature data is read by the I2C controller and the GPIO controller is used for “heart beat” flashing through an onboard LED & reading of “L” and “R” buttons.

The application uses several layers to operate with the hardware modules connected to the Pmod ports. The picture below illustrates the module hierarchy.

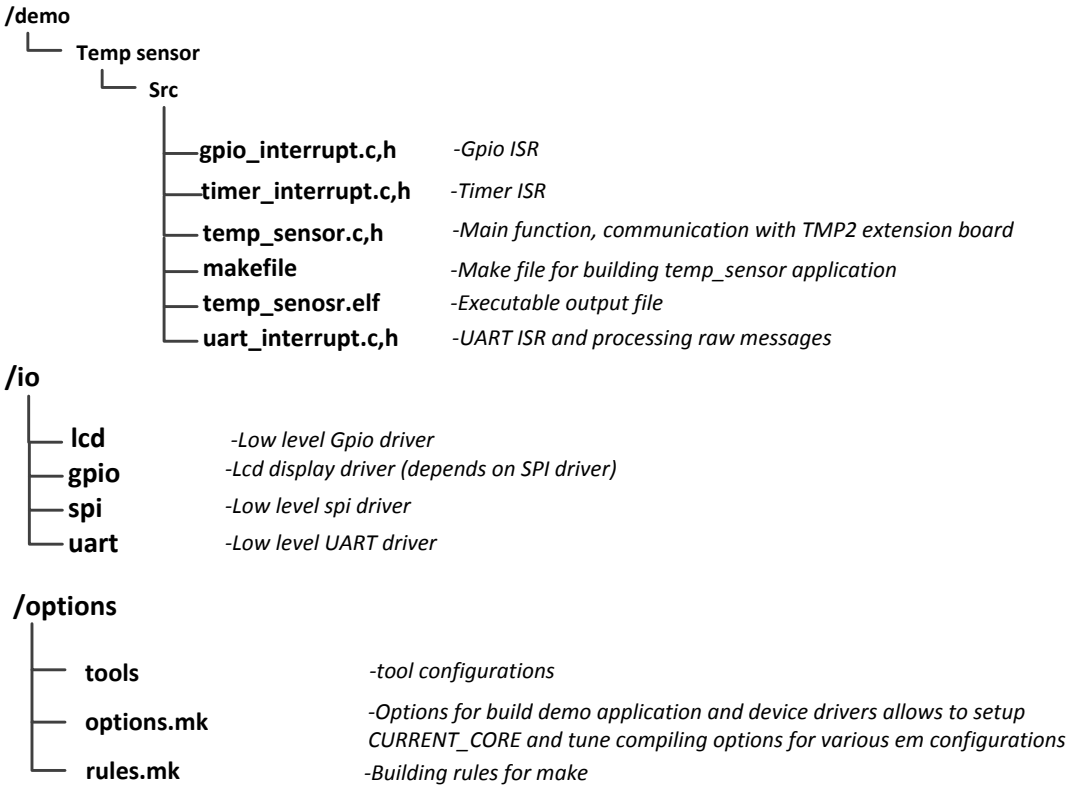


3.2 Flow chart



3.3 Project tree

The project includes three main components: application code located in the **/demo/temp_sensor** folder, low level io drivers located in the **/io** folder and the **/project** folder includes options and rules for building the application. The figure below illustrates the file hierarchy of the project:



3.4 Compiling the application

Edit the **option.mk** located in the **project** directory to setup the *CURRENT_CORE* corresponding to the SW1.1 and SW1.2 settings on the board.

```
CURRENT_CORE = em5d
```

Go to the **/demo/temp_sensor** folder and build application by using the "**make**" command

```
make
```

Perform a fresh recompilation by executing a "**make clean build**" to rebuild all files.

```
make clean build
```

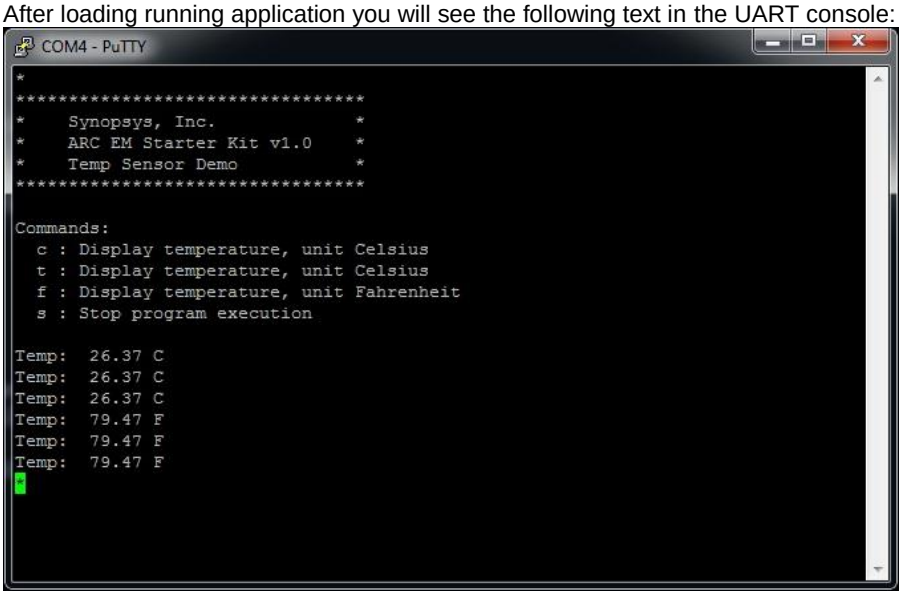
3.5 Running the application

The last step is to be able to run the *temp_sensor* application on the ARC EM Starter Kit board. This can be done in the following way:

1. Load and run application on the command line.

```
make run
```

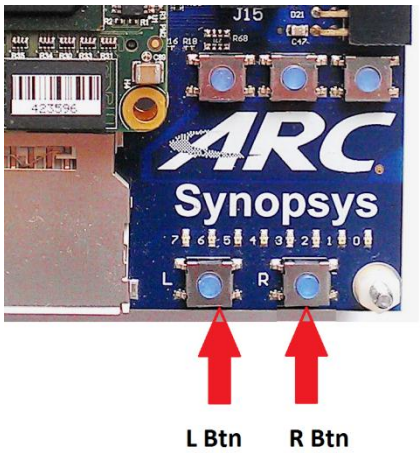
After loading running application you will see the following text in the UART console:



2. Or, run the application in debug mode using the GUI.

```
make gui
```

3. After running the application you will see list of commands in the terminal window as shown on the picture above. Also you can manage the application using buttons “L” and “R” on the Starter Kit board. The application will measure temperature every time you press one of these buttons and print current temperature in Fahrenheit units for the “L” button or Celsius for the “R” button. The button location is shown on the picture below.



4. The application uses LED0 to indicate a heart beat. While the application is running, the LED will flash every 0.6 sec.

4 Useful References

[1] ARC EM Starter kit databook

[2] Digilent PmodTMP2 - Thermometer/thermostat

[3] PmodCLS - Character LCD w/ serial interface