CG2271

Lab 1: Getting Your Freedom!

Objective

In this lab, we will be getting to know the FRDM-KL25Z board that you have been issued. We will complete the installation of the required SW and ensure that we can download and run a simple code.

Introduction

The Freescale Freedom development platform is a set of software and hardware tools for evaluation and development. It is ideal for rapid prototyping of microcontroller-based applications. The Freescale Freedom KL25Z hardware, FRDM-KL25Z, is a simple, yet sophisticated design featuring a Kinetis L series microcontroller, the industry's first microcontroller built on the ARM® Cortex™-M0+ core.

FRDM-KL25Z can be used to evaluate the KL1 and KL2 Kinetis L series devices. It features a KL25Z128VLK, a KL2 family device boasting a max operating frequency of 48MHz, 128KB of flash, a full-speed USB controller, and loads of analog and digital peripherals. The FRDM-KL25Z hardware is form-factor compatible with the Arduino™ R3 pin layout, providing a broad range of expansion board options. The on-board interfaces include an RGB LED, a 3-axis digital accelerometer, and a capacitive touch slider.

The FRDM-KL25Z is the first hardware platform to feature the Freescale open standard embedded serial and debug adapter known as OpenSDA. This circuit offers several options for serial communications, flash programming and run-control debugging.

Hardware

The features of the FRDM-KL25Z include:

- MKL25Z128VLK4 in an 80 LQFP package
- Capacitive touch slider
- MMA8451Q accelerometer
- Tri-color (RGB) LED
- Flexible power supply options – USB, coin cell battery, external source
- Battery-ready, power-measurement access points
- Easy access to MCU I/O via Arduino ™ R3 compatible I/O connectors
- Programmable OpenSDA debug interface with multiple applications available including:
    - Mass storage device flash programming interface
    - P&E Debug interface provides run-control debugging and compatibility with IDE tools
    - CMSIS-DAP interface: new ARM standard for embedded debug interface
    - Data logging application

Figure 1 shows the board with the main components.

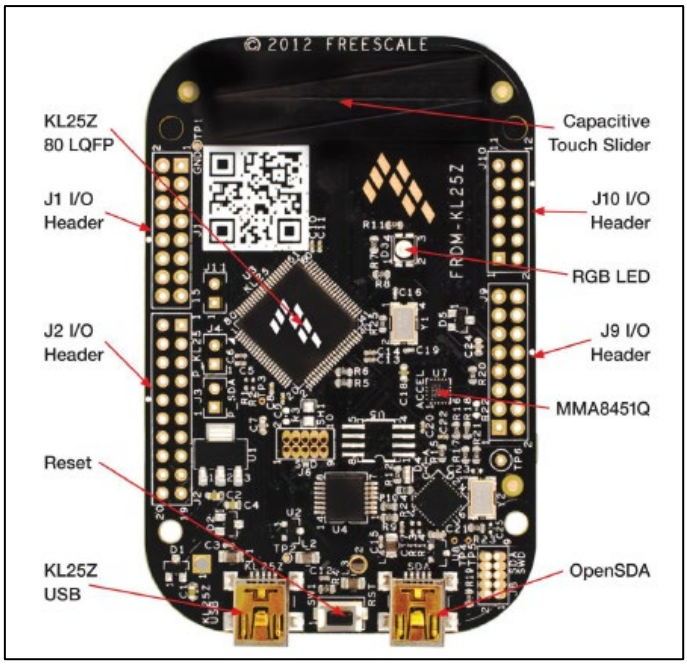


Figure 1: FRDM-KL25Z Feature Call-outs

Though there are a lot of features, we will start with a simple one, the RGB LED.

RGB LED

Three PWM-capable signals are connected to a red, green, blue LED, D3. The signal connections are shown in Table 1 below. Figure 2 shows the schematic.

RGB LED	KL25Z128
Red Cathode	PTB18
Green Cathode	PTB19
Blue Cathode	PTD1 [1]

Table 1: Mapping of RGB LED

(Note 1: PTD1 is also connected to the I/O header on J2 pin 10 (also known as D13).)

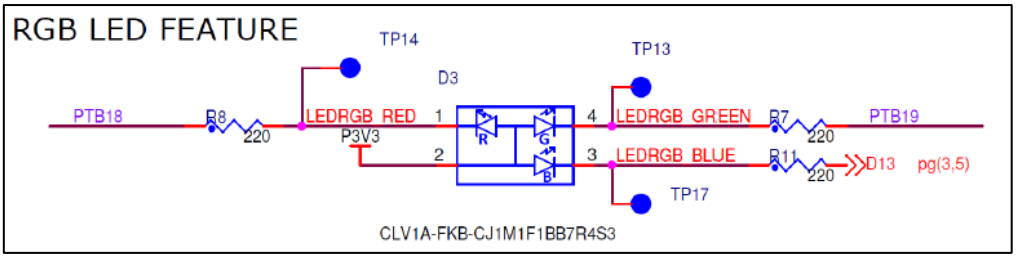
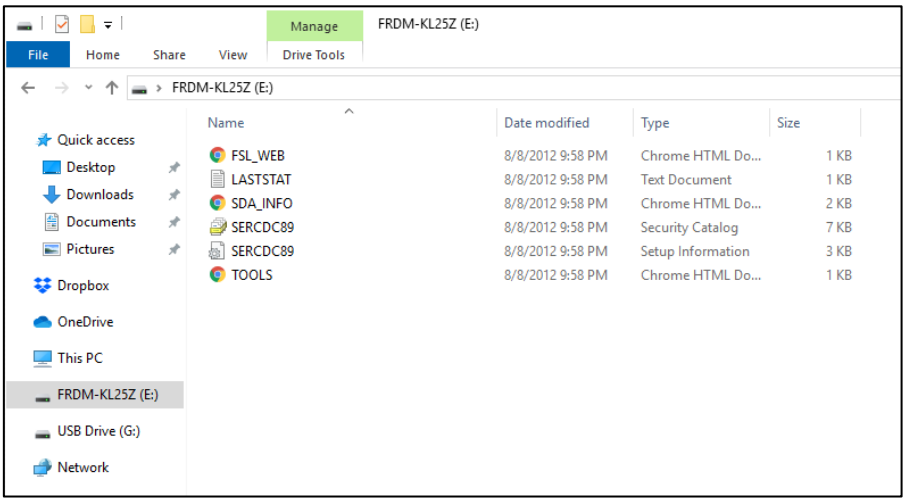


Figure 2: RGB LED Schematic

Testing Pre-Installed Software

The FRDM board comes with a pre-installed software that reads the accelerometer readings and controls the RGB LED accordingly. These are the steps to test that the board is working with the existing software.

1. Unbox the board and plug in the cable to your PC/Laptop and the other end to the port on the board labelled SDA.
2. You will notice that a small Green LED lights up to indicate that the board is powered up.
3. As you start to tilt the board around, the RGB LED should be changing its color.
4. Great! Your board is working fine. ☺
5. Open up your File Explorer and you will notice that the FRDM board actually is recognized like a normal Flash Drive in the system.



This is because, by default, the board is configured to operate under the mbed OS platform. In that platform, the online development tool generates a .bin file that you drag to your board. Upon reboot, the new code will start to execute. As mentioned in the Lecture, we are going to use the RTOC-RTX platform that is provided by Keil. We will now proceed with the necessary software installation.

Software Installation

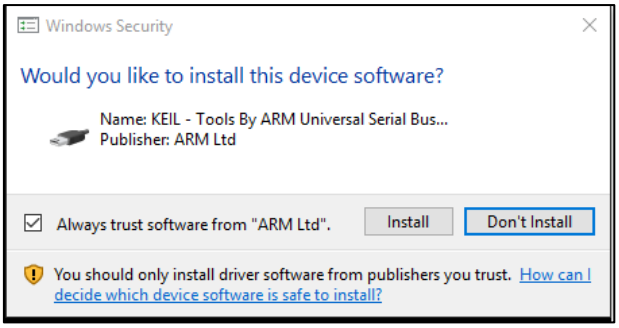
1. Download the Kiel MDK529.exe from this link.

   https://www.keil.com/demo/eval/arm.htm

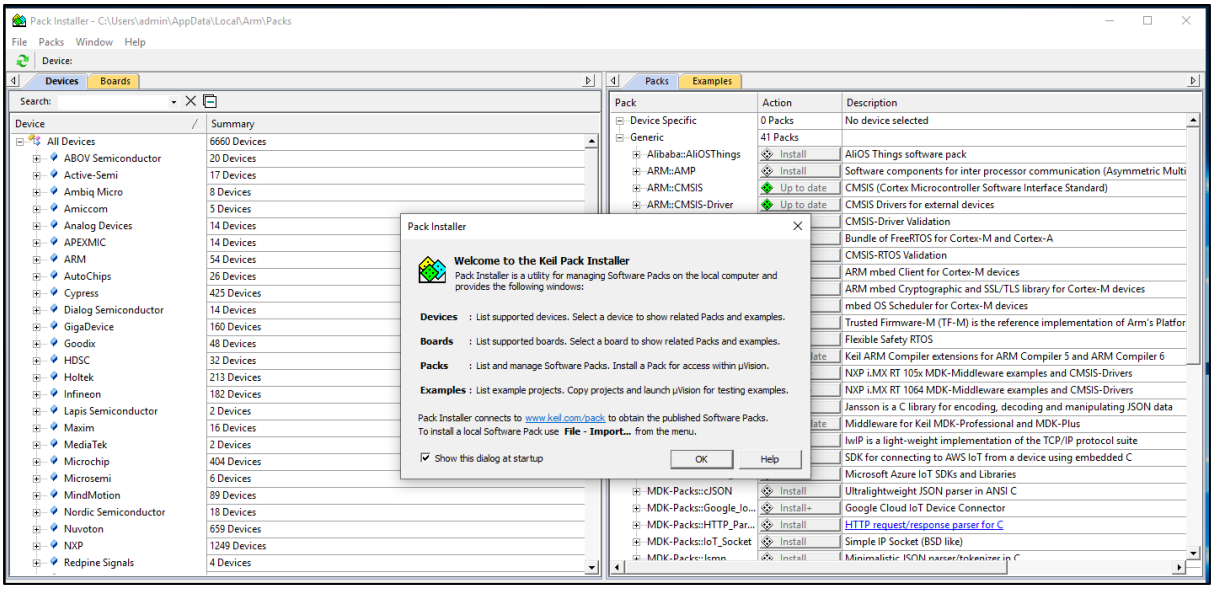
   Alternatively, you can also download it from the LumiNUS under the "Lab Material/SW Installation" Directory.

2. Double-Click on the file to start installation.

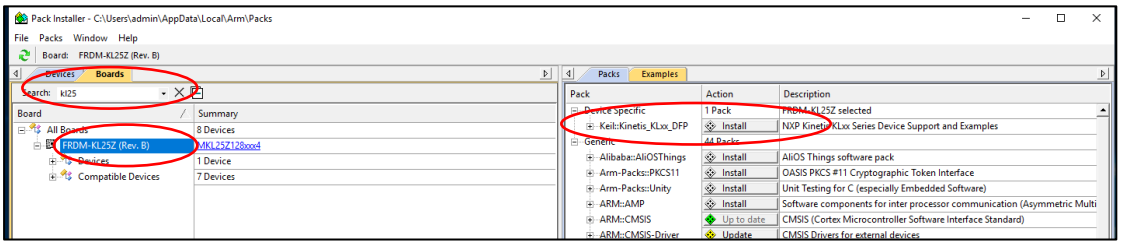
3. If you see a pop-up asking permission to install some drivers, please install them.

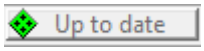


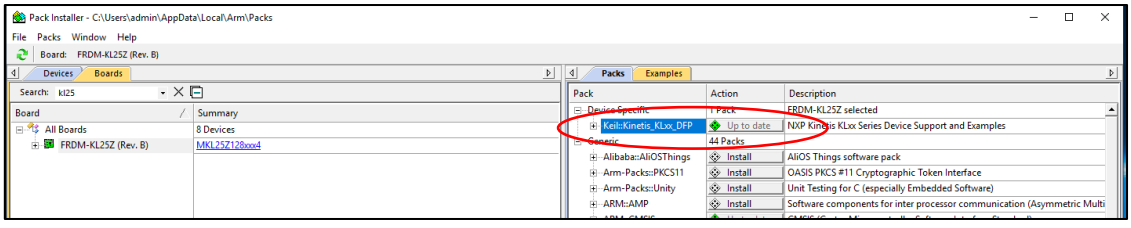
4. Once the basic installation is complete, you need to install the Packages associated with your development board/controller. You will see this window appear. Click “OK”.



5. Select the ‘Board’ tab. In the Search box, key in “kl25”. Select FRDM-KL25.
6. Beside Keil::Kinetis_KLxx_DFP, click on Install. This Software Pack will download and install to C:\Keil_v5\ARM\Pack\Keil\Kinetis_KLxx_DFP\1.0.0\ by default. This download can take a few minutes.



7. Its status is indicated by the “Up to date” icon: 



8. You can now close the Pack Installer.

Creating your First Project

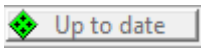
Follow the Steps below to create and download your first project onto the board.

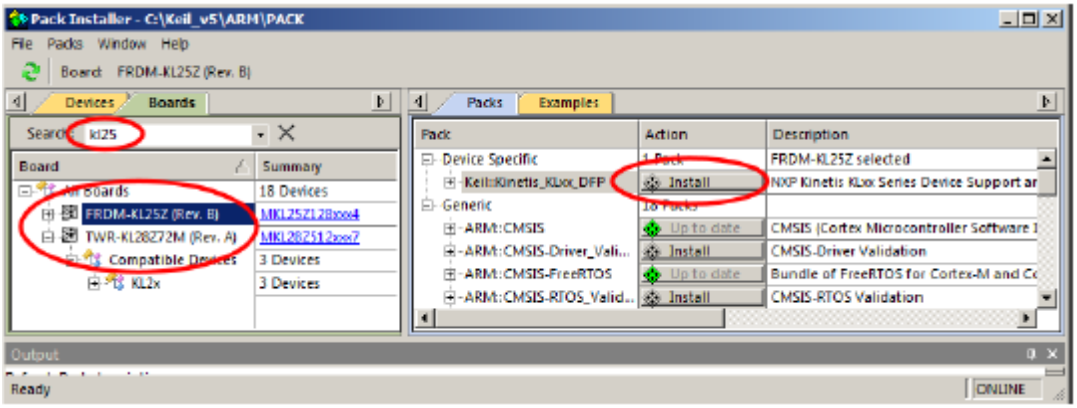
Steps:

A. Start µVision and open Pack Installer:

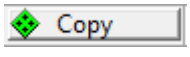
1. Start µVision by clicking on its icon. Ensure your laptop is connected to the internet so that you can download the required SW packs.
2. Open the Pack Installer by clicking on its icon. 

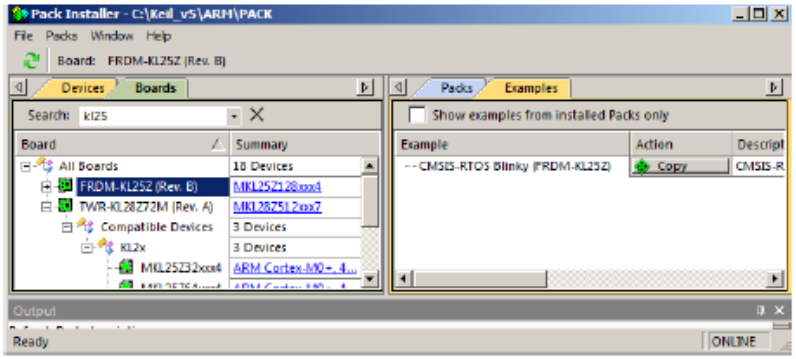
B. Install the KL25 Software Pack: (If have already done it in the earlier step, proceed to Step C)

1. Select the 'Board' tab. In the Search box, key in "kl25". Select FRDM-KL25.
2. Beside Keil::Kinetis_KLxx_DFP, click on Install. This Software Pack will download and install to C:\Keil_v5\ARM\Pack\Keil\Kinetis_KLxx_DFP\1.0.0\ by default. This download can take a few minutes.
3. Its status is indicated by the "Up to date" icon: 



C. Install the RTX_Blink Example:

1. Select the Examples Tab.
2. Select Copy  opposite CMSIS-RTOS Blinky (FRDM-KL25Z): as shown here:



3. The Destination Folder window opens up:
   <Select> Use Pack Folder Structure: <Unselect> Launch µVision.
4. Type in C:\00MDK. Click OK to copy the RTX_Blinky project. You are free to use any folder you like. "00MDK" is the folder that we will be referencing in this tutorial.
5. The RTX_Blinky example will now copy to C:\00MDK\Boards\NXP\FRDM-KL25Z\Blinky\.
6. Close the Packs Installer.

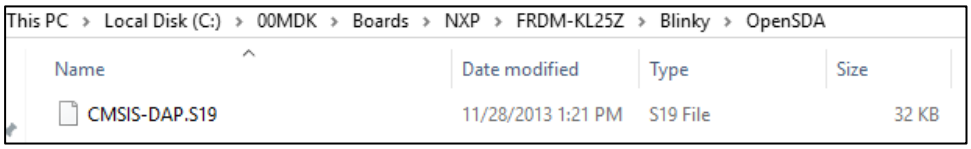
D. <u>Programming the KL25Z with OpenSDA: an on-board Debug Adapter:</u>

This document will use OpenSDA as a SWD Debug Adapter. Target connection by µVision will be via a standard USB cable connected to the OpenSDA port. The on-board Kinetis K20 acts as the debug adapter.

This STEP MUST be Done ONCE!

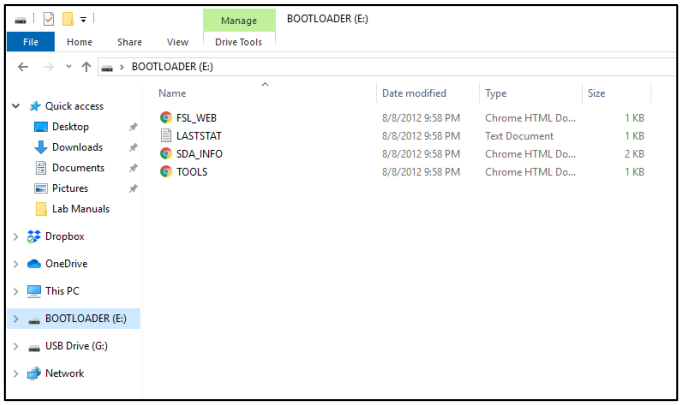
Program the K20 with the CMSIS-DAP application file CMSIS-DAP.S19:

1. Locate the file CMSIS-DAP.S19:
   - CMSIS-DAP.S19 is located in the OpenSDA directory in MDK KL25 projects. Using Windows Explorer navigate to C:\00MDK\Boards\NXP\FRDM-KL25Z\Blinky\OpenSDA. CMSIS-DAP.S19 is located here. The other projects also contain this file. You will copy this file into the Freedom board USB device as described below.

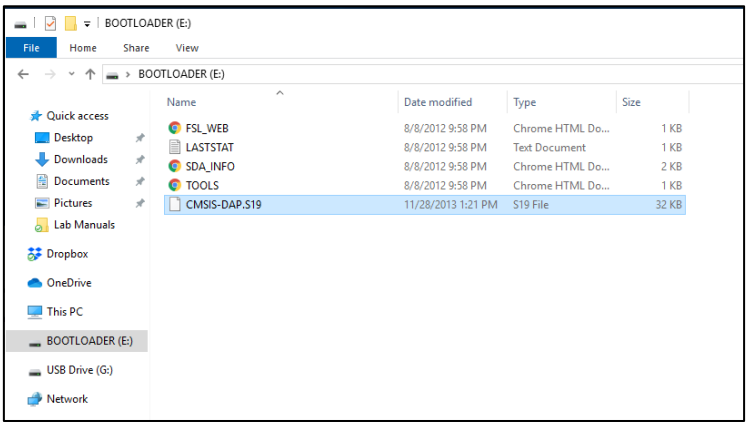


   Note: The Directory depends on where you copied the RTX_Blinky files to in the earlier instruction.

2. Put the Freedom Board into Bootloader: Mode:
   - Hold RESET button SW1 on the Freedom board down and connect a USB cable to the OpenSDA port.
   - When you hear the USB dual-tone, release RESET.
   - The green led D4 will blink about once per second. The Freedom is now ready to be programmed with the CMSIS-DAP application.
   - The Freedom will act as a USB mass storage device called BOOTLOADER connected to your PC. Open this USB device with Windows Explorer.



3. Copy CMSIS-DAP.S19 into the Freedom Board:
    - Copy and paste or drag and drop CMSIS-DAP.S19 into this Bootloader USB device.



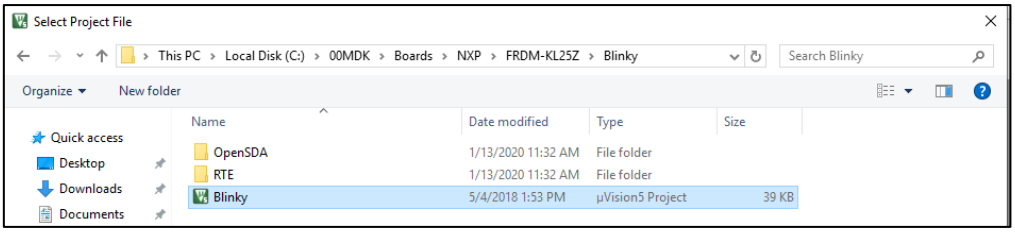
4. Exit Bootloader Mode:
    - Cycle the power to the Freedom board while not holding RESET button down. Do this by plugging out the USB cable and plugging it back in. The green led will blink once and then stay off.
    - The Freedom board is now ready to be used with the µVision debugger and Flash programmer.

Please note that the steps done in Section D need to be done ONLY once for every new board. Subsequently, it will work directly with the µVision debugger and Flash programmer.

E. Blinky Example Program using the NXP Freedom KL25Z and OpenSDA:

Now we will connect a Keil MDK development system using the Freedom board and OpenSDA in CMSIS-DAP mode. Your board must have the application CMSIS-DAP.S19 programmed into the OpenSDA processor before you can continue. (This was done in the earlier steps)

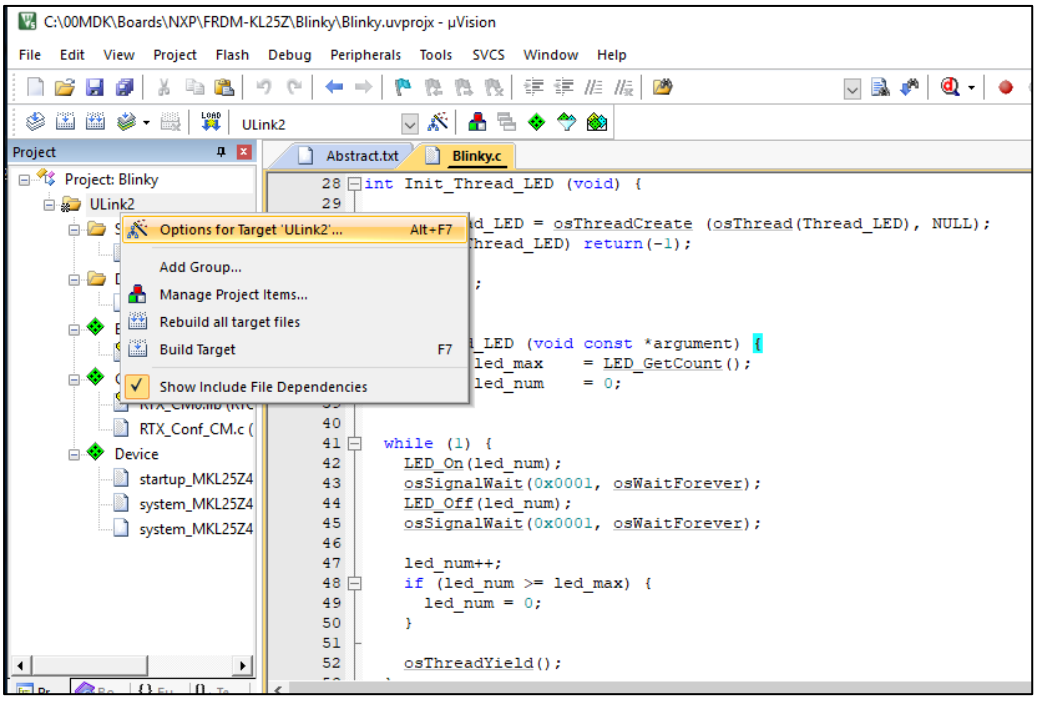
1. Connect a USB cable between your PC and Freedom SDA J7 as shown here:
2. Start µVision by clicking on its desktop icon.
3. Select Project/Open Project.
4. Open the Blinky file:
   C:\00MDK\Boards\NXP\FRDM-KL25Z\Blinky\Blinky.uvprojx.



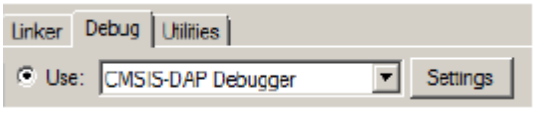
Once the project has been opened, you can click on the "Blinky.c" file in the project directory on the left. Briefly go through the code. Its ok if you don't quite understand it now. It will become clearer over the next few weeks.

Now, we need to create Target Options for OpenSDA (in CMSIS-DAP mode), so that we can download the compiled code onto the board.

5. Select Options for Target or ALT-F7. Click on the Debug tab to select a debug adapter.



6. Select CMSIS-DAP Debugger as shown here: <an important step>



7. Select the "Use MicroLIB" option under the Target Tab.
8. Click OK to Save your settings.

F. Compile and RUN the Blinky Project:

1. Compile the source files by clicking on the Rebuild icon. 
2. Enter Debug mode by clicking on the Debug icon  .
   Select OK if the Evaluation Mode box appears.

3. Click on the RUN icon. 

   Note: You can stop the program with the STOP icon. 

OBSERVATION:

The three colour LED D3 on the Freedom board will now blink in sequence.

Now you know how to compile a program, program it into the KL25Z processor Flash, run it and stop it! Note: The board will start Blinky stand-alone. Blinky is now permanently programmed in the Flash until reprogrammed.

Do not be concerned with understanding the code right now. We will get to that pretty soon! ☺

THE END!