BBM 434 – Embedded Systems Lab Lab 1 Instructions

Based on Lab 2 of the EDX course UT.6.01x Embedded Systems - Shape the World.

Lab Preparation

Watch the introduction to the board:

https://www.youtube.com/watch?v=SRr6-6Bwb00

Installation of the required software

In this lab, you will first need to install the required software and drivers.

Step 1) Installing Keil µVision for the ARM, MDK-Lite (32KB) Edition

We will be using Keil uVision IDE, and writing software in C. These programs only run on Windows (XP, Vista, 7, 8 or 10). There is a way to install software on a Macintosh so Windows and its applications will run on the Macintosh, see running Keil on a Macintosh. There are no solutions for Linux (note that if you are a Linux user you may use Texas Instruments Code Composer Studio[™] (CCStudio) to develop software for Texax Instruments microcontrollers, but in this course we will be using Keil uVision). The Keil application does not require a serial number or license key.

1) Go to <u>https://www.keil.com/demo/eval/arm.htm</u> and download mdk526.exe and download this 894MB file to your computer (or download it from <u>https://web.cs.hacettepe.edu.tr/~bbm432/files/mdk526.exe</u>).

3) Execute the mdk526.exe file, installing the application to C:\Keil_v5.

Setup MDK-ARM V5.26			×
Welcome to Keil MDK-ARM Release 9/2018		arm	KEIL
This SETUP program installs: MDK-ARM V5.26 This SETUP program may be used to update a previ However, you should make a backup copy before pr	ous product installation oceeding.		
Follow the instructions to complete the product install	s before continuing wit lation.	N SETUP.	
Keil MDK-ARM Setup			
	<< Back	Next >>	Cancel

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To continue with SETUP, you must accept the terms of the License Agreement. To accept the agreement, click the check box below. END USER LICENCE AGREEMENT FOR MDK-ARM THIS END USER LICENCE AGREEMENT ("LICENCE") IS A LEGAL AGREEMENT BETWEEN YOU (EITHER A SINGLE INDIVIDUAL, OR SINGLE LEGAL ENTITY) AND ARM LIMITED ("ARM") FOR THE USE OF THE SOFTWARE ACCOMPANYING THIS LICENCE. ARM IS ONLY WILLING TO LICENSE THE SOFTWARE TO YOU ON CONDITION THAT YOU ACCEPT ALL OF THE TERMS IN THIS LICENCE. BY CLIMING "I AGREE" OR BY INSTALLING OR OTHERWISE USING OR COPYING I agree to all the terms of the preceding License Agreement eit MDK-ARM Setup	Please read the following license agreement carefully	у.	um	KEI
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Install Keil to C:\Keil_v5, and click Next.

older Selection	armveil
Select the folder where SETUP will install files.	UTTIKEI
Press 'Neut' to install MDK-ARM to these folders. Press 'Prowe	e' to select different folders for installation
Destination Folders	
Core: C:\Keil_v5	Browse
Pack: C:\Keil_v5\ARM\PACK	Browse
Update Installation: Create backup tool folder	
I ■ Backup old core files to C:\Keil_v5\Backup.002	
tel MDK-ARM Setup	

Update these fields with your correct information, and click Next.

ascomer mitorina	ion	armveil
Please enter your	information.	UTTIKEI
Please enter your r	name, the name of the company for wh	nom you work and your E-mail address.
First Name:	Your name	
Last Name:	Your surname	
Last Name: Company Name:	Your surname Hacettepe University	
Last Name: Company Name: E-mail:	Your surname Hacettepe University your e-mail	

Wait while it installs.

etup MDK-ARM V5.26			×	
Setup Status	armke			
MDK-ARM Setup is performing the requested operations.				
Install Files				
Installing TARMP3.dll.				

If prompted, select Add example Projects to the recently used project list, and click Finish.

etup MDK-ARM V5.26			>
Keil MDK-ARM Setup completed		arm	KFII
MDK-ARM V5.26			
MDK-ARM Core Setup has performed all requested ope	rations successfully.		
🔽 Show Release Notes.			
I Retain current µVision configuration.			
Keil MDK-ARM Setup			
	<< Back	Finish	Cancel

Step 2) Installing Windows drivers for the LaunchPad board

Once Keil is installed you will need to install the windows drivers for the Texas Instruments microcontroller board. The process is the same for both the LM4F120 and the TM4C123 LaunchPads. You will need the actual physical LaunchPad board to complete this step. So if you have ordered your board and it hasn't yet arrived, come back to this step once your board arrives.

Download the current drivers from: http://www.ti.com/tool/stellaris_icdi_drivers

Plug in the LaunchPad into a USB port. Pick the USB port you will most likely want to use. Plug the mini-USB into the socket labelled **Debug**. Make sure the LaunchPad power is on. There is a slider switch near the USB that should be in the **Debug** position. The green LED near the USB will illuminate when power is applied. Open the device manager program (click **Start**, and then in the **Search for files and programs** window type **device manager**) and you should see three In-Circuit Debug Interface devices that do not have drivers (yellow exclamation point).





For each device, first right-click on the device and then select Update Driver Software.



You will be given a choice to "Search automatically..." or to "Browse my computer...". Click **Browse my** computer for driver software.

🔋 Update Driver Software - In-Circuit Debug Interface	×
Update Driver Software - In-Circuit Debug Interface	
How do you want to search for driver software?	
Search automatically for updated driver software Windows will search your computer and the Internet for the latest driver software for your device, unless you've disabled this feature in your device installation settings.	
Browse my computer for driver software Locate and install driver software manually.	
	Cancel

Browse your computer and find the location of the windows drivers you downloaded (you may get a security warning about Windows not being able to verify the publisher. If so, click **Install this driver anyway**).



Repeat these steps for all devices with yellow exclamation points. After you have successfully installed the drivers, there should be no yellow exclamation points. However, if you do see one of Stellaris devices with a driver error, try right-clicking on the device with error and select **Update driver software**, and try the process again. Sometimes it doesn't install on the first try, but does install on the second try.



You may also check the Driver Installation Instructions for Stellaris® In-Circuit Debug Interface (ICDI) and Virtual COM Port for more details at <u>http://www.ti.com/lit/ml/spmu287c/spmu287c.pdf</u>

Lab Experiment Instructions

Part 1) Run the lab in the simulator

For each lab we will first design, develop, and debug in simulation. Since Lab 1 does not require you to build any hardware or software, all you will do here is run the example program in simulation mode. This step also verifies you have properly installed **Keil uVision**. Verify that you have the file <u>LaunchPadDLL.dll</u> TExaS simulator is in your **Keil_v5****ARM****BIN** folder.

You will find the example files and starter codes for lab 1 in the **434_Lab1_Toggle_PF1** folder. Download from here: <u>https://web.cs.hacettepe.edu.tr/~bbm432/files/434_Lab1_Toggle_PF1.zip</u>

1) Open the Lab1 project file C2_Toggle_PF1.uvproj in the 434_Lab1_Toggle_PF1 directory.

2) Verify it is configured to run in the simulator (see Figure below).

C:\Keil_v5\TExaS	\Keil_v5\TExaSware\434_Lab1_Toggle_PF1\C2_Toggle_PF1.uvproj - µVision									
File Edit View	Project	Flash	Debug	Peripherals	Tools	SVCS	Window	Help		
i 🗋 💕 🛃 🥔	Nev	w µVisio	n Project							Γ
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	Sel	ect Devic	e for Targ	et						il
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	💦 Op	tions for	Target 'C	2_Toggle_PF1'					Alt+F7	
	Cle	an Targe	ts							

🕅 Options for Target 'C2_Toggle_PF1'	×
Device rarget Output Listing User C/C++ Asm	Linker Debug Utilities
Use Simulator with restrictions Settings Limit Speed to Real-Time	O Use: Stellaris ICDI
Load Application at Startup Iver Run to main() Initialization File: Edit	Load Application at Startup Run to main() Initialization File:
Restore Debug Session Settings Breakpoints Toolbox Watch Windows & Performance Analyzer Memory Display System Viewer	Restore Debug Session Settings
CPU DLL: Parameter: SARMCM3.DLL -MPU Dialog DLL: Parameter:	Driver DLL: Parameter: SARMCM3.DLL -MPU Dialog DLL: Parameter:
DCM.DLL pCM4 -dLaunchPadDLL	TCM.DLL pCM4
Manage Component Vi	ewer Description Files
ОК Са	ncel Defaults Help

- 3) Build the project by executing **Project->Build Target**.
- 4) Start the debugger in simulation mode.

C:\Keil_v5\TExaSware\434_Lab1_1	loggle	PF1\C2_Toggle_PF	F1.uvproj - µVis	ion		
File Edit View Project Flash	Deb	ug Peripherals	Tools SVCS	W'r .ow	Help	
i 🗋 💕 🛃 🥥 🕺 🖻 🛍	٩	Start/Stop Debug	Session	Ctrl+F5	115 🖄	V 🗟 🥠
🏼 🍪 📽 🐳 - 📖 🙀 🕻 c	Q.	Energy Measureme	ent without Deb	ug	2	
Project 🛛 📮 🔀	RST	Reset CPU				
Project: C2_Toggle_PF1		Run		F5	D;	<pre>// 6) disable alt funct</pre>
🖃 归 C2_Toggle_PF1	0	Ston				<pre>// enable pull-up on Pl</pre>

5) Run the program and notice the LED outputs.

TExaS LaunchPadDLL		\times
Port F Hardware	☐ TM4C123	16 MHz
SW1 🗖 🛓	+33 F ₹ F PF4 F +33 F	2F3 ↓ LED 2F1 ★ ✓ LED ↓ LED ↓ LED
SW2 ⊫ ≢	PFO	
Port F Registers		
DATA: 0x15	PUR: 0x11	LOCK: 0x00
DIR: 0x0E	PDR: 0x00	CR: 0x1F
DEN: 0x1F R	CGCGPIO: 0x00000	020 Clock enabled

If you do not see the window with the Port F input/output, execute **Peripherals->TExaSPortF.** Another trick to reset all the windows in their default position is to execute **Window->SetViewToDefault**.

Part 2) Run the lab on the LaunchPad

After you have completed the lab in simulation mode, you will switch over and debug it on the real board. You will simply run the same project on the actual LaunchPad.

- In Keil, open Project->OptionsForTarget. Under the Device tab, search for your board and select it (TM4C123GH6PM). In the Target tab, select TExaS in the Operating System drop-down menu, and for the option Floating Point Hardware select Not Used. In the Debug tab, click on the Use button on the right (instead of Use Simulator) and select the Stellaris ICDI. Under the Utilities tab, click on Use Target Driver for Flash Programming and select Stellaris ICDI.
- 2) Compile the project by executing **Project->Rebuild all target files**
- 3) Download the object code into Flash EEPROM by executing Flash->Download
- 4) Start the debugger by executing **Debug->Start/Stop Debug Session**
- 5) Run your program executing by **Debug->Run**. At this point you can watch the LEDs on your board.

Part 3) Experiment with the code

Open the file *main.c* and have a look at the C code in the Keil IDE. Discuss the following:

- 1) Which part of the code turns on and off the LEDs?
- 2) What is the purpose of Delay() function?
- 3) How can you make the LED flash slower? Which part of the code needs to change and how?
- 4) From what you see in the code, how can you make the LED flash just one color, e.g. green?

You will be graded for both written report and lab demonstration performance.

How to Submit the Written Report

The deadline for the submission is **Friday 15 March 2019 until 13:00** (no further extensions will be allowed!). Submit your work through <u>http://submit.cs.hacettepe.edu.tr/</u> (submission via e-mail will not be accepted!) in the following format:

- b<studentID>.zip
 - **report.pdf**