Laboratory 3: LED Blinking
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CSE 2240 –Spring_2017_Lab_Assignments
Assembly Language Programming and Machine Organization
TA: Naseer Jan
Junkins 215 & 217
Due date: 10 April, 2017
Section N11 - Tu 12:00PM - 1:50PM Junkins 215
Section N12 - Th 3:00PM - 4:50PM Junkins 217
Section N13 - Tu 8:00AM - 9:50AM Junkins 215

Laboratory 3: LED Blinking

This lab comprises three parts: part-I (Board Set Up and Blinking LEDs Example), part II (i.e. Project setup) & Part-III (ARM assembly programming for LED Blinking). This lab enables you that how to control LEDs and introduce delay among LEDs

STEP I : Board and Blinking LEDs Example

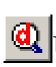
a) Open the ARM evaluation board user's guide
http://www.keil.com/support/man/docs/mcbstm32c/default.htm
b) Follow steps given in sub-topic 'setup' to setup your board
The MCBSTM32 board requires a power connection and a ULINK-USB adapter between your development PC and the JTAG connector.
To use the MCBSTM32C Evaluation Board with ULINK, you must:

- Connect the ULINK adapter to the JTAG connector of the MCBSTM32C board
- Connect the ULINK adapter to the PC via a standard USB cable
- Connect power from your PC to the board using either a USB A to Micro A or USB A to Micro B cable

c) Load and Debug Blinky project to understand the concept which is as follows:
You can see this in action using uVision Debugger.
Go to: C\ Keil_v5\ARM\Boards\Keil\MCBSTM32C\Blinky\ Blinky.uvproj

Click the **Download to Flash** toolbar button. This executes the Flash download program (**Target Driver** or **External**) selected in **Project — Options for Target — Utilities** and downloads the application program into the STM32F10x device

Start the Debugger


Use the **Start/Stop Debug Session** toolbar button to start debugging the program.

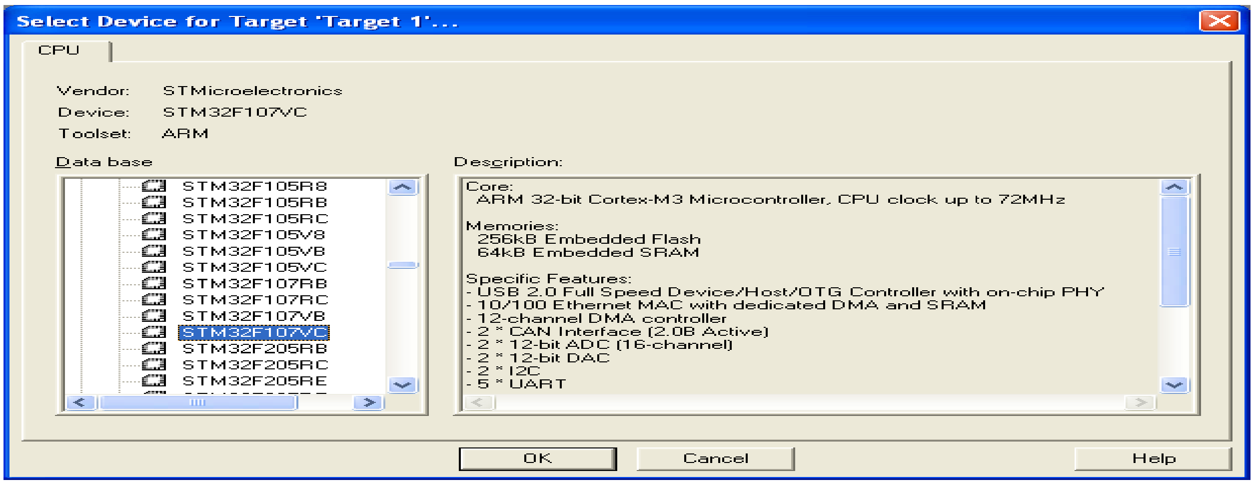
Or Use the µVision command, **Debug — Start/Stop Debug Session**, to start debugging the program

STEP II: Project setup

a) Create new project under **Project → New → µVision Project**, name it 'Led' and save it under project directory. Select the device STM32F107VC under STMicroelectronics. DO NOT add the default startup file. The default startup file is meant to work with C-programs. We have edited the default startup file so that it works with ASM code.

Device selection

Select the microcontroller from the Device Database
Vendor: STMicroelectronics
Device: STM32F107VC



b) Please check the appendix to verify if your project settings are correct.
c) Create groups 'startup' and 'source' to organize all project files
d) Copy the file ***system_stm32f10x_cl.s*** in the project directory and in Keil add under group 'system' link: https://drive.google.com/open?id=0BwUNL1MgoXQkcDl6em1ZUlBKZEE or http://bit.ly/2dQoeee
e) Add a new source file under 'source'. You can now start writing assembly codes for your lab (refers to **step III**).

STEP III: ARM assembly programming for LED Blinking

Write an ARM assembly program using c code for Blinky project. The 'Blinky' project is a simple program for the ST 'STM32F107VC' microcontroller using Keil 'MCBSTM32C' Evaluation Board.
Functionality: 8 LEDs blink with speed depending on user defined value.

Hints:

- Ignore /* Setup and initialize ADC converter in C program i.e. from line # 29 to line#53. Use user specify value instead of ADC converter.

- Setup the clock for port E (GPIOE) and configure port E to work as an output port. LEDs are connected to this port.

- Calculate and determine the addresses of registers required to configure and use port E by referring to section 2.3 Memory map, Table 1. Register boundary addresses for RCC and GPIOE.

- RCC_APB2ENR refers section 6.3.7 APB2 peripheral clock enable register (RCC_APB2ENR)
  GPIOE_CRH and GPIOE_BSRR refers to section 8.2 GPIO registers.

- For example: address of GPIOE_BSRR (Port bit set/reset register) is GPIOE boundary address =0x4001 1800 + and BSRR = 0x10
  GPIOE_BSRR = 0x40011810

- You will have to store these addresses in one the general purpose registers to access these port registers.

  - setup the clock for port E store value 0x40 in APB2ENR

- To setup port E as an output port store value 0x33333333 in GPIOE_CRH

- To turn ON any port pins on port E set appropriate bits in lower half of GPIOE_BSRR. Please refer to the 'ARM STM32 Reference Manual' for Cortex M3 for more information about BSRR.

- To turn OFF any port pins on port E set appropriate bits in lower half of GPIOE_BSRR. Please refer the reference manual for Cortex M3 for more information about BSRR

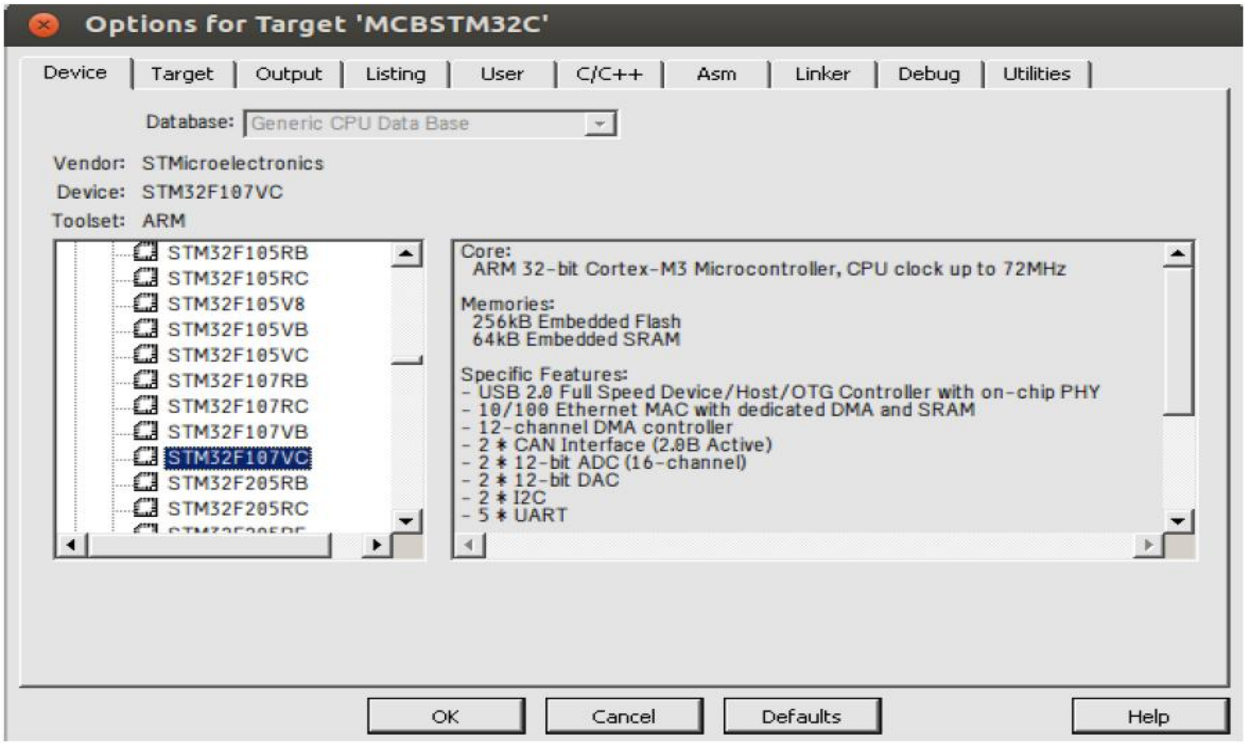
```
#include <stm32f10x_cl.h>
#define LED_NUM 8                          /* Number of user LEDs */
const long led_mask[] = { 1<<15, 1<<14, 1<<13, 1<<12, 1<<11, 1<<10, 1<<9, 1<<8 };
int main (void) {
int AD_val, i;
int num = -1;
int dir = 1;
SystemInit();
                                           /* Setup GPIO for LEDs */
RCC->APB2ENR |= 1 << 6;                     /* Enable GPIOE clock */
GPIOE->CRH = 0x33333333;                   /* Configure the GPIO for LEDs */
/* Setup and initialize ADC converter      */
RCC->APB2ENR |= 1 << 9;                    /* Enable ADC1 clock */
GPIOC->CRL &= 0xFFF0FFFF;                  /* Configure PC4 as ADC.14 input */
ADC1->SQR1 = 0x00000000;                   /* Regular channel 1 conversion */
ADC1->SQR2 = 0x00000000;                   /* Clear register */
ADC1->SQR3 = 14 << 0;                      /* SQ1 = channel 14 */
ADC1->SMPR1 = 5 << 12;                     /* Channel 14 sample time is 55.5 cyc */
ADC1->SMPR2 = 0x00000000;                  /* Clear register */
ADC1->CR1 = 1 << 8;                         /* Scan mode on */
ADC1->CR2 = (1 << 20) |                    /* Enable external trigger */
(7 << 17) | /* EXTSEL = SWSTART            */
(1 << 1) | /* Continuous conversion        */
(1 << 0) ; /* ADC enable                   */
ADC1->CR2 |= 1 << 3;                       /* Initialize calibration registers */
while (ADC1->CR2 & (1 << 3));              /* Wait for initialization to finish */
ADC1->CR2 |= 1 << 2;                       /* Start calibration */
while (ADC1->CR2 & (1 << 2));              /* Wait for calibration to finish */
ADC1->CR2 |= 1 << 22;                      /* Start first conversion */
for (;;) {                                 /* Loop forever */
if (ADC1->SR & (1 << 1)) {                 /* If conversion has finished */
AD_val = ADC1->DR & 0x0FFF;                /* Read AD converted value */
ADC1->CR2 |= 1 << 22;                      /* Start new conversion */
}
/* Calculate 'num': 0, 1, ... , LED_NUM-1, LED_NUM-1, ... , 1, 0, 0, ... */
num += dir;
if (num >= LED_NUM) { dir = -1; num = LED_NUM-1; }
else if (num < 0) { dir = 1; num = 0; }
GPIOE->BSRR = led_mask[num]; /* Turn LED on */
for (i = 0; i < ((AD_val << 8) + 100000); i++);
```

```
GPIOE->BSRR = led_mask[num] << 16;                    /* Turn LED off */
}
}
```

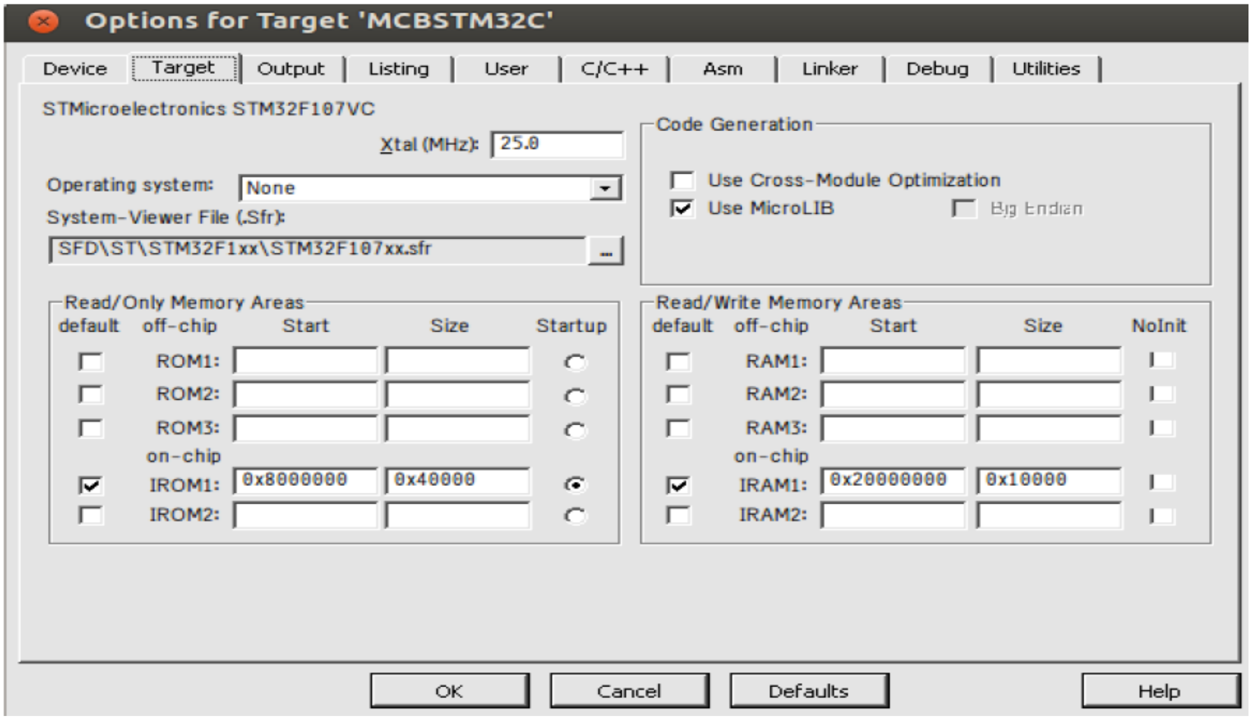
Demonstrate result to the lab instructor
Print and submit the file led.s

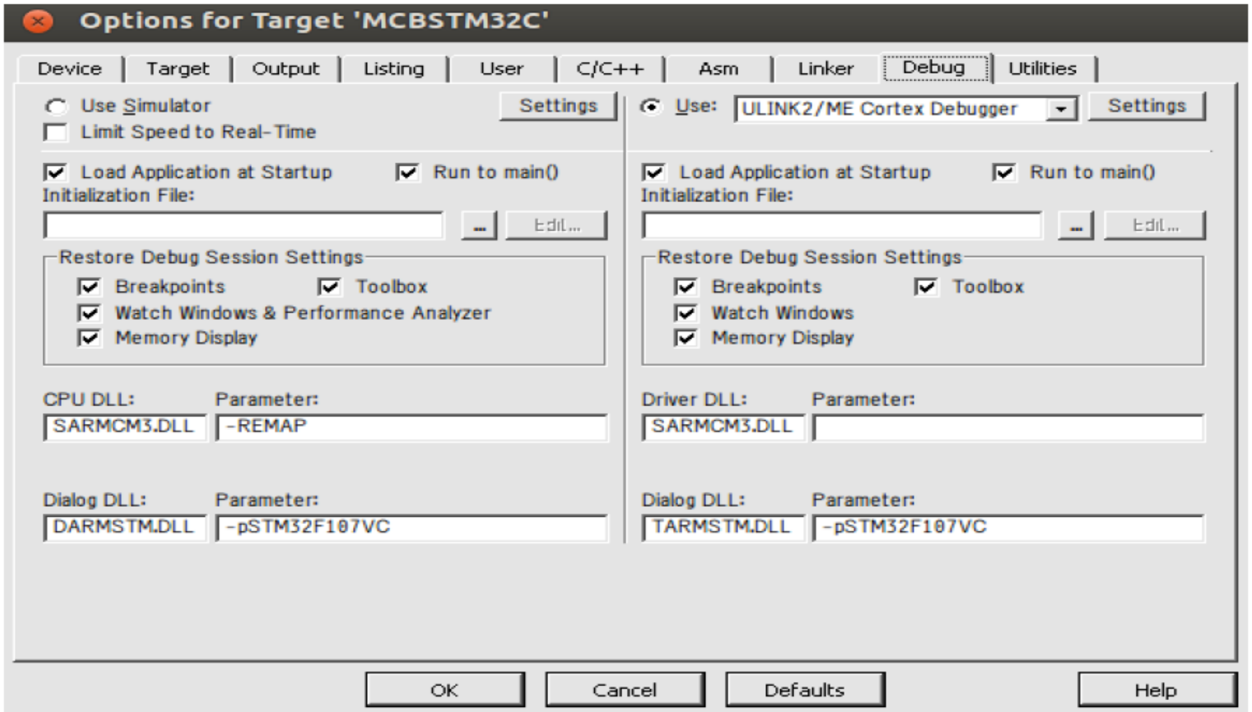
APPENDIX

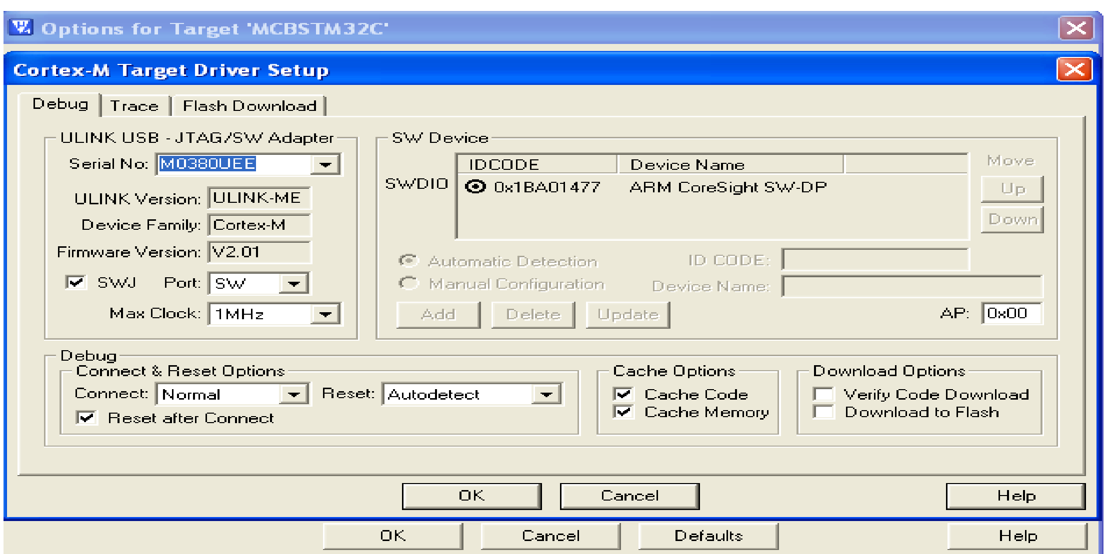
Select STM32F107VC under devices.



Select appropriate range for read/write memory areas. Under 'Code Generation' make sure that 'Use MicroLIB' is checked




Options for Target 'MCBSTM32C'
Device
Target
Output
Listing
User
C/C++
Asm
Linker
Debug
Utilities
Use Simulator
Settings
Limit Speed to Real-Time
Load Application at Startup
Run to main()
Initialization File:
Edit...
Restore Debug Session Settings
Breakpoints
Toolbox
Watch Windows & Performance Analyzer
Memory Display
CPU DLL:
Parameter:
SARMCM3.DLL
-REMAP
Dialog DLL:
Parameter:
DARMSTM.DLL
-pSTM32F107VC
Use:
ULINK2/ME Cortex Debugger
Settings
Load Application at Startup
Run to main()
Initialization File:
Edit...
Restore Debug Session Settings
Breakpoints
Toolbox
Watch Windows
Memory Display
Driver DLL:
Parameter:
SARMCM3.DLL
Dialog DLL:
Parameter:
TARMSTM.DLL
-pSTM32F107VC
OK
Cancel
Defaults
Help


Options for Target 'MCBSTM32C'
Cortex-M Target Driver Setup
Debug
Trace
Flash Download
ULINK USB - JTAG/SW Adapter
Serial No:
M0380UEE
ULINK Version:
ULINK-ME
Device Family:
Cortex-M
Firmware Version:
V2.01
SWJ
Port:
SW
Max Clock:
1MHz
SW Device
IDCODE
Device Name
SWDIO
0x1BA01477
ARM CoreSight SW-DP
Move
Up
Down
Automatic Detection
ID CODE:
Manual Configuration
Device Name:
Add
Delete
Update
AP:
0x00
Debug
Connect & Reset Options
Connect:
Normal
Reset:
Autodetect
Reset after Connect
Cache Options
Cache Code
Cache Memory
Download Options
Verify Code Download
Download to Flash
OK
Cancel
Help
OK
Cancel
Defaults
Help