

Lab 2

Brief: Toggle LED connected to GPIO PORTA Pin13 in STM32F103C6 board which use ARM cortex-m3 chip.

1. **Code Files:** Attached in GitHub repo. In which this file.

2. **Section analyze of each object file and .elf file**

2.1. main.o:

```
MINGW64:/d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Uni...
Mina@Bello MINGW64 /d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit3-
Embedded_C/Lecture_3/Lab_2 (main)
$ arm-none-eabi-objdump -h main.o

main.o:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA           LMA           File off  Algn
  0 .text          000000c8  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data          00000010  00000000  00000000  000000fc  2**2
    CONTENTS, ALLOC, LOAD, DATA
  2 .bss           00000000  00000000  00000000  0000010c  2**0
    ALLOC
  3 .rodata        00000004  00000000  00000000  0000010c  2**2
    CONTENTS, ALLOC, LOAD, READONLY, DATA
  4 .debug_info    00000252  00000000  00000000  00000110  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev  000000e5  00000000  00000000  00000362  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_loc     0000002c  00000000  00000000  00000447  2**0
    CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges 00000020  00000000  00000000  00000473  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_line    00000069  00000000  00000000  00000493  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  9 .debug_str     0000019d  00000000  00000000  000004fc  2**0
    CONTENTS, READONLY, DEBUGGING
10 .comment       00000012  00000000  00000000  00000699  2**0
    CONTENTS, READONLY
11 .ARM.attributes 00000033  00000000  00000000  000006ab  2**0
    CONTENTS, READONLY
12 .debug_frame   00000028  00000000  00000000  000006e0  2**2
    CONTENTS, RELOC, READONLY, DEBUGGING
```

2.2. startup.o:

```
MINGW64:/d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Uni...
Mina@Bello MINGW64 /d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit3-
Embedded_C/Lecture_3/Lab_2 (main)
$ arm-none-eabi-objdump -h startup.o

startup.o:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA           LMA           File off  Algn
  0 .text          000000fc  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data           00000000  00000000  00000000  00000130  2**0
    CONTENTS, ALLOC, LOAD, DATA
  2 .bss            00000000  00000000  00000000  00000130  2**0
    ALLOC
  3 .vectors        0000001c  00000000  00000000  00000130  2**2
    CONTENTS, ALLOC, LOAD, RELOC, DATA
  4 .debug_info     00000171  00000000  00000000  0000014c  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev   000000c2  00000000  00000000  000002bd  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_loc      00000064  00000000  00000000  0000037f  2**0
    CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges  00000020  00000000  00000000  000003e3  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_line     0000007b  00000000  00000000  00000403  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  9 .debug_str      00000181  00000000  00000000  0000047e  2**0
    CONTENTS, READONLY, DEBUGGING
10 .comment         00000012  00000000  00000000  000005ff  2**0
    CONTENTS, READONLY
11 .ARM.attributes  00000033  00000000  00000000  00000611  2**0
    CONTENTS, READONLY
12 .debug_frame     0000004c  00000000  00000000  00000644  2**2
    CONTENTS, RELOC, READONLY, DEBUGGING
```

2.3. lab_2.elf:

```
MINGW64:/d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit...
Mina@Bello MINGW64 /d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit3-Embedded_C/Lecture_3/Simulator (main)
$ arm-none-eabi-objdump -h lab_2.elf

lab_2.elf:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA           LMA           File off  Algn
  0 .text          000001e4  08000000  08000000  00008000  2**2
    CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .data          00000010  20000000  080001e4  00010000  2**2
    CONTENTS, ALLOC, LOAD, DATA
  2 .bss           00001004  20000010  080001f4  00010010  2**2
    ALLOC
  3 .debug_info     000003c3  00000000  00000000  00010010  2**0
    CONTENTS, READONLY, DEBUGGING
  4 .debug_abbrev   000001a7  00000000  00000000  000103d3  2**0
    CONTENTS, READONLY, DEBUGGING
  5 .debug_loc      00000090  00000000  00000000  0001057a  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges  00000040  00000000  00000000  0001060a  2**0
    CONTENTS, READONLY, DEBUGGING
  7 .debug_line     000000e4  00000000  00000000  0001064a  2**0
    CONTENTS, READONLY, DEBUGGING
  8 .debug_str      000001ff  00000000  00000000  0001072e  2**0
    CONTENTS, READONLY, DEBUGGING
  9 .comment        00000011  00000000  00000000  0001092d  2**0
    CONTENTS, READONLY
10 .ARM.attributes 00000033  00000000  00000000  0001093e  2**0
    CONTENTS, READONLY
11 .debug_frame     00000074  00000000  00000000  00010974  2**2
    CONTENTS, READONLY, DEBUGGING
```

3. Symbols of object files and .elf

3.1. main.o:

```
MINGW64:/d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit...
Mina@Bello MINGW64 /d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit3-Embedded_C/Lecture_3/Simulator (main)
$ arm-none-eabi-nm main.o
00000000 D APB2ENR
00000000 R const_Var
0000000c D g_variables
00000008 D GPIOA_ODR
00000004 C i
00000000 T main
00000004 D R_CRH
```

3.2. startup.o:

```
MINGW64:/d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit3-Embedded_C/Lecture_3/Simulator (main)
$ arm-none-eabi-nm startup.o
                 U _E_bss
                 U _E_data
                 U _E_text
                 U _S_bss
                 U _S_data
                 U _stack_top
00000000 W Bus_Fault
00000000 T Default_Handler
00000000 W H_Fault_Handler
                 U i
                 U main
00000000 W MM_Fault_Handler
00000000 W NMI_Handler
0000000c T Reset_Handler
00000000 W Usage_Fault_Handler
00000000 D vectors
```

3.3. lab_2.elf:

```
MINGW64:/d/Mastering_embedded_systems/GitHub_Repo/Embedded_Systems_Online_Diploma/Unit3-Embedded_C/Lecture_3/Simulator (main)
$ arm-none-eabi-nm lab_2.elf
20000010 B _E_bss
20000010 D _E_data
080001e4 T _E_text
20000010 B _S_bss
20000000 D _S_data
20001010 B _stack_top
20000000 D APB2ENR
080000e4 W Bus_Fault
080001e0 T const_Var
080000e4 T Default_Handler
2000000c D g_variables
20000008 D GPIOA_ODR
080000e4 W H_Fault_Handler
20001010 B i
0800001c T main
080000e4 W MM_Fault_Handler
080000e4 W NMI_Handler
20000004 D R_CRH
080000f0 T Reset_Handler
080000e4 W Usage_Fault_Handler
08000000 T vectors
```

4. Map_file.map:

```
D:\Mastering_embedded_systems\GitHub_Repo\Embedded_Systems_Online_Diploma\Unit3-Em...
File Edit Selection Find View Goto Tools Project Preferences Help
linker_script.ld x main.c x Makefile x Map_file.map x startup.c x + v
1
2 Allocating common symbols
3 Common symbol      size      file
4
5 i                  0x4      main.o
6
7 Memory Configuration
8
9 Name              Origin              Length              Attributes
10 flash             0x08000000          0x00020000          xR
11 sram               0x20000000          0x00050000          xRW
12 *default*         0x00000000          0xffffffff
13
14 Linker script and memory map
15
16
17 .text              0x08000000          0x1e4
18 *(.vectors*)
19 .vectors           0x08000000          0x1c startup.o
20                   0x08000000          vectors
21 *(.text*)
22 .text              0x0800001c          0xc8 main.o
23                   0x0800001c          main
24 .text              0x080000e4          0xfc startup.o
25                   0x080000e4          H_Fault_Handler
26                   0x080000e4          MM_Fault_Handler
27                   0x080000e4          Usage_Fault_Handler
28                   0x080000e4          Bus_Fault
29                   0x080000e4          Default_Handler
30                   0x080000e4          NMI_Handler
31                   0x080000f0          Reset_Handler
32 *(.rodata)
33 .rodata            0x080001e0          0x4 main.o
34                   0x080001e0          const_var
35                   0x080001e4          _E_text = .
36
37 .glue_7            0x080001e4          0x0
38 .glue_7            0x00000000          0x0 linker stubs
39
40 .glue_7t           0x080001e4          0x0
41 .glue_7t           0x00000000          0x0 linker stubs
42
43 .vfp11_veneer      0x080001e4          0x0
44 .vfp11_veneer      0x00000000          0x0 linker stubs
45
46 .v4_bx             0x080001e4          0x0
47 .v4_bx             0x00000000          0x0 linker stubs
48
49 .iplt              0x080001e4          0x0
50 .iplt              0x00000000          0x0 main.o
51
52 .rel.dyn           0x080001e4          0x0
53 .rel.iplt          0x00000000          0x0 main.o
54
55 .data              0x20000000          0x10 load address 0x080001e4
56                   0x20000000          _S_data = .
57 *(.data)
58 .data              0x20000000          0x10 main.o
59                   0x20000000          APB2ENR
60                   0x20000004          R_CRH
61                   0x20000008          GPIOA_ODR
62                   0x2000000c          g_variables
63 .data              0x20000010          0x0 startup.o
64                   0x20000010          _E_data = .
65
66 .igot.plt           0x20000010          0x0 load address 0x080001f4
67 .igot.plt           0x00000000          0x0 main.o
68
69 .bss               0x20000010          0x1004 load address 0x080001f4
70                   0x20000010          _S_bss = .
71 *(.bss)
```

```

72      .bss                0x20000010      0x0 main.o
73      .bss                0x20000010      0x0 startup.o
74                                0x20000010      . = ALIGN (0x4)
75                                0x20000010      _E_bss = .
76                                0x20001010      . = (. + 0x1000)
77      *fill*              0x20000010      0x1000
78                                0x20001010      _stack_top = .
79      COMMON              0x20001010      0x4 main.o
80                                0x20001010      i
81  LOAD main.o
82  LOAD startup.o
83  OUTPUT(lab_2.elf elf32-littlearm)
84
85      .debug_info          0x00000000      0x3c3
86      .debug_info          0x00000000      0x252 main.o
87      .debug_info          0x00000252      0x171 startup.o
88
89      .debug_abbrev         0x00000000      0x1a7
90      .debug_abbrev         0x00000000      0xe5 main.o
91      .debug_abbrev         0x000000e5      0xc2 startup.o
92
93      .debug_loc            0x00000000      0x90
94      .debug_loc            0x00000000      0x2c main.o
95      .debug_loc            0x0000002c      0x64 startup.o
96
97      .debug_aranges        0x00000000      0x40
98      .debug_aranges        0x00000000      0x20 main.o
99      .debug_aranges        0x00000000      0x20 startup.o
100
101      .debug_line           0x00000000      0xe4
102      .debug_line           0x00000000      0x69 main.o
103      .debug_line           0x00000069      0x7b startup.o
104
105      .debug_str             0x00000000      0x1fb
106      .debug_str             0x00000000      0x17d main.o
107      .debug_str             0x00000000      0x19d (size before relaxing)
108      .debug_str             0x0000017d      0x7e startup.o
109      .debug_str             0x0000017d      0x181 (size before relaxing)
110
111      .comment               0x00000000      0x11
112      .comment               0x00000000      0x11 main.o
113      .comment               0x00000000      0x12 (size before relaxing)
114      .comment               0x00000000      0x12 startup.o
115
116      .ARM.attributes        0x00000000      0x33
117      .ARM.attributes        0x00000000      0x33 main.o
118      .ARM.attributes        0x00000000      0x33 startup.o
119
120      .debug_frame          0x00000000      0x74
121      .debug_frame          0x00000000      0x28 main.o
122      .debug_frame          0x00000028      0x4c startup.o
123
124
125
126
127
128

```