Lab

❖ Toggle LED By STM32 and processor CortexM3 :

➢ Main.c :

-

```c
/* By Abdelrahman Matarawy */
#include "Platform_Types.h"

/* Register Address */
#define RCC_Base_Address    0x40021000
#define GPIO_PortA          0x40010800
/* Bit in Register RCC */
#define RCC_APB2ENR             *(( vuint32_t*) (RCC_Base_Address + 0x18))
/* Bits In Register GPIO */
#define GPIO_CRH                *(( vuint32_t*) (GPIO_PortA + 0x04))
#define GPIO_ODR                *(( vuint32_t*) (GPIO_PortA + 0x0c))
/* To Write in all register bits or specific bit */
typedef union{
    vuint32_t all_fields;
    struct{
    vuint32_t reserved : 13;
    vuint32_t p_13 : 1;
    }Pin;
}R_ODR_T;

volatile R_ODR_T *  R_ODR =  (( volatile R_ODR_T *) (GPIO_PortA + 0x0c));
uint8_t g_variables[3] = {1,2,3}; /* Saved in .data section */
uint8_t const const_variables[3] = {1,2,3}; /* Saved in .rodata section */
uint8_t uninit_Gvariable[3]; /* Saved in .bss section */

/* For check weak feature */
extern void NMI_Handler()
{
}
extern void Bus_Fault()
{
}
int main(void)
{
    int i;
    RCC_APB2ENR |= (1<<2); // Write on bit 2 logic high
    GPIO_ODR |=(1<<13); // Write on bit 13 logic high
    GPIO_CRH &=0xFF0FFFFF;
    GPIO_CRH |=0x00200000;
    while(1)
    {
        /* For Applying Logic 1 for seconds and toggle it with logic low */
        R_ODR ->Pin.p_13 = 1;
        for(i = 0; i < 5000; i++);
        R_ODR ->Pin.p_13 = 0;
        for(i = 0; i < 5000; i++);
    }
}
```

➢ StartUp.s :

```
/* By Abdelrahman Matarawy */
/* StartUp for CortexM3 */

/* Interupt Vector Table */
.section .vectors

.word 0x20001000          /* Address added for stack top */
.word _reset              /* 1 Reset Handler */
.word vector_handler      /* 2 NMI */
.word vector_handler      /* 3 Hard fault */
.word vector_handler      /* 4 MM fault */
.word vector_handler      /* 5 Bus fault */
.word vector_handler      /* 6 usage fault */
.word vector_handler      /* 7 Reserved */
.word vector_handler      /* 8 Reserved */
.word vector_handler      /* 9 Reserved */
.word vector_handler      /* 10 Reserved */
.word vector_handler      /* 11 SV call */
.word vector_handler      /* 12 Debug reserved */
.word vector_handler      /* 13 Reserved */
.word vector_handler      /* 14 pendSV */
.word vector_handler      /* 15 SysTick */
.word vector_handler      /* 16 IRQ0 */
.word vector_handler      /* 17 IRG1 */
.word vector_handler      /* 18 IRG2 */
.word vector_handler      /* 19 ... */

.section .text
_reset:
    bl main
    b .

/* For activate 16 bits mode */
.thumb_func

vector_handler:
    b _reset
```

➢ StartUp.c :

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```c
/* StartUp.c For CortexM3
By Eng:Abdelrahman Matarawy
*/

#include "Platform_Types.h"
int i;
extern unsigned int stack_top;
extern int main(void);

void Reset_Handler() ;

void Default_Handler()
{
    Reset_Handler();
}

void NMI_Handler() __attribute__((weak, alias("Default_Handler")));

void H_Fault_Handler() __attribute__((weak, alias("Default_Handler")));

void MM_Fault_Handler() __attribute__((weak, alias("Default_Handler")));

void Bus_Fault() __attribute__((weak, alias("Default_Handler")));

void Usage_Fault_Handler() __attribute__((weak, alias("Default_Handler")));
/* Array for IVT */

uint32_t vectors[] __attribute__((section(".vectors")))={
    (uint32_t) &stack_top,
    (uint32_t) &Reset_Handler,
    (uint32_t) &NMI_Handler,
    (uint32_t) &H_Fault_Handler,
    (uint32_t) &MM_Fault_Handler,
    (uint32_t) &Bus_Fault,
    (uint32_t) &Usage_Fault_Handler,
};

extern uint32_t _E_text;
extern uint32_t _S_data;
extern uint32_t _E_data;
extern uint32_t _S_bss;
extern uint32_t _E_bss;
void Reset_Handler()
{
    /* Copy data section from flash to ram */
    uint32_t  Data_Size = (uint8_t*)&_E_data - (uint8_t*)&_S_data;
    uint8_t* source = (uint8_t*)&_E_text;
    uint8_t* destination = (uint8_t*)&_S_data;
    for(i = 0 ; i < Data_Size ; i++ )
    {
        *((uint8_t*)source++) = *((uint8_t*)destination++);
    }
    /* Init bss section with zeros in ram */
    uint32_t  Bss_Size = (uint8_t*)&_E_bss - (uint8_t*)&_S_bss;
    destination = (uint8_t*)&_S_bss;
    for(i = 0 ; i < Data_Size ; i++ )
    {
        *((uint8_t*)source++) = (uint8_t)0;
    }
    /* jump to main */
    main();
}
```

➢ Linker Script:

```
/* Linker_Script for CortexM3 */
/* By Abdelrahman Matarawy */

MEMORY
{
    flash(RX): ORIGIN = 0x08000000, LENGTH = 128K
    sram(RWX): ORIGIN = 0x20000000, LENGTH = 20K
}

SECTIONS
{
    .text : {
        *(.vectors*)
        *(.text*)
        *(.rodata)
        . = ALIGN(4);
        _E_text = . ;
    } > flash

    .data : {
        _S_data = . ;
        *(.data)
        . = ALIGN(4);
        _E_data = . ;
    } > sram AT> flash

    .bss : {
        _S_bss = . ;
        *(.bss*)
        . = ALIGN(4);
        _E_bss = . ;
        . = . + 0x1000 ;
        stack_top = . ;
    } > sram
}
```

➢ Make file:

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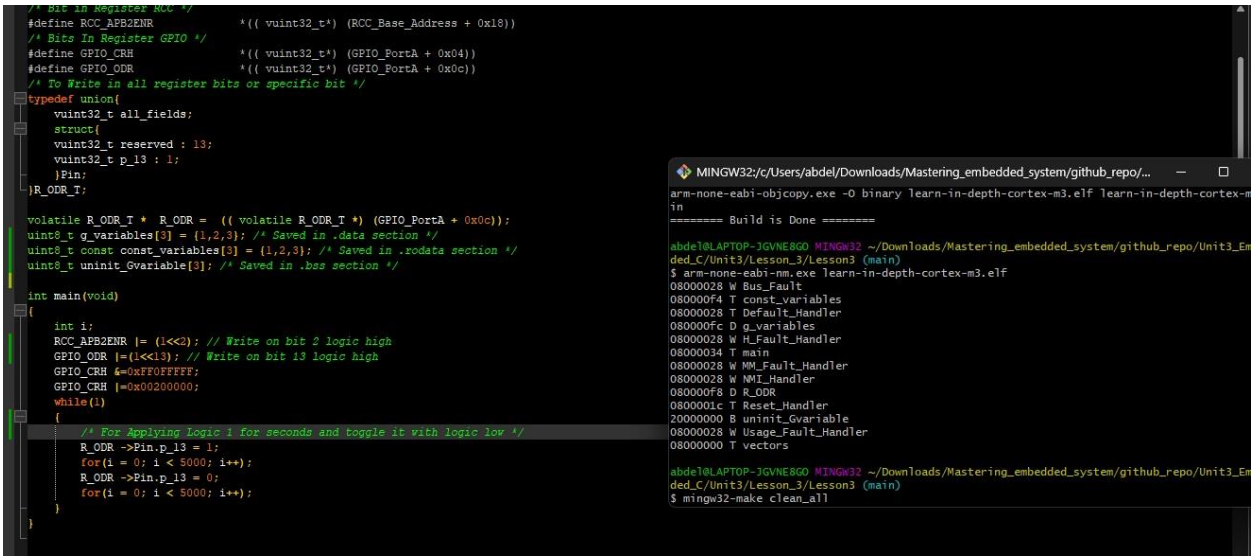
```
#@CopyWriter: Matarawy

CC=arm-none-eabi-
CFLAGS= -mcpu=cortex-m3 -gdwarf-2
INCS=-I .
LIBS=
SRC =$(wildcard *.c)
OBJ =$(SRC:.c=.o)
As = $(wildcard *.s)
AsOBJ=$(As:.s=.o)
Project_Name= learn-in-depth-cortex-m3


all: $(Project_Name).bin
    @echo "======== Build is Done ========"

%.o: %.s
    $(CC)as.exe $(CFLAGS) -mthumb $< -o $@

%.o: %.c
    $(CC)gcc.exe -c $(INCS) $(CFLAGS) -mthumb $< -o $@

$(Project_Name).elf: $(OBJ) $(AsOBJ)
    $(CC)ld.exe -T linker_script.ld  $(LIBS) $(OBJ) $(AsOBJ) -o $@ -Map=Map_file.map

$(Project_Name).bin: $(Project_Name).elf
    $(CC)objcopy.exe -O binary $< $@

clean_all:
    rm *.o *.elf *.bin

clean:
    rm *.elf *.bin
```

Before Weak and alias :



```
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#define RCC_APB2ENR             *(( vuint32_t*) (RCC_Base_Address + 0x18))
/* Bits In Register GPIO */
#define GPIO_CRH                *(( vuint32_t*) (GPIO_PortA + 0x04))
#define GPIO_ODR                *(( vuint32_t*) (GPIO_PortA + 0x0c))
/* To Write in all register bits or specific bit */
typedef union{
    vuint32_t all_fields;
    struct{
    vuint32_t reserved : 13;
    vuint32_t p_13 : 1;
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}R_ODR_T;

volatile R_ODR_T *  R_ODR =  (( volatile R_ODR_T *) (GPIO_PortA + 0x0c));
uint8_t g_variables[3] = {1,2,3}; /* Saved in .data section */
uint8_t const const_variables[3] = {1,2,3}; /* Saved in .rodata section */
uint8_t uninit_Gvariable[3]; /* Saved in .bss section */

int main(void)
{
    int i;
    RCC_APB2ENR |= (1<<2); // Write on bit 2 logic high
    GPIO_ODR |=(1<<13); // Write on bit 13 logic high
    GPIO_CRH &=0xFF0FFFFF;
    GPIO_CRH |=0x00200000;
    while(1)
    {
        /* For Applying Logic 1 for seconds and toggle it with logic low */
        R_ODR ->Pin.p_13 = 1;
        for(i = 0; i < 5000; i++);
        R_ODR ->Pin.p_13 = 0;
        for(i = 0; i < 5000; i++);
    }
}
```
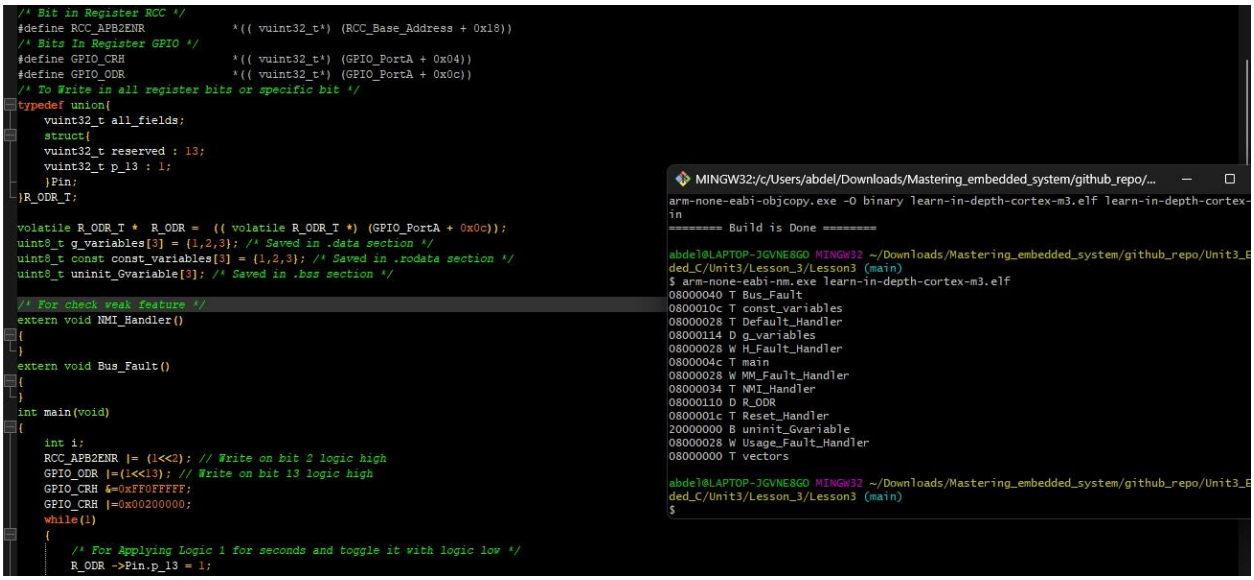

```
MINGW32:/c/Users/abdel/Downloads/Mastering_embedded_system/github_repo/...
arm-none-eabi-objcopy.exe -O binary learn-in-depth-cortex-m3.elf learn-in-depth-cortex-m
in
======== Build is Done ========

abdel@LAPTOP-JGVNE8GO MINGW32 ~/Downloads/Mastering_embedded_system/github_repo/Unit3_Em
ded_C/Unit3/Lesson_3/Lesson3 (main)
$ arm-none-eabi-nm.exe learn-in-depth-cortex-m3.elf
08000028 W Bus_Fault
080000f4 T const_variables
08000028 T Default_Handler
080000fc D g_variables
08000028 W H_Fault_Handler
08000034 T main
08000028 W MM_Fault_Handler
08000028 W NMI_Handler
080000f8 D R_ODR
0800001c T Reset_Handler
20000000 B uninit_Gvariable
08000028 W Usage_Fault_Handler
08000000 T vectors

abdel@LAPTOP-JGVNE8GO MINGW32 ~/Downloads/Mastering_embedded_system/github_repo/Unit3_Em
ded_C/Unit3/Lesson_3/Lesson3 (main)
$ mingw32-make clean_all
```

After weak and alias :



```
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#define RCC_APB2ENR             *(( vuint32_t*) (RCC_Base_Address + 0x18))
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#define GPIO_CRH                *(( vuint32_t*) (GPIO_PortA + 0x04))
#define GPIO_ODR                *(( vuint32_t*) (GPIO_PortA + 0x0c))
/* To Write in all register bits or specific bit */
typedef union{
    vuint32_t all_fields;
    struct{
    vuint32_t reserved : 13;
    vuint32_t p_13 : 1;
    }Pin;
}R_ODR_T;

volatile R_ODR_T *  R_ODR =  (( volatile R_ODR_T *) (GPIO_PortA + 0x0c));
uint8_t g_variables[3] = {1,2,3}; /* Saved in .data section */
uint8_t const const_variables[3] = {1,2,3}; /* Saved in .rodata section */
uint8_t uninit_Gvariable[3]; /* Saved in .bss section */

/* For check weak feature */
extern void NMI_Handler()
{
}
extern void Bus_Fault()
{
}
int main(void)
{
    int i;
    RCC_APB2ENR |= (1<<2); // Write on bit 2 logic high
    GPIO_ODR |=(1<<13); // Write on bit 13 logic high
    GPIO_CRH &=0xFF0FFFFF;
    GPIO_CRH |=0x00200000;
    while(1)
    {
        /* For Applying Logic 1 for seconds and toggle it with logic low */
        R_ODR ->Pin.p_13 = 1;
```
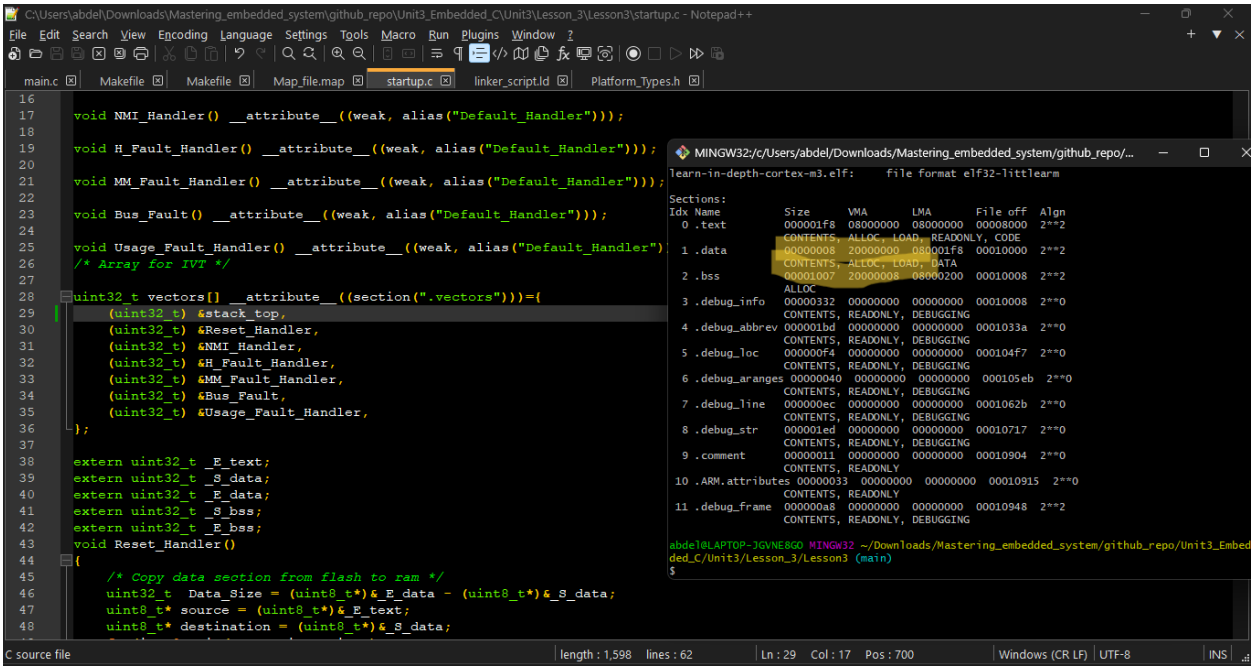

```
MINGW32:/c/Users/abdel/Downloads/Mastering_embedded_system/github_repo/...
arm-none-eabi-objcopy.exe -O binary learn-in-depth-cortex-m3.elf learn-in-depth-cortex-
in
======== Build is Done ========

abdel@LAPTOP-JGVNE8GO MINGW32 ~/Downloads/Mastering_embedded_system/github_repo/Unit3_E
ded_C/Unit3/Lesson_3/Lesson3 (main)
$ arm-none-eabi-nm.exe learn-in-depth-cortex-m3.elf
08000040 T Bus_Fault
0800010c T const_variables
08000028 T Default_Handler
08000114 D g_variables
08000028 W H_Fault_Handler
0800004c T main
08000028 W MM_Fault_Handler
08000034 T NMI_Handler
08000110 D R_ODR
0800001c T Reset_Handler
20000000 B uninit_Gvariable
08000028 W Usage_Fault_Handler
08000000 T vectors

abdel@LAPTOP-JGVNE8GO MINGW32 ~/Downloads/Mastering_embedded_system/github_repo/Unit3_E
ded_C/Unit3/Lesson_3/Lesson3 (main)
$
```

Copy data section and init bss section :



When led on :