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1-introduction

This project is about how to detect high pressure in cabin and inform the crew of cabin with an alarm when the pressure exceeds 20 bars and the alarm duration equals 60 seconds.

2- system architecting /design sequence

2.1 case study (pressure controlling system)

-” **client**” expects you to deliver the software of the following system:

- Specification (from the client)

- **A pressure controller** informs the crew of a cabin with an alarm **when the pressure exceeds 20 bars in the cabin**

- **The alarm duration** equals 60 seconds.

- keeps track of the measured values.

- Pressure Controller: Assumptions

The controller set up and shutdown procedures are not modeled

The controller maintenance is not modeled

The pressure sensor never fails

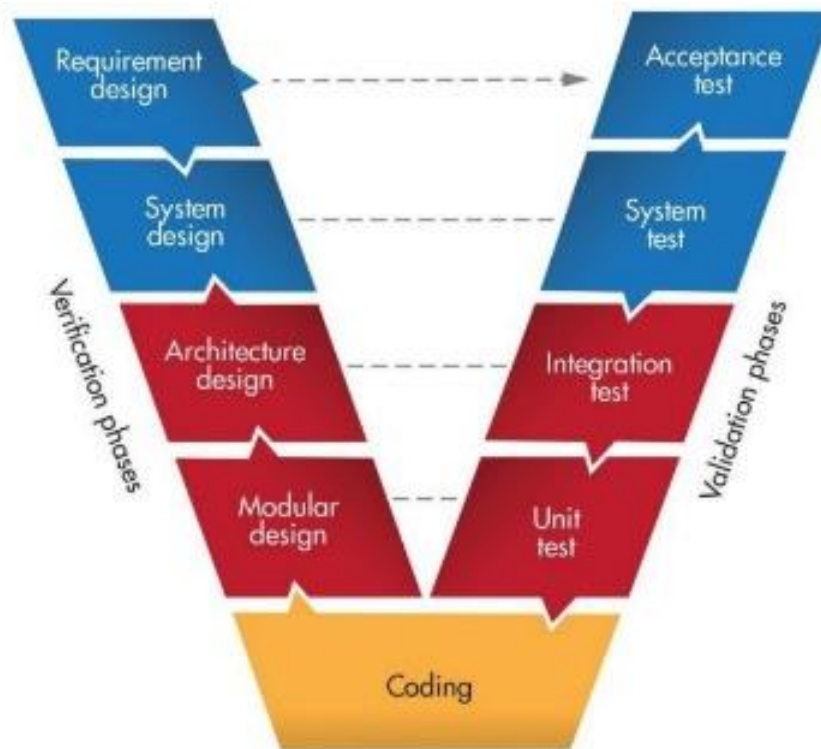
The alarm never fails

The controller never faces power cut

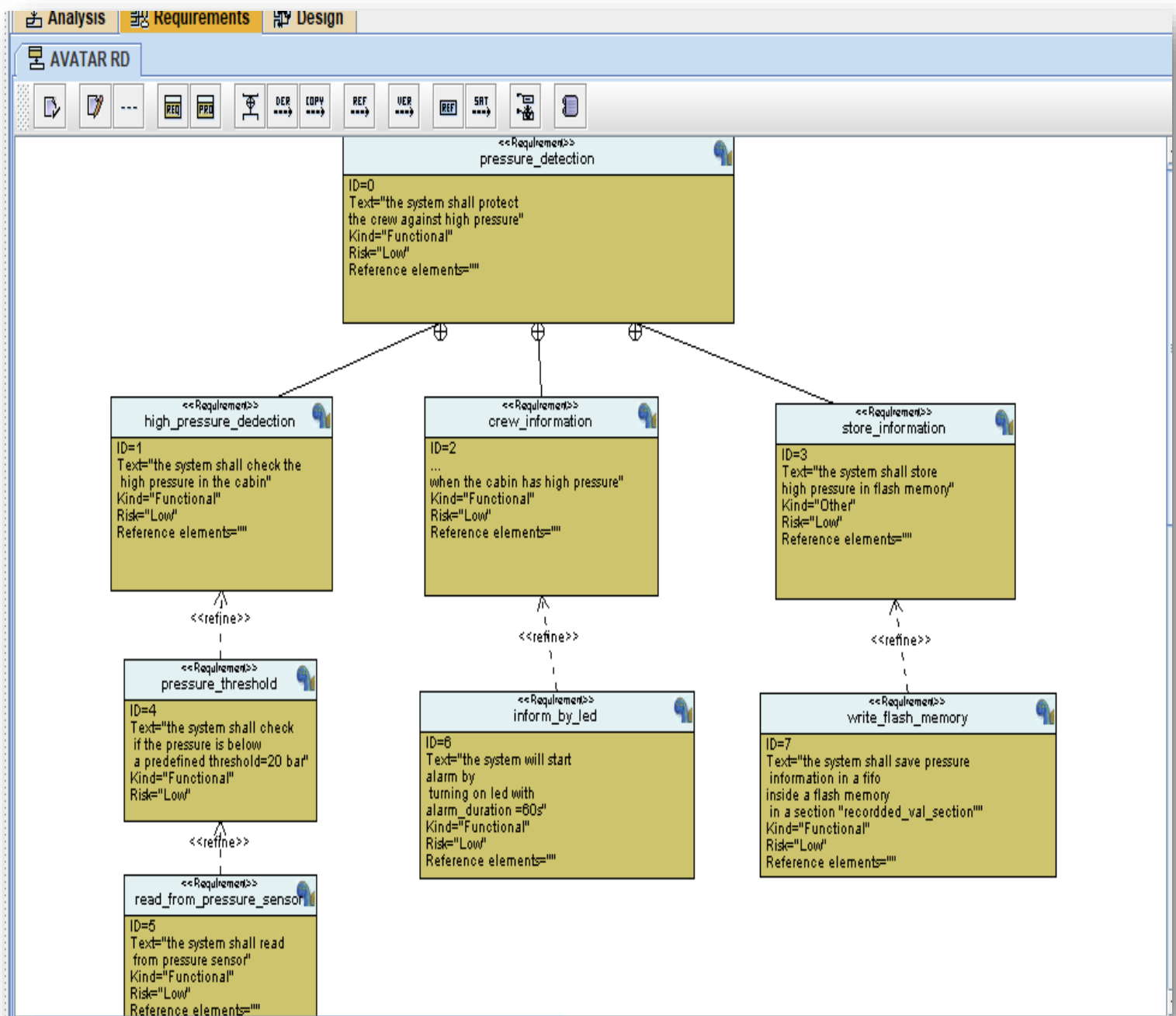
- **Versioning**• The” keep track of measured value” option is not modeled in the first version of the design

2.2 method (SDLC &STLC)

starting with v-model for example



2.3 system requirement

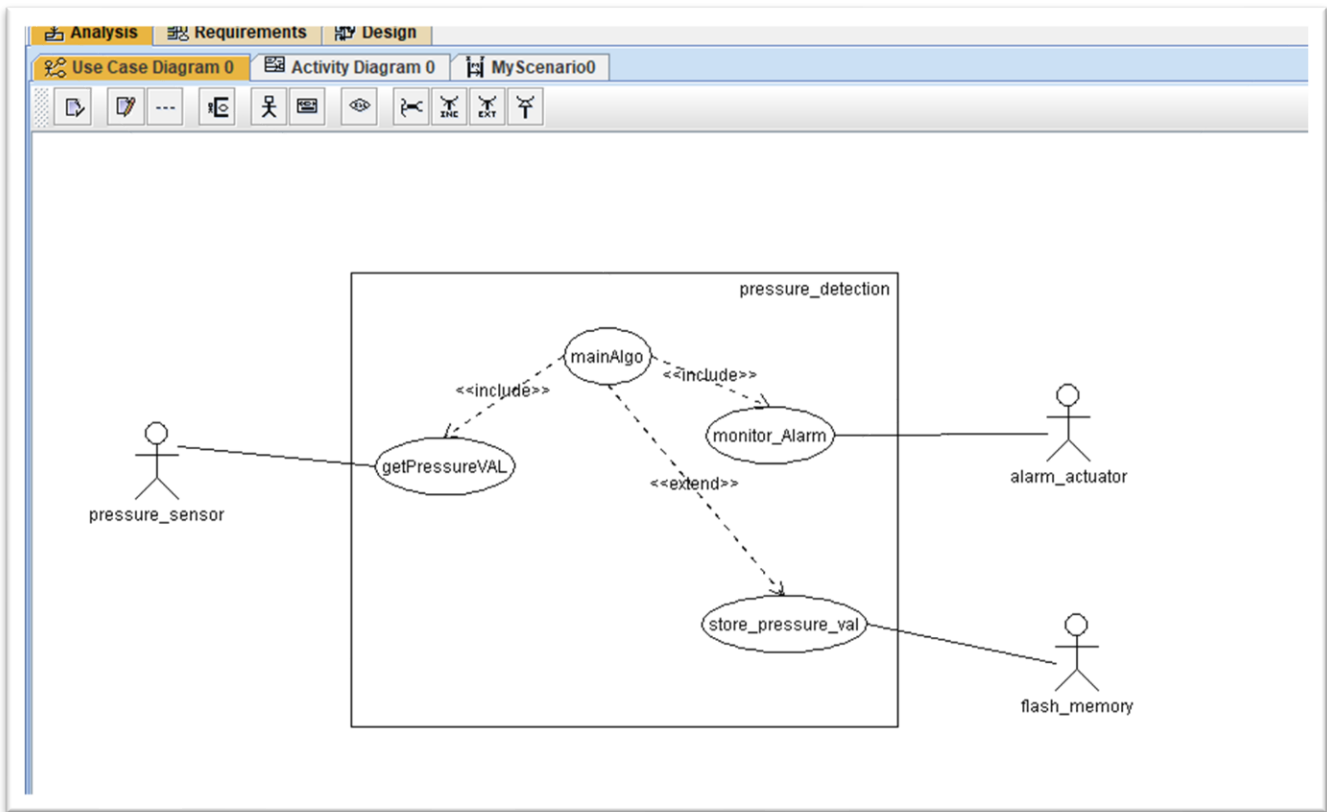


2.4 space exploration/partitioning

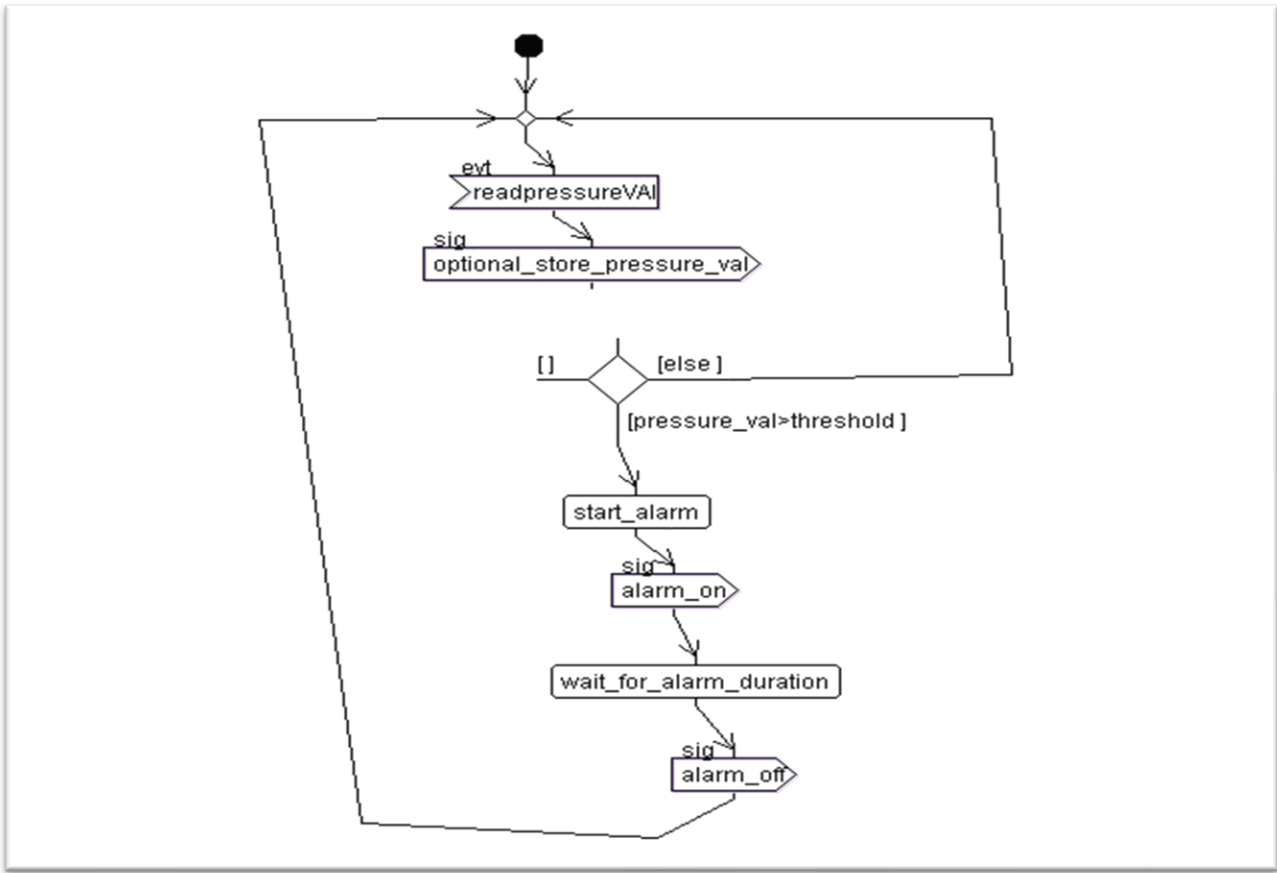
How to chose MCs and number of MCs.

2.5 System analysis

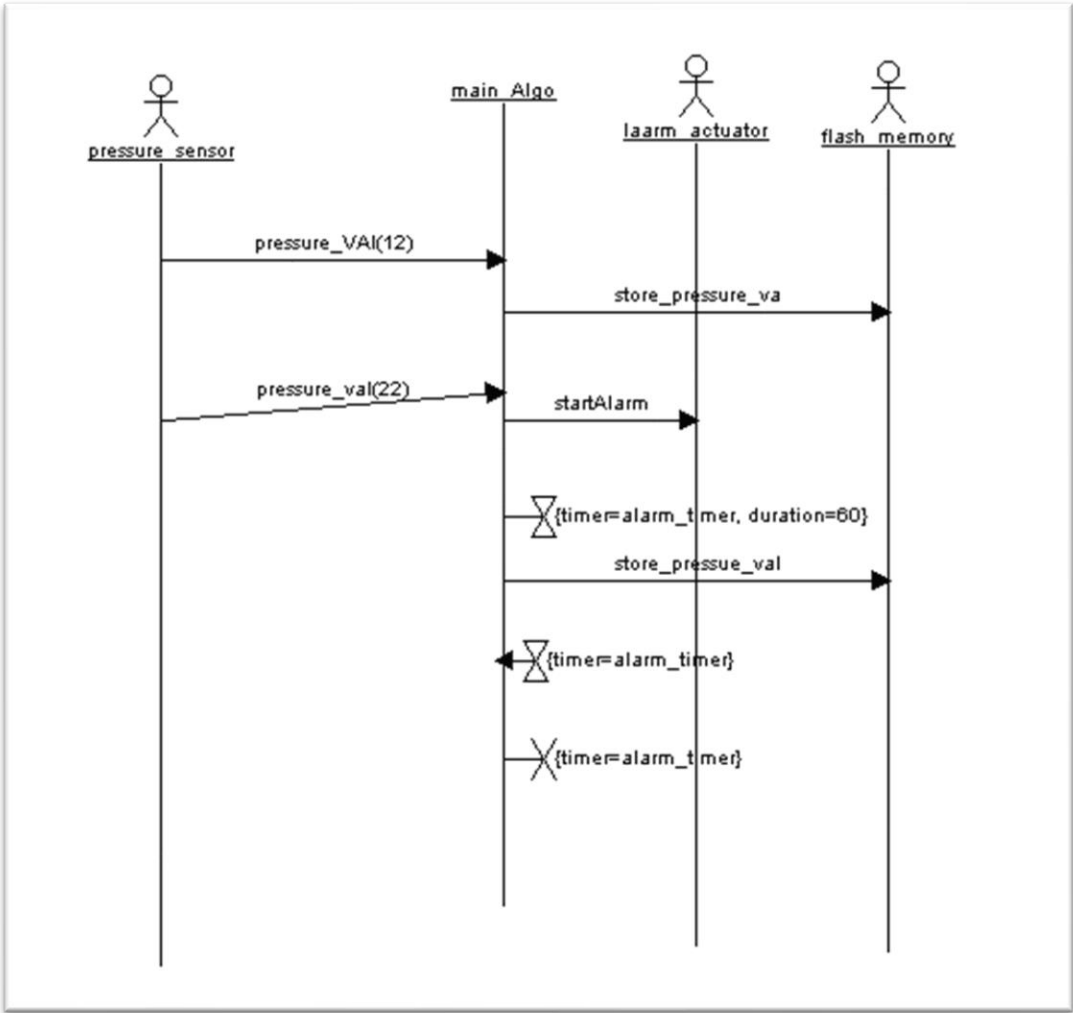
2.5.1 use case diagram



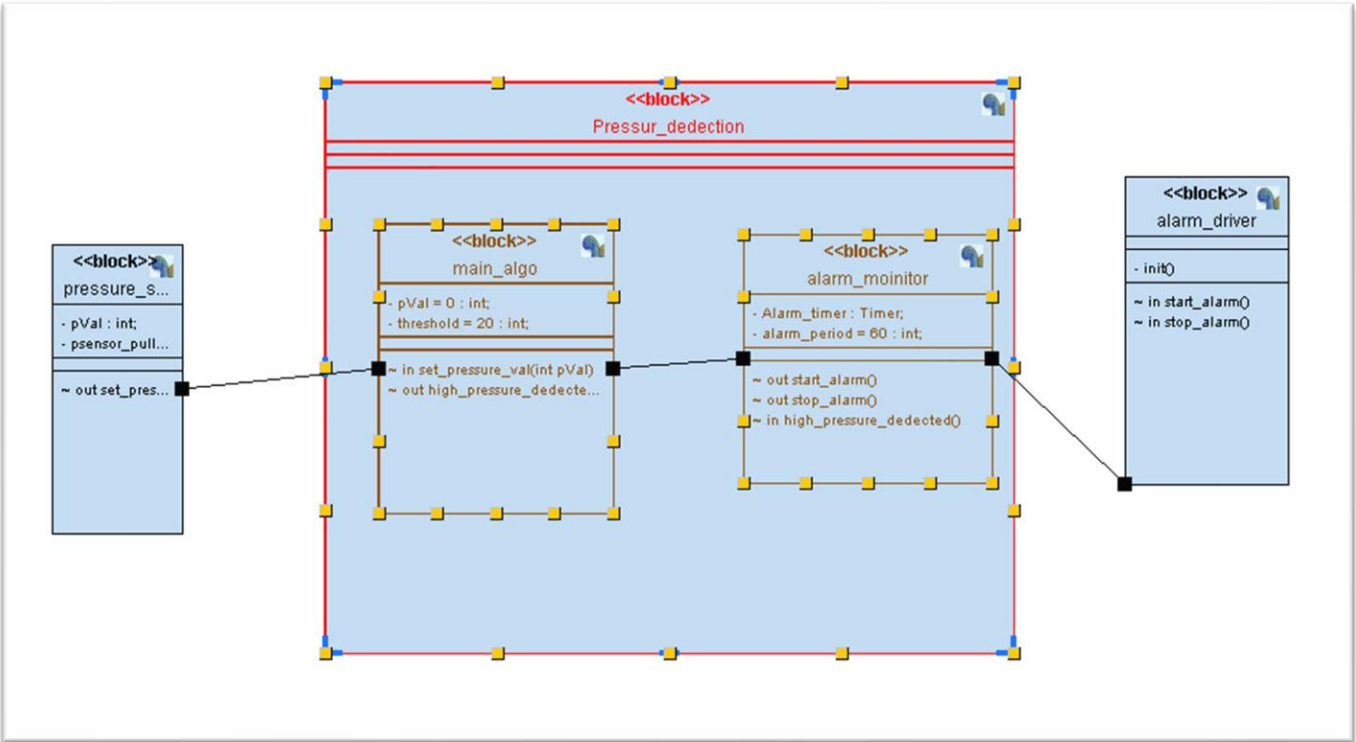
2.5.2 Activity diagram



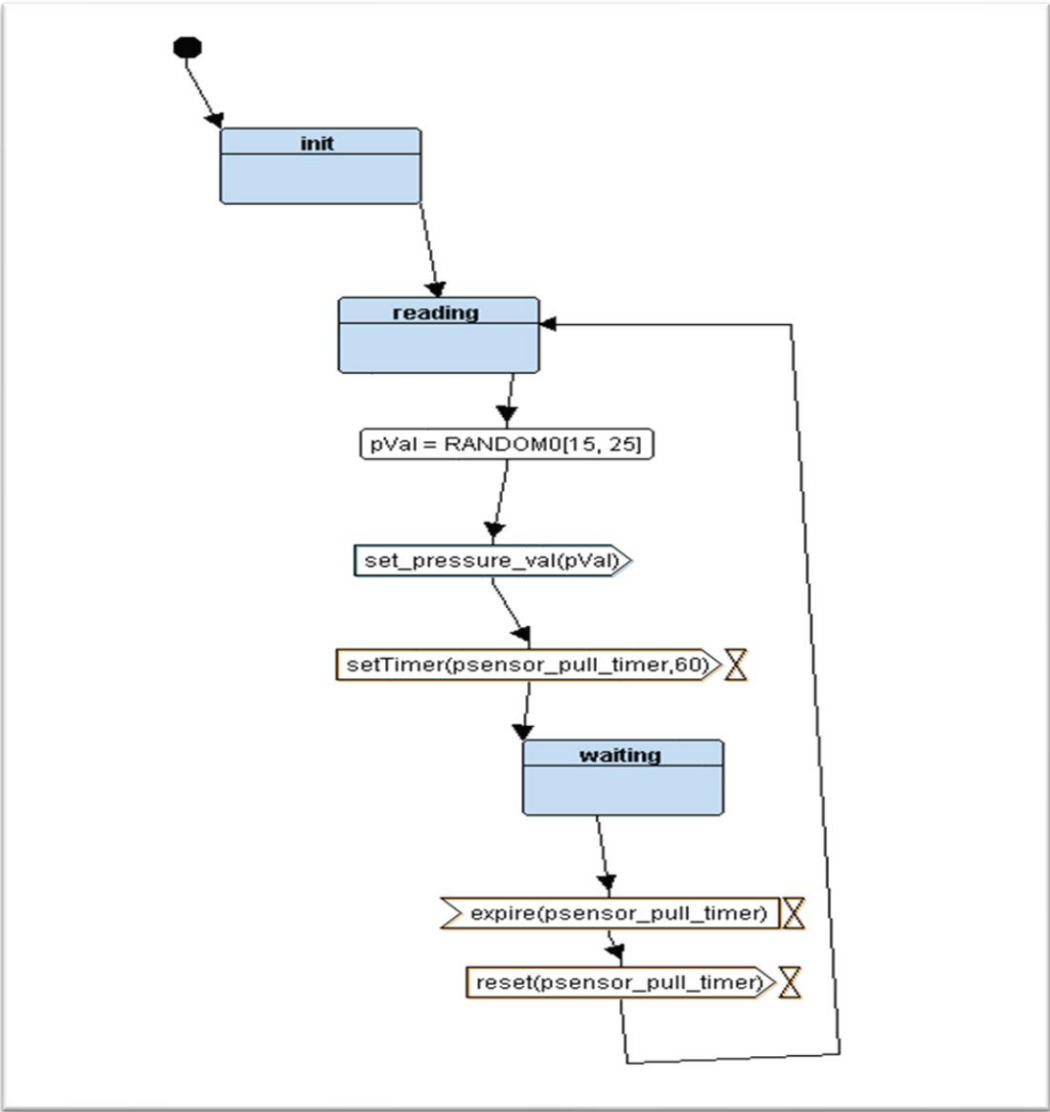
2.5.3 sequence diagram



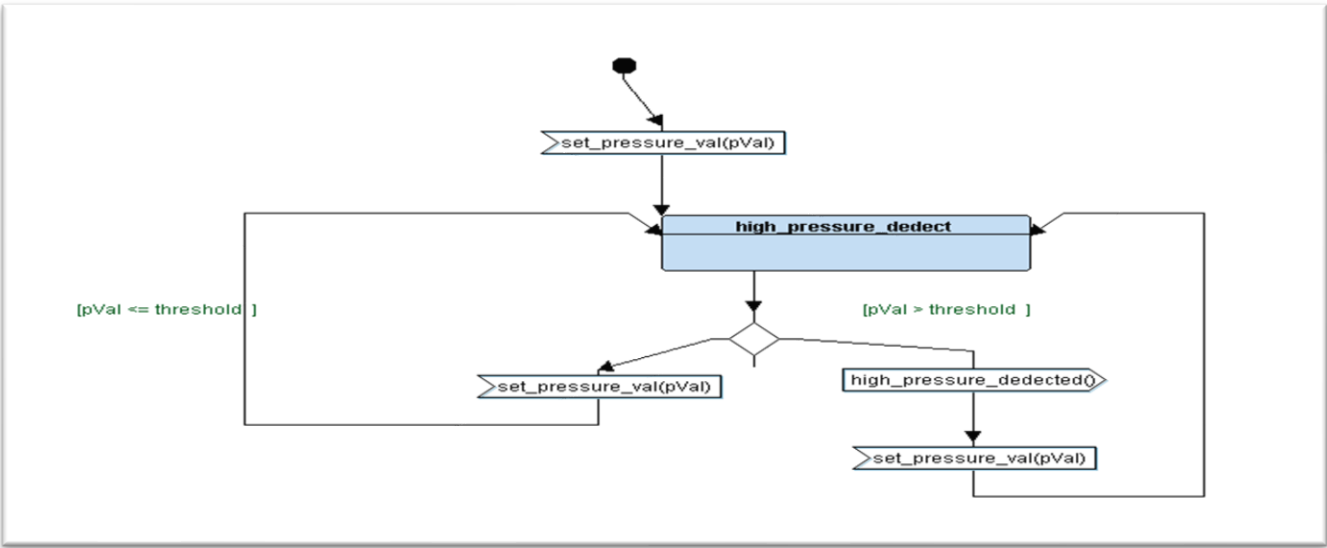
2.6 system design



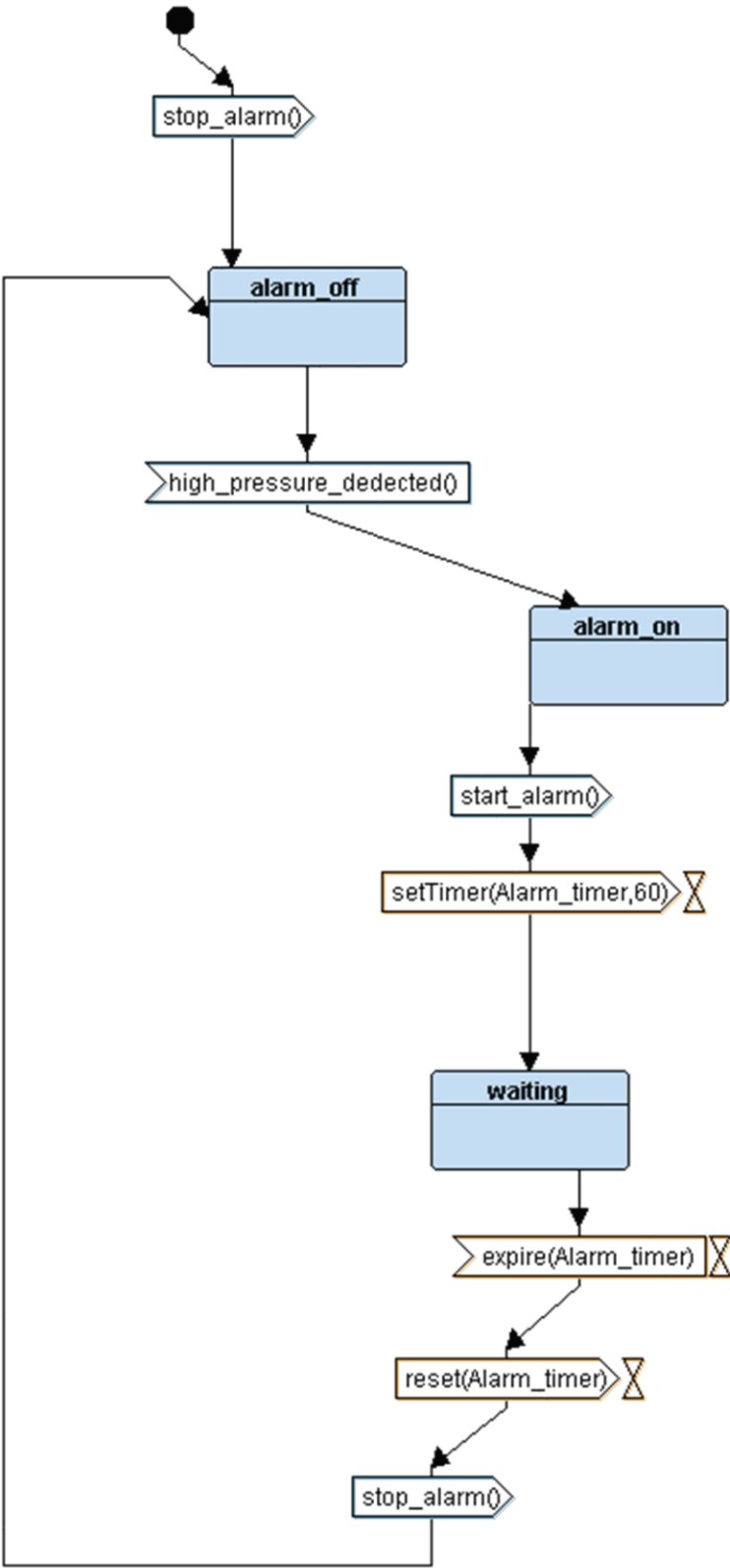
Pressure detection state diagram



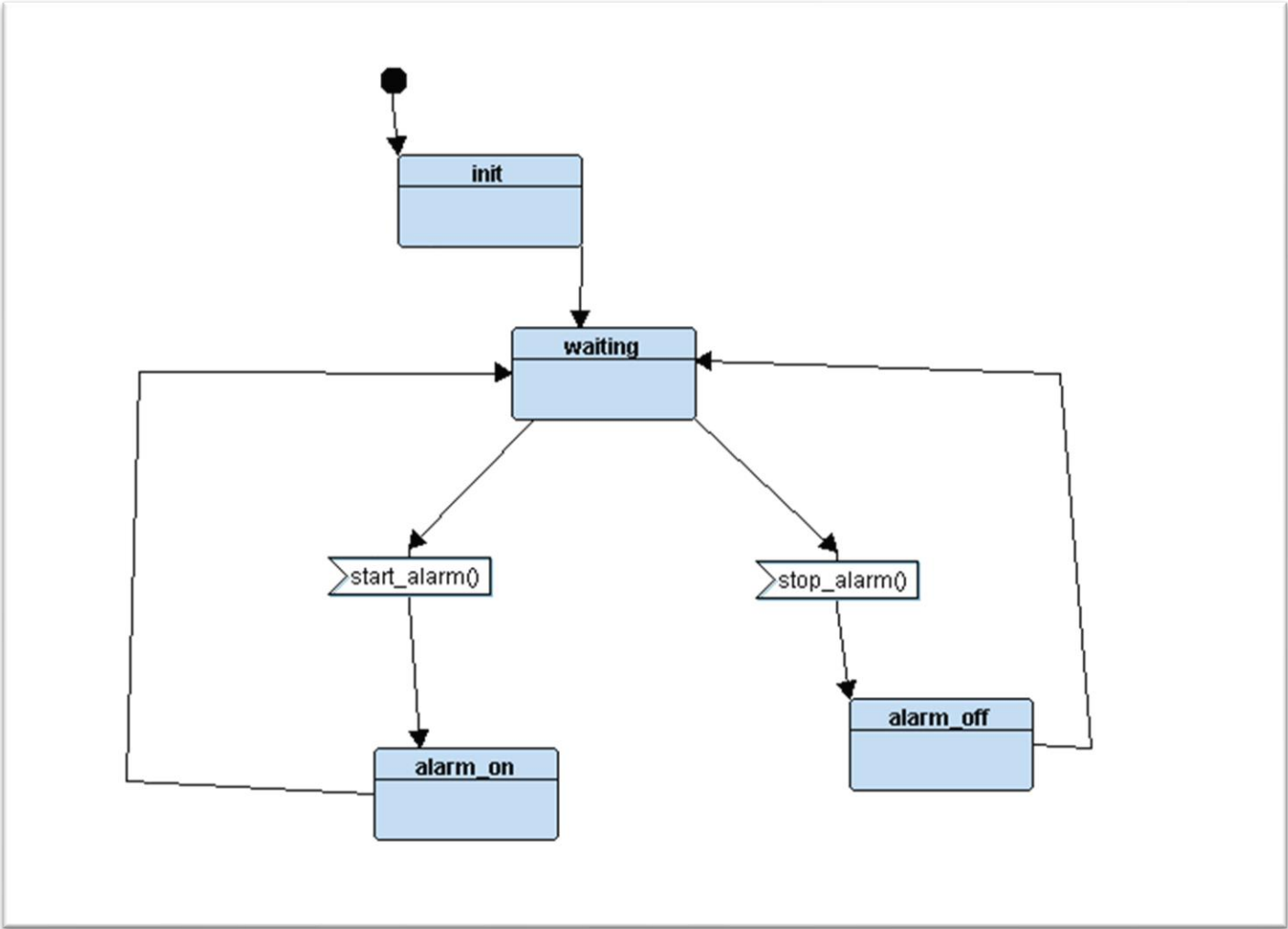
Main algorithm state diagram



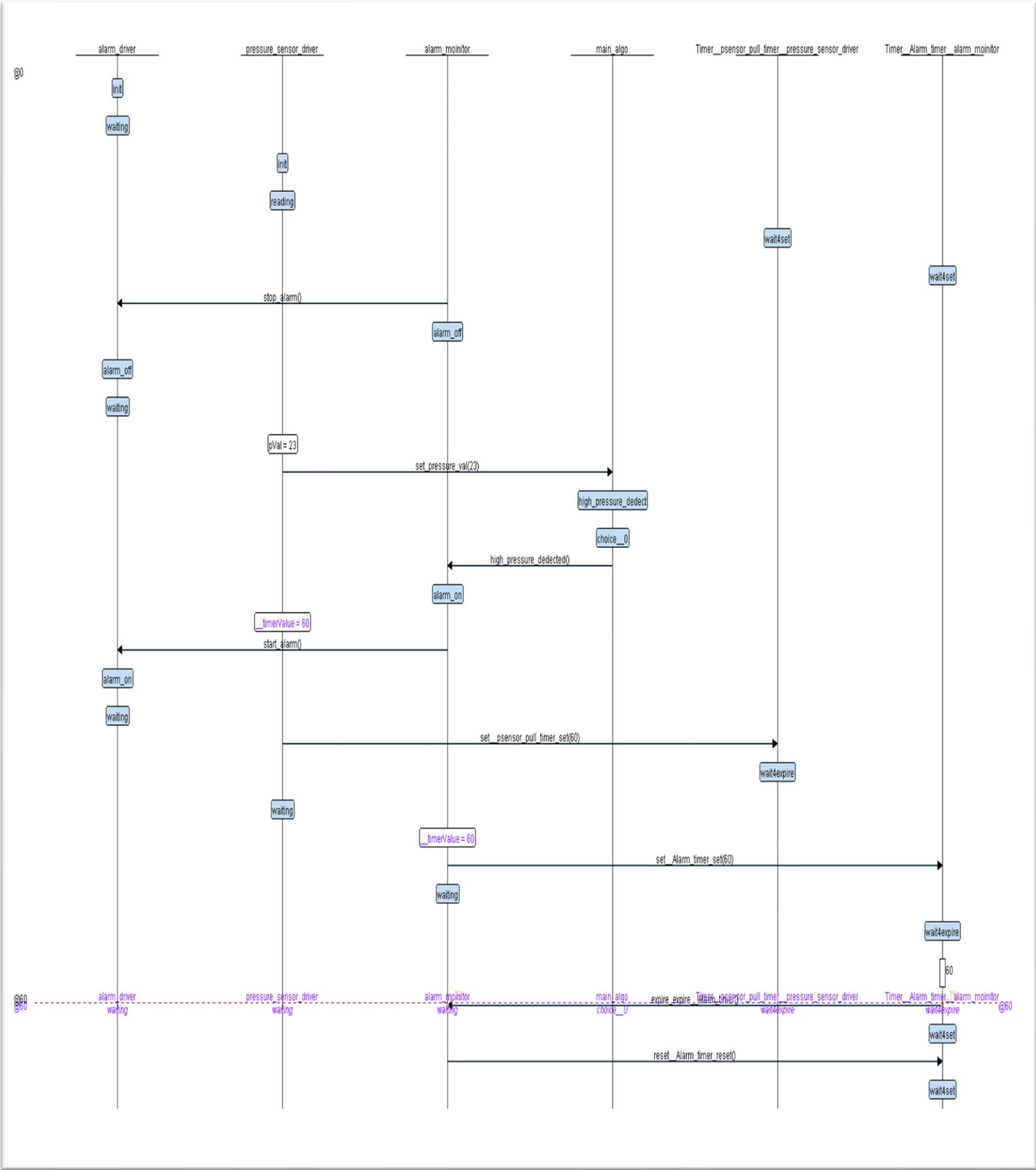
Alarm monitoring state diagram



Alarm driver state diagram



2.7 system vervation



3- source code

3.0- make file

```
File Edit Format View Help
# eng <ahmed>
cc= arm-none-eabi-
CFLAGS=-mcpu=cortex-m3 -mthumb -gdwarf-2
INCS = -I .
LIBS =
SRC = $(wildcard *.c)
OBJ = $(SRC:.c=.o)
As = $(wildcard *.s)
As_OBJ = $(As:.s=.o)
PROJECT_NAME=first_term_project1
all: $(PROJECT_NAME).bin
    @echo "-----all is done-----"
startup.o: startup.s
    $(cc)as.exe $(CFLAGS) $(INCS) $< -o $@
%.o: %.c
    $(cc)gcc.exe -c $(INCS) $(CFLAGS) $< -o $@

$(PROJECT_NAME).elf: $(OBJ) $(As_OBJ)
    $(cc)ld.exe -T linker_script.ld $(LIBS) $(OBJ) $(As_OBJ) -o $@ -Map=map_file
$(PROJECT_NAME).bin: $(PROJECT_NAME).elf
    $(cc)objcopy.exe -O binary $< $@
clean_all:
    rm *.o *.bin *.elf

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

3.1 – state.h

```
1  /*
2   * state.h
3   *
4   * Created on: Sep 10, 2022
5   * Author: soft
6   */
7
8  #ifndef STATE_H_
9  #define STATE_H_
10
11 #include<stdio.h>
12 #include <stdlib.h>
13
14 //Automatic state function generated
15 #define STATE_define(_statefunc_) void ST_##_statefunc_()
16 #define STATE(_statefunc_) ST_##_statefunc_
17
18 //state connections
19 int set_pressure_val(int pressure_Val);
20 int high_pressure_detected(int i);
21 void start_alarm();
22 void stop_alarm();
23
24 #endif /* STATE_H_ */
25
```

3.2- pressure_sensor.c/.h

```
4  * Created on: Sep 10, 2022
5  * Author: soft
6  */
7  #include "pressure_sensor.h"
8  #include "driver.h"
9
10 //variables
11 int pressure_val=0;
12 /*int generate_random(int l, int r, int c){
13     int i;
14     for(i = 0; i < c; i++){
15         int rand_num = (rand() % (r-l+1)) + l;
16         return rand_num;
17     }
18 }*/
19 //global pointer
20 void(*pressure_state)();
21 //init
22 void pressure_init(){
23     //printf("pressure_init\n");
24     pressure_state=STATE(pressure_reading);
25 }
26
27 STATE_define(pressure_waiting){
28     //state name
29     pressure_sensor_state_id=pressure_waiting;
30     //state action
31     Delay(200000);
32     pressure_state=STATE(pressure_reading);
33     //check event
34     //printf("pressure_waiting\n");
35 }
36 STATE_define(pressure_reading){
37     //state name
38     pressure_sensor_state_id=pressure_reading;
39     //state action
40     pressure_val=getPressureVal();
41     //pressure_val=generate_random(15,25,1);
42     //check event
43     //printf("pressure_reading\n");
44     set_pressure_val(pressure_val);
45     pressure_state=STATE(pressure_waiting);
46 }
47 }
```

```
/*
 * pressure_sensor.h
 *
 * Created on: Sep 10, 2022
 * Author: soft
 */
#ifndef PRESSURE_SENSOR_H_
#define PRESSURE_SENSOR_H_

#include "state.h"

//states
enum {
    pressure_waiting,
    pressure_reading
}pressure_sensor_state_id;

//declare state function
STATE_define(pressure_waiting);
STATE_define(pressure_reading);
void pressure_init();

extern void(*pressure_state)();

#endif /* PRESSURE_SENSOR_H_ */
```

3.3 – main_algo.c/.h

```
1  /*
2  * main_algo.c
3  *
4  * Created on: Sep 10, 2022
5  * Author: soft
6  */
7
8  #include "main_algo.h"
9
10 //variables
11 int pVAL=0;
12 int threshold=20;
13 //global pointer
14 void (*pmain_algo)()=STATE(idle);
15 int set_pressure_val(int pressure_val);
16 //states
17 STATE_define(high_pressure_deduct){
18     main_algo_state_id=high_pressure_deduct;
19     start_alarm();
20     //printf("high_pressure_deduct\n");
21     high_pressure_detected(1);
22     pmain_algo=STATE(idle);
23 }
24
25 }
26 STATE_define(idle){
27     set_alarm_actuator(0);
28     stop_alarm();
29     high_pressure_detected(0);
30     main_algo_state_id=idle;
31     //printf("idle\n");
32 }
33
34 }
35 int set_pressure_val(int pressure_val){
36     if(pressure_val>threshold){
37
38         pmain_algo=STATE(high_pressure_deduct);
39     }
40     else if(pVAL<=threshold)
41     {
42         pmain_algo=STATE(idle);
43     }
44 }
45
46 }
```

```
1  /*
2  * main_algo.h
3  *
4  * Created on: Sep 11, 2022
5  * Author: soft
6  */
7
8  #ifndef MAIN_ALGO_H_
9  #define MAIN_ALGO_H_
10
11 #include "state.h"
12 #include "driver.h"
13
14 //states
15 enum {
16     idle,
17     high_pressure_deduct
18 }main_algo_state_id;
19
20 // state function
21 STATE_define(high_pressure_deduct);
22 STATE_define(idle);
23
24 //global pointer
25 extern void (*pmain_algo)();
26
27
28 #endif /* MAIN_ALGO_H_ */
29
```

3.4- alarm_moinitor.c/.h

```
1  /*
2  * alarm_moinitor.h
3  *
4  * Created on: Sep 10, 2022
5  * Author: soft
6  */
7
8  #ifndef ALARM_MOINITOR_H_
9  #define ALARM_MOINITOR_H_
10
11 #include "state.h"
12 #include "driver.h"
13
14 //states
15 enum {
16     alarm_moinitor_off,
17     alarm_moinitor_on,
18     alarm_moinitor_waiting
19 }alarm_monitor_state_id;
20
21 //functions
22 STATE_define(alarm_off);
23 STATE_define(alarm_on);
24 STATE_define(alarm_waiting);
25
26 //pointer
27 extern void (*pMoinitor_alarm)();
28
29 #endif /* ALARM_MOINITOR_H_ */
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```

3.6 – driver.c/h

```
1 /*
2  * driver.c
3  *
4  * Created on: Sep 10, 2022
5  * Author: soft
6  */
7
8 #include "driver.h"
9
10 void Delay(int ncount){
11     for(;ncount!=0;ncount--);
12 }
13 int getPressureVal(){
14     return (GPIOA_IDR & 0XFF);
15 }
16 void set_alarm_actuator(int i){
17     if(i==1)
18     {
19         SET_BIT(GPIOA_ODR,13);
20     }
21     else if(i==0)
22     {
23         CLEAR_BIT(GPIOA_ODR,13);
24     }
25 }
26 void GPIO_INITILAIZATION(){
27     SET_BIT(APB2ENR,2);
28     GPIOA_CRL &= 0xff0fffff;
29     GPIOA_CRL |= 0x00000000;
30     GPIOA_CRH &= 0xff0fffff;
31     GPIOA_CRH |= 0x22222222;
32 }
```

```
1 /*
2  * driver.h
3  *
4  * Created on: Sep 10, 2022
5  * Author: soft
6  */
7
8 #ifndef DRIVER_H_
9 #define DRIVER_H_
10
11 #include <stdint.h>
12 #include <stdio.h>
13
14 #define SET_BIT(ADDRESS,BIT) ADDRESS|=(1<<BIT)
15 #define CLEAR_BIT(ADDRESS,BIT) ADDRESS &= ~(1<<BIT)
16 #define TOGGLE_BIT(ADDRESS,BIT) ADDRESS ^= (1<<BIT)
17 #define READ_BIT(ADDRESS,BIT) ((ADDRESS) & (1<<BIT))
18
19 #define GPIO_PORTA 0X40010800
20 #define BASE_RCC 0X40021000
21
22 #define APB2ENR *(volatile uint32_t*)(BASE_RCC + 0X18)
23
24 #define GPIOA_CRL *(volatile uint32_t*)(GPIO_PORTA + 0X00)
25 #define GPIOA_CRH *(volatile uint32_t*)(GPIO_PORTA + 0X04)
26 #define GPIOA_IDR *(volatile uint32_t*)(GPIO_PORTA + 0X08)
27 #define GPIOA_ODR *(volatile uint32_t*)(GPIO_PORTA + 0X0C)
28 //APIS
29 void Delay(int ncount);
30 int getPressureVal();
31 void set_alarm_actuator(int i);
32 void GPIO_INITILAIZATION();
33
34 #endif /* DRIVER_H_ */
35
```

3.7-main.c

```
1 /*
2  * main.c
3  *
4  * Created on: Sep 11, 2022
5  * Author: soft
6  */
7
8
9 #include "alarm_driver.h"
10 #include "alarm_moinitor.h"
11 #include "main_algo.h"
12 #include "pressure_sensor.h"
13
14 void setup(){
15     GPIO_INITILAIZATION();
16     pressure_init();
17     alarm_init();
18 }
19
20
21
22
23 int main(){
24     setup();
25     while(1){
26         pressure_state();
27         pmain_algo();
28         pMoinitor_alarm();
29         palarm_driver();
30         Delay(10000);
31     }
32
33
34
35
36
37     return 0;
38 }
39
```

3.8 – startup code with assembly

```
1 //startup.s
2 //Eng.Ahmed Mohsen
3
4 .section .vectors
5
6 .word 0x20001000 //stack top address
7 .word _reset //1 reset
8 .word vector_handler //2 NMI
9 .word vector_handler //3 HARD FAULT
10 .word vector_handler //4 MM FAULT
11 .word vector_handler //5 BUS FAULT
12 .word vector_handler //6 USAGE FAULT
13 .word vector_handler //7 RESERVED
14 .word vector_handler //8 RESERVED
15 .word vector_handler //9 RESERVED
16 .word vector_handler //10 RESERVED
17 .word vector_handler //11 SV CALL
18 .word vector_handler //12 DEBUG RESERVED
19 .word vector_handler //13 RESERVED
20 .word vector_handler //14 PENDSV
21 .word vector_handler //15 SYS TICK
22 .word vector_handler //16 IRQ0
23 .word vector_handler //17 IRQ1
24 .word vector_handler //18 IRG2
25 .word vector_handler //19 ...
26 // on to IRQ67
27
28 .section .text
29 _reset:
30     bl main
31     b .
32
33     .thumb_func //enable 16 and 32 bit
34 vector_handler:
35     b _reset
```

3.9 -linker script

```
1
2
3
4
5 MEMORY
6 {
7     flash(RX) : ORIGIN = 0x08000000, LENGTH = 128k
8     sram(RWX) : ORIGIN = 0x20000000, LENGTH = 20k
9 }
10
11 SECTIONS
12 {
13     .text :
14     {
15         *(.vectors*)
16         *(.text*)
17         *(.rodata)
18         _E_text = .;
19     } > flash
20     .data :
21     {
22         _S_data = .;
23         *(.data)
24         _E_data = .;
25     } > sram AT> flash
26     .bss :
27     {
28         _S_bss = .;
29         *(.bss*)
30         . = ALIGN(4);
31         _E_bss = .;
32     } > sram
33 }
34
35
36
```

4- Symbols

4.1- pressure_sensor.o

```
U Delay
U getPressureVal
00000000 T pressure_init
00000001 C pressure_sensor_state_id
00000004 C pressure_state
00000000 B pressure_val
U set_pressure_val
00000050 T ST_pressure_reading
0000001c T ST_pressure_waiting
```

4.2 – main_algo.o

```
U high_pressure_detected
00000001 C main_algo_state_id
00000004 D pmain_algo
00000000 B pVAL
U set_alarm_actuator
0000005c T set_pressure_val
00000000 T ST_high_pressure_deduct
00000034 T ST_idle
U start_alarm
U stop_alarm
00000000 D threshold
```

4.3- alarm_moinitor.o

```
00000001 C alarm_monitor_state_id
U Delay
00000078 T high_pressure_detected
00000000 D pMoinitor_alarm
00000000 T ST_alarm_off
00000018 T ST_alarm_on
00000044 T ST_alarm_waiting
U start_alarm
U stop_alarm
```

4.4 – alarm_driver.o

```
$ arm-none-eabi-nm.exe alarm_driver.o
00000001 C alarm_driver_state_id
00000000 T alarm_init
U Delay
00000004 C palarm_driver
U set_alarm_actuator
0000006c T ST_alarm_driver_off
00000050 T ST_alarm_driver_on
0000003c T ST_alarm_driver_waiting
0000001c T start_alarm
0000002c T stop_alarm
```

4.5 – driver.o

```
00000000 T Delay
00000024 T getPressureVal
0000008c T GPIO_INITILAIZATION
0000003c T set_alarm_actuator
```


4.6-main.o

```
00000001 C alarm_driver_state_id
          U alarm_init
00000001 C alarm_monitor_state_id
          U Delay
          U GPIO_INITIALIZATION
00000014 T main
00000001 C main_algo_state_id
          U palarm_driver
          U pmain_algo
          U pMoinitor_alarm
          U pressure_init
00000001 C pressure_sensor_state_id
          U pressure_state
00000000 T setup
```

4.7 – starup .o

```
00000000 t _reset
          U main
00000006 t vector_handler
```

4.8- elf image symbols

```
0800044c t _reset
20000008 B alarm_driver_state_id
08000050 T alarm_init
20000010 B alarm_monitor_state_id
08000190 T Delay
080001b4 T getPressureVal
0800021c T GPIO_INITIALIZATION
08000150 T high_pressure_detected
080002b0 T main
20000011 B main_algo_state_id
2000000c B palarm_driver
0800045c D pmain_algo
08000454 D pMoinitor_alarm
080003b4 T pressure_init
20000012 B pressure_sensor_state_id
20000014 B pressure_state
20000004 B pressure_val
20000000 B pVAL
080001cc T set_alarm_actuator
08000350 T set_pressure_val
0800029c T setup
080000bc T ST_alarm_driver_off
080000a0 T ST_alarm_driver_on
0800008c T ST_alarm_driver_waiting
080000d8 T ST_alarm_off
080000f0 T ST_alarm_on
0800011c T ST_alarm_waiting
080002f4 T ST_high_pressure_deduct
08000328 T ST_idle
08000404 T ST_pressure_reading
080003d0 T ST_pressure_waiting
0800006c T start_alarm
0800007c T stop_alarm
08000458 D threshold
08000452 t vector_handler
```

5- Sections Headers

5.1- pressure sensor

```
pressure_sensor.o:      file format elf32-littlearm

Sections:
Idx Name              Size      VMA           LMA           File off  Algn
  0 .text              00000098  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data              00000000  00000000  00000000  000000cc  2**0
    CONTENTS, ALLOC, LOAD, DATA
  2 .bss               00000004  00000000  00000000  000000cc  2**2
    ALLOC
  3 .debug_info        00000111  00000000  00000000  000000cc  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev      00000092  00000000  00000000  000001dd  2**0
    CONTENTS, READONLY, DEBUGGING
  5 .debug_loc         00000084  00000000  00000000  0000026f  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges     00000020  00000000  00000000  000002f3  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line        00000063  00000000  00000000  00000313  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str         00000188  00000000  00000000  00000376  2**0
    CONTENTS, READONLY, DEBUGGING
  9 .comment           00000012  00000000  00000000  000004fe  2**0
    CONTENTS, READONLY
10 .ARM.attributes    00000033  00000000  00000000  00000510  2**0
    CONTENTS, READONLY
11 .debug_frame       00000060  00000000  00000000  00000544  2**2
    CONTENTS, RELOC, READONLY, DEBUGGING
```

5.2 – main algo

```
main_algo.o:          file format elf32-littlearm

Sections:
Idx Name              Size      VMA           LMA           File off  Algn
  0 .text              000000c0  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data              00000008  00000000  00000000  000000f4  2**2
    CONTENTS, ALLOC, LOAD, RELOC, DATA
  2 .bss               00000004  00000000  00000000  000000fc  2**2
    ALLOC
  3 .debug_info        0000013b  00000000  00000000  000000fc  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev      000000a7  00000000  00000000  00000237  2**0
    CONTENTS, READONLY, DEBUGGING
  5 .debug_loc         00000090  00000000  00000000  000002de  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges     00000020  00000000  00000000  0000036e  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line        0000005b  00000000  00000000  0000038e  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str         0000017a  00000000  00000000  000003e9  2**0
    CONTENTS, READONLY, DEBUGGING
  9 .comment           00000012  00000000  00000000  00000563  2**0
    CONTENTS, READONLY
10 .ARM.attributes    00000033  00000000  00000000  00000575  2**0
    CONTENTS, READONLY
11 .debug_frame       00000064  00000000  00000000  000005a8  2**2
    CONTENTS, RELOC, READONLY, DEBUGGING
```

5.3- alarm_moinitor

```
alarm_moinitor.o:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA           LMA           File off  Algn
  0 .text          000000b8  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data           00000004  00000000  00000000  000000ec  2**2
    CONTENTS, ALLOC, LOAD, RELOC, DATA
  2 .bss            00000000  00000000  00000000  000000f0  2**0
    ALLOC
  3 .debug_info     00000130  00000000  00000000  000000f0  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev   000000a7  00000000  00000000  00000220  2**0
    CONTENTS, READONLY, DEBUGGING
  5 .debug_loc      000000bc  00000000  00000000  000002c7  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges  00000020  00000000  00000000  00000383  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line     00000066  00000000  00000000  000003a3  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str      0000019e  00000000  00000000  00000409  2**0
    CONTENTS, READONLY, DEBUGGING
  9 .comment        00000012  00000000  00000000  000005a7  2**0
    CONTENTS, READONLY
10 .ARM.attributes  00000033  00000000  00000000  000005b9  2**0
    CONTENTS, READONLY
11 .debug_frame     00000080  00000000  00000000  000005ec  2**2
    CONTENTS, RELOC, READONLY, DEBUGGING
```

5.4 – alarm driver

```
alarm_driver.o:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA           LMA           File off  Algn
  0 .text          00000088  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data           00000000  00000000  00000000  000000bc  2**0
    CONTENTS, ALLOC, LOAD, DATA
  2 .bss            00000000  00000000  00000000  000000bc  2**0
    ALLOC
  3 .debug_info     00000148  00000000  00000000  000000bc  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev   00000094  00000000  00000000  00000204  2**0
    CONTENTS, READONLY, DEBUGGING
  5 .debug_loc      00000108  00000000  00000000  00000298  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges  00000020  00000000  00000000  000003a0  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line     00000063  00000000  00000000  000003c0  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str      000001b3  00000000  00000000  00000423  2**0
    CONTENTS, READONLY, DEBUGGING
  9 .comment        00000012  00000000  00000000  000005d6  2**0
    CONTENTS, READONLY
10 .ARM.attributes  00000033  00000000  00000000  000005e8  2**0
    CONTENTS, READONLY
11 .debug_frame     000000b4  00000000  00000000  0000061c  2**2
    CONTENTS, RELOC, READONLY, DEBUGGING
```

5.5 – driver

```
driver.o:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA           LMA           File off  Algn
  0 .text          0000010c  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .data          00000000  00000000  00000000  00000140  2**0
    CONTENTS, ALLOC, LOAD, DATA
  2 .bss           00000000  00000000  00000000  00000140  2**0
    ALLOC
  3 .debug_info     00000103  00000000  00000000  00000140  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev   0000009d  00000000  00000000  00000243  2**0
    CONTENTS, READONLY, DEBUGGING
  5 .debug_loc      000000c8  00000000  00000000  000002e0  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges  00000020  00000000  00000000  000003a8  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line     0000009e  00000000  00000000  000003c8  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str       0000013e  00000000  00000000  00000466  2**0
    CONTENTS, READONLY, DEBUGGING
  9 .comment        00000012  00000000  00000000  000005a4  2**0
    CONTENTS, READONLY
10 .ARM.attributes  00000033  00000000  00000000  000005b6  2**0
    CONTENTS, READONLY
11 .debug_frame     00000078  00000000  00000000  000005ec  2**2
    CONTENTS, RELOC, READONLY, DEBUGGING
```

5.6- main

```
main.o:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA           LMA           File off  Algn
  0 .text          00000058  00000000  00000000  00000034  2**2
    CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data          00000000  00000000  00000000  0000008c  2**0
    CONTENTS, ALLOC, LOAD, DATA
  2 .bss           00000000  00000000  00000000  0000008c  2**0
    ALLOC
  3 .debug_info     000001a2  00000000  00000000  0000008c  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev   000000ae  00000000  00000000  0000022e  2**0
    CONTENTS, READONLY, DEBUGGING
  5 .debug_loc      00000058  00000000  00000000  000002dc  2**0
    CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges  00000020  00000000  00000000  00000334  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line     000000a4  00000000  00000000  00000354  2**0
    CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str       0000023a  00000000  00000000  000003f8  2**0
    CONTENTS, READONLY, DEBUGGING
  9 .comment        00000012  00000000  00000000  00000632  2**0
    CONTENTS, READONLY
10 .ARM.attributes  00000033  00000000  00000000  00000644  2**0
    CONTENTS, READONLY
11 .debug_frame     00000048  00000000  00000000  00000678  2**2
```

5.7 – startup

```
Sections:
Idx Name          Size      VMA       LMA       File off  Algn
 0 .text          00000008 00000000 00000000 00000034 2**1
CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
 1 .data          00000000 00000000 00000000 0000003c 2**0
CONTENTS, ALLOC, LOAD, DATA
 2 .bss           00000000 00000000 00000000 0000003c 2**0
ALLOC
 3 .vectors       00000050 00000000 00000000 0000003c 2**0
CONTENTS, RELOC, READONLY
 4 .ARM.attributes 00000021 00000000 00000000 0000008c 2**0
CONTENTS, READONLY
 5 .debug_line    0000003b 00000000 00000000 000000ad 2**0
CONTENTS, RELOC, READONLY, DEBUGGING
 6 .debug_info    0000007d 00000000 00000000 000000e8 2**0
CONTENTS, RELOC, READONLY, DEBUGGING
 7 .debug_abbrev  00000014 00000000 00000000 00000165 2**0
CONTENTS, READONLY, DEBUGGING
 8 .debug_aranges 00000020 00000000 00000000 00000180 2**3
CONTENTS, RELOC, READONLY, DEBUGGING
```

5.8- elf image symbols 6- run application on protus

```
first_term_project1.elf:      file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
 0 .text          00000454 08000000 08000000 00008000 2**2
CONTENTS, ALLOC, LOAD, READONLY, CODE
 1 .data          0000000c 08000454 08000454 00008454 2**2
CONTENTS, ALLOC, LOAD, DATA
 2 .bss           00000018 20000000 20000000 00010000 2**2
ALLOC
 3 .debug_info    000007e6 00000000 00000000 00008460 2**0
CONTENTS, READONLY, DEBUGGING
 4 .debug_abbrev  000003d3 00000000 00000000 00008c46 2**0
CONTENTS, READONLY, DEBUGGING
 5 .debug_loc     000003f8 00000000 00000000 00009019 2**0
CONTENTS, READONLY, DEBUGGING
 6 .debug_aranges 000000e0 00000000 00000000 00009418 2**3
CONTENTS, READONLY, DEBUGGING
 7 .debug_line    00000304 00000000 00000000 000094f8 2**0
CONTENTS, READONLY, DEBUGGING
 8 .debug_str     0000033e 00000000 00000000 000097fc 2**0
CONTENTS, READONLY, DEBUGGING
 9 .comment       00000011 00000000 00000000 00009b3a 2**0
CONTENTS, READONLY
10 .ARM.attributes 00000031 00000000 00000000 00009b4b 2**0
CONTENTS, READONLY
11 .debug_frame   000002b8 00000000 00000000 00009b7c 2**2
CONTENTS, READONLY, DEBUGGING
```