Mastering Embedded System Online Diploma

www.learn-in-depth.com

First Term Project 1

High Pressure Detection System

BY :
Eng. Mohamed Kamel Aly

My Profile : No progess page created,
Email: mohamed.kamel.m73@gmail.com

Contents

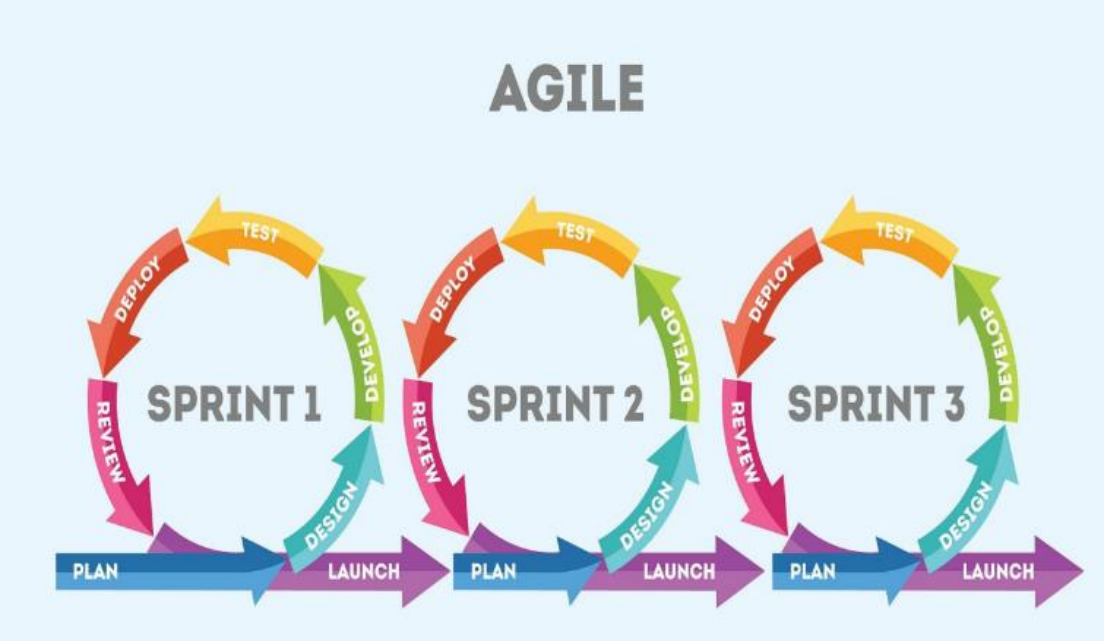
Business Analysis (Case Study)

This case study describes a pressure detection system which lights an LED alarm when triggered:

1. A pressure sensor reads pressure values each 60 seconds
2. The system checks if the pressure is above a threshold of 20
3. If the pressure is above the threshold, an LED alarm is turned on
4. The alarm duration equals 60 seconds
5. Optional: the system keeps track of the measured pressure values.

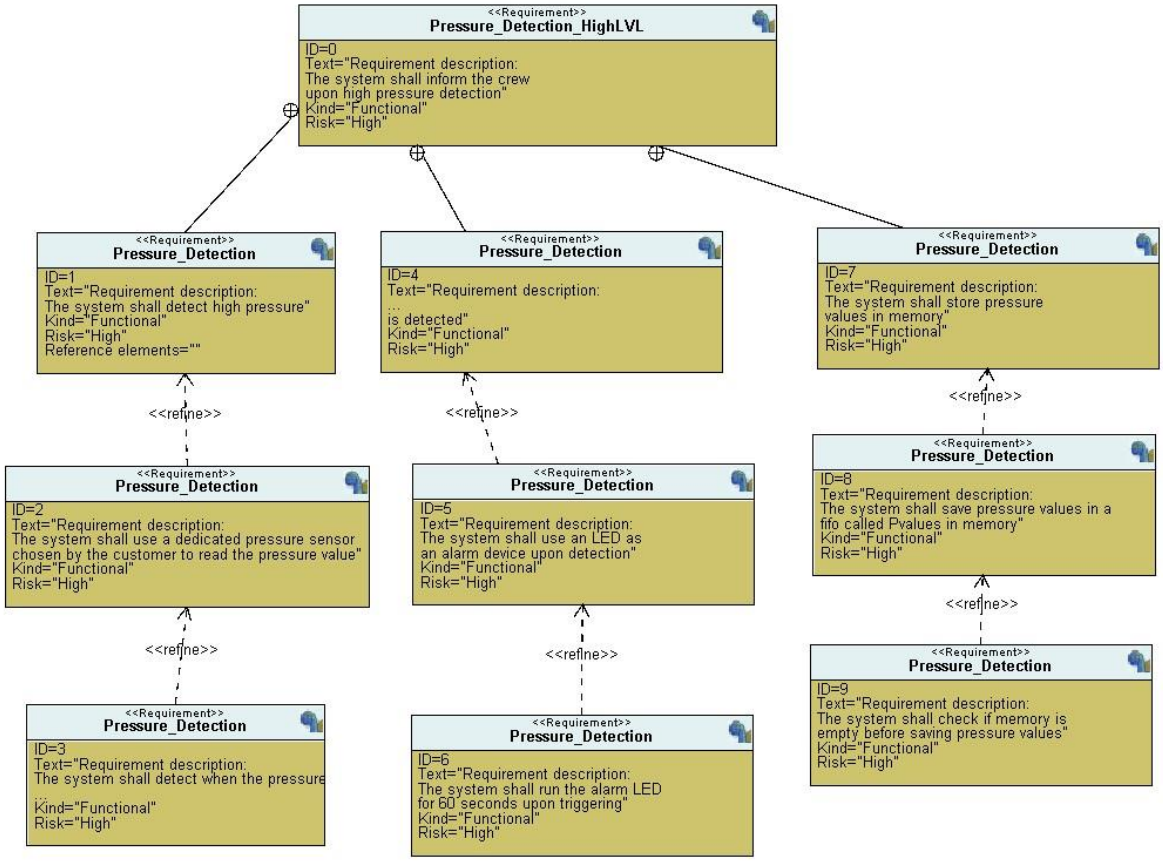
Methodology

Agile methodology is an iterative and incremental approach to software development that prioritizes flexibility, collaboration, and customer satisfaction. It emerged as a response to the shortcomings of traditional waterfall methodologies, which often resulted in lengthy development cycles and a lack of adaptability to changing requirements.



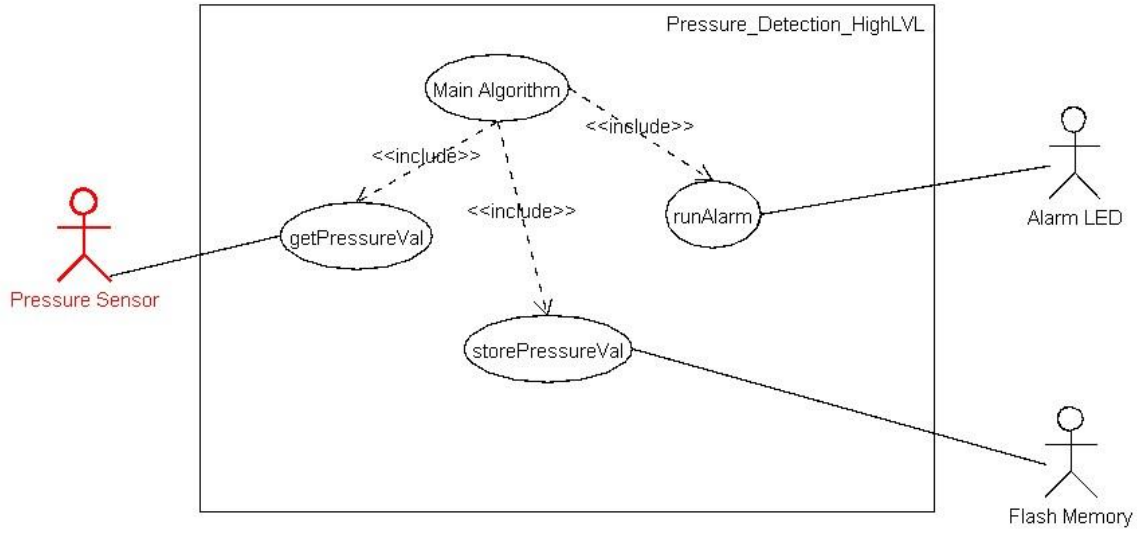
Requirements

A ”client” expects 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.

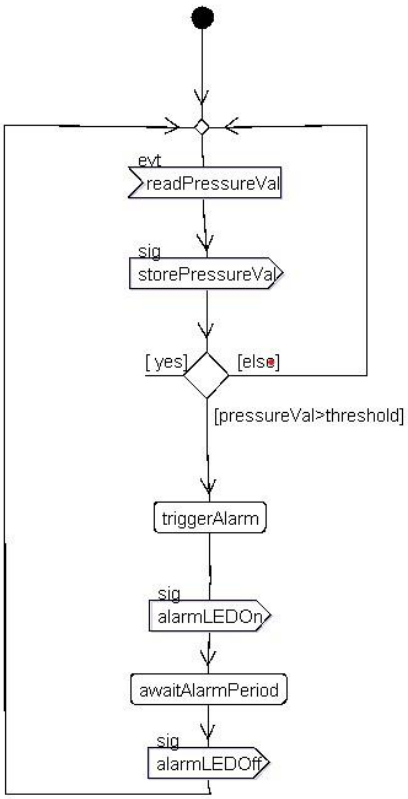


System Analysis

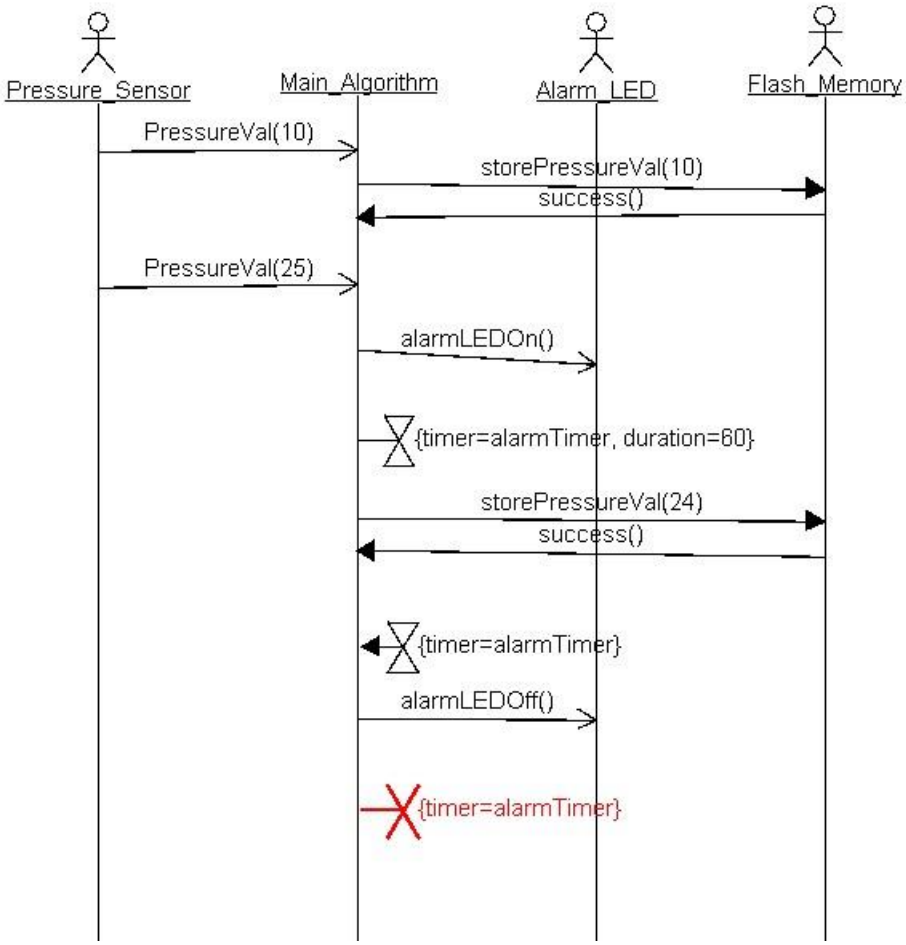
Use Case Diagram



Activity Diagram

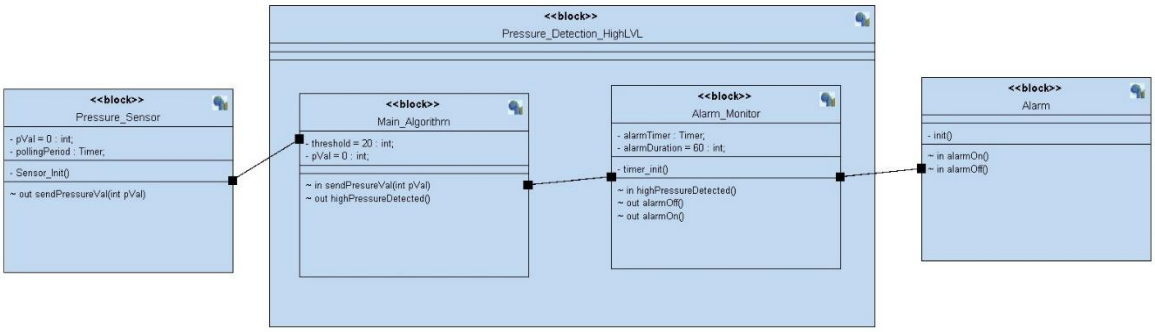


Sequence Diagram

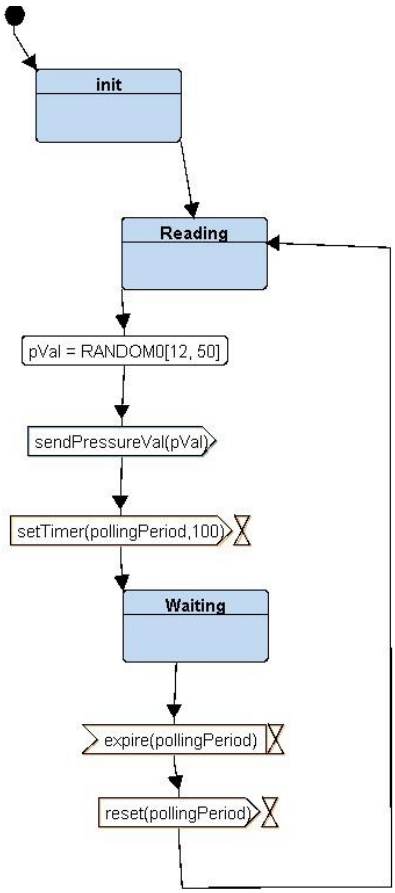


System Design

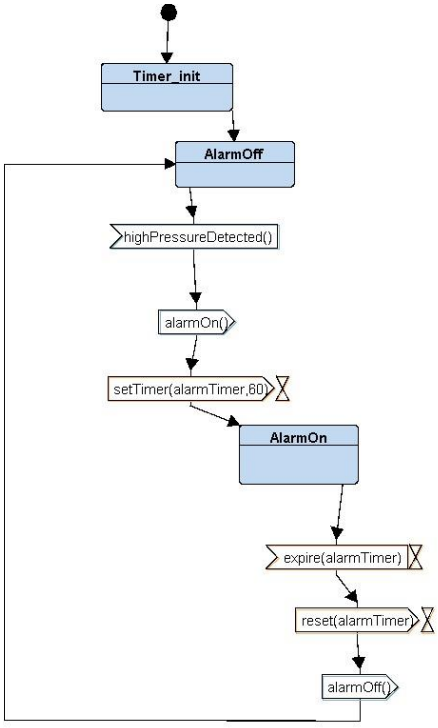
Block Diagram



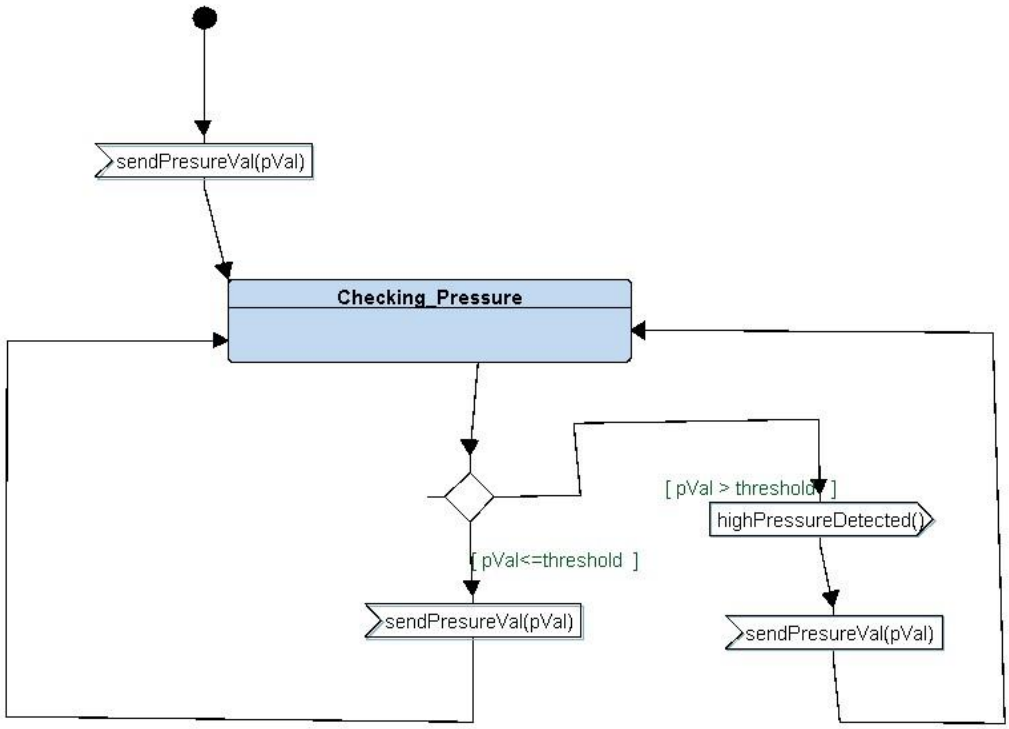
Pressure Sensor State Machine



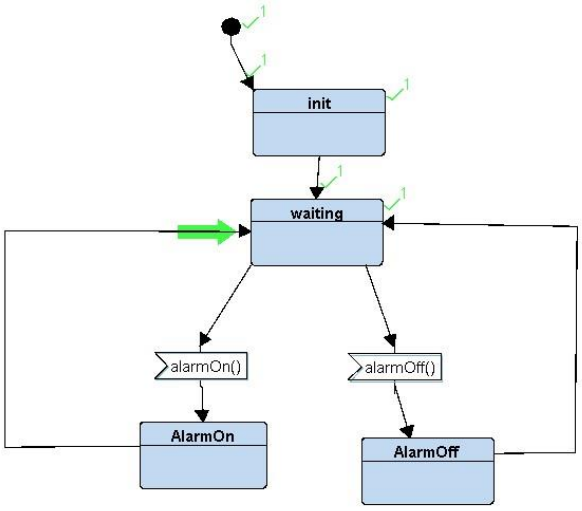
Alarm Monitor State Machine



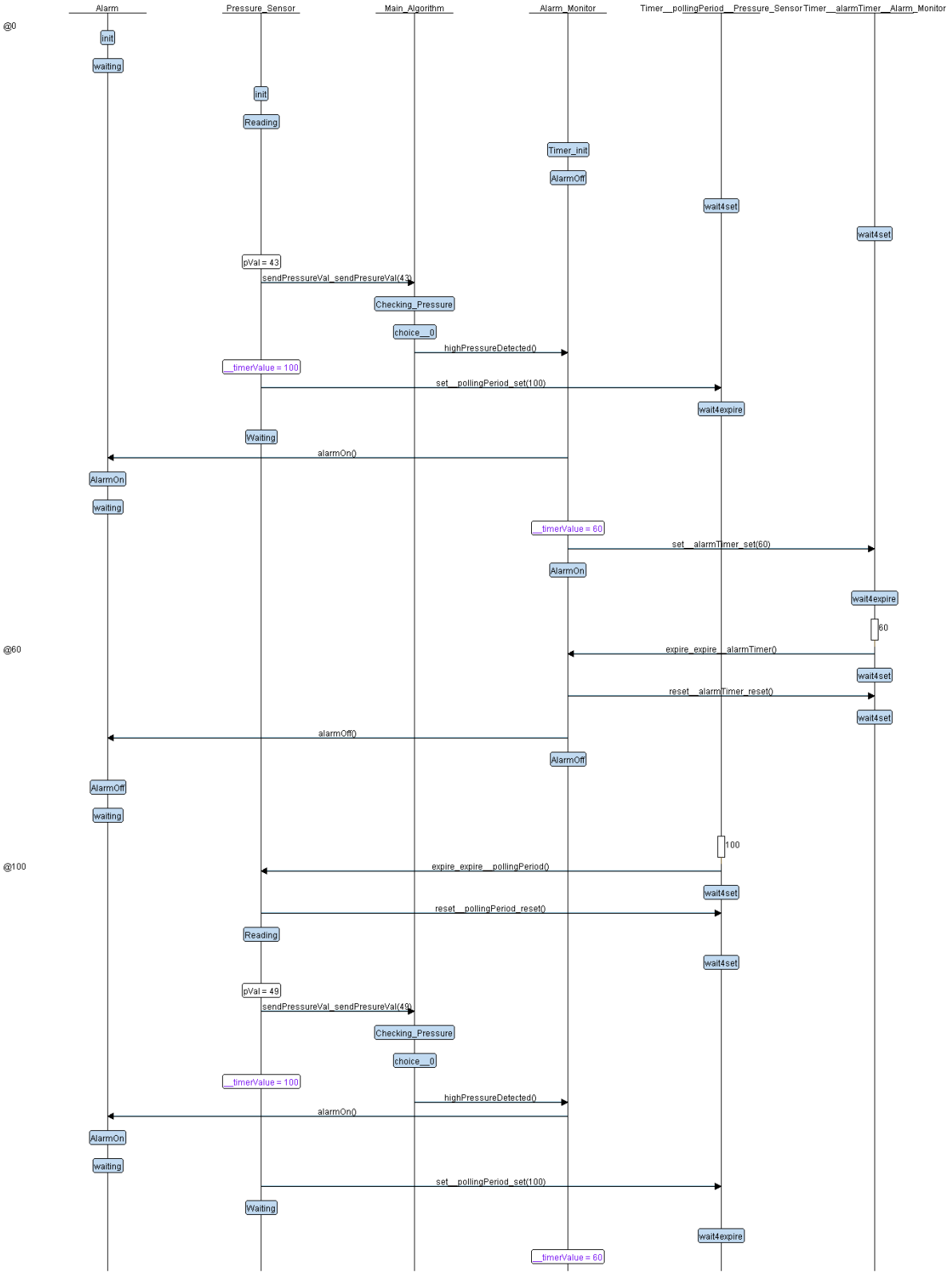
Main Algorithm State Machine



Alarm State Machine



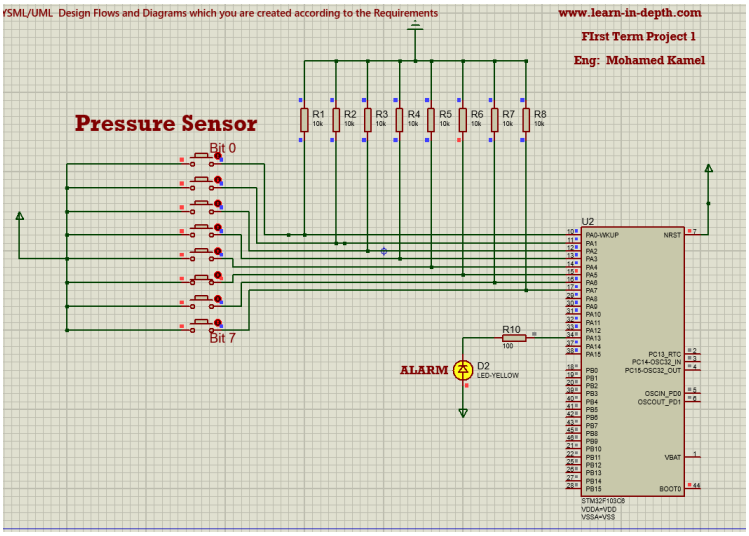
State Machines' Simulation



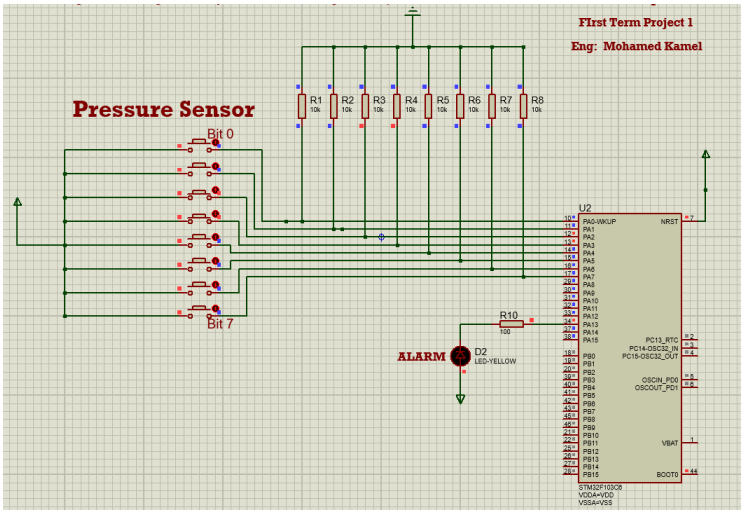
Proteus Simulation

Test Cases:

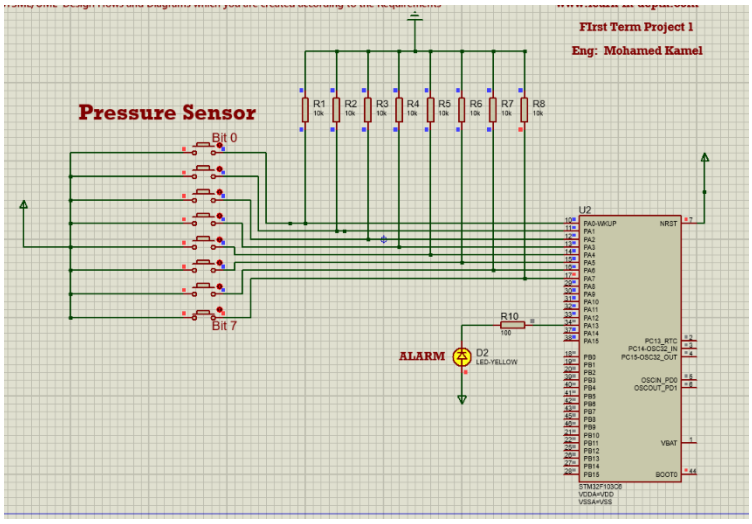
Pressure Input Value:32



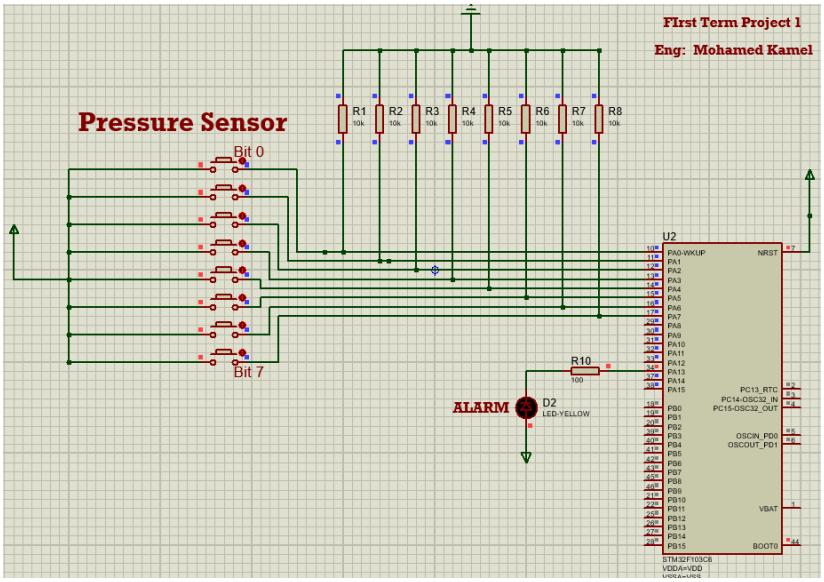
Pressure Input Value:12



Pressure Input Value:128



Pressure Input Value:0



Code Analysis

Repo:

https://github.com/Kamelz70/LID_Diploma/tree/main/First_Term_Projects/Project_1

Symbol Table

```
20000004 B _E_bss
20000000 T _E_DATA
0800041c T _E_text
20000000 B _S_bss
20000000 T _S_DATA
20001004 B _stack_top
20001010 B alarm_state
2000100e B alarm_state_id
08000418 T alarmDuration
20001018 B alarmMonitor_state
2000100c B alarmMonitor_state_id
08000178 T alarmOff
0800015c T alarmOn
0800001c W Bus_fault_Handler
0800001c T Default_Handler
080002c4 T Delay
080002e4 T getPressureVal
08000338 T GPIO_INITIALIZATION
0800001c W H_fault_Handler
08000388 T highPressureDetected
08000128 T main
```

```
08000128 T main
20001008 B mainAlgo_state
20001004 B mainAlgo_state_id
0800001c W MM_fault_Handler
0800001c W NMI_Handler
08000414 T pollingPeriod
20001014 B pressureSensor_state
2000100d B pressureSensor_state_id
20000000 B pVal
08000028 T Reset_Handler
080000ac T sendPressureVal
08000228 T sensor_init
080002fc T Set_Alarm_actuator
08000114 T setup
080001e8 T ST_A_ALARM_OFF
080001c0 T ST_A_ALARM_ON
08000194 T ST_A_INIT
08000210 T ST_A_WAITING
080003c8 T ST_AM_ALARM_OFF
080003e0 T ST_AM_ALARM_ON
080003a4 T ST_AM_TIMER_INIT
080000d8 T ST_MA_CHECKING_PRESSURE
08000234 T ST_PS_INIT
08000258 T ST_PS_READING
08000294 T ST_PS_WAITING
08000410 T threshold
0800001c W Usage_fault_Handler
08000000 T vectors
```

Relocatable code Sections

main:

```
PS D:\Trainings\LearnInDepth Embedded\Code\First_Term_Projects\Project_1\Code> arm-none-eabi-objdump.exe -h .\main.o

.\main.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         00000048  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000000  00000000  00000000  0000007c  2**0
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  0000007c  2**0
                  ALLOC
  3 .debug_info   00000ab4  00000000  00000000  0000007c  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev 000001d6  00000000  00000000  00000b30  2**0
                  CONTENTS, READONLY, DEBUGGING
  5 .debug_loc    00000058  00000000  00000000  00000d06  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges 00000020  00000000  00000000  00000d5e  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line   0000017b  00000000  00000000  00000d7e  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str    0000065a  00000000  00000000  00000ef9  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .comment      0000007f  00000000  00000000  00001553  2**0
                  CONTENTS, READONLY
 10 .debug_frame  00000048  00000000  00000000  000015d4  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
 11 .ARM.attributes 00000033  00000000  00000000  0000161c  2**0
                  CONTENTS, READONLY
```

pressureSensor.o:

```
.\pressureSensor.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         0000009c  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000000  00000000  00000000  000000d0  2**0
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  000000d0  2**0
                  ALLOC
  3 .rodata       00000004  00000000  00000000  000000d0  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, DATA
  4 .debug_info   00000a7d  00000000  00000000  000000d4  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev 000001c6  00000000  00000000  00000b51  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_loc    000000b0  00000000  00000000  00000d17  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges 00000020  00000000  00000000  00000dc7  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_line   000001de  00000000  00000000  00000de7  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  9 .debug_str    000005f9  00000000  00000000  00000fc5  2**0
                  CONTENTS, READONLY, DEBUGGING
 10 .comment      0000007f  00000000  00000000  000015be  2**0
                  CONTENTS, READONLY
 11 .debug_frame  00000080  00000000  00000000  00001640  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
 12 .ARM.attributes 00000033  00000000  00000000  000016c0  2**0
                  CONTENTS, READONLY
```

mainAlgo.o:

```
.\mainAlgo.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         00000068  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000000  00000000  00000000  0000009c  2**0
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000004  00000000  00000000  0000009c  2**2
                  ALLOC
  3 .rodata       00000004  00000000  00000000  0000009c  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, DATA
  4 .debug_info   00000a54  00000000  00000000  000000a0  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev 000001f2  00000000  00000000  00000af4  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_loc    00000088  00000000  00000000  00000ce6  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges 00000020  00000000  00000000  00000d6e  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_line   000001cb  00000000  00000000  00000d8e  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  9 .debug_str    000005d0  00000000  00000000  00000f59  2**0
                  CONTENTS, READONLY, DEBUGGING
 10 .comment      0000007f  00000000  00000000  00001529  2**0
                  CONTENTS, READONLY
 11 .debug_frame  00000054  00000000  00000000  000015a8  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
 12 .ARM.attributes 00000033  00000000  00000000  000015fc  2**0
                  CONTENTS, READONLY
```

alarmMonitor.o:

```
.\alarmMonitor.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 .rodata       00000004  00000000  00000000  000000bc  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, DATA
  4 .debug_info   00000a3a  00000000  00000000  000000c0  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  5 .debug_abbrev 000001d5  00000000  00000000  00000afa  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_loc    000000e0  00000000  00000000  00000ccf  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_aranges 00000020  00000000  00000000  00000daf  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_line   00000147  00000000  00000000  00000dcf  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  9 .debug_str    000005e6  00000000  00000000  00000f16  2**0
                  CONTENTS, READONLY, DEBUGGING
 10 .comment      0000007f  00000000  00000000  000014fc  2**0
                  CONTENTS, READONLY
 11 .debug_frame  00000088  00000000  00000000  0000157c  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
 12 .ARM.attributes 00000033  00000000  00000000  00001604  2**0
                  CONTENTS, READONLY
```

alarm.o:

```
.\alarm.o:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         000000cc  00000000  00000000  00000034  2**2
                  CONTENTS, ALLOC, LOAD, RELOC, READONLY, CODE
  1 .data         00000000  00000000  00000000  00000100  2**0
                  CONTENTS, ALLOC, LOAD, DATA
  2 .bss          00000000  00000000  00000000  00000100  2**0
                  ALLOC
  3 .debug_info   00000a53  00000000  00000000  00000100  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  4 .debug_abbrev 000001d5  00000000  00000000  00000b53  2**0
                  CONTENTS, READONLY, DEBUGGING
  5 .debug_loc    00000150  00000000  00000000  00000d28  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_aranges 00000020  00000000  00000000  00000e78  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  7 .debug_line   00000141  00000000  00000000  00000e98  2**0
                  CONTENTS, RELOC, READONLY, DEBUGGING
  8 .debug_str    000005c4  00000000  00000000  00000fd9  2**0
                  CONTENTS, READONLY, DEBUGGING
  9 .comment      0000007f  00000000  00000000  0000159d  2**0
                  CONTENTS, READONLY
 10 .debug_frame  000000c4  00000000  00000000  0000161c  2**2
                  CONTENTS, RELOC, READONLY, DEBUGGING
 11 .ARM.attributes 00000033  00000000  00000000  000016e0  2**0
                  CONTENTS, READONLY
```

Full Code Sections

```
.\PRESSUREDET.elf:     file format elf32-littlearm

Sections:
Idx Name          Size      VMA       LMA       File off  Algn
  0 .text         0000041c  08000000  08000000  00010000  2**2
                  CONTENTS, ALLOC, LOAD, READONLY, CODE
  1 .bss          0000101c  20000000  0800041c  00020000  2**2
                  ALLOC
  2 .debug_info   00003fa7  00000000  00000000  0001041c  2**0
                  CONTENTS, READONLY, DEBUGGING
  3 .debug_abbrev 00000bec  00000000  00000000  000143c3  2**0
                  CONTENTS, READONLY, DEBUGGING
  4 .debug_loc    0000057c  00000000  00000000  00014faf  2**0
                  CONTENTS, READONLY, DEBUGGING
  5 .debug_aranges 000000e0  00000000  00000000  0001552b  2**0
                  CONTENTS, READONLY, DEBUGGING
  6 .debug_line   00000aa3  00000000  00000000  0001560b  2**0
                  CONTENTS, READONLY, DEBUGGING
  7 .debug_str    0000079e  00000000  00000000  000160ae  2**0
                  CONTENTS, READONLY, DEBUGGING
  8 .comment      0000007e  00000000  00000000  0001684c  2**0
                  CONTENTS, READONLY
  9 .ARM.attributes 00000033  00000000  00000000  000168ca  2**0
                  CONTENTS, READONLY
 10 .debug_frame  00000358  00000000  00000000  00016900  2**2
                  CONTENTS, READONLY, DEBUGGING
```

Map File Sample:

This is a map file sample showing section/symbol locations in memory

```
.text           0x08000000      0x41c
 *(.vectors*)
 .vectors       0x08000000       0x1c startup.o
                0x08000000                vectors
 *(.text*)
 .text          0x0800001c       0x90 startup.o
                0x0800001c                Bus_fault_Handler
                0x0800001c                MM_fault_Handler
                0x0800001c                Usage_fault_Handler
                0x0800001c                H_fault_Handler
                0x0800001c                Default_Handler
                0x0800001c                NMI_Handler
                0x08000028                Reset_Handler
 .text          0x080000ac       0x68 mainAlgo.o
                0x080000ac                sendPressureVal
                0x080000d8                ST_MA_CHECKING_PRESSURE
 .text          0x08000114       0x48 main.o
                0x08000114                setup
                0x08000128                main
 .text          0x0800015c       0xcc alarm.o
                0x0800015c                alarmOn
                0x08000178                alarmOff
                0x08000194                ST_A_INIT
                0x080001c0                ST_A_ALARM_ON
                0x080001e8                ST_A_ALARM_OFF
                0x08000210                ST_A_WAITING
 .text          0x08000228       0x9c pressureSensor.o
                0x08000228                sensor_init
                0x08000234                ST_PS_INIT
                0x08000258                ST_PS_READING
                0x08000294                ST_PS_WAITING
```