Single chip Board Control

Table of Contents

Table of Contents 2

Table of Figures 3

Chapter 1 Algorithm Introduction 5

The purge 5

Zero Check 6

Span Check 8

Chapter 2 Electrical Diagrams 13

Input 13

Control 13

Outputs 14

Chapter 3 PCB Elements 15

Chapter 4 Hardware Connection 18

Chapter 5 Touch Panel 19

Page 0: 19

Page 1 20

Page 2 21

Page 3 22

Page 4 23

Page 5 24

Chapter 6 Settings 25

Table of Figures

Figure 1.1 Purge Timer 1 (1 second) D1 D2 D6 5
Figure 1.2 Purge Timer 2 (5 seconds) D1 D2 D3 D6 5
Figure 1.3 Purge Timer 3 (5 seconds) D1 D2 D4 D6 6
Figure 1.4 Zero Check D1 D2 D8 D9 D10 6
Figure 1.5 Lower Limit -4% 7
Figure 1.6 Working Cycle 7
Figure 1.7 Less 86% D8 D9 8
Figure 1.8 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D8 D10 for T4 8
Figure 1.9 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D10 for 1 Sec 9
Figure 1.10 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D9 D10 for 1 Sec 9
Figure 1.11 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D10 for 1 Sec 9
Figure 1.12 86 %< Sensor Value < 88% 10
Figure 1.13 88 %< Sensor Value < 92% D1 D2 D5 D6 D7 D10 for 5 Sec 10
Figure 1.14 88 %< Sensor Value < 92% 11
Figure 1.15 92 %< Sensor Value D1 D2 for 0.5 Sec 11
Figure 1.16 92 %< Sensor Value D1 D2 for 0.5 Sec 12
Figure 2.1 Inputs 13
Figure 2.2 Arduino Nano Board 14
Figure 2.3 Outputs 14
Figure 3.1 PCB ARES Design 15
Figure 3.2 3D Visualizer Mode Proteus Ares 16
Figure 3.33D Visualizer Mode Proteus Ares Bottom Copper 16
Figure 3.4 PCB result 17
Figure 4.1 Box PCB 18
Figure 5.1 Page 0 Nextion Editor 19
Figure 5.2 Page 1 Nextion Editor 20

Figure 5.3 Page 2 Nextion Editor 21
Figure 5.4 Page 3 Nextion Editor 22
Figure 5.5 Page 4 Nextion Editor 23
Figure 5.6 Page 6 Nextion Editor 24
Figure 6.1 Nextion Screen Page 0..... 25
Figure 6.2 Nextion Screen Page 1..... 26
Figure 6.3 Graphics Timer 1, 2, 3..... 27
Figure 6.4 Nextion Screen Page 2..... 28
Figure 6.5 Nextion Screen Control Sensor 30

Chapter 1 Algorithm Introduction

The program follows the rules which are detailed below:

The purge

Within this process, the system has three timers which different valves are going to carry out the purge. The first timer (timer 1) works for 1 second in this working cycle the valve D1 (S1), D2 (S2) and D6 (S6) will be turned on.

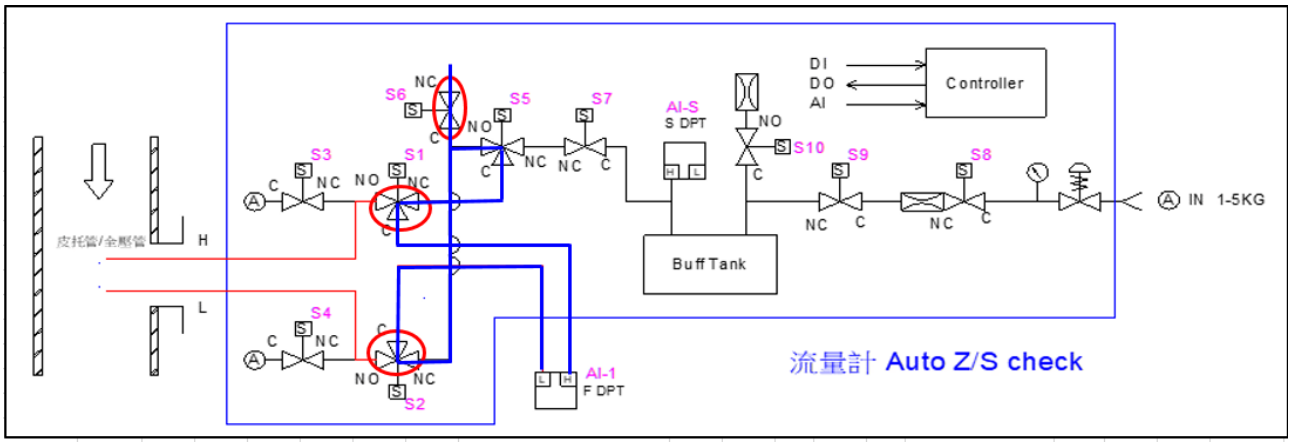


Figure 1.1 Purge Timer 1 (1 second) D1 D2 D6

The second timer (timer 2) is going to work during 5 seconds (Timer 6), the valve D1, D2, D3, and D6 are activated.

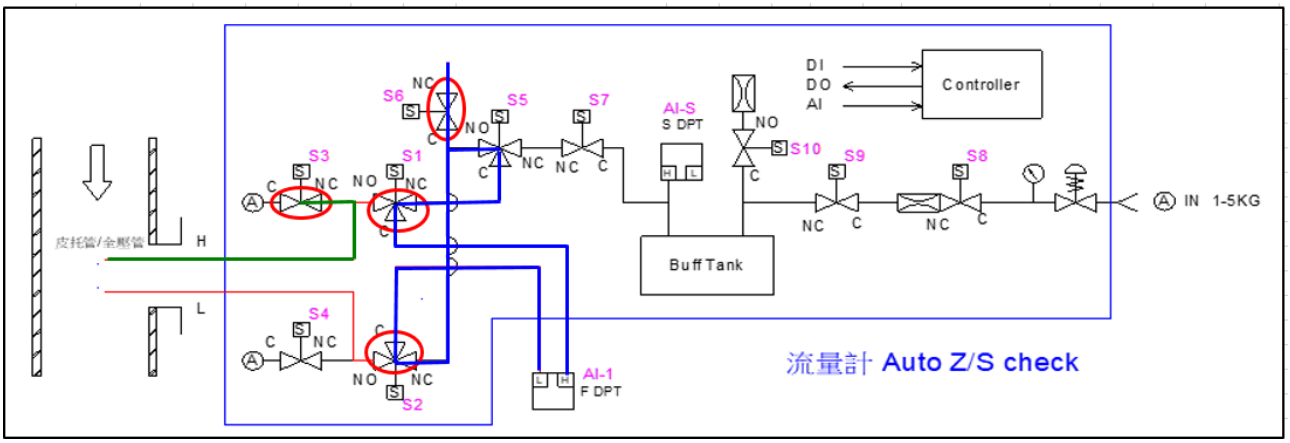


Figure 1.2 Purge Timer 2 (5 seconds) D1 D2 D3 D6

The third timer (Timer 3) has the same work cycle as timer 2 but the valve D3 is turned off and the valve D4 is turned on (Timer 6).

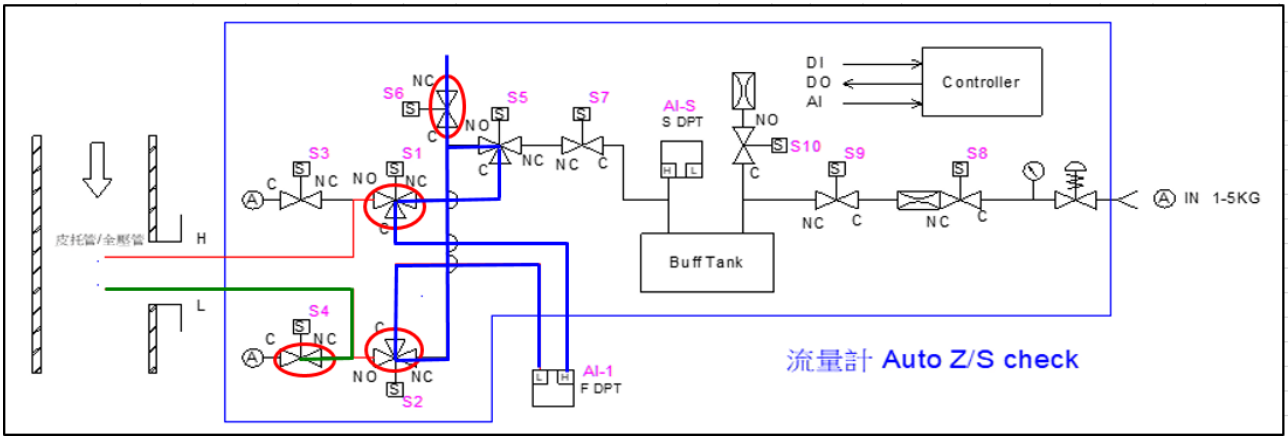


Figure 1.3 Purge Timer 3 (5 seconds) D1 D2 D4 D6

The total time of the purge is about 11 seconds after that the Zero check starts.

Zero Check

The goal of the zero check is to achieve the value of the set point, in this case the value was entered by the touch screen.

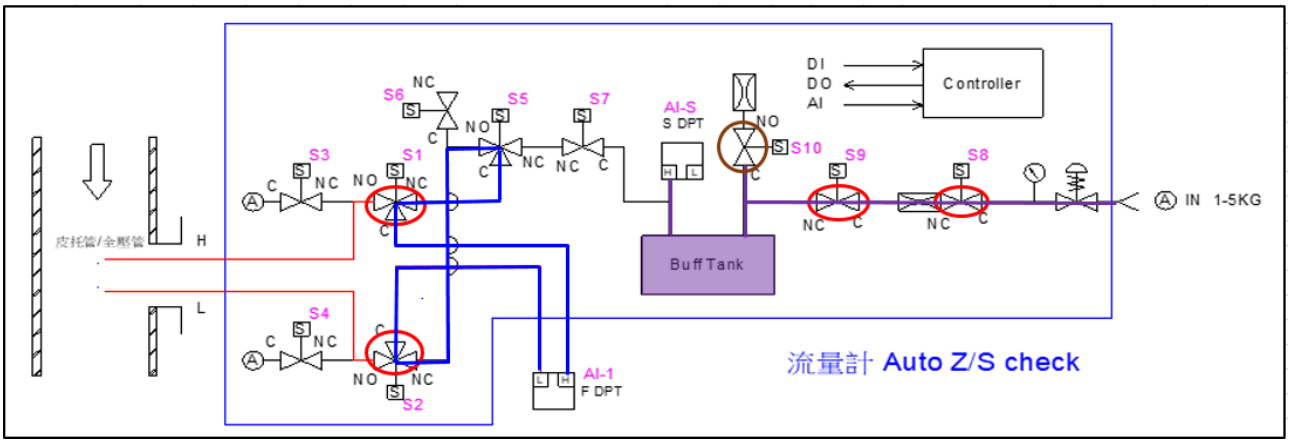


Figure 1.4 Zero Check D1 D2 D8 D9 D10

The zero check is going till the S DPT sensor gets the set point. In order to control the fluctuation of the sensor the program stops at less four percent.

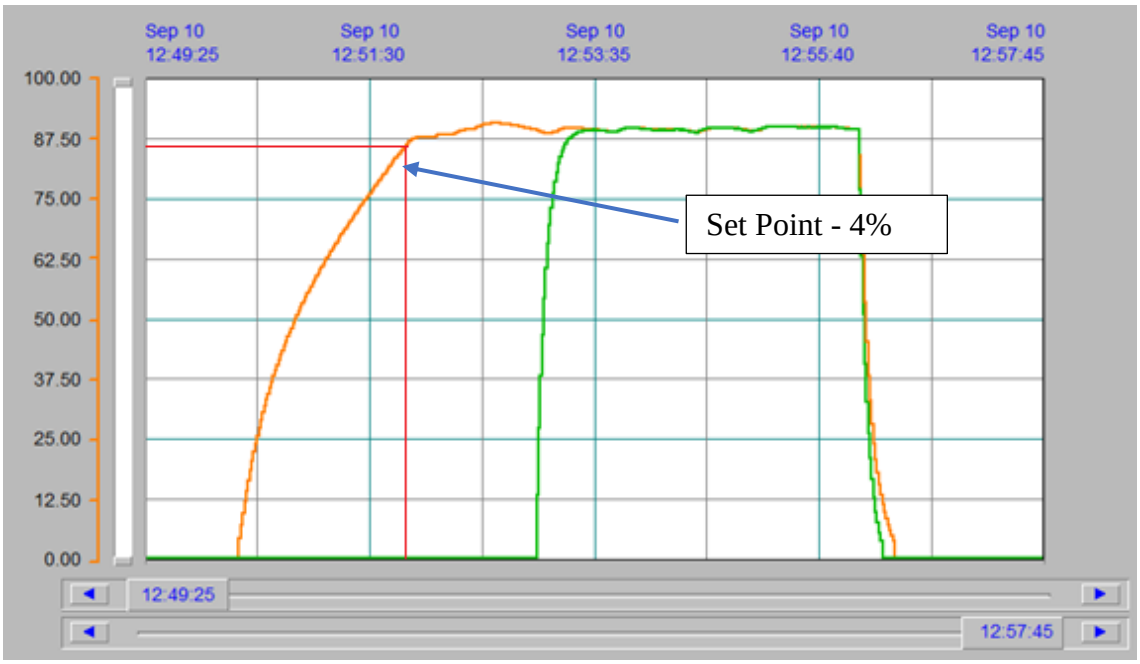


Figure 1.5 Lower Limit -4%

Afterwards the control of the set point, three minutes later the Field DPT is activated (Timer 1).

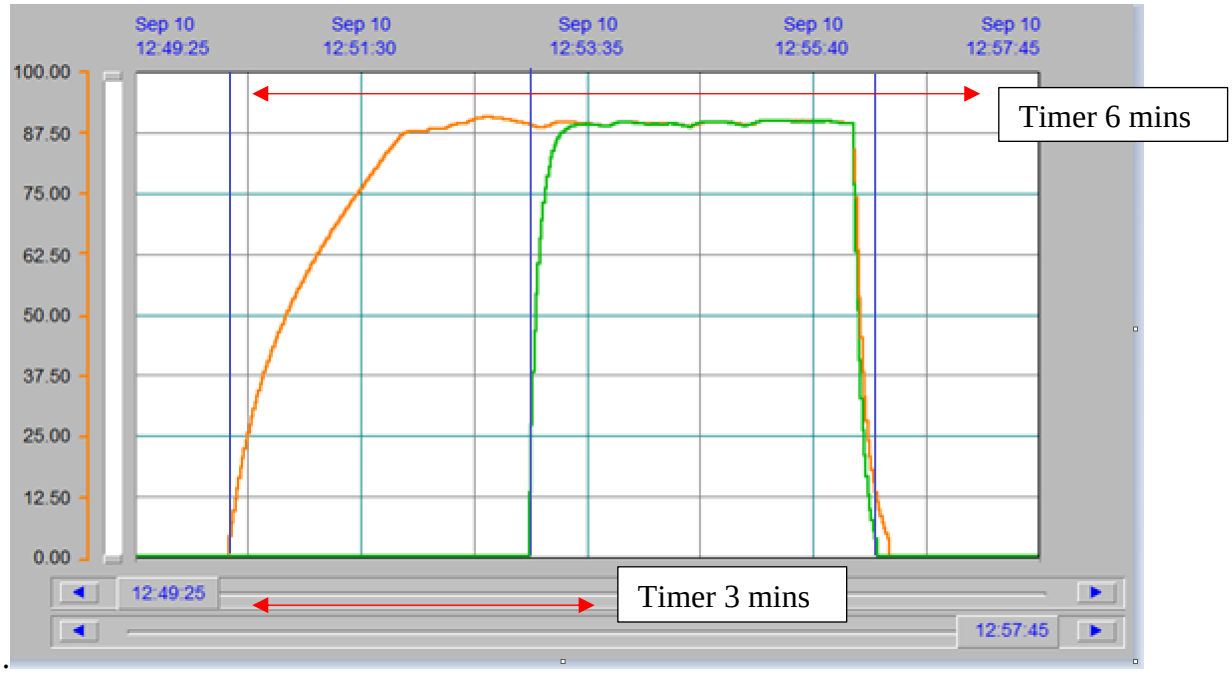


Figure 1.6 Working Cycle

The system waits for the set point and during 5 seconds (this time can be changed Timer 3) the sensor gets the stabilization.

Span Check

The Span Check has different cases, they are going to depend of the sensor value:

When the sensor value is less 86 % (lower limit) both valves (D8 D9) are activated.

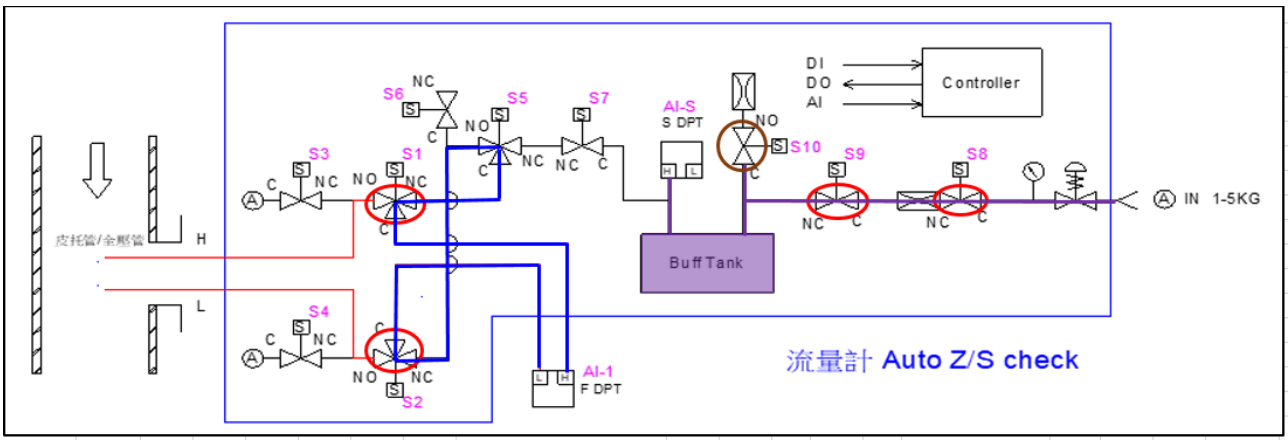


Figure 1.7 Less 86% D8 D9

If the sensor value is between 86% (lower limit) and 88% (Compensate Factor), the program carries out the next cycle, D8 turned on for T4 (Timer 4), D8 turned off for 1 second, D9 turned on for 1 seconds, D9 turned off 1 seconds.

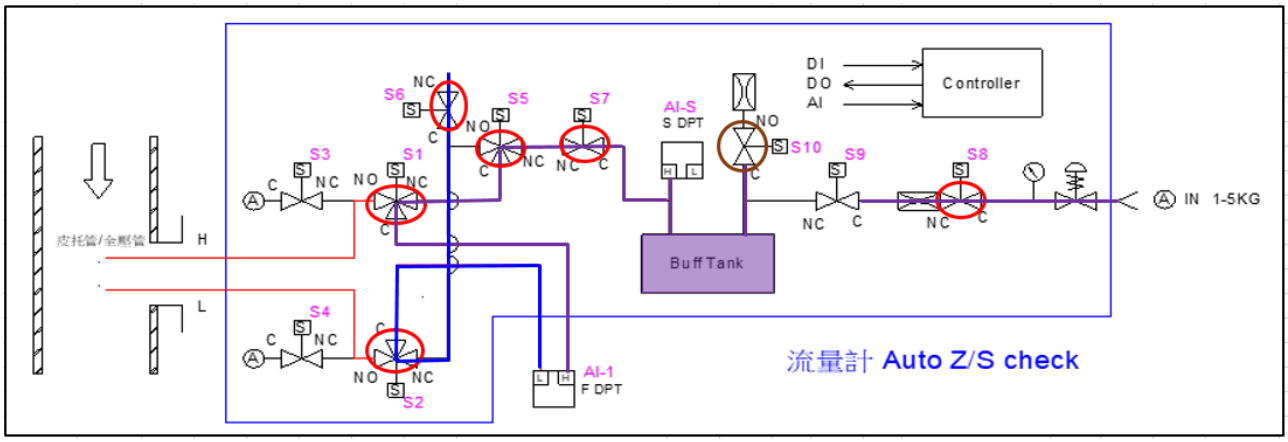


Figure 1.8 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D8 D10 for T4

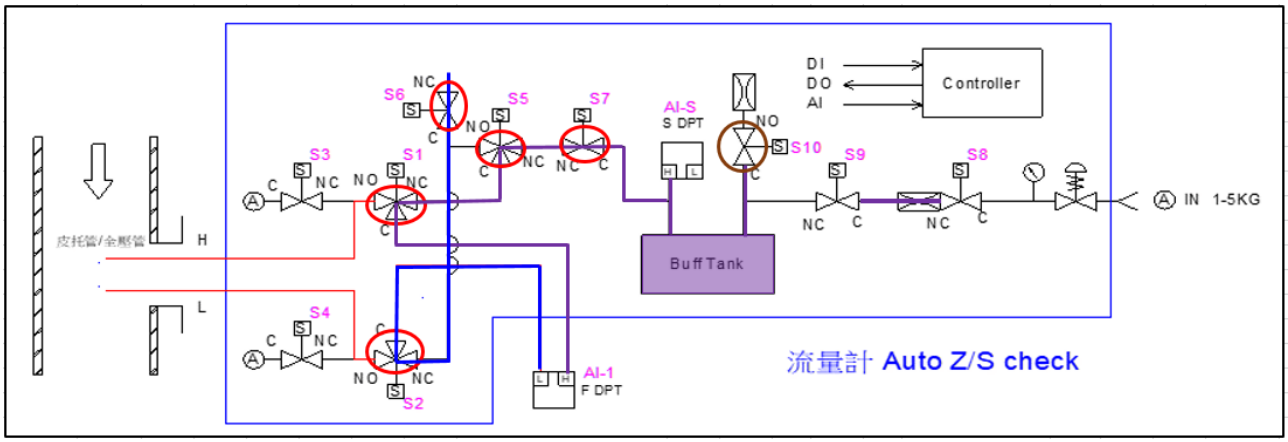


Figure 1.9 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D10 for 1 Sec

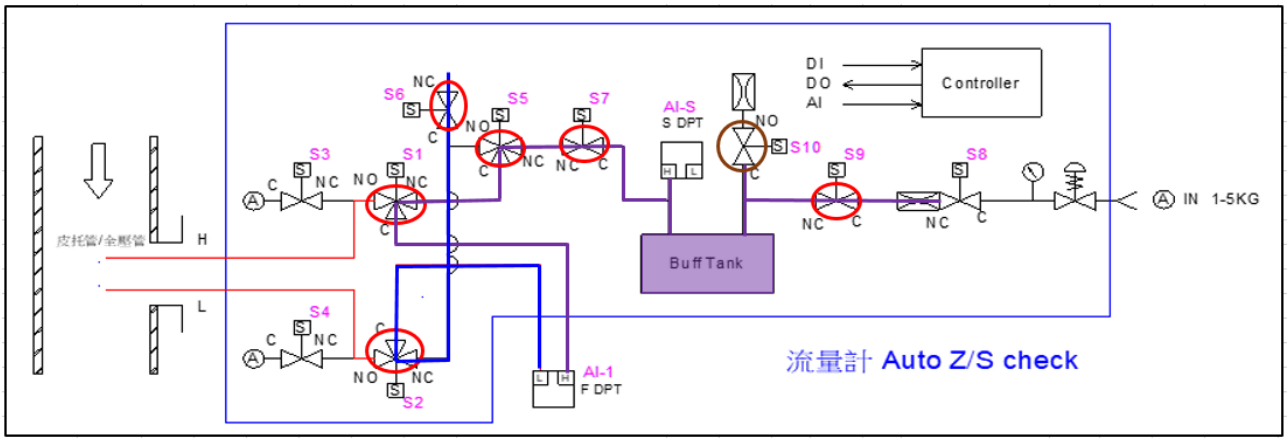


Figure 1.10 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D9 D10 for 1 Sec

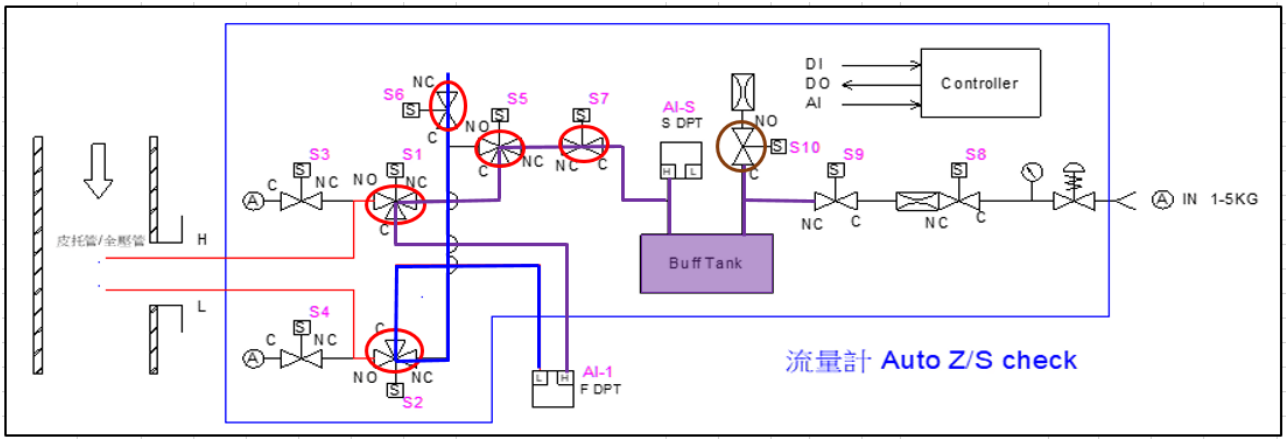


Figure 1.11 86 %< Sensor Value < 88% D1 D2 D5 D6 D7 D10 for 1 Sec

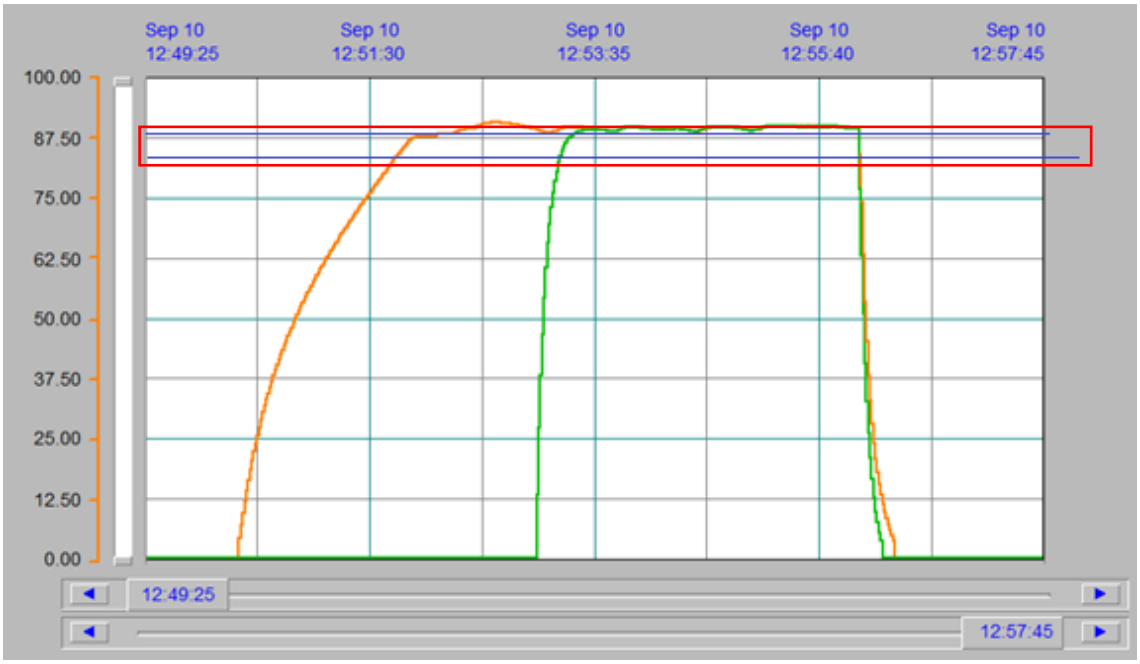


Figure 1.12 86 %< Sensor Value < 88%

The third case between 88% (Compensate Factor) and 92% (Release Factor) is the operational range where the set point has to wait for 5 seconds (Timer 3). The valves activated in this case are D1 D2 D5 D6 D7 D10.

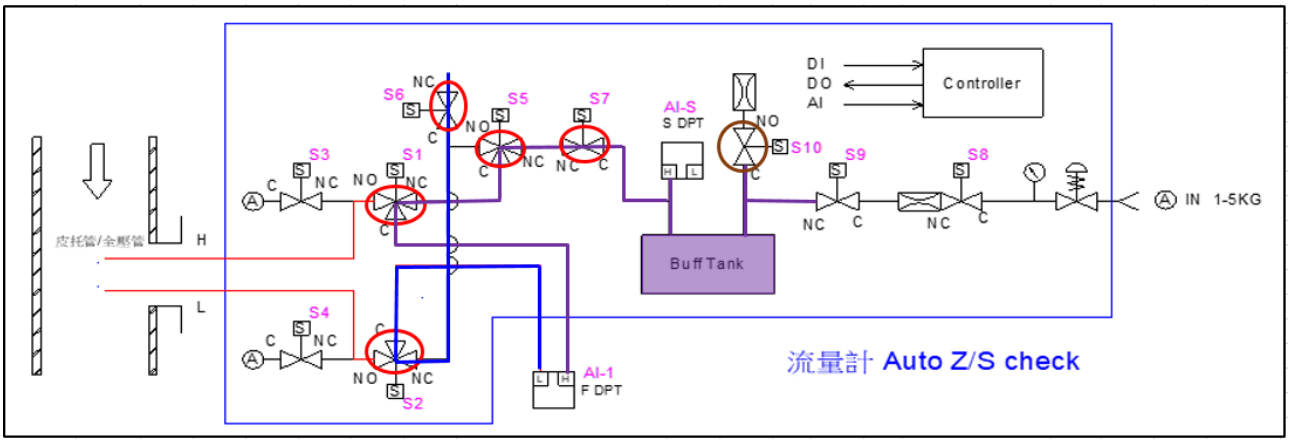


Figure 1.13 88 %< Sensor Value < 92% D1 D2 D5 D6 D7 D10 for 5 Sec

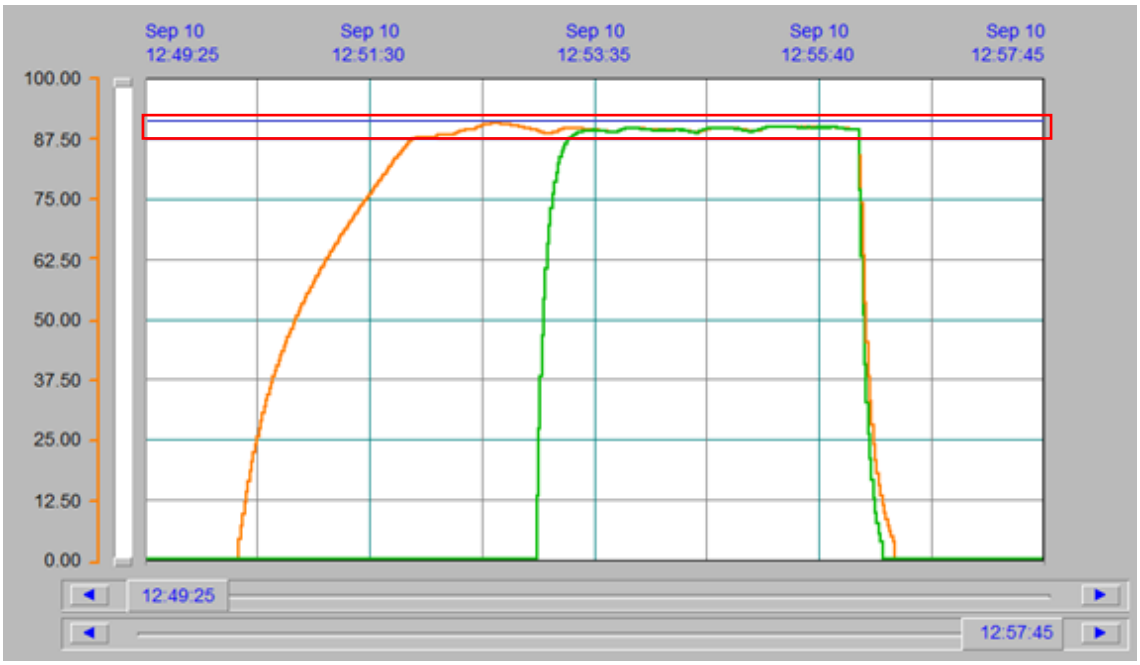


Figure 1.14 88 %< Sensor Value < 92%

The last case is when the sensor value is higher than 92% (Release Factor), during this cycle the valve D10 is activated for 0.5 seconds (Timer 5).

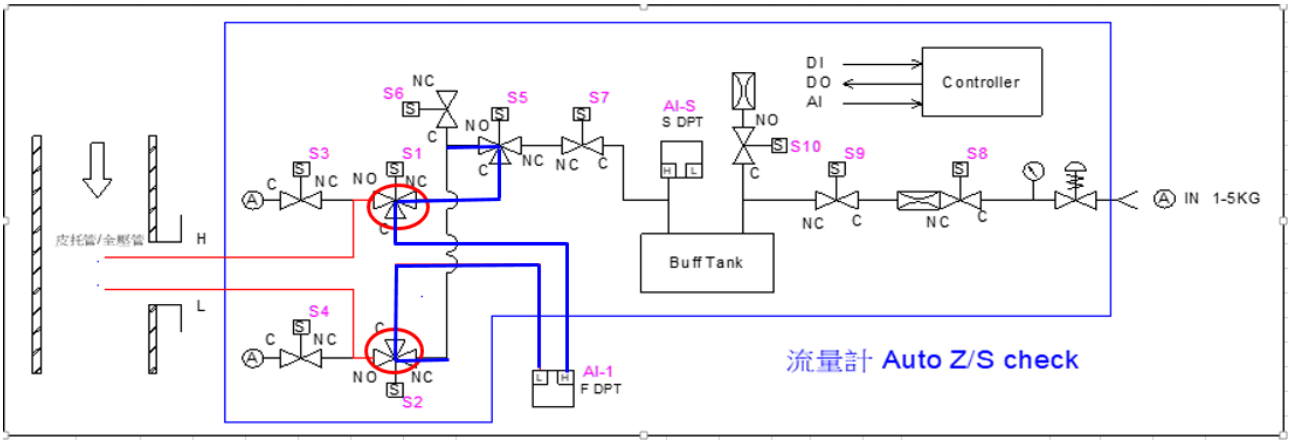


Figure 1.15 92 %< Sensor Value D1 D2 for 0.5 Sec

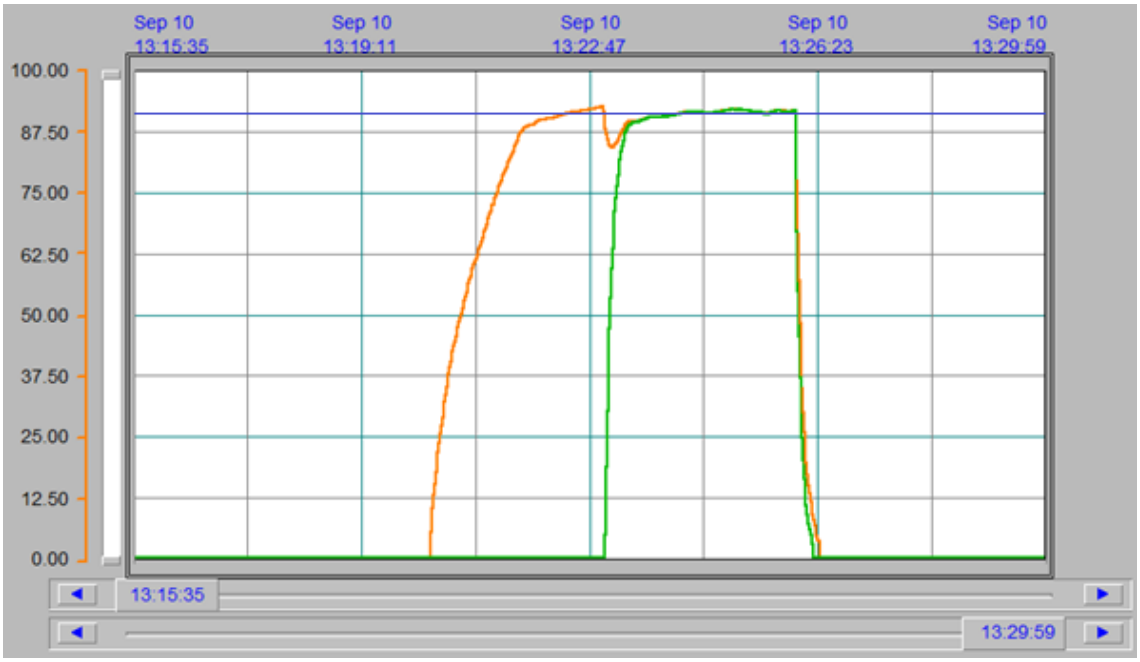


Figure 1.16 92 %< Sensor Value D1 D2 for 0.5 Sec

The final working time is 6 minutes, after that the process will be restarted (Timer 2).

Chapter 2 Electrical Diagrams

The Electrical Diagram shows the entire design of the control board, in order to understand every function is divided by three parts:

Input

In this group we can find the sensor input, the external trigger and the voltage supply (5 volts Arduino Nano and 24 Volts relays)

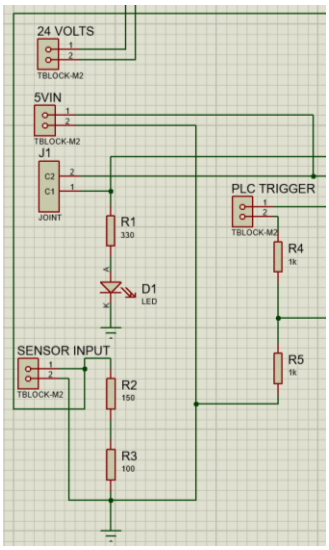


Figure 2.1 Inputs

The way to condition the sensor is using a voltage current transform, due to the sensor uses a current value, the resistor transforms the current to voltage it means the range 4 mA to 25 mA to 1 volts and 5 Volts, the resistors used are 150Ω and 100Ω. The external trigger works with resistors connected in series (1kΩ and 1kΩ). The final resistor is to control the current of the diode Led, the value of this resistor is from 100 Ω to 330Ω.

Control

The simple control is based on Arduino Nano, which has the firmware of the system.

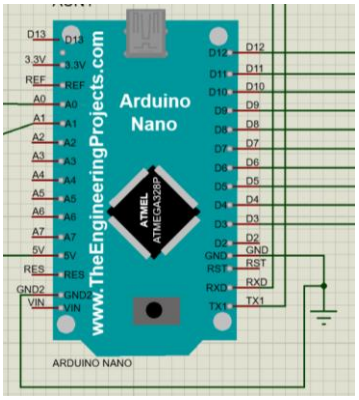


Figure 2.2 Arduino Nano Board

We use ten digital outputs to control the relays, and two analogic input to read the sensor and trigger, furthermore the communication with nextion Touchscreen is through Rx and Tx.

Outputs

The outputs of the system are the relays and the HMI, we use ten digital outputs and four pins for touchscreen.

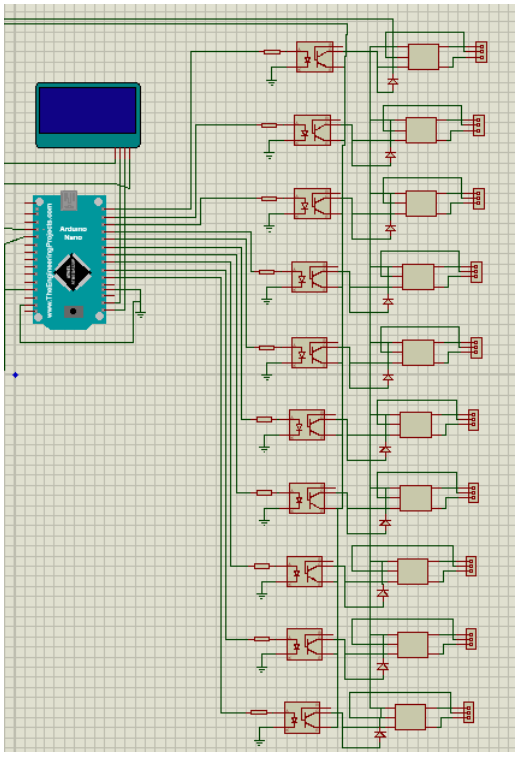


Figure 2.3 Outputs

The connections with the relays has an optocoupler to avoid the direct current to the Arduino Nano, moreover a diode was used to control the high currents of the valves.

Chapter 3 PCB Elements

The PCB was designed by Proteus Isis to satisfy the control of valves.

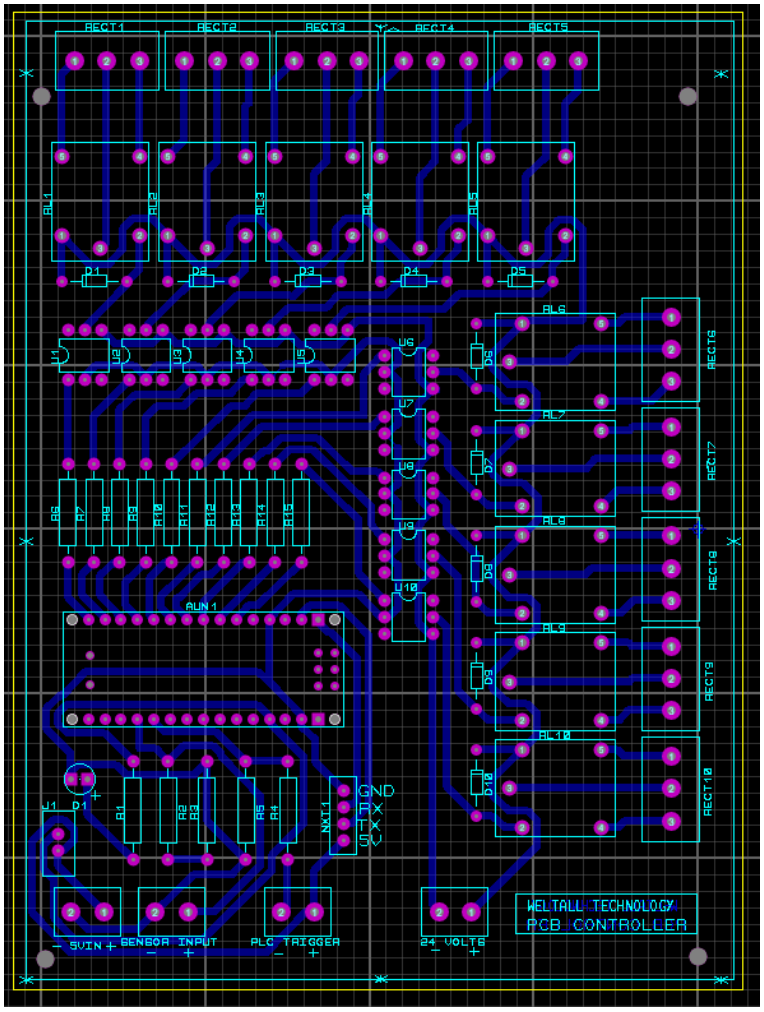


Figure 3.1 PCB ARES Design

Using the 3D visualizer mode we can check the real size out.

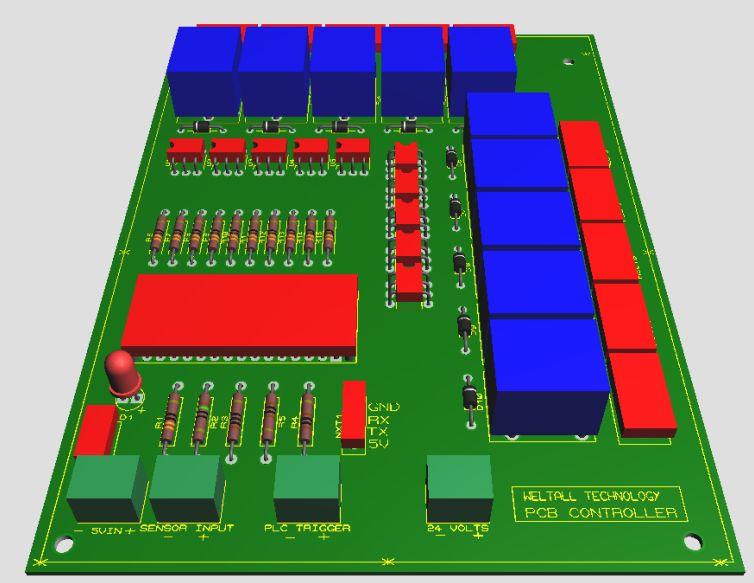


Figure 3.2 3D Visualizer Mode Proteus Ares

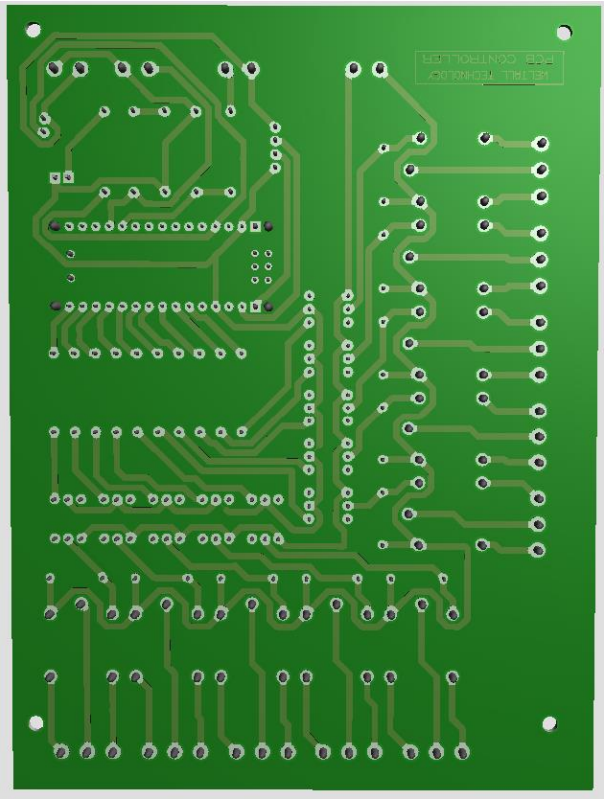


Figure 3.33D Visualizer Mode Proteus Ares Bottom Copper

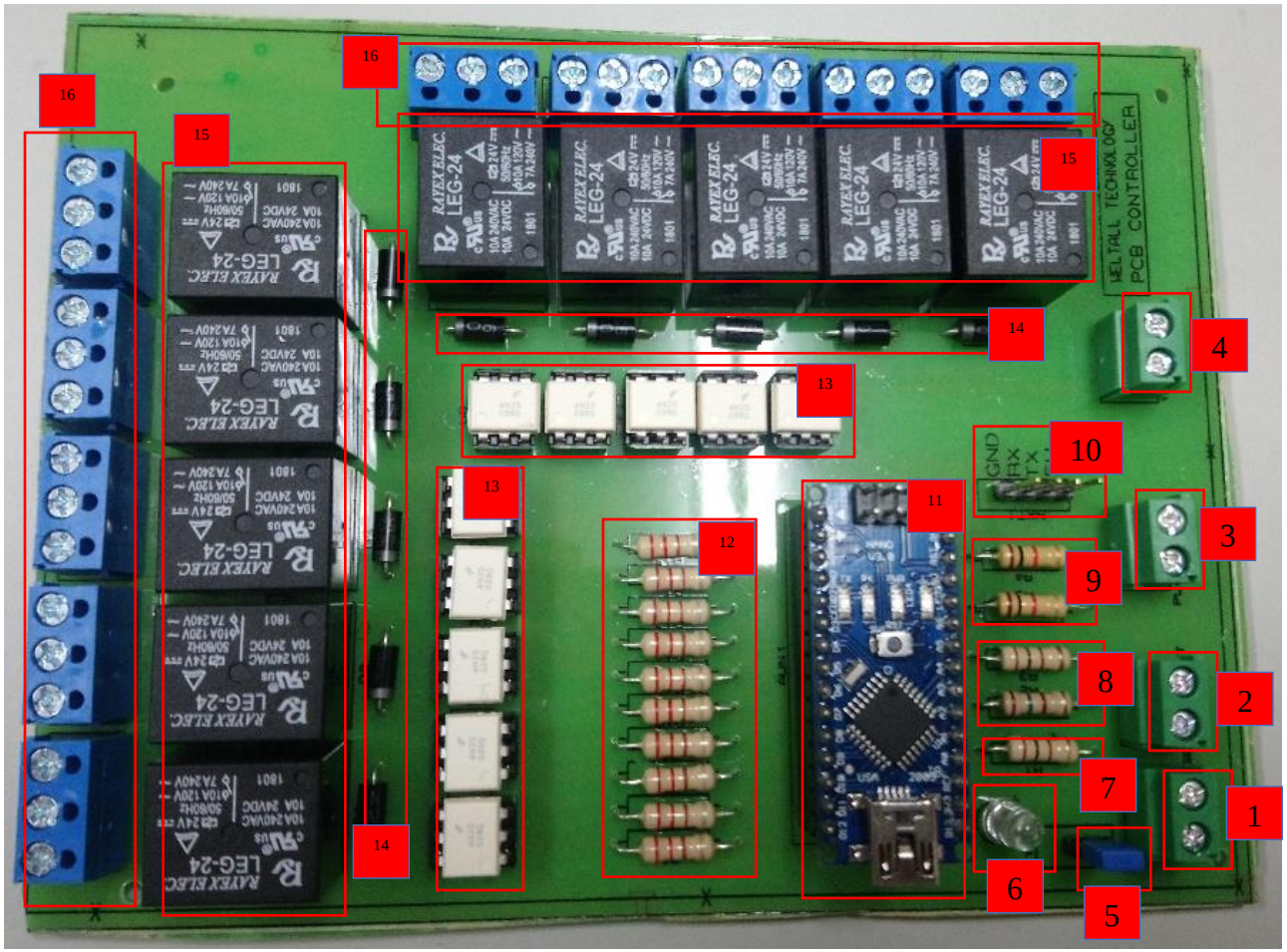


Figure 3.4 PCB result

1	5 volts input	5	Jumper Connection Arduino 5 volts	9	PlC trigger sensor 1kΩ	13	10 Optocoupler 4n25
2	Sensor Input	6	Diode Led Alert	10	Input Nextion LCD	14	Diode Rectifier
3	PLC trigger	7	Resistor 100Ω~330Ω Led	11	Arduino Nano	15	10 Relays 24 volts
4	24 Volts Relay	8	Resistor sensor 100Ω and 150Ω	12	Resistor 220Ω	16	10 output terminal

Chapter 4 Hardware Connection

The connection of the board doesn't need any complicated rules, each terminal has an indication on the board.

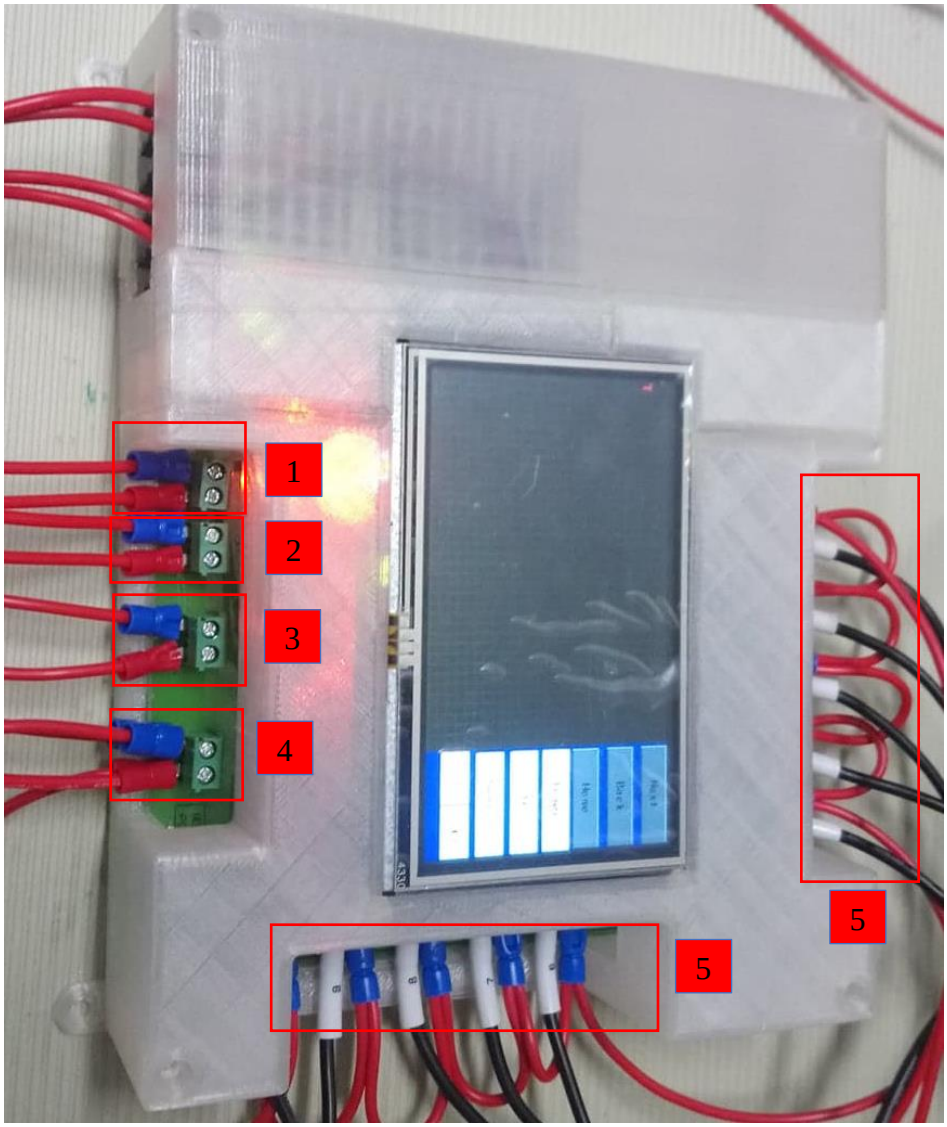


Figure 4.1 Box PCB

1	Input 5 volts to Arduino Nano, negative and positive marks
2	Sensor Input with negative and positive marks
3	PlC trigger with negative and positive marks
4	24 Volts with negative and positive marks, to relays
5	Connections to relays

Chapter 5 Touch Panel

The touch panel is composed for six pages which are going to be detailed below:

Page 0:

Figure 5.1 Page 0 Nextion Editor

1	Option to change the page, next page 1.
2	Tag used for showing the connection with the system is online, activated.
3	Button set, which its function is to change the page to the settings.

The principal page has the logo of the company, two buttons and one graphic alert.

Page 1

Figure 5.2 Page 1 Nextion Editor

1	Timer 1 with addition and subtraction number buttons (– and +).
2	Timer 2 with addition and subtraction number buttons (– and +).
3	Timer 3 with addition and subtraction number buttons (– and +).
4	Timer 4 with addition and subtraction number buttons (– and +).
5	Timer 5 with addition and subtraction number buttons (– and +).
6	Timer 6 with addition and subtraction number buttons (– and +).
7	Option to change the page, next page 2.
8	Button option to change the page, back to page 0.

Page 2

Figure 5.3 Page 2 Nextion Editor

1	Button Release factor, with addition and subtraction number buttons (– and +).
2	Button Compensate factor with addition and subtraction number buttons (– and +).
3	Button lower limit factor with addition and subtraction number buttons (– and +).
4	Button Set point with addition and subtraction number buttons (– and +).
5	Option to change the page, next page 3.
6	Button option to change the page, back to page 1.
7	Button “save” to store the configuration.

Page 3

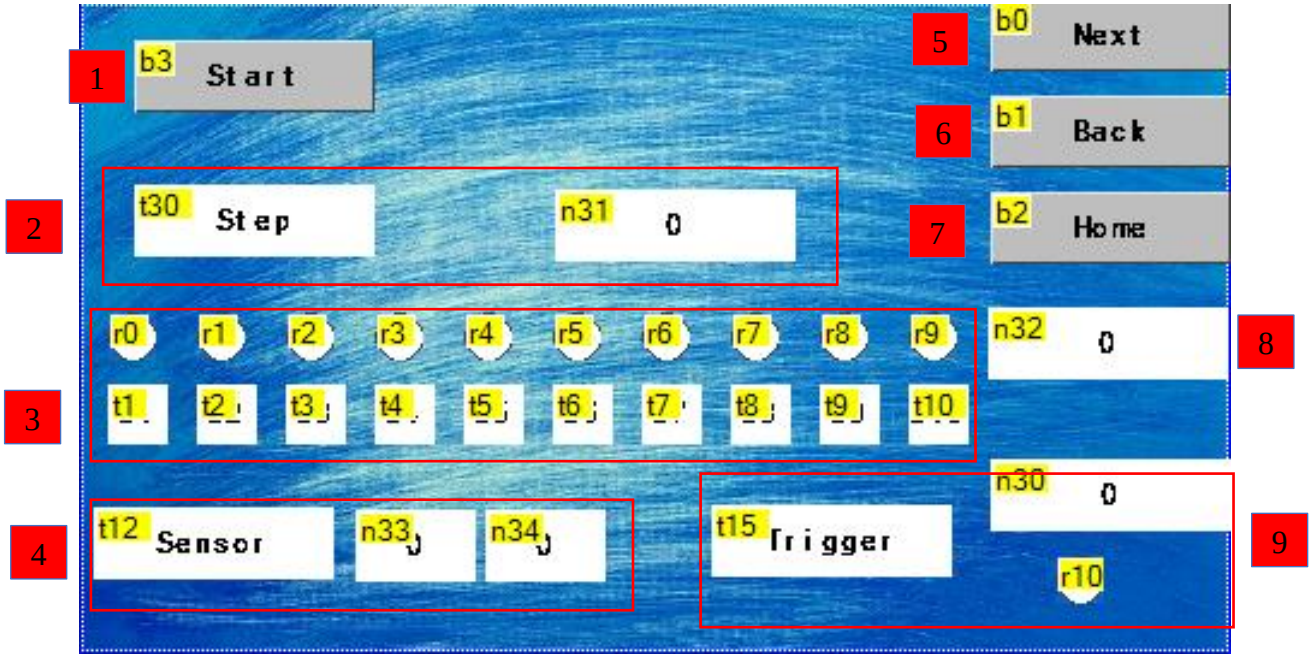


Figure 5.4 Page 3 Nextion Editor

1	Button “Start” its functions is to activate the program.
2	Text Signal to show the real time of cycle.
3	Digital output to visualize the correct function of the valves.
4	N33 and N34 show the real value of the sensor.
5	Option to change the page, next page 4.
6	Button option to change the page, back to page 2.
7	Button “Home” to return to the principal page.
8	N32 shows the time of each process.
9	Trigger, working value and activate visualization.

Page 4

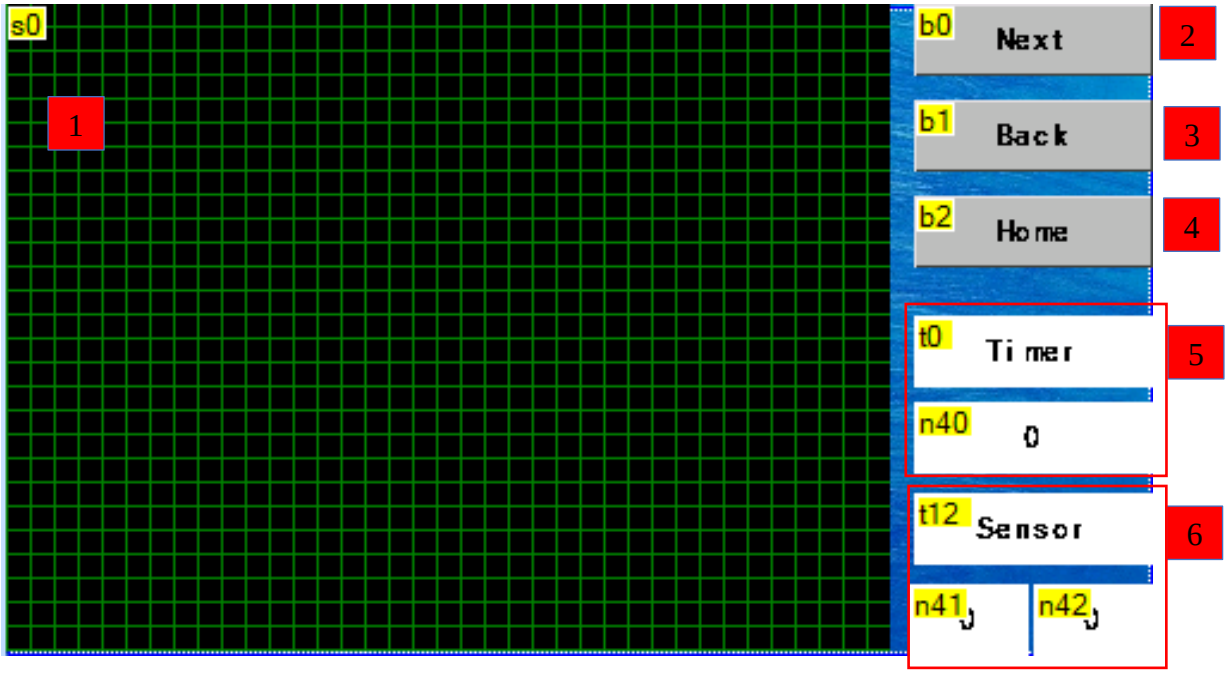


Figure 5.5 Page 4 Nextion Editor

1	Wave form chart
2	B Option to change the page, next page 5.
3	Button option to change the page, back to page 3
4	Button “Home” to return to the principal page.
5	Working Time shows the timer , 0~6 mins
6	N41 and N42 show the real value of the sensor.

Page 5

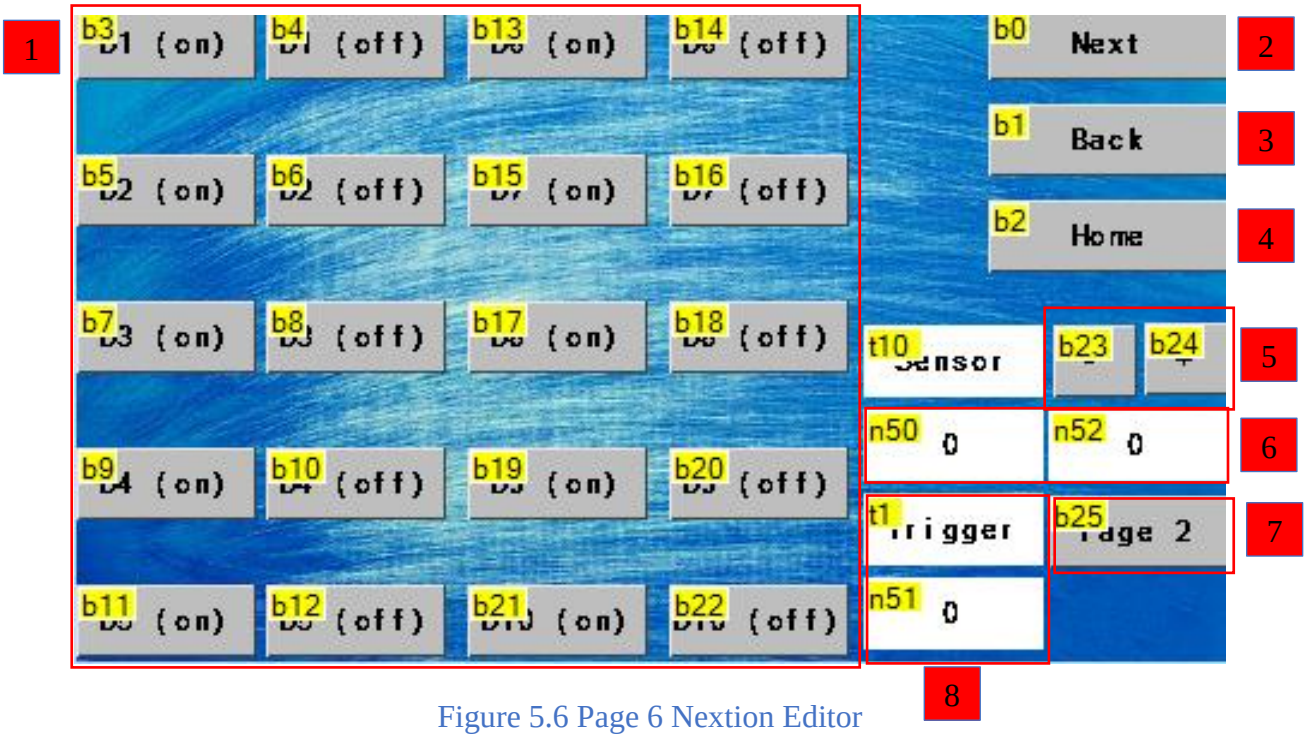


Figure 5.6 Page 6 Nextion Editor

1	Selector Buttons to check the functionality of each valve.
2	B Option to change the page, next page 0.
3	Button option to change the page, back to page 4
4	Button “Home” to return to the principal page.
5	Sensor Buttons to control the calibration of the current sensor.
6	N50 and N52 show the real value of the sensor. 0
7	Button option to change the page, back to page 2
8	Trigger visualizer shows the analogic value of the input signal from the PLC.

Chapter 6 Settings

The first screen shows the options to calibrate the sensor or to move directly to the program:

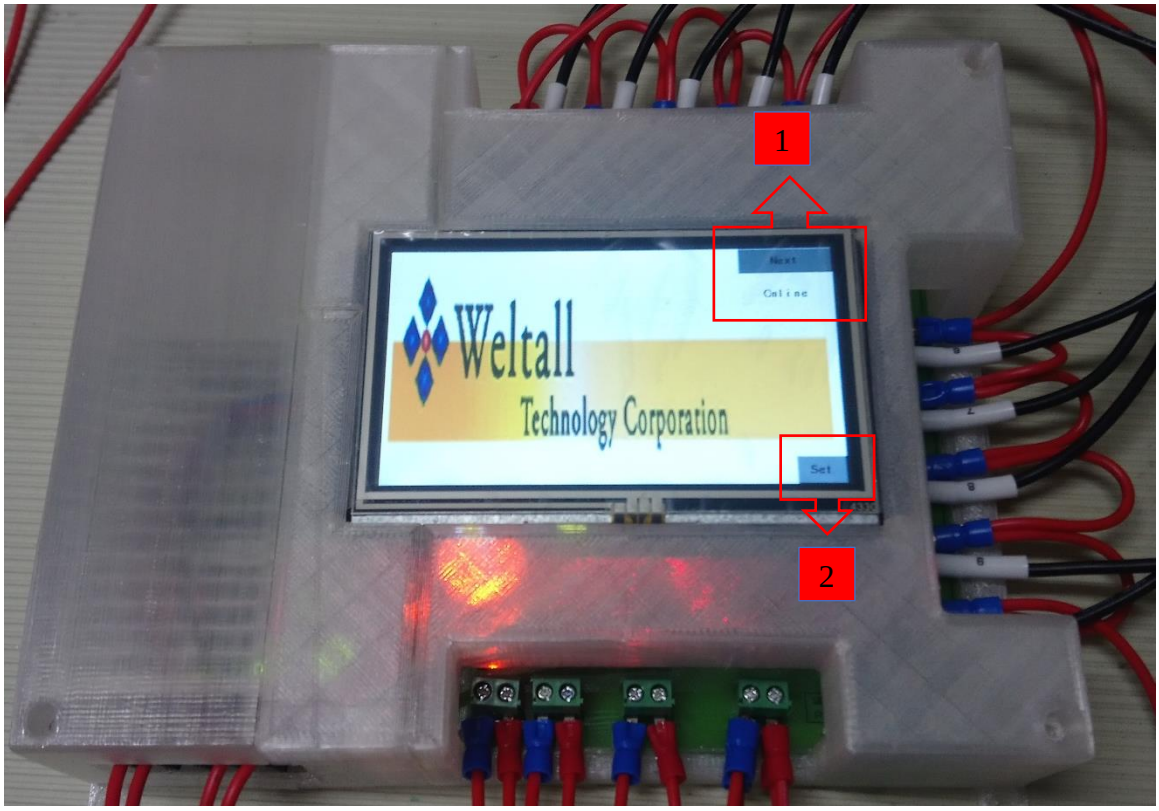


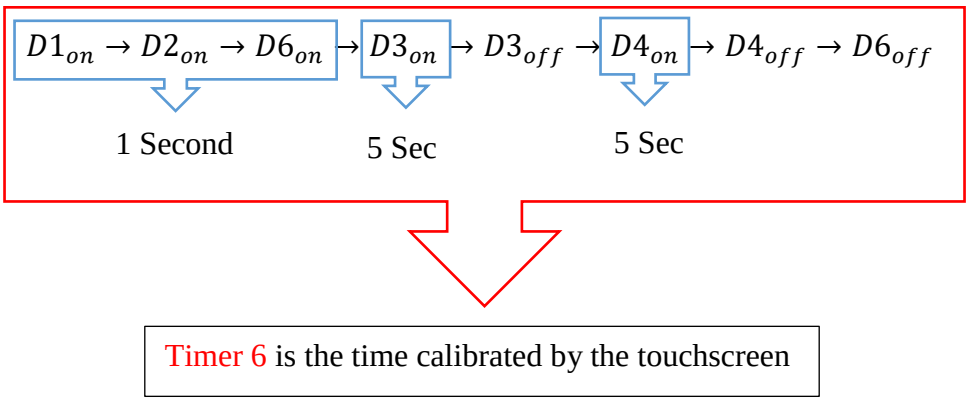
Figure 6.1 Nextion Screen Page 0

The buttons which have the tag 1 shown the options to move to the settings programs and the number 2 is the option to check the correct functionality of the valves, sensor, and trigger.

The next table is going to explain the principal features of the simple control board.

Timer 1	180 Seconds Standard DPT Building
Timer 2	360 Seconds Total Cycle
Timer 3	5 Seconds Judge Time
Timer 4	5 Seconds Compensate Time
Timer 5	25 = 0.25 seconds Release Time
Timer 6	5 seconds Purge time (11 seconds total)

The purge time is the next:



Timer 6 is the time calibrated by the touchscreen

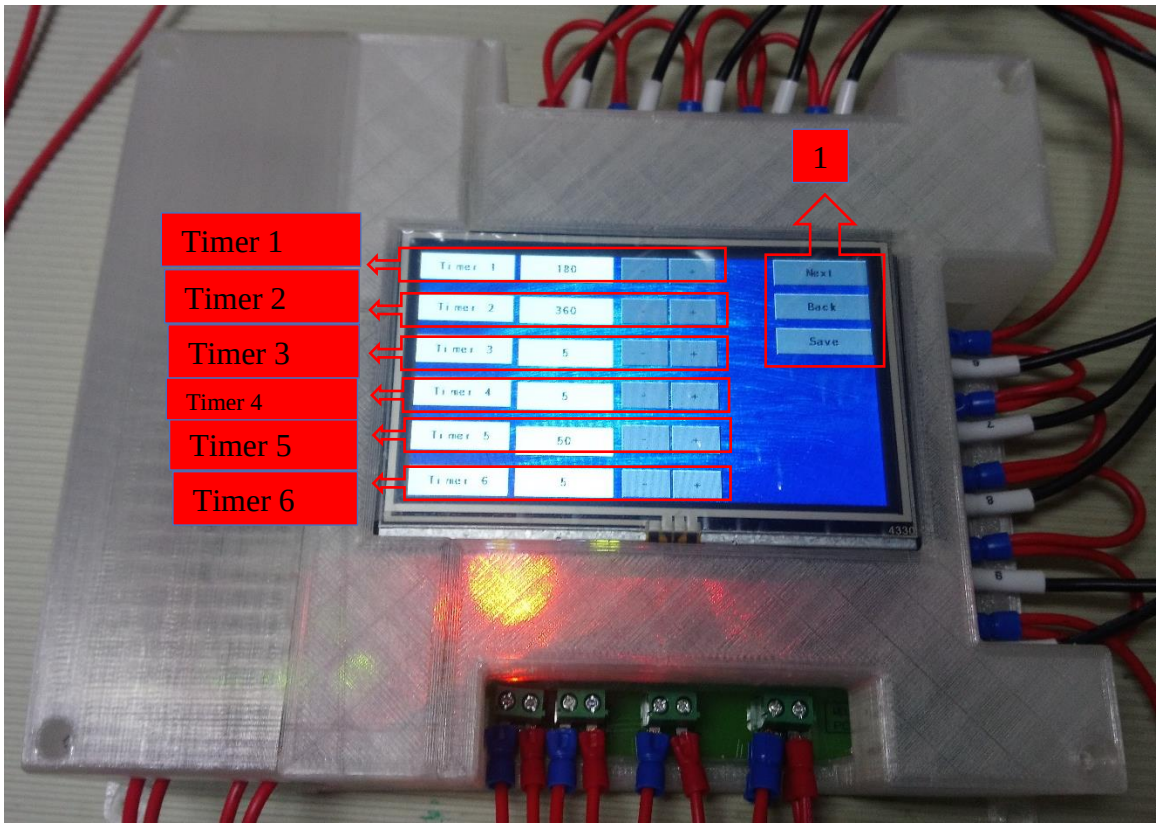


Figure 6.2 Nextion Screen Page 1

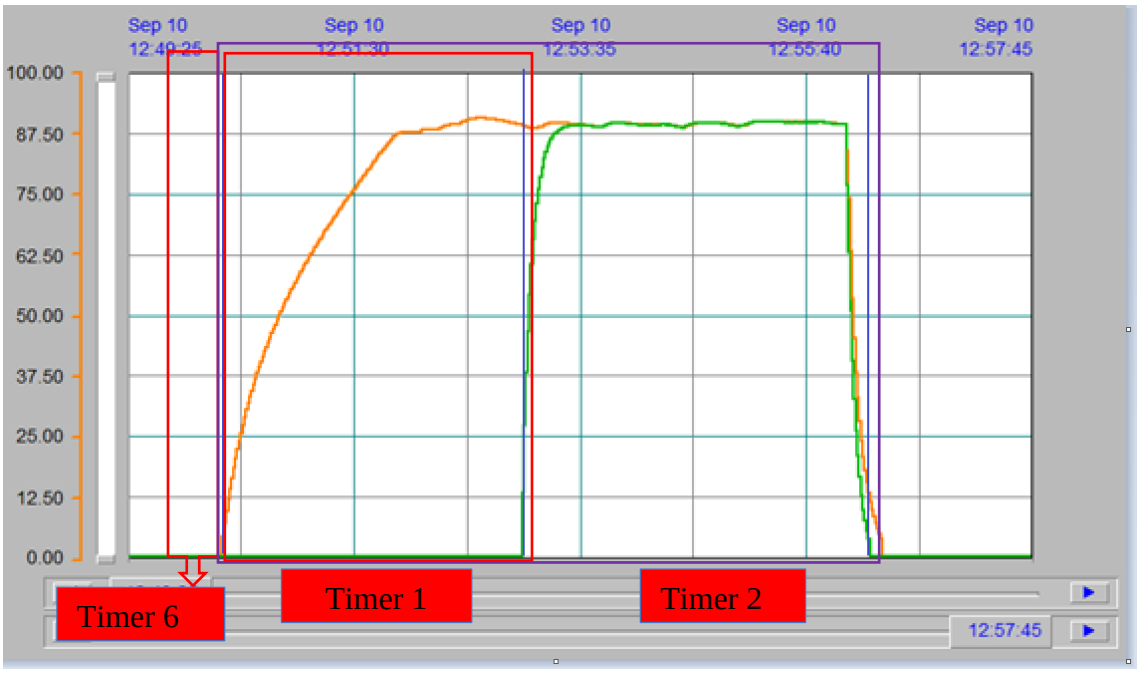


Figure 6.3 Graphics Timer 1, 2, 3

Timer 6 contains the value for the purge, for this process, the total value is 11 seconds, but we can modify it. Timer 1 is the function to produce the standard DPT, pre-configured for 180 seconds, and Timer 2 is the cycle of work the total time is 360 seconds.

Timer 3 Waiting time for decision making, Timer 4 valve ignition time (valve D8), Timer 5 valve D10 release time (0.5 seconds).

Release Factor	Factor number of 2 (90% + 2)
Compensate Factor	Factor number of 2 (90% - 2)
Lower Limit	Factor number of 4 (90% - 4)
Set Point	90 % pre-selected
Sensor Calibration	0~±10

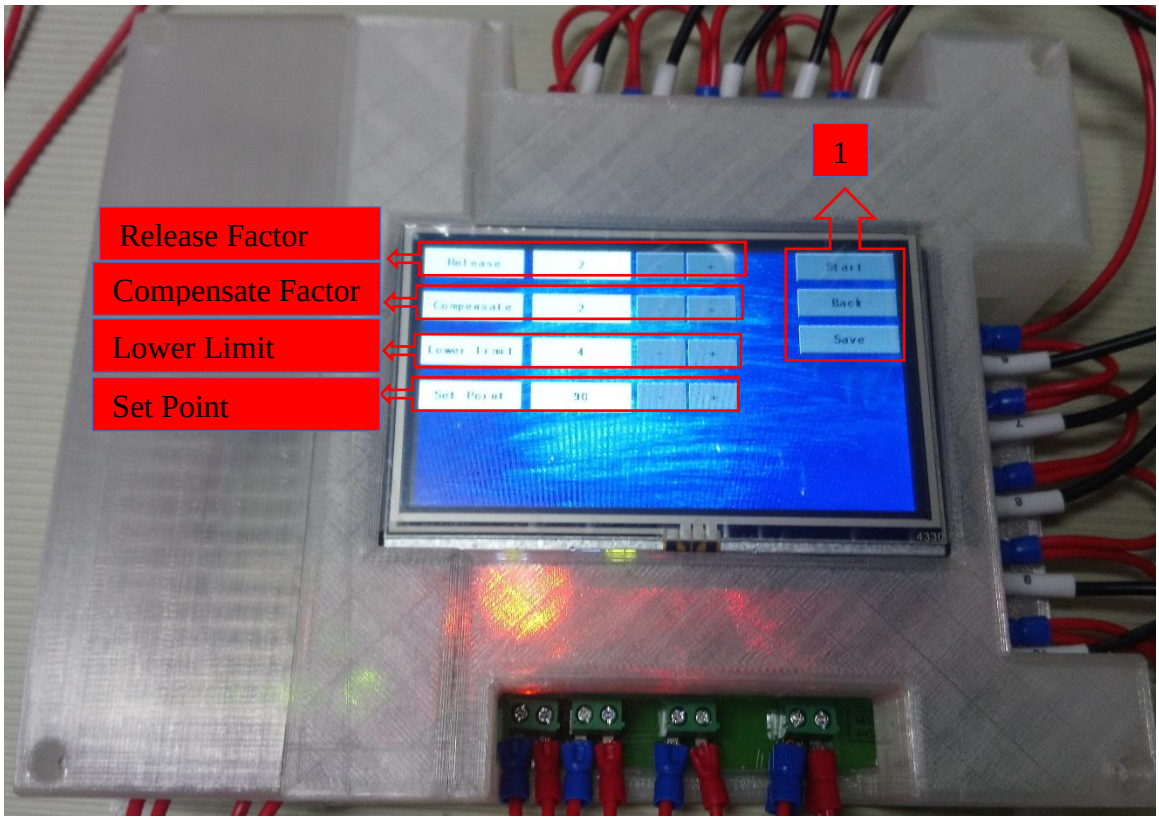
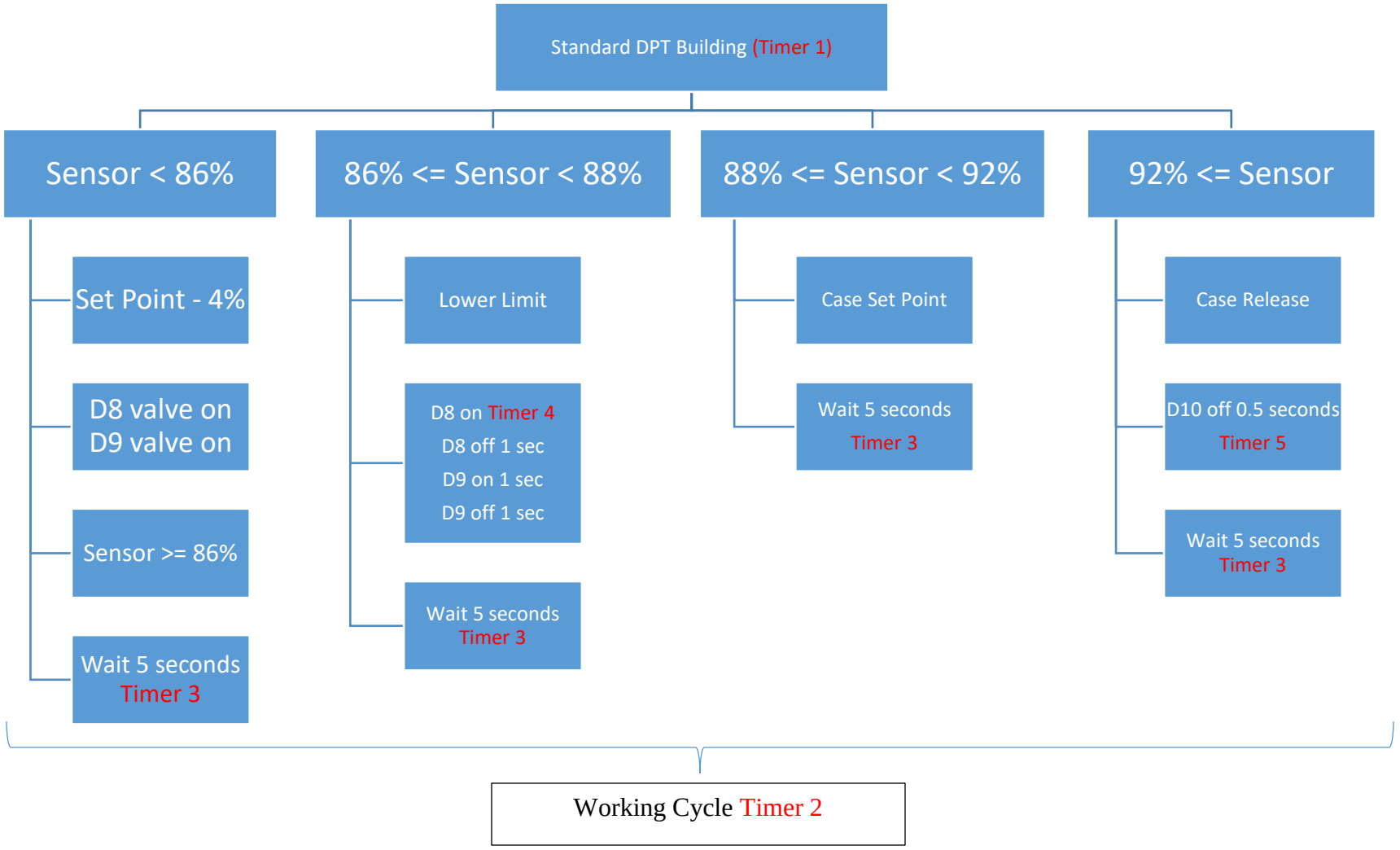


Figure 6.4 Nextion Screen Page 2

Release Factor this factor is a higher limit of control, (Sensor setpoint plus number), Compensate Factor the second limit of control which is the set point minus the chosen number. Lower Limit the lowest limit of the systems.


Standard DPT Building (Timer 1)
Sensor < 86%
Set Point - 4%
D8 valve on
D9 valve on
Sensor >= 86%
Wait 5 seconds
Timer 3
86% <= Sensor < 88%
Lower Limit
D8 on Timer 4
D8 off 1 sec
D9 on 1 sec
D9 off 1 sec
Wait 5 seconds
Timer 3
88% <= Sensor < 92%
Case Set Point
Wait 5 seconds
Timer 3
92% <= Sensor
Case Release
D10 off 0.5 seconds
Timer 5
Wait 5 seconds
Timer 3
Working Cycle Timer 2

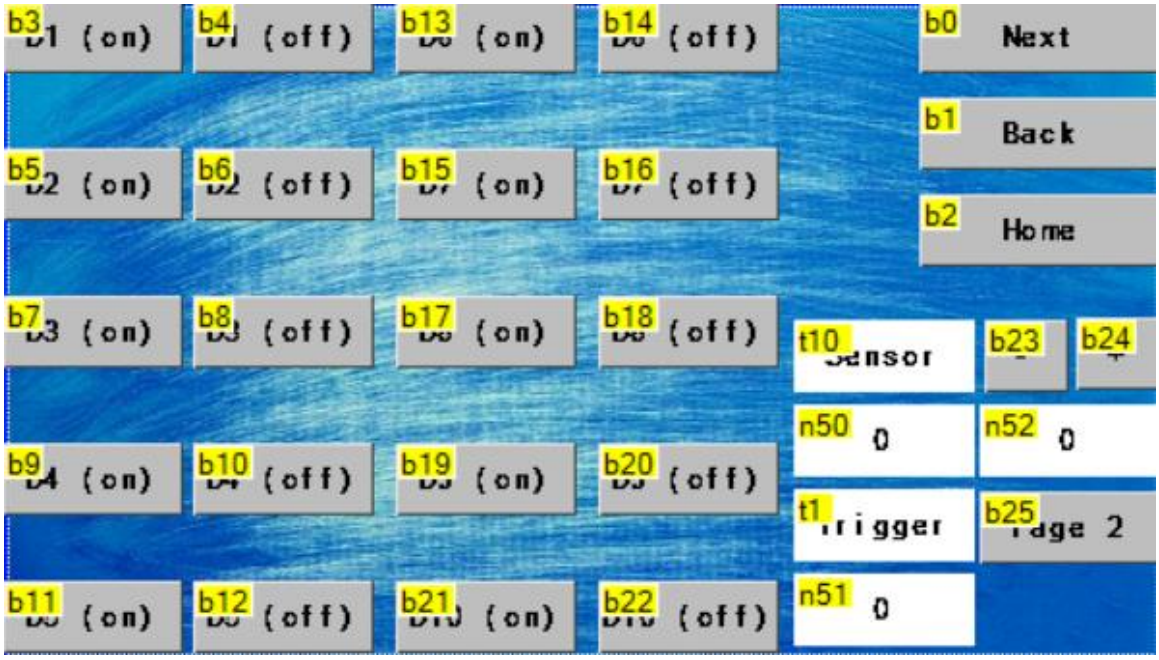


Figure 6.5 Nextion Screen Control Sensor

The sensor is calibrate to 100 because that is the value when the current is 4 mA, and 500 when the current is 25mA.