VIETNAM GENERAL CONFEDERATION OF LABOUR
TON DUC THANG UNIVERSITY
FACULTY OF ELECTRICAL ENGINEERING

LUU PHUOC SANG – 420H0317

Alcohol detection circuit in factory

PROJECT OF EMBEDDED SYSTEM

ELECTRONICS AND TELECOMMUNICATIONS ENGINEERING

HO CHI MINH CITY, YEAR 2023

PROJECT OF EMPLOYED SYSTEMS

LUU PHUOC SANG – 420H0317

Alcohol detection circuit in factory

PROJECT OF EMBEDDED SYSTEM

ELECTRONICS & TELECOMMUNICATIONS ENGINEERING

Advised by

Dr. Tran Thanh Phuong

HO CHI MINH CITY, YEAR 2023

PROJECT OF EMPLOYED SYSTEMS

ACKNOWLEDGMENT

Dear Professor Tran Thanh Phuong,

I would like to express my sincere gratitude for the guidance and support you have provided throughout my project. Your knowledge, expertise, and patience have been invaluable, and I could not have completed this project without your help.

Your feedback and constructive criticism have helped me to refine my ideas and improve my work. You have challenged me to think critically and creatively, and have inspired me to strive for excellence.

I have learned a great deal from this project, and I am confident that the skills and knowledge I have acquired will serve me well in my future endeavors. Your mentorship has been instrumental in my growth as a student and as a person, and I am truly grateful for the opportunity to work with you.

Besides, I would like to take a moment to express my heartfelt gratitude to my family and friends for their unwavering support and encouragement throughout my project. Their love and encouragement kept me motivated and inspired me to give my best.

Ho Chi Minh city, day month year

Author

Luu Phuoc Sang

TRƯỜNG ĐẠI HỌC TÔN ĐỨC THẮNG
KHOA ĐIỆN – ĐIỆN TỬ
BỘ MÔN ĐIỆN TỬ - VIỄN THÔNG

PROJECT PLAN
EMBEDDED SYSTEM PROJECT

Student's name: Lưu Phước Sang Student's ID: 420H0317

Class: 20H40201 Major: Electronics and Telecommunication

Name of Advisor: TS.Trần Thanh Phương

Topic name: Alcohol detection circuit in factory

Week/Day	**Content progress made** **(Please write details)**	**Advisor confirm**
1 **(6/3 – 12/3/2023)**	- Learn about PIC microcontrollers - Learn about Module SIM sends SMS messages - Learn about MQ3 alcohol concentration detection circuit - Write report	
2 **(13/3–19/3/2023)**	- Design the principle of operation, the function of blocks in the circuit - Write report	
3 **(20/3–26/3/2023)**	- Write the program to detect the event that alcohol concentration exceeds a threshold - Test the program with proteus or breadboard - Write report	
4 **(27/3–2/4/2023)**	Advisor complete volume assessment ……..% ☐ continue ☐ not continue	
5	- write the program to send SMS signal when the alarm	

(3/4–9/4/2023)	occurs - Test the program with proteus or breadboard - Write report	
6 **(10/4–16/4/2023)**	- Implement the hardware prototype - Write report	
7 **(17/4–23/4/2023)**	- Test and debug the prototype - Submit the final report	
8 **(24/4–30/4/2023)**	Recommendation by the advisor □ Can defend □ Can not defend	

Table of Contents

LIST OF ACRONYM

IC	Integrated Circuit
LED	Light Emitting Diode
LCD	Liquid Crystal Display
OSC1	Oscillator 1
OSC2	Oscillator 2
PIC	Programmable Intelligent Computer
RX	Receiver
TX	Transmitter
UART	Universal Asynchronous Receiver Transmitter
VDD	Voltage Drain
VSS	Voltage for Substrate and Sources

CHAPTER 1. INTRODUCTION

1.1 Research purpose

Currently, alcohol consumption worldwide is still at a relatively high level and is trending upwards over time. However, excessive consumption of alcoholic beverages poses serious health and social problems. According to the World Health Organization's report, alcohol consumption causes approximately 3 million deaths annually and affects many different aspects of life, including increased risk of traffic accidents, increased risk of occupational accidents, and increased risk of diseases related to liver, cardiovascular, nervous, and mental health.

Therefore, designing a system that uses alcohol sensor to measure the alcohol concentration in the environment is very important. This system can help reduce excessive alcohol consumption and ensure safety for users. It can be used in many different fields, including bars, restaurants, eateries, and other entertainment areas.

Moreover, designing a system that uses alcohol sensors is also necessary to help functional agencies better control alcohol consumption and apply prevention and control measures in high-risk areas. At the same time, this system can also be used to monitor the health status of certain groups of people such as drivers or workers in environments with potential risks of excessive alcohol consumption.

In this report, I have an idea to design a system for measuring and detecting alcohol concentration in the environment. This system provides the ability to detect alcohol concentration and send alerts to the user if there is a sudden increase in alcohol concentration, which is very effective. The system includes a PIC16F877A microcontroller, an MQ3 alcohol sensor, an LCD1602 display screen, a SIM800L module, a buzzer, and a V1 geared motor.

The alcohol sensor is very sensitive to alcohol, so when it detects a sudden increase in alcohol concentration in the environment, it will send data to the PIC microcontroller for calculation. Then, the LCD screen will display a specific number for the alcohol level in the air, and if it exceeds the standard level, the system will issue an alert and send an SMS to the user via the SIM module.

1.2 Technical specification

The main function of the alcohol concentration sensor system using PIC16F877A microcontroller and MQ3 alcohol sensor is to accurately determine the current alcohol concentration in the environment through the air, then measure and provide specific and accurate numbers about the detected alcohol concentration. The system outputs the collected data to the LCD display for users to view directly. Additionally, the system integrates an alert function using a buzzer and SIM module to send messages to users alerting them about the alcohol concentration level exceeding the predetermined threshold set by the user. At the same time, the motor will stop working to symbolize the automatic shutdown of the system when placed in a high alcohol consumption environment.

This project is capable of detecting alcohol concentration in the air within a relatively short distance, approximately 1-2 meters, in a working environment with only 2-3 personnel. This detection range is modest but has the advantage of requiring fewer personnel and a smaller area, resulting in more accurate readings and easier control of alcohol usage by workers. However, each worker needs to check their own breath by exhaling into the sensor for detection. If the distance exceeds this range, the system may not detect accurately. Next, the threshold is set at around 2.50mg/L because, after testing the circuit, the baseline detection in the natural environment is approximately >= 1.80mg/L. Additionally, this value may vary depending on ideal or non-ideal conditions. However, the threshold can be continuously adjusted by the supervisor. Each press of the increase or decrease button will adjust the threshold by 0.01mg/L, and continuous pressing can further increase or decrease it. Furthermore, when a significant increase in alcohol concentration is detected in the air, all machinery in the working environment will automatically shut down immediately to warn and ensure the safety of the workers and those around them. The system will also send an SMS alert to the supervisor's phone after approximately 1-5 seconds of triggering the alarm signal with a sound alarm. The system will not send a second SMS alert to the supervisor, but the machinery will remain inactive and the alarm will continue until the supervisor responds to the system's message using any character or syntax, at which point the system will resume normal operation. This project provides relatively accurate measurements and displays to the users, with quick response times when detecting high alcohol concentrations. It has the potential to achieve about 70% superiority compared to a typical alcohol concentration measuring device currently available on the market, as well as compared to traffic police alcohol breathalyzers. However, occasional malfunctions and delays may still occur, although they are not frequent. It is important to note that this assessment is subjective as there have been no comparisons or real-world measurements conducted between this project and the existing alcohol concentration measuring devices in the environment, due to financial constraints and other objective factors. Another important feature of this project is the ability to store the system's activities for a certain period, around 24 hours or a week. This storage will be implemented through an external memory with a storage capacity of about 16 bits, allowing for easy monitoring of the system's activities. These activities will be encoded into different command codes for storage, for example, command code 01 for "alcohol detection" and command code 02 for "sending a message to the supervisor." When the supervisor wants to review the operational status in the workshop, they can simply press the available history viewing button on the project, and the corresponding command codes will be displayed on the LCD screen with respective notifications. The supervisor can proactively set the storage time for various operational states, making control easier.

This project consumes a budget of approximately 500-600k for the cost of individual components, along with about 400-500k for other supporting devices such as pickit... The project involves designing a circuit board based on Proteus software and drawing a PCB layout, which is then printed with a length of about 23-25 cm and a width of 16-18 cm for a rectangular-shaped board. This is the optimal size because making it too large would be wasteful, resulting in a bulky and inflexible board. Conversely, if it is made too small, there won't be enough space for the components, and if the components are tightly packed, it would be difficult to repair or replace them in case of damage. However, this project is still at a rudimentary stage, with the circuit board being soldered and components being manually attached. The components are connected to the board using solder and wires, and the power supply unit, including transformers, is not yet separated from the system to form a unified unit. Therefore, the project is still quite basic. In the future, the project will be streamlined and designed in a way that aligns with market trends, aiming to create a positive impression on consumers regarding the product and its quality. Additionally, the project will be further developed with additional functions to optimize the product, which will be discussed in the later part of the report.

1.3 Implementation idea

Using the PIC16F877A microcontroller to control all functions in the system, the system receives signals from the MQ3 alcohol sensor module to calculate data and output it to the LCD screen. The LCD screen will display parameters such as the permissible alcohol concentration and the current alcohol concentration in the environment. If the alcohol concentration exceeds the permissible threshold, the SIM800L module will immediately send an SMS alert to the user, notifying them of the excessive alcohol concentration to ensure user safety. The system also includes a small motor to simulate a production line in a factory, which will be turned off if the system detects an alcohol concentration above the threshold. Additionally, there is an auxiliary alarm horn that will sound to alert the user. The circuit will be simulated on a computer using Proteus software and will be programmed using the CCS C compiler.

CHAPTER 2. HARDWARE DESIGN

2.1 Function block diagram

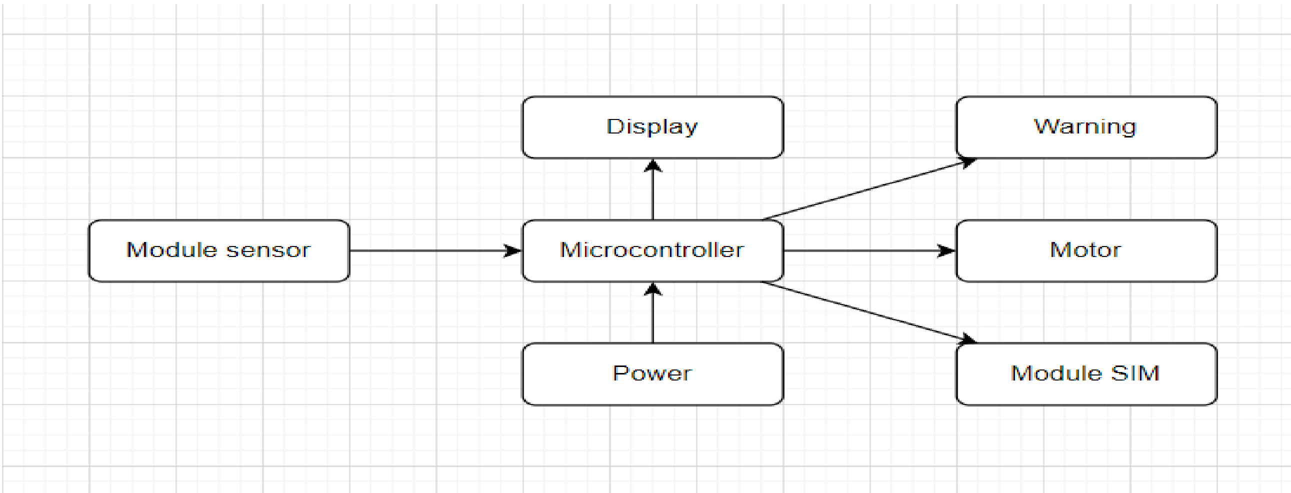

Figure 2.1 The block function diagram of the project

The alcohol detection circuit in factory is divided into 7 different blocks corresponding to different functions and tasks in the circuit to combine together to form a unified body. The 7 blocks include: Power block (or Power supply block), PIC microcontroller block, Sensor block, Display block, SIM Module block, Warning block, Motor block.

2.2 Power supply

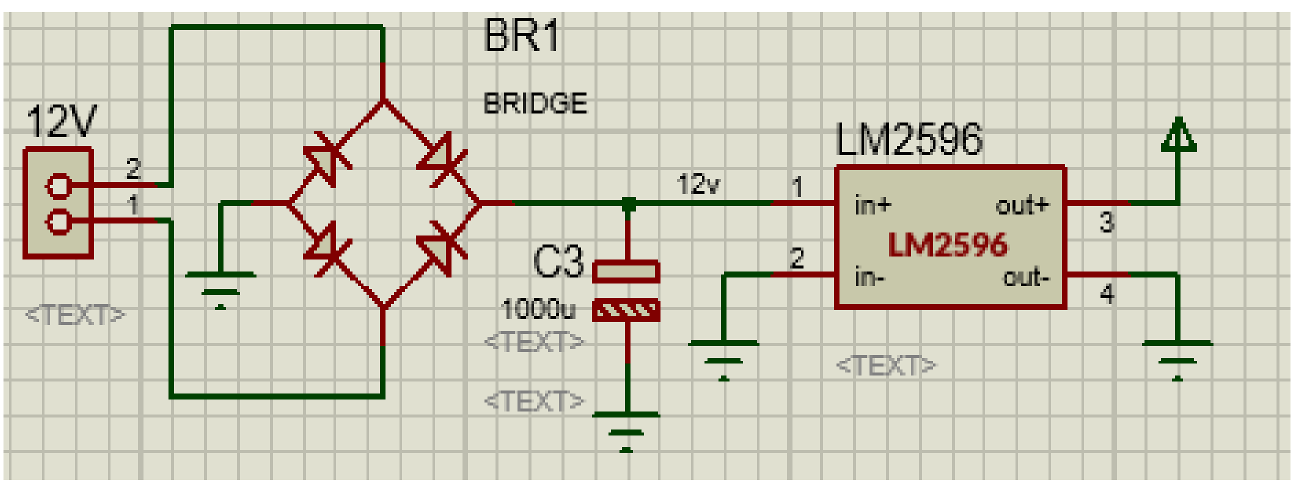

Figure 2.2 Schematic of Power supply

First, use a 220V AC power source from the mains to supply power. Then, the power will pass through a transformer to step down to a 12V AC power source. Next, a full-wave rectifier diode bridge will convert the AC power into a 12V DC unidirectional power source. It will then pass through a 1000uF capacitor to filter the signal. After that, the LM2596 voltage regulator IC will be used to stabilize the signal and step it down to a 5V DC power source. This is the power supply for the electrical circuit.

We have the equation $V_{in-max} = V_{in} - 2V_D = 12 - 2 \times 0.7 = 10.6V$

Therefore $V_{ripple} = V_{in} - V_{min} = 10.6 - 7 = 3.6V$

On the other hand, we have $V_{ripple} = \frac{I_{max}}{f \times C} => C = \frac{I_{max}}{V_{ripple} \times f}$

Insert all the value into equation we get the value of capacitor C = 1000uF

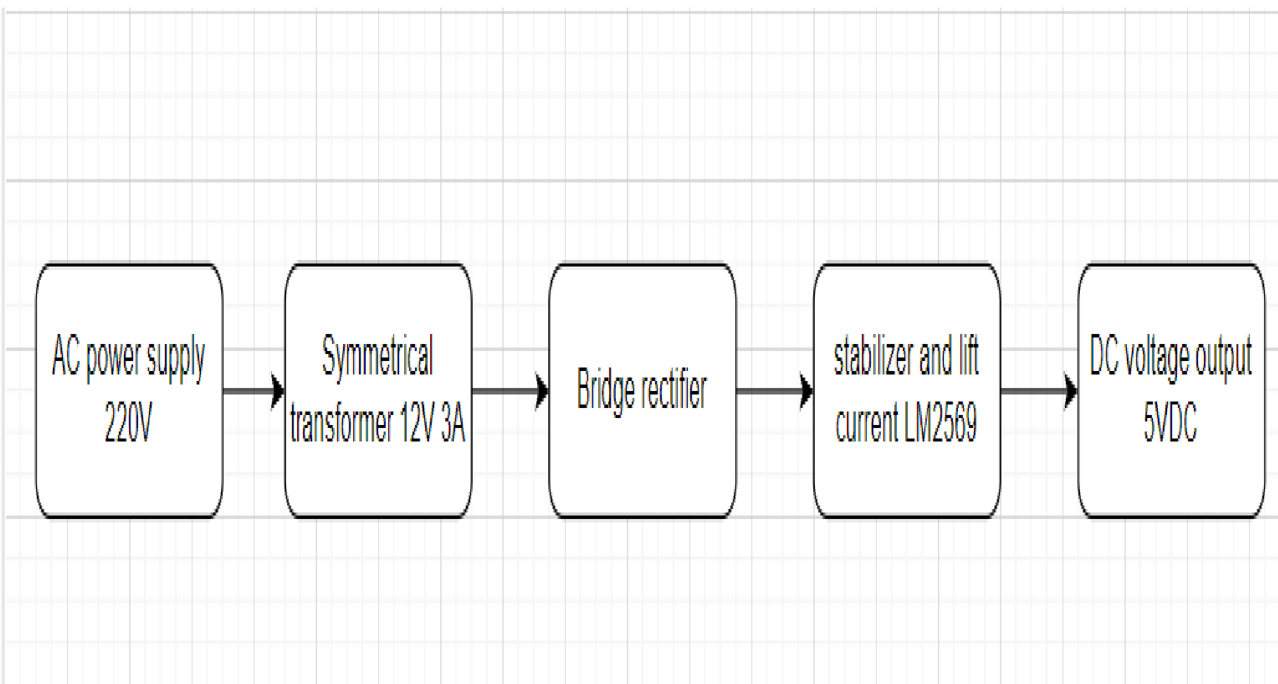

Figure 2.3 The operational diagram of the power supply

Figure 2.4 symmetrical transformer

A 12V 3A symmetrical transformer is a type of transformer with an input voltage of AC 220V (or 110V depending on the region of use) and an output voltage of DC 12V with a maximum current of 3A. A symmetrical transformer is a type of transformer that has the characteristic of two coils with equal numbers of turns and placed symmetrically on each other. When voltage is applied to one coil, the other coil will generate a symmetrical and opposite voltage to the input voltage. This helps to create a stable and safe output voltage for electronic devices. With the specifications of a 12V 3A symmetrical transformer, it can be used to supply power to electronic devices with a required input voltage of 12V and current not exceeding 3A. It is commonly used to power devices such as computers, LED lights, audio equipment, cameras, camcorders, and many other electronic devices.

Table 2.1:

Input voltage: AC 220V or AC 110V (depending on the region of use)
Output voltage: DC 12V
Output current: maximum 3A
Power: 36W
Operating frequency: 50Hz or 60Hz
Efficiency: from 80% and up

Transformer type: symmetrical
Isolation voltage between input and output coils: from 1000VAC to 3000VAC

The main function of a symmetrical transformer 12V 3A is to provide stable power supply to electronic devices, medical equipment, security camera systems, control systems, and other motor-driven devices. The symmetrical transformer 12V 3A is capable of supplying power with a stable output voltage of 12V and a maximum current of 3A.

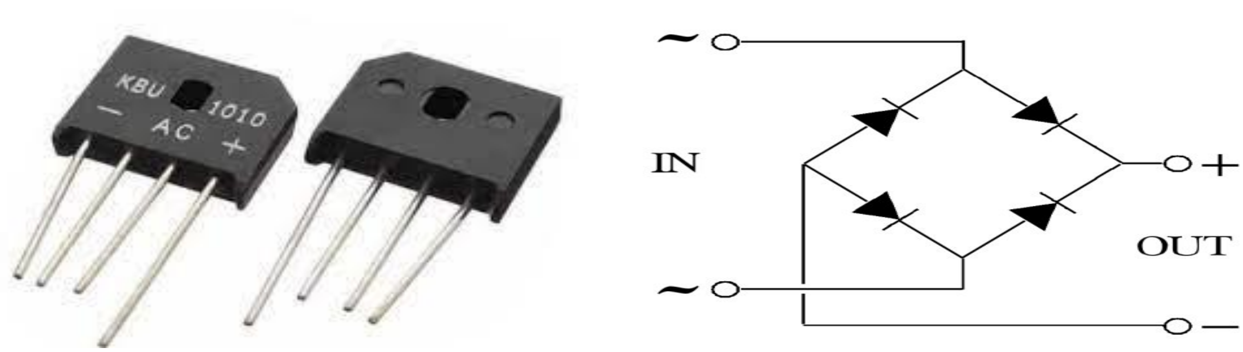

Figure 2.5 Bridge diode

Bridge diode (or diode bridge) is an electrical circuit used to convert alternating current (AC) power into direct current (DC) power. This circuit consists of four diodes connected in a bridge configuration to ensure the conversion of AC signals into DC. When AC power is applied to the bridge diode circuit, in each half cycle of the voltage wave, two diodes at the input of the positive half-bridge will conduct, while two diodes at the input of the negative half-bridge will be cut off. This allows only one direction of current to flow from the input of the positive half-bridge to the output of the negative half-bridge, creating a DC power supply. Using a bridge diode, we can filter out the fluctuations and transformations of AC power to create a stable and reliable DC power supply. This helps DC power to be used in a wide range of applications, including electronic systems, machinery, and household appliances.

Table 2.2:

Maximum reverse voltage: 1000V.
Maximum forward current: 10A.

Forward voltage drop: 1V.
Reverse current: 1mA.
Operating temperature range: -65oC ~ 150oC.

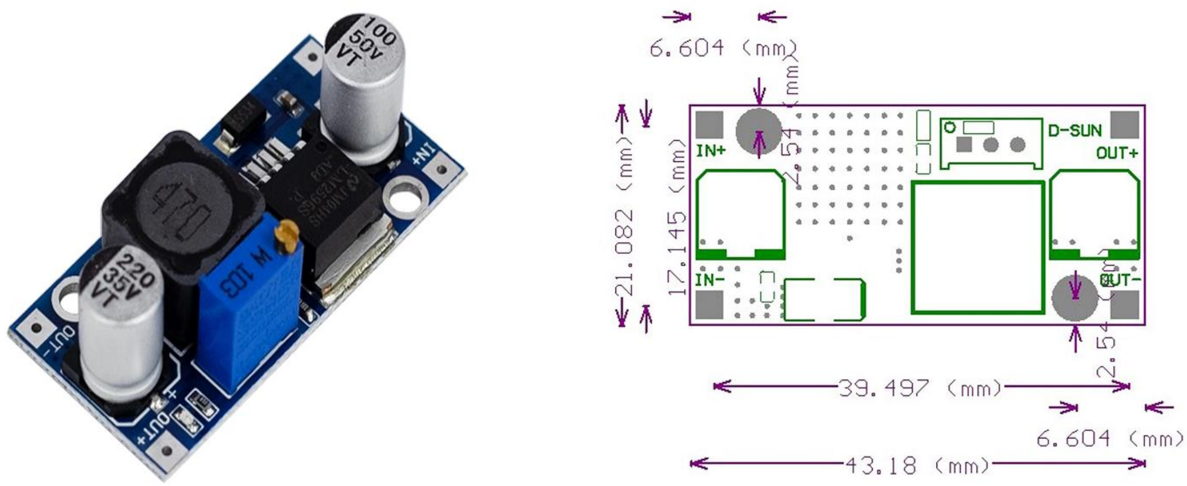

Figure 2.6 IC LM2596

LM2596 is a voltage regulator integrated circuit (IC) that is widely used in electronic circuits to convert a higher voltage to a lower voltage. It is a step-down switching regulator that is capable of producing a fixed or adjustable output voltage. The LM2596 IC has a wide input voltage range, typically from 4.5V to 40V, and can supply a maximum output current of 3A. It has a high efficiency, typically up to 92%, which makes it a popular choice for battery-operated applications where power consumption is critical. The LM2596 has a simple design with a few external components, making it easy to use in various applications. It also has built-in protection features such as thermal shutdown, current limiting, and reverse voltage protection, which ensures the safety and reliability of the circuit.

Table 2.3:

Input voltage: from 4.5V to 35V DC.	Output voltage: adjustable from 1.23V to 30V DC.
Output current: up to 3A.	Conversion efficiency: up to 92%.
Operating frequency: 150kHz.	Output voltage ripple: 100mV.

Quiescent current: 2mA.	Size: 43mm x 21mm x 14mm.
Operating temperature: -40 to 85 degrees Celsius.	Overload and overtemperature protection.
Isolation voltage between input and output: 1.23kV DC.	

We use a 12V 3A symmetrical transformer because it is not possible to directly convert from 220V to 5V immediately. We use a full-wave rectifier diode bridge to convert it into a DC unidirectional power source suitable for the circuit. The 1000uF (Using a 1000uF capacitor is recommended because with a large capacitance, it can effectively store a significant amount of electrical energy when powering the circuit, right from the first operation, thus ensuring efficient performance). Capacitor is used to filter the signal, and the LM2596 IC helps stabilize the power supply while stepping it down to 5V DC, enabling efficient operation of the electrical circuit.

The current flows from the 220V source through a transformer, which converts the AC voltage from 220VAC to 12VAC. A 5A bridge diode is used for rectifying the AC voltage, with an effective value of 12V. They are combined with a filter capacitor to produce a smoother DC voltage of 15V. A 1000uF capacitor is used to filter the signal further. The LM2596 voltage regulator circuit is used to generate a stable current and convert the 15V input voltage to a rated 5VDC voltage to power the operating system.

2.3 PIC Microcontroller

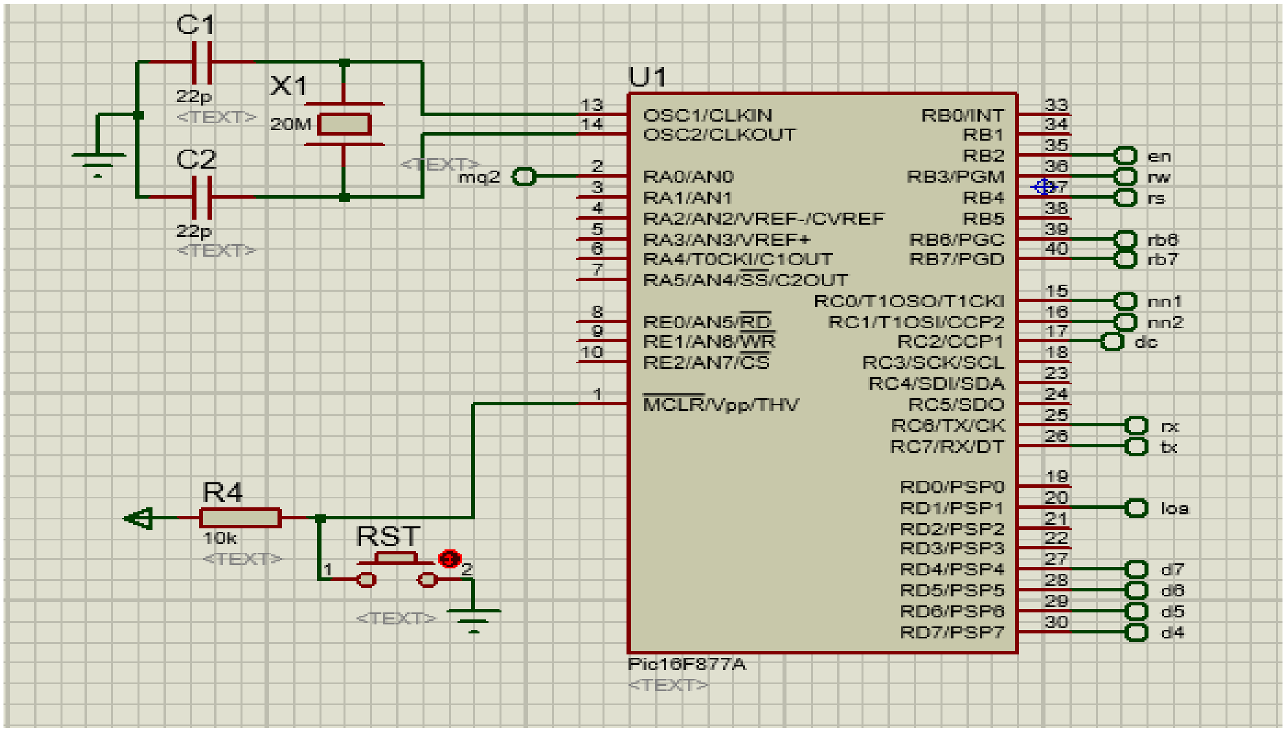

Figure 2.7 Schematic of Microcontroller block

The microcontroller unit is responsible for receiving signals from the sensor, processing the data and displaying the specific numerical value in mg/L units on the LCD screen. This is also the most important component controlling the operation of all other units.

Figure 2.8 Microcontroller PIC16F877A

The PIC16F877A microcontroller is an 8-bit microcontroller produced by Microchip Technology Inc. It is one of the most popular microcontrollers and widely used in electronic applications, especially in device control and automation. The PIC16F877A microcontroller has a large memory, including 8KB of flash program memory, 368 bytes of data RAM, and 256 bytes of EEPROM memory. It can operate with a supply voltage from 2.0V to 5.5V and has a maximum clock frequency of up to 20MHz. This microcontroller has many advanced features such as a 10-bit A/D converter, a timer, USART, SPI, and I2C communication interfaces, a versatile direction finding unit, and a counter/timer unit. It also supports many sleep modes and low power consumption. The PIC16F877A microcontroller can be programmed with several programming languages such as C, Assembly, and BASIC. It can also be connected to other peripherals such as external memory, sensors, LED circuit boards, and LCD screen controllers.

Table 2.4:

Architecture: 8-bit RISC
Memory: 14KB Flash, 368 byte RAM
I/O pins: 33 pins
Operating voltage: 2.0V - 5.5V
Maximum clock speed: 20 MHz
Timers: 3 timers
Watchdog timers: 1 watchdog timer
ADC channels: 8 channels 10-bit
Communication: USART, SPI, I2C
Security: 2 code protection blocks.

Function of the ports

Port A: consists of 6 I/O pins. These are bi-directional pins that can be used as both input and output. The I/O function is controlled by the TRISA register (address 85h). Port A is also the output port of the ADC, comparator, and input clock of timer0.

Port B: consists of 8 I/O pins. The corresponding input/output control register is

TRISB (address 86h). In addition, 2 pins of Port B are used for the programming process. Port B is also related to interrupts and timer0.

Port C: consists of 8 I/O pins. The corresponding input/output control register is TRISC (address 87h). Port C contains the functional pins of the comparator, timer1, PWM, timer1 event counting, and communication standards.

Port D: consists of 8 I/O pins. The corresponding input/output control register is TRISD (address 88h). Port D is also the data output port of the PSP communication standard.

Port E: consists of 3 I/O pins. The corresponding input/output control register is TRISE (address 89h). The Port E pins are analog input ports, and they are also control pins of the PSP communication standard.

The OUT pin of the MQ-3 sensor is connected to an input pin of the PIC16F877A to read the alcohol concentration value. The GND pin of the MQ-3 sensor is connected to the GND pin of the PIC16F877A to share a common ground. The VCC pin of the MQ-3 sensor is connected to a 5V DC positive power supply. The TXD pin of the SIM800L module is connected to the RXD pin (or RC7) of the PIC16F877A to send data from the PIC to the SIM800L module. The RXD pin of the SIM800L module is connected to the TXD pin (or RC6) of the PIC16F877A to receive data from the SIM800L module to the PIC. The GND pin of the SIM800L module is connected to the GND pin of the PIC16F877A to share a common ground. The VCC pin of the SIM800L module is connected to a 5V DC positive power supply. We use appropriate pin mapping for the PIC16F877A microcontroller to ensure reading and writing data from the MQ-3 sensor. Set up suitable GPIO pins to read the analog value from the OUT pin of the MQ-3 sensor. We use relevant programming functions and libraries to convert the analog value into alcohol concentration units. We use appropriate AT commands and functions to set up and send data through the SIM800L module. Set up UART functions for communication with the SIM800L module. Then we build a suitable communication protocol to send alcohol concentration data from the PIC16F877A.

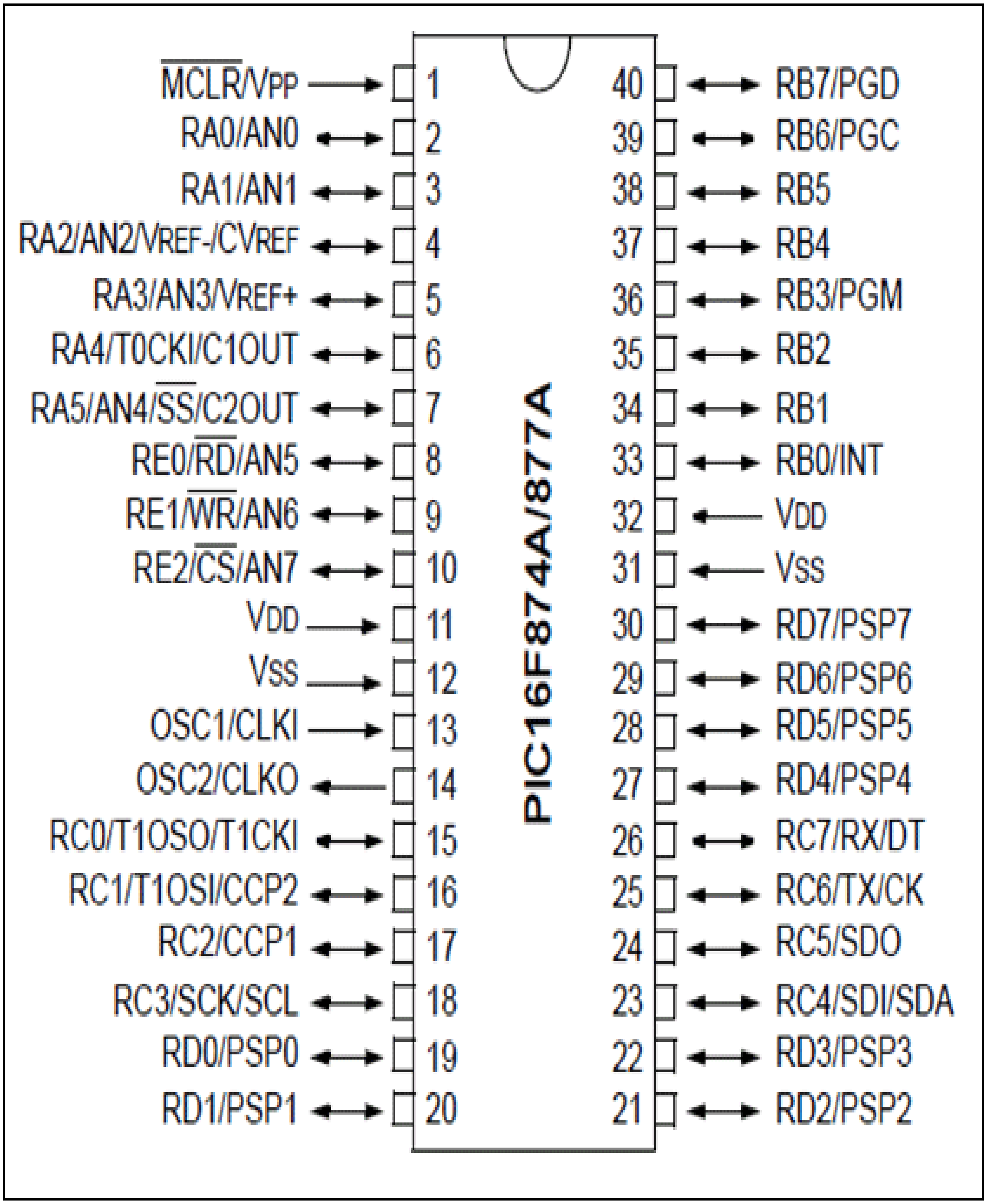

Figure 2.9 Schematic diagram of PIC16F877A pinout

2.4 Module sensor

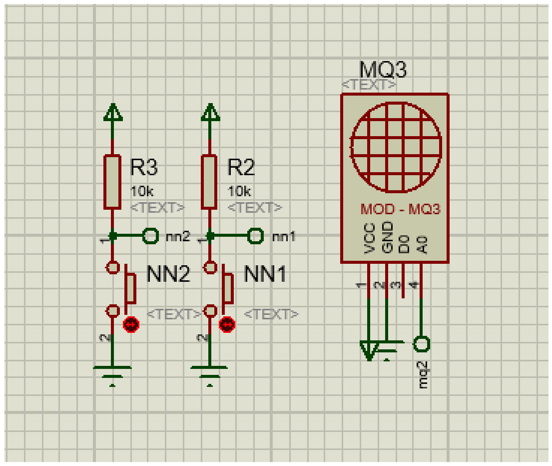

Figure 2.10 Schematic of MQ3

The sensor module is responsible for detecting the alcohol concentration in the environment, then converting it into a digital signal and sending it to the controller module. It also has a function to alert with a buzzer.

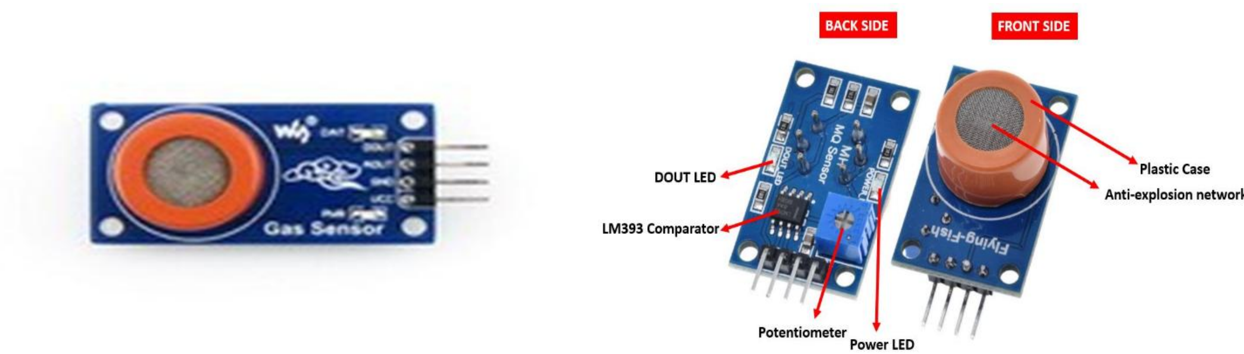

Figure 2.11 Alcohol sensor MQ3

The MQ3 alcohol sensor is a gas sensor that is widely used to detect the concentration of alcohol in the air. It is commonly used in breathalyzers and other devices that measure the level of alcohol in the breath. The MQ3 sensor is based on the principle of metal oxide semiconductors (MOS), which allows it to detect alcohol in the air by changing its resistance in the presence of alcohol. The MQ3 sensor has a detection range of 25-500 ppm and a high sensitivity to alcohol. It operates on a voltage of 5V and consumes very little power. The output signal of the sensor is analog and can be easily processed by a microcontroller or other digital circuits. The MQ3 sensor is small in size, easy to use, and can be easily integrated into various electronic devices. It is widely used in the automotive industry, breathalyzer devices, and other applications where alcohol detection is required.

Table 2.5:

Operating voltage: 5V DC
Operating temperature: -10°C to 50°C
Operating relative humidity: Below 95% RH (non-condensing)
Signal output: Analog
Measurement range: 25-500ppm alcohol (at 25°C, 60%RH)
Sensitivity: 0.04-0.5ppm
Stabilization time: 5-10 minutes
Preheating resistance: 30 kohm
Dimensions: 36mm x 22mm x 21mm

Table 2.6:

Sensitive to alcohol and ethanol.
Output voltage increases as the measured gas concentration increases.
Quick response and recovery.
The sensitivity of the module can be adjusted.
Results can be displayed on an LCD screen.
Schematic diagram of MQ-3 alcohol sensor pins:

Schematic diagram of MQ-3 alcohol sensor pins

VCC: Operating voltage 5V

GND: Connect to ground

D0: Digital output interface (0 and 1)

A0: Analog output interface

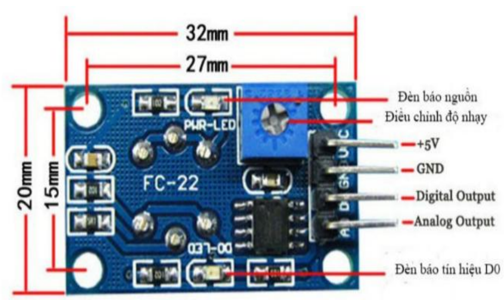

Figure 2.12 Schematic diagram of MQ3 pinout

Using MQ3 because The MQ3 sensor is a type of alcohol concentration sensor based on the working principle of gas sensors. It is a commonly used sensor for detecting alcohol concentration in the air. The MQ3 sensor is known for its high sensitivity, low cost, and ease of use. Pin number 1 of MQ3 will be connected to the positive power supply of the circuit, and pin 2 will be connected to ground. Pin number 4 will be connected to the microcontroller PIC16F877A (pin number 3 is not used). We add two buttons for adjusting the concentration level, NN1 and NN2, corresponding to increase and decrease. They will be connected to the microcontroller.

2.5 Module SIM

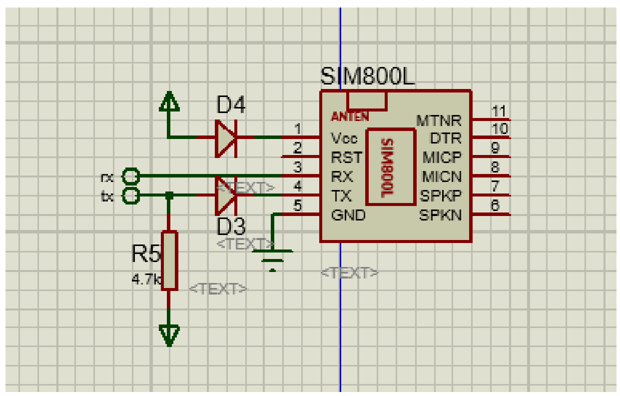

Figure 2.13 Schematic of Module SIM

The SIM module is responsible for sending alerts to the user via SMS when it receives a signal that the alcohol concentration has exceeded the set threshold by the user.

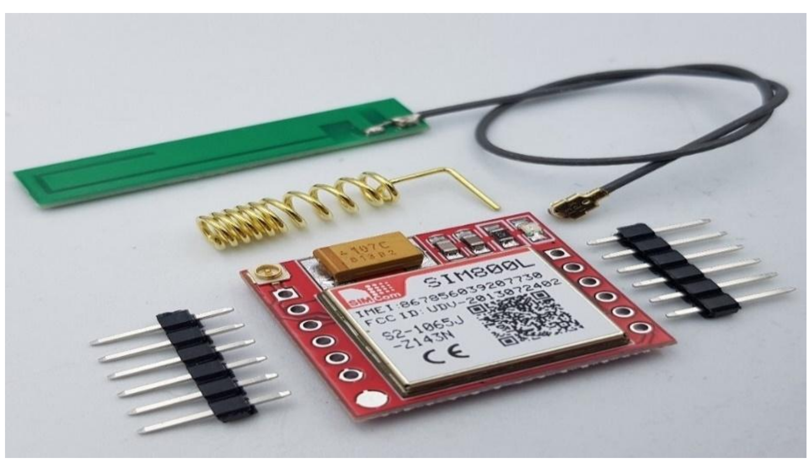

Figure 2.14 Module SIM800L

The SIM800L module is a GSM/GPRS communication module on the mobile network, integrated with functions such as sending/receiving messages, calls, accessing the Internet, and GPS. It uses the SIMCOM SIM800L chip and operates on multiple different bands, including 4 GSM bands (850MHz, 900MHz, 1800MHz, 1900MHz) and 2 GPRS bands (900MHz, 1800MHz). The SIM800L module is compact in size and consumes low power, so it is often used in IoT applications and embedded projects. It can also be connected to different types of microcontrollers through interfaces such as UART and SPI. To use the SIM800L module, it needs to be connected to a 5V power source and a GSM antenna for data transmission. In addition, the AT commands can also be used to control the module and perform functions such as sending/receiving messages or making calls.

Table 2.7:

Chipset: SIMCOM SIM800L
Operating frequency: GSM/GPRS: 850MHz, 900MHz, 1800MHz, 1900MHz GPRS Class 10, Class 12
Operating voltage: 3.4V - 4.4V DC
Maximum power consumption: 2A
Power consumption in standby mode: <1.0mA
Power consumption during communication: <200mA
Sensitivity of signal reception: -109dBm
ADC signal input impedance: 1MΩ
Interface: UART communication with baud rate from 1200 bps to 115200 bps SPI communication
Dimensions: 24mm x 24mm x 3mm

Table 2.8:

VCC: Positive power supply 3.4V - 4.4V DC.
GND: Ground.
TXD: Data transmit pin of UART.
RXD: Data receive pin of UART.
RST: Reset pin for the module.
KEY: Phone on/off control pin.
MIC+: Microphone positive input pin.
MIC-: Microphone negative input pin.
SPK+: Speaker positive output pin.
SPK-: Speaker negative output pin.
Antenna: Pin for connecting to GSM/GPRS antenna

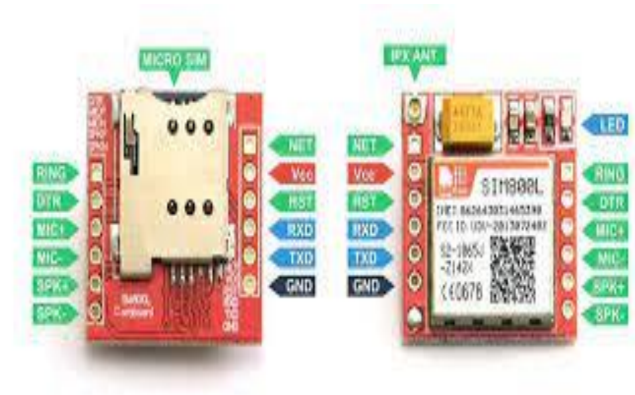

Figure 2.15 Schematic diagram of Module SIM800L pinout

Pin number 1 will pass through a diode and connect to the positive power supply of the circuit. Pin number 3 will be connected to pin 25 of the microcontroller. Pin number 4 will pass through a diode and connect to pin 26 of the microcontroller. Lastly, pin number 5 will be connected to ground.

Because the power supply for the circuit is 5V DC, but the SIM800L module only operates within the range of 4.2 ~ 4.3V DC. Therefore, when supplying 5V DC to the positive power of the SIM module, an additional diode must be connected to reduce the voltage to a level at which it can operate. The signal receiving pin of the SIM module will be connected to the signal transmitting pin of the PIC, and vice versa, the signal transmitting pin of the SIM module will be connected to the receiving pin of the PIC.

2.6 Display

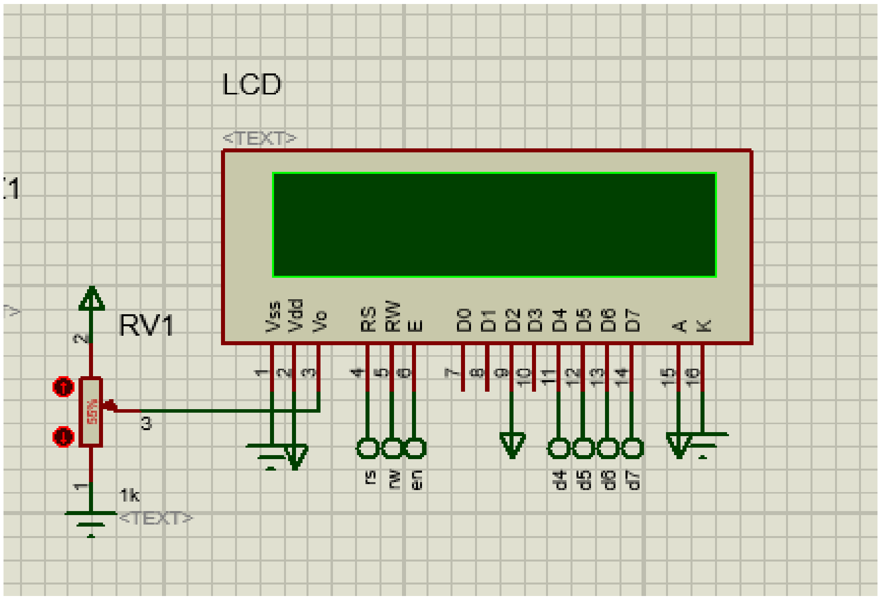

Figure 2.16 Schematic of Display

The display module uses the LCD1602 screen to display the data collected after being calculated by the controller unit to show the following parameters on the screen: the current alcohol concentration in the environment and the set alcohol concentration limit.

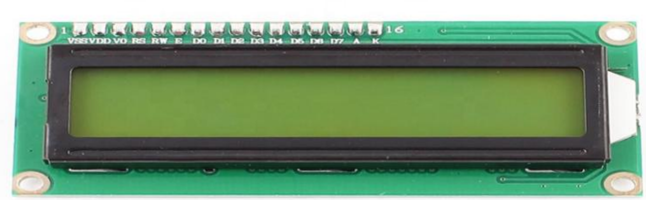

Figure 2.17 LCD1602

LCD1602 is a type of LCD (Liquid Crystal Display) display with a size of 16x2 characters, meaning it can display 16 characters on 1 line and up to 2 lines. This display is commonly used in electronics projects such as Arduino, Raspberry Pi, and other microcontrollers to display information about variables, measurement results, notifications, and messages. The LCD1602 display uses LED backlight technology for illumination and uses a 16-pin connector to connect with other microcontrollers. It also has a built-in controller to display characters, commas, special characters, and numeric characters. The LCD1602 display can be adjusted for contrast and brightness, allowing users to fine-tune the display to meet their needs. The applications of the LCD1602 display are diverse, from displaying information in household electronic devices to displaying information in medical and industrial equipment. Additionally, the LCD1602 display is used in educational and research projects by students, teachers, and scientists.

Table 2.9:

Screen size: 16x2 characters
Operating voltage: 5V DC
Brightness: Adjustable
Contrast: Adjustable
Interface: 16-pin connector
Maximum power consumption: 1mA
Minimum input voltage: 4.7V DC
Maximum input resistance: 1MΩ
Operating temperature: -20 to 70 degrees Celsius
Operating humidity: 10% to 80% non-condensing.

Table 2.10:

LEG	CHARACTERISTIC	DESCRIBE	VALUE
1	VSS	GND	0V
2	VCC		5V
3	V0	Contrast	

4	RS	register selection	RS=0 (low) selects instruction register RS=1 (high) selects data register
5	R/W	Select data read/write register	R/W=0 write register R/W=1 read register
6	E	Enable	
7	DB0	Data pins	8 bit: DB0DB7
8	DB1		
9	DB2		
10	DB3		
11	DB4		
12	DB5		
13	DB6		
14	DB7		
15	A	LED background anode	0V to 5V
16	K	LED background cathode	0V

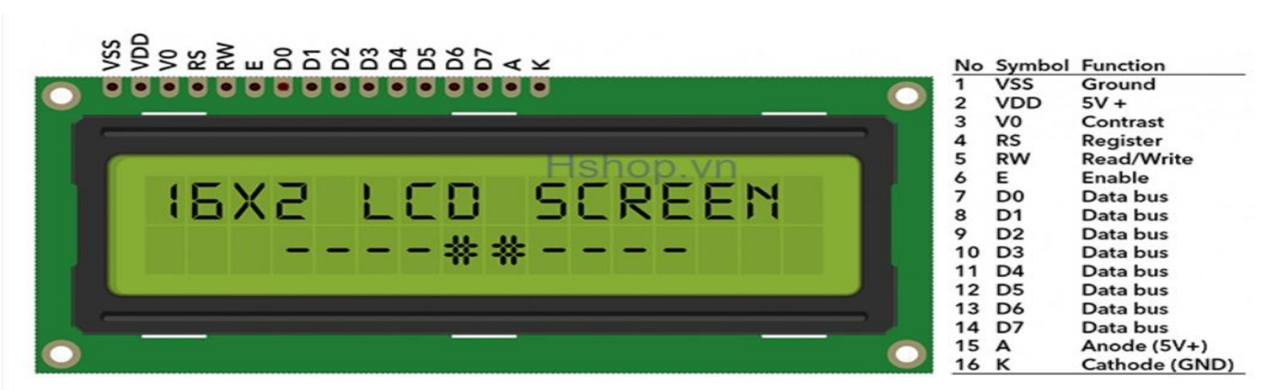

Figure 2.18 Schematic diagram of LCD1602

Figure 2.19 Variable resistor

Variable resistor is a device that has a pure resistance that can be adjusted as desired. They can be used in electronic circuits to adjust the operation of the circuit. Variable resistors are usually connected to other components in an electronic circuit and have three terminals: two terminals connected to the two ends of the resistor and the remaining terminal connected to the wiper (or rotary arm).

Pin number 1 and 16 will be connected to ground. Pins number 2, 9, and 15 will be connected to the positive power supply. Pin number 3 will be connected to a variable resistor to adjust the brightness of the display screen. Pins 4, 5, and 6 will be connected to pins 37, 36, and 35 of the microcontroller, respectively. Pins 11, 12, 13, and 14 (D4, D5, D6, D7) will be connected to pins 30, 29, 28, and 27 of the microcontroller, respectively.

2.7 Motor

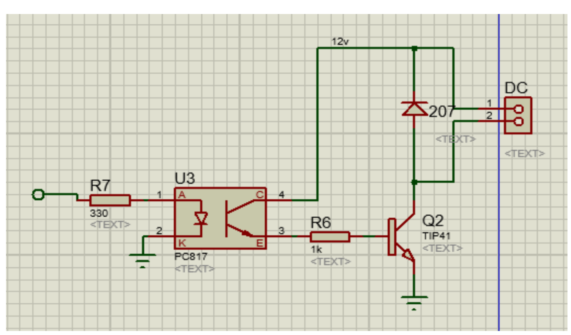

Figure 2.20 Schematic of Motor block

This is a circuit that simulates the function of a machine or production in a factory to stop operating whenever it detects an abnormal increase in the alcohol concentration in the environment beyond the permissible limit.

Figure 2.21 PC817 Optocoupler

PC817 is a type of Optocoupler (or Opto-isolator) that can isolate the signal between two different electrical circuits. It consists of an input which is a light emitter (LED) and an output which is a phototransistor, protected by a black plastic case. PC817 can be used to isolate signals in electronic projects such as Arduino, Raspberry Pi, and other microcontrollers. PC817 is used to safely and efficiently convert signals between different electrical circuits, especially in applications related to high voltage or electrical noise. With the ability to isolate signals, PC817 helps minimize signal noise issues and ensures safety for electronic devices. PC817 can be used in applications such as control panels, switching circuits, motor speed controllers, LED displays, and many other electronic applications. It is an essential component in electronic projects and is a popular product used in the DIY community.

Table 2.11:

The pin specifications of Optocoupler PC817	
Pin number 1 - Anode.	The positive pin of the input IR in Optocoupler, providing the logic input signal for the internal IR.

Pin number 2 – Cathode	The negative pin of the IR in the optocoupler, providing the ground connection for the IR to establish a common point with the circuit and power supply.
Pin number 3 – Collector	The output pin of the internal IR receiver in the Optocoupler, providing the logic output by receiving the IR signal.
Pin number 4 - Emitter	Ground pin for the IR receiver, used to establish a common point with the power supply and circuit.

V1 reduction motor is a type of small-sized AC (alternating current) electric motor with smooth operation and high durability. This motor is designed for use in applications that require low speed and high torque, such as in the drive systems of machines, equipment, and household appliances.

Figure 2.22 V1 reduction motor

The V1 reduction motor has many applications in daily life, such as in misting machines, fans, ice cream makers, dishwashers, blenders, and many other applications. This motor is favored because of its high durability, energy efficiency, and long service life.

The motor module will be connected to the RC2 pin of the PIC through a 330 ohm resistor using PC817 to isolate the electrical circuit, filter out electrical signal noise, and eliminate low voltage from the high voltage circuit. When a positive current flows through the anode pin and connects the ground to the cathode pin of PC817, the LED will be activated and emit light, which saturates the internal optocoupler transistor. As a result, pins 3 and 4 are connected to each other. The emitter pin will reduce the current through a 1k resistor, pass through a transistor to ground, and connect to one terminal of the motor. The collector pin, which carries 12V voltage, will connect to the remaining terminal of the motor, and a diode will be added to reduce noise for the signal.

2.8 Warning

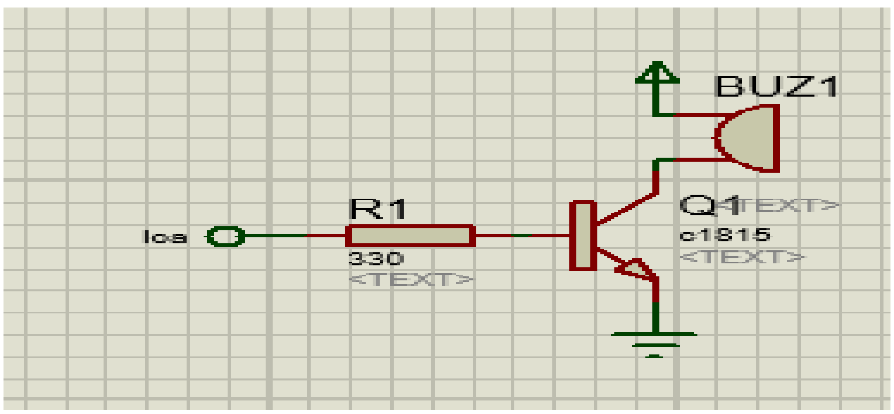

Figure 2.23 Schematic of Warning block

The warning block uses an active buzzer with a 5V power supply to emit a sound when it receives a signal that the alcohol concentration has exceeded the permissible threshold, in order to alert the user.

Figure 2.24 5V active buzzer

The 5V active buzzer is a type of sound device used in electronic applications to generate warning or notification sounds. The active buzzer operates by creating sound through the rapid vibration of a metal reed inside when stimulated by an electrical signal.

The horn will be connected to the RD1 pin of the PIC through a 330 ohm resistor to limit the current. Next, it will pass through a transistor acting as an amplifier and switch, connected to the negative power supply to establish the ground connection for the horn. The positive power of the horn will be connected to the positive 5V DC power supply provided to the circuit.

CHAPTER 3. PROGRAMMING

3.1 Flowchart

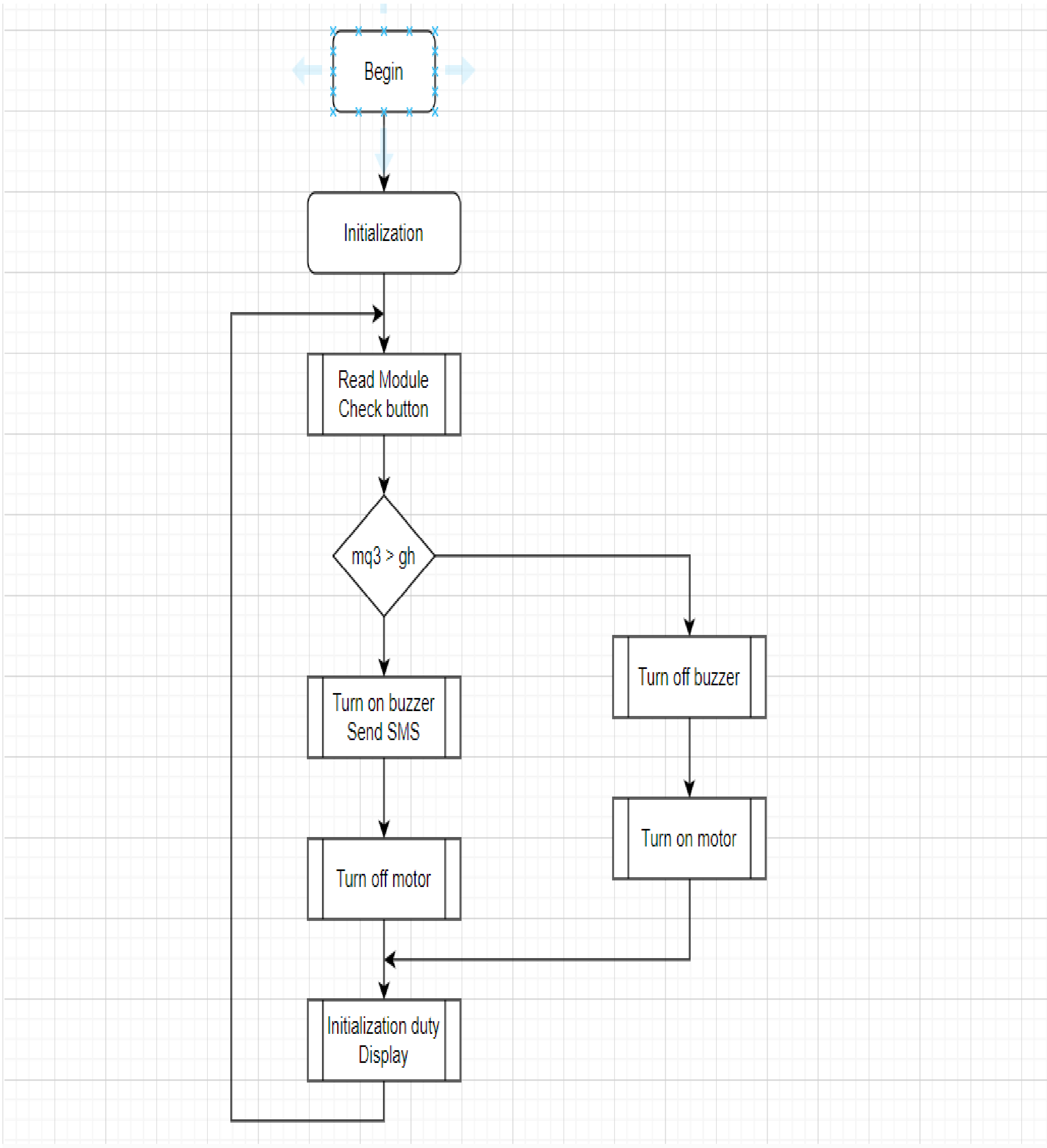

Figure 3.1 Flow chart

3.2 Explanation

First, the system will start initialization and initialize the LCD display task. Then, the system will read the sensor and check the button, then one of two cases will occur:

Case 1: If the measured alcohol concentration exceeds the threshold (mq3 > gh), the condition is true, then the buzzer will be activated and an SMS will be sent to the user, the motor will be turned off, and the measured data will be displayed on the LCD before the system returning to read module sensor and check button again.

Case 2: If the measured alcohol concentration has not exceeded the threshold (mq3 < gh), the condition is false, the buzzer will not be activated, the motor will continue to operate, and the measured data will be displayed on the LCD, then the system return to read module and check button again.

3.3 Software / Library / Installation

3.3.1 Software

1. **Proteus 8 professional**

Proteus 8 Professional software is a professional electronic circuit simulation and design software. It allows users to simulate and design electronic circuits, verify the correctness of the circuit, and display the circuit graphics on the computer. Proteus software includes many components such as schematic diagrams, microcontroller simulation software, Analog and Digital circuit simulation software, PCB drawing software and many other tools to help users create accurate and effective electronic circuits.

Proteus can help design and simulate complex circuits including electronic components such as microcontrollers, drives, sensors, power supplies, and many other types of components. Proteus also allows users to simulate input, output and control signals to check the correctness of the circuit before actual production.

Proteus 8 Professional is widely used in fields such as electronic design, telecommunications, automation control, measurement, education, and scientific research. With convenient and efficient features, Proteus 8 Professional is an indispensable software for experts and engineers in electronic circuit design.

2. CCS C Compiler

CCS C Compiler is a software used to compile programs written in the C programming language for PIC and dsPIC microcontrollers. This software provides users with a complete integrated development environment for programming, simulation, debugging, and creating embedded applications on the PIC and dsPIC microcontroller platforms.

CCS C Compiler provides users with many features such as support for Microchip's various microcontrollers, including PIC10, PIC12, PIC16, PIC18, dsPIC30, and dsPIC33. In addition, CCS C Compiler supports programming functions such as variable declaration, conditional statements, functions, loops, standard libraries, and many other features.

CCS C Compiler is widely used in embedded applications, especially in PIC and dsPIC microcontroller applications. It is evaluated as one of the best embedded software development tools on the market today, and is popular among engineers and developers worldwide.

3.3.2 Library

1. Library of Proteus 8 professional

The library of Proteus 8 Professional includes commonly used electronic components in electronic circuit design such as transistors, ICs, resistors, capacitors, inductors, and many other types of components. It also includes popular microcontrollers such as 8051, PIC, AVR, ARM, and many other types of microcontrollers. In addition, Proteus 8 Professional allows users to create their own libraries by adding electronic components, microcontrollers, and other modules to the library. This helps users to reuse components and modules created previously in new electronic circuit designs. All components and microcontrollers in the library of Proteus 8 Professional are accurately simulated and can be used to design and test complex electronic circuits before production.

2. **Library of CCS C Compiler**

CCS provides a comprehensive software library for Microchip's various microcontrollers, including PIC10, PIC12, PIC16, PIC18, dsPIC30, and dsPIC33. The CCS library includes functions and devices such as microcontrollers, EEPROM and Flash memory, digital and analog input and output, timing system, and peripheral signals. It also includes libraries for protocols such as I2C, SPI, USART, TCP/IP, and USB. CCS provides libraries to simplify the software development process and reduce the time and cost of projects. In addition, CCS also provides users with simulation and debugging tools for embedded software development.

3.3.3 Installation

PICkit 2

Pickit 2 is a Microchip MCU programmer designed to program and load code for Microchip microcontrollers. It is a very popular product and widely used in embedded application development and production projects. Pickit 2 provides users with a user-friendly interface and powerful features to program Microchip microcontrollers. It allows users to load code into the internal memory and flash memory of the microcontroller, as well as providing simulation and debugging features to help users develop embedded software. Pickit 2 can also be used to read and write the memory settings of the microcontroller, backup and restore code, and check hardware and software errors of the microcontroller.

3.3.4 Simulate on Proteus

Step 1: Press the button  on the screen to starting the circuit

Step 2: On the LCD1602 screen will display “KHOI DONG SIM” and “VUI LONG CHO”

Step 3: Module SIM will send SMS to the phone number of user "KHOI DONG THANH CONG" to confirm that the circuit is ready to start, also the motor spin maxium speed at this time.

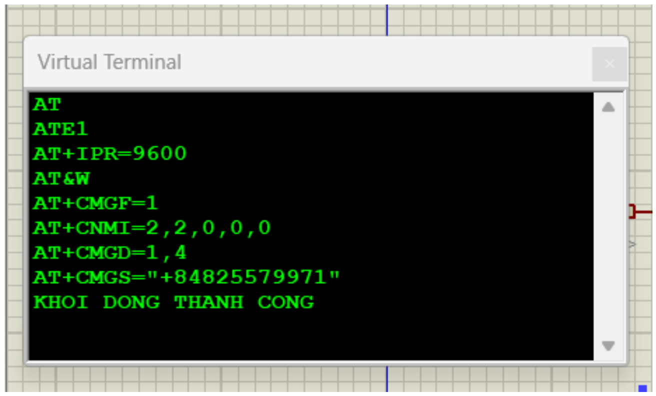

Figure 3.2 Simulation of Module SIM send SMS

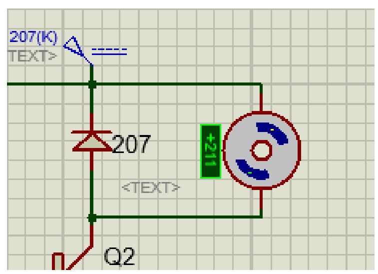

Figure 3.3 Simulation of Motor spinning

Step 4: When the alcohol concentration exceeds the permissible limit, the system will immediately send a message to the user's phone number "CANH BAO VUOT NGUONG" to alert them. Also the motor will slow down and stop.

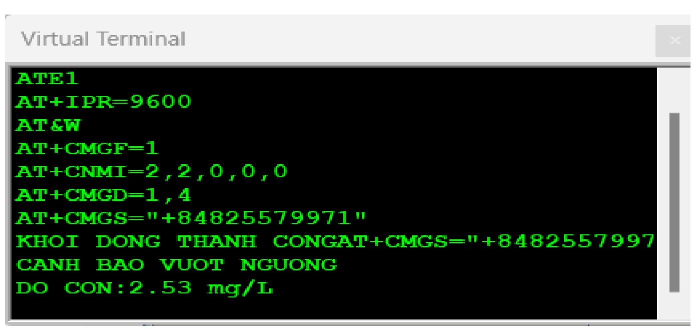

Figure 3.4 Simulation of send alert via SMS

Furthermore, users can adjust the permissible alcohol level by pressing one of the two buttons labeled "NN1" or "NN2" to increase or decrease the limit.

This is the entire circuit when simulated.

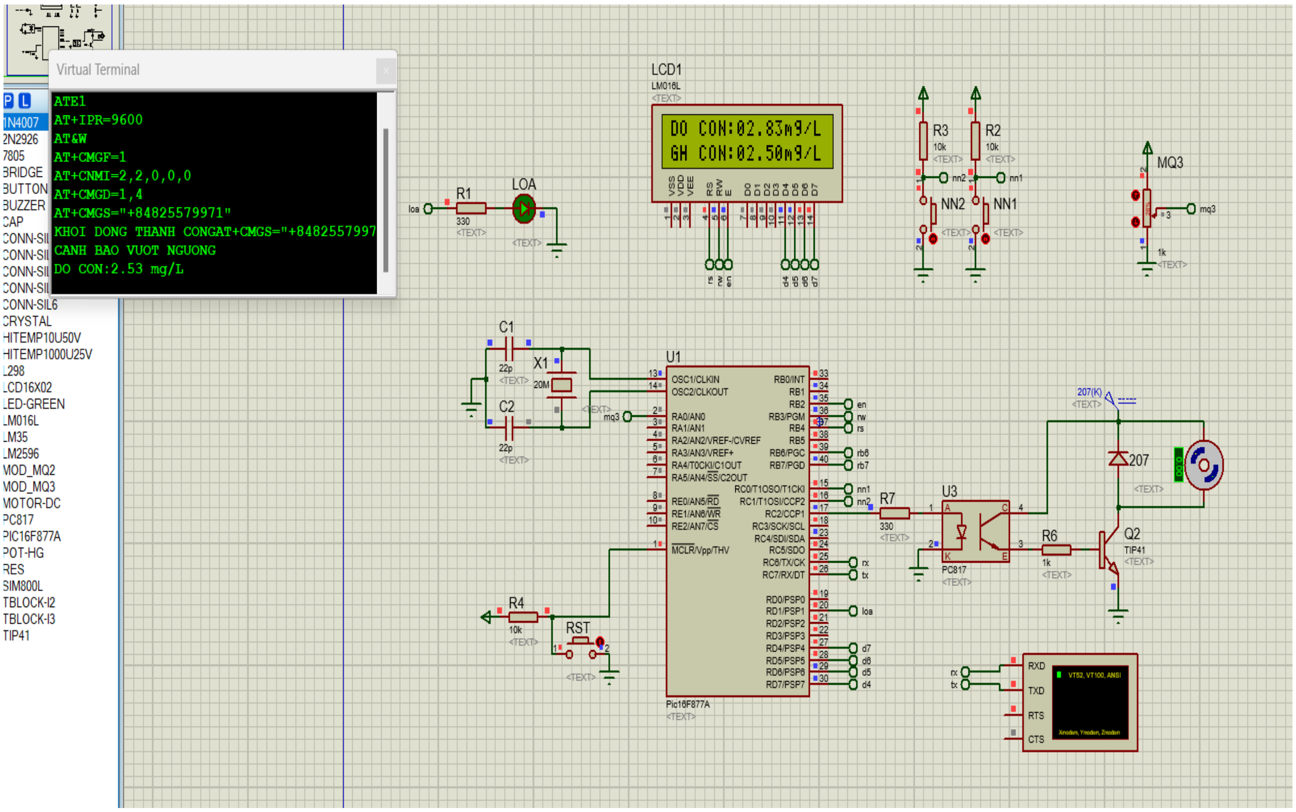

Figure 3.5 All of the system after simulation on Proteus

CHAPTER 4. IMPLEMENTAION

4.1 PCB Layout

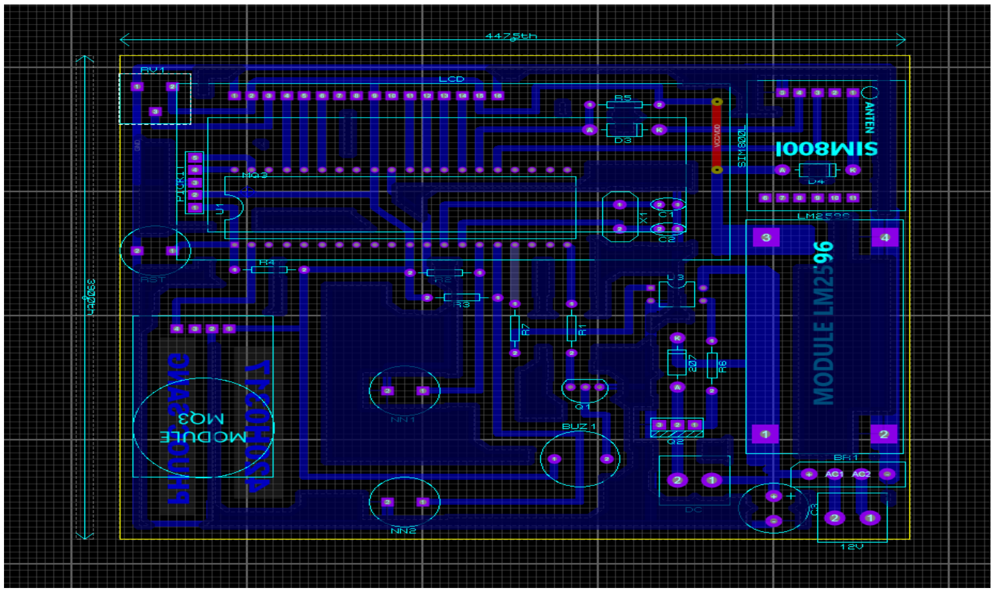

Figure 4.1 PCB Layout on Proteus simulation

First, open Proteus and create a new project. Select "Schematic Capture" from the toolbar to open the schematic editor. Design circuit by selecting components from the Proteus library and connecting them with wires. After completing the schematic, save and close the schematic editor. In the Proteus interface, choose "Layout Mode" from the toolbar to open the PCB editor. From the "Select Component" window, drag and drop the components from the schematic onto the PCB. Place the components in the desired positions on the PCB. Connect the pins of the components by drawing wires or tracks on the PCB. Use the "Route Mode" tool to draw the connection lines. If needed, add different layers for routing, power planes, and other purposes on the PCB. Check and edit PCB layout to ensure there are no technical errors such as short circuits or component conflicts. Save the PCB layout and select "Auto Router" if want Proteus to automatically route the connections. After completing the PCB layout design, can use the "3D Viewer" function to preview the final product. Finally, print or publish your PCB layout to prepare for the manufacturing process.

4.2 Prototype

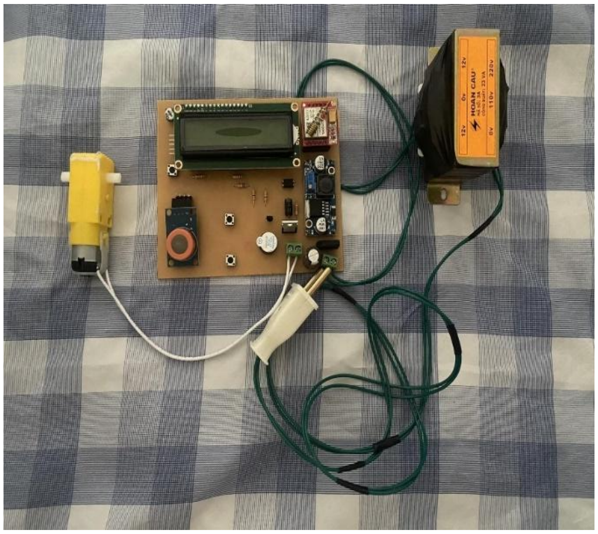

Figure 4.2 The front of circuit

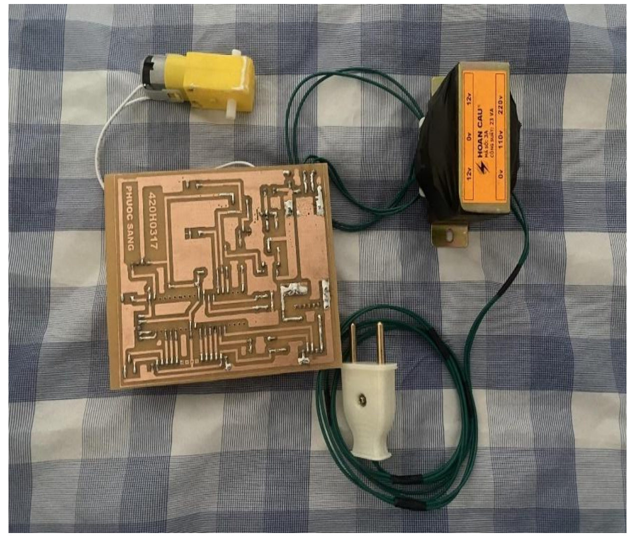

Figure 4.3 The back of circuit

4.3 Testing

4.3.1 Set up

First, we use a socket to connect to the 220V AC power supply, and the system will start operating. The LCD screen will display "KHOI DONG SIM" and "VUI LONG CHO", which means "STARTING SIM" and "PLEASE WAIT" in English. The SIM module will send a message to the user's phone number to notify that the system has started successfully.

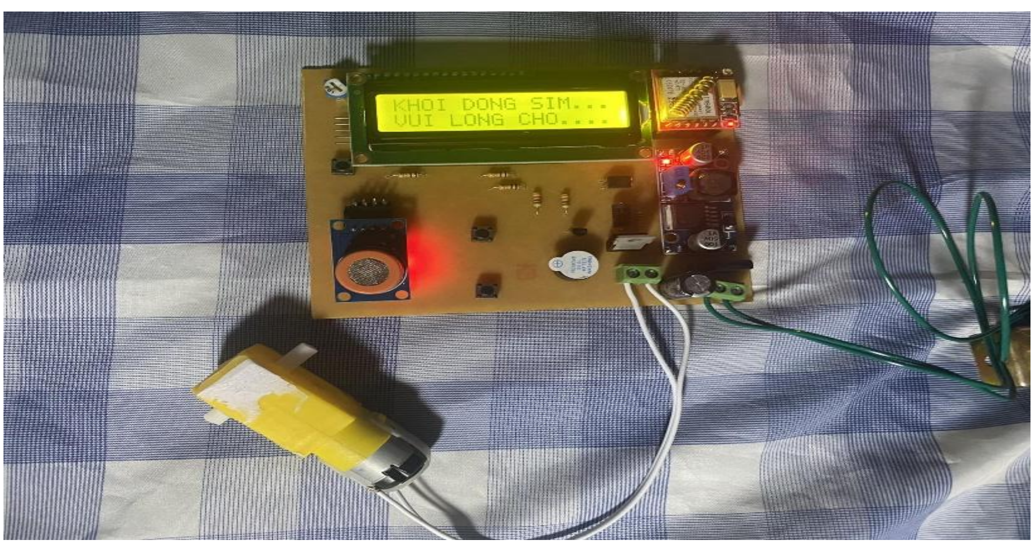

Figure 4.4a Starting the circuit

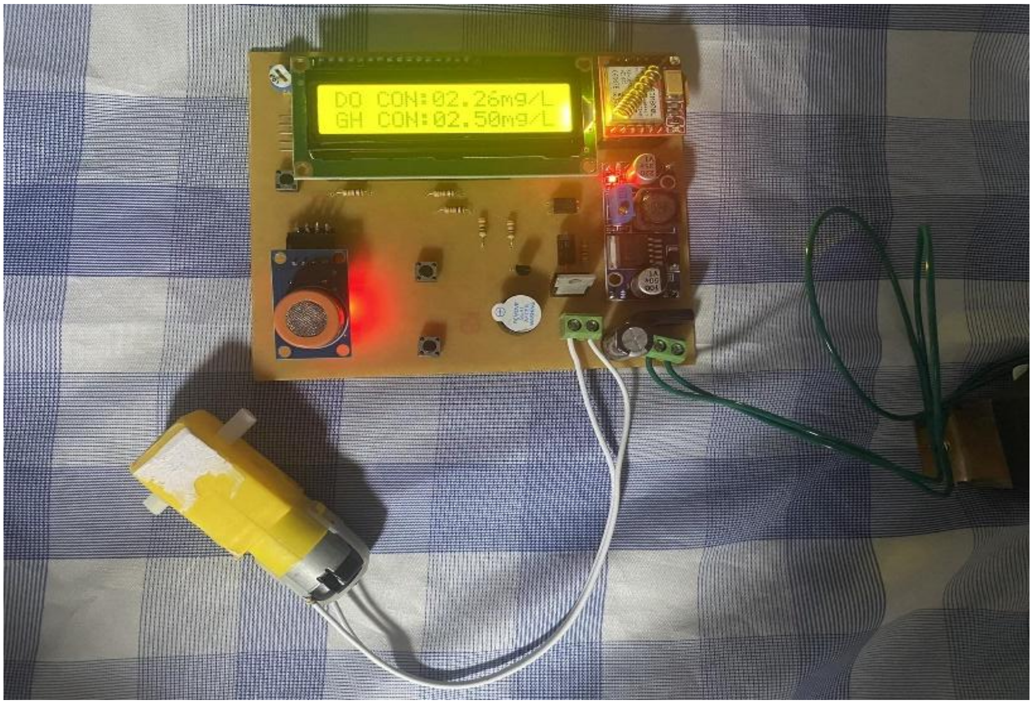

Figure 4.4b Exceeded threshold concentration displayed on the LCD screen

After that, the LCD display will show: "DO CON: ...mg/L" and "GH CON: ...mg/L", at the same time, the motor will also start rotating. Now we will use an alcohol-soaked tissue to pass over the MQ3 sensor. Immediately, the alcohol concentration displayed on the LCD screen will increase sharply. At this point, the motor will also stop working. Module SIM will immediately send an alert to the user. Of course, there will be a delay in the system operation, so the SIM module cannot accurately send the alcohol concentration displayed on the LCD at that time, so there will be a practical error, but it will not be too large. In addition, when using a motor for this system, there may be some minor malfunctions during operation because the motor can cause interference to the system, resulting in initial detection parameters being excessively high when running the circuit for the first time. At the same time, there may also be a situation where the system automatically restarts after a few seconds of operation due to the influence of the motor.

Figure 4.5a send notifications via SMS

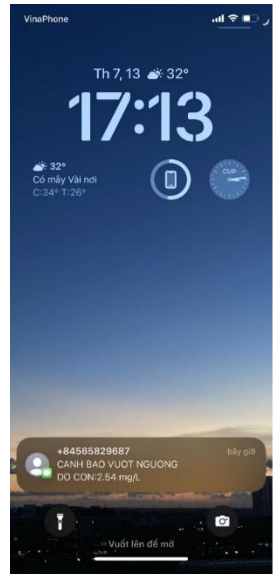

Figure 4.5b send alert via SMS

Finally, we stop the system by cutting off the 220V power supply from the socket, or we can also press the reset button on the circuit to start over again. The standard set here is that the system starts and operates normally without any errors, and can measure sensitively when the sensor detects a concentration in the air and when it exceeds the allowable threshold, there will be an alarm from the buzzer and send a quick warning to the user via SMS. Conduct 5 different measurements to determine whether the system is stable and functioning properly, as well as meeting the set standards.

Times	Parameters displayed on the LCD screen.	Parameters send by SMS
1	2.7 mg/L	2.54 mg/L
2	3.23 mg/L	2.6 mg/L
3	3.41 mg/L	3.21 mg/L
4	2.84 mg/L	2.65 mg/L
5	3.67 mg/L	3.15 mg/L

In general, comparing the obtained data with the set standards, we can see that the circuit can operate relatively stable without significant issues. The received data can be considered acceptable according to the requirements. When comparing the data received from the LCD display and the SMS message, there is a delay between when the circuit receives the signal and sends the SMS message to the user, as well as when it displays on the LCD screen. This delay is acceptable because when the circuit receives a signal indicating that the alcohol concentration has exceeded the threshold, it will immediately send a warning message to the user. At that moment, the exceeded value is no longer the same as when it was initially received, due to abnormal fluctuations in the alcohol concentration in the air. Overall, the circuit has performed as intended.

4.3.2 Debug / Disadvantages

Debug

In general, when starting to process the circuit and run the test, there were some certain errors. The biggest issue the system encountered was that every time it started the test for the first time, the system would always exceed the threshold even though there was no alcohol concentration in the environment, and sometimes it would automatically restart after a few seconds of powering on, which repeated many times. This is a known error caused by when connecting the motor, it is often interfered, causing the system to malfunction and not work properly. The solution to this after going through many trials and errors is to disconnect the motor connection and let the system run without the motor for the first time when starting up. Then, when the system has run stably, the motor can be connected to run again, and the system will not have the error anymore.

Disadvantages

The limitation of this system is that it has not been able to fulfill requirement 4 of the project which is to store the status of the system and the user cannot export that data to see what states the system has gone through during operation. The main reason for this issue is due to my limited knowledge, thinking, and my own level of proficiency, so I have not been able to fully complete all the tasks assigned to design the system.

CHAPTER 5. CONCLUSION

5.1 Conclusion

Overall, in my own assessment, this is a system that meets almost all the requirements that have been set. The system operates relatively stable with almost no deviation in calculations or minor errors during long-term operation. The functions in the circuit all handle their tasks and the functions of each block well. However, this is my first project, so mistakes or limitations are inevitable. Through this first project, I have gained more experience and from there, I can apply the knowledge gained to do better in future projects.

5.2 Development

The first thing I want to develop for this system is to create a larger measurement range for a larger environment. Currently, the system can only operate within a radius of a few meters. I want to extend the measurement range to the size of a classroom or even larger to ensure high accuracy and avoid discrepancies between the displayed values on the LCD screen and the SMS messages sent to the user. I aim to reduce the delay when the system receives a signal so that the message can be immediately sent to the user, and the value must be close to the displayed value on the LCD screen to ensure user safety. Lastly, an important feature that cannot be overlooked is the ability of the system to record operational events over a period of one day. This allows users to export the data to the display screen for reviewing the system's operation and what events have occurred during that time if needed.

REFERENCES

Vietnamese:

Nguyễn Đình Phú. (2007). *Giáo trình Vi điều khiển. TP Hồ Chí Minh. Trường ĐH Sư Phạm Kỹ Thuật TP. Hồ Chí Minh.*

English:

M. A. Mazidi, R. D. McKinlay, and D. Causey. (2007). *PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18 . Pearson Education, Inc., Upper Saddle River, New Jersey 07457.*

Tim Wilmshurst. (2007). *Designing Embedded Systems with PIC Microcontrollers Principles and applications. Copyright [a] 2010. Published by Elsevier Ltd.*

Bohdan Borowik. (2011) *Interfacing PIC Microcontrollers to Peripherial Devices. Publisher by Springer; 2011th edition (February 23, 2011).*

APPENDIX

```
#include <16F877a.h>
#device    adc=10
#fuses     HS
#use delay(clock=20000000)
#use rs232(baud=9600,xmit=PIN_C6,rcv=PIN_C7)

#define LCD_ENABLE_PIN PIN_b2
#define LCD_RS_PIN PIN_b4
#define LCD_RW_PIN PIN_b3

#define LCD_DATA4 PIN_D7
#define LCD_DATA5 PIN_D6
#define LCD_DATA6 PIN_D5
#define LCD_DATA7 PIN_D4

#include <lcd.c>

#define    loa       pin_d1
#define    dc        pin_c2
#define    tang       pin_c0
#define    giam        pin_c1

void doc_lm35();

unsigned int8 i;
unsigned int32 kq0,mq3;
unsigned int32 gh,tr,ch,duty;

int1  tt;

void gui_tin_nhan(unsigned char tn)
{
  tr=mq3/100;
```

```
 ch=mq3%100;
   printf("AT+CMGS=\"+84825579971\"\r\n");
   delay_ms(500);
   switch(tn)
   {
     case 1:     printf("KHOI DONG THANH CONG");
                 break;
     case 2:     if(ch<10)            printf("CANH BAO VUOT NGUONG\r\nDO
CON:%ld.0%ld mg/L",tr,ch );           // truyen gia tri nhiet do vao vi tri %ld
                 else                 printf("CANH BAO VUOT NGUONG\r\nDO CON:%ld.%ld
mg/L",tr,ch );
                 break;
   }
    delay_ms(500);
    putc(26);
    delay_ms(500);
}

void khoi_dong_sim()
{
   lcd_gotoxy(1,1);
   lcd_putc("KHOI DONG SIM...");
   lcd_gotoxy(1,2);
   lcd_putc("VUI LONG CHO....");
   delay_ms(10000);

   printf("AT\r\n");                 delay_ms(500);
   printf("ATE1\r\n");               delay_ms(500);
   printf("AT+IPR=9600\r\n");        delay_ms(500);
   printf("AT&W\r\n");               delay_ms(500);
   printf("AT+CMGF=1\r\n");          delay_ms(500);
   printf("AT+CNMI=2,2,0,0,0\r\n");  delay_ms(500);
   printf("AT+CMGD=1,4\r\n");        delay_ms(500);


delay_ms(200);
   gui_tin_nhan(1);
```

```
delay_ms(500);
}
void doc_mq3()
{
  SET_ADC_CHANNEL(0);
  kq0=0;
  for(i=0;i<100;i++)
  {
    kq0 = kq0 + READ_ADC();
    delay_ms(2);
  }
  kq0=kq0/100;
  kq0=kq0*5000/1023;
  mq3=5+kq0*995/5000;
  lcd_gotoxy(1,1);
  lcd_putc("DO CON:");
  lcd_putc(mq3/1000%10+0x30);
  lcd_putc(mq3/100%10+0x30);
  lcd_putc(".");
  lcd_putc(mq3/10%10+0x30);
  lcd_putc(mq3%10+0x30);
  lcd_putc("mg/L");
}

void kiemtra_nn_tang()
{
  if(input(tang)==0)
  {
    delay_ms(20);
    if(input(tang)==0)
    {
      gh++;
      if(gh>1000)       gh=1000;



while(input(tang)==0);
    }
```

```
  }
}

void kiemtra_nn_giam()
{
  if(input(giam)==0)
  {
    delay_ms(20);
    if(input(giam)==0)
    {
      gh--;
      if(gh<1)       gh=1;
      while(input(giam)==0);
    }
  }
}

void main()
{
  set_tris_a(0Xff);
  set_tris_d(0X00);
  set_tris_b(0x00);
  set_tris_c(0x83);

  lcd_init();
  output_low(loa);
  khoi_dong_sim();
  duty=0;
  SETUP_ADC(ADC_CLOCK_DIV_32);
  SETUP_ADC_PORTS(AN0);
  setup_timer_2(t2_div_by_16,249,1);
  setup_ccp1(ccp_pwm);
  set_pwm1_duty(duty);
```

```
output_low(loa);
  gh=250;
  tt=1;
  while(true)
  {
    doc_mq3();
    kiemtra_nn_tang();
    kiemtra_nn_giam();
    if(mq3>gh)
    {
      output_high(loa);
      duty=0;
      if(tt==1)
      {
        tt=0;
        gui_tin_nhan(2);
        delay_ms(500);
      }
    }
    else
    {
      output_low(loa);
      duty=150;
      tt=1;
    }
    set_pwm1_duty(duty);
    lcd_gotoxy(1,2);
    lcd_putc("GH CON:");
    lcd_putc(gh/1000%10+0x30);
    lcd_putc(gh/100%10+0x30);
    lcd_putc(".");
    lcd_putc(gh/10%10+0x30);
    lcd_putc(gh%10+0x30);
    lcd_putc("mg/L");
  }
}
```