

Fire Alarm System Design Based On PLC Pi Pico At MCC XYZ Company

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ABSTRACT

As is known, the development of technology today is much faster than in previous eras. Especially in the field of industrial automation systems. With the rapid development of technology, one of its functions is to facilitate human work with the existence of an automatic control system. MCC or known as the motor control center is equipment in industrial applications that is used to control motors centrally on a panel. This article describes the design and prototype method for a fire alarm system based on the PLC pi pico at the MCC XYZ company. The work process in this system is to monitor fires in the MCC room of the XYZ company, this system is controlled using the PLC Raspberry pi pico. While SCADA(Supervisory Control and Data Acquisition) is used as a monitoring system with the MQ 2 sensor, Flame detector sensor, pushbutton as a temperature sensor and can also be accessed via the melsec protocol. The output is in the form of an alarm and a pump. The results of this study show that the tool works well and is able to help minimize fires in the area.

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1. INTRODUCTION

In today's technological developments, the control system is one of the systems that cannot be separated from everyday life, starting from room temperature control, robot control, and so on. Basically, the control system can make everyday life easier and is also expected to speed up the process stably and can reduce (human error) which is usually done by humans. One form of application of the fire alarm system in the MCC room. MCC or known as the motor control center is equipment in industrial applications that is used to control motors centrally in a panel. In addition, the main purpose of the MCC is used to provide a centralized location and protection so as to facilitate the maintenance process.

The general understanding of a fire alarm system is a system or tool for detecting fires in a room. Basically, fires are a fatal problem in factories or a room. In addition, fires can cause the production process to stop or can also destroy a particular factory. So that from some of these problems, a fire detection device or known as a fire alarm system is needed.

Based on the research, it has been discussed about the automatic cooling system. From [1] conducted a study using the MQ2 sensor and IR Flame Sensor as input, then monitored with android in real time. In this

study, it was controlled by the esp8266 microcontroller. In this study, it was monitored via Whatsapp Bot and there is no report data that records history in real time on the system and SCADA. In the study [2] conducted a study using fire sensor input, MQ7 sensor, Lm35 sensor. The system is controlled using Arduino Uno which is connected to Esp8266 by connecting to the blynk application. This study does not use PLC PI Pico or Scada. In the study [3] designed a fire detection system with a programming algorithm on the Arduino idea. In the working system of the designed tool, the sensor can detect fire points and provide signals to the microcontroller by converting the infrared light emitted by the fire and converting it into analog voltage and given to the microcontroller. In the study [4] designed a fire alarm system with the aim of This system has been designed to cover three protection zones (three rooms) where when detecting a fire, zone 1 produces a light-emitting diode (LED) alarm that can be heard and seen, while the LED, direct current (DC) water pump and buzzer are triggered in zone 2 and the LED, buzzer, and Solenoid valve are triggered for zone 3. From [5] designing a system aims to create a fire and smoke alarm device consisting of PLC components, solenoid, sprinkler, power supply, adapter, smoke detector, heat detector, pilot lamp, push button, relay and selector switch. The application design is set to detect smoke and heat generated during a fire. If the smoke detector detects a ceiling and heat height, the sensor will send a signal to the PLC to turn on the alarm to warn all units to work and extinguish the fire. From [6] a fire alarm system was created using the MQ-2 Sensor, DHT22 sensor, IR flame sensor and using a communication system using the telegram application. In this study, the ESP32 MCU-32S Node acts as a data processing center obtained from sensors due to changes in different conditions. From [7] conducted a fire alarm system study with the aim of preventing fire accidents to residents and building property. This project uses an Arduino Uno board and an ATmega328 chip. The main controller used is the ATmega328 which controls the home fire alarm based on temperature signals. The LM35 temperature sensor is used to detect heat from the fire. Notification messages are sent to users via short message service (SMS) via the GSM module.

From the background above, the author made an innovation, namely creating a fire alarm system design and construction system based on PLC Pi Pico on MCC XYZ company. Where PLC Rapsberry Pi Pico[8] is the controller. Where this PLC[9] is programmed using GX work software version 2[10] which has been changed to PLC Mitsubishi FX1n. The display uses Haiwell SCADA. The input section uses a flame detector sensor and MQ2 and pushbutton. At the output, it uses indicator lights, buzzers and motors, these devices are driven by relay[11] coils. In this study, the results can overcome the above problems and as a development of previous research.

2. METHOD

This research method is divided into three stages to implement this System. The first stage is the Design of the detailed part and the next stage is the design of the overall system as a prototype. The third stage and the last stage is implementation.

2.1. Designing Detailed Part

At the design stage of this system device, the components that will be used in the tool will be explained. In the process of designing the fire alarm system based on PLC Pi Pico on MCC XYZ company, several supporting components are used, including PLC Pi Pico as a controller, Sensors (MQ-2, flame detectors and pushbuttons) used as process input, and DC motors and buzzers [12] and LED indicators as outputs. For the monitoring system, Haiwell Cloud Scada software [13] is used. In this system, the power supply uses a power supply [14] and is equipped with Rs485 to t1 [15] as a slave to this PLC. The design of this system is by assembling components and programming the system so that it can work as desired. In general, the system design is as follows in the figure 1.

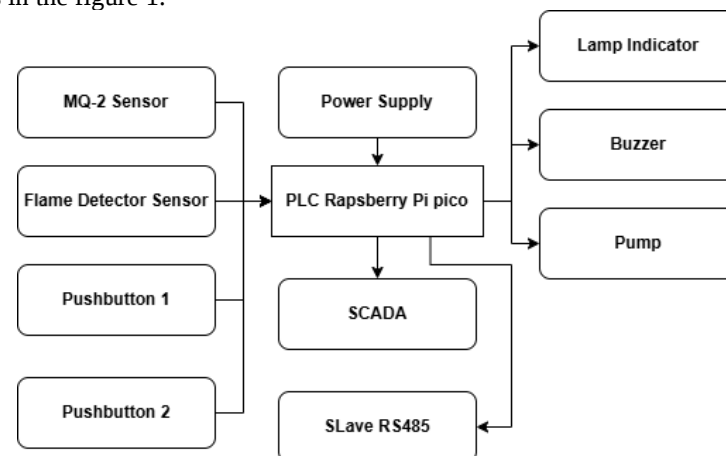


Figure 1. System Design Block

In terms of wiring, it will produce a circuit as shown in the following figure 2.

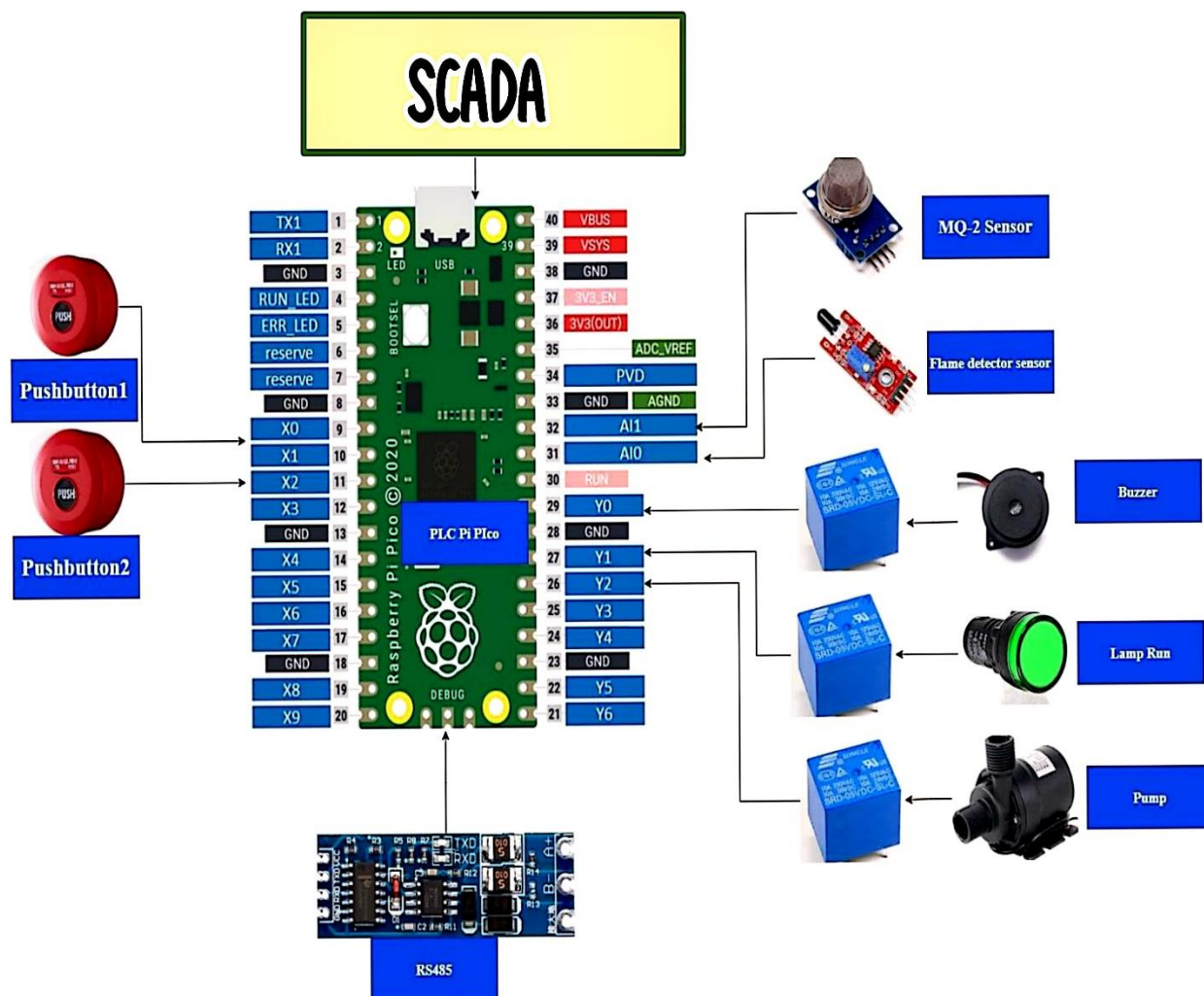


Figure 2. Wiring Input And Output

The following is a table 1 of the system input and output layout.

Table 1. Configuration Pin IO

Component	PLC Pi Pico Pins
MQ-2 sensor	Ai 0
flame detektor sensor	Ai 1
Pushbutton 1	Di x0
Pushbutton 2	Di x1
Pump	Do Y3
Lamp Indikator Buzzer	Do Y0-Y1
Rs 485	Rx and Tx

The following is the display design of this system.

2.1.1 SCADA Design

The SCADA display has several features including the main menu, data reports, graphs and parameters.

Main Menu

Figure 3 or main menu is part of the SCADA screen that functions as part of the main screen. This menu has several functions. These are Graphics, parameters and reports. In addition, there are pop up control pushbutton, motor control, buzzer control, MQ2 sensor popup and flame sensor.

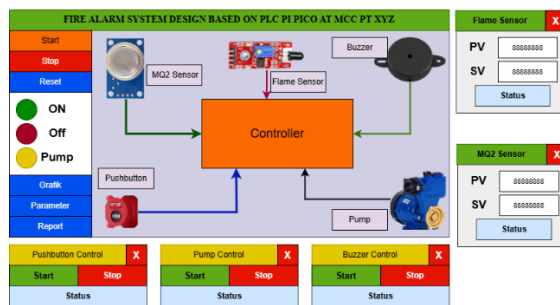


Figure 3. Design main menu

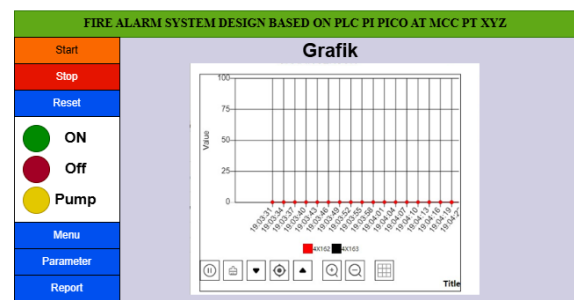


Figure 4. Design grafik

Graphic

Figure 4 or graphic display is also a part that shows the process of rising and falling of an object indicated in the form of line fluctuations, with the graphic display giving a more detailed impression to see changes in temperature and humidity in every second, minute, or hour. In Figure 4 the red color is the MQ2 sensor graph while the black color is the flame detector sensor.

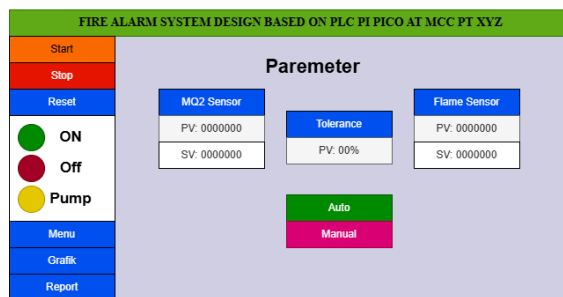


Figure 5. Design Parameter

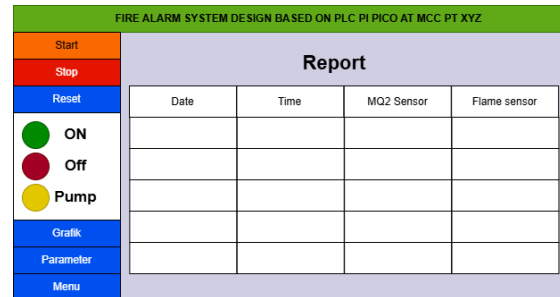


Figure 6. Design report

Parameter

This display also displays Parameters. In Figure 5 there are 3 types of data displayed, including PV, SV and tolerance. The definition of PV itself is the sensor input value. SV is a set value that is set as a reference for the output. Tolerance is the value of the sensor value calculation. In this menu there are also auto and manual buttons on the system.

Report

Figure 6 is a section that shows real-time system events from the start of the system to the end of operation. This report section can also be saved in PDF, XLS or CSV format. The information read from the report is the value of the mq2 sensor and the flame detector sensor.

2.2 Prototype Design

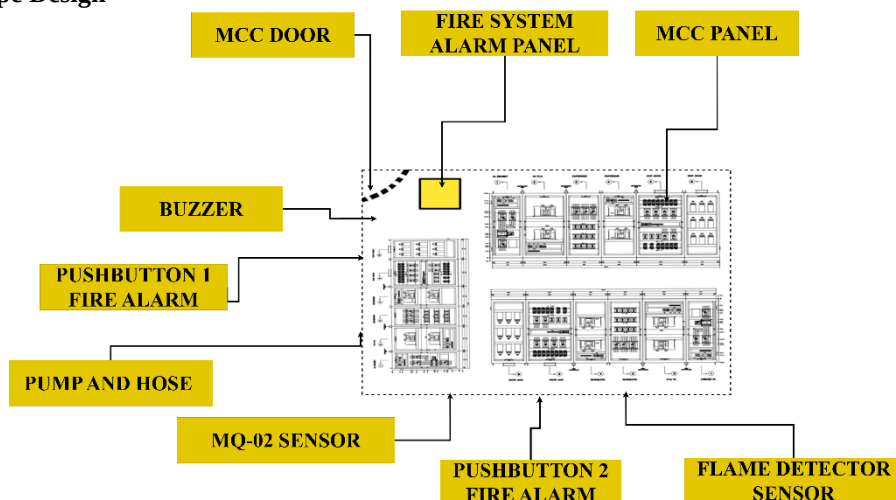


Figure 7. Prototype Design

In the process of making a prototype control circuit design (PLC Raspberry pi pico), the design of a fire alarm system based on PLC Pi Pico on MCC XYZ company requires supporting tools such as wood or acrylic as a base. The main components and their outputs use relays as pump drivers, buzzers, indicator leds, flame detector sensors are used as input for detecting fire in the room. The MQ-2 sensor is used to detect fire smoke. The controller uses PLC PI Pico while SCADA is used as a monitoring system. After the material is made, the next step is to install the components as shown in Figure 7. From is the layout of the prototype design to be made. On Pusbutton it will be used as a manual system button.

2.3 Function Diagram

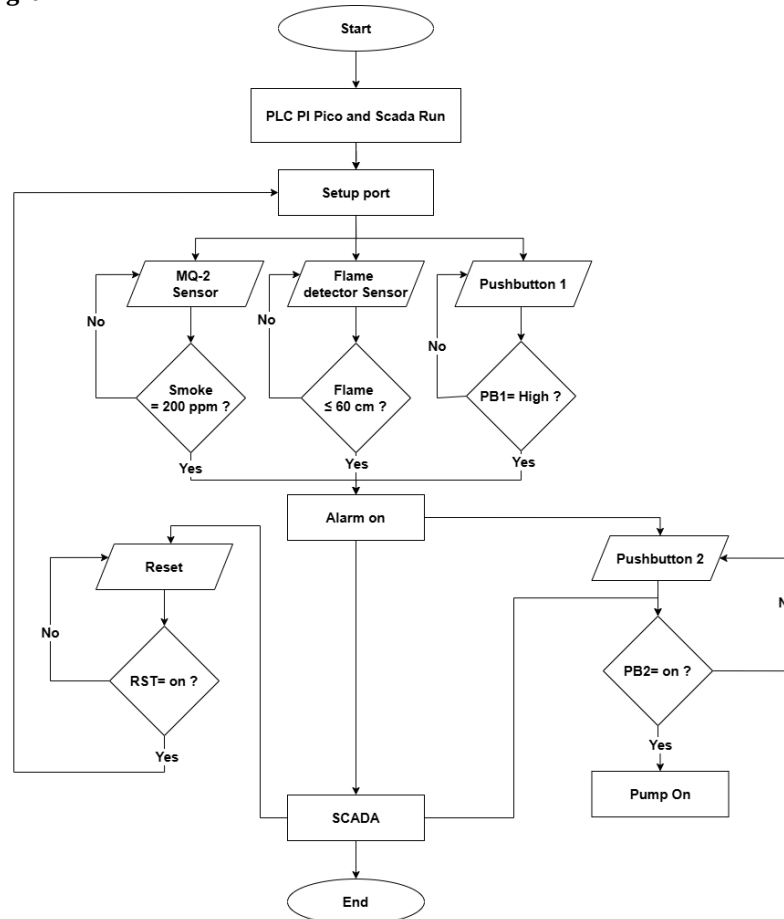


Figure 8. System Workflow Flowchart

According to figure 8, the way this system works is centered on the PLC Pi Pico and SCADA as a centralized controller. In the flowchart, it starts from the PLC Pi Pico and SCADA when on. When the MQ2 sensor is on which is connected to the Ai0 pin. After that, the flame detector sensor is on which is configured on the Ai1 pin. If the sensor value exceeds the specified setpoint and pushbutton1 is pressed, an alarm occurs. While the pump will go off if pushbutton 2 is pressed if the system is in an alarm state. When to research all systems are controlled by SCADA.

3. RESULTS AND DISCUSSION

After the tool is made, the next step is to test the tool. During the testing of this tool, several analyzes were carried out including MQ2 sensor testing, flame detector sensor testing, pushbutton testing and SCADA testing. The following is the test data on this system.



Figure 9. System Design Results

3.1 MQ2 Sensor Testing and Analysis



Figure 10. MQ2 sensor test

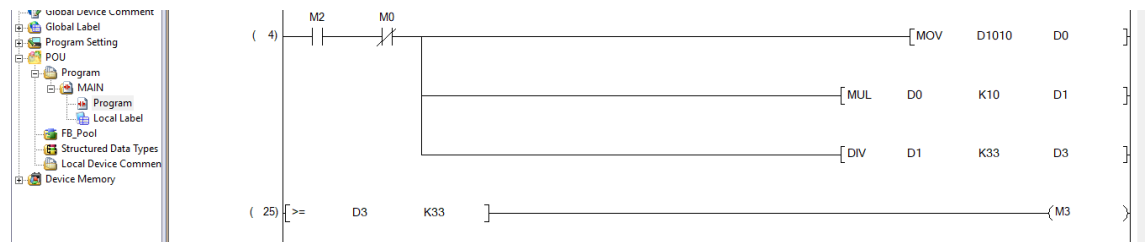


Figure 11. MQ2 Sensor Program Test

The following are the results of testing the MQ2 sensor on this system.

Table 2. MQ2 Sensor Testing and Analysis

No.	Date	Sensor values	Setpoint	alarm
1.	27/11/2024	175 Ppm	200 Ppm	Alarm Off
2.	27/11/2024	180 Ppm	200 Ppm	Alarm Off
3.	27/11/2024	200 Ppm	200 Ppm	Alarm On
4.	28/11/2024	190 Ppm	200 Ppm	Alarm Off
5.	28/11/2024	150 Ppm	200 Ppm	Alarm Off

If you look at the data in table 2, the sensor test results are running well. This test uses the mq2 sensor analog pin. The set point parameter used is 200ppm. This means that there is a scaling of the analog value between the minimum and maximum values between 0 and 200ppm. This is processed through the raspberry pi pico PLC program with the ascii value. From the program above, the sensor analog pin is configured at d1010 which is issued at d0.

3.2 Flame Detector Sensor Testing and Analysis

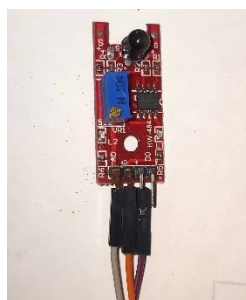


Figure 12. Flame Detector Sensor Test

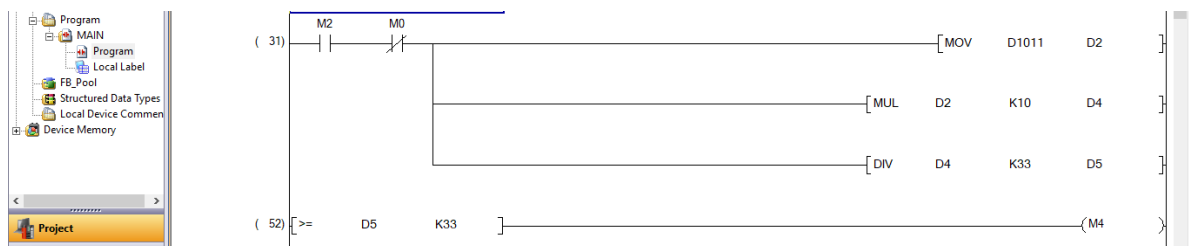


Figure 13. Flame Detector Sensor Program Test

The following are the results of testing the flame detector sensor on this system.

Table 3. Flame Detector Sensor Testing and Analysis

No.	Date	Sensor Values	Setpoint	Alarm
1.	27/11/2024	45 Cm	60 Cm	Alarm On
2.	27/11/2024	55 Cm	60 Cm	Alarm On
3.	27/11/2024	60 Cm	60 Cm	Alarm On
4.	28/11/2024	63 Cm	60 Cm	Alarm Off
5.	28/11/2024	7 Cm	60 Cm	Alarm On

In table 2 are the results of the flame detector sensor test. This test uses analog output. This means that the analog pin is connected to the ADC 2 which is configured on the D1011. This test uses a set point distance of 60 cm. From the data in table 2, if the sensor value is below 60 cm, the system will display an alarm. If the sensor value is above 60 cm, the alarm is off.

3.3 Digital Component Testing and Analysis

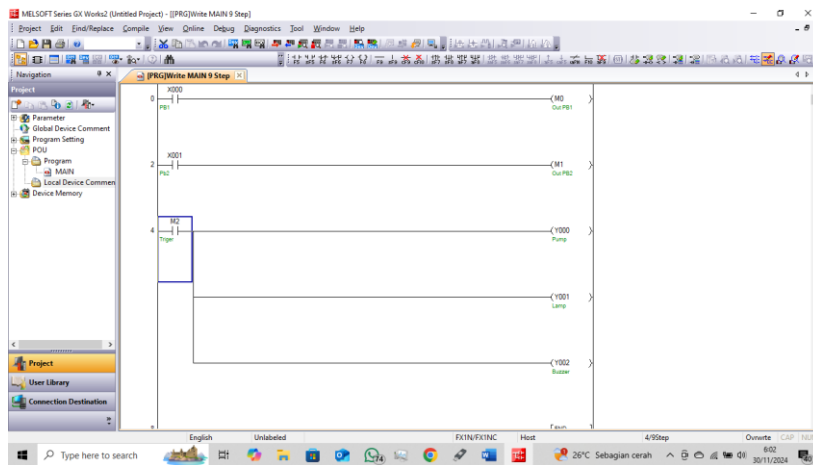


Figure 14. Digital Component Program Test

The following are the results of testing the flame detector sensor on this system.

Table 4. Digital Component Test And Analysis

Digital Component	Component	Remark
Pushbutton 1	Yes	Components work according to function
Pushbutton 2	Yes	Components work according to function
Pump	Yes	Components work according to function
Buzzer	Yes	Components work according to function
Lamp	Yes	Components work according to function

Table 4 shows the results of digital component testing. Basically, digital components only use high and low commands. In the test above, pushbutton 1 is configured at x0, pushbutton 2 x1, pump y0, lamp y1 and buzzer y2. In this test, the input is issued with the memory instruction (m) and the output is triggered by the instruction (m).

3.4 SCADA Testing and Analysis

No.	Types of Testing	Compliance		Remark
		Yes	No	

1. Main menu design

✓

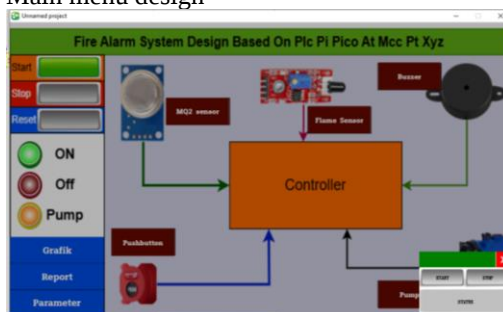


Figure 15. Main Menu Design

Figure 15 shows the design of the main menu. In testing this display contains several buttons, namely the toolbar on the left and the pop-up menu in the input and output.

2. Grafik design

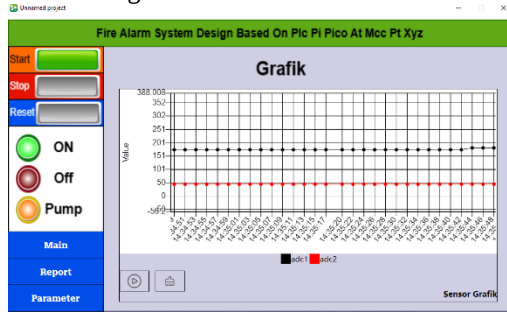


Figure 16. Grafik design

3. Report design

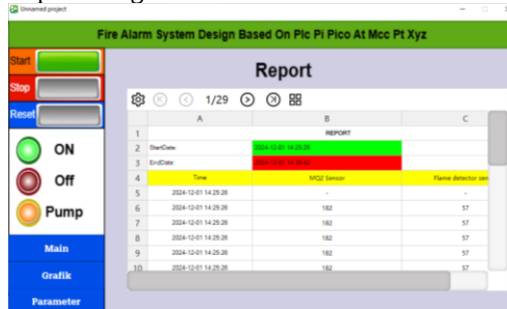


Figure 17. Report design

4. Parameter design

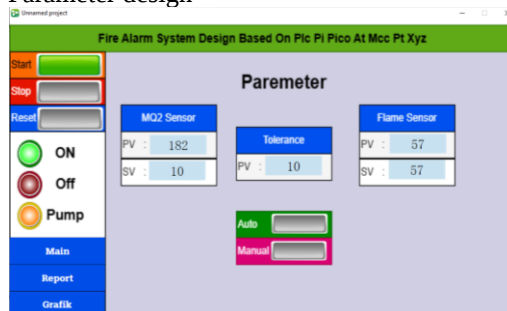


Figure 18. Parameter design

Figure 16 shows the graphic design. In this display test, there are 2 graphs, namely the ADC 1 graph (mq2 sensor) and ADC2 (flame detector sensor). This display is loaded in real time every second.

Figure 17 shows the data report display. The results of this report can be saved in Excel, PDF and CSV formats. From this test, the values recorded are the mq 2 sensor and the flame detector sensor. At the time according to the computer used.

Figure 18 shows the parameter display. In this display, the PV or real value of the mq 2 sensor is 182 ppm with an SV or set point value of 200. On the flame detector sensor, the PV value is 57 cm with an SV of 60. Here, there is also a tolerance value of 10 which is used for maximum sensor reading guidance if there is a difference in value.

4. CONCLUSION

Based on the design and testing of the PLC Pi Pico based fire alarm system on the MCC XYZ company equipment, it was concluded that the device works well and can overcome fires in the MCC. For its implementation, it can make it easier for workers to monitor fire protection in the MCC area. This system is suitable because it is cheaper than using an official PLC. The features contained in SCADA are very helpful for monitoring and acquiring fire protection data in the MCC room. The relative display uses a serial for the future can be used via Ethernet using the moxa msgate module.

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