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Abstract

Programmable Logic Controllers (PLCs) are modern tools, especially in the control. This lab experiment aims and explores the role of PLCs in the performance of controlling various type of systems, highlighting their flexibility, precision, and remote monitoring capabilities.

A PLC analog output was a connected to an (RS-Electrical 1500 W) heater to give feedback and adjust the power output of the heater according to the temperature, the temperature sensor used was (RTD PT100 Temperature sensor) which was connected to a solid state relay that acts as a switch to turn on and off and the heater and the feedback to the plc for the voltage. This solid-state relay was connected to a fuse on the wall for power. A power converter was used to give power to the plc (so that the plc doesn't burn from overvoltage) and gives power to the plc and another component, that is a temperature transmitter module that converts temperature reading to currents in mA. The whole system is connected together via these parts (Power converter, Solid-State Relay, Temperature Transmitter module, PLC). After connecting the system together a logo soft PLC code was programmed to give feedback and control the temperature through the plc controller to the desired setpoint of (37 °C). unfortunately, the heater did turn off. However, no control on the setpoint whatsoever which was verified with a digital thermometer as the temperature kept increasing without stopping.

Introduction

Most of modern-day systems have been designed to be controlled using PLCS. Programmable logic controller known as (PLC) are a fascinated tool to control the systems and having it to be in the best operation. In this experiment its desired to design a controlled temperature system that consist of electric heater to heat up water to desired setpoint temperature.

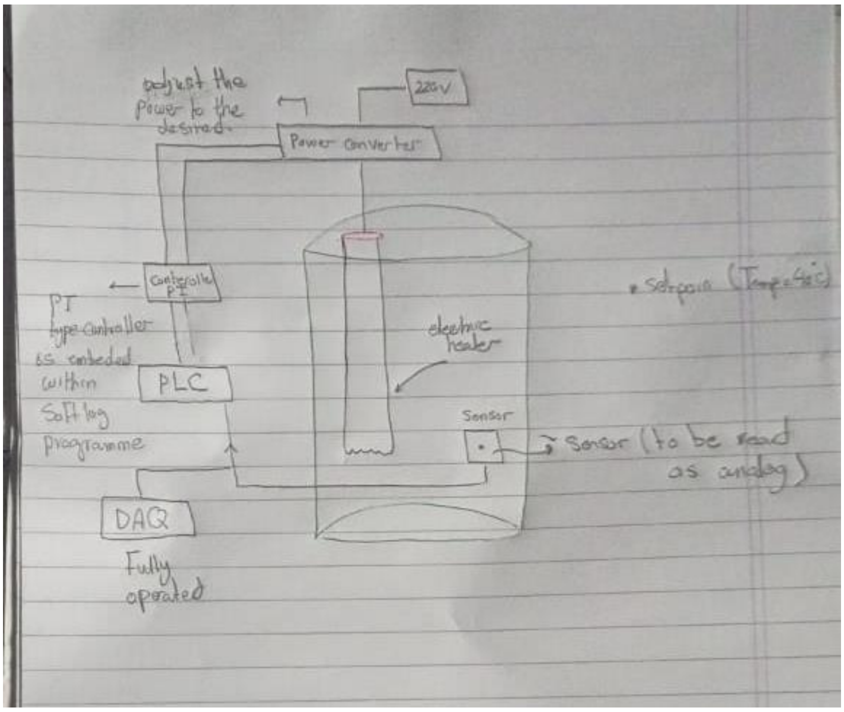

Figure 1: Sketch diagram of Experiment.

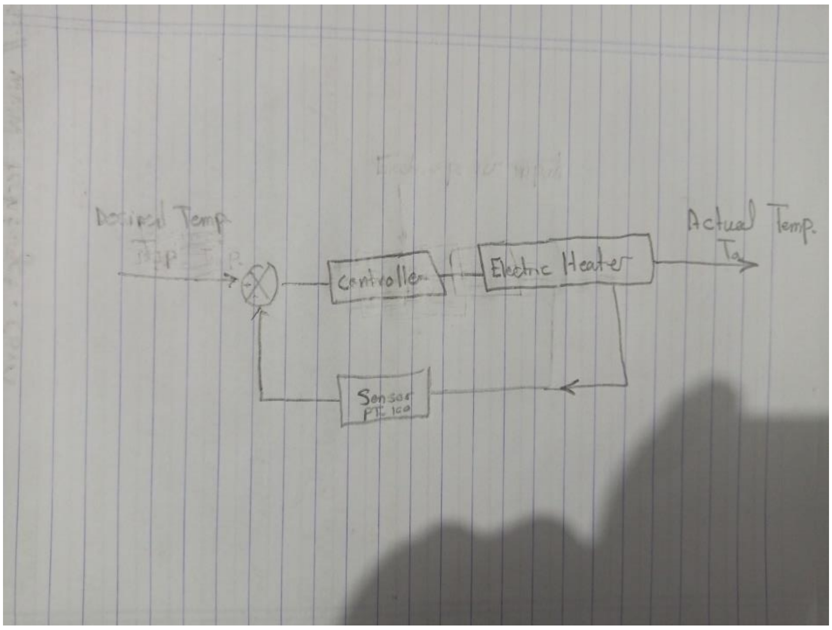

Figure 2: Block diagram of the system.

Objective

- Design a Laboratory Temperature Control System.
- Better understanding of the operation of the PLC's.
- Compare the experimental results with the theoretical values.

Experiment Apparatus

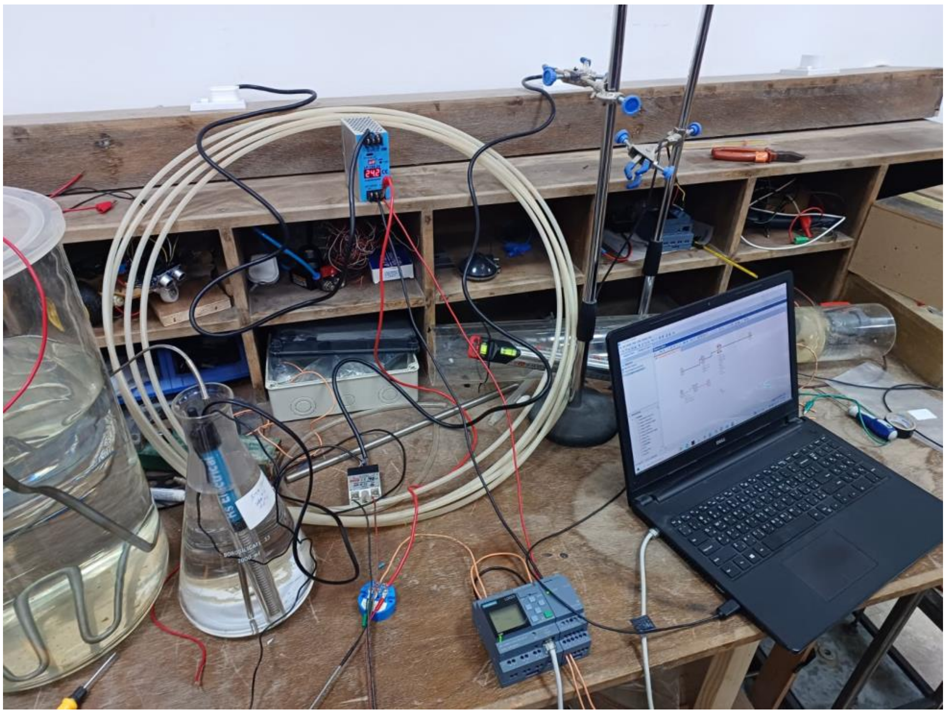

Figure 1: Appartus setup.

Procedure

The procedure of this experiment was dived into meeting sessions, each meeting a component was introduced and connected to complete the experiment setup, a brief description of experiment setup in each session.

- Session one

In the first Session, the laboratory was attended, with the aim to identify the main various components of the system, and the explanations were provided for each component and the entire system. Additionally, the end goal of utilizing a switch relay to control the heating system was outlined.

- Session Two

During the second Session, the Logo Soft software was introduced, and a basic circuit of the system was designed. Additionally, the address of the PLC IP address was added to our laptops to establish a connection between the PLC and the software. The circuit was comprised of two digital inputs, a latching switch, and an output.

Furthermore, basic testing with a voltmeter was conducted, where the PLC was connected to the red and black probes. If a beeping sound was heard, it indicated that the system had power, and if no sound was heard, it signified that the system was off.

- Session Three

During the third Session, Additional Components were made to the main circuit that was created in the previous session created in Logo Soft, the following components are analog input, amplifier, PI controller, analog output, and a status block. In the lower circuit, a status block, text block, and an open connector are present.

As for the physical setup, a relay switch (SSR-40 DA) was connected to the power source and heater. The temperature transmitter module was linked to the temperature sensor, with its purpose being to convert the temperature reading into current. Additionally, a resistor piece was connected to create a voltage drop.

- Session Four

By the fourth week of the experiment, all the connections had been made, and the experiment was tested. The PLC on and off functions operated as intended, but no temperature information was attained, as the temperature continued to increase. This was likely to a fault in programming or a malfunction in the equipment. Due to time constraints and the unavailability of replacement equipment, further investigation could not be undertaken.

Components and SOFT LOGO Circuit

The section Shows the main components of the experiment and SOFT LOGO circuit that was created to control. As the description is provided in the appendix.

1. PLC (Programmable logic control)

A Programmable Logic Controller (PLC) is a digital computer designed for industrial purposes and control systems. It is programmable and used to automate various electromechanical processes, such as machinery on a factory assembly line, lighting systems in buildings, or even environmental controls. PLCs receive input data from sensors, process the information through a programmed logic, and then generate output signals to control machines or processes. They play a crucial role in improving efficiency, reliability, and flexibility in industrial settings by allowing for the automation and monitoring of complex tasks.

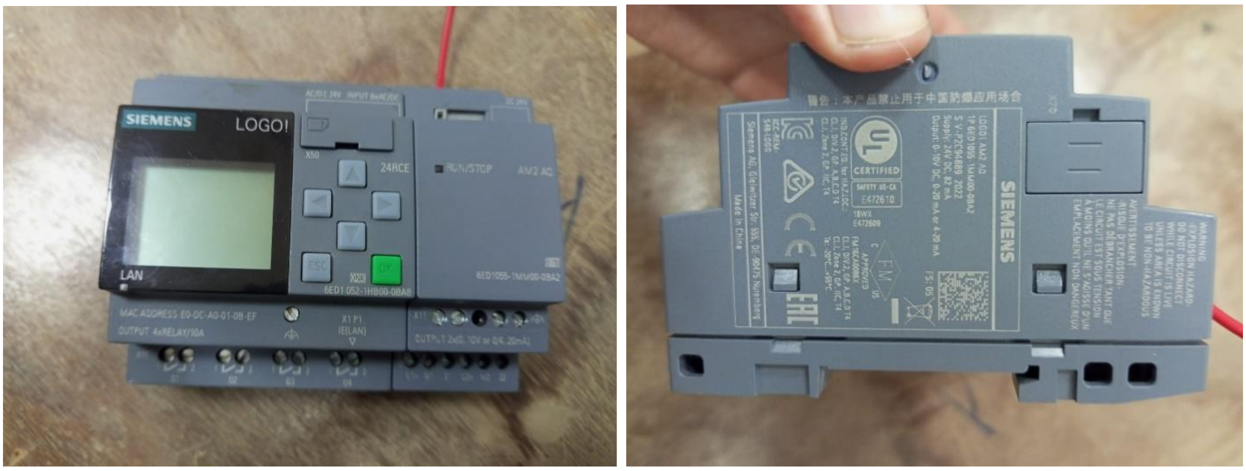

Figure 2: Siemens PLC.

2. PT-100 Sensor

The PT-100 sensor, also known as resistance temperature detector (RTD), is a type of temperature sensor commonly used for accurate and precise temperature measurements. The PT-100 sensor has a resistance of 100 ohms at 0 degrees Celsius.

As the temperature changes, the electrical resistance of the PT-100 sensor changes. This change in resistance is highly predictable and can be measured to determine the temperature with a high degree of accuracy. PT-100 sensors are known for their stability, repeatability, and linearity across a wide temperature range, making them valuable in various industrial, scientific, and laboratory applications where precise temperature control and measurement are essential.

Figure 3: PT-100 Temperature Sensor.

3. Solid State Relay

A solid-state relay (SSR) is an electronic switch that employs semiconductor components to execute tasks typically handled by conventional electromechanical relays, eliminating the necessity for moving parts. This technology offers a dependable and efficient method for managing electrical loads across diverse applications. The fundamental components of a solid-state relay encompass semiconductor devices, notably transistors, distinguishing it from traditional relays by its reliance on solid-state principles for enhanced performance and reliability in controlling electrical circuits.

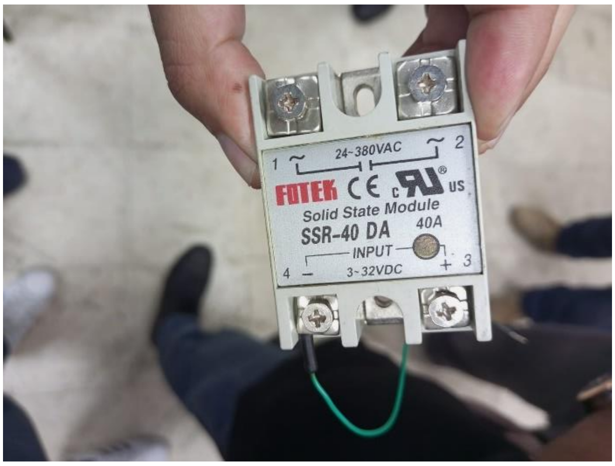

Figure 4: Solid State Relay (SSR-40 DA).

4. Power Converter

A power converter is an electronic device that converts electrical energy from one form, level, or voltage to another, involving alterations in voltage, frequency, or waveform. Vital in diverse applications, power converters efficiently enable the use of electrical energy in various systems and devices. Designed for specific purposes, there exist multiple types of power converters.

Figure 5: Power Converter.

- ## LOGO-SOFT Circuit

The first consecrated circuit consisted of two digital inputs which acts as set and reset buttons for the PLC, a latching switch, and an output.

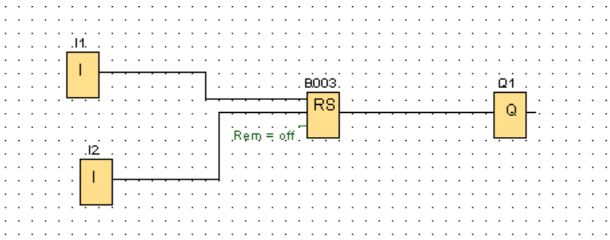

Figure 6: The Set-reset SOFTLOGO circuit.

In the second SOFTLOGO circuit more components was added to ensure controlling the system.

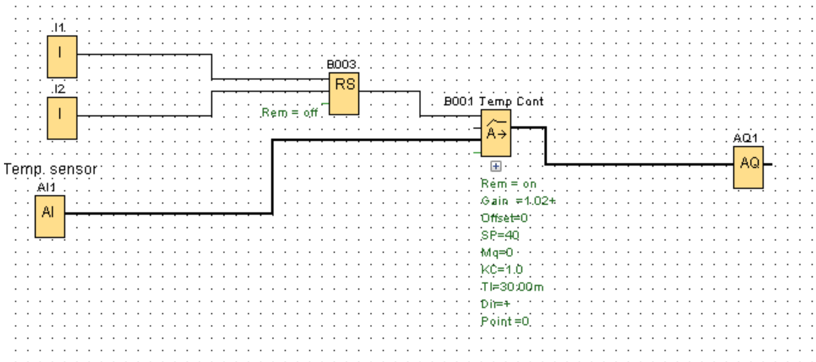

Figure 7: Modified Circuit.

The final circuit was constructed to generate the system response and use it to compare it with the theoretical response using Similink.

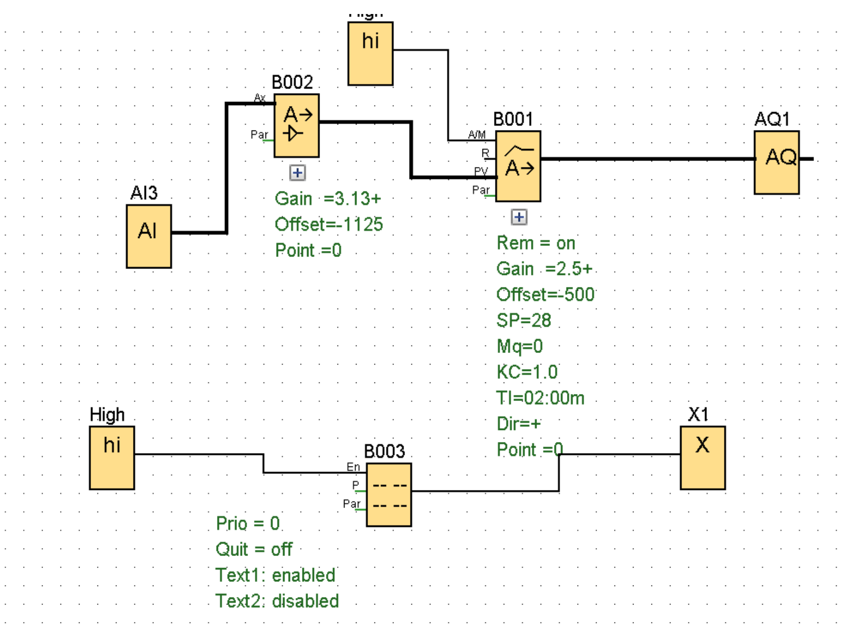

Figure 8: FInal circuit.

Results

From figure (9) the system response was generated, it's a first order system response as its took time to reach steady state.

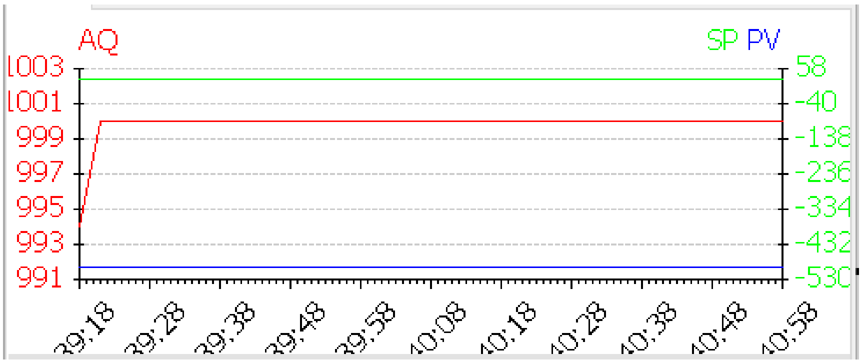

Figure 9: Experimental Response.

The system was studied using similink to obtain the theoretical response and use the result to compare it with the experiment value.

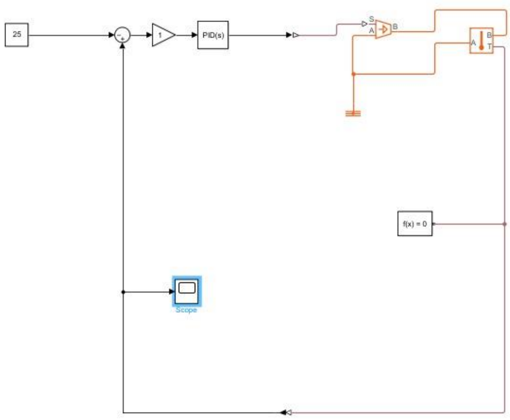

Figure 10: Similink Temperature control system circuit.

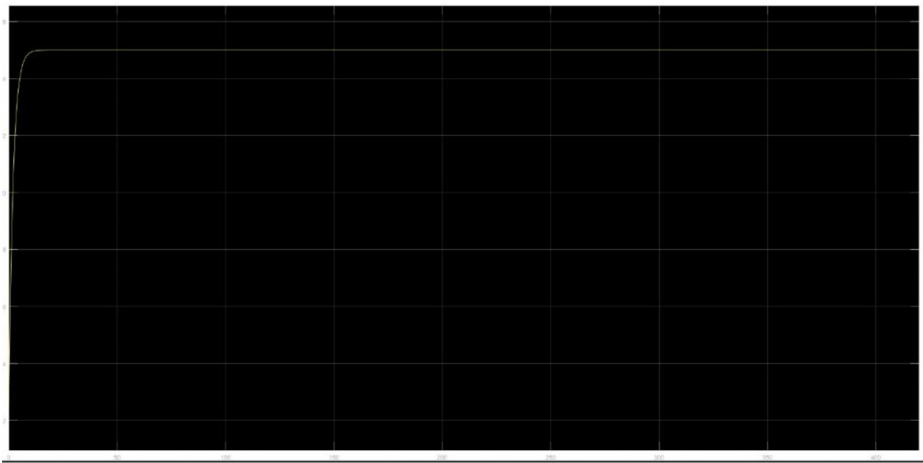

Figure 11: Theoretical Response using Similink.

Discussion and Conclusion.

In the Simulink representation the system behaved as a first order system and reach a steady state. While the heater in the experiment kept on increasing the temperature without reaching a steady state, as if the feedback signal doesn’t reach. In another trail for the experiment the heater didn’t even turn on as it didn’t receive electricity/ electric power from the plc as the multimeter reads zero for voltage output of the plc. In another trail the system reaches a temperature of 34 C and turned on and off as if it was working correctly but then kept on increasing the temperature as if there is no feedback signal.

The code of the plc on logosoft should be adjusted so that the heater reaches a steady state and receives feedback signal from the plc. After making sure the connections and wires are correctly circuited for the heater to receive power.

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