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Room Temperature Control System Prototype Industry Based Programmable Logic Controller Zelio SR2 B121 BD

Sumardi Sadi
Lecturer of the Faculty of Engineering, University of Muhammadiyah Tangerang
Jl. Perintis Kemerdekaan I No. 33 Cikokol Kota Tangerang-Banten -Indonesia
Email : mardiesadi99@gmail.com

Abstract

Prototype room temperature control system based on Programmable Logic Controller industry Zellio SR2 B121 BD works based on the room temperature rises predetermined / programmed by programming the PLC, the increase in temperature of the room and the value of the temperature rise can be monitored using the LCD screen. Room temperature control industry can work from a temperature of 0 ° C to 90 ° C degrees (Ninety derarajat Celsius). Room temperature pendali equipment industry uses three components: first controller, Zelio Logic SR 121BD, second, Integrated Circuit (IC) LM35 and third, a 24 VDC power supply. This made the system utilizes the data acquisition capabilities and decision-making. Coverage temperature can be controlled in the room ranged from 0 ° C to 90 ° C samapai. Retrieval application temperature range is based on the influence of temperature not only as a noise in the world of electronics, but also the effect on the health of the world, for example in infant incubator, the results of the quality of production, for example in food, agriculture, plantation, as well as the building's security system. Prototype room temperature control system based on Programmable Logic Controller industry Zellio SR2 B121 BD consists of hardware and software. The hardware consists of a Programmable Logic Control (PLC) type of Zelio Logic SR121BD, and software on this system created using zeliosoft software version 3. This study uses Zelio Logic SR121BD as room temperature control with a prototype measuring 20 x 40 x 25 cm3. From the test results at room temperature control system prototype based on this PLC, can be determined at the time of programming in ladder Zelio soft, so the room can be controlled at a temperature of 0ºC - 90ºC.

Keywords : PLC Zelio logic, LM35 Sensor

Introduction

The development of the automotive industry which is very rapidly requires a device that can work automatically to support the production process. The use of automated devices can also help improve the efficiency of the production time. The development of increasingly advanced technology plays an important role, in the industrial world today. Modern technology and renewable covers must be synergy between cost efficiency, natural resources and human resources. if one of them is ignored then there will be problems in the future.

Control automatically control various fields at this time continuously developed, including the application of temperature control in the room that can be set and displayed. This made the system utilizes the ability of Zelio Logic SR 121BD in data acquisition and decision making. Tempetatur region that can be controlled is the circumstances surrounding ambient temperature up to 90 ° Celsius. Making the application of this temperature is based on the influence of temperature not only as a noise in the world of electronics but also the effect on the world of health (infant incubator, and so on), the result of the quality of production (food, agriculture, plantations and so on), as well as building security systems and so forth.

The advantage of this system is that many circuit components in the market and the price is quite affordable so that the cost efficiency can be achieved its use, easy to maintain, the temperature can be monitored on the LCD screen, easy operation. The system automatically controls room temperature on a tool that is designed to keep the room in order to remain stable according to the program are made, as well as using the control system OFF and Zelio Logic is used as a center for process control. In this research coverage devoted to the problem of how to design a prototype for ndustri Rungan climate control, apply and control systems in the Zelio Logic SR 121BD to control the temperature in the room. The aim of the research is to apply the system Zelio Logic SR 121BD and IC LM35 for controlling the air temperature in the room, especially in the industrial space.

Literature Review

2.1 Programmable Logic Controller (PLC)

2.2 Hardware

Understanding the PLC according to the National Electrical Manufacture Association (NEMA) is an electronic device that works digitally using "Programmable Memory" for storage of internal instructions to implement the

fung--specific functions such as logic, sequencing, the measurement time, dasn arithmetic calculation, for control modules input / output analog or digital, various types of machinery or process certain. PLC is a major component in the environment Computer Integated Manufacturing (CIM). PLC can realize the real time environment / real where all the information is stored. Information such as target, which reject the results, the status of the operation, the test results can be directly seen from the computer.

PLC is an electronic computer that can perform various functions in the control of complex levels. PLC can be programmed, controlled and operated by an operator who is not experienced in operating a computer. PLC is generally depicted with lines and equipment on a ladder diagram. The results of these images on the computer depicting wirring / relationships necessary for a process. PLC will operate all systems that have the output is to be on or off. Can also operated a system with varying output. PLC can be operated with input in the form of on / off or variable input devices. PLC is required for conventional logic control systems. Table 1 is a depiction of a comparison between wired logic with PLC.

2.2.1 Zelio Logic Smart Relay

Smart relay is a device that can be programmed by a specific language used in process automation. Smart relay has a small size and relatively light weight. Zelio Logic smart relays are designed for automated systems commonly used in industrial and commercial applications. For industrial purposes are usually used for small applications finishing, packaging and production process. It is also used for machines with a small scale to large-scale and sometimes also used for the home industry. For the commercial sector or building used for roller, entrances, electrical installations, compressor and others who use the automation system.

There are two types of smart relay that is the type of compact and modular type. The difference is in the type of modular extensions can be added so that the module can be added to the input and output. However the addition of the module is still limited to only be added up to 40 I / O. In addition to the modular type can also be monitored remotely with the addition of modules.

Smart relay function is a special form of microprocessor-based controller utilizing programmed memory for storing instruction - instruction with certain rules and can implement functions - special functions such as the function of logic, sequencing, timing, counting and arithmetic with destination control machines and processes that will be carried out automatically and repeatedly. Smart relays are designed as possible so easy to operate and can be programmed by a special non-programmers. Therefore, designers of smart relay has put an interpreter in this device that allows the user meinput control programs in accordance with their needs in their needs in a form of a programming language that is relatively simple and easy to understand and can be easily modified or replaced in accordance with the needs. Programming is used on the smart relay Schneider is can be done in two ways: by using the button - the button on the smart relay that can change the program directly from the smart relay. In addition, programming can also use a computer that uses software "Zelio Soft 2".

How it works first smart relay is checking the condition of the input. Smart relay will check every input there. Then everything will be entered into memory. The second step is to execute porogram on an instruction. So the smart relay work is based on the program. Each condition is determined by the program. The final step on the status of the smart relay set the output device. We can see that the smart relay is very important in the process.
The advantage of using the Smart Relay is:
a. Programming is simple. With the large LCD display with backlight allows programming via the front panel or using the Zelio Soft 2 Software.
b. Installation is easy.
c. Prices are cheaper than using a PLC.
d. Flexible, compact and can add additional modules as needed, dual programming language, and multiple power capabilities (12VDC, 24VDC, 24VAC and 120 VAC).
e. Open connectivity. Zelio system can be monitored remotely by adding extension modules such as modems. Also available Modbus modules that can be a slave Zelio OLC in a PLC network.

2.2.2 Smart Relay SR2B121BD Schneider Electric

Smart relay is used SR2B121BD Telemecanique brand made by the manufacturer Schneider. Smart relay is a relay Smart modular expandable. Smart software used for this relay is Zelio Soft 2. The use of language or ladder diagrams can also use the function block diagram. Smart relays are used can be expandable as needed. So that the input and output can be added to the Smart Relay. Smart relay also has a screen that can be used to view and change the program that has been inputted into the Smart relay this. On the screen there is also a backlight is

used to illuminate the display for easy reading on the screen. Smart relay also has backup data that is done by the Flash EEPROM memory. Communication used is the Modbus network. Smart relay has a range of 24 VDC power supply. Supplynya voltage limits are 19.2 to 30 VDC. Nominal currents of 70 mA without extensions when using extensions 180 mA.

From the picture above we can see there is a screen that can be used to perform programming directly from a smart relay without having to use a computer. With the buttons that have been provided we can program more easily. Zelio SR2 B121 BD is a smart relay 2nd generation, modular type that will be used is designed for an automation system. The advantage of this modular type is only requires a 24 volt supply to the I / O numbering 12 pieces and numbered analog input 4. Zelio SR2 B121 BD is also a smart PLC which has a CPU, memory and integrated relay in it. In addition, with this type Zelio able to be expanded the number of input / output. In contrast to the usual PLC, Zelio SR2 B121 BD has an analog input that serves to facilitate the use of inputs in the form of analog data and the comparison voltage.

To program Zelio SR2 B121 BD module can be used in two ways, first by way via the front panel and the second Zelio module through programming workshop Zelio Soft 2 programming language in Zelio Soft 2, there are two kinds, namely the ladder diagrams and FBD (Functional Block Diagram), two programming languages are equally implement predefine the Function Block as timers and counters as well as specific functions to another. Zelio is a collection of relays, where the relay is a device that works based on the electromagnetic force that can close and open a contact switch. Relay was originally developed to facilitate two electronic control, the remote control and power amplification. Examples of power amplification is the starting relay on a car. Relay contacts have two basic configurations are Normally Open (NO) and Normally Closed (NC). Normally Open have open contact condition when it is energized and the contact will close when the in-energized. While Normally Closed contacts have closed condition when it is energized and the contact will open when in-energized. Under the agreement, the symbol of the relay contacts are always indicate the condition when it is energized. Relay has an assortment of variations in contact configuration. As the double-pole / double-throw (DPDT), triple-pole / double-throw (3PDT), double-pole / single-throw (DPST), single-pole / single-throw (SPST) and so on. Switches and relays are widely used in industries to control motors, machines and processes. Switches can run a single machine on and off, but in contrast to the relay logic networks that can control the process run, turn on a machine, waiting until the process is complete, then run the next process.

Zelio Logic modular type of module that can be added as needed. But the addition of modules is quite limited. Only up to 40 I / O only. Smart relay has a good performance compared with other smart relay because it has a small form factor and relatively lighter and has a number of input and output is quite a lot compared to the other the size of a smart relay and also a screen for easy control.

Programming and easy installation, Zelio Logic is suitable for all applications. Zelio Logic is also flexible offers two kinds of options, the first is a compact version which in this version has a fixed configuration, while for the latter, namely Modular version, you can add extensions Modules and 2 programming languages (FBD or ladder).
Independently, using the buttons on the Zelio Logic smart relay (ladder language)
Using the programming on a PC using "Zelio Soft 2 2" software.

2.1.2 Input dan Output (I/O)

Smart relays have input number 8 which consists of analog and digital and has 4 relay outputs normally open. Smart relays can also be combined with additional modules that can multiply the number of input and output amount up to the total of 40 I / O. For discrete inputs have a nominal voltage of 24 V and the current is 4 mA and for the analog inputs 0-10 or 0-24 VDC. 12K input impedance. For response time when using a ladder language requires 50 ms and if using block diagrams require a minimum of 50 ms and a maximum of 255 ms. As for the output device. There are two types, namely the relay and transistor characteristics. For the type is normally open relay that will light if given a logic 1 and would die if given a logic 0. The limit operation of 5-30 VDC and 24-250 VAC. Thermal currents 8 outputs and 2 outputs 8A worth worth 5A. Minimum switching capacity is 10 mA. Time respone to trip 10 ms and 5 ms to reset. For transistor operation limit 19,2-30V. Nominal load voltage of 24 VDC and the current 0.5a. Time respone to trip and resetnya less than 1 ms. I / O on the smart relay can be given additional modules according to need, but there are limitations in the addition. For analogue I / O extension modules with 4 I / O, using the 24 VDC supply. Discrete I / O extension modules with 6, 10, 14 I / O, supply Zelio Logic smart relays via the same voltage.

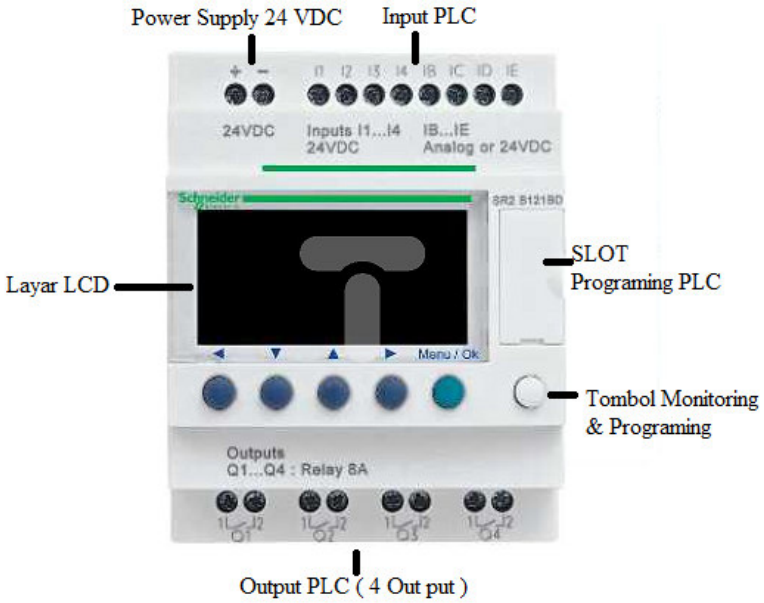

Figure 2.1 Zelio Logic Modular SR2 B121 BD
Source: Personal Documentation

2.1.3 Specification

Zelio type SR2 B121 BD has a number of I / O as many as 12 pieces, which have amounted to 8 discrete inputs, which include such amounts to 4 analog inputs, while its output consists of 4 pieces of type relay. Zelio this type disupplay with 24Volt DC voltage (between 19.2 to 30 volts).

2.2.4 Temperature Sensor

IC LM35 is the temperature or temperature sensing provides the output voltage that is directly proportional to the temperature / temperature is measured in degrees Celsius. This means that if the temperature read 00C, the output voltage is 0 volts. the output voltage to the IC LM 35 will rise with an increase of 10 mV for every degree centigrade. This is the advantage of this form of IC temperature sensor uses a silicon chip to the sensing element (sensor) which has a voltage and current output configuration. The temperature sensor used is the IC LM35DZ. LM35DZ supplied voltage 4V-30V DC start by draining 60 microampere currents, possess selfheating effect level (self heating) is low 0,080C. In Figure 2.3 are shown the physical form LM35DZ temperature sensor.

Figure 2.2 Temperature Sensor LM35DZ
Source: *http://matuari.wordpress.com/2012/02/17/sensor-suhu-lm35/*

2.3 Software

2.3.1 Programming PLC (Programmable Logic Control)

According to the basic ladder diagrams Agfianto Eko Putra (2004: 57), a ladder diagram or ladder diagram consists of a downward line on the left side with lines branching to the right. Existing lines on the left side called crossbar bus (bus bar), while The Branching Lines is barisinstruksi or stairs. Along the lines of instruction placed various conditions that are connected to other instructions on the right. Combination logic of conditions stated when and when and how the instructions on the right side is done. Example ladder diagram is shown in Figure 2.4. Along the lines of instruction can branch out again and then joined again. The lines of vertical pairs (such as capacitors symbol) that is called the condition. The figures contained in each condition is bit operand instructions. Status bits associated with each of the conditions that determine the condition of the execution of the next instruction.

1. Ladder instruction is instruction - instruction related to conditions in the ladder diagram. Instructions stairs, either independently or in combination, or combined with the following instruction block or earlier, will establish conditions for execution. 2. mnemonic code

2. According to the Son Afgianto Eko (2004: 60) ladder diagram can not be directly sent to the PLC using the Programming Console. To send a ladder diagram using the programming console to do the conversion to the ladder diagram mnemonic codes (software specifically Syswin Omron PLC Sysmac) can do this automatically. Mnemonic code provides exactly the same information with the ladder diagram only in a form that can be typed directly into the relevant PLC (via console programming). 3. Execution Program

3. When the execution of the program is executed, the CPU unit in the PLC will scan the program from top to bottom, checking all conditions and work on all relevant instructions downward. Thus it is important to put the instructions in the order they should be, so that the program can work or in accordance with the will. And the CPU is always working on instruction from left to right before returning again to the branch point and then work on the next instruction line and so on.

2.3.2 Software

Programming used on the smart relay is using software Zelio Soft 2. The programming language used is Ladder Diagram (LD) and Function Block Diagram (FBD). In the picture we can see from Figure 2.3 layout example program that uses ladder diagrams

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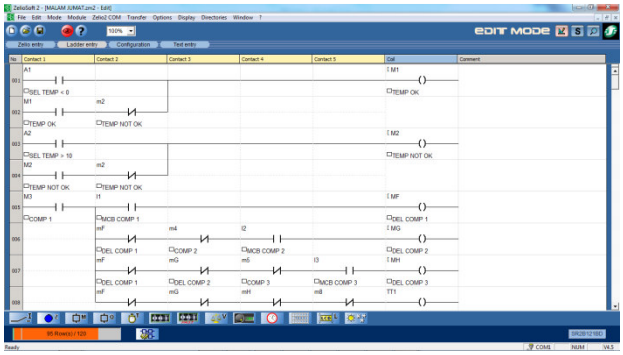


Figure 2.3 Layout that uses ladder diagrams
Source : Personal documentation

On the ladder language, there are two kinds of symbols that can be used is the ladder symbol and electrical symbols. On the ladder symbol contained 120 lines which can be used to program. Features that there is a timer, which is used to calculate the delay either on / off. The counter is used to count forward or backward. Analogue comparator and counter comparator is used to compare. Clock is used for valid time range during the process. Control relay is used as an internal relay. Input and output coil and also a comment field to make comments on each row.

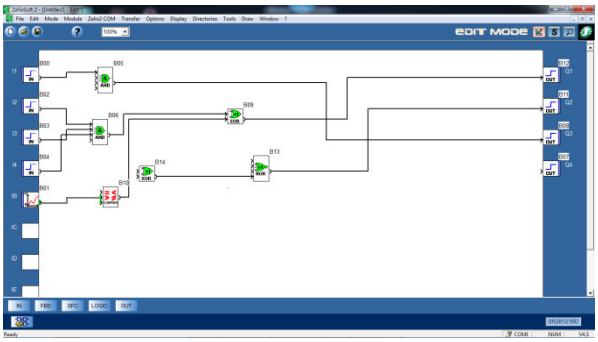


Figure 2.4 Layout that uses ladder diagrams
Source : Personal documentation

In addition, this software can also be used for simulation, monitoring, and supervision. In addition it can also upload and download programs. Can be made in the form of files. Compile the program automatically. There are also on-line help menu.

PROTOTYPE DESIGN TOOLS

Method Of Collecting Data

In this study found that some of the data used as material for making or designing control systems in the conditioning process suadah room of existing systems using a special device as a breaker and connecting systems and other support materials to the proposed use of the PLC as a more modern tool to perform automatically controls the process easier, saving and very popular. Stages to be taken are as follows:

1. Researchers conducted a phase observations of the temperature control system has been installed that is observed, recorded events and events that often occur in the system cooling process of the technical and non-technical systems, the study found a variety of technical problems that occur as the operation of all compressors, fans / blower is not rotating, the contactor is not working properly, the temperature is not reached, the cold air supply is unstable, motor overload, motor windings broken, damaged motor bearings, compressor and instrumentation damaged or defective measuring instrument caused by a wiring system that is not in accordance with the standards which exists. So found some cases that may result in the conditioning room can not be fulfilled to the fullest because the system does not work well due to a technical malfunction, for the non-technical problems occurred because at the time of power supply interruption occurs resulting in the system must be turned on manually, and other factors.
2. The second stage researchers documentation methods to materials and instrumentation used in the conventional control system which often result in damage to both technical and other components resulting in temperature is not reached. This stage in the form of a data specification tools, instrumentation, which are used as temperature sensors, contactors, motors, compressors and safety relays. Similarly, the identification of the material to be used props such as PLC, pushbutton, indicator light, temperature sensors, power supply 24 VDC, fans - fans who describe the actual process.

Research Methods

In the process of this research include the collection of data that is primary and secondary data so it can be more detailed subject review. Primary data collection process is done in the form of data collection on the case against the control system is installed using a special device in the process of cooling the room, which are as follows:

The use of control systems using a special device that is regin type TT S4 / D serves as a step to control the compressor, which works based on the time just after a given input of an analog signal, which is often found damage to the device or system that is used because it does not have reliability good.

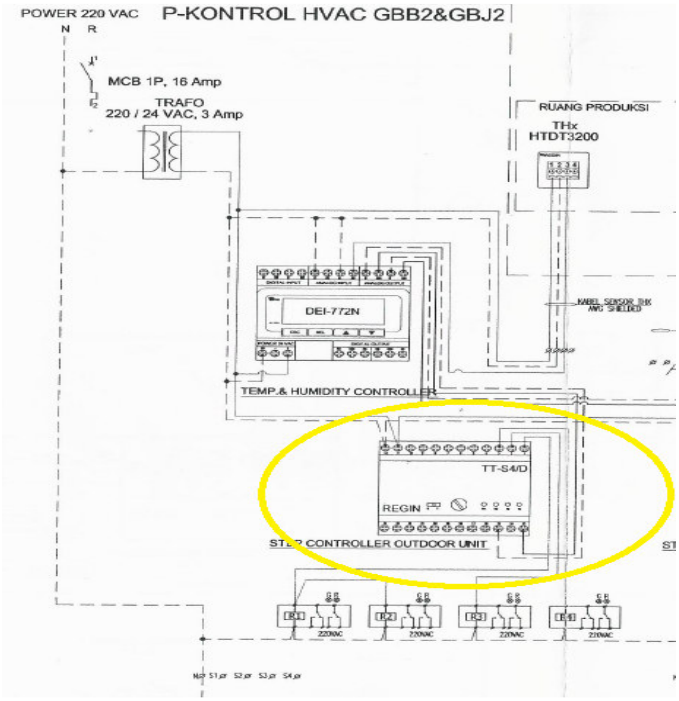


Figure 3.1 Wiring control Regin TT S4 / D
Source: Personal Documentation

The impact caused by the lack of reliability of these tools include the contactor is often damaged resulting in the compressor does not work. With these considerations, the necessary replacement or tools and instrumentation on the system more reliable and can support the system as well it works. The use of conventional control system is very difficult to carry out repairs in the event of damage to the control panel because it is difficult in mengidentfikasi cause damage, it is very disturbing air temperature in the area of process because if there is damage takes a long time to find the damage and repair.

Design Tools

To facilitate in making the props, the researchers did the stages of preparation from the beginning to the end in terms of determining the components that will be used so that in get optimal results, are as follows:

a. Making the PLC control panel, switches and indicators on acrylic board with ukuaran 30 cm x 20 cm
b. Making the actuator in the form of props with a size of 20 cm x 30 cm x 26 cm, and was given the 4 holes for the fan with a diameter of 8 inches
c. Making the module LM 35 as a temperature sensor 1 set, Wiring, Identification of Input-Output to the terminal
d. Programming temperature control system in a space

Making the Control Panel

In making this control panel aims to facilitate simulation of the conditioning process control room. process control is made using acrylic board with a size of 30 cm x 20 cm, containing hardware in the form of PLC Zelio Logic SR 121 SW 2B, indicator lights, and press the switch. all controls are processed through this control panel of the start signal is input, the process of executing the PLC into an output signal or output to the LCD display backlight until the indicator light. In assembling this panel controls required accuracy when viewing on the terminal control equipment, it is because a notation on the control equipment is very small and the coupling is usually only given a very small gap and narrow. To select a control apparatus things - things that must be considered are:

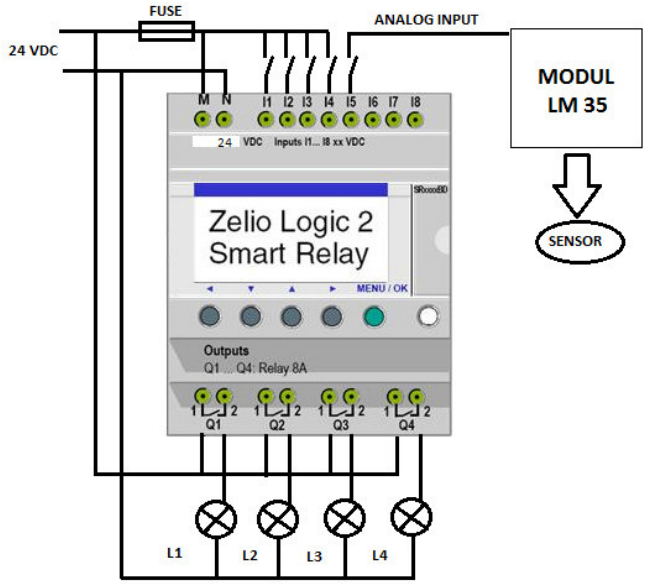
a. Function equipment

b. Equipment specifications

c. Prices and availability of market

Figure 3.2 Temperature Display Control Panel space
Source: Personal Documentation

Block diagram of a whole series of process control panel using four input of the switch, the module LM 35 as analog inputs, the control process carried out by the Zelio PLC logic, until the actuator in the form of a fan with 4 pieces.



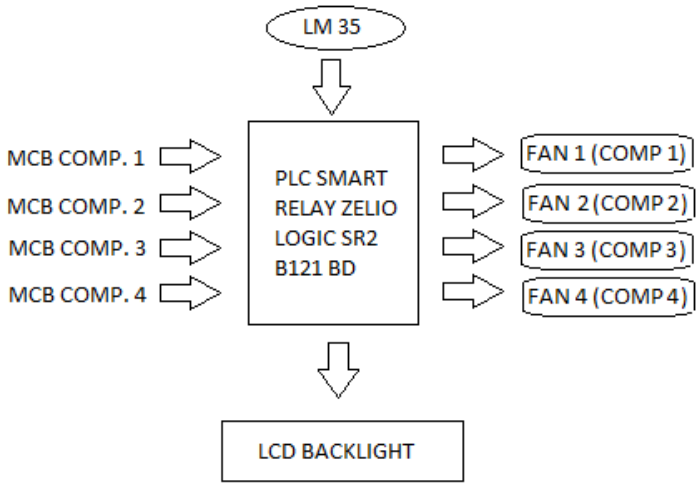


Figure 3.3 Block diagram of the entire system
Source: Personal Documentation

Making Viewer Tool Prototype room

Making props or actuator in the form of a room with a size of 20 cm x 30 cm x 26 cm is intended to mimic the actual conditions. provision of holes intended to be installed fan with 8-inch size, as if - if the compressor that works to cool a space, so that the room is used as its function. The following hardware actuators in the form of room and a cooling fan.

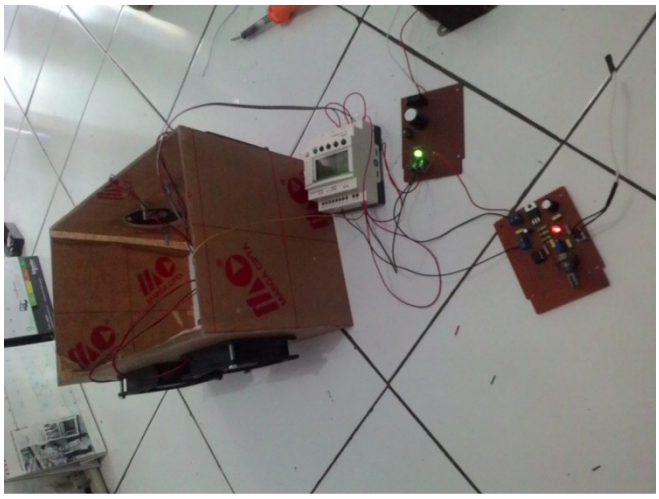


Image Viewer Tool or Actuators
Source: Personal Documentation

In making props conditioning process control room with PLC control, there are several tools and the main ingredients are prepared, namely Electrical Components and Components PLC. To facilitate the conduct of research in the simulation control room conditioning process is made a prototype or demonstration module engine control approaches that use acrilic actual control is equipped with a fan as well as a supporting device such as a push button on / off control, the indicator light for the fans, sensors, displays temperature, power supply 24VDC supply voltage, and props that describes the actual conditions. To facilitate understanding of the process of conditioning the room then made digaram flow describes in outline the process of conditioning the room by using the LM 35 and PLC module. Explained that the switch or mcb switched input signal to the PLC as process input fan, LM35 module serves as an analog input of temperature measured on a prototype space that has been created. when the room temperature is reached or equal to the predetermined temperature in the PLC program, the fan nothing is working, on the contrary, if the condition of the room changed at predetermined

temperature, the fan will work in stages according to the temperature rise that had been controlled by the PLC. At the current condition of the room has been reached then the fan will stop working in accordance with the temperature limit has been set.

Making Module LM35

In making this series aims to detect the temperature in the room, this module is designed to scale LM35DZ sensor output voltage that ranges from 0-1V be 0-10V. Thus it is suitable to interface with Zelio Logic smart relays and to improve the accuracy and precision temperature gauge, it is necessary to setup the optimal ADC reference voltage is used so that if you use an 8-bit ADC for example, the range 0-255 must represent value the minimum and maximum temperature can be measured by the temperature sensor circuit. Not to give a wrong reference voltage at the ADC circuit, so that the range of the ADC exceeds or is less than the input voltage range.

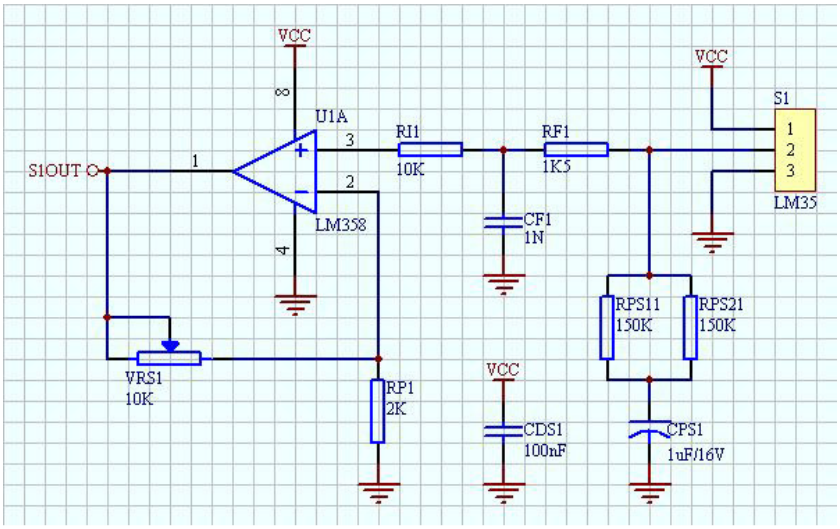


Figure 3.5 Module circuit LM35
Source: https: // Telinks / circuit-temperature-sensor-LM35 /

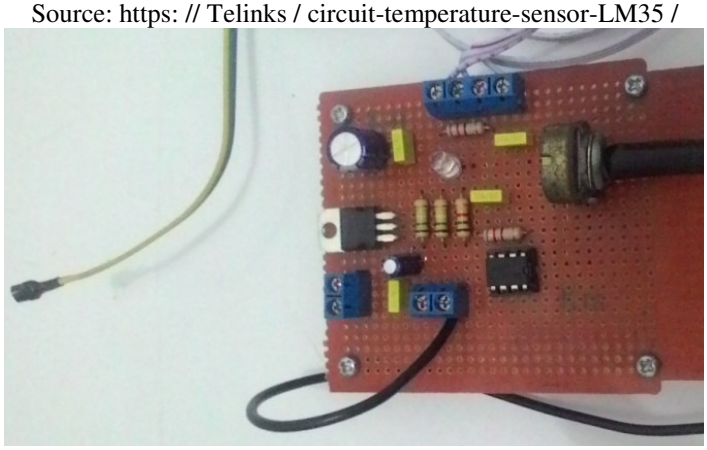


Figure 3.6: Hardware Module LM35
Source: Personal Documentation

Design of Smart Relays Zelio PLC Programming

Based on the temperature control process flow diagram of existing space and the number of I / O that has been identified then the making of the program can be done easily by outlining step by step into the PLC programming language Zelio Smart Relay from the beginning of the sensor to the cooling process. In planning the creation of this program used programming languages Ladder where this option is easy to understand and be understood, the following is the program design space temperature control.

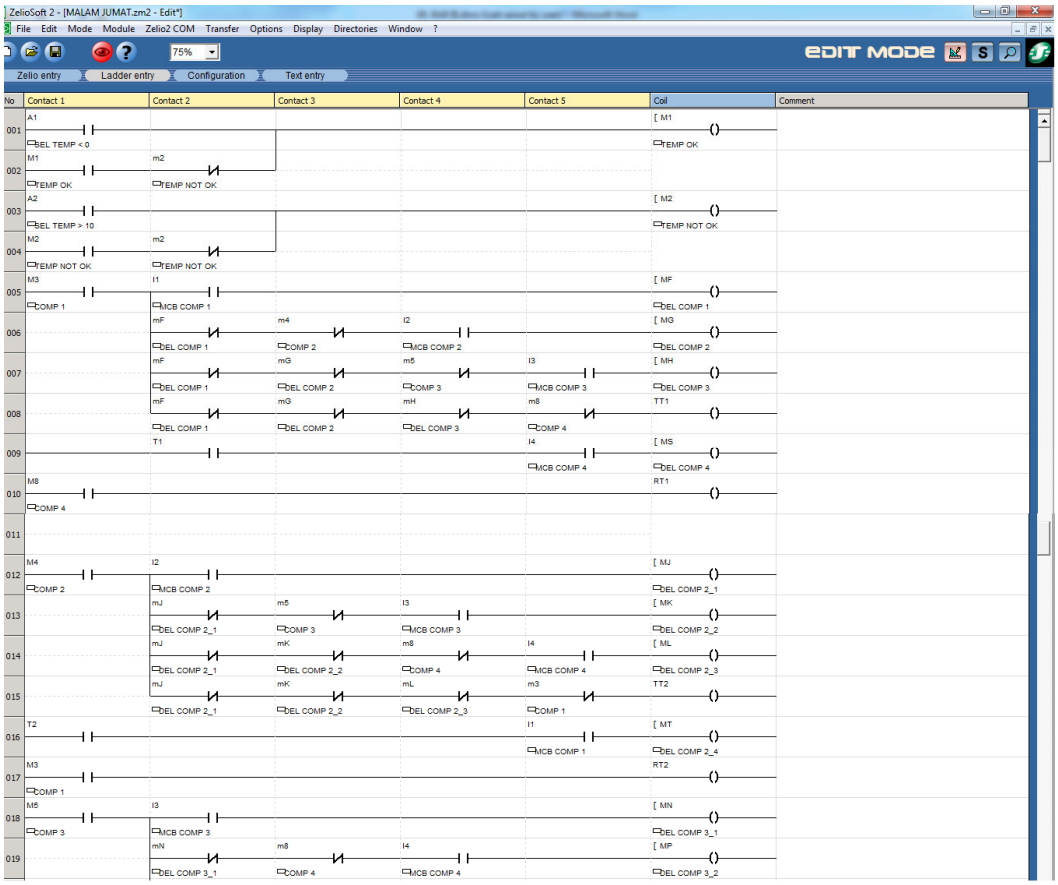


Figure 3.7 Ladder Program Control Room Temperature
Source: Personal Documentation

Physical inputs

No	Symbol	Function	Lock	Parameters	Location of (L/C)	Comment
I1		Discrete inputs	---	No parameters	(5/2) (16/5) (20/5) (25/4) (56/1)	MCB COMP 1
I2		Discrete inputs	---	No parameters	(6/4) (12/2) (22/5) (26/5) (63/1)	MCB COMP 2
I3		Discrete inputs	---	No parameters	(7/5) (13/4) (18/2) (28/5) (70/1)	MCB COMP 3
I4		Discrete inputs	---	No parameters	(9/5) (14/5) (19/4) (24/2) (77/1)	MCB COMP 4

Physical outputs

No	Symbol	Function	Latching	Location of (L/C)	Comment
Q1		Discrete outputs	No	(52/6) (63/5) (64/5) (65/5) (70/4) (71/4) (72/4) (77/3) (78/3) (79/3) (83/1) (84/1) (91/1) (92/1) (93/1) (94/1) (95/1) (96/1)	
Q2		Discrete outputs	No	(56/3) (57/3) (58/3) (59/6) (70/5) (71/5) (72/5) (77/4) (78/4) (79/4) (85/1) (86/1) (91/2) (92/2) (93/2) (94/2) (95/2) (96/2)	
Q3		Discrete outputs	No	(56/4) (57/4) (58/4) (63/3) (64/3) (65/3) (66/6) (77/5) (78/5) (79/5) (87/1) (88/1) (93/3) (94/3) (95/3) (96/3)	
Q4		Discrete outputs	No	(56/5) (57/5) (58/5) (63/4) (64/4) (65/4) (70/3) (71/3) (72/3) (73/6) (89/1) (90/1) (95/4) (96/4)	

Configurable functions

No	Symbol	Function	Lock	Latching	Parameters	Location of (L/C)	Comment
A1		Analog comparators	No	---	Ib < 0.0	(1/1)	SEL TEMP < 0
A2		Analog comparators	No	---	Ib > 2.1	(3/1)	SEL TEMP > 10
A3		Analog comparators	Yes	---	Ib > 2.4	(34/1)	SEL TEMP > 20
A4		Analog comparators	Yes	---	Ib < 2.3	(37/1) (38/2)	SEL TEP < 10
A5		Analog comparators	Yes	---	Ib > 2.6	(40/1)	SEL TEMP > 30
A6		Analog comparators	Yes	---	Ib < 2.5	(43/1) (44/2)	SEL TEMP < 20

Figure 3.8 Data Input and Output PLC
Source: Personal Documentation

Discussion control system design

The process flow diagram depicting an outline of the sequence of PLC as the scanning mode that is read or receive data from field devices via the input interface, execute programs stored in the memory system based on data received from field devices, and write or update the state of the output devices through output interface. Conditioning of the prototype room space is a condition where the temperature is controlled or regulated by PLC Zelio Logic SR2 B121BD and fan works as a cooling medium such rooms. The fan works in accordance with the ladder program that has been transferred to the PLC Zelio Logic SR2 B121BD. The control system works in which the PLC receives analog data from the sensor module LM35 form of voltage values ranging from 0-10 V

analog data is then converted into digital data in the ladder program and converts it into a temperature value range between 0-100 ° C. This value will vary the temperature of the working of the fan.

DISCUSSION AND ANALYSIS SYSTEM

Testing is useful to determine the reliability of the system or tool made from hardware to software. So that the desired results can be achieved with either. Tests performed with several stages ranging from the testing of the equipment used to test integration.

Testing Hardware and System Integrity

Testing Module Sensor LM35

In this test will be measured at the output of LM35 temperature sensor to any increase in temperature. In the measurement of the output voltage by an increase in temperature will eat obtained data will then be processed and proven its linearity level. Figure 4.1 shows the process of measuring the output voltage on the sensor LM35.

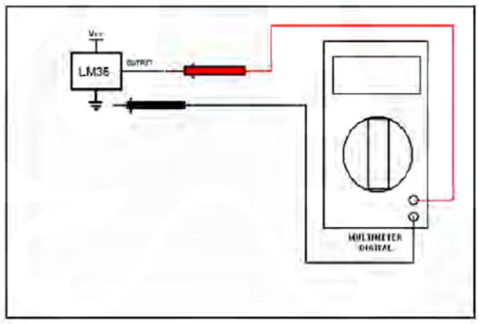


Figure 4.1 Block diagram of measurement LM35
Source: http://Flib.ui.ac.id/ R231083.pdf

LM35 temperature sensor is used to sense the temperature function with 0-100ºC range. Based on preliminary data from component specifications, the LM35 will produce an output voltage of 0-1000mV. It is known from the specification of components which states that the voltage rise every 1º temperature rise will cause an increase in voltage of 10 mV.

VLM35 = temperatur X 10 mV .....(4.1)

Measurements were made for a range of 20ºC - 50ºC because the range covers the working temperature range in a normal room commonly used. Figure 4.2 shows a graph of the results of measurements on the sensor output voltage of the voltage changes measured at thermocontrol.

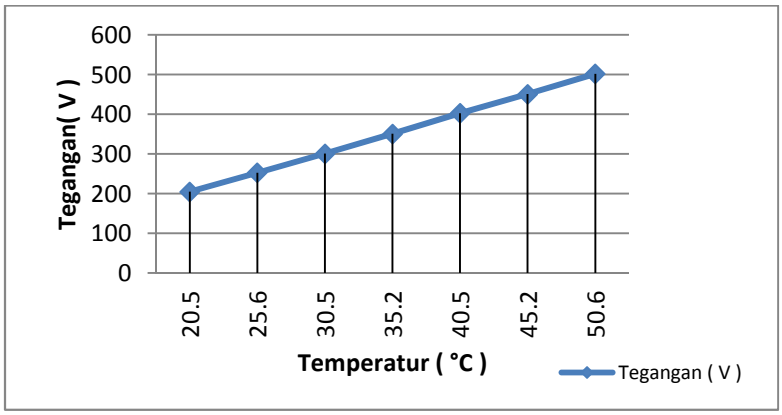


Figure 4.2 Graph of output voltage change with temperature
Source: Personal Documentation

The data is then graphed comparison between the temperature of the output voltage. Graph 4.2 obtained from the equation that has a gradient of 9.43, proving that every increase in temperature by 1 ° C voltage value increased by 9,43mV (9,43mV / ° C). These results are almost in line with the values characteristic of the sensor LM35 that any increase in temperature by 1 ° C, the voltage value will increase by 10mV (10mV/ ° C).

The amplifier circuit

In testing the data obtained LM35 sensor output voltage is then connected to the amplifier subsystem. The use of the amplifier circuit LM35 sensor because the sensor output is in the range 0-500mV, while the LM358 input has a range of 3-32V. In the amplifier system, large incoming voltage to be amplified sebasar 10 times, it is that the range of the sensor output voltage can be adjusted with the input voltage range of Zelio PLC logic. Here are the results of measurements on the amplifier using IC LM 358 is shown in Table 4.2.

Table 4.2 Data Measurement Results Upholstery In LM35

No.	Temperatur (°C) pada Thermocontrol	Tegangan Output sensor LM 35 (mV)	Tegangan Output Penguat (mV)
1	20.5	205	2000
2	25.6	253	2500
3	30.5	301	3000
4	35.2	351	3500
5	40.5	403	4000
6	45.2	451	4500
7	50.6	502	5000

From the data presented above, in accordance with the formula amplifier circuit op-amp non-inverting input of this amplifier has made through the non-inverting input. Thus the output voltage will be the phase with the input voltage.

Figure 4.3 amplifier circuit Op-Amp Non-Inverting
Source: http: //non-inverting-amplifier.html

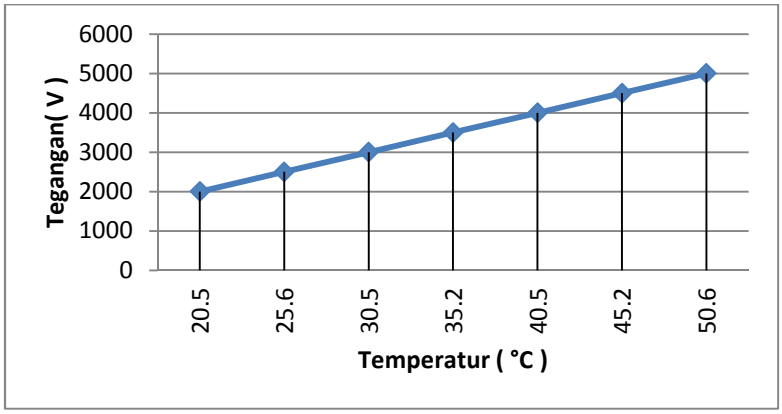


Figure 4.4 Graph of IC LM358 amplifier measurement
Source: Personal Documentation

Figure 4.4 shows a graph of the characteristics of the measurement result of the strengthening of the sensor LM35 series with 10 times the strengthening of the temperature measured at termocontrol.

Testing Control Systems

System testing is done to determine whether the system can work well. This test refers to the temperature setting on the prototype chamber with a temperature range of 25 ° C - 40 ° C. To keep the room temperature to match the chill.

1. At temperatures> 26 ° C Module LM35 will provide input voltage of 2600 mV or 2.6 V input to the PLC as an analog signal which has been set on the ladder program in the PLC output will work (Fan 1 ON).
2.

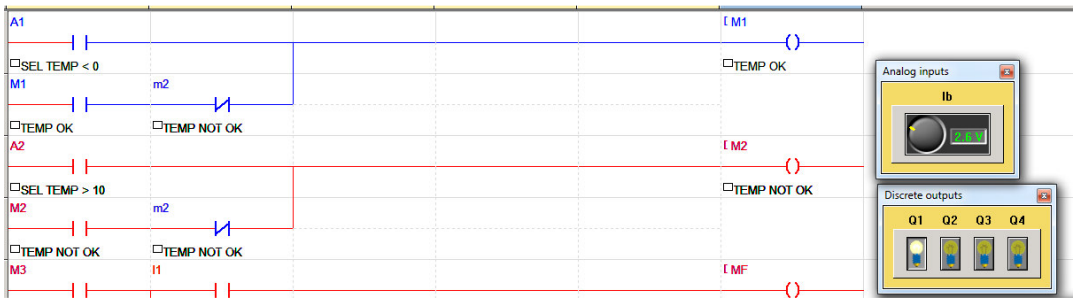


Figure 4.5 Simulation of Analog Signal Input & Output 1 ON
Source: Personal Documentation

3. At temperatures> 28 ° C Module LM35 will provide input voltage of 2800 mV or 2.8 V input to the PLC as an analog signal which has been set on the ladder program in the PLC output will work (Fan 1 & 2 ON).

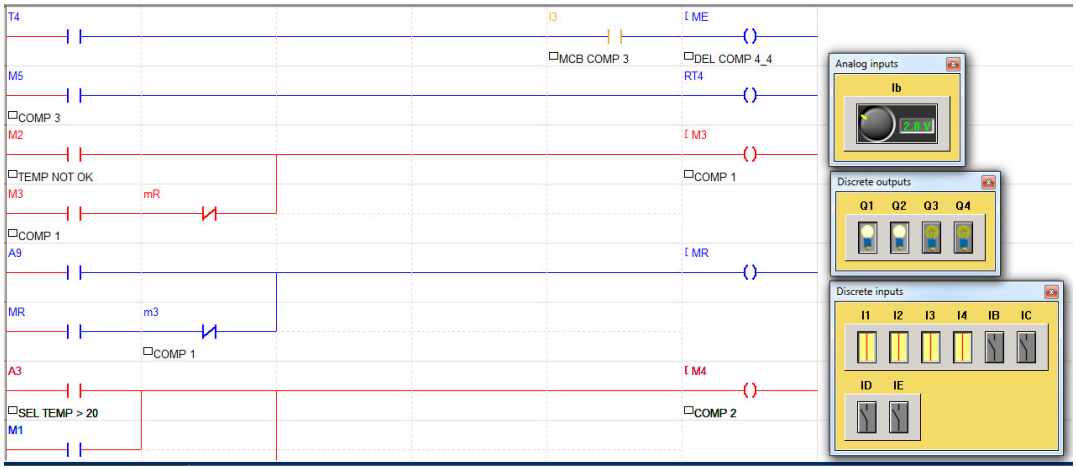


Figure 4.6 Simulation of Analog Signal Input & Output 1, 2 ON
Source: Personal Documentation

4. At temperatures> 30 ° C Module LM35 will provide input voltage of 3000 mV or 3.0 V input to the PLC as an analog signal which has been set on the ladder program in the PLC output will work (Fan 1, 2 & 3 ON)

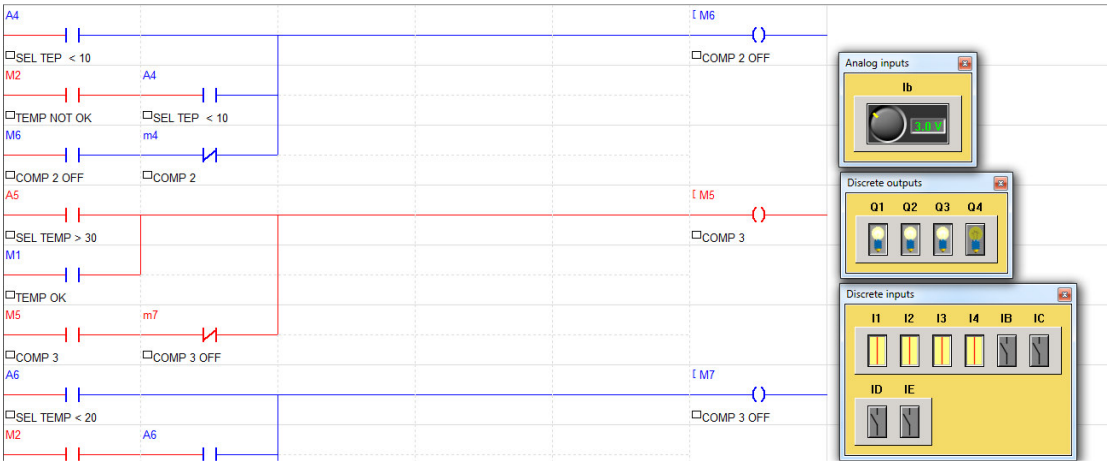


Figure 4.7 Simulation of Analog Signal Input & Output 1, 2 & 3 ON
Source: Personal Documentation

4. At temperatures> 32 ° C Module LM35 will provide input voltage of 3200 mV or 3.2 V input to the PLC as an analog signal which has been set on the ladder program in the PLC output will work (Fan 1, 2, 3 & 4 ON).

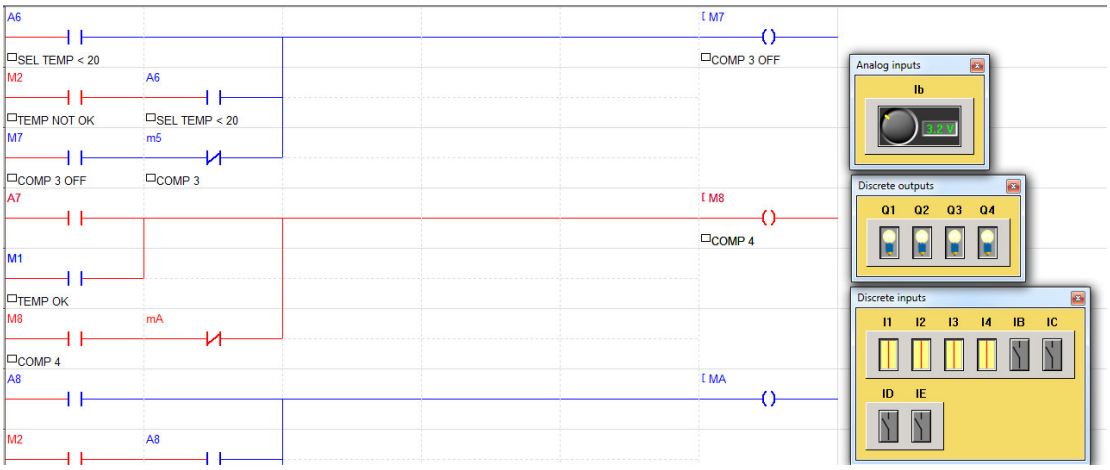


Figure 4.8 Simulation of Analog Signal Input & Output 1, 2, 3 & 4 ON
Source: Personal Documentation

Based on the above simulation systems or programs designed in accordance with the design. The temperature control is a condition where the temperature in the room is controlled using Zelio PLC logic and fans as a cooling medium. In the process works Zelio Logic PLC receives analog data from the LM35 temperature sensor module in the form of voltage values ranging from 0 to 10 Volts. Analog data is then converted into digital data in the ladder program and convert be a range of values of temperature between 0-100 ° C. This value will vary the temperature of the working of the fan. In Table 4.3 described the working process of the fan as a cooling medium temperature based on those received by the sensor. From the above table it can be seen that, the fan will operate at temperatures> 26 ° C, the fan 1 will work and at any temperature rise of 2 ° C, the fan will be activated according to the program are made. The fan will stop when the temperature decrease of 1 ° C of temperature increase has been set. This system was designed to prevent the flame die on the fan that will cause the fan or other control equipment quickly broken. In tests on a prototype tool room temperature controller using Zelio SR2 B121 BD and LM35 temperature sensor module, the testing process using additional heating assistance in the form of a 100 watt light bulb and thermocontrol as an indicator of the room temperature. LM35 temperature sensor module is placed on the prototypes for detecting the temperature of the room in it. Then the heater is turned on and placed in the room prototypes that will lead to an increase in temperature slowly. Climate change will make the sensor work and send the data to the Zelio SR2 B121 BD. The fan will be activated in sequence according to the ladder program and by the increase in temperature in the room prototypes. Any increase in temperature occur and turn on the fan, showing a temperature control device testing on prototypes room using Zelio SR2 B121 BD and LM35 temperature sensor module.

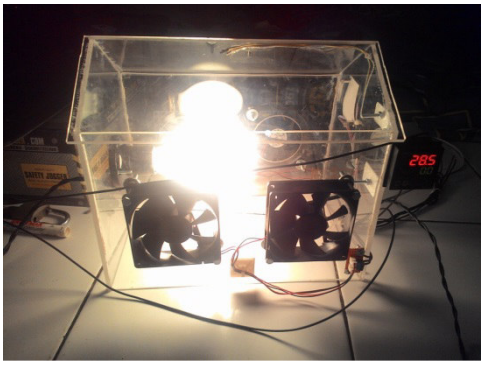


Figure 4.9 Testing Process Temperature Control System in Prototype
Source: Personal Documentation

Conclusion

Based on the analysis and discussion related to the prototypes of the room
temperature control using Zelio SR2 B121 BD can be concluded that:

1. The test equipment using Zelio SR2 B121 BD and LM35 temperature sensor module has been successfully created and can control the temperature in the room with a good prototype.
2. Achievement of the desired temperature of 25 ° C is influenced by the amount of fans that work and the resulting room temperature heating. When the room temperature reaches 32 ° C fan 1, 2, 3 and 4 live everything,

then the fan 4 will die if the temperature of the room is already a 31 ° C and followed by death of fan 3 if the room temperature has reached 29 ° C to 27 ° C 2 dead fan, and the fan 1 dead at 25 ° C.

3. The control system is equipped with a delegate or representative program that is when one fan is damaged or the switch is turned off, then the fan directly to the fan switch being off and the fan still can cool the room.

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