Wireless Communication Design with Omron Type CP1L-E Programmable Logic Control Using TPI-Link WA901ND Access Point

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Abstract. Programmable Logic Controller is electronic equipment that operates digitally, which uses programmable memory to store internally for specific function instructions. In the process of transmitting PLC data, it still uses cables or cannot use wireless because the PLC itself does not have wireless. To increase the effectiveness in the use of PLC, wireless communication is designed on PLC using tp-link wa901nd access point. Wireless communication on this PLC is a tool that utilizes the tp-link wa901nd access point as a wireless transmission medium, using modscan64 software as an output controller this tool is also equipped with 3 outputs, namely lights, fans, and irons that can be controlled remotely. In an open space, wireless communication can be carried out and can still control the output at a distance of 100 meters with the number of packets sent when wireless communication is connected is 3 packets/s and when the output is turned on the packets sent increase to 6 to 8 packets/s. In a closed room, wireless communication can be effectively carried out at a distance of 35 meters because at a distance of 40 meters communication cannot be done.

Keywords: PLC Omron; Access Point; Wireless Communication; CX One; Modscan64

1 Introduction

Programmable Logic Controller is a controller device based on logic circuit functions, but in its development in line with industrial needs, PLCs have more functions and applications than logic circuits. PLC is a digitally operated electronic device, which uses programmable memory to store internal instructions for specific functions such as logic, sequencing, timing, counting and arithmetic to control digitally or analog inputs or outputs as a type of machine. In the data transmission process, PLCs still use cables or cannot use wireless because PLCs themselves do not have wireless features and if these features are sold in separate extensions, the price will be very expensive[1][2][3]. An access point is a device in a computer network that can create a wireless local network or Wireless Local Area Network. The access point will be connected to a router or hub or switch via an Ethernet cable and transmit a WiFi signal in a certain area. To be able to connect to the local network that has been configured, the device must go through an access point. Wireless communication for PLCs can be done with an access point but with an ideal distance range of 80 meters. In this tool there are 3 outputs with different voltages, namely 24 VDC lights, fans, 220 VAC irons which must be

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converted from PLC DC output to AC input to turn it on. For output results that can turn off and turn on automatically using this tool program designed on the CX-One must be for 3 outputs, so that the commanded functions will work properly.

Wireless communication can work well within a range of 100 meters for open spaces and 35 meters for closed spaces. From the throughput measurement results, it was found that the throughput for wireless communication from a measuring distance of 5 – 100 meters was categorized as very good with the smallest throughput of 463 bit/s and the largest of 607 bit/s. Jitter for wireless communication on PLC has very good results at several measuring distances but at certain measuring distances it is categorized as bad. Wireless communication for PLCs has low packet loss and is categorized as very good with the highest packet loss percentage of 8%.

2 Method

In designing a wireless communication, there must be steps that must be carefully considered in order to achieve what is expected and in accordance with the initial design. Bef ore making wireless communications, there must be a design, literature study and collection of the necessary data, then start making. The aim of this design is to obtain a circuit that is appropriate and works well by considering the characteristics of the components used. The circuit block diagram is one of the most important parts in designing a device. From the block diagram, you can understand the working principle of the entire circuit. So that the entire block circuit diagram will produce a system that can function according to the working principles of the design of a device.

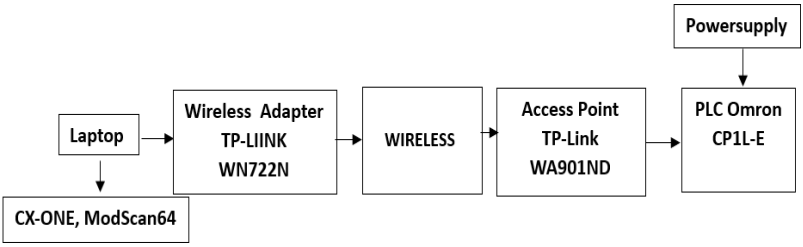

Fig.1. Blok Diagram Wireless Communication Design with Omron Type CP1L-E Programmable Logic Control Using TP-Link WA901ND Access Point

From the block diagram above, several functions of each tool component can be described; A laptop with Modscan64 is used as a medium for the server to request data to the PLC and also displays information on the data received, ;The TP-LINK WN722N wireless adapter here is used as a WiFi adapter for laptops and is also used to make the wireless connection more stable, ; The TP-link WA901N access point functions as a wireless data transmission medium for PLCs because PLCs themselves do not yet have a wireless system, ; Program Logic Control (PLC) is used as the final component which will later send data to the PC and will be displayed via modscan 64, ; Power Supply is used as main voltage source for PLC.

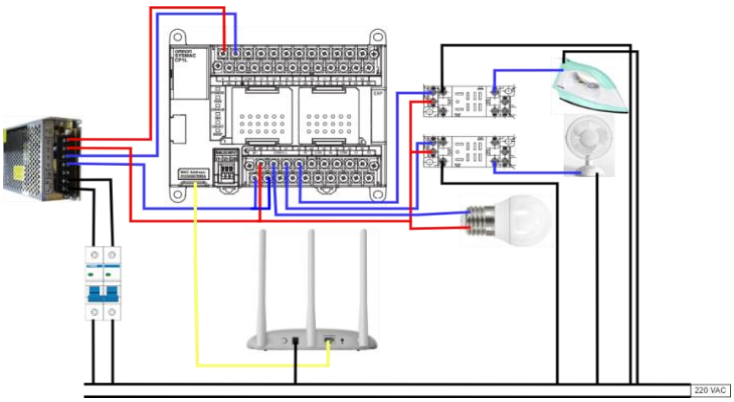

Fig.2. Wireless Communication Design with Omron Type CP1L-E Programmable Logic Control Using TAPI-Link WA901ND Access Point

The working principle of wireless communication on a PLC using the TP-LINK WA901ND access point starts with a PC that has Modscan64 software installed which makes a Modbus data request to the PLC via the TL-WN722N wireless adapter which is connected wirelessly to the TP-WA901ND access point, as a response the PLC will sending Modbus TCP data, the data will be transmitted via wireless to the TP-WA901ND access point which will be received by the laptop and the data will be displayed on the ModScan 64 software. The program used in the Omron PLC is made into a CX-One applied circuit, where the circuit functions to activate the output, so that the output is live and can be loaded on the output, then to test the program that has been created, simulation from CX-Designer is used so that the program created correct and running according to its function.

3 Result and Discussion

In this results section, we will first explain the results and discuss the results of research and testing to make it easier to explain when collecting data; The tool testing stage is useful for obtaining significant data regarding the tool being made. Testing is carried out to find out whether wireless communication on the PLC can be carried out by seeing whether the output can still be turned on at a certain distance and also to find out the quality of wireless communication on the PLC in accordance with QoS standards. Testing is carried out using the Wireshark application to observe the parameters to be measured, measurements are carried out at several predetermined distances. Then, from the test results, analysis can be carried out based on the results of the tool's work. This test was carried out to test the successful connection of the CX-Programmer application to the Omron PLC used.

In carrying out this test, activate the electricity flow on the hardware that has been arranged and connect the application connection to the designed hardware device. Henceforth, the results of the hardware device's response to the successful connection status can be seen in CX-Programmer below.

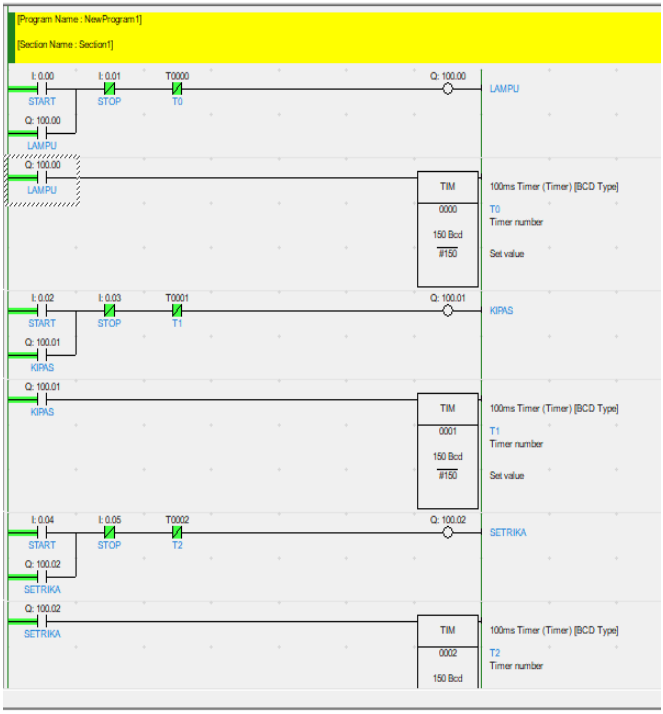

Fig.3. CX-Programmer Application Connection on Omron PLC Hardware

Omron PLC, this simulation is made with the aim that the response from the program to the output can run according to its function, this simulation can be monitored simultaneously from the CX-Designer and CX-Programmer so that results are obtained and function as designed. For this simulation, the only output that lights up is the program, not the Omron PLC. It can be seen from the following image data:

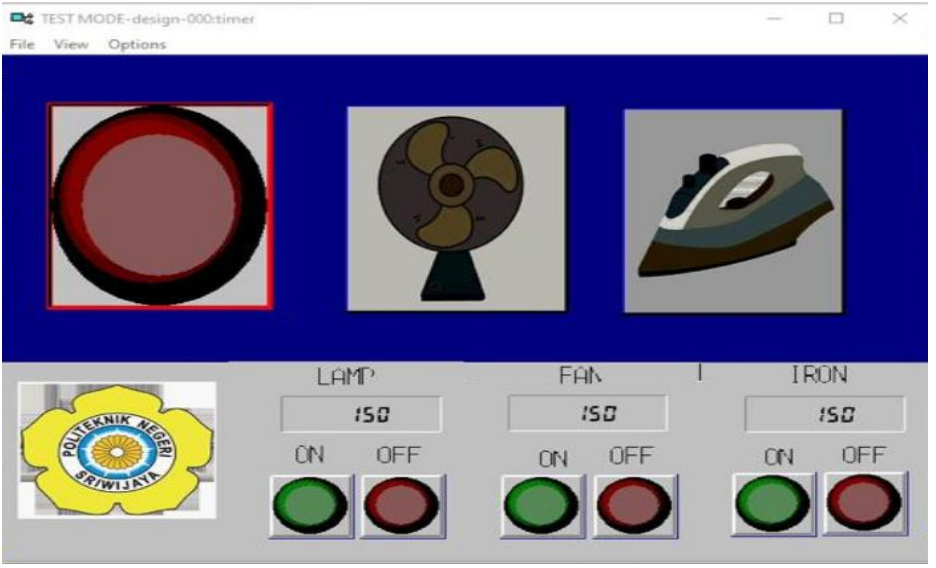

Fig.4. CX-Designer simulation

This simulation can be run by pressing the on button, where the on button itself is connected to normally open, so you can see the light is on and the timer is doing its calculations, which means the program is successful and running as designed.

Furthermore, by using Wireshark, parameters can be measured to determine the quality of wireless communication on the PLC according to QOS. Testing and measurements for open spaces are carried out on Jalan Kikim III with the distance to be measured being 5-100 meters. Meanwhile, testing and measurements in closed rooms are carried out in the Electrical Engineering laboratory of the Sriwijaya State Polytechnic.

Table 1. Result for Throughput data

Distance (M)	Throughput (Bits/s)	Information
10	522	Very good
20	607	Very good
50	607	Very good
70	607	Very good
100	529	Very good

Table 1 is a throughput measurement using wireshark. Where the results obtained from measuring a distance of 5 meters to 100 meters throughput are still categorized as very good. Jitter measurement is carried out using the Wireshark application and aims to see the delay variation in network data transmission. For more complete jitter measurement data, it can be seen in table 2 as follows. Table 2 is the result of jitter

measurements on wireless communication using wireshark where the number of packets processed is 25. The results of the measurements are categorized as bad at several measurement distances. This happens at a distance when the measurement experiences an RTO or request time out which affects the results of the jitter calculation.

Table 2. Result for Jitter data

Distance (M)	Jitter (ms)	Information
10	169,5457	Bad
20	0,01322	Very good
50	0,581391	Very good
70	0,261174	Very good
100	154,9627	Bad

Table 3. Result for wireless capabilities in sending packets

Distance (M)	Packet loss	Presentation (%)	Information
10	1	4	Good
20	0	0	Very good
50	0	0	Very good
70	0	0	Very good
100	1	4	Good

From the measurement results, it can be seen from table 3 that wireless capabilities in sending packets are categorized as good, with the highest number of packet loss, namely 2 with a percentage of 8% occurring at a distance of 10 meters and 95 meters. However, even though it is fairly good, the existence of packet loss affects the results of jitter calculations which makes jitter categorized as bad.

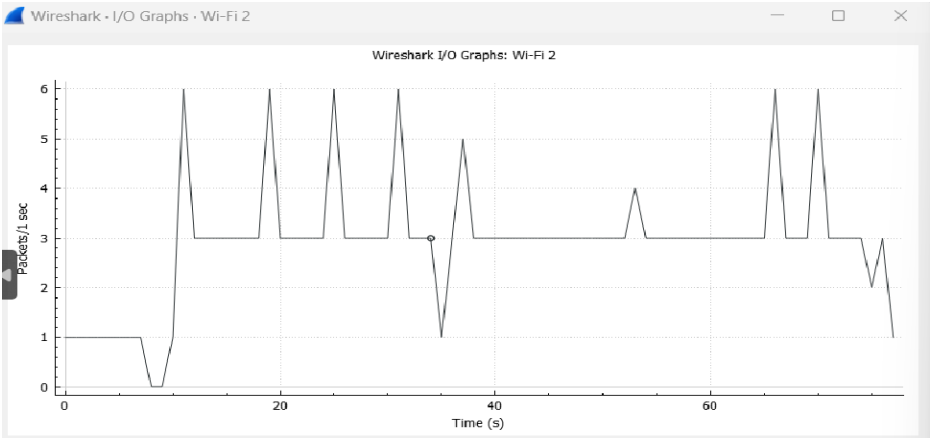

Fig.5. Result for open space distance of 100 m

Testing of the tool in a closed room was carried out in the electrical laboratory of the Sriwijaya State Polytechnic, with the aim of knowing whether the tool worked properly when in a closed room.

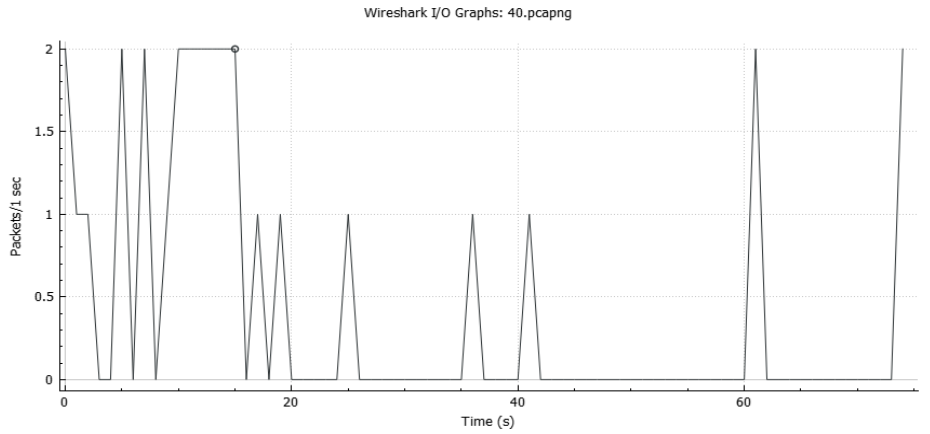

Fig.6. Result for closed space distance of 45 m

The testing tool in a closed space, it can be seen that the results obtained are different from testing in an open space where for this closed space the tool can function well only up to a distance of 35 meters.

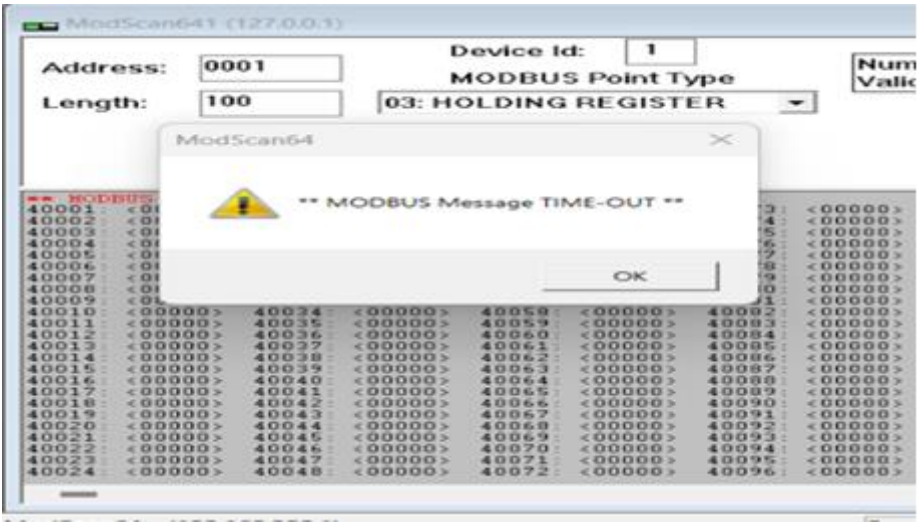

Fig.7. Modscan state at distance of 40 m

In the tests and simulations that have been carried out, the tools that have been designed are in accordance with the program and run according to the functions of the program made. The tool will work if the voltage from the mains enters the power supply of 24 VDC and is ready to run, then after starting, before running the program, make sure the Omron PLC is on and the PC is connected to a wireless communication network or TP-Link, after it is connected, the device and output ready to run or use according to the function of the program.

Based on testing the output and the timer through simulation, what is produced is normally open giving input or being in position number 1 then the input will automatically run and normally closed will close so that the input reaches the output then normally open will also provide input to the timer so that the timer does the calculation , and will turn off automatically if the timer stops doing calculations. And if the simulation has successfully executed the command, then the tool will be able to execute the output command without any errors in the command and function.

Based on the QoS standard for each parameter, the throughput for wireless communication on PLCs at a measuring distance of 5 – 100 meters is included in the good category with the highest throughput of 607 bit/s. The results of jitter calculations are very different from throughput where jitter experiences very good results at some distances but poor at other distances, this is because at the time of measurement packet loss occurs at several measuring distances which causes the results of jitter calculations to be categorized as bad. The results of the packet loss measurement are categorized as good because there are not many lost packets during the measurement, the highest packet loss is at a measuring distance of 15 and 95 meters where the lost packets amount to 2 out of 25 packets sent with a percentage of 8%. In testing and collecting wireless communication data on PLCs in open and closed spaces, the results are obtained, for open spaces wireless communication can still be carried out and can still control output using modscan up to a distance of 100 meters. From the data obtained for open space when wireless communication is connected, the number of packets sent is 3 packets/s,

but when the value in modscan is changed to turn on the output, the data sent increases to 6 to 8 packets/s with an average delivery time of 1s .

4 Conclusion

In this tool there are 3 outputs with different voltages, namely a 24 VDC lamp, a fan, a 220 VAC iron which must be converted from the PLC DC output to AC input to turn it on. For output results that can be turned off and on automatically, use this program. What is designed on the CX-One must be for all 3 outputs, so that the commanded function will run well.

Wireless communication can work well within a distance of 100 meters for open spaces and 35 meters for closed spaces. From the throughput measurement results, it was found that the throughput for wireless communications from a measuring distance of 5 - 100 meters was categorized as very good with the smallest throughput being 463 bit/s and the largest being 607 bit/s. Jitter for wireless communication on PLCs has very good results at some measuring distances but at certain measuring distances it is categorized as bad. Wireless communication for PLCs has low packet loss and is categorized as very good with the highest packet loss percentage, namely 8%.

In open spaces, wireless communication on the PLC can be carried out up to a distance of 100 meters with the average number of data packets sent when the communication is connected is 3 and when the value in modscan is changed to activate the output the average number of packets sent is 6

In closed spaces, wireless communication can be carried out up to a distance of 35 meters because at 40 meters the Modbus communication experiences a timeout, which means the PC tries to send data to the PLC but does not get a response from the PLC so communication cannot be carried out.

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