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Automatic Continuity Test Machine (CT) Using Proximity Sensors, Photoelectric Sensors and Programmable Logic Controllers (PLC) Systems: The case at PT. "V" Batam Indonesia

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Abstrak

Continuity test Machine (CT) merupakan alat pendeteksi kerusakan sambungan arus pada AC *plug* kabel. Permasalahan pada PT "V" adalah masih mengunakan sistem manual. Sehingga diperbaharuilah menjadi *continuity test machine* (CT) otomatis menggunakan sensor *proximity, photoelectrik* sebagai pendeteksi panjang pin *connector* dan sistem *Programmable Logic Control* (PLC) sebagai pengendali. Pengujian keakuratan alat menggunakan 12 sampel *plug* dan *connector* dengan cara pengukuran manual menggunakan "caliper" dan satu lagi menggunakan *continuity test machine* (CT) otomatis. Hasil yang diperoleh sama yaitu 10 sampel *plug* dan *connector* yang standar (19.05 +_0.2 mm) dan 2 tidak standar. Pengujian performa alat dilakukan beroperasi selama 184 jam atau 23 hari kerja. Hasil analisis data ditemukan peningkatan yang signifikan yaitu rata-rata sebesar 25,94% dari total hasil tes yang digunakan oleh C*ontinuity test machine* (CT) manual. Secara total mampu meningkatkan rata-rata 970 unit produk setiap bulannya, dengan rincian mengurangi sebesar -20,03% produk yang rijek, meningkatkan sebesar 26,74% produk yang bagus.

Kata kunci: Mesin *Continuity Test(CT)*, Sensor *proximity, Programmable Logic Control* (PLC)

Abstract

A Continuity test Machine (CT) is a tool for detecting damage to the current connection on the AC plug cable. The problem with PT "V" is that it still uses a manual system. So that it is updated to an automatic continuity test machine by manual measurement using a "caliper" and another using an automatic continuity test machine (CT). The results obtained (CT) using a proximity sensor, photoelectric as a detector for the length of the pin connector and a Programmable Logic Control (PLC) system as a controller. Testing the tool's accuracy using 12 plug and connector samples was the same: ten plug and connector samples were standard (19.05 +_0.2 mm) and two places were not standard. Tool performance testing is carried out operating for 184 hours or 23 working days. The results of data analysis found a significant increase, namely an average of 25.94% of the total test results used by the manual Continuity test machine (CT). Totally capable of increasing an average of 970 product units per month, with details reducing by -20.03% good products, rising by 26.74% good products.

Keywords: *Continuity test Machine (CT)*, *Proximity Sensor, Programmable Logic Control* (PLC)

1. INTRODUCTION

In an increasingly developing and modern manufacturing industry, human labor is no longer the main source of finishing industrial products[1][2]. By using an automation system and with a high level of reliability and productivity, this system is able to save costs and increase profits[3]. The ability of automation technology in the Cable Manufacturing Industry is already abundant and has become a priority competitiveness in the global scope[4].

The development of world technology is quite rapid, so that various electronics companies release products with various technological innovations and good quality[5]. Likewise with technological developments in the cable industry (harness)[6][7]. So that spurred electronics companies to make machines that can track in more detail and quickly on product damage during the process of making connection cables[8]. The goal is to achieve targets that are in accordance with consumer demand with global quality.

PT V is one of the industries engaged in cable wiring, so it is certain that it has the tools to produce and test connectors or cable connections. Therefore, several series of machine technologies are needed that are more practical, faster and more accurate[9][10]. Previously, the tools that were owned using switch buttons still used a manual system by relying on operator performance that was more thorough and fast.

In the use of automated technology, human operators must be minimized or even not used anymore[11]. Everything has to use an automatic machine both from the beginning to the end of the packing. However, it is possible to have to spend quite a lot of money to make a fully automatic tool[12][13]. Therefore, to overcome and provide solutions in the manufacture of automated tools, an automatic continuity test machine (CT) tool was designed using a more practical and profitable Programmable Logic Controllers (PLC) system.

2. METODE

The method in this study was carried out by following the flowchart for making the following continuity test machine (CT).

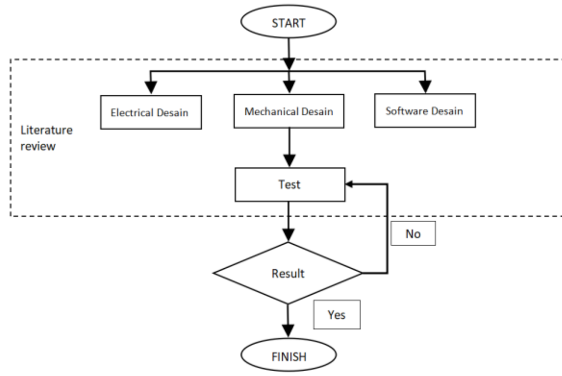

Figure 1: Flowchart Creating a Continuity Test Machine (CT)

2.1 Design Tool

The design of this tool can be divided into three parts, the following are the parts of the tool design.

2.1.1 System Planning of *Continuity Test Machine* (CT)

The system works starting from the plug or connector that is tested and inserted into the plug hole then detected from the Proximity Sensor forwarded to the Ormon Sensor and then processed by the NAIS PLC[14][15]. If a connection damage is detected on the cable, the NAIS PLC will give an order to the Buzzer and the red indicator light will light up. Meanwhile, if the cable is connected and the pin or terminal matches the specified distance, then the NAIS PLC will give an order to the Selenoid valve to give a dot mark on the plug, the Buzzer and the green indicator light will light up.

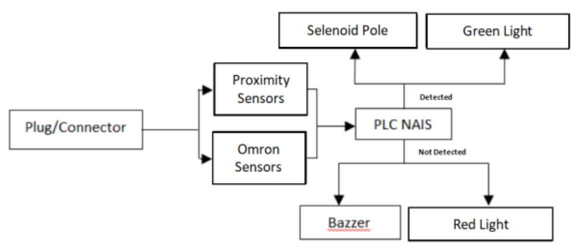

Figure 2: Work System Block Diagram *Continuity Test Machine* (CT)

In this continuity test machine (CT) series it uses a buzzer and 3 lights namely yellow (process), red (not detected), and green (detected). The process carried out in the NAIS PLC determines whether plugs and connectors are detected or not detected so that each sensor works according to the program in the NAIS PLC.

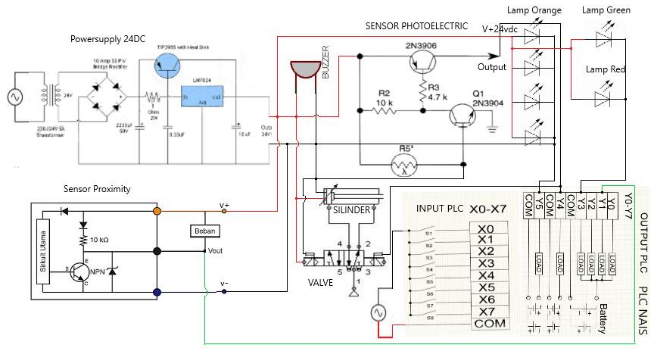

Figure 3: Wiring Diagram C*ontinuity Test Machine* (CT)

2.1.2 Mechanical Design *Continuity Test Machine* (CT)

In the design of the mechanical continuity test machine (CT) it is made of carbon material which is then galvanized and painted to avoid corrosion and does not conduct electricity. With a size that has been designed according to the specifications of the working system of the tool. There are four types of image designs, namely 3D, top view, left and right side.

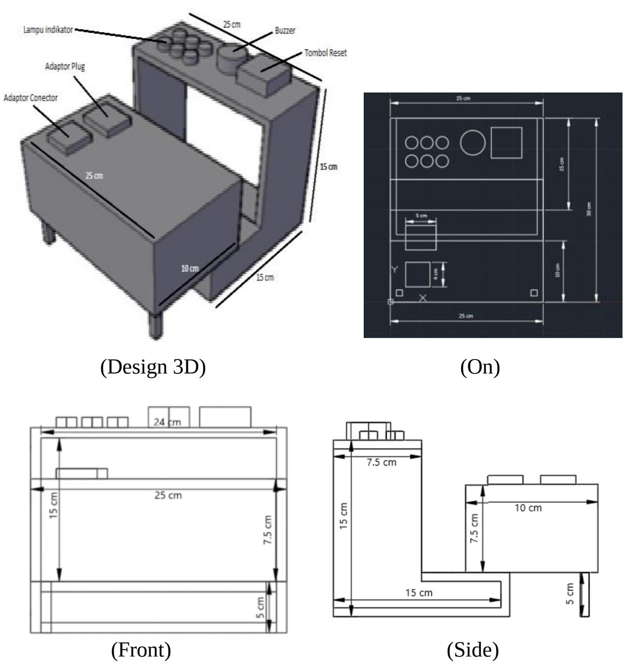

Figure 4: Design Mechanical C*ontinuity test machine* (CT)

2.1.3 Perancangan Software *continuity test machine* (CT)

In software design, proximity and omron sensors use software programmed by NAIS PLC. The software used in the NAIS PLC program has been designed according to the needs as shown in the following flowchart.

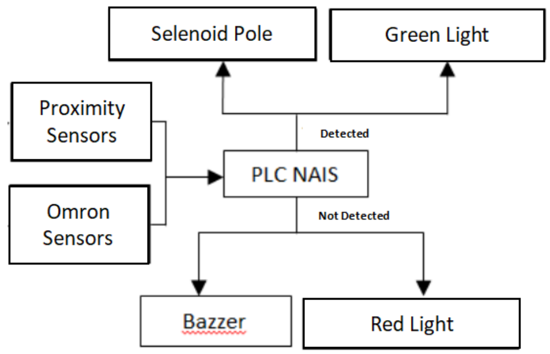

Figure 5: Desain Mechanical C*ontinuity test machine* (CT)

Starting from the plug and connector are inserted into the adapter (where the plug and connector enter) then two processes occur here, namely first the proximity sensor reads the distance of the pin or short terminal. The second process is to detect the connection on the cable. Then it is processed by the PLC with the command that if a short pin or short terminal is detected, the PLC gives a command to the Buzzer and the red indicator light lights up as long as the reset button has not been turned off. Meanwhile, if the distance on the pin or terminal matches the distance that has been set, the PLC will give an order to the solenoid to open the air faucet so that the cylinder gives a point (small hole) to the plug and the buzzer and green indicator light will light up for 1 second. The following is the software programming process in PLC.

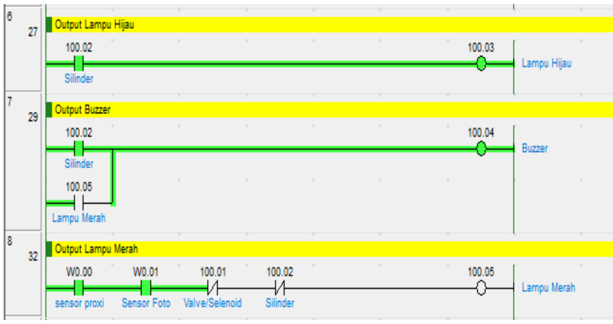

Figure 6: Software programming process in PLC

3. RESULTS AND DISCUSSION

After assembling and programming the PLC, a Continuity test machine (CT) tool is produced as shown below.

Figure 7: Completed C*ontinuity Test Machine* (CT)

Operating System Continuity test machine (CT) :

1. Connect the 220 volt AC Current and Voltage sources
2. The Reset Key Position is in the ON Position
3. Insert the plug and connector into the proximity sensor and photoelectric holes
4. If the Orange LED lights up completely and the Green Light turns on then the Buzzer sounds (1 second) then the Plug and Connector are declared "Good"
5. The cylinder will function to push the Plug and Connector up as a sign that the test is complete
6. If the Orange LED lights only 1 or 2 or even not at all and the Red Lamp lights up then the Buzzer sounds continuously then the plug and connector are declared "Rijeck" (damaged) and the cylinder off.

3.1. Function and Accuracy Testing Of Automatic Continuity test machine (CT)

At this stage the aim is to determine the functioning of the Sensor, LED and Buzzer. The trick is to do a test and comparison on a good (standart) Plug and Connector with a "rijeck" (damaged) Plug and Connector. The steps taken are as follows.

a) Prepare 10 good Plugs and Connectors (standard) by measuring the length of the PIN using a digital caliper measuring instrument. The length of the PIN must comply with company standards, namely 19.05+/- 02 mm.

Figure 8: Manual testing using the "Calipers" (Standard Plug)

b) Prepare 2 plugs and connectors that are damaged or non-standard by measuring the length of the PIN using a digital caliper measuring instrument. The PIN length that does not comply with company standards is 19.05 mm.

Figure 9: Manual testing using the "Calipers" (Non-Standard Plug)

c) Carry out the test by connecting the Plugs and Connectors alternately to the holes of the proximity sensor and photo electricity on the automatic continuity test machine (CT), so that there are two conditions, namely good and damaged (reject) as shown below:

(Good) (Reject)

Figure 10: Testing using the Automatic C*ontinuity test machine* (CT)

Then a trial was carried out on 12 plug connectors using a Continuity test machine (CT). Then the data obtained in the following table.

TABLE I

TEST RESULTS FOR THE ACCURACY AND FUNCTIONALITY OF THE CONTINUITY TEST MACHINE (CT)

No	*Connector*	LED & Lamp (Menyala)	*Buzzer* (bunyi)	Silider	Hasil pengujian
1	Bagus 1	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
2	Bagus 2	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
3	Rusak 1	2 LED & Lamp Merah	Nonstop	Tdk Berfungsi	Sesuai
4	Bagus 3	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
5	Bagus 4	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
6	Bagus 5	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
7	Bagus 6	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
8	Rusak 2	2 LED & Lamp Merah	Nonstop	Tdk Berfungsi	Sesuai
9	Bagus 7	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
10	Bagus 8	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
11	Bagus 9	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai
12	Bagus 10	4 LED & Lamp Hijau	1 detik	Berfungsi	Sesuai

The table shows a comparison of the results of standard and non-standard manual sample measurements against testing using an automatic CT machine. The results obtained from the 12 samples are in accordance with manual measurements.

3.2. Performance Testing Of Automatic Continuity test machine (CT)

Testing performance of Continuity test machine (CT) is carried out for approximately 23 working days or around 184 operating hours. The test is carried out by comparing the number of good products and defective products (reject), then the total number of products tested by the automatic Continuity test machine (CT) against the manual Continuity test machine (CT). The test results data are in the following table.

TABLE II

COMPARING RESULTS FOR THE PERFORMANCE OF THE AUTOMATIC CONTINUITY TEST MACHINE (CT) AND MANUAL

Hari Kerja Alat	Continuity test machine (CT) Lama (Manual)			Continuity test machine (CT) Baru (Otomatis)			Peningkatan (%)		
	Produk Bagus (unit)	Produk Gagal (Unit)	Jumlah (Unit)	Produk Bagus (unit)	Produk Gagal (Unit)	Jumlah (Unit)	Produk Bagus	Produk Gagal	Jumlah
1	4500	40	4540	6000	40	6040	33.33%	0.00%	33.04%
2	4000	80	4080	5400	30	5430	35.00%	-62.50%	33.09%
3	3500	70	3570	5500	78	4421	57.14%	11.43%	23.84%
4	4100	20	4120	4100	20	4120	0.00%	0.00%	0.00%
5	4200	100	4300	5200	30	5230	23.81%	-70.00%	21.63%
6	4000	50	4050	4800	50	4850	20.00%	0.00%	19.75%
7	4200	70	4270	5200	70	5270	23.81%	0.00%	23.42%
8	3100	60	3160	5100	30	5130	64.52%	-50.00%	62.34%
9	3100	50	3150	5800	20	5820	87.10%	-60.00%	84.76%
10	4200	40	4240	5200	10	5210	23.81%	-75.00%	22.88%
11	4000	90	4090	4700	90	4790	17.50%	0.00%	17.11%
12	4200	80	4280	4200	80	4280	0.00%	0.00%	0.00%
13	4600	50	4650	4600	50	4650	0.00%	0.00%	0.00%
14	4800	40	4840	5800	40	5840	20.83%	0.00%	20.66%
15	4300	70	3370	4700	30	4730	9.30%	-57.14%	40.36%
16	4000	40	4040	4900	40	4940	22.50%	0.00%	22.28%
17	3200	50	3250	5200	40	5240	62.50%	-20.00%	61.23%
18	4300	40	4340	4788	29	4817	11.35%	-27.50%	10.99%
19	4300	30	4330	4309	12	4321	0.21%	-60.00%	-0.21%
20	4500	80	4580	5800	88	5712	28.89%	10.00%	24.72%
21	4200	30	4230	4600	30	4630	9.52%	0.00%	9.46%
22	3500	40	3440	5500	40	5460	57.14%	0.00%	58.72%
23	4500	100	4600	4800	100	4900	6.67%	0.00%	6.52%
Rata-rata	**4057**	**57**	**4066**	**5052**	**46**	**5036**	**26.74%**	**-20.03%**	**25.94%**

Table 2 shows a significant comparison of product improvements produced using an automatic Continuity test machine (CT) compared to manual ones. This increase can be seen clearly in the following comparison chart.

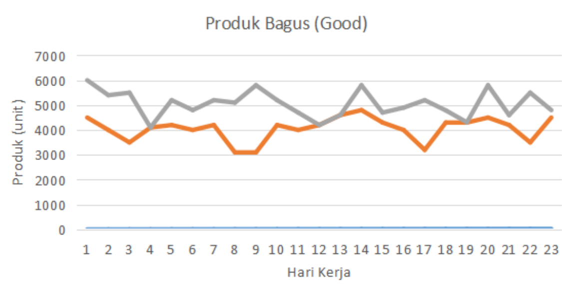

Figure 11: Standard Product Testing Comparison Chart

At **Figure 11** shows an increase in the average number of good products through calculations using the equation:

$$\overline{X} = \frac{\sum x_i}{n} \quad (1)$$

Explanation :

$\overline{X}$ = Average (mean)

$\sum x_i$ = Standard Number Of Product

n = Number Of Working Days

Then the average number of good product (standart) improvement percentages is obtained :

$$\overline{X}_1 = \frac{5052 - 4057}{4057}(100\%)$$

$$\overline{X}_1 = 26{,}74\%$$

A value of 26.74% was obtained, or an average of 996 units month. Then to calculate the percentage of products that are rejected or not good using formula (1) the average percentage value is obtained:

$$\overline{X}_2 = \frac{46 - 57}{57}(100\%)$$

$$\overline{X}_2 = -20{,}03\%$$

A value of -20,03% was obtained, or an average of -12 units month. This means that products that are rejected are decreasing on average day. More details can be seen in the following graphic image.

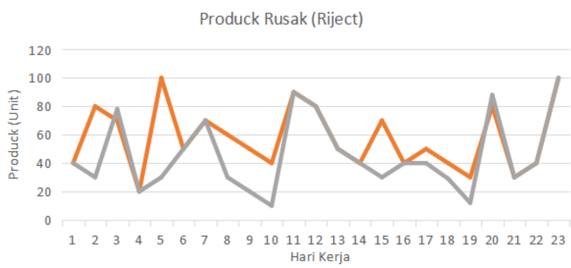

Figure 12: Rejected Product Testing Comparison Chart

Then for the average total product tested, whether reject or good, obtained using equation (1) obtained an average percentage value of:

$$\overline{X}_{tot} = \frac{5036 - 4066}{4066}(100\%)$$

$$\overline{X}_{tot} = 25{,}94\%$$

By 25.94% increase or as much as 970 units an average increase at month. This means that the total product tested exceeds the average target a day. More details can be seen in the following graphic image.

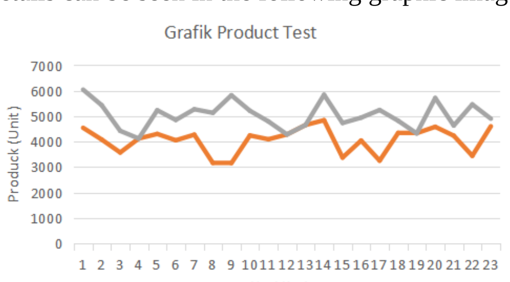

Figure 13: Total product tested exceeds Comparison Chart

4. Conclussion

Based on the calculations and analysis of the functioning and performance trials of the Continuity test machine (CT) it is concluded that the automatic Continuity test machine (CT) is able to provide benefits to the company in terms of efficiency and accuracy of measuring product ac cable plug connectors with a significant increase, namely an average of 25 .94% of the total test results used by the manual Continuity test machine (CT). As a unit, it is capable of increasing an average of 970 units of product each month. The results of the analysis can also be concluded that the automatic Continuity test machine (CT) is able to reduce losses in riject products each month with an average increase of -20.03% per month. This means that products that are damaged (riject) are reduced by an average of 12 units of product each month. Likewise for good or standard products, it increases by 26.74% of the total test results used by the manual Continuity test machine (CT) or by 996 units, the average increase every month.

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