Design Control Systems for Display Curing on Human Machine Interface using Communication CC-Link at the Curing Machine

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Abstract. PT. XYZ is one of manufacturing Industry which produces tire and tube. In order to improve the quality of its high productivity, PT. XYZ through its Division of Engineering makes improvements continuously and sustainably. One of them carried out on data capture counter in curing machines by operators of the EBS. The process of data capture counter through several stages is started from the production process, data retrieval into the field and data entry into system EBS. Time is less efficient because the data retrieval is performed manually and human error likely occurs. Cycle data retrieval is done every 45 minutes for each shift. To cope with this problem do Improvement with the rendered display system using HMI (Human Machine Interface) that is connected with curing machines that use CC-Link communication and network LAN for controlling of the workplace without having to down spaciousness. Results in the creation of this system, the operator of EBS does not need to go down to retrieve data counter space, simply by looking at the display, HMI and integrate it into the system EBS. Data acquisition time can be reduced to 100% because there is no other process in addition to view the data view production and integrate it into the system EBS without compromising the accuracy of the data obtained.
Keywords: curing machine; display curing; CC-Link communication; Human Machine Interface

1. INTRODUCTION

PT. XYZ is one of manufacturing Industry which produces tire and tube in a special motorcycle. PT. XYZ produces two brands of tires and wheels, namely the FDR on sale free and the federal tire is the original equipment market (OEM) motorcycles. The outer tire and inner tube production PT. XYZ has been used by millions of motorbikes in Indonesia and have been exported to countries in Europe, Asia and Africa.

In the production process, PT. XYZ pays attention to guarantee safety, hazards and risk the health of workers and the environment. In addition PT XYZ also has high productivity and keep fit quality with the culture of Astra. In achieving high productivity and quality needed time and the effectiveness of production. The effectiveness of the production of very influential over time, the condition of the machine and production environment of the industry. In addition, the effectiveness of production is also very influenced by some factors that can decrease the level of the barrier to efficient which caused losses for the company. Therefore, the company has its own efficiency targets, one of which is through the Division of Engineering.

Engineering Division tries and always tries in the efficiency and effectiveness of production time to increase corporate profits one through improvisation. Improvisation is being done gradually that is monitoring the production process at the start of the curing machine number 1 to 5 in the curing Process d. Factory is the end of the process of making tires. Here the raw tire is printed with a temperature of about 175 °C for approximately 8 minutes using the analog timer, depending on the size of the tires that are made. The result of the process of imi, the tire is formed including profiles, brand, type, tire size and all the information is on the wall of tires. Each machine has 4 cavity tire curing that are counted every once in the end of the manufacturing process by analog counter. In the process of curing is a process monitoring namely process periodically every 45 minutes once managed by EBS (E-Bussiness Switch) for checking and recording the number of quantity production tire curing machines each.

G. Valencia-Palomo et al. have design an auto-tuned predictive control based on minimal plant information using PLCs [1]. While Buhrer et al. have discussed about changeability of manufacturing automation systems using an Orchastration Engine for PLCs [7]. Milik have researched on PLCs control program hardware implementation selected problems of mapping and scheduling [8]. Alphonsus et.al study and review on the applications of programmable logic controllers (PLCs) Renewable and Sustainable Energy [10]. In our previous researches [2, 3, 4, and 9], we have designed and analysis the various sensor applications on the machine automation PLC-based in manufacturing automotive industry

Monitoring process requires one operator of EBS to examine and record the results analog production counter periodically on the curing machine in the Factory's C and D and enter the data into the program of the EBS. On the data retrieval process counter field takes about 10 minutes and the process of data entry into system EBS takes about 14 minutes. Total time of data acquisition requires about 24 hours not including doing the work of the other. This process was judged inefficient in curing counter data retrieval. In this research, we design a system that is efficient in the process of data capture process of curing results counter to operators of EBS; we study how to test interface which has been created in order to facilitate the operator's EBS.

2. METHODOLOGY

Communication of CC-link

CC-Link is a network developed by Mitubishi Electric Corp. this device useful as the local station or station intelligence devices. Just as communication with other Link units, CC-Link can be communicated with the PLC without the communications program. CC-Link is also able to connect some of the station into a master PLC with high speed. CC-Link communication system can connect modules such as I/O module, a module of intelligent function, and special function modules using the cable so that the module can be controlled by PLC. CC-Link communication system has several advantages such as:

- with the device module to distribute any work like line conveyor and machine cabling system can be done efficiently.
- information such as when the inputs and outputs are active and non-active as well as numeric data can be sent and received by the module with high speed.
- Can connect multiple units PLC to form a simple distribution system.
- Connect with any device made by manufacturer Mitsubishi partner, the system can provide a variety of solutions to meet customer needs.

Figure 1 shows CC-link configuration example. Table 1 shows cable CC-link specification. The cable used for CC-Link communication system is shielded twisted pair cable.

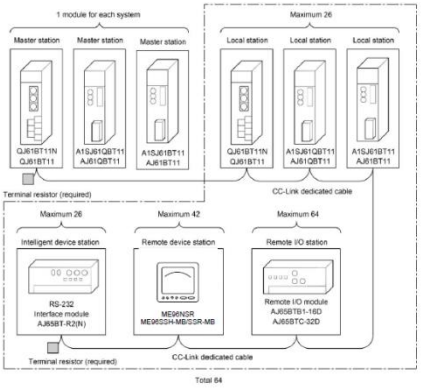
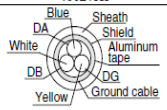


FIGURE 1. CC-Link configuration example

TABLE 1. Cable CC-Link specification

Item	Specifications
Model name	FANC-SB 0.5mm²X3
Cable type	Shielded twisted pair cable
Conductor cross sectional area	0.5mm²
Conductor resistance (20°C)	37.8 Ω/km or less
Insulation resistance	10,000 MΩ-km or more
Withstand voltage	500 VDC, 1 min
Electrostatic capacity (kHz)	60 nF/km or less
Characteristic impedance (1 MHz)	100±15Ω
Cross section	
Outside dimensions	7mm
Approximate weight	65kg/km

There are several parameters that must be set to start the data link. Data links consisting of buffer memory, EPROM and internal memory.

- The Buffer memory. The buffer memory is a temporary storage area to store the information into internal memory or EPROM. When the source of the power module is deactivated, the parameter information will be erased.
- EPROM. By activating the start using a data link query parameter EPROM, the data link can be directly started. This makes us do not need to set the parameter to the buffer memory per do starting up to the master station. Because of source power is turned off, the information will remain the EPROM parameter
- Internal memory. Data links are executed using the parameter information will be stored in the internal memory. When the voltage source module is turned off, the parameter will be deleted.
  The picture below will explain the structure of a data flow link from the CC-Link communication system.

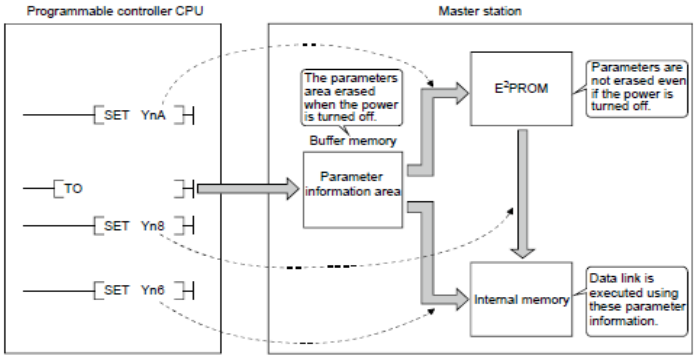


FIGURE 2. Data flow links

The Curing Machine

The curing machine is a machine that is processed in the last formation of the ban. The curing process is a concoction of green tire vulcanization or become a ban so. The curing process (ripening) requires heat and pressure of the steam is very high, the green tire will be placed on the mold (mold) and in accordance with the desired temperature for the production. Figure 3 shows the curing machine.

FIGURE 3. The curing machine

Data Counter Retrieval from the Curing Machine

Production Process. The production process is the process by which the curing machine operates from you submitted green tire into the machine to finish pemasakkan green tire into a ban so and sent to the next process. This process is done continuously divided into 3 shifts a day and results in cooking every once and count on the reset every turn of the shift.

Logging Production Data by the operators of the EBS. In this section where the calculation results of curing machine in production note by one operator of EBS. The way his acquisition with came up to the counter and see results in each machine, total number of curing machines by as much as 32 fruit machines in the factory and factory data Acquisition counter d. done every 45 minutes once per shift.

Enter Production data to system EBS. After the operator of EBS has got data counter machines curing, further data is brought into the workplace to entered into its system EBS, the aim to find out whether there is any difference in the number of products that come out of the process of curing with the products that go into the process of curing, as well as the need to control the amount of product that should be produced.

The problem the process of Curing Machine Counter Data retrieval

In the process of data capture counter is known such data retrieved manually through operator countering that go to the engine and note any production results in curing machine every shift as already described in Chapter 3.2 above regarding the curing machine counter data retrieval. Acquisition of data manually is inefficient. Data from the trials, the time it takes to walk from the operator's work area towards curing machine in the production area factory C and D as well as a factory for data retrieval from the machine by the operator takes about 10 minutes not including for returning to the operator's work area and do the data entry of the EBS to the database which takes about 14 minutes. The following test data time to tally the data.Cause Effect Analysis.

TABLE 2. Plan countermeasures

No.	Times	Logging data (menit)	Enter Data (menit)
1	12:00	9 minute; 56 second	13 minute; 21 second
2	12:45	10 minute; 18 second	13 minute; 29 second
3	13:30	9 minute; 32 second	13 minute; 44 second
4	14:15	9 minute; 44 second	14 minute; 13 second
5	15:00	10 minute; 7 second	14 minute; 22 second

Modification Concept

Design concept

Figure 3 shows the initial draft of the system to be created. Curing machine serves as the main source of data acquisition. Each curing machine is controlled by a PLC that will provide information to the production number of the curing machine HMI and delivers information to the PLC via cable CC-Link and then processed and sent to the HMI operator EBS through LAN network for showing the results of the production for the machine to operate in real time.

The use of a PLC in the engine is the default PLC from curing the maker of the machine, and the PLC has limitations of its specifications in communicating, then needed enhancements in the form of the CC-Link communication extension mounted on curing machine PLC. This further extension is connected to the Master PLC cable through CC-Link. The use of PLC Master function to control and hold the information sent from the curing machine PLC which was then processed and displayed to the operator HMI EBS via the LAN network.

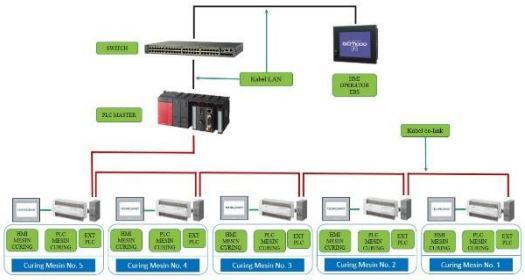


FIGURE 3. the concept of work machine

3. DESIGN, TESTING, AND ANALYSIS

Wiring Fabrication

According the design concept is illustrated in the design, manufacture of wiring done into 4 sections, namely:

Electrical Wiring Diagram. Wiring the power is divided into two power HMI diagrams and wiring power curing machine master panel. Figure 4 shows wiring power HMI curing machine, and Figure 5 shows wiring power master panel.

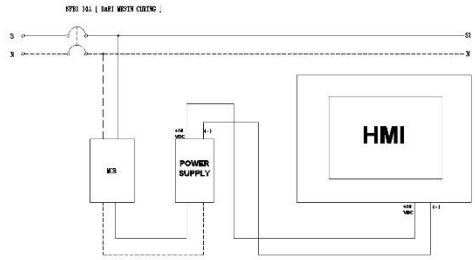


FIGURE 4. wiring power HMI curing machine

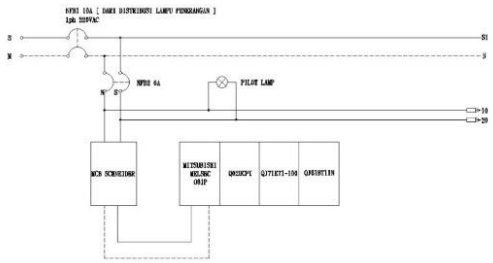


FIGURE 5. wiring power master panel

Wiring CC-Link Between PLC. For the wiring is also done on parameter settings of each module CC-Link. Figure 6 shows addressing each PLC.

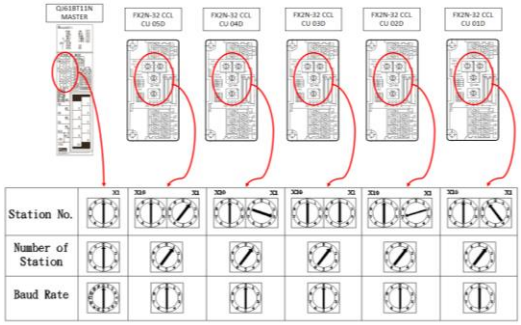


FIGURE 6. addressing each PLC

a. Wiring LAN network. Wiring the master PLC with HMI operator EBS uses a network cable with RJ45 connectors straight models.
b. Wiring HMI machines with PLC Machine. To display the data counter machine production curing in HMI needed a communication, this communication uses the RS232 serial cable to connect it.

Design Layouts HMI
Before creating of design layouts, HMI it takes some configuration settings on the HMI to be able to connect with another device.
a. The Design Layout HMI Curing Machine. The use of HMI in the curing machine is intended as display timer and counter, so the operator knows easily the ongoing production process.

(a) (b)

FIGURE 7. Design layout HMI curing machine (a) (b) counter screen screen timer

b. Design Layouts for the Operator HMI EBS. Its HMI operator for EBS uses Mitsubishi GOT1000 is meant to make it easier for operators of EBS in counter production data retrieval.

(a) (b)

FIGURE 8. design layout HMI operator EBS (a) the display of the home screen, (b) display any curing machine

Design Programming
On the creation of this system displays counter curing, programming is carried out using a PC using software provisioning Mitsubishi GX Developer version 8. Programming PLC is also concerned with addressing on HMI. The following example program counter to count the number of the production is done by machines curing. Figure 9 shows the program counter on PLC curing machine.

FIGURE 9. the program counter on PLC curing machine

Description:

A: When the M8000 is active then the command TO runs which function to write data in the C101 to C104 from master CC-curing machine Link to buffer memory (K9 to K11) that will be read by the master in CC-Link in the PLC master address D100 until D103.

B: On the Counter up addressable C104 C101 on curing machine HMI for displaying the data counter. Counter C101 to C104 function to save data counter number of production being performed by machines curing.

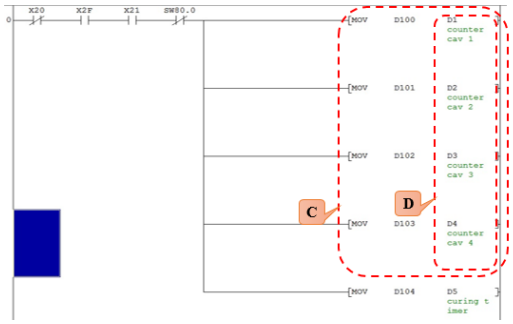


FIGURE 10. the program counter on PLC master

Description:

A: Command MOV will be active if active and X2F X 21. MOV functions to move data memory of the D100 until D103 to D1 to D4.

B: D1 to D4 is data memory that is addressed to the counter on the operator HMI EBS for curing machine number 05.

For more details about addressing counter on HMI operator EBS from other curing machine can be seen in table 3. The following table addressing in HMI operator EBS.

TABLE 3. address counter each machine curing on HMI

No	No. Mechine	Data Memori Address			
		Counter Cavity 1	Counter Cavity 2	Counter Cavity 3	Counter Cavity 4
1	**Curing 01**	D80	D81	D82	D83
2	**Curing 02**	D60	D61	D62	D63
3	**Curing 03**	D40	D41	D42	D43
4	**Curing 04**	D20	D21	D22	D23
5	**Curing 05**	D1	D2	D3	D4

Testing

Address Testing Program On PLC HMI

This test can be done in two ways. The first way by looking straight on view HMI. The second way by using the monitor mode.

HMI Operator EBS on other places:

a. Mechanical Electrical Engineering PE1. This testing is done by observation directly. Things to note is that the testing is done when curing machines produce the goal to be able to see whether the display of the counter and the timer on the HMI in accordance with actual curing machine. Next connect the HMI to the source of power and connect the HMI with a network cable. When all is connected properly, it can be seen on the display HMI data that will show the actual suit.
After doing a test on this place, the results obtained are OK, the HMI can display them well and in accordance with their functions. Display counters and timers each machine showing actual results.
Office Engineering. The location of the testing on this place have a greater distance from the venue of the first test, his goal was to see the extent to which communication can work well. The test measures on this same place with testing in the first place and results in may as well get the result OK, HMI can display them well and in accordance with their functions. Display counters and timers per engine displays the results in realtime.

Results Analysis
When you are finished making this system obtained the results of the removal of production data retrieval time and accuracy counter production more guaranteed. While someone needs information about the production data, then he could immediately see the HMI display data production and State of simple machines. Without the need to descend directly into production line to do the recording, the time required to retrieve any data is reduced, so the operator working hours could be used more effectively because the data displayed is the actual data. if data retrieval directly onto the field takes about 10 minutes, then the time is reduced by the presence of these systems reach 100% because of the absence of any process other than the production data view and integrate it into the system EBS.

4. CONCLUSION

In this paper, we discussed about design control systems for display curing on Human Machine Interface using communication CC-Link at the Curing Machine. We made a counter display system using CC-Link communication between PLC and curing machine PLC master which is then communicated using a LAN network in order to connect with HMI operator EBS and can be controlled from the workplace without the need to go down to the field, production data acquisition so more quickly and efficiently without the worry of data obtained are not actual. Testing was done by looking at the accuracy of the results on HMI with curing machine and test the distance communication can be done..

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