

Boiler Application Using Wireless Bridge between PLC and SCADA

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Abstract: *In this paper, study of wireless SCADA system which is powerful setup for monitoring and controlling the various applications from remotely placed is presented. Wireless SCADA is required in those applications when wire line communications to the remote site is prohibitively expensive or it is too time consuming to construct. In certain industries like Oil & Gas or Water & Wastewater, wireless SCADA is often the appropriate solution due to the remoteness of the sites. The project discusses the concept of monitoring, recording and controlling of a small part of the boiler process. This is done by using PLC and SCADA. The PLC and SCADA are connected with a wireless medium, that is, the Bluetooth module. The boiler process consists of parameters such as, temperature, level and pressure. The effect of these parameters, when they exceed their limit is shown in SCADA and its resulting control is done on the real time operation of the boiler. This is done with a help of Bluetooth module, which will be wirelessly used to connect the PLC and the SCADA. Wireless based solutions have universally accepted, familiar and user friendly system. Real-time logging would allow warnings to be flagged to the relevant personnel (e.g. Indicate warning signs in the SCADA display for the personnel to operate and rectify the problem/ issue) and allow corrective action to be taken before the quality and value of the catch is degraded. The SCADA can be connected by using a Wi-Fi, but in our case of project to control the boiler we use Bluetooth as the medium, as we are going to operate the process in a smaller range of the Bluetooth module. This is done with a help of Bluetooth module, which will be wirelessly used to connect the PLC and the SCADA.*

Keywords: SCADA, PLC, Bluetooth, wireless Power transmission, Wi-Fi

1. Introduction

This project deals with the control and monitoring of processes taking place in the industries. The wireless block consists of a Bluetooth module connected to OMRON PLC and the Bluetooth receiver present in the system containing SCADA software. The PLC is further connected to a process which is controlled by the SCADA system through wireless medium. This technique of operation can be used over a certain range of area, for example, it can be used in industries and plants. The transfer of data from the application to the PLC is done using wire, whereas from the PLC to the system is done wirelessly using Bluetooth. The process we operate is a boiler based process. In this process we control the parameters such as, temperature, level and pressure, and also show its effects on the process using SCADA software.

In this project we use two types software's for the operation. These both connect with each other and operate uniformly and instantly for giving the desired output. The two types of software's used are: (1) PLC CX programmer (2) SCADA Wonderware Intouch. PLC CX-Programmer, the programming software for all Omron's PLC series, is fully integrated into the CX-One software suite. This software creates a hostlink known as OMRON-Hostlink which creates the connection between the CX programmer and the SCADA Intouch. This software has the scan time of 0.4ms. In this software, we program or construct the ladder logic for the operation to be carried out. The SCADA used for this PLC is SCADA Intouch Wonderware software. The SCADA is basically is used for the pictorial representation and monitoring and collection of data. In SCADA we create the design of the operation which needs to be operated and connect it with the OMRON PLC using OMRON hostlink. This connection is done by giving tag names to the respected

design with respect to the input and outputs present in the ladder logic of the CX- programmer.

A wireless PLC/SCADA network has been set up to investigate the reliability of wireless communication systems in a local area network. It has been shown that the integrity of data flow can be maintained within certain limits of the signal strength in a coverage area of an Access Point. The wireless can successfully be applied in industrial operations provided a careful site surveys has been be conducted and the boundaries are determined to ensure adequate signal strength to avoid any possible dropouts however short lived they may be.

2. Problem Statement

The present system of transferring data from the PLC to the SCADA system is by using a RS-232 cable and a RS-232 to USB convertor. This process or phenomenon of transferring of data is a risky process. In this transmission, there are chances of data loss due to attenuation, and also there might be chances of getting delayed output. The proposal of this project is to transfer the data from the PLC to SCADA using a wireless medium. For this purpose, we use a Bluetooth module for the transmission of data. The inputs of the application is given to the PLC, from here they are transferred to the system containing SCADA by Bluetooth and then, these data are processed in the system and again send back to PLC by Bluetooth and further to the output present in the application or process to be operated.

The wireless medium of data transfer is highly present and used in developed countries. These countries do not share these technologies easily with other countries, and therefore demand high for setting up these technologies in other countries. Hence to avoid such money loss, we are proposing

this technique of wireless transmission. This medium of wireless transfer can avoid data loss, connect multiple processes, and also easily operate them without much difficulty. This medium of transmission also helps to get a wide circular range, so that a maximum number of connections are made possible. The Bluetooth forms an adhoc network, and thus forms a network connection without much relying on the pre-existing infrastructure of the program. The adhoc network forms a peer-to-peer network connection and thus can be used for smooth operation of the process.

These techniques of transferring of data can be implemented in large scale and small scale industries to overcome the problems created by the wired system present currently in the huge number of plants. We use PLC for its smooth working, efficiency, short scan time and also for its instant output based on logical program, which is programmed into it. The process consists of the controlling of the flow of water from tanks to the heater and the control of heater coil to maintain temperature.

3. Proposed Methodology

A. Process

The process starts with manual feeding of water into the source tank. Then the low level sensor in the source tank is in the on state. Also the low level sensor of the process tank

is also in the "on" state. This causes the pump1 to turn "on", thus causing the water from the source tank to move into the process tank. This increases the level of water in the process tank causing it to activate the high level sensor present in the process tank. Now, when the high level sensor gets activated, the pump1 turns "off", causing an interruption in the flow of water from the source tank to the process tank. Also the low level sensor in the steamer is in "on" state. Now, when the high level sensor of the process tank and the low level sensor of the steamer are in "on" state, the pump2 automatically turns "on".

This causes the flow of water from the process tank to the steamer. Also the water flow from the process tank to the steamer is interrupted after the boiler reaches a particular set point defined by the user/operator. Once the water level in the steamer reaches the defined set point, the pump2 turns "off". This prevents the flow of water from the process tank to the steamer to get interrupted. Also the steamer consists of a temperature sensor that senses the temperature and gives its analog value to the PLC. The level sensors from the source and the process tank and from the steamer are connected to the LM324 comparator block, which is also connected to the ULN2803. These values are given to the PLC for using I/O modules (Input / Output modules). The values from the PLC are transferred to the SCADA operating system using Bluetooth medium of wireless transfer.

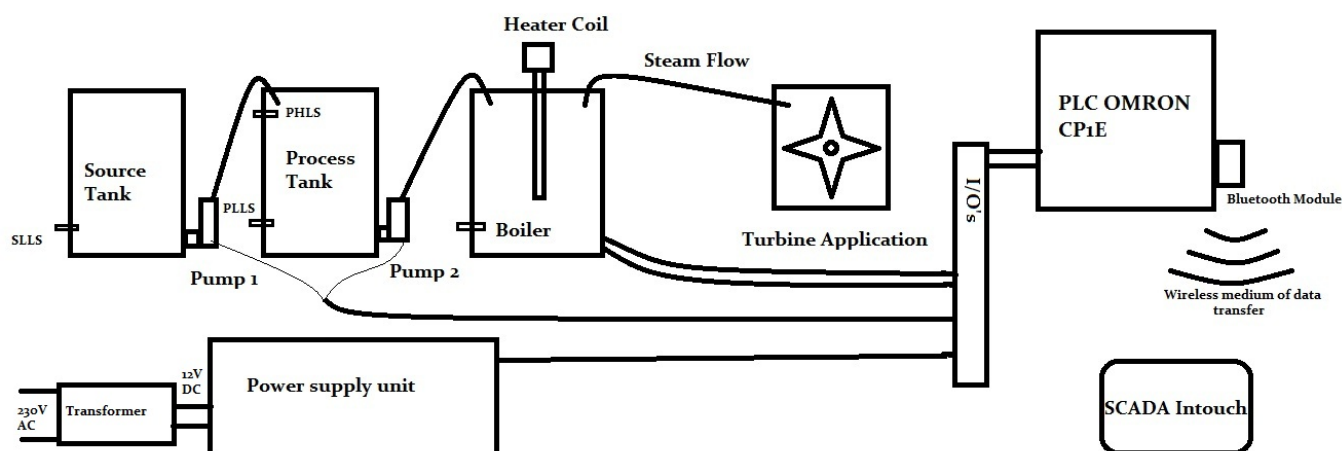


Figure 1: Block diagram of the process

The data's are logically analyzed and sent back to the PLC which performs the required function, by controlling the water level and temperature. SCADA system consists of software required for interfacing which is known as PLC CX-programmer. The CX-programmer used ladder diagram for its operation. This ladder diagram for the process is given below:

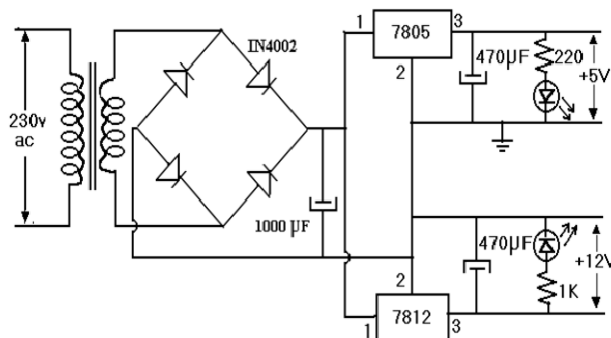


Figure 2: Power supply unit

The power supply unit does the important work of bringing the 230 VAC supply to the desired voltage of the equipments used. The step down transformer converts the 230VAC to 12VAC and then is send to the bridge rectifier. The bridge rectifier converts the 12VAC to 12VDC. Then the capacitor present removes the undesired ripples of SC components and then passes the supply to the voltage regulators. There are two types of voltage regulators 7805 & 7812. Both these regulators are used to bring the voltage to 5V and 12 V respectively. The 5V is used by the LM35 sensor, whereas the 12V is used by the comparator block for level sensing. Also the 78' series is the positive range of voltage regulators, whereas the 79' series is the negative range of voltage regulators. These 12v and 5v are given to the sensors present in the circuit board.

B. Ladder Diagram

This is the first page of the program. In this page we make use of the inputs, memories and output icons for the neat representation of the program. In the first rung we make use of a start button for starting the process and the emergency stop button as normally closed contact, so that in case of emergency we can stop the process directly by just hitting the emergency stop button. In the second rung we have configured connections for the program to be operated in the automatic format. In the third rung, we have configured connections for the program to be operated in the manual mode. In the 4th, 5th, 6th and the 7th rung we have given memory allocation addresses for the four types of sensors we use. In the 8th rung we have given connections for the activation of the heater. Finally in the last two rungs we have given connections for the outputs, which are pump1 and pump2.

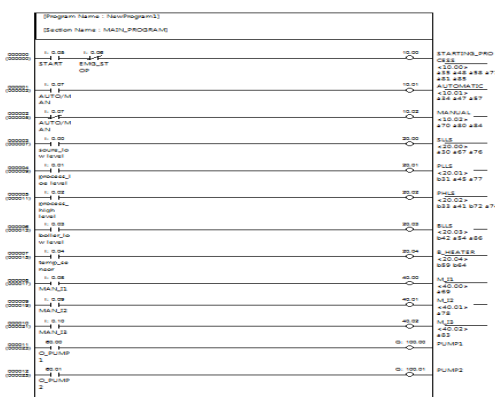


Figure 3: Main Page of Ladder Program

This is the second page of program for the process. This page of program is fully automated. This means that this process does not need any manual attendance, and it operated just with a single start button. Nowhere in the process, there is any activation of switch by an external force.

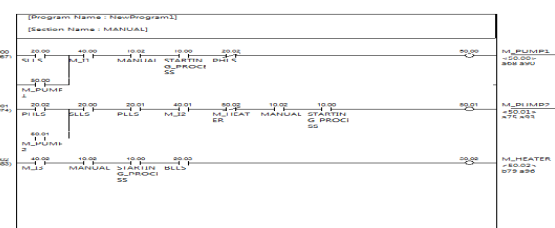


Figure 4: Manual Page of Ladder Program

This is the third page of the program for the project. In this page, the program is based on manual activation. This program is used just for the purpose of safety. If there is any mal-function in the automatic system, then this manual mode is used.

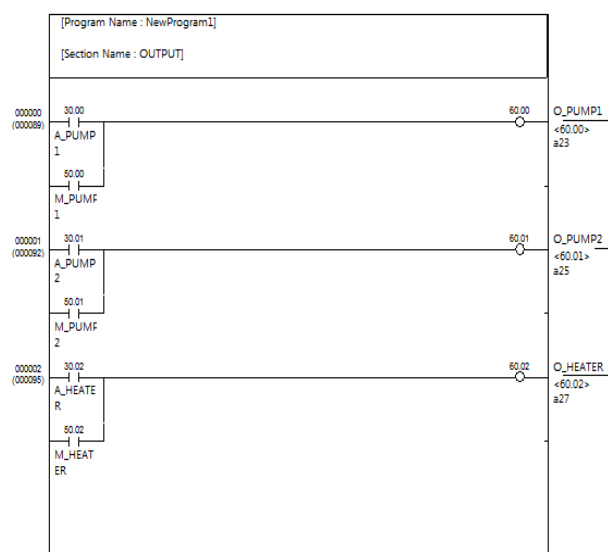


Figure 5: Manual Page of Ladder Diagram output Page of Ladder Diagram

This forms the fourth page of the program of the project. This page consists of an output which gets activated by the switching actions taking place in the 1st, 2nd and the 3rd pages of program.

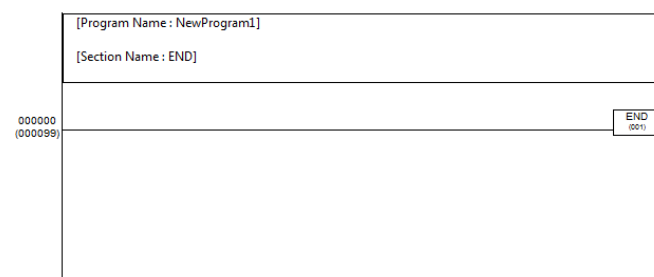


Figure 6: End Page of Ladder Diagram

This page is the last and the final page of the program. This page marks the end of the program. The PLC scans the program and when it comes across the "END" statement it stops scanning further.

4. Result

The result of the process done in the above programs can be showed in the form of SCADA representation. The above

process starts with manual feeding of water into the source tank. Then the low level sensor in the source tank is in the "on" state. The low level sensor of the process tank is also in the "on" state. This causes the pump1 to turn "on", thus causing the water from the source tank to move into the process tank. This increases the level of water in the process tank causing it to activate the high level sensor present in the process tank. Now, when the high level sensor gets activated, the pump1 turns "off", causing an interruption in the flow of water from the source tank to the process tank.

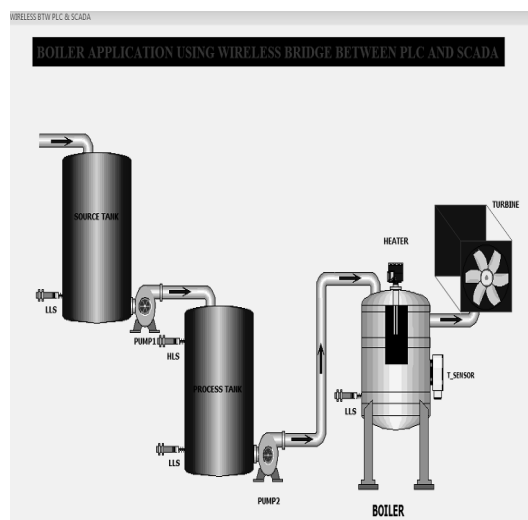


Figure 7: SCADA Display of the Whole Process

Also the low level sensor in the steamer is in "on" state. Now, when the high level sensor of the process tank and the low level sensor of the steamer are in "on" state, the pump2 automatically turns "on". This causes the flow of water from the process tank to the steamer. Also the water flow from the process tank to the steamer is interrupted after the boiler reaches a particular set point defined by the user/operator. Once the water level in the steamer reaches the defined set point, the pump2 turns "off". This prevents the flow of water from the process tank to the steamer to get interrupted. The boiler when reaches the user defined set point the heater switches "on" and the pump2 switches "off". This causes the water to get and convert into steam, thus driving the turbine. Hence the production of steam is directly proportional to the speed of the turbine.

5. Conclusion

The process of controlling boiler application, water level using cables and wire are found commonly in many industries. The wired communication is used in the industries have some disadvantages, such as: 1) Cost of laying down of cables and wires for long distance is high. 2) cost of maintaining the cables is also high. 3) loss of data in the wire transmission due to attenuation. To overcome these limitations we use wireless communication for the process. In this medium of communication, we use wireless medium for communication and also prevent the above limitations from occurring along with the below advantages; 1) since it is wireless, it is possible to connect more than 1 field devices and operate them simultaneously. 2) Also the loss of data can

be prevented. With the above advantages and the limitations, we prefer the use of wireless communication over wire communication.

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