

Low cost wireless control and monitoring using PLC and SCADA

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Abstract- PLC is a controller used to automate the industrial process and monitor itself. Programmable logic controller is used in many industries to control the whole process automatically with less human intervention and to avoid errors. With the rapid growth in technology wireless instrumentation has come into existence to avoid cabling infrastructure and to obtain efficient control. In order to have a wireless control the existing plcs have to be replaced with wireless plcs. PLCs are also used in homes and small scale industries to automate small process applications. So it is undesirable to invest on wireless PLCs which are expensive for home based applications. In this paper we present a novel approach of converting the existing wired plc into wireless plc by configuring XBEE in direct mode using X-CTU software as communication interface between plc and process, the process used here is batch process and controlled through SCADA.

Index Terms: PLC, XBEE, X-CTU software and SCADA

I. INTRODUCTION

A Programmable logic controller (PLC) is a device that was invented to replace the necessary sequential relay circuits for relay control. The plc we used here is ge-fanuc in which the ladder diagram is designed for the batch process. As the wireless plcs use modem for transmitting signals from plc to the process here we are using Xbee as the communication interface which is used for transmitting and receiving the signals from the plc to process and vice-versa. The X-ctu software is used for configuring the xbee from uart mode to direct mode. In our process we use two xbee's one is for the process side and the other is for plc. The two xbee's are configured with same pan id and addressing to communicate each other. With respect to desired operation the pins are configured using x-ctu software. The process is monitored and controlled using the proficity hmi/scada- cimplicity software in which the whole process is designed and interfaced with versapro ladder diagram designed earlier.

II. BLOCK DIAGRAM OF PROCESS:

We have created a batch process in which the temperature and level are the main parameters to be controlled and the setpoint

for these two parameters are given by the operator/user in the SCADA HMI interface. As in the block diagram the process is in one side and the plc & SCADA on the other side transfer and receives the signals through the xbee's placed in between. The process is initiated by the user from the SCADA HMI interface and can be monitored and controlled by observing the flow of the process designed.

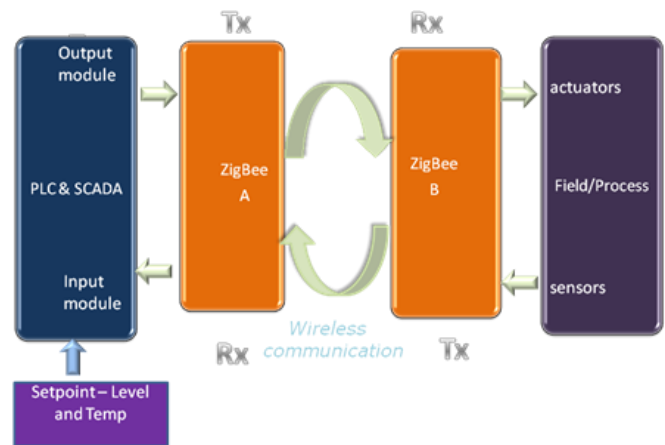


Fig1: Block diagram of proposed system.

III. OVERVIEW OF XBEE

ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost and low-power wireless personal area networks (WPANs). The ZigBee standard takes full advantage of the IEEE 802.15.4 physical layer specification and operates in unlicensed bands worldwide at the following frequencies: 2.400 – 2.484 GHz, 902 – 928 MHz and 868.0 – 868.6 MHz. ZigBee may operate in different kinds of networks: in *star network* the ZigBee coordinator starts the network and all the other nodes are directly associated with the ZigBee coordinator. In the other two types of networks there is a third type of ZigBee nodes, ZigBee routers, to which end devices can associate. The ZigBee routers can associate themselves to other ZigBee routers or the ZigBee coordinator. In *tree networks* the ZigBee routers form a tree that is rooted at the ZigBee coordinator. In the *mesh networks*, the network

topology might be a general mesh network involving ZigBee routers and the ZigBee coordinator. There are two methods for reading the data as it comes to xbee:-

1. By default it is done through the **UART**.
2. By **XBEE DIRECT**: support ADC and digital I/O line passing.

When the appropriate DI pin is toggled, the module will toggle the corresponding DO pin on the base module.

IV. ROLE OF X-CTU SOFTWARE

X-CTU is a Windows-based application provided by Digi shown in fig 2. This program was designed to interact with the firmware files found on Digi's RF products and to provide a simple-to-use graphical user interface to them.

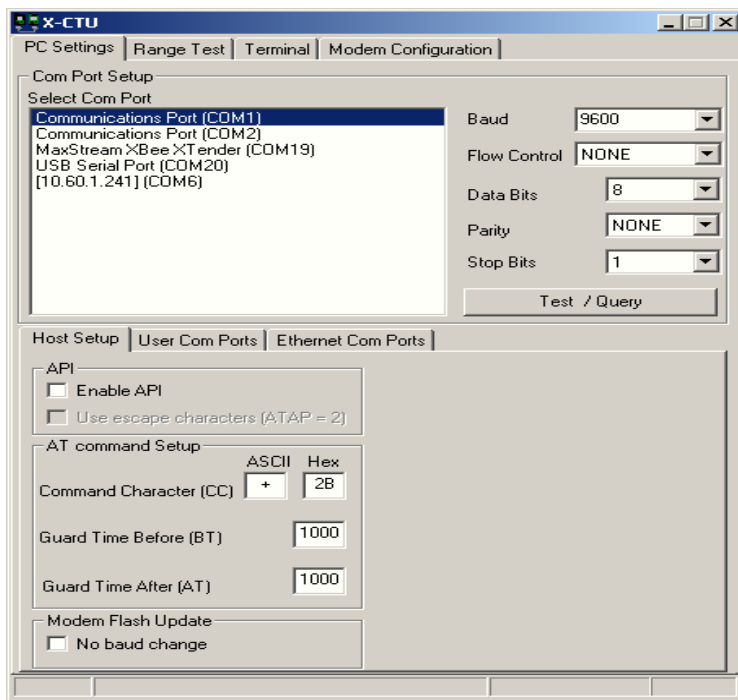


Fig 2: X-CTU software

When launched, four tabs will be seen across the top of the program

1. **PC Settings**: Allows a customer to select the desired COM port and configure that port to fit the radios settings
2. **Range Test**: Allows a customer to perform a range test between two radios.
3. **Terminal**: Allows access to the computers COM port with a terminal emulation program. This tab also allows the ability to access the radios' firmware using AT commands.

4. **Modem Configuration**: Allows the ability to program the radios' firmware settings via a graphical interface. This tab also allows customers the ability to change firmware versions

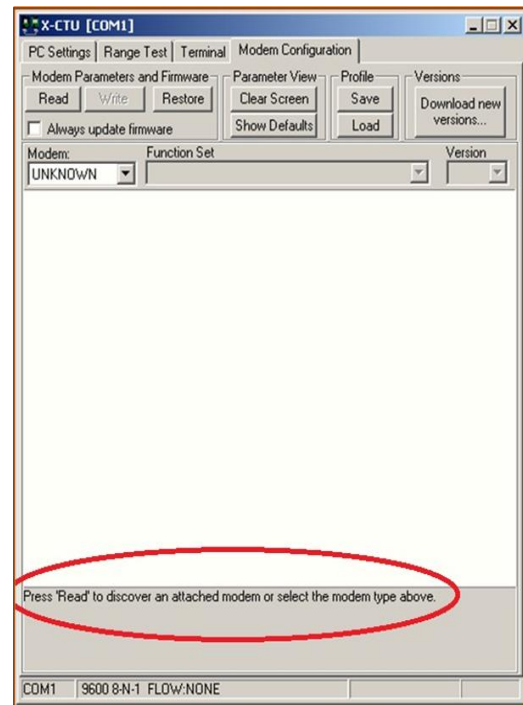


Fig 3: before reading the xbee connected to pc.

When the read button is pressed after connecting the xbee to pc the configuration parameters of xbee are seen on the screen to change accordingly as shown in fig 3.

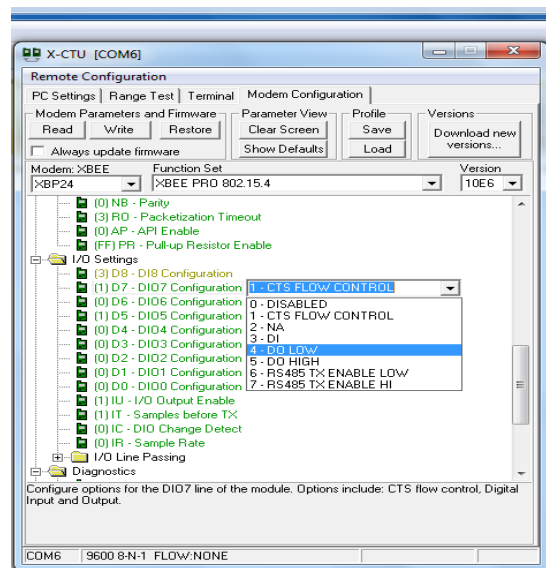


Fig 4: after reading the xbee connected to pc

V. OVERVIEW OF SCADA

SCADA is used to monitor and control the process parameters in a pc, to access data accurately, to make informed decisions in

real time and the power & security to precisely monitor and control every aspect of the process. The SCADA software being used is proficy cimplicity. It is a proven client/server-based HMI/SCADA software solution that collects and shares real-time and historical data across all levels and provides actionable visibility to monitor and control plant processes, equipment and resources. Helps to visualize, control, analyze and optimize production data across your operations, CIMPLICITY delivers value-added results for a competitive edge:

- Enhanced decision making.
- Faster time-to-market.
- Improved productivity.
- Reduced development costs.
- Lower total cost of ownership.

VI. DESIGN AND IMPLEMENTATION

The PLCs provide analog and digital series input/output that can be used to control the field devices. For the PLC to be made to control data wirelessly, a wireless interface is needed. The messages from the controller are sent to PLCs through the RF transceivers. Thus, two RF transceiver circuits have to be developed such that they are able to communicate with each other as shown in figure 5.

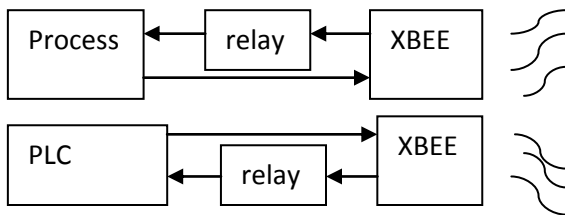


Fig 5: Schematic diagram

A. HARDWARE REQUIREMENT:

1. **PLC:** Versamax PLC manufactured by GE-Fanuc has been selected for this project. It is a fixed type plc with 14 digital, 2 analog inputs and 10 digital and 1 analog output.
2. **RF Transceivers:** Digi zigbee module which supports 9 digital i/o and 2 analog i/o in direct xbee mode.
3. **Relays:** used to step up 3.3 v output voltage from zigbee to 24 v for the PLC input module and to required voltage for the actuators.
4. **Sensors:** E-TAPE level sensor is used for level measurement, float switches for sensing the high and low levels in the reservoirs and RTD for temperature measurement.

B. SOFTWARE REQUIREMENT:

1. **X-CTU:** The software used to configure the Digi Xbee module from uart mode to direct xbee mode and to assign the i/o pins.
2. **Versa pro:** this software is used to design ladder diagram for the process.
3. **proficy HMI/SCADA-cimplicity:** used for supervisory control and data acquisition.

C. HARDWARE SETUP:

1. Batch process prototype:

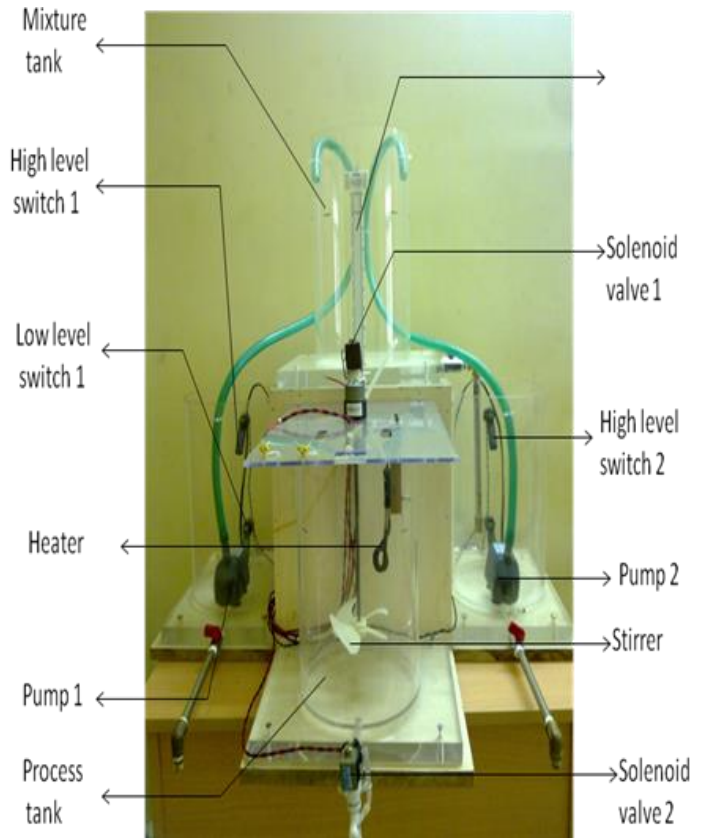


Fig 6: Batch Process.

2. Connections:

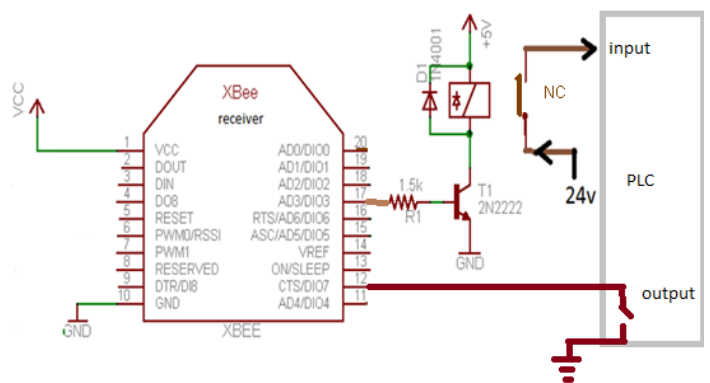


Fig 7: Base module connection.

Input pin DIO 12 of base module is connected to the plc output and output pin DIO 17 is connected to the PLC through a relay circuit.

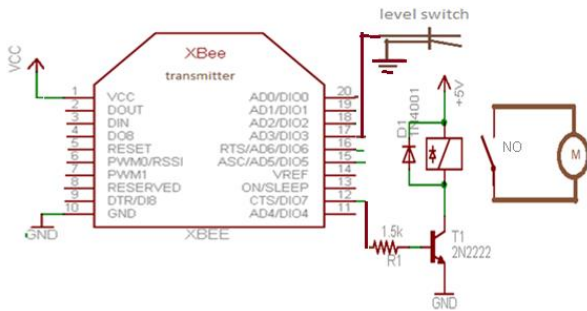


Fig 8: Remote module connection.

Corresponding DIO 12 pin of remote module gives the output signal of PLC to the actuator through the relay circuit and the sensor signal is given to the DIO 17 pin of remote module.

3. XBEE configuration:

The pin signals (high or low) from one radio will be passed to the other after configuring.

3.1. On base module:-

- Under modem configuration- read settings.
- under I/O settings, set the pins that will be transmitted to “3-DI”(data in), set the pins that will receive to “4 or 5”(data out) and “2” (ADC).
- set IR – sample rate to 20 ms(hex 14).
- set IT- samples before Tx to 5.
- write settings.

3.2 On remote module:

- Under modem configuration- read settings.
- under I/O settings, set the corresponding pins that will be transmitted to “3-DI”(data in), set the pins that will receive to “4 or 5”(data out).
- Set IU to “1” (enable).
- set IR – sample rate to 20 ms(hex 14).
- set IT- samples before Tx to 5.
- Under i/o line passing set PO to “2”(PWM output).
- Set IA- to “FFFF”
- Write settings.

D. SCADA INTERFACE:

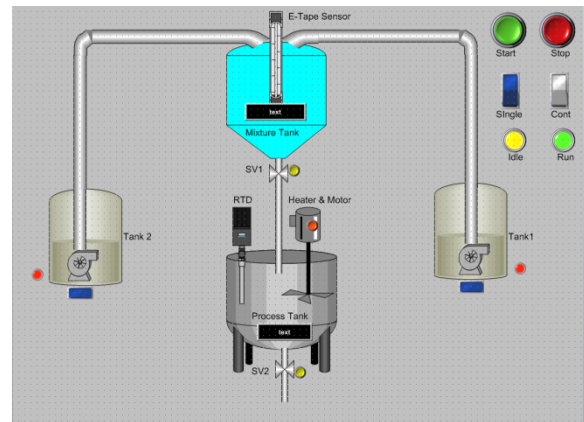


Fig 9: Process diagram.

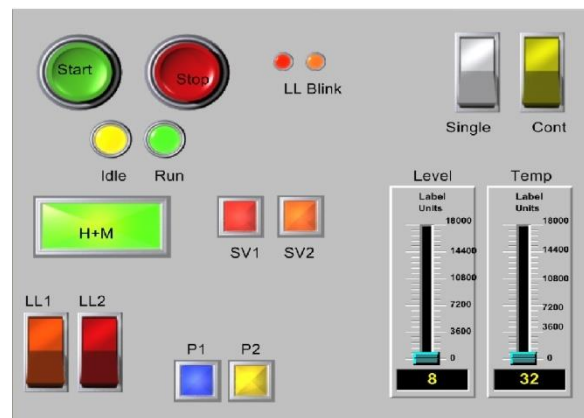


Fig 10: Basic input and outputs

VII. CONCLUSION

The prime focus of this paper is replace the existing home and small scale industries based wired plc system into wireless plc system using xbee as communication interface by configuring it with x-ctu software because the wireless plcs modules are very expensive and is not desired in replacing for small applications. Using xbee as communication interface between process and plc is one of the approach for operating wired plc as wireless to automate small applications.

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