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Low cost Wireless I/O's using PLC, HMI & ZIGBEE

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Abstract: During the past decade, the industrial sector throughout the world has shifted from the classical methods of Control and Automation to the state of the art techniques. This allowed the industries to attain a higher percentage of growth and production, which consequently gave rise to reduction in costs of the products. This trend of automation is gaining popularity at a very slow pace due to huge initial costs associated with it. This problem can be addressed by promoting Wireless I/O's interfaced to Programmable Logic Controllers using Zigbee, which might encourage the industries to take the path of modern automation.

Keywords: Wireless I/O's, PLC, HMI, ZIGBEE Automation System**.**

I. INTRODUCTION

PLC's are solid state devices using integrated circuits to control process or machines. They can store instructions like sequencing counting, timing, arithmetic, data manipulation and communication [7]. A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.PLC reads the status of the external input devices, e.g. Keypad, sensor, switch and pulses, and execute by the microprocessor logic, sequential, timing, counting and arithmetic operations according the status of the input signals as well as the pre-written program stored in the PLC [8]. The generated output signals are sent to output devices as the switch of a relay electromagnetic valve, motor drive, control of a machine or operation of a procedure for the purpose of machine automation or processing procedure.

Zigbee falls in the category of wireless domain like GSM and RF technology. Zigbee provides the wireless communication. It means Zigbee only reduces the cost and maintenance of the wires used for connections else all the process will be same such as Zigbee will provide a particular bit on/off status to the other side due to which same message or data we can get on the other side as wire provides. Thus Zigbee replaces the connecting wires and provides a wireless communication [1]. As the wireless PLCs use modem for transmitting signals from PLC to the process here we are using Zigbee as the communication interface which is used for transmitting and receiving the signals from the PLC to3 process and vice-versa. 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

II. METHOD OF INTERFACING

PLC and SCADA/HMI placed at control room and consists of PLC input and output Module and a TARANG Zigbee for receiving and transferring signal.

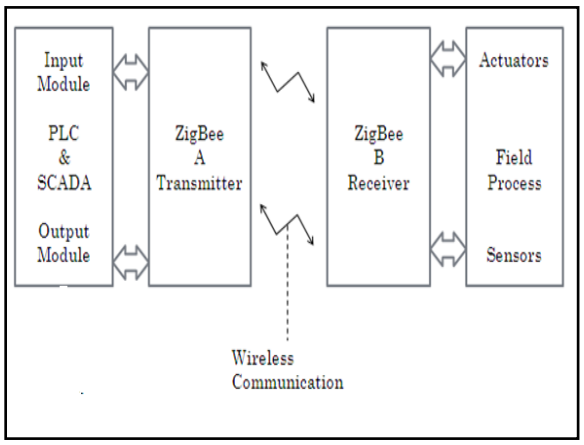

Figure 1 Block Diagram

TARANG Zigbee acts as transreceiver. A pair of TARANG Zigbee transmitter and receiver is used where wireless exchange of data takes place and hence two way communication is done. The application "Monitoring" takes place at the field/process site. It is placed in a remote area and consists of sensors and actuators [1]. The process controlled in the project using a PLC is a Batch process used to manufacture a chemical and the parameters to be controlled and measured is level.

Some applications require specific quantities of raw materials be combined in specific ways for particular durations to produce an intermediate or end result. A batch process performs list of actions in a sequence. It executes a series of non-interactive actions all at one time. Once a batch job begins, it continues until it is done.

One example is the production of adhesives and glues, which normally require the mixing of raw materials in a heated vessel for a period of time to form a quantity of end product. Other important examples are the production of food, beverages and medicine. Batch processes are generally used to produce a relatively low to intermediate quantity of product per year (a few pounds to millions of pounds).

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Benefits of Batch Process

- A batch process can be used to automate much of the work.
- Batch processing can save time and energy by automating repetitive tasks.
- Batch time can be adjusted to meet quality specs
- Slow dynamics permit real-time calculations

Batch process component-

- Process Tank 1(for mixing the two liquids in proportion)
- UNIT Tank 1 (containing liquid A)
- UNIT Tank 2(containing liquid B)
- Stirrer
- Solenoid Valve 1
- Solenoid Valve 2
- Solenoid Valve 2
- High Level Float Switches

The BATCH PROCESS setup is placed in a remote area (field/process site) and is controlled from the control room wirelessly using TARANG Zigbee where PLC, SCADA and the control panel are placed. The process is controlled through SCADA&PLC in auto mode and can also be controlled in manual mode. The process can be controlled and monitored directly from SCADA and also from the control panel.

The main components are TARANG Zigbee and PLC which control the whole process.The TARANG is used as the source and which is used in direct mode.PLC is used to control and monitor the batch process. [1]

III. TARANG ZIGBEE

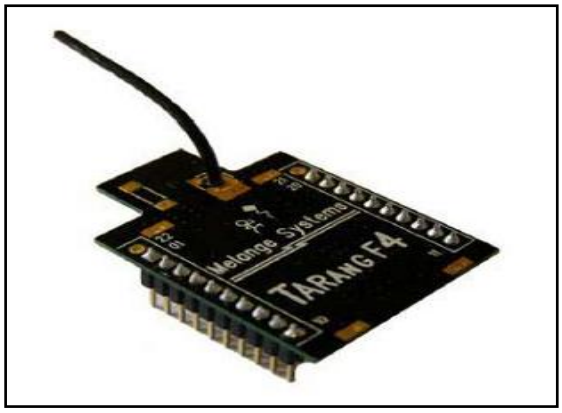


Figure 2 Zigbee TARANG

TRANG modules are designed with low to medium transmit power and for high reliability wireless networks. The modules require minimal power and provide reliable delivery of data between devices. The interfaces provided with the module help to directly fit into many industrial applications. The modules operate within the ISM 2.4-2.4835 GHz frequency band with IEEE 802.15.4 baseband. [3]

IV. ROLE OF TMFT SOFTWARE

TMFT Software is used to configure the TARANG Zigbee via RS -232 or USB cable. [5]

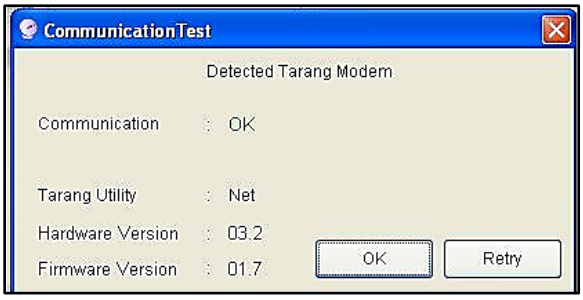


Figure 3 Communication Test

Module Programming:

Step1: Open TMFT Software

Step2: Connect the TARANG module to the Serial/USB Port.

Step3: Choose the appropriate Port and serial parameters in terminal software& press query modem.

Step 4: For setting I/O pins as input and output the following steps should be followed-

Step 5: Enter the command mode with '+++' Response from modem should be ok.

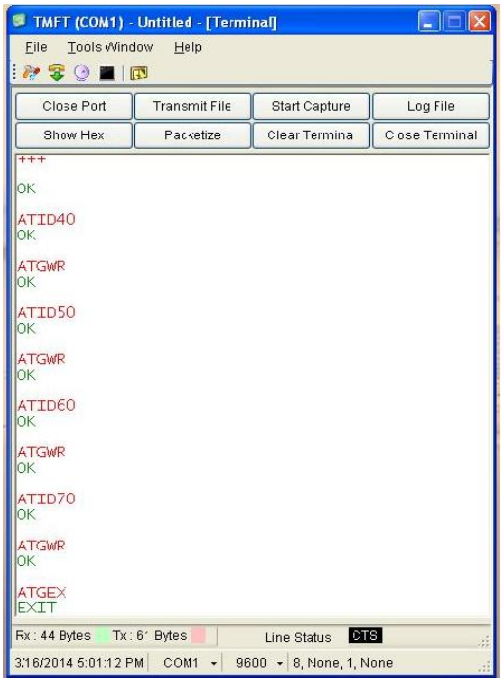
Step 6: Enable the desired I/O pin as input with command ATIDxx. In this example first I/O line ID0 is used. For configuring it to Digital I/O input, send command as ATID02. Response from module should be 'OK'.

Step 7: Write these parameters to memory with 'ATGWR' command.

Step 8: Follow the same steps for configuring I/O pins to INPUT.

Step 9: Exit command mode with 'ATGEX' command.
Note: Once I/O pins are configured to input their default status Will be logic high (3.3V).

Step 10: Enable the desired I/O pin as input with command ATIDxx. In this example first I/O line ID0 is used. For configuring it to Digital I/O input, send command as ATID40. Response from module should be 'OK'.



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V. 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 Process Side & Control Side.

PROCESS SIDE:

The figure 6 shows process side hardware. The components used on process side consist of three tanks, Zigbee, Solenoid valve, Float switch and relay card. The Zigbee receives the data & control the process. The circuit diagram or wiring diagram is given below

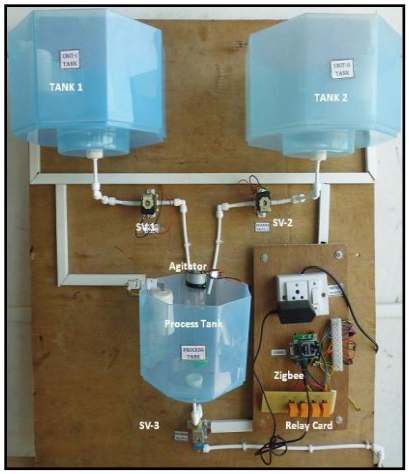

Figure 5 Process Side Hardware

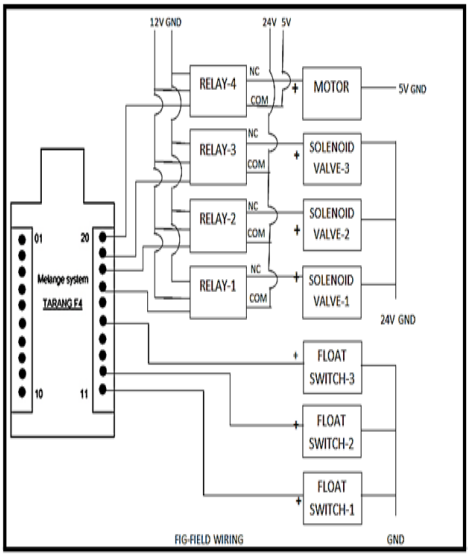

Figure 6 Process Side Wiring Diagram

CONTROL SIDE:

The above figure shows the control panel which controls the field or process site. The main components are TARANG Zigbee and PLC which control the whole process. The TARANG is used as the source and which is used in direct mode.PLC is used to control and monitor the batch process. The circuit diagram or wiring diagram is given below

VI. WORKING

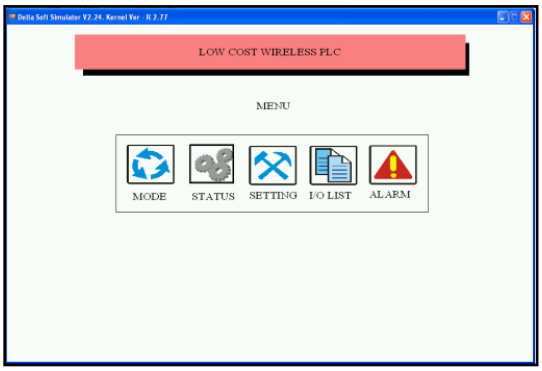

FIGURE 7 CONTROL SIDE WIRING DIAGRAM

When the START button is pressed by the user batch process starts. Then according to control algorithm written in PLC, the control signals from output module of the controller is given to TARANG Zigbee 'A', which acts as a transmitter. The first solenoid valve 1 is ON for time set in HMI screen from UNIT TANK 1 and then solenoid valve 2 is on from UNIT TANK 2. Simultaneously if PROCESS tank becomes overflow then either solenoid valve 1 or solenoid valve 2 is off and avoid overflow condition. After this agitator is on which mix the two liquids uniformly. As soon as agitator is off we get uniform mixed liquid and solenoid valve 3 is on and we get the output. At this operation TARANG Zigbee on process side acts as a receiver and TARANG Zigbee on control side acts as a transmitter

Now if the tank level of UNIT TANK 1, UNIT TANK 2 or PROCESS tank becomes high the signal is received by Zigbee on process side and sends this signal to control side Zigbee which monitor on input section of PLC and SCADA. At this operation TARANG Zigbee on control side acts as a receiver and TARANG Zigbee on process acts as a transmitter.

VII. HMI

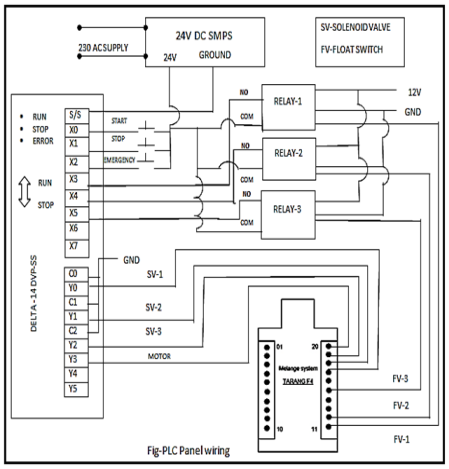

Figure 8 Main Screen of HMI

HMI stands for Human Machine Interface. It is not a full control system, but rather focuses on the supervisory level. As such, it is a purely hardware package that is positioned on top of hardware to which it is interfaced, in general via

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Programmable Logic Controllers (PLCs), or other commercial hardware modules.[6]

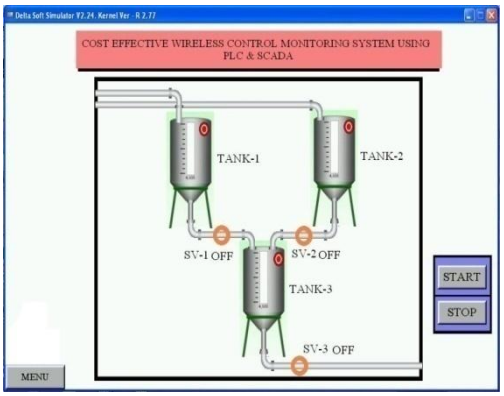

Figure 9 Menu Screen of HMI

It is a small scale control system for automated industrial processes like municipal water supplies, power generation, steel manufacturing etc.

HMI systems monitor and control these operations by gathering data from sensors at the facility or remote station and then sending it to a central computer system that manages the operations using this information. The above figure shows the main MENU screen of HMI. By using this operator can select the mode of operation like auto mode or manual modem, we can check the status of overall process, by using setting we can set the timer for solenoid valve for on and off operation. By using I/O list we can check the status of input and output. Alarm is used for displaying overflow condition.

VIII. CONCLUSION

Batch Process is a very important and a widely used process in today's Industries. This is an effort to eliminate the use of cables for transmission and overcome a major drawback in a mini setup. We achieve the task of monitoring as well as controlling the Batch Process from a remote location via a control panel, PLC program as well as HMI. The parameter controlled in a closed loop process is Level.

We have used TARANG Zigbee to transmit signals wirelessly between the Control room and the Process.

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BIOGRAPHIES

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