Wireless DOL: An Open System Low Cost Wireless DOL Module for Industrial Environment

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Abstract— In existing industries the communication between control feeders and automation controllers is through hard wires. Large industries with hundreds of feeders need lot of wiring and thus huge cost and complexity. In this paper we propose an open system low cost wireless control feeder scheme. We specify this technique taking a DOL feeder and communicating it to the controller. We are using nodeMCU which is having built-in Wi-Fi moduleESP8266to establish the wireless communication.

Keywords: Wireless Communication, Industrial Environments, Wireless Marshalling Module

I. INTRODUCTION

Using wireless communication for control feeders in industrial settings is required to realize industrial IOT. There are now thousands of industrial wired control feeders. So, the next questions are, "How far can we extend the reach of wireless technologies to address the problem of realizing wireless feeders. The solution should also be flexible. We report in this paper wireless scheme that enables different control feeders to communicate wirelessly in an industrial setting. We describe the design and implementation of wireless DOL feeder.

Wireless communication means transfer of information from one place to another without having a physical connection. In this paper we create an Intranet for the Industrial controllers and feeders to communicate wirelessly. In industries, we have power feeders and motor feeders which are connected to the controller directly with the wires. We are intended to integrate those control feeder wires and transmit the signals wirelessly. And the transfer of information can be done in many ways, here we use DOL motor feeder for doing this. DOL means Direct On Line. In this paper, we use two Node MCU's, one for the controller side and another for the control feeder side. Node MCU power ratings are between (0-5) V, but the machines in the industries will operate at 230V power supply. To use Node MCU'sforourapplicationweareusing5V and 24V DC relays and integrate the wires at the controller to Node MCU and Node MCU to control feeder. In order to transfer the data one Node MCU will act as Client while another is acting as server. We are doing the transfer of digital data from one node MCU to another.

For the better understanding of our project, We have explained each component which we used.

II. CONTROLLERS

A. PLC-Programmable Logic Controller Introduction:

Programmable controller is an industrial digital computer which has been adapted for the control of manufacturing processes.

PLCs were first developed in the automobile manufacturing industry to provide flexible, ruggedized and easily programmable controllers to replace hard- wired relays, timers and sequencers.

B. Specifications of PLC 7-1200:

- Programming language : Ladder logic
- Output voltage (Digital) : 0-24v
- Output current (Analog) : 4-20mA
- Digital Inputs : 16
- Digital outputs :16
- Analog inputs : 5
- Analog outputs : 2

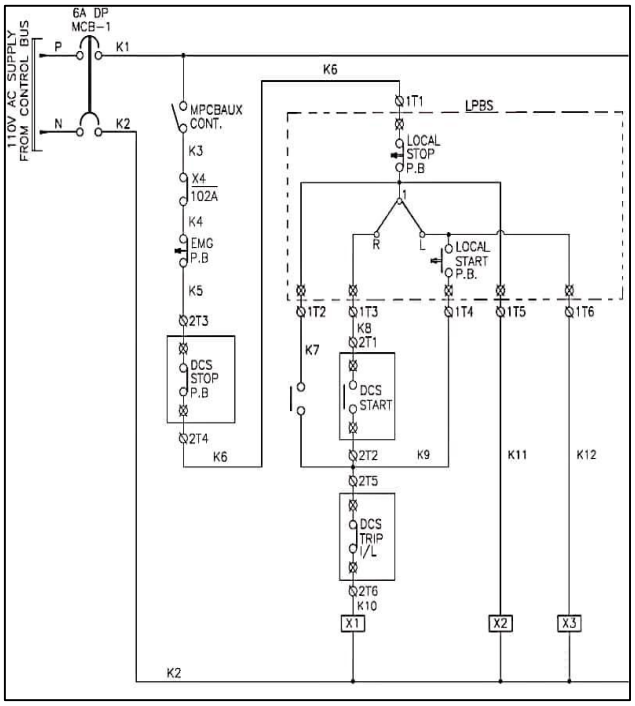
C. Applications:

PLCs are used in almost all the industries.

Communication with the SIMATIC STEP 7 Basic engineering system for programming, with SIMATIC HMI Basic Panels for visualization, with additional controllers for PLC-to-PLC communication and with third-party devices for advanced integration options.

D. Control Feeders

Control feeders may be for controlling motors or for distributing power, called as motor feeders and power feeders industrially. In the industry approximately 95% of the feeders are motor feeders and of them 90% are Direct on Line type. Here the diagram below shows a typical control diagram of a DOL motor feeder.



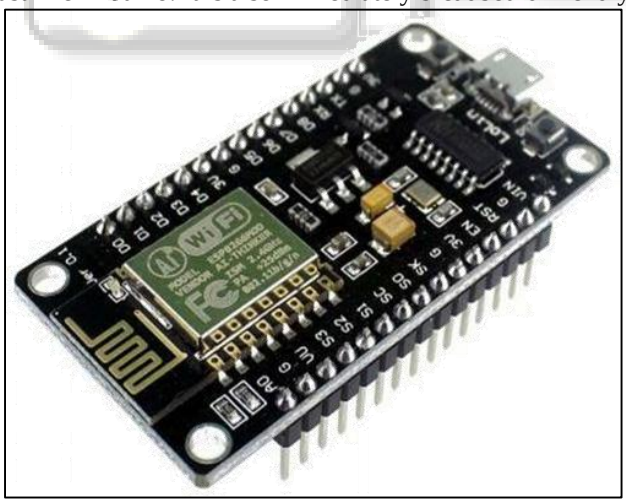
DOL feeder to Controller inputs and outputs

E. Node MCU ESP8266

1) Introduction

The ESP8266 is the name of a micro controller designed by Espress if Systems. TheESP8266itselfisaself-containedWi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications.

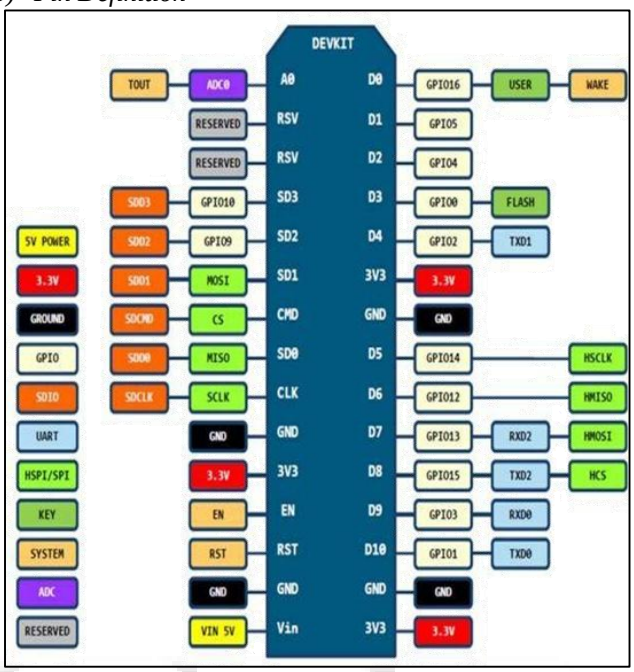
With a micro USB cable, you can connect Node MCU dev kit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.



2) Specification:

- Voltage: 3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Current consumption:10uA~170mA.
- Flash memory attachable: 16MBmax (512Knormal).
- Integrated TCP/IP protocol stack.
- Processor: Tensilica L10632-bit.
- Processor speed:80~160MHz.
- RAM: 32K +80K.
- GPIOs: 17 (multiplexed with other functions).
- Analog to Digital: 1 input with 1024 step resolution.
- +19.5dBm output power in 802.11b mode.
- 802.11 support:b/g/n.
- Maximum concurrent TCP connections.

3) Pin Definition

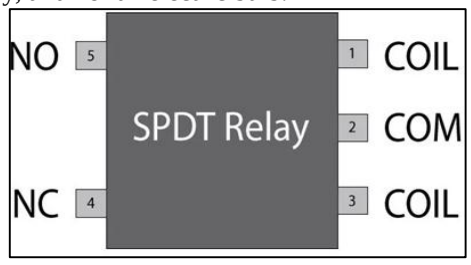


F. Arduino IDE

The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a Wi-Fi/Serial transceiver. However, this is not convenient. What we recommend is using the very cool Arduino ESP8266 project, which is a modified version of the Arduino IDE that you need to install on your computer. This makes it very convenient to use the ESP8266 chip as we will be using the well-known Arduino IDE. Following the below step to install ESP8266 library to work in Arduino IDE environment.

G. Relays

Basically, PLCs operate at 24Vs and Node MCUs at 3.3Vs. In order to interface these two we need to use 5V and 24V relays before giving and accepting the signals. Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage. For example, a relay can make a 5V DC battery circuit to switch a 230V AC mains circuit. Thus a Small sensor circuit can drive, say, a fan or an electric bulb.



1) Input and output integration of NodeMCU with DOL feeder

DOL feeder has contactor in it. Using the free contactors, we can connect the Node MCU to feeder to transmit the signal. But the problem is feeder can accept only 24V and the signal coming from the Node MCU is of 5V. Therefore we need to use a 5V relay to interface them. In the same way the output of feeder has to convert into 5V to connect with Node MCU, so we use a 24V relay there.

2) Input and output integration of NodeMCU with controller

The connections are same for the controller side too. We have to use a 5V relay to transfer the data to controller from Node MCU and a 24V relay for the data coming from the controller to Node MCU.

III. WORKING METHODOLOGY

To implement this, we create a network. We connect one Node MCU at control feeder and another NodeMCU at controller using relays as shown in the input and output integration part mentioned above. They both communicate wirelessly through the network.

The above demonstration is for a single feeder. The same process can be done with another DOL feeder of the Control panels.

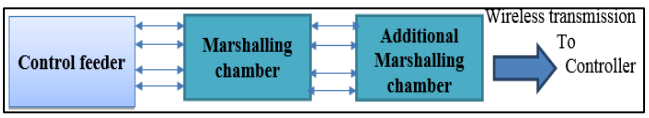
The entire control panel inputs and outputs are connected at one marshalling chamber of the control panel. Typical marshalling chamber looks as shown in figure below.

Marshalling box

Now to communicate the entire panel an additional marshalling chamber, which houses all NodeMCUs, is created and connected as shown.

A. Traditional Method:

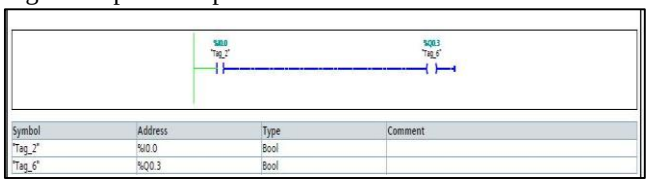
B. Proposed Method:



This additional marshalling chamber needs its temperature to be maintained.

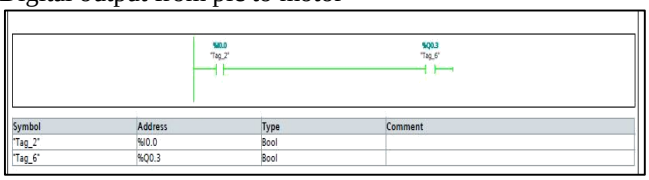
IV. RESULTS

Digital output from plc to motor



When motor is off

Digital output from plc to motor



When motor is on

V. CONCLUSION

By integrating the wiring between control panels and control feeders we can reduce lot of hardwires for the longer distances and the plant may look simple. This will reduce the cost of plenty of wires and maintenance. Therefore, wireless communication is advantageous over the wired communication as we can work without the hassles of wires and network cables and enhance overall productivity and also at a higher speed.

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