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Ethernet Modbus/TCP based Weighing Transmitter

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***Abstract*: Ethernet has become the de-facto standard for high speed communication. Popularity of Internet has spread the use of this technology. Weighing Transmitter is a very important part of any process industry to transmit the weight information from factory/shop floor to the Plant Control System (PLC/DCS/SCADA). Transmission of Weight Signals in the Factory is done either using Analog signals (0-10Vdc/4-20mA/etc.) or using Digital communication protocols like Modbus RTU/PROFIBUS/etc. using interfaces like RS485/RS232/CAN/etc. Ethernet is fast gaining popularity in the shop floor with different devices being introduced by vendors Ethernet/IP, Modbus/TCP, Profinet, EtherCAT are some popular industrial Ethernet protocols which have found wide acceptability in Shop floor automation products. Ethernet/IP based Weighing Transmitters have been introduced by some manufacturers. As of date, we have not come across Modbus/TCP based Weighing Transmitters from any manufacturer. Considering the popularity of Modbus/TCP for other Plant control systems, we feel it is an important & un-explored need that can be addressed by this Project. This project aims to combine both technologies and create an Ethernet Modbus/TCP based Weighing Transmitter to bring the speed and ease of Ethernet interfacing to the Factory and Automation Industry**

***Keywords*: Load cell, ARM cortexM3, ADC, DAC, Ethernet, USB, Leaded veriestor, Voltage regulator, Transreciever.**

1. Introduction

In an industrial sector, there are a number of tools which are used, these tools basically make it possible to do the entire work in a proficient way so that there will be no scope for making errors. As we know that weighing is very important part of any process industry. Suppose we are working in chemical industry and if any mistake doing in weighing process then it can be explosive or dangerous. Similarly if company are making a small packet of product and the quantity is different in some packet then it create a bad impression of company in market. The transmission of Weight Signals in the Factory is done either using Analog signals (0-10Vdc/4-20mA/etc.) or using Digital communication protocols like Modbus RTU/PROFIBUS/etc. using interfaces like RS 485/RS232/CAN/etc. Analog signal have major disadvantages like hardware complexity, signal distortion, external interference, low signal resolution etc. basically it is scaled based system. Many problem are overcome by digital communication protocol but still some issues are there like No plug and play facility, Low speed and low volume data transmission.

2. Problems

Analog Transmission: Signal distortion due to cable length possible in situations where a signal often has high signal-to-noise ratio and cannot achieve source linearity and long distance, high output systems. Analog is unattractive due to attenuation problems. External interference can affect signal quality, Noise and interference cannot be completely removed in the transmission of an analog signal, with good engineering and proper installation. Digital transmission: No plug and play facility, if you connect a Plug-and-Play any external device to the any port on your computer, it will begin to work within a few seconds of being plugged in. A non-plug-and-play device would require you to go through several steps of installing drivers and setting up the device before it would work. Low speed and low volume, you can have a lot of issues trying to get the RS485 network to work correctly. You must deal with wire termination issues, network termination issues and more configuration issues with Ethernet Modbus/RTU devices. It is generally accepted that RS-485 can be used with data rates up to 10 Mbit/s. Or, at lower speeds, distances up to 1,200 m (4,000 ft.).

3. Objective

This project is based on the modern concept of the weighing transmitter in process industry. It is suitable for all status development in industries. This project is making great strides in term of technological innovation and continuing to bring a multiple of few concepts to the market including high performance indicator and weight transmitter at extremely completive price. With the advent popularity of Ethernet based protocol high volume data can now easily be transmitted across globe in the fraction of seconds. Bringing the ease and speed of Ethernet based communication standard to the factory by integrating in it a weighing transmitter will simplify the plant network architecture and enable seamless and high speed communication from the factory to the control system and further to MIS system for reporting and analyzing.

4. Outline

Load cell and Ethernet Modbus/TCP is the core of our project. In this project load cell act as a sensor. This is sense the weight and give the analog output to ADC (analog to digital converter), ADC convert the analog output into digital output. After getting digital value ARM cortex M3 start processing according to code. 3.3v power supply is given to the ARM cortexM3 microprocessor. Finally by using the Ethernet Modbus/TCP protocol start the communication between the weighing transmitter and control system (PLC, SCADA, DCS).

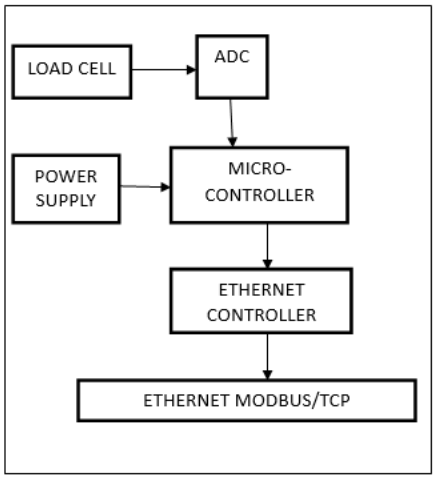

Fig. 1. Block diagram

5. Proposed methodology

It work on the principle of protocol system that is user by using Ethernet protocol to communicate between the weighing transmitter and control system(PLC, SCADA, DCS).Ethernet Modbus/TCP is half duplex type of communication. When weighing transmitter transmit the data to the control system the next data will not be transmit until the feedback given by the control system .that is the mean reason we are choose Ethernet Modbus/TCP protocol. Ethernet is open source system that why do not need to pay any globe for Ethernet.

6. Hardware

ARM cortex M3 processor: The LPC1769 are ARM cortex M3 based microcontrollers for embedded application featuring a high level of integration and low power consumption. The arm cortex m3 is the next generation core that offers system enhancements such as enhances debug features. The LPC1769 operates at CPU frequencies of up to 120MHZ. the ARM cortex M3 CPU incorporates a three stage pipe line and uses Harvard architecture with separate local instruction and data buses as well as third bus peripheral. The LCP1769 are pin-compatible to 100 pin LPC236x ARM7-based microcontroller series. Sigma-Delta ADC: The CS5532 are highly integrated analog to digital converter which use charge-balance technique to achieve 24bit performance. The ADCs are optimized for measuring low level unipolar or bipolar signals in weigh scale, process control scientific and medical application. To ease communication between the ADCs and microcontroller, the converters include a simple three wire serial interface which is SPI and micro-wire compactible with Schmitt trigger input on the serial clock. Load cell (strain gauge): A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. The various load cell types include hydraulic, pneumatic, and strain gauge. Strain gauge load cells are the most common in industry. These load cells are particularly stiff, have very good resonance values, and tend to have long life cycles in application. Strain gauge load cells work on the principle that the strain gauge (a planar resistor) deforms when the material of the load cells deforms appropriately. Deformation of the strain gauge changes its electrical resistance, by an amount that is proportional to the strain. The change in resistance of the strain gauge provides an electrical value change that is calibrated to the load placed on the load cell.

The output of the transducer can be scaled to calculate the force applied to the transducer. Sometimes a high resolution ADC, typically 24-bit, can be used directly. A six-wire configuration is used. The two additional wires are "sense" (Sen.+ and Sen.−), and are connected to the bridge with the Ex+ and Ex- wires, in a fashion similar to four-terminal sensing. With these additional signals, the controller can compensate for the change in wire resistance due to e.g. temperature fluctuations. The bridge is typically electrically insulated from the substrate. The sensing elements are in close proximity and in good mutual thermal contact, to avoid differential signals caused by temperature differences.

ETHERNET: The DP83848C is a robust fully featured 10/100 signal port physical layer device offering low pass consumption, including several intelligent power down states. The DP83848C includes a 25 MHZ clock out this means that the application can be design with a minimum of external part, which in turn results in the lowest possible total cost of the solution. The DP83848C easily interface to twisted pair media via an external transformer. Both MII and RMII are supported ensuring ease and flexibility of design. The DP83848C futures integrated sub-layers to support both 10 BASE-T and 100BASE-TX Ethernet protocol, which ensures compatibility and interoperability with all other standers base Ethernet solution.

7. Software details

A. Software required

- Kiel software
- EAGLE Software
- *Kiel Software:* Kiel MDK is the complete software development environment for a wide range of Arm Cortex-M based microcontroller devices. MDK includes the µVision IDE and debugger, Arm C/C++ compiler, and essential middleware components. It

supports all silicon vendors with more than 5000 devices and is easy to learn and use.

- *EAGLE Software:* The EAGLE Software Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics.

8. Conclusion

In this paper, we have studied Ethernet Modbus/TCP based weighing transmitter .fast and accurate transmission is possible with the help of Ethernet Modbus/TCP protocol. The proposed system is simple, fast and cost effective. It acts as connection between weighing transmitter and the control system (PLCs SCADA). The hardware for this project is implemented and output results are verified successfully.

References

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