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Design of Ultrasonic Water Flow Measurement

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Abstract:- The main objective of this design is to flow measurement of water by using ultrasonic sound waves which is ideal for providing highly accurate measurement across wide-flow ranges as low as 1.4 GPM. The design is fully compatible with RF-Plug-in evaluation module for Wireless advanced metering infrastructure (AMI) which is used in Smart grid application. The implantation of demand response and demand control programs are supported by AMI, communication is performed well through wireless medium. The goal of an AMI is to provide utility with real-time data about power consumption by through Centralized routing which reduces operational cost and remote meter control. This system is based on single Ultra-Low power Ferroelectric RAM (FRAM) Microcontroller, processes optimized signal processing with the frequency of 2.4GHZ for RF wireless communication modules. FRAM Microcontroller provides speed, flexibility and reliability of flash, all at lower power consumption. On concluding that, the test results captured by varying the flow of water multiplies times throughout the day to validate the system across time and temperature.

Key Words: Ultrasonic flow meter, Audiowell transducers, Advanced metering infrastructure (AMI) network, Ultrasonic low power microcontroller (MCU).

I. INTRODUCTION

Evolution of a new product which provides some advancement about existing system, should have improvement in maximization of measurement accuracy in energy management and minimization of total power consumption of new system. An ultrasonic flow meter provides reliable power consumption and energy management. Unlike the existing system, it does not only measure the depth and angle of flow measurement, but also provides approximation on values without measuring the angle. The flow meter that measures the velocity of a fluid with ultrasound to calculate volume flow, averaging the difference in measured transit time between the pulses of ultrasound propagating into and against the direction of the flow. Ultrasonic flow meters are affected by the acoustic properties of the fluid and can be impacted by temperature, density, viscosity and suspended particulates depending on the exact flow meter. They are often inexpensive to use and maintain because they do not use moving parts, unlike mechanical flow meters.

II. PROPOSED SYSTEM

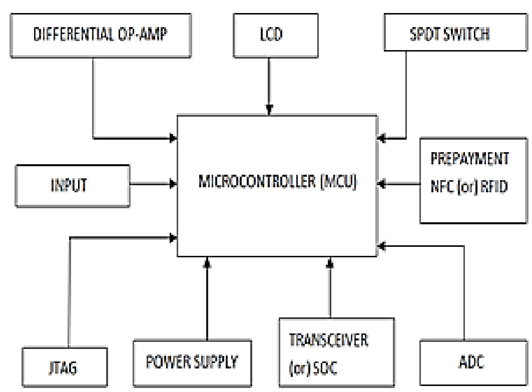

Fig1: Proposed Method

III. WORKING PRINCIPLE

By using analog components we are passing analog signals such as ultrasound waves, it is generated by audiowell transducers. An audiowell transducer is made up of a brass type material ,so audiowell has developed two models of brass pipe such as DN20 and DN24 adopting popular U-type reflecting structure.
Transducer converts mechanical vibration to electrical signals or generates mechanical vibrations that is driven by electric field .By using audiowell model the signal is validated for the flow measurement.

The design is fully compactable with RF-plug in evaluation modules for wireless advanced metering infrastructure (AMI) networks which is used in small grid applications.The design set up provides how much water flows across the pipe and it can be also detected that whether the setup is having any volume leakage or zero volume leakage.

The ultrasonic waves where passed from where the liquid starts to flow and ends ,stored up in a tank.The input is given as ultrasonic waves which is fed into Microcontroller(MCU) unit and it processes the signal.

The system also consist of prepayment Near-Filed communication (NFD) and Radio frequency Identification (RFID).It is possible to measure the flow,when it is.But when it is Far-Field communication radio-frequency of two-modulated signals is identified and then the flow is measured.

Flow rate is measured in GPM.While the flow rate is the amount of water moving the velocity is the speed at which the water is moving.The waters velocity is measured in Feet Per Second(FPS). Then finally analog signal is converted into digital signal by using ADC and then it is displayed by LCD.

IV. ULTRASONIC LOW POWER MICROCONTROLLER (MCU)

This system is based on single Ultra-Low power Ferroelectric RAM (FRAM) Microcontroller (MSP430) processes optimize signal processing with the frequency of 2.4GHZ for RF wireless communication modules.The most important feature of the MSP430 is its low power consumption. However, the flexibility of its peripheral modules and the easy way to use it is the reason why this microcontroller is also used as a general purpose microcontroller.

1. Ferroelectric Random Access Memory (FRAM)

As the name of the memory implies, the ferroelectric RAM technology depends upon the ferroelectric effect for its operation. Itprovides the same features as that of flash memory. If a field is applied to the crystal in the required plane, then the atom will move in the direction of the field. The two states of the ferroelectric material are referred to as 'up polarisation' when the atom is on the top position, and 'down polarisation' when the atom is in the bottom position.

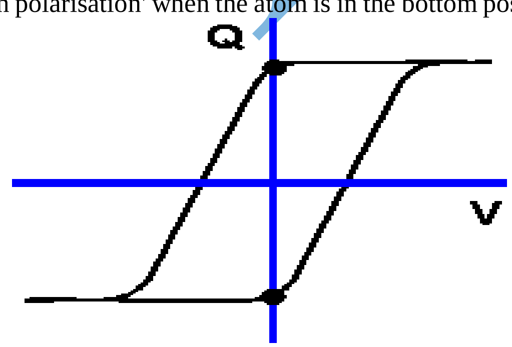

Fig2: Ferroelectric hysteresis loop

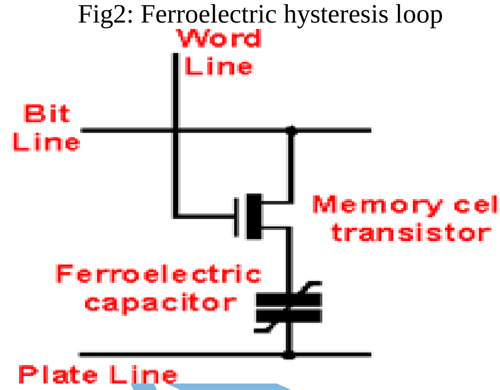

Fig3: Basic Ferroelectric memory cell

The key to the operation of the FRAM is that the capacitance of the ferroelectric capacitor is variable. If the capacitor is not switched when an electric field is applied, i.e. no change in polarization. However if is switched, then an additional charge is induced and this must have resulted from an increase in capacitance.To enable this effect to be used in a memory cell an additional active element, a FET is used. The cell has a word line and also a bit line to enable the individual cell to be accessed.

V. DUAL-BIT DUAL-SUPPLY BUS TRANSCEIVER

The SN74LVC2T45 is dual-bit, dual-supply non inverting voltage level translation. Pin Ax and direction control pin are support by VCCA and pin Bx are support by VCCB. The A port and B port is able to accept I/O voltages ranging from 1.65 V to 5.5 V.The high on DIR allows data transmission from A to B and a low on DIR allows data transmission from B to A. The logic levels of the direction-control (DIR) input activate either the B-port outputs or the A-port outputs.

Input DIRECTION	OPERATION OF PORTS
L	B data to A bus
H	A data to B bus

VI. DIFFERENTIAL AMPLIFIER

At common mode, the emitter voltage follows the input voltage variations; there is a full negative feedback and the gain is minimum. At differential mode, the emitter voltage is fixed (equal to the instant common input voltage); there is no negative feedback and the gain is maximum. There are three modes of operation,

- Normal mode
- Overdriven mode
- Breakdown mode

VII. TRANSCEIVER (OR) SYSTEM ON CHIP (SOC)

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Transceiver (or) System on Chip (SOC) which is used to transmit and receive signals by using two ports, port A and port B . When port A is used to transmit the signal , port B is used to receive the signal which is called as downstream. Similarly, when port B is used to transmit the signal , port A is used to receive the signal which is called as upstream. So it can be decided that either port A or port B is made as transceiver.

VIII. JOINT TEST ACCESS GROUP(JTAG)

The power supply is given as 3.3 V is given to the test setup. This setup utilizes a water reservoir with a motor pump water .This motor can operate manually or automatically and it controls to debug the errors of the flow meter.

IX. BUILDING WATER FLOW RATE CALCULATION & MEASUREMENT PROCEDURE

The equation of continuity states that flow rate can be calculated from the multiple of the velocity times the cross-sectional area of flow,

Q = A x V or V = Q/A

where,

Q = flow rate in ft3 / second

A = cross sectional area flow in sq. ft. of the pipe(A = π x D2/4 and of course pi or π = 3.1416)

V = velocity in ft/sec

X. TEST RESULTS

As water moves through any pipe, pressure is lost because of turbulence created by the moving water. The amount of pressure lost in a horizontal pipe is related to the velocity of the water, the inside diameter of the pipe, and the length of pipe through which the water flows. When velocity increases, the pressure loss increases. Increasing the pressure in the system increases the flow rate.

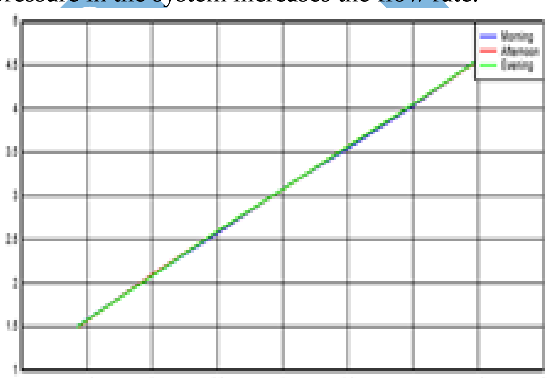

Fig4: Test data

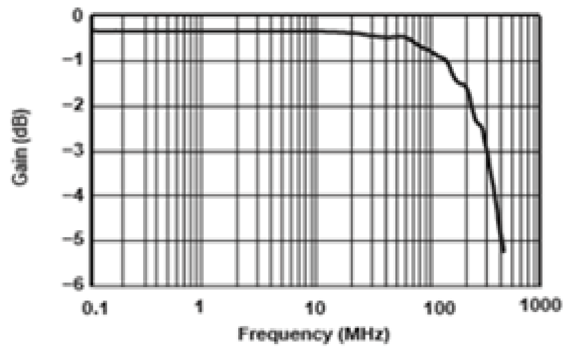

Fig5: Bandwidth (V+=3.3V)

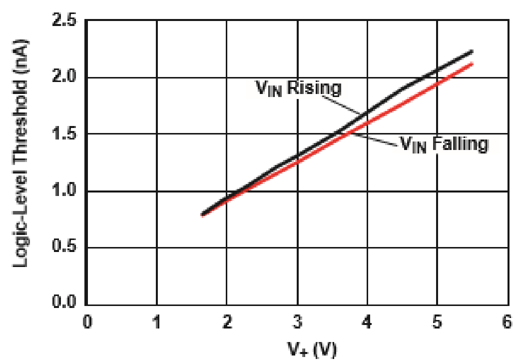

Fig6: Logic Level Threshold vs V+

XI. CONCLUSION

The test results were captured by varying the flow of water multiples times throughout the day to validate the system across time and temperature. The accuracy error of the system was approximately 1% based on the captured test data.The current consumption of the system is approximately 20 uA.

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