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MEASUREMENT OF POWER CONSUMPTION BY USING VARIOUS COMPONENTS INAN EMBEDDED SYSTEM

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ABSTRACT

The Accurate measurement and analysis of pH data is necessary for a multitude of applications ranging from agriculture sector to clinical laboratories. Preferably an inexpensive hand-held unit is needed for these applications. This paper presents the modeling of embedded systems for measurement of pH using 8051 microcontroller.

In Battery operated embedded systems, power saving is most important thing. We require to measure power consumption of embedded system. For that purpose in this project, we can measure current taken by each and every module by using DMM. Integrated solutions, involving power awareness at all levels (from the application, OS, and compiler level, down to memory and processor hardware resources), is another trend that is the outcome of chip-level power and temperature limits. Again, such hardware software code sign approaches are far from new in the world of embedded systems. Hence, high-end chip and system design teams stand to gain a lot by examining the low-end, embedded systems arena. This is an interesting new turn of events, brought on by current technological trends that dictate a rather rapid powerconsumption increase over the nextdecade.

With embedded systems moving toward faster and smaller processors and systems on a chip, it becomes increasingly difficult to accurately quantify embedded-system behavior. Therefore measurement of power consumption in an embedded system is very important.

KEYWORD-Microcontroller 8051, pH sensor, Power measurementin embedded system, DMM

INTRODUCTION

This paper motivates the use of simulated embedded microcontrollers for system. The pH meter has innumerable applications in industry and R&D laboratories. Although several attempts have been made to design analog and digital pH meters, its suffer from

limitations like compactness, complexity in design, lack of storage and serial communication facilities etc., which are very important for research applications. Then microcontroller 8051 based pH meter overcomes the above difficulties.

The Hydrogen ion concentration in the solution is measured as pH. The pH scale ranges from 0 to 14. A solution with pH 7 is considered as neutral and with pH 0 as highly acidic and with pH 14 is considered as highly basic. Many important properties of a solution can be determined from accurate measurement of pH, including acidity of the solution and the extent of reaction in the solution. The microcontroller computes mV readings from the ADC chip and converts it to pH scale.

Also we goes for measurement of power taken by each and every component used in our project that is power consumed by microcontroller8051, LCD and ADC 0808 from power supply. It gives us idea about total power consumed by whole embedded system used in our project and efficiency of battery operated embedded system.

Block Diagram

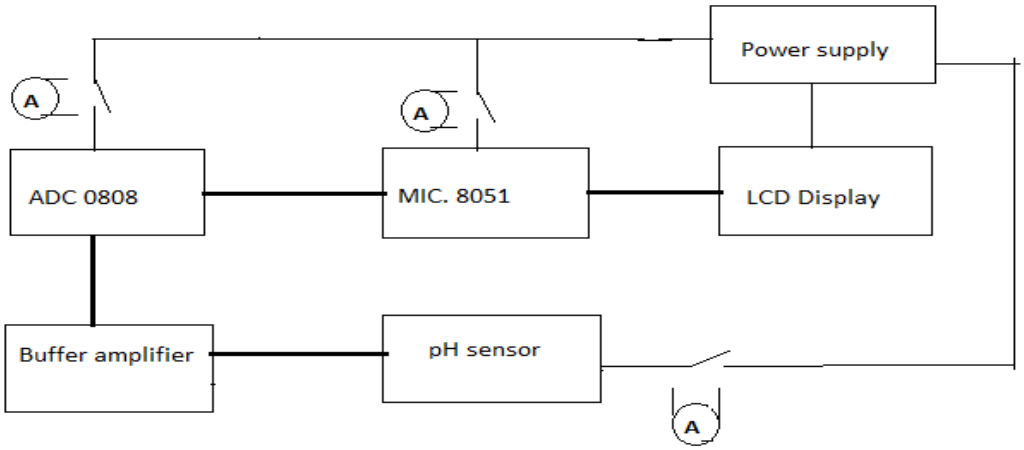

Fig.1 Block diagram of microcontroller based pH measurement

The main motto of our project is to measure the power taken by the every module that are used in our project e.g. - measurement of power taken by microcontroller, LCD display, ADC 0808 and sensor used in our project i.e. pH sensor. For this purpose we can install one application i.e. measurement of pH.of various solutions. To measure power taken by each module we can connect the ammeter in series with the power line (supply line between source and module) as shown in block diagram.

Hardware description

1. pH probe –

The meter is designed to read the DC potential of + 1.0000 full scales. The glass electrode for pH measurement produces approx. +414mV output for pH 0-14. This makes the meter is able to use with many types of electrodes. The specification is as follows.

- Measurement range: 0.00-14.00 pH
- Resolution: 0.01 pH
- Accuracy: ± 0.05 pH
- Operating temperature: 0ºC-50ºC
- Dimensions: 150mm
- Cable length: 1.2m (3.93ft)

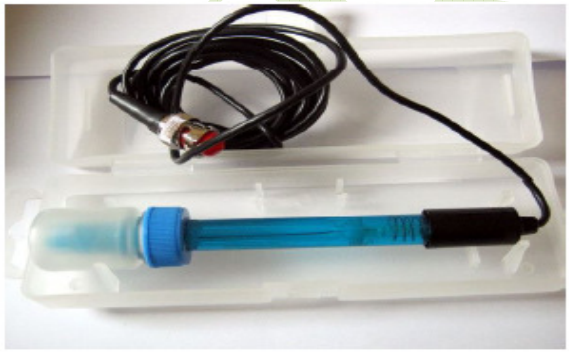

Fig.2 pH probe [1]

2.Microcontroller 8051 –

The 8051 microcontroller is an 8-bit microcontroller introduced by Intel Corporation. this microcontroller has 128 bytes of Random Access Memory(RAM), 4K bytes of on-chip Read Only Memory(ROM), two timers, one serial port and four port(each 8-bits wide) all on a single chip. The Central Processing Unit (CPU) can work only on 8-bit of data at a time. The 8051 has four I/O ports, each 8-bit wide.

3. ADC 0808 –

Analog-to-digital converters are among the most widely used devices for dataacquisition. We need an analog to digital converter to translate he analog signals to digital numbers so that the microcontroller can read and process them. In our project we use the ADC 0808.

Circuit diagram

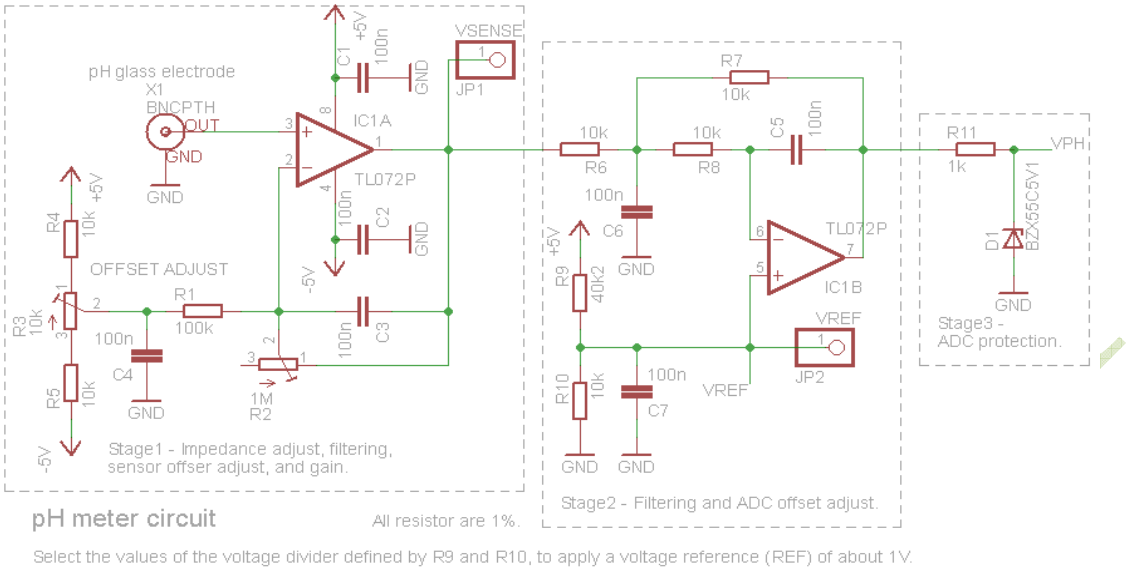

Fig.3 pH measurement [2]

The electrode is placed inside the beaker filled with a solution whose pH is to be measure. The glass bulb welded at the end of the measurement electrode consists of lithium ions doped to it which makes it act as an ion selective barrier and allows the hydrogen ions from the unknown solution to migrate through the barrier and interacts with the glass, developing an electrochemical potential related to the hydrogen ion concentration. The measurement electrode potential thus changes with the hydrogen ion concentration. On the other hand, the reference electrode potential doesn't changes with the hydrogen ion concentration and provides a stable potential against which the measuring electrode is compared. It consists of a neutral solution which is allowed to exchange ions with the unknown solution through a porous separator, thus forming low resistance connection to complete the wholecircuit. The potential difference between the two electrodes gives a direct measurement of the hydrogen ion concentration or pH of the system and is first preamplifier to strengthen it and then given to the analog to digital converter , in which the analog data is converted into specified digital signal and then gives corrective digital signal to the 8051 microprocessor.

In 8051 microprocessor signal coming from ADC 0808 compared with the data stored in the log or in memory and find out exact result and displayed on the LCD.

$$U = E_{pH} - E_{ref}$$

E_{pH}– Voltage potential of measurement electrode

E_{ref} – Voltage potential of reference electrode

The pH is calculated based on the Nerns't equation which states that change in total potential for every change in pH is

$$U = -kTpH$$

k- Boltzmann's constant, T- temperature

Power measurement

Integrated solutions, involving power awareness at all levels (from the application, OS, and compiler level, down to memory and processor hardware resources), is another trend that is the outcome of chip-level power and temperature limits. Again, such hardware software co design approaches are far from new in the world of embedded systems. Hence, high-end chip and system design teams stand to gain a lot by examining designs at the low-end, embedded systems arena. This is an interesting new turn of events, brought on by current technological trends that dictate a rather rapid power consumption increase over the next decade. Historically, it has been the embedded processor designers who have had to evolve their cores toward more and more complex micro architectures to meet increased system-level, application-driven performance demands.[3]

In our project we measure the power consumed by every module and compare these value with its data log sheet value and try find out total energy consumption in whole circuitry and given design economical or not.

CALIBRATION AND RESULTS

After designing of pH meter we done calibration in the laboratory by using various buffer solutions, while designing of gain of amplifier we measure the output voltage given by pH sensor and then according standard value of buffer solution we design the gain of the buffer amplifier. Finally we measure the pH of various solutions which are shown in following table no 1.

Table no- 1. Observation for pH measurement

Sr.no	Solution name	Standard pH value (S .pH)	Reading of our pH meter (C. pH)	% error = $\frac{\text{S. pH} - \text{C. pH}}{\text{S. pH}}$
1	Standard buffer sol.	4.2	3.94	6.1
2	Standard buffer sol.	9.3	8.96	6.5
3	Distilled water	7	6.43	8.14

Similarly we measure the power taken by every module used in our embedded system by using digital multimeter and compared those reading with the standard data log sheet provide by the module designer or seller. Following table no. 2 shows a measurement of power consumption by component used in our project.

Table no.-2. MeasurementPower consumption

Sr.no	Module name	Standard value (A) watt	Measure value (B) Watt	%error = $\frac{\text{A} - \text{B}}{\text{A}}$
1	Whole kit	-	0.132	-
2	8051 microcontroller	0.074	0.081	-8
3	ADC 0808 and other	0.03	0.035	-16.6
4	LCD	0.012	0.016	-6.66

CONCLUSION

Finally we conclude that the measurement of pH of any solution is necessary in variousindustries to maintain their quality hence such project gives effective result in this era. Also the measurement of power consumption for every component used in embedded system and we conclude that the effective use of various module increase the overall performance of system and gives better results and helps in the low cost signal conditioning circuit was designed using inexpensive components and without external memory by utilizing on-chip and unused flash memory.

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