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Designing of Water Quality Detector Using pH Sensor

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Abstract: In this paper a novel technique has been developed to determine the water quality in order to identify whether the water is drinkable or not. This approach uses an electronic circuit consisting of pH sensor, comparator (741- 8 pin IC), ADC (0808-28 pin IC), micro controller (A89s51-40 pin IC), and LCD (2 lines x 16 characters) for the purpose of output display. Micro controller based program has been generated and results are observed with the help of pH sensor for different water samples. *Copyright © 2009 IFSA.*

Keywords: pH sensor, Comparator, ADC, Micro controller, LCD Device

1. Introduction

The history of measuring the acidity of liquids electrically began in 1906 when Max Cremer in his studies of liquid interfaces discovered that the interface between liquids could be studied by blowing a thin bubble of glass and placing one liquid inside it and another outside. It created an electric potential that could be measured. This idea was taken further by Fritz Haber and Zygmunt Klemsiewicz who discovered that the glass bulb could be used to measure hydrogen ion activity and that this followed a logarithmic function.

Earth is the “water planet” having 80 % of its part covered with water or ice but less than 2 % of earth’s water is drinkable. In this study, we are proposing an idea of a water quality detector based on pH sensor determining the acidic, neutral or basic nature of available water samples.

The paper is organized as follows: Section II gives the working guidelines of the pH sensor, Section III describes Comparator and ADC, Section IV explains about micro controller, Section V shows the

experimental set-up & measurements performed, Section VI gives the results obtained and Section VII draws the conclusion. The block diagram for the detector is shown in Fig. 1.

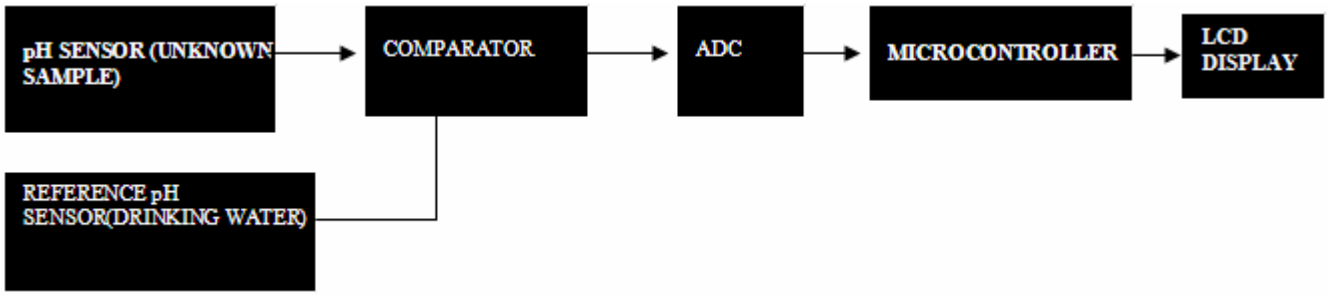

Fig. 1. Block Diagram for Detector.

2. pH Sensor

pH refers the percentage of hydrogen ions in a given solution. A pH sensor is a device (shown in Fig. 2), which converts the pH value in to corresponding voltage when immersed in a solution. In pH scale, as shown in Fig. 3, drinkable water has pH value of 7. Most natural waterfalls are in the range of 5-8. It gives 2 Volts for pure water sample.

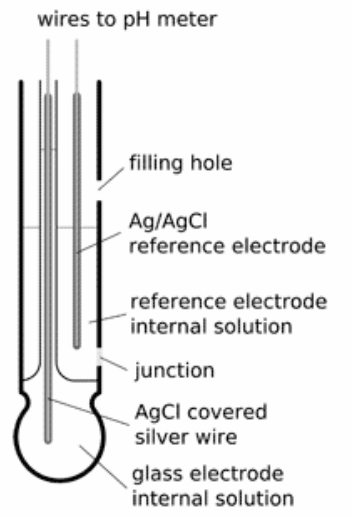

Fig. 2. pH Sensor.

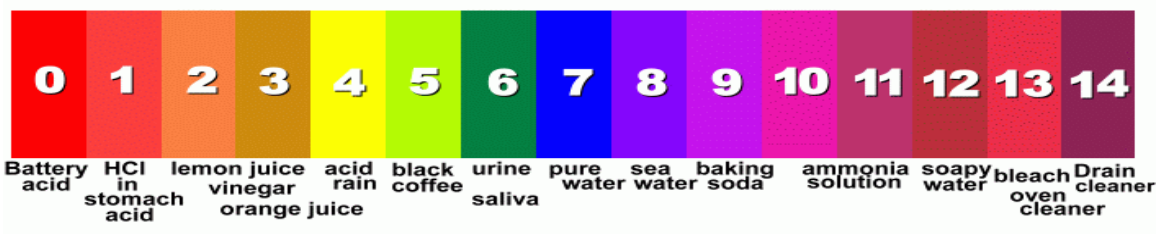

Fig. 3. pH Scale.

The pH Sensor is a combination of electrodes [4], which combines both the glass and reference electrode into one body. The bottom of a pH sensor balloons out into a round thin glass bulb. The pH sensor is best thought of as a tube within a tube. The inside most tube contains an unchangeable saturated KCL and a 0.1 M HCL solution, acting as the cathode terminal of the reference electrode. The anodic terminal wraps itself around the outside of the inner tube and ends with the same sort of reference electrode as was on the inside of the inner tube.

3. Comparator and ADC

The comparator used is 741 IC [5]. It compares the voltage of given sample of water with reference sample i.e. with the voltage of pure water [1].

The ADC chip used here is ADC0808 from national semiconductors consisting 8 analog inputs. This ADC will convert the given analog voltage to its digital value. The block diagram of 0808ADC chip is shown in Fig. 4. The analog input channels are multiplexed and selected using 3 address pins. In this chip, Vref (+) and Vref (-) set the reference voltage. The step size used is of 10 mV.

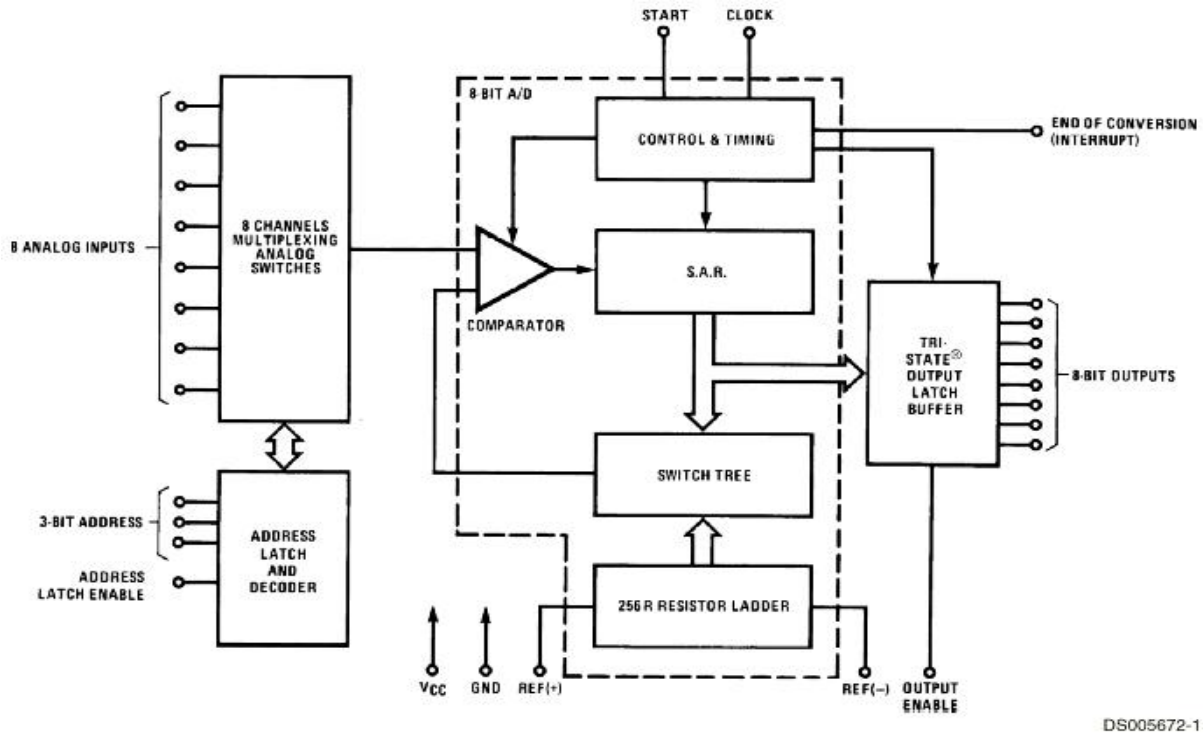

Fig. 4. Block Diagram of 0808ADC chip.

4. Microcontroller

Intel corporation chip AT89s51 micro controller has been used, shown in Fig. 5, in the circuit [2]. It has 128 Bytes of RAM, 4 Kbytes of on given chip ROM, 2 timers, 1 serial port and 4 ports (each 8-bit wide), all on a single chip [3]. The program for water quality detector is generated as follows in which we compare the water sample voltage with the voltage of pure water using pH sensor and the results are displayed on LCD device (Appendix).

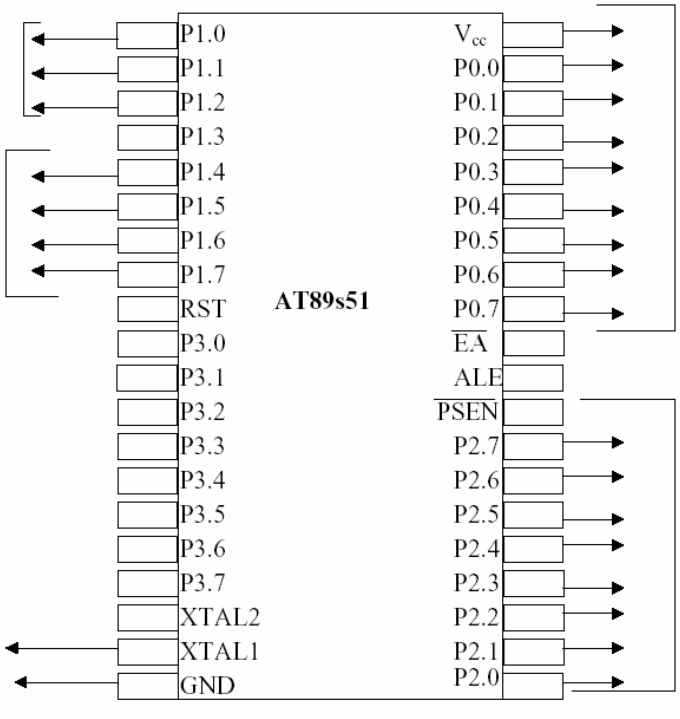

Fig. 5. Pin configuration of micro controller AT89s51.

5. Experimental Set-Up and Measurements

In the circuit of water quality detector, the pH electrode is immersed in the sample of water to be detected, which will give its equivalent voltage. This voltage is fed in to IN4 i.e. pin 2 of ADC. The ADC will convert the analog voltage in to digital voltage, which is further fed to the micro controller through port 2. The voltage fed is then compared with already tested (using pH sensor), value of pure water i.e. 2 Volts. If the voltage of unknown sample is equal to or less than 2 Volts then to show "DRINKABLE", otherwise "NON-DRINKABLE", on LCD. The micro controller is interfaced with LCD using 1 three pins of port 1.

P1.0, P1.1 and P1.2 are used as control signals for LCD.P1.4, P1.5, P1.6 and P1.7 are used as control signals for ADC. XTAL1 and XTAL2 are used for Crystal Oscillator. Port 0 pins act as data pins for LCD and Port 2 is used to take input from ADC.

6. Results

S.No.	Water Sample	Voltage from pH sensor(Volts)
1.	Bisleri Water	1.94-2.05 V
2.	Tap Water	2.05-2.20 V
3.	Muddy Water/ Contaminated Water	2.94-3.20 V

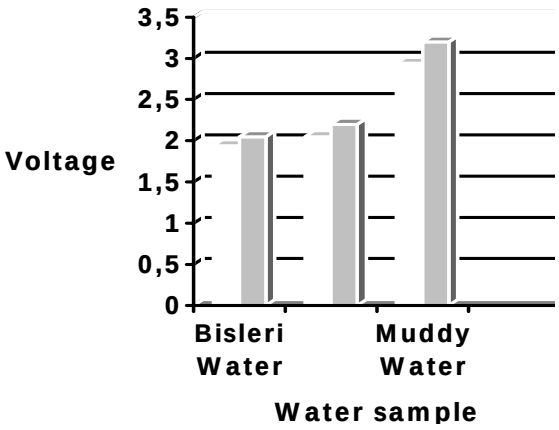

Fig. 6. Graphical Representation of Observations.

7.Conclusions

Water quality has been detected with this technique using pH sensor. We can further modify this study to display the percentage of impurity contents present in the sample. Also it can be integrated on a single chip with a device to purify it up to drinkable values.

Appendix

```
$MO51

ALE BIT P1.4
OE BIT P1.5
SC BIT P1.6
EOC BIT P1.7
MYDATA EU P2
ORG 0000H
MOV MYDATA EQU P2
ORG 0000H
MOV MYDATA,#0FFH              ;make P2 an input port
SETB EOC                      ;make EOC an input
CLR ALE                       ;clear ALE
CLR SC                        ;clear WR
CLR OE                        ;clear RD
BACK:
ACALL DELAY                   ;call delay
SETB ALE                      ;latch address
ACALL DELAY                   ;call delay
SETB SC                       ;start conversion
ACALL DELAY                   ;call delay
CLR ALE                       ;clear ALE
CLR SC                        ;clear WR
HERE:
JB EOC,HERE                     ;wait until done
HERE1:
JNB EOC,HERE1                 ;wait until done
SETB OE                       ;enable RD
ACALL DELAY                   ;wait
MOV A,MYDATA                  ;read data
CLR OE                        ;clear RD for next time
ACALL MAIN                    ;call main
MAIN:
```

```
MOV A,P2                    ;move data of accumulator to port P2

CJNE A,#02,OVER             ;jump if A not equal to 2
ACALL DLCD                  ;call DLCD
SJMP EXIT                   ;and exit
OVER:
JNC NXT                     ;if CY=0 then A>2
ACALL NLCD                  ;call NLCD
SJMP EXIT                   ;and exit
NEXT:
ACALL DLCD                  ;call DLCD
RET                         ;return
EXIT:
SJMP BACK
DELAY:
MOV R3,#50H                 ;50 or higher for fast CPUs
HERE4: MOV R4,#255H         ;R4=255
HERE3:DJNZ R4,HERE3         ;stay until R4 becomes 0
DJNZ R3,HERE4
RET
DLCD:
MOV A,#38H                  ;initiate LCD 2 lines
ACALL COMMAND               ;issue command
MOV A,#0EH                  ;LCD on ,cursor on
ACALL COMMAND               ;issue command
MOV A,#01H                  ;clear LCD command
ACALL COMMAND               ;issue command
MOV A,#06H                  ;shift cursor right
ACALL COMMAND               ;issue command
MOV A,#86H                  ;cursor: line l, position 6
ACALL COMMAND               ;command subroutine
MOV A,#'D'                  ;display letter D
ACALL DATA_DISPLAY
MOV A,#'R'                  ;display letter R
ACALL DATA_DISPLAY
MOV A,#'I'                  ;display letter I
ACALL DATA_DISPLAY
MOV A,#'N'                  ;display letter N
ACALL DATA_DISPLAY
MOV A,#'K'                  ;display letter K
ACALL DATA_DISPLAY
MOV A,#'A'                  ;display letter A
ACALL DATA_DISPLAY
MOV A,#'B'                  ;display letter B
ACALL DATA_DISPLAY
MOV A,#'L'                  ;display letter L
ACALL DATA_DISPLAY
MOV A,#'E'                  ;display letter E
ACALL DATA_DISPLAY
HERE2:
SJMP HERE2                  ;stay here
COMMAND:
ACALL READY1                ;is LCD ready?
MOV P0,A                    ;issue command code
SETB P1.0                   ;RS=0 for command
CLR P1.1                    ;R/W=0 to write to LCD
SETB P1.2                   ;E=1 for H-to-L pulse
CLR P1.2                      ;E=0, latch in
RET
DATA_DISPLAY:
ACALL READY1                ;is LCD ready?
MOV P0,A                    ;issue data
SETB P1.0                   ;RS=1 for data
```

```
CLR P1.1                    ;R/W=0 to write to LCD
SETB P1.2                   ;E=0 for H-to-L pulse
ACALL DELAY                 ;give LCD some time
CLR P1.2                    ;E=0, latch in

RET
READY1:
SETB P0.7                   ;make P0.7 input port
CLR P1.0                    ;RS=0 access command reg.
SETB P1.1                   ;R/W=1 read command reg.
BACK1:
CLR P1.2                    ; E=0 for L-to-H pulse
ACALL DELAY                 ;give LCD some time
SETB P1.2                   ;E=1 L-to-H pulse
JB P0.7,BACK1               ;stay until busy flag=0
RET
NLCD:
MOV A,#38H                  ;initiate LCD 2 lines
ACALL COMMAND1              ;issue command
MOV A,#0EH                  ;LCD on ,cursor on
ACALL COMMAND1              ;issue command
MOV A,#01H                  ;clear LCD command
ACALL COMMAND1              ;issue command
MOV A,#06H                  ;shift cursor right
ACALL COMMAND1              ;issue command
MOV A,#86H                  ;cursor: line l, position 6
ACALL COMMAND1              ;command subroutine
MOV A,'N'                   ;display letter N
ACALL COMMAND1
MOV A,'O'                   ;display letter O
ACALL COMMAND1
MOV A,'N'                   ;display letter N
ACALL COMMAND1
MOV A,#'D'                  ;display letter D
ACALL DATA_DISPLAY1
MOV A,#'R'                  ;display letter R
ACALL DATA_DISPLAY1
MOV A,#'I'                  ;display letter I
ACALL DATA_DISPLAY1
MOV A,#'N'                  ;display letter N
ACALL DATA_DISPLAY1
MOV A,#'K'                  ;display letter K
ACALL DATA_DISPLAY1
MOV A,#'A'                  ;display letter A
ACALL DATA_DISPLAY1
MOV A,#'B'                  ;display letter B
ACALL DATA_DISPLAY1
MOV A,#'L'                  ;display letter L
ACALL DATA_DISPLAY1
MOV A,#'E'                  ;display letter E
ACALL DATA_DISPLAY1
HERE5:
SJMP HERE5                  ;stay here
COMMAND1:
ACALL READY2                ;is LCD ready?
MOV P0,A                    ;issue command code
CLR P1.0                    ;RS=0 for command
CLR P1.1                    ;R/W=0 to write to LCD
SETB P1.2                   ;E=1 for H-to-L pulse
CLR P1.2                    ;E=0, latch in
RET
DATA_DISPLAY1:
ACALL READY2                ;is LCD ready?
```

```
MOV P0,A                    ;issue data
SETB P1.0                   ;RS=1 for data
CLR P1.1                    ;R/W=0 to write to LCD
SETB P1.2                   ;E=1 for H-to-L pulse
ACALL DELAY                 ;give LCD some time
CLR P1.2                    E=0,latch in
RET
READY2:
SETB P0.7                   ;make p0.7 input pot
CLR P1.0                    ;RS=0 access command reg.
SETB P1.1                   ;R/W=1 read command reg.
BACK2:
CLR P1.2                    ;E=0 for L-to-H pulse
ACALL DELAY                 ;give LCD some time
ETB P1.2                    ;E=1 L-to-H pulse
JB P0.7,BACK2               ;stay until busy flag=0
RET
END                         ;stop program
```

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Guide for Contributors

Aims and Scope

Sensors & Transducers Journal (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because it is an open access, peer review international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per annual by International Frequency Association (IFSA). In additional, some special sponsored and conference issues published annually. *Sensors & Transducers Journal* is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List, Open J-Gate, Google Scholar, etc.

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Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
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