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Original Research Article

Design and Construction of AT89C2051 Microcontroller Based Water Level Indicator

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Abstract

The aim of this project is to design and construct microcontroller based water level indicator that would sound an alarm when the water tank is empty and light a bulb when the water tank is full. The reason is to find a way of producing low cost microcontroller based water level indicator modules that can be repaired and maintained locally. The electronic components that were used to design and construct the device were AT89C2051 Microcontroller, Quartz Crystal Oscillator, TIP 41C, Resistors, Capacitors, Copper Probes, Perforated Circuit Board, Bulb, Solid state relay and Buzzer. There are various types of microcontroller that come in different sizes and capacity. The one being implemented in this project is AT89C2051 from Atmel. The sound of alarm indicate low water level signifying water tank empty and needs to be refill. The bulb light up to indicates that the water tank is not empty, the water tank level is high (that is the water tank is full).The microcontroller based water level indicator sound an alarm when the tank is empty or the water level is low and lights a bulb when the tank is full. The result is satisfactory since the module is working and indicating that the water level is low or high (that is the tank is empty or full.

Keywords: AT89C2051, Bulb, Buzzer, Microcontroller, ROM, Sensor, TIP 41C, and Ultra Sonic Sensor

INTRODUCTION

A microcontroller is a device that is used in most domestic and industrial systems. Example are microwave oven, sewing machines, electronic toys, just to mention a few to control the temperature, speed or timing etcetera of the said system. The prime use of a microcontroller is to control the operation of a machine using fixed programs that is stored in the ROM. And that does not change over the life time of the system.

The AT89C2051 microcontroller based water level indicator project is a simple indicator project using AT89C2021 microcontroller IC from Atmel, copper probes, bulb, solid state relay, buzzer, perforated circuit board and TIP41C. The project uses a copper probes sensor to determine whether there is water or no water in a tank by conducting electronic current. The copper probes sensor allows conduction to be transmitted and received. The microcontroller sends a signal to the buzzer and it sounds an alarm indicating that the water level in the tank is low. The same way when the water thank is full there is transmission of current by conduction between the copper probes sensor and the microcontroller sends a signal to the bulb indicating that the water tank is full.

MATERIALS AND METHOD

The materials used for the construction of the electronic circuit are listed below.

- AT89C2051 microcontroller
- TIP 41C
- Bulb
- Alarm buzzer

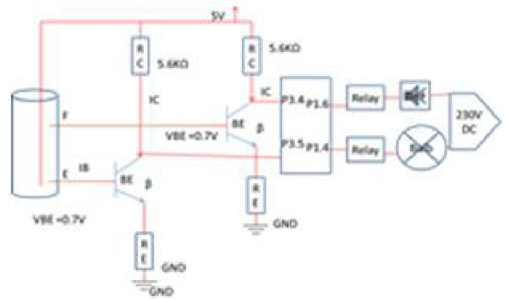

Figure 1. Circuit operation

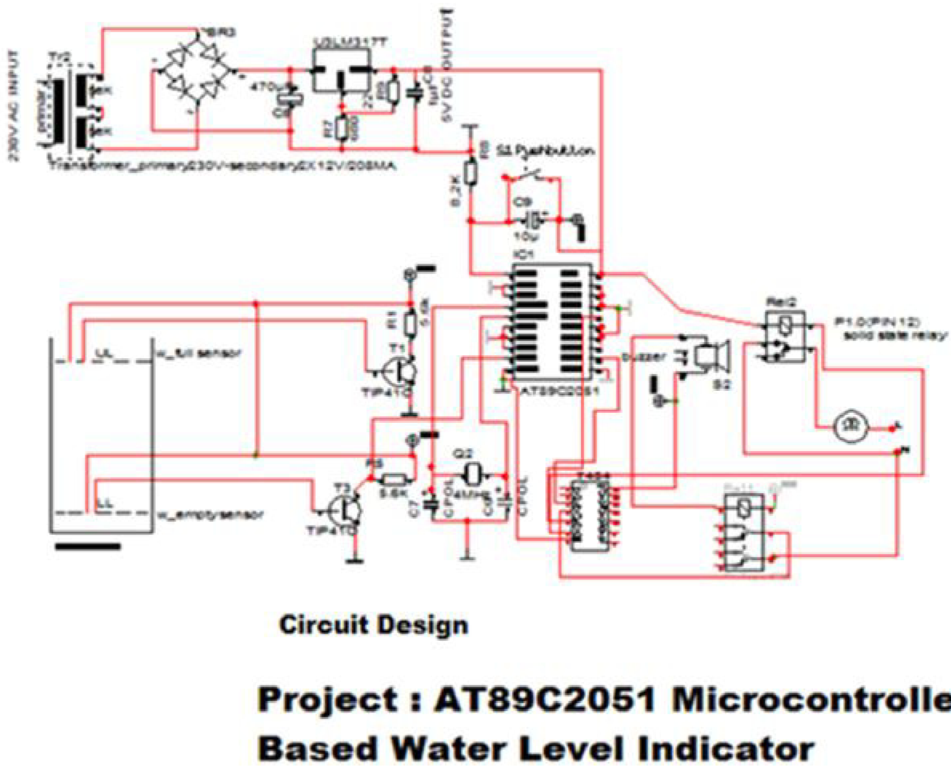

Figure 2. AT89C2051 microcontroller based water level indicator circuit diagram and 5V DC power supply. Target 3001! V13 was used for the circuit diagram design in figure 2. (www.target3001!V13.com).

- Solid state relay
- Capacitors
- Resistors
- Quartz crystal oscillator
- copper probes sensor
- Perforated circuit board

The method used to build the circuit was soldering. The components were soldered on the circuit board.

Brief Theory: Circuit operation

The device operates when the base emitter of the transistor is forward biased in the circuit below current flows through the circuit. Beta is equal to the collector current divided by the base current. The collector current is equal to Beta multiply by the base current. The conductivity is equal to the inverse of resistivity. Figure 1 shows transistor operation.

How the AT89C2051 Microcontroller Based Water Level Indicator works. The operation of the AT89C2051 Microcontroller Based Water Level Indicator is simple and based on the laws or principles of physics and electrical and electronics principles. The flow of electrons in a conducting medium, in this case water and copper. Copper is a good conductor to its mixed- valence Cu (II) /Cu (III) oxides which gives it zero electrical resistance. Copper and any other metals are good conductors because they allow current in electricity to easily flow through them. On the other hand, materials like rubber,

Table 1. Shows the 5 Volt DC power supply readings during circuit operation

Component	Pin number	VCC	Pin number	GND
AT89C2051	Pin 20	5.183V	Pin 10	0.00V
7404	Pin 14	5.181V	Pin 7	0.00V
Solid state relay	Pin 3	5.183V	-	-
LM317T	Pin 2	5.185V	Pin 1	0.00V
TIP 41C	Pin 2	5.181V	Pin 3	0.00V

plastic, and wood are poor conductors. Copper is a good conductor, that's why it is used to make electrical wire. Copper and gold are both good conductors. Both have free electrons. Gold is expensive so it is not used. Pure water is a very poor conductor but its conductivity is greatly improved when it contains dissolved salt or any other ionic compound.

Water is a good conductor of electricity because it contains salts. Pure water is not, but if it contains the slightest amounts of salt or mineral solids then it will be. Pure water (H2O) is actually an insulator. It only becomes a conductor because it is exceptionally good solvent. Most water contains a lot of mineral salts which are ionized in solution. Soluble ionic compounds are excellent conductors of electricity when dissolved in water - such as sodium chloride (common salt).

The AT89C2051 Microcontroller Based Water Level Indicator senses water in a tank and indicates by lightning a bulb. Also the AT89C2051 Microcontroller Based Water Level Indicator does not sense water and indicate by sounding an electric bell.

The base resistor is 60KΩ-100KΩ but is not physically connected because conductivity which is the inverse of resistivity has been implemented.

The program is bit addressing not byte addressing. The type of transistor used for the project is NPN TIP 41C.

The emitter –base junction is forward biased and the base collector is reversed biased. When the base emitter voltage is 0.6V current will flow through the transistor, electrons flowing through the base from the emitter to the collector. No current will flow without this base –emitter voltage, since it is needed to overcome the potential barrier formed at the junction. Electrons flow into the collector, although the base –collector junction is reversed biased because the base is very thin. The emitter current (IE) is the sum of the base current (IB) and the collector current (IC) (IAEA-TECDOC-426, 1987):

$IE = IB + IC$……………………………………….(1)

Where: IE = emitter current, IB = base current and IC = collector current

The emitter -base junction is forward biased and therefore has low resistance; while the base -collector junction is reverse biased and has a high resistance. From the project circuit diagram, for its basic operation, the output of the collector is connected to pin 8, Port 3 bit 4 of the AT89C2051 microcontroller. Ib >0 ,VBE≥0 and VCE =0. The potential at base is at least 0.6 V. The transistor is on when the base emitter p.d, potential difference is bigger than 0.6V and off when it is less than 0.6V. When the transistor is off, that is there is no current flowing through it, the potential difference (p.d) across the emitter –collector is high. As soon as the transistor starts to conduct this p.d falls very close to zero. So the output p.d (VCE) is small when the input p.d (VBE) is large and large when the input p.d is small (<0.6V).

This activates the solid state relay connected to pin 12 port1.bit0.that lights a bulb indicating that there is water in the tank, upper level (UL,).

Also if there is no water in the tank, lower level (LL), When there is no water in the tank or low level $VCC = IcRc + VCE$……………………………………(2)

Where: VCC = supply voltage, common collector voltage IC = collector current, RC = collector resistance and VCE = collector emitter voltage

$IcRc = 0$

$VCC = VCE = 5V$

This indicates that water is in the tank by the AT89C2051 microcontroller activating the buzzer, which is connected to pin 13, port1 bit 1 of AT89C2051 microcontroller.

If there is water in tank, $Ib > 0$ and $VBE \geq 0.7(2V\ DC)$, the transistor will switch on (saturation).

$Ic > 0$

$VCE = 0$. Indicates there is water in the tank by the AT89C2051 microcontroller activating the relay to switch on the bulb.

When there is no water in the tank from equation (2),

$VCC = IcRc + VCE$

$IcRc = 0$

$VCC = VCE = 5V$

This indicates that there is no water in the tank by the AT89C2051 microcontroller activating the buzzer.

IC = βIb……………………………………… (3)

Where: IC = collector current, β =gain of the transistor and IB = base current (Table 1)

Software and Programming

The software used for the hardware design is the target 3001 V13 professional software. The programming software to generate code for the AT89C2051 is MIDE51Software.

Figure 3a. Water tank empty

Figure 3b. Water tank full

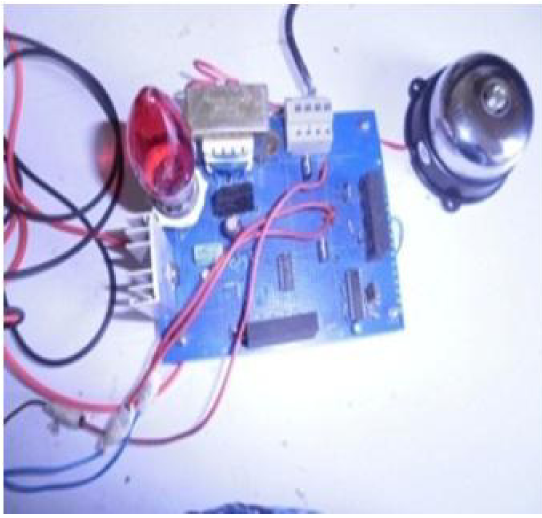

Figure 3c. Buzzer and bulb

Table 2. Tank level in ml Voltage supply in Volts

120ml	220V
100ml	220V
80ml	220V
60ml	220V
40ml	220V
20ml	220V
0ml	220V

Table 3.Tank level in ml

Tank level in ml	Voltage supply in Volts
30000ml	220V
15000ml	220V
7500ml	220V
3750ml	220V
1875ml	220V
940ml	220V
234ml	220V
120ml	220V
60ml	220V
30ml	220V
15ml	220V
0ml	220V

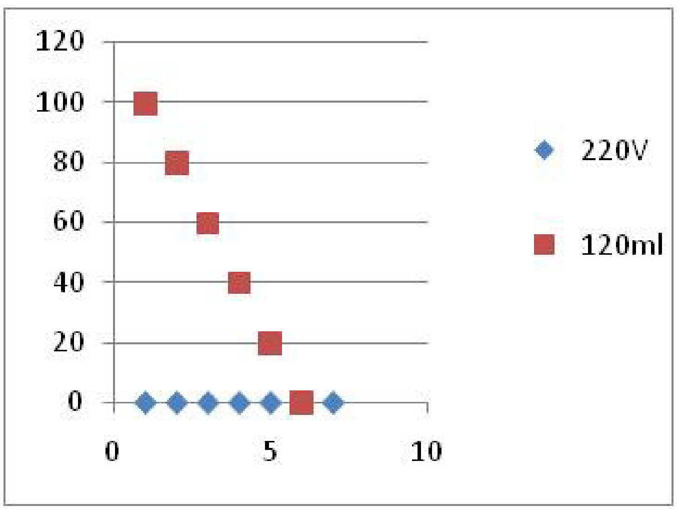

Figure 4. Graph showing how the tank level changes with constant voltage of 220V

Programming Index

Mnemonic	comments
org 0000h	Origin
sjmp 30h	short jump to 30h
org 30h	origin 30h
clr P1.0	clear bit
clr P1.4	clear bit
start: a call waterful	delay
start1: acall water empty	delay
ajmp start	
water full: Mov C, P3.4	set direct bit
jc start1	jump on carry start1
setb P1.0	set direct bit
clr P1.4	clear bit
acall delay	delay

```
ret                              return
water empty: Mov C, P3.5         set direct bit
jnc start                        jump on no carry
setb P1.4                        set direct bit
clr P1.0                         clear bit
acall delay                      delay
ret                              return
delay: Mov r1, #01h              delay
wait: Mov r2, #08h               delay
wait1: djnz r2,wait              delay
djnz r1, wait                    delay
ret                              return
end                              end program
```

Programming Codes

LineI	Address	Code	Source
1:	N	0000	org 0000h
2:	0000	80 2E	sjmp 30h
3:	N	0030	org 30h
4:	0030	C2 90	clr P1.0
5:	0032	C2 94	clr P1.4
6:	0034	11 3A	start: acall water full
7:	0036	11 45	start 1: acall water empty
8:	0038	01 34	ajmp start
9:	003A	A2 B4	water full: Mov C, P3.4
10:	003C	40 F8	jc start 1
11:	003E	D2 90	setb P1.0
12:	0040	C2 94	clr P1.4
13:	0042	11 50	a call delay
14:	0044	22	ret
15:	0045	A2 B5	water empty: Mov C, P3.5
16:	0047	50 EB	jnc start
17:	0049	D2 94	setb P1.4
18:	004B	C2 90	clr P1.0
19:	004D	11 50	a call delay
20:	004F	22	ret
21:	0050	79 01	delay: Mov r1, #01h
22:	0052	7A 08	wait: Mov r2, #08h
23:	0054	DA FC	wait1: djnz r2, wait
24:	0056	D9 FA	djnz r1, wait
25:	0058	22	ret
26:	end		

no errors

RESULT AND DISCUSSIONS

The observation made from the graph in figure 3 indicates that constant voltage was used for all levels from 0ml to 100 ml. Please note that table 2. and figure 3. Values are for graphical representation purpose. The practical values are represented in table 3. Results are shown in figure 3a, 3 b and 3c.

CONCLUSION

The circuit designed work well as expected indicating water tank full when the bulb is on and water tank empty when the buzzer sounds the alarm.

RECOMMENDATIONS

The recommendation for the implementation of this project is that an ultra-sonic sensor should be used to replace the copper probes.

ACKNOWLEDGEMENT

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