Water Level Measurer

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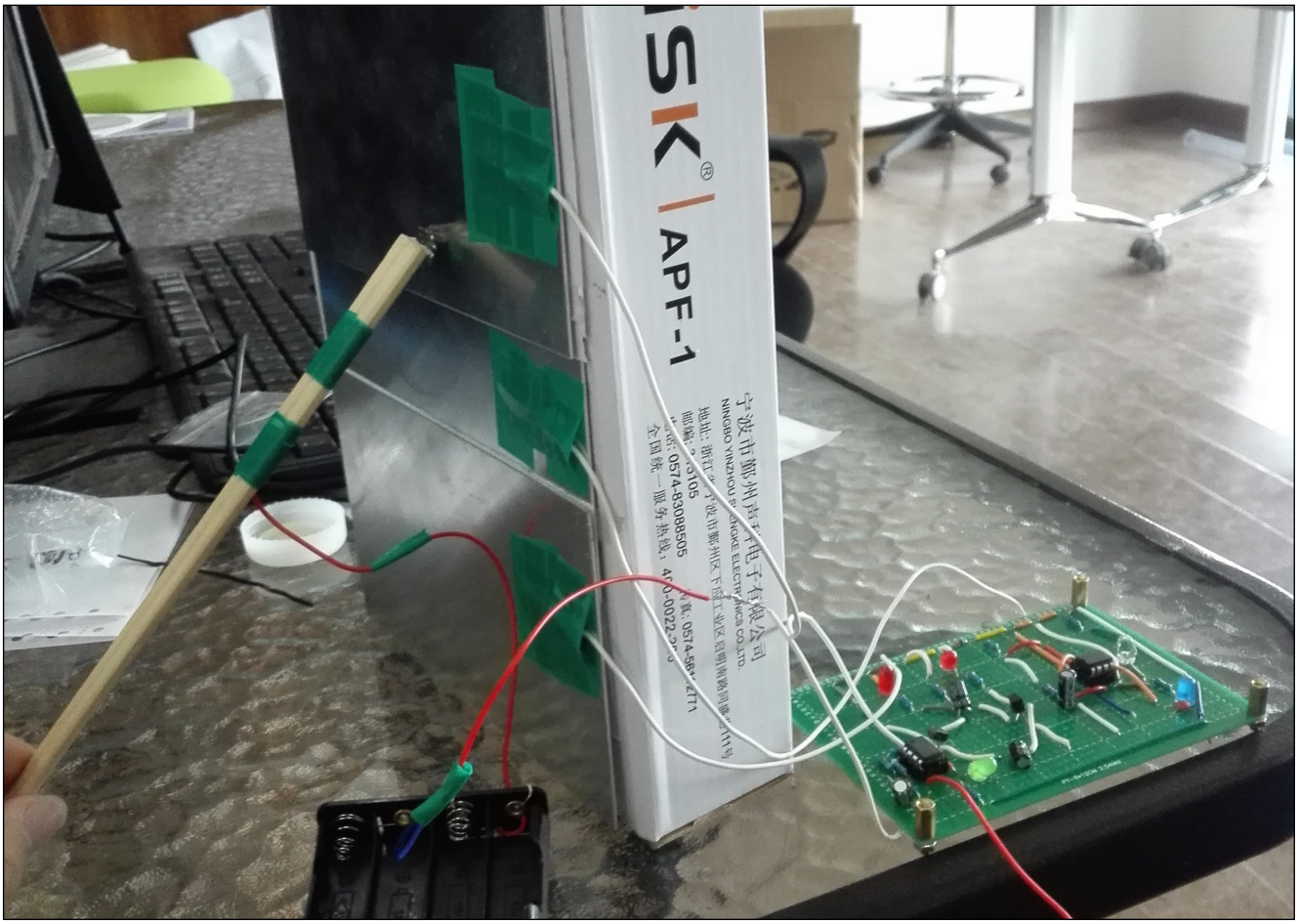
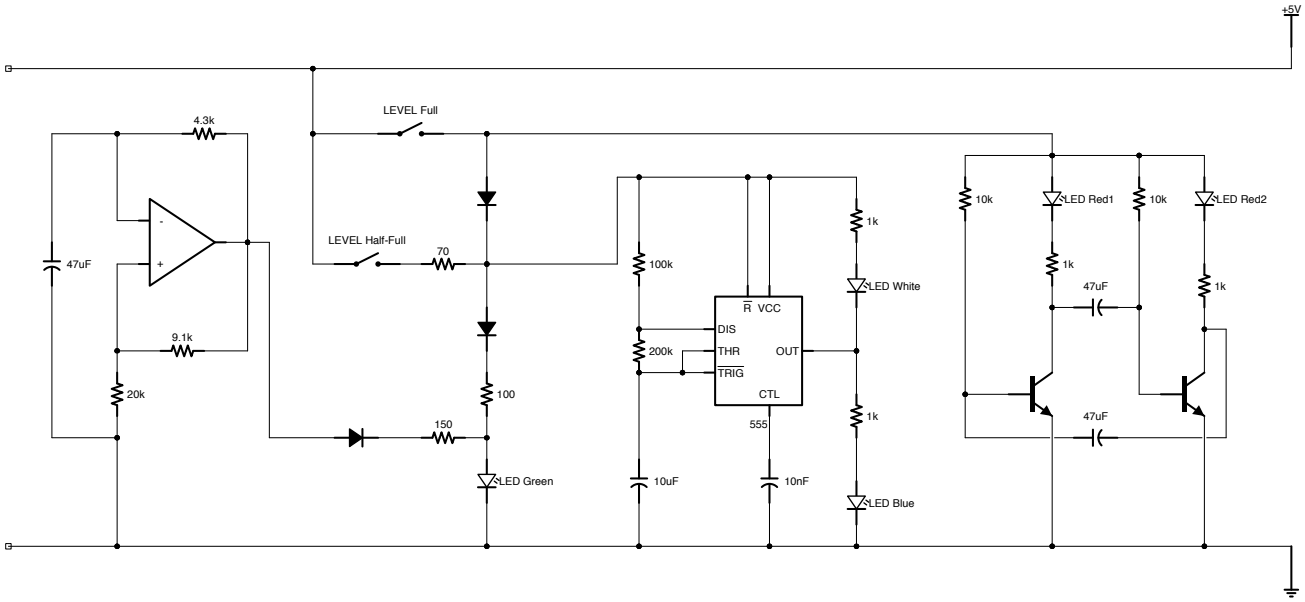


Introduction

The water level measurer has four parts.

The first part is a mechanic part, which is to determine the water level and supply the power, the other three are the corresponding circuit.

When the water level is in different part, the circuit will behave differently.



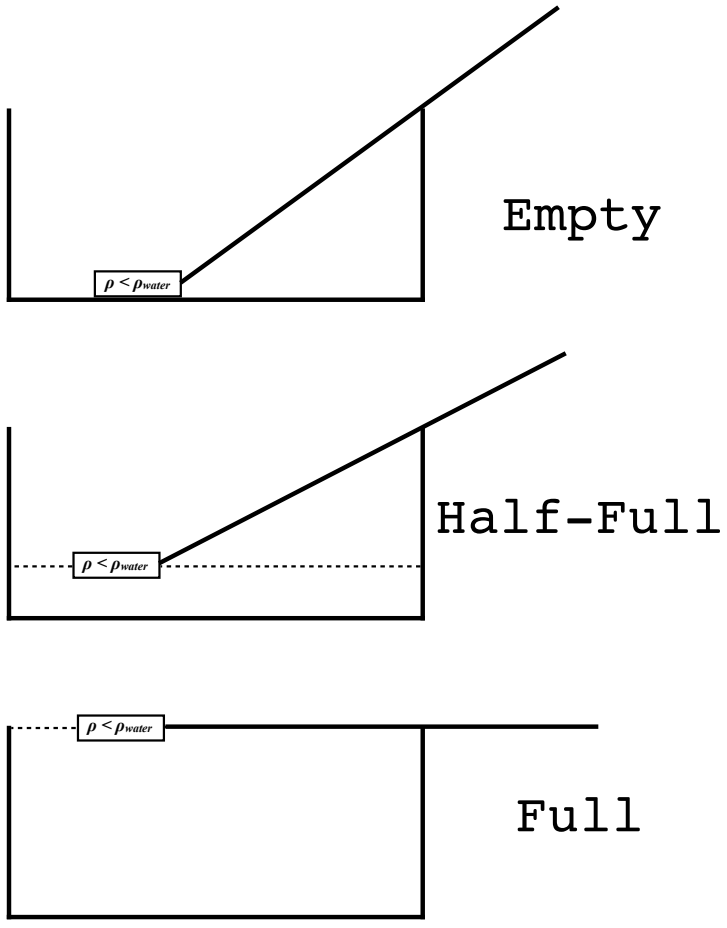
Circuit Principle

Part 1

Part 1 is made up of a water tank, a flotation device, a pair of chopsticks, batteries and wire.

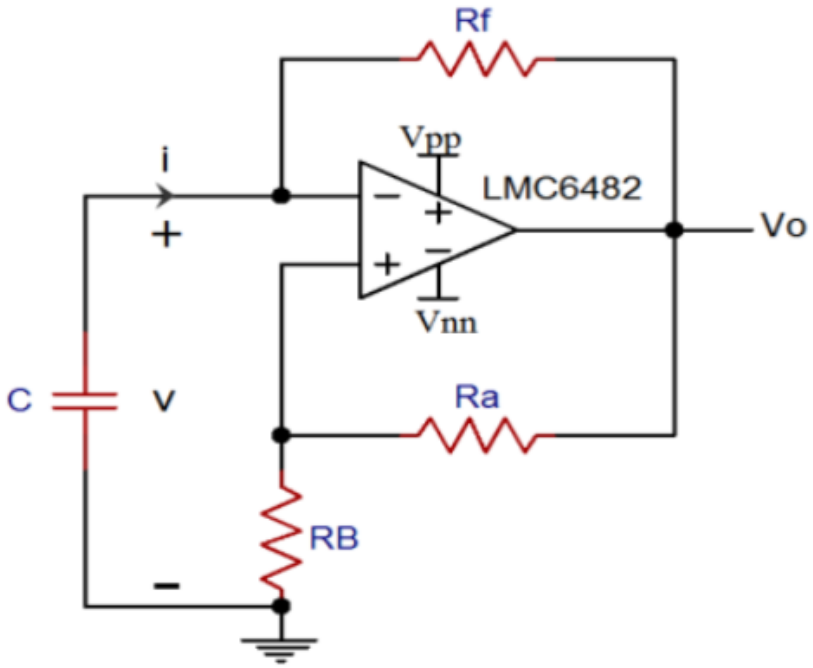
When the water level goes higher, the ball will be floated up. Then the position of the power supply will change correspondingly. As the figure 1 shows, when the water level is empty, the power supply will move to position 1, when the water level is half, the position will be position 2, when it is full, the position goes to position 3, and the corresponding circuit will work.

The power supply is made up of AA batteries, So the power supply is 6 volts.



Part 2

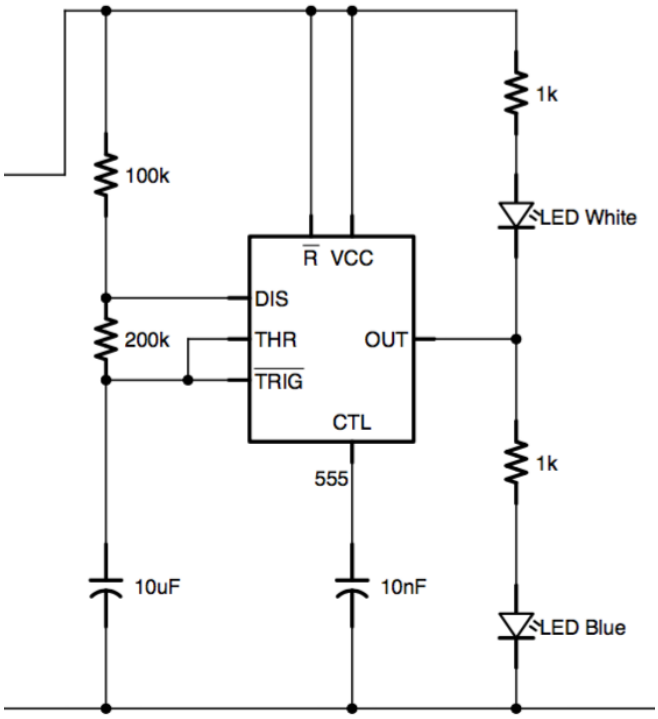
Part 2 is a RC Oscillator, which is a part of lab7.



The output of the circuit is connected to a light-emitting diode in green. And we put a switch to control the Vpp, as long as the switch is on, the circuit will work. The diode will twinkle because the output of the circuit is square wave. And the flickering green light means the water level is low and to stop it from twinkling, you need to pour water in the tank.

Part 3

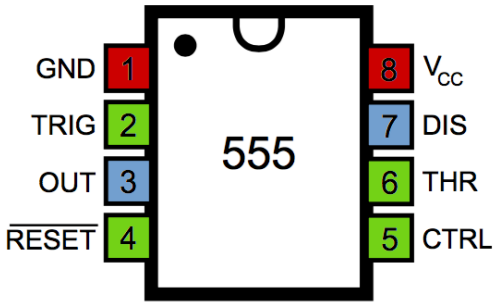
Part 3 is a 555 flashing circuit.

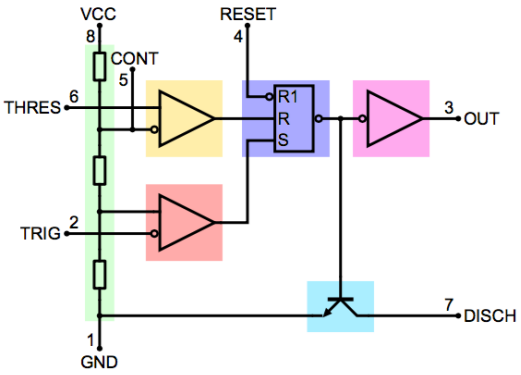


There are two light-emitting diodes in the circuit, one is blue, the other one is white, which means safe and sound.

The core part of this part is the 555 Timer IC.

The trigger and the threshold is short circuited so the rising and falling of the potential will cause the different behaviors of the LEDs by the Timer IC.





FUNCTION TABLE

RESET	TRIGGER VOLTAGE(1)	THRESHOLD VOLTAGE(1)	OUTPUT	DISCHARGE SWITCH
Low	Irrelevant	Irrelevant	Low	On
High	<1/3 V_{CC}	Irrelevant	High	Off
High	>1/3 V_{CC}	>2/3 V_{CC}	Low	On
High	>1/3 V_{CC}	<2/3 V_{CC}	As previously established	

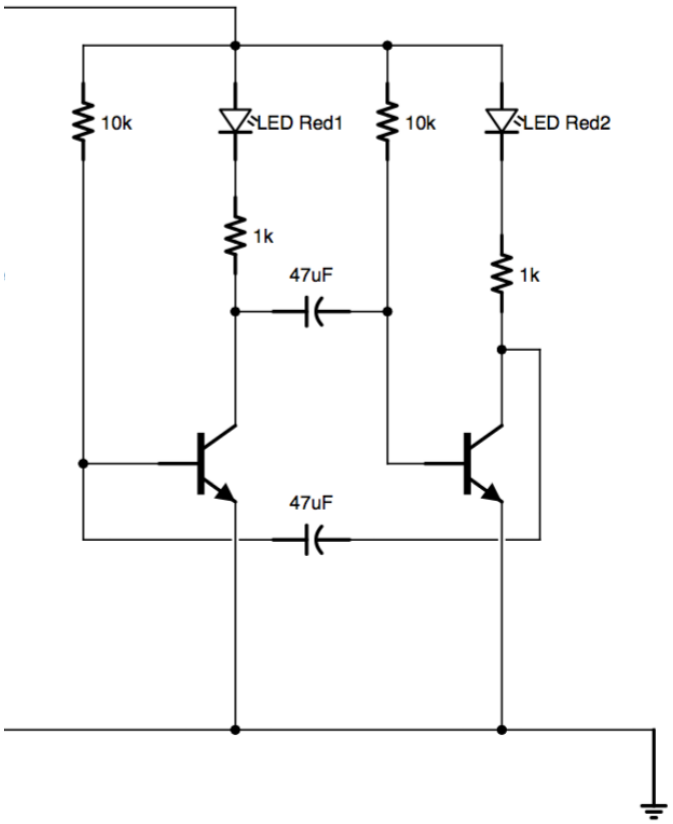
When the circuit starts work, Since the 10 microfarad capacitor will be charged, and the potential of the Trigger and the Threshold is 0, then the output is high and the discharge is off. The blue LED start lighting. Then the potential of Trigger and Threshold is rising, when it's over 1/3Vcc and below 2/3Vcc, it behaves as previous until it is larger than 2/3Vcc.

When the potential is over 2/3Vcc, the output is low, and the discharge is on. Then the white LED will light and the blue one will extinguish. The 10 microfarad capacitor start discharging until the potential of Trigger and Threshold is below 1/3Vcc. Then the blue one will light again and the white one will extinguish.

The circuit will repeat the sequence.

Part 4

Part 4 is a RC resonant circuit.



Triode in this circuit works as a switch.

Assume the left triode is Q1, the right one is Q2, and the upper capacitor is C1, the lower one is C2.

When the Q1 is turned on, LED1 will light, C1 will discharging and C2 will be charged. Similarly, when the Q2 is turned on, LED2 will light, C2 will discharging and C1 will be charged.

When Q1 is turned on, C2 is charged, the charging current goes to the base of Q1, which keeps Q1 turned on. Until C2 is charged completely, the charging current cannot keeps Q1 to turning on, meanwhile, C1 has been discharged completely.

Then Q2 is turned on, LED2 starts lighting, C1 will be charged and C2 will discharge until C1 is charged completely.

The circuit will repeat the sequence.

Result Analysis

In part 2, the frequency of the circuit is:

$$f = \frac{1}{2\ln(3)R_f C}$$

$$f = \frac{1}{2 \times \ln(3) \times 4300 \times 47 \times 10^{-6}} = 2.25 \text{ Hz}$$

In part 3, the frequency of the circuit is:

$$f = \frac{1.44}{(100 \times 10^3 + 200 \times 10^3) \times 10 \times 10^{-6}} = 0.48 \text{ Hz}$$

In part 4, the frequency of the circuit is:

$$f = \frac{1}{0.693 \times 11000 \times 47 \times 10^{-6}} = 2.79 \text{ Hz}$$

Result of the Device

1、The switch is at empty, the part 2 works, the green LED will twinkle.

2、The switch is at half-full, the part 3 works, the blue LED and the while LED will twinkle alternately, and the lower diode works, so the green LED will light constantly.

3、The switch is at full, the part 4 works, two red LED will twinkle in a high frequency, which is for an alarm. Meanwhile , the two diodes work together, so part 3 also works and the green LED will light constantly.

Discussion

Hongxiang Gao

Apart from the usual lab part, project is much more complicated and interesting. Project 7 is a creative one amongst the seven, we need to design the circuit by ourselves and find material outside the lab.

One point I will mention is teamwork. Although the usual lab part is also a team game, doing a project needs more team spirit. To cite an instance, when we were designing the circuit, we might have different ideas about it, then we need to have a discussion and try to persuasive each other. Or when we were welding the circuit board, someone might make some mistakes, we need to debug together and forgive the fault from my partner.

About the product, what I want to say is we really really did well in doing this project. The device can measure the three state of water level, and show the result to the user directly. But it also has some weakness. First one is the device is less automatically, the user need to adjust the position of three metal board so that the the contact point can touch the board and the circuit can work normally. Second one is about the whole device, it is too heavy so it is not portable. Of course we can find some solutions to carry out these problems and make it more like a product instead of a demo one.

What I did in this project is design the part 2 and part 4, welding part of the circuit and writing part of the report. We bought materials together and worked like a team.

When I was debugging the circuit, the most frequent problem I founded was welding problem, we might forget to weld two points together or weld two points together which two should not be, then the circuit would behave differently. The method I used is using a multi-function volt measurer, I measured the resistance between two point to make sure whether they are short circuit or not. If the result was out of my expectation, I would compare the board it with the diagram.

At last, doing the project gave me a lot of fun, helped me learn more about circuit and the experience will influence my whole life in a profound way.

Yi You

My partner and I have spent nearly 4 weeks on this project. Project 7 is very open, which means we can (or must) build up the whole device by ourselves. Unlike other projects, Project 7 consists not only a circuit part, but a mechanical part as well. This makes the work more interesting and complicated.

The circuit can separated into 4 parts, and I have designed two of them. We used a simulation tool called *iCircuit* on OS X to test our design. Simulation tools is very helpful. It can tell us some design errors, and then we can quickly correct them before welding. But some problems will still appear even if it simulates perfectly. One of the reason is that the components we use are not ideal, which we didn't consider at the beginning. Another one is that neither of us has good command of welding, which may cause some connectivity problems. After we found this, we used a multimeter to check all the welding spots. This might take more time, but it is worth to do.

I used a 555 Timer IC in my design, which makes a couple of LEDs flash alternately. This component is seldom mentioned in this course, therefore I have searched for many documents about it on the Internet, and try to understand how it works with other components (resistors and capacitors). With efforts, I finally finished that part. This project helped me to learn some new techniques which this course did not cover.

Multimeters and oscillographs are good friends while testing the real circuit. I become more and more familiar with the use and analysis on them.

The device we finished at last achieved the required functions. It can tell the user which state the water level is at present (Empty, Half-full or Full). Considering the actual use, we made some LED flash at certain level to notify the user. The device still have some weakness. It should be adjusted for different environments, which is an annoying operation for many users.

During the 4 weeks, my partner has a good cooperation with me, even if some small disagreements appeared, we handled them at last. Working with him has impressed me a lot.