

WATER LEVEL CONTROLLER

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► INTRODUCTION

Background of the Study

Water tank level controller has been widely used in various countries of Asia and America including some parts of Europe.

Water level controllers come in different types such as floater type, the tube design, spilling type and many other types. The water tank level controllers have the ability to detect the water level on the tank and trigger the electric motor to pump water on the tank. Water level controllers are mostly used on huge water reservoirs from the ships during the critical condition in navigation. It is also used to prevent water input from reaching the limit of water level inside the vessel.

Many residences and manufacturing companies use water tank as water storage to ensure adequate amount of water supply. Oftentimes, the problem arises when the water level in the tank is unnoticed to be empty. Thereby causing major household chores such as laundry, household cleaning, dish washing and many more to be undone. Another problem is the running motor water pump unmonitored. The tendency is, the motor pump will be left running thereby causing water spillage and sometimes leads to malfunctioning of the motor due to heating.

To combat these problems, the researchers decided to design a device called AUTOMATIC WATER LEVEL CONTROLLER WITH INDICATOR.

Objective

This study aims to design a water level controller with attached indicator to determine the water content of the tank as well as to control the on-off operation of the electric water pump.

Scope and Limitation

This study was conducted at Magsaysay Village, La Paz, Iloilo City from September 25 to October 16, 2000.

This project is applicable only for constant water source like deep wells, irrigation and waterway systems. The device is only intended for an electric motor that has a running current not higher than 5 amperes.

Significance of the Study

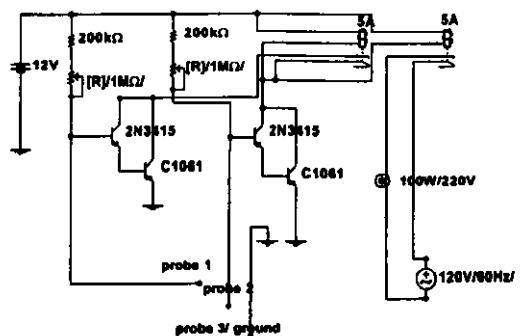
The water level controller with indicator is important to residences, manufacturing companies and other business establishments that use water tank and motor driven pump to store sufficient amount of water for daily use. It can provide convenience and less effort to those who have water tank due to the controlling feature and indication of water level.

Furthermore, the use of the said device will minimize water spillage thus, conserving water.

► METHODOLOGY

Schematic Diagram Circuit design

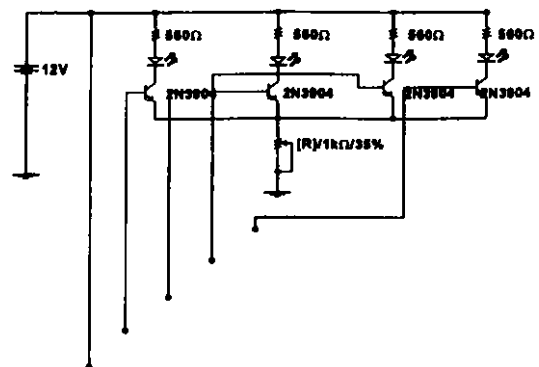
1. Water Level Controller



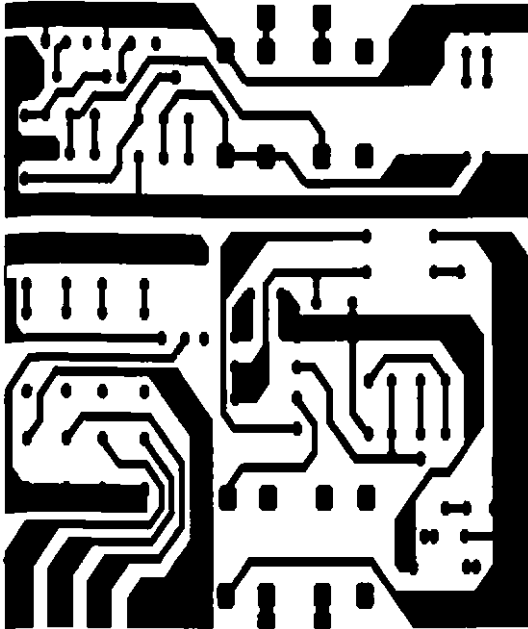
Note:

Water resistance serves as the base junction resistance and a resistance between probes and has the value that varies with temperature and mineral content of the water, which has an approximate range from 200 kΩ to 1MΩ.

2. Water Level Indicator



PCB Layout



► CALCULATIONS

A. Indicator

(Solution based on saturation region)

$$\text{@ } I_{CSAT}; V_{CE} = 0V$$

$$b = 200$$

$$H_2O \text{ Resistance} = 250\Omega \text{ to } 1M\Omega$$

Assumption:

$$V_{LED} = 3V$$

$$R_B (H_2O \text{ Resistance}) = 200 k\Omega$$

$$V_{RC} = 3V$$

$$V_{RE} = 6V$$

$$12 - I_B R_B - V_{BE} - I_E R_E = 0; \text{ but } V_{RE} = I_E R_E = 6V$$

$$I_B = (12 - 0.7 - 6) / 200K$$

$$= 26.5 \text{ mA}$$

$$I_C = \beta I_B = (200)(26.5 \text{ mA}) = 5.3 \text{ mA}$$

$$I_E = (\beta + 1) I_B = (201)(26.5 \text{ mA}) = 5.3265 \text{ mA}$$

$$R_C = V_{RC} / I_C = 3 / 5.3 \text{ mA} = 566.04 \Omega$$

$$R_E = V_{RE} / I_E = 6 / 5.3265 \text{ mA} = 1.126K\Omega$$

*The choice of R_E is to vary the intensity of LED

Controller

Given: Voltage Divider Biased (Darlington Connection)

$$V_{CC} = 12 \text{ volts}$$

$$R_1 = 0 - 1M\Omega$$

$$R_E = 0\Omega$$

$$R_C = 150\Omega (\text{coil})$$

Required: V_{RC}, R_2 (maximum resistance)

Solution: $V_B = V_{BE1} + V_{BE2} + I_E R_E$; but $R_E = 0\Omega$

$$V_B = 0.7 + 0.7$$

$$V_B = 1.4 \text{ volts}$$

By CDR

$$V_B = V_{CC} [R_2 / (R_1 + R_2)]$$

$$1.4 = 12 [R_2 / (1M\Omega + R_2)]$$

$$12R_2 = 1.4M\Omega + 1.4R_2$$

$$R_2 = 1.4M\Omega / 10.6$$

$$R_2 = 132075.47\Omega$$

$$132.075K\Omega$$

For VRC

$$V_{CC} = V_{RC} + V_C; \text{ but } V_C = 0 \text{ volts}$$

$$V_{CC} = V_{RC} = 12 \text{ volts}$$

Components Description

Components	Description	Quantity	
Transistor (NPN)	C1061	2	
	2n3415	2	
	2n3904	4	
	Resistor	560 Ω , 1/4 Watt	4
		1k Ω	2
Switch	1M Ω (trimmer)	2	
	1k Ω (trimmer)	1	
	20k Ω	2	
	12VDC/5A		
	(DPDT relay)	1	
LED	Push button (NC)	1	
	Push button (NO)	1	
	SPDT	1	
	Jumbo type	6	
	Push button (NC)	1	
LED	Push button (NO)	1	
	SPDT	1	
	Jumbo type	6	

Table 2. Materials and Accessories Description

Materials	Description	Dimension/ Quantity
Power Supply	12VDC/300mA	1
	12VDC/850mA	1
Pump w/ built-in motor	220VAC/4.4 watts	1
Connecting wires		
PCB	Single face	5x5 in.
Illustration board		1/8
Glue	Cyanoacrylic (bulldog)	1
	Glue stick	1
Prototype tank	Glass	9.4 x 9.4 x 15.5 cm
Hose	Transparent	1/2 m (length)
	Green	1/8 m (length)
	Chemical	1 in
Pipe	Copper	1/3 m (length)
Faucet	Plastic	1
Jack Plug	black	1

Construction .

The automatic water level controller with indicator was constructed with separate circuit for indicator and controller. It is supplied individually with 12VDC/300mA and 12VDC/850mA sources respectively. LED's indicator was constructed separately from the main circuit to provide more expansion for the setup. The prototype structure was patterned to the actual water tank that uses an electric motor to fill the tank.

► RESULTS AND DISCUSSION

Circuits Operation

A. Controller

The circuit is being supplied by a 12-volt DC supply. It is operated by a Darlington connection of C1061 and 2N3415 transistors. These transistors serve as a switch that drives the relay switch. A double-pole double-throw relay is driven by 12-volts DC supply with an 8-ampere coil. The variable resistor is ranged by a 1MΩ trimmer. This trimmer functions as an adjuster for the probes' sensitivity. A 20KΩ/ ½-watt resistor is placed as a protection for the transistor if it is reduced to minimum. Two LEDs are placed as an indicator (red light) for the operation of relay switch and (green light) for presence of supply voltage in the circuit.

The circuit uses three probes. Two of three probes were connected on each base of two primary transistors on the individual Darlington circuit. The remaining one is connected to the ground or the emitter of the secondary transistors. These probes are placed in different level: the common is placed at the bottom, probe 2 is placed in the middle and probe 1 is placed near the top of the tank. The probe 1 is connected directly to the base of primary transistor of first Darlington where the collector is connected to the normally open switch of relay. Probe 2 is connected to the base of the primary transistor of second Darlington where the collector is connected to the neutral point of relay. The characteristics of the relay switch helps transistor to keep on operation during the cut off of the other transistor. When the tank is initially empty the relay is "on state". When water level reaches probe 2, the second Darlington will "cut off", but the first Darlington still trigger the relay switch. When probe 1 establish connection with two other probes through water, the first Darlington will then be "cut off". At the time where water subsides the relay still on the "off state" until it passes probe 2 (see Logical Operation). In analysis, the first Darlington depends on the function of second Darlington.

B. Indicator

The circuit is supplied by a 12VDC/300mA. It uses a four 2N3904 transistor that has been cascaded into four and their emitter were connected into a trimmer of 1kΩ which serves as an adjustment for the sensitivity of the circuit. Every LED's were activated with individual cascaded circuit assigned as sensor for the level of the tank. Four LED's for every specific level of water tank indicate its general operation.

Logic Operation

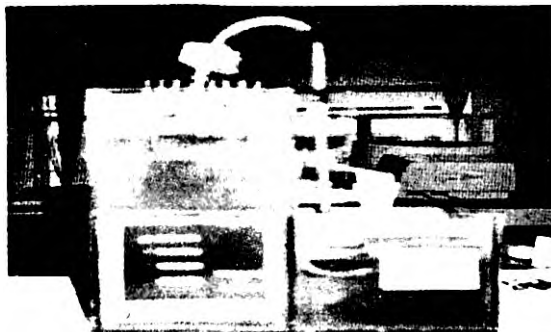
A. Controller

Common	Probe 2	Probe 1	Output
0	0	0	1*
1	0	0	1
1	1	0	1
1	1	1	0
1	1	0	0
1	0	0	1

* Water tank initially empty

B. Indicator

PRCBE					1 OUTPUT			
1	2	3	4	5	Z1	Z2	Z3	Z4
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
1	1	0	0	0	1	0	0	0
1	1	1	0	0	1	1	0	0
1	1	1	1	0	1	1	1	0
1	1	1	1	1	1	1	1	1
1	1	1	1	0	1	1	1	0
1	1	1	0	0	1	1	0	0
1	1	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0



Water Level Controller Prototype

► CONCLUSION

The researchers concluded that the **AUTOMATIC WATER LEVEL CONTROLLER WITH INDICATOR** could control the on-off operation of the water pump thereby controlling the level of water that entering the tank. Furthermore, the device can indicate the level of water in the tank.

► RECOMMENDATION

The use of **AUTOMATIC WATER LEVEL CONTROLLER WITH INDICATOR** is recommended for household and establishment with water tank and constant water source driven by the electric motor pump.

Moreover, the use of the said device varies depending on the power supply needed by the water pump. Thus, the researchers suggest that specific relay must be use for certain capacity of motor.

Further improvements and study on the device must be done in order to insure greater efficiency.

Price List

Quantity	Material	Item Price	Total Price
4	2N3904	P 10.00	P 40.00
3	2N3415	P 20.00	P 60.00
3	C1061	P 35.00	P 105.00
8	LED	P 3.50	P 28.00
1	LDR	P 35.00	P 35.00
1	IC	P 25.00	P 25.00
1	IC socket	P 8.00	P 8.00
10	¼ Watt resistor	P 0.30	P 3.00
2	Capacitor	P 12.00	P 24.00
2	Potentiometer	P 15.00	P 30.00
3	Trimmer	P 8.00	P 24.00
5 m	Lead	P 5.00	P 25.00
2	PCB	P 25.00	P 50.00
1 m	5 Color Wires	P 15.00	P 15.00
2	Relay switch (DPDT)	P 180.00	P 360.00
1	Pump w/ built-in motor	P 450.00	P 450.00
	Pump accessories	P 103.00	P 103.00
1	Water tank	P 600.00	P 600.00
1	Faucet	P 130.00	P 130.00
3	12 VDC, adapter	P 120.00	P 360.00
1	Aluminum sheet	P 80.00	P 80.00
1 m	Aluminum Wire	P 6.50	P 6.50
1	Ferric chloride	P 25.00	P 25.00
1	Push button (NC)	P 10.50	P 10.50
1	Push button (NO)	<u>P 10.50</u>	P 10.50
	TOTAL		P 2,607.50