Automatic Water Pump Switch with Smart Level Indicator

Project Proposal

The 3 in 1 Automatic water pump switch with smart level indicator facilitates automatic switching and remote switching and indicates the water level in the tank for enhancement of household activities with the technology.

Group No: 20

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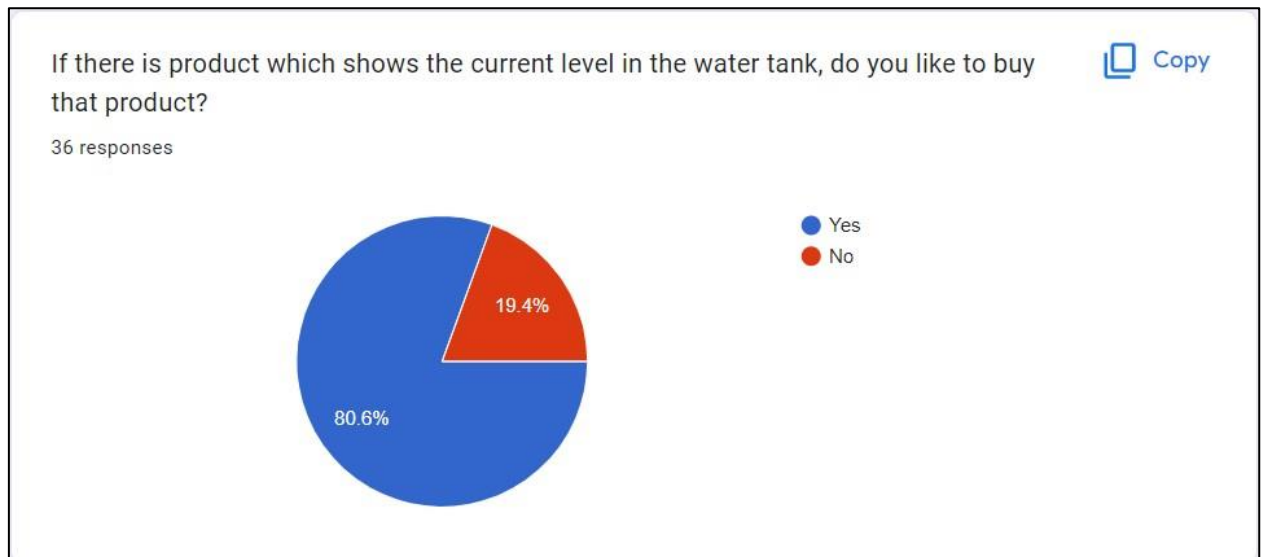# 1. Problem Description and Product Idea Validation

❖ Problem description

> ➢ The economic crisis in Sri Lanka has led to a failure of supplying power to meet the average demand. It is affected many household activities. It is important to minimize the wastage of power. In many houses, they forget to *switch off the water pump* after they switch on it. Because of that, there is a water overflow and waste of the water as well as power. The reason for that is not only forgetfulness but also because they do not have any method to indicate the current water level of the tank. They have another two problems. They want a method to *switch on the water pump before the tank gets empty* and to *know the current water level* to confirm the remaining water amount is sufficient till the power came back. Because nowadays our country is facing several power cuts per day. As an answer to that main problem, we decided to produce an automatic water pump switch with a level indicator.
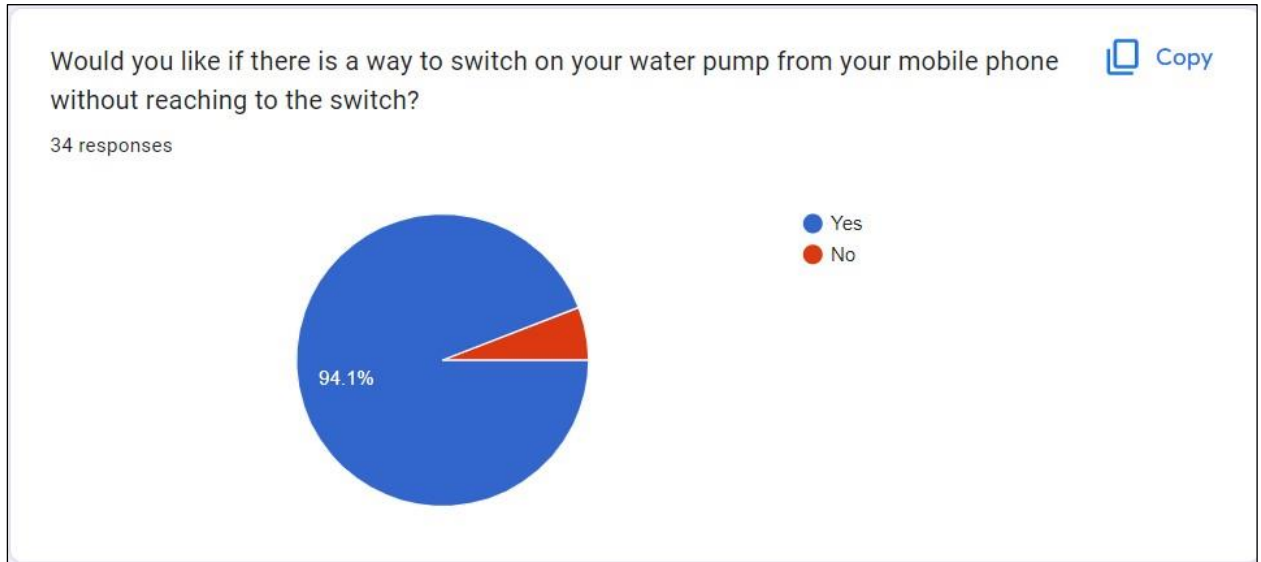
❖ Motivation

> ➢ We did a survey, and it gave people's ideas and expectations about the product that we are going to introduce to them. According to the survey, 97.2% of people like to buy automatic switch.
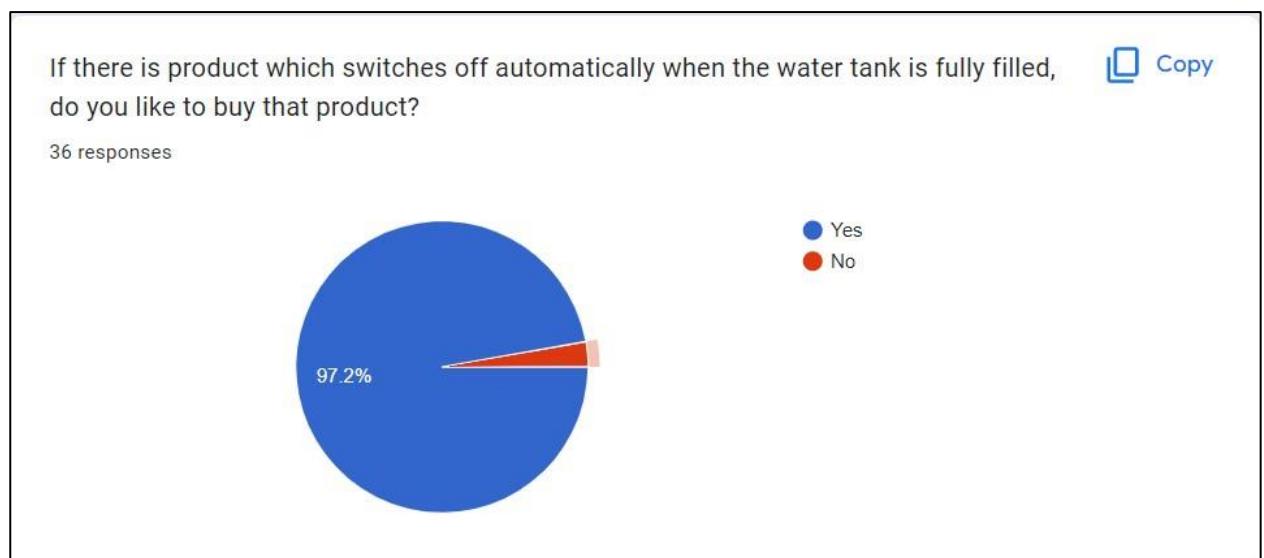
> ➢ If there is an option to identify the current water level, 80.6% of people are willing to buy that product.

If there is product which shows the current level in the water tank, do you like to buy that product?

36 responses

Legend:
- Yes
- No

19.4%
80.6%

> There are 94.1% of people who would like to have a remote-control method to switch on and off the water pump.

Would you like if there is a way to switch on your water pump from your mobile phone without reaching to the switch?

34 responses

Legend:
- Yes
- No

94.1%

> According to the survey, 66.7% of people like to buy the complete product around Rs.3000-Rs.3500. 19.4% of people are willing to buy it for around Rs.3500-Rs.4000. 2.8% of people like to buy it for less than Rs.5000 or at a suitable price.

- There is still no product that has all these options in one, so there will be a lot of demand for our final product.

❖ Justifications

➤ To make proper utilization of power in the household we are going to build an automatic water pump switch with a smart level indicator. Water pump consumes a considerable number of units in electricity bill. So, it is important to switch off and on the water pump precisely to reduce the waste of power. If an average household pump runs unnecessarily for about 10 minutes each day the calculated number of wasted units will be 2.5. The automatic switch will turn off the motor automatically just after the water level of the tank is above a certain level. According to the survey that we did, 66.67% of people forget to turn off the pump before the overflow of water. The automatic switch will provide the solution to that problem. So, it will not let the water overflow and run the pump unnecessarily.
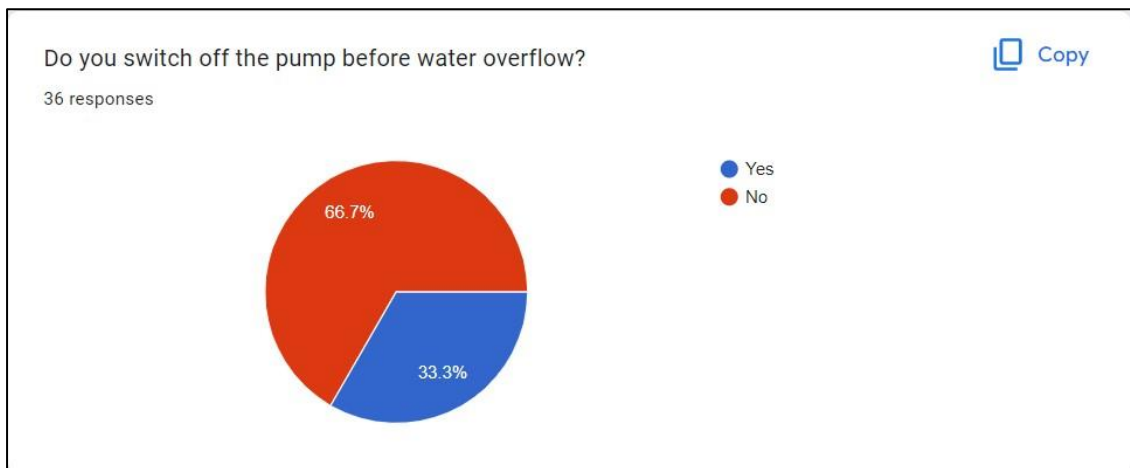
➤ The next need which we identified is to *switch on the water pump before the tank gets empty.* For that, we improved the automatic switch to turn on the pump when the water in the tank is below a certain level. For that, we use a lower threshold level. Now, the improved automatic switch will give the solution to both problems.

➤ The third problem we identified was the need to know the current water level in the water tank. For that, we produce a water level indicator which can show the current water level of the tank by numbers. From those customers can easily get an idea about the current level of the water tank.

➤ According to the survey, we identified that people are willing to buy a product which has a facility to control the water pump switch from their mobile phones. Because of the high percentage, we decided to improve our product by adding an option to control the water pump from phones.

• Then our final product contains the automatic switch, level indicator and Bluetooth controller.

4

2. Technical Feasibility

For this product, we use digital electronic technology and Bluetooth technology. Op-amp, 74hc147 (Seven Segment), 4511 IC, and 555 timer IC are used in the product. They are operating under electronic and digital technology. We can handle these ICs under the electronic knowledge we have. Op-amp is used to control the threshold levels and 74hc147 is used to display the water levels in relevant numbers. 4511 IC is used to control the digits shown on the seven-segment display. The 555 timer IC is used as a flip flop. Another technology we use is Bluetooth technology. We apply it to control the water pump switch from the mobile phone.

3. Technical Specifications

❖ Key features

- ➢ 10 level indicator (seven-segment display)
- ➢ Automatic switch
- ➢ Virtually on off system via Bluetooth

❖ Physical dimensions

- ➢ Length = 18 cm
- ➢ Width   = 10 cm
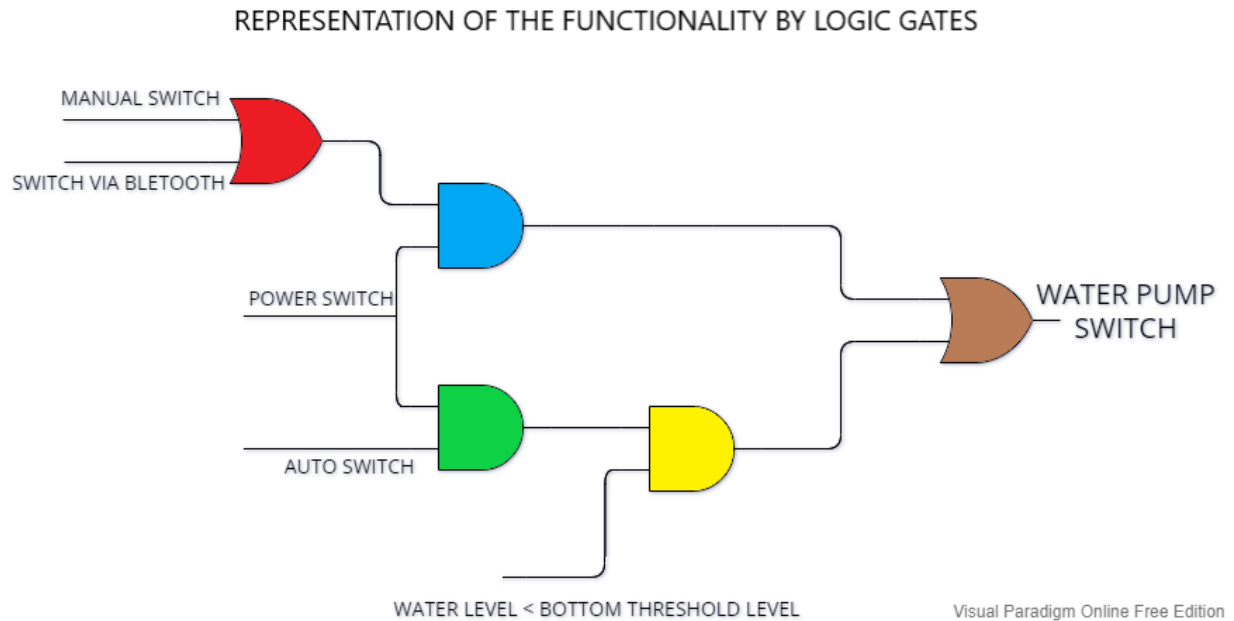- ➢ Height = 7.5 cm

❖ Weight

350 – 450 g

❖ Interfaces

- ➢ Seven segment display
- ➢ Indicating LED panel
- ➢ Switch panel
- ➢ Input Output socket panel

❖ Power consumption

0.7 W

4. Product Architecture

Automatic water pump switch with water level indicator

REPRESENTATION OF THE FUNCTIONALITY BY LOGIC GATES

MANUAL SWITCH

SWITCH VIA BLETOOTH

POWER SWITCH

AUTO SWITCH

WATER LEVEL < BOTTOM THRESHOLD LEVEL

WATER PUMP SWITCH

Visual Paradigm Online Free Edition

The project design of the automatic water pump switch with the water level indicator consists of three main sub-systems. They can be categorized as,

1. **Regulated DC power supply**
2. **Automatic water pump switch**
3. **Water level indicator**

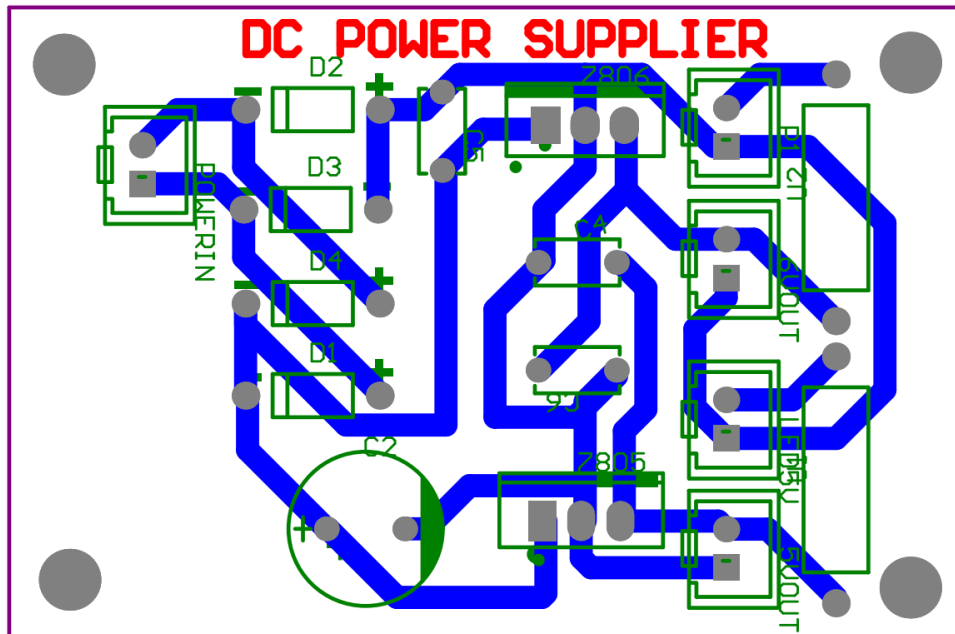Above mentioned subsystems are described in detail as follows.
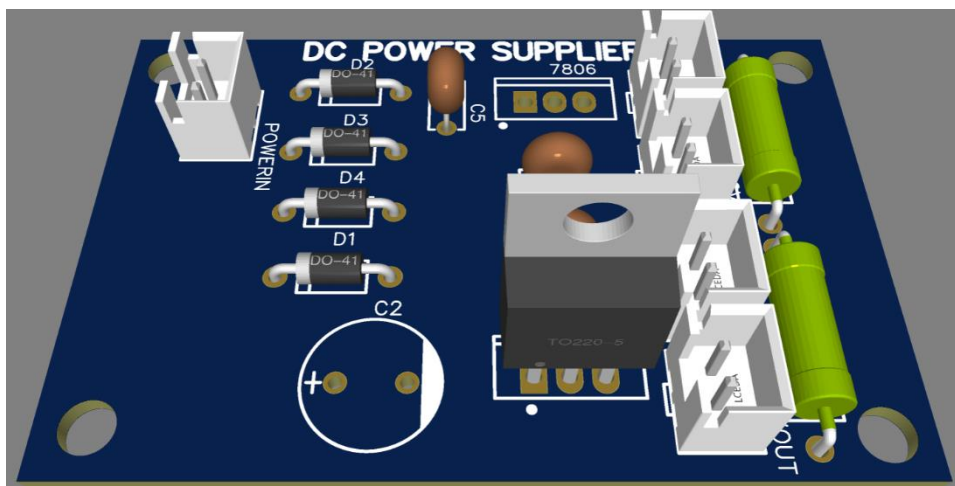
❖ Regulated DC power supply

Regulated Power Supply Block Diagram
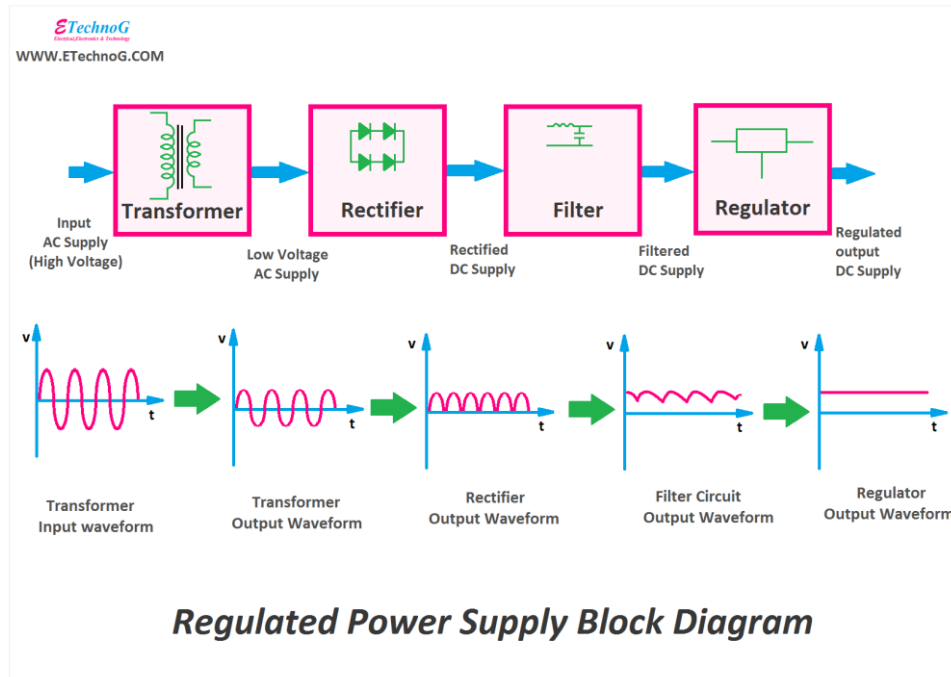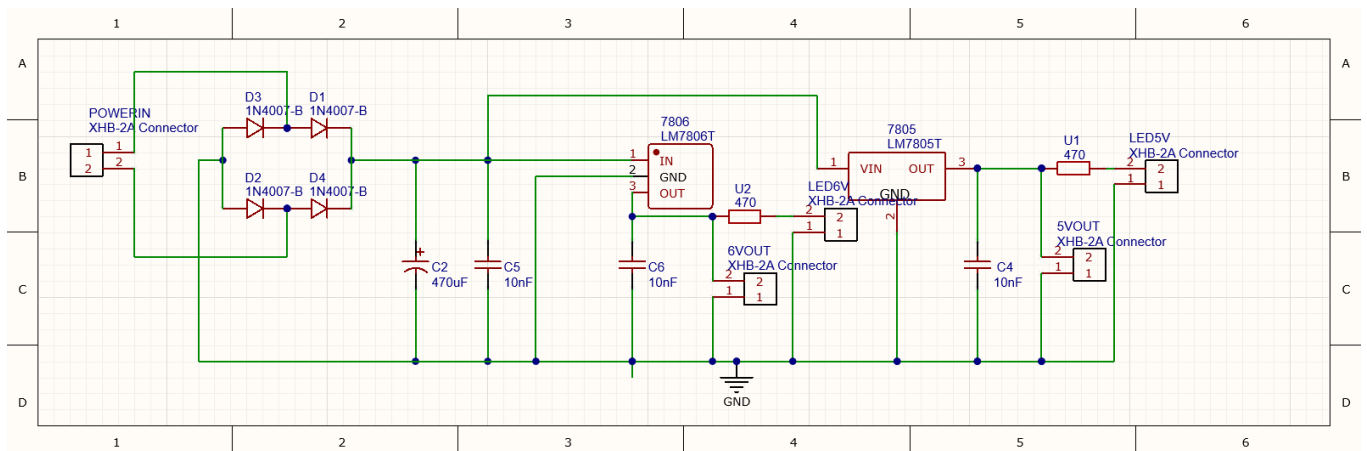
The schematic diagram (Altium 2022) view of the Regulated power supply

The PCB diagram (Altium 2022) of the Regulated power supply

3D view (EasyEDA Online 2022) of Regulated power supply

The function *When we produce a nonregulated alternative AC power supply as the input to the regulated power supply unit, then it provides a filtered regulated DC voltage as the output. The role of our design is to provide relevant voltages to each subsystem.*
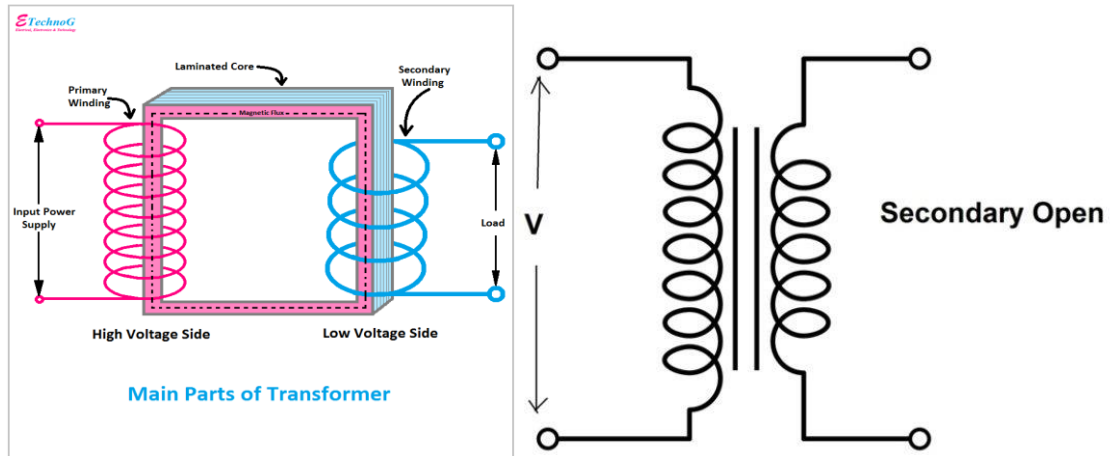
The main blocks of this subsystem are

- Transformer
- Rectifier
- Filter
- Regulator

Let's talk about each block individually.

i.   Transformer

<u>Working principle of transformer</u>

This is a statical electrical device to transport the electrical energy between two systems by electromagnetic induction without an electrical connection. Variation of the current in one coil produces a varying magnetic field, which can induce a varying electromotive force. Therefore, a voltage must be built up in the second coil.

Sources: https://www.etechnog.com/2021/10/electrical-transformer-types-parts.html   https://electricalbaba.com/phasor-diagram-transformer/

The function of a transformer is to step up or step down the alternating input voltages. Therefore, transformers are categorized into step-up transformers and step-down transformers by considering the turn ratio of the transformer. In our project, we have used a 230v/9v step-down transformer. Turns ratio means N1/N2. In this case, N1 is the primary winding turn and N2 is the secondary winding turn.

If power losses are equal to zero, then input and output powers are equal. By considering this we can obtain an equation as follows.

V1I1=V2I2

And, the magneto motive force produced by the primary current and secondary current are equal, then,

N1I1=N2I2,

From these equations, we can find out secondary voltage as V2=(N2/N1) V1

Not only that but there is also a 1A fuse that is held in series to the transformer's primary winding to ensure the protection of the PCB furthermore against the high current that flows through the system.
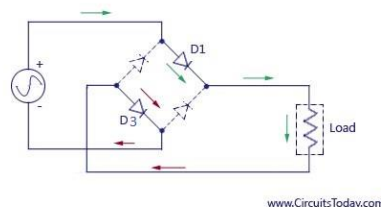
ii.   Rectifier

The role of the rectifier circuit is to convert the input AC voltage into a DC voltage.

Most of the time silicon diodes are used to make this circuit. Three different ways can be used to build this. These methods are,

- Half Wave rectification - One side of the alternative signal is lost when using this.
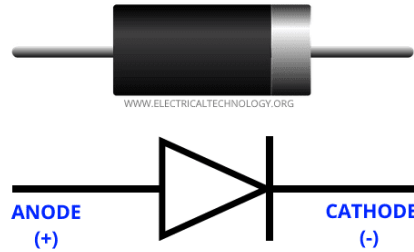- Full Wave rectification
- The Bridge rectification

However, we have planned to build the bridge wave rectifier. The figure below shows the functionality of this method.


Bridge wave rectifier

In both the positive half cycle and the negative half cycle, the current through the load should be one direction due to the function of four diodes. Since the current can only flow through a diode from the positive terminal to the negative terminal. In our design, we use IN4007 rectifier diodes.

ANODE
(+)

CATHODE
(-)

Source: *https://www.electricaltechnology.org/2020/06/diode.html*

iii.   Filter

Filtering the pulsating rectified dc output to a more stable dc output by smoothing the waveform. Because there is possible to have high peak-to-peak ripple voltage in the rectified waveform.
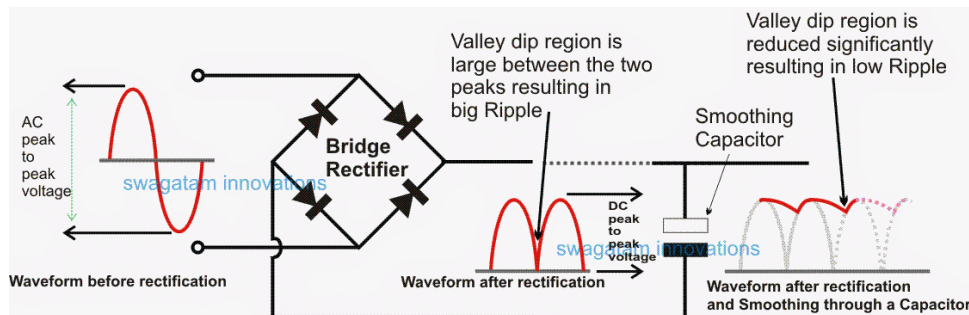
Waveform rectification and smoothing

Source: https://makingcircuits.com/blog/calculate-filter-capacitor-smoothing-ripple/

Many types have been made for various cases. But to perform this from our design we have used a 470uF 50v Electrolytic capacitor and three 0.01uF ceramic capacitors.
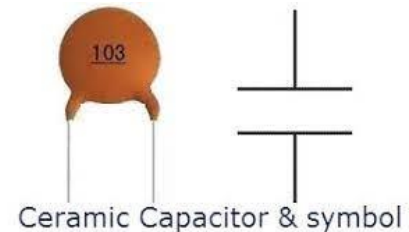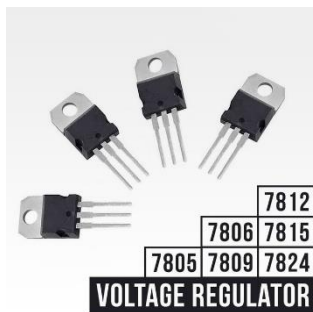

Source: https://www.dev.faranux.com/product/electrolytic-capacitors-470uf50v/

iv.   Regulator

Although filter circuits produce a smoother waveform, we can't guarantee that the voltage is exactly equal to the desired voltage. The regulated circuit ensures that the output voltage is constantly fixed always.
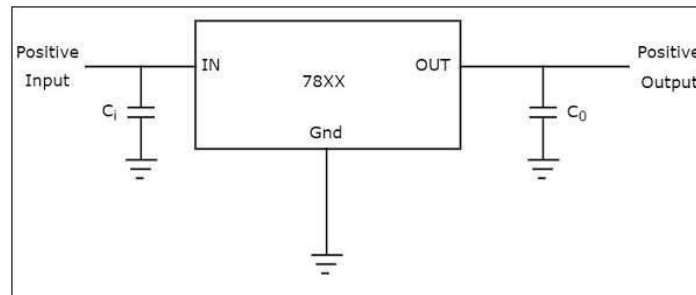
Source:*https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_voltage_regulators.html*
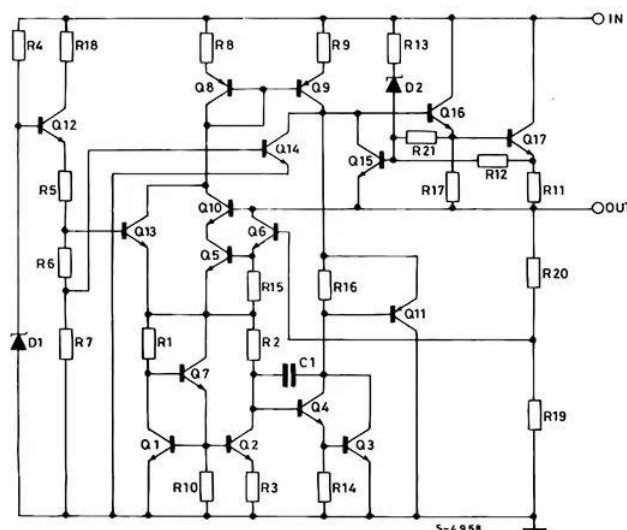
When considering the other two main sub-systems, the Automatic water pump switch circuit should be supplied with a 6v DC voltage as well as Water level indicator circuit should be powered by a 5v DC voltage. Therefore, to fulfil, both cases, we have used 2 regulating ICs. 7805 IC and 7806 IC are the regulators that can be mentioned to produce 5v and 6v DC voltages, respectively. Also, this regulator circuit consists of 0.01uF ceramic capacitors.

Source: *https://www.linquip.com/blog/what-is-ceramic-capacitor-2/*

Source: *https://shopee.com.my/Three-Terminal-Positive-Voltage-Regulator-IC-%287805-7806-7809-7812-7815-7824%29-i.294606683.7662791257*
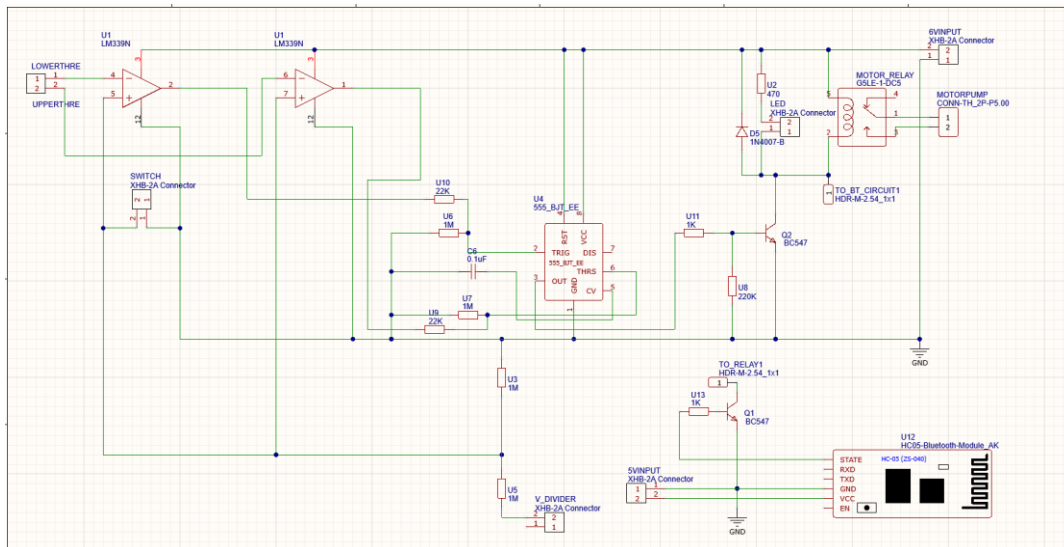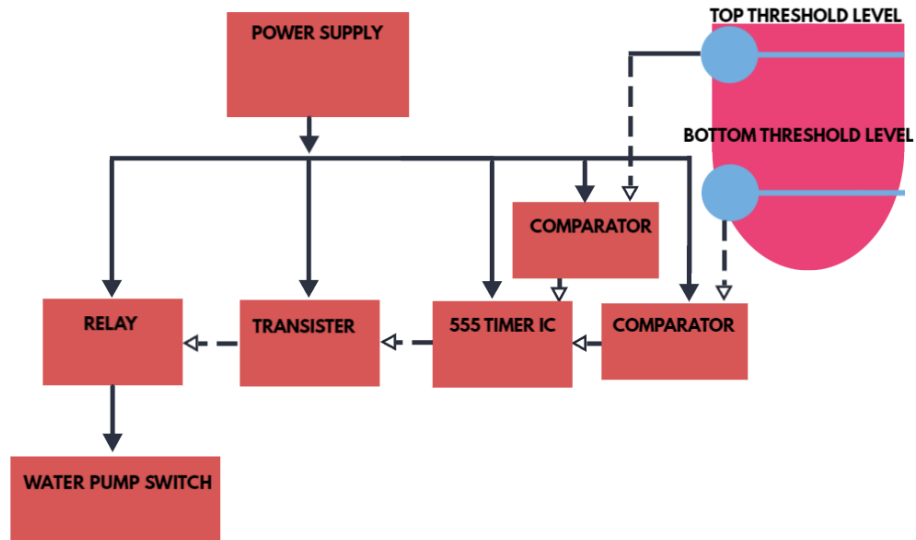

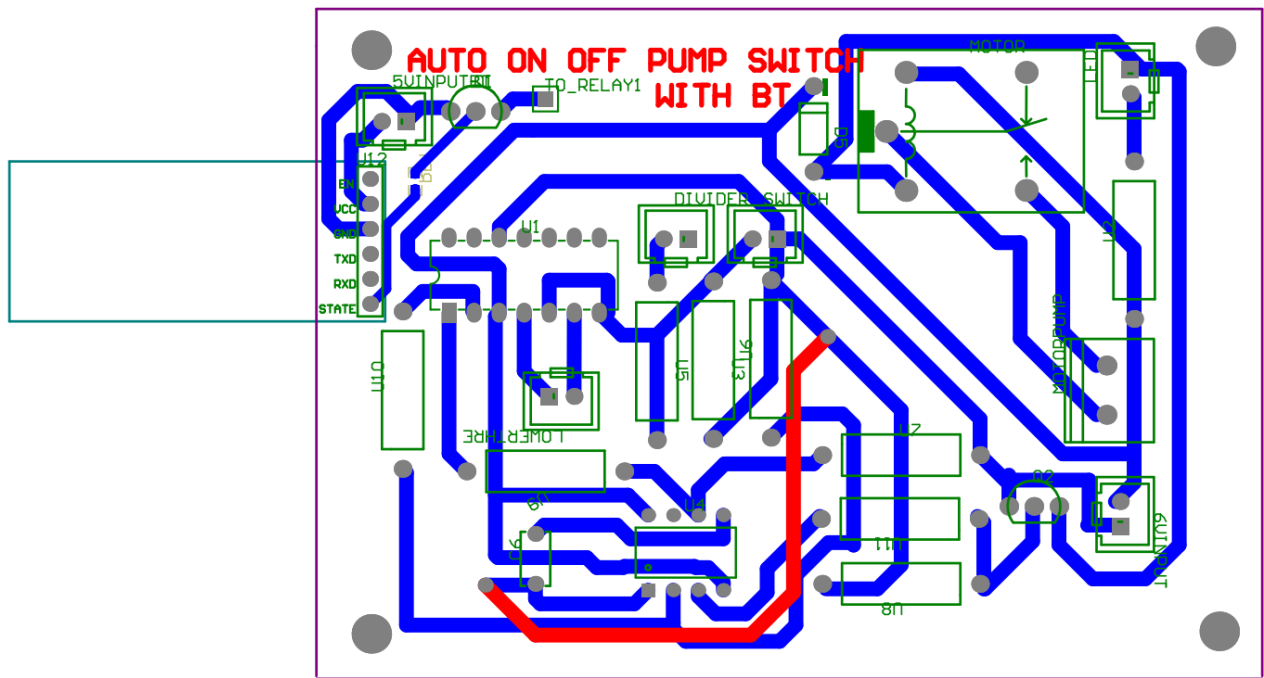*Schematic diagram of a 7805-voltage regulator*

Source: *https://www.quora.com/In-what-things-is-a-7805-voltage-regulator-found-in-And-can-I-make-one-myself*
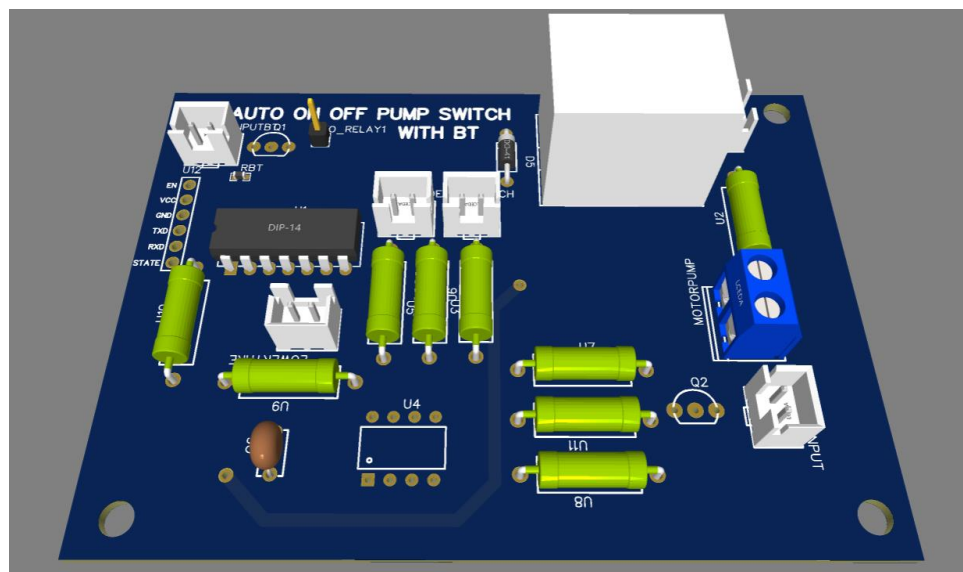
❖ Automatic water pump switch

The schematic diagram view of the Automatic water pump switch

The PCB diagram of the Automatic water pump switch

3D view of Automatic water pump switch

The function

   When the current is lower than the bottom threshold level then the relay switch will be turned on by the circuit until the water level passes the top threshold level. After the water level passes, the upper level then relay switch will be turned off. However, the water level must be lower than the bottom level to turn on again the relay switch.
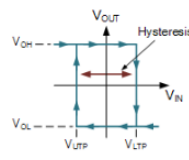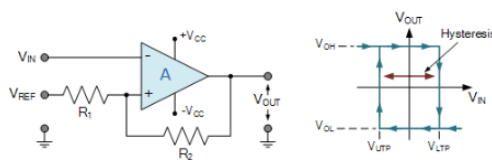
The main blocks of the above subsystem are,

- Op-amp comparator
- 555 timer IC as a threshold detector
- Transistor as a switch
- Relay switch

Let's talk about each block

i. Op-amp comparator

Compare one analog voltage with another analog voltage or a preset voltage value, if the voltage at the noninverting terminal (positive terminal voltage) is greater than the voltage at inverting terminal (negative terminal voltage) then, it produces the output voltage as a positive value and otherwise, it produces the output voltage as a negative value.

Also, we can calculate the out voltage from the equation $V = A (V+ - V-)$ where $V+$ and $V-$ correspond to the voltages at the non-inverting and the inverting terminals, respectively. The symbol A represents the open loop gain since the magnitude of the above coefficient has a very high value. Therefore, practically we can achieve output voltage as $-Vcc$ and $+Vcc$ where $-Vcc$ and $+Vcc$ correspond to the voltages at positive supply and negative supply, respectively.
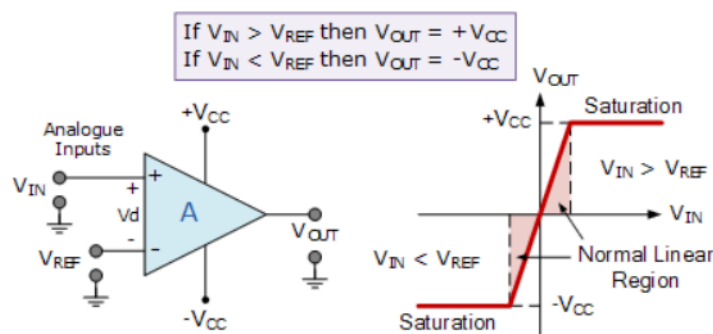
In our design, we have used LM339 comparator IC to identify two threshold levels. The non-inverting terminals of both Op-amps are connected to a positive preset voltage. Also, inputs for the inverting terminals of Op-amps are transferred by the water level indicator circuit.
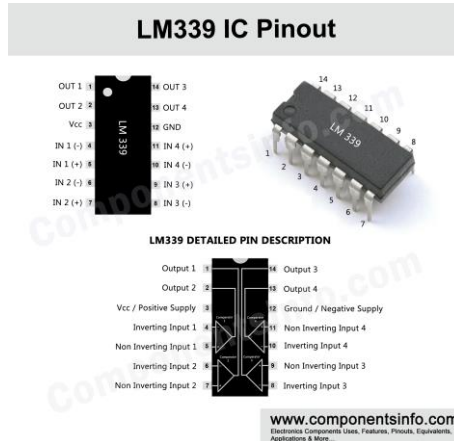
ii.   555 timer IC as a threshold detector

This is an integrated device that can be used as a simple timer to generate single pulses or long-time delays, or as a relaxation oscillator.

To succussing our purpose, we use NE555 timer IC. When the water level is less than the bottom threshold level then one op-amp supplies the output as 6v voltage. In that case, approximately 5v will be supplied as one input to the timer IC. Also, when the water level is greater than the top threshold level approximately 5v will be supplied as a second input to 555 IC. The output voltage is produced after some process that occurs in 555 timer IC. However corresponding output values for each input can be shown as follows.
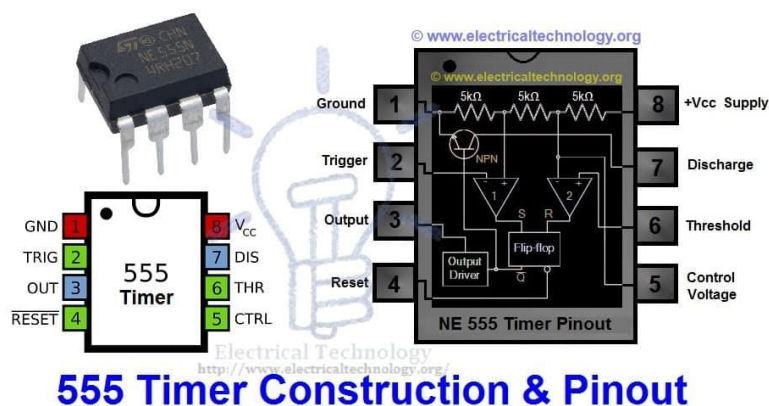
iii. Transistor as a switch

Types of transistors

1) BJT
2) JFET
3) FET
4) MOS

Also, some applications of transistors are

- Amplifying circuit
- Oscillator circuit
- As a switch
- Modulators
- Detectors etc.

However, an NPN BJT transistor is capable of switching purposes,

When a zero-voltage is applied to the Base terminals then the base current is zero. Therefore, the collector current is equal to zero (CUT-OFF) as well. In this case, the transistor acts as an" OFF" switch and when a positive signal is applied to the Base, then the maximum collector current (SATURATION) flows, therefore now the transistor acts as an "ON" switch.

Also, transistors have four distinct operation modes

- **Saturation** - acts like a **short circuit**.
- **Cut-off** - acts like an **open circuit**.
- **Active** - base current is proportional to collector current. Current flows from collector to emitter
- **Reverse-Active** -the current is also proportional to the base current, but Current flows from emitter to collector
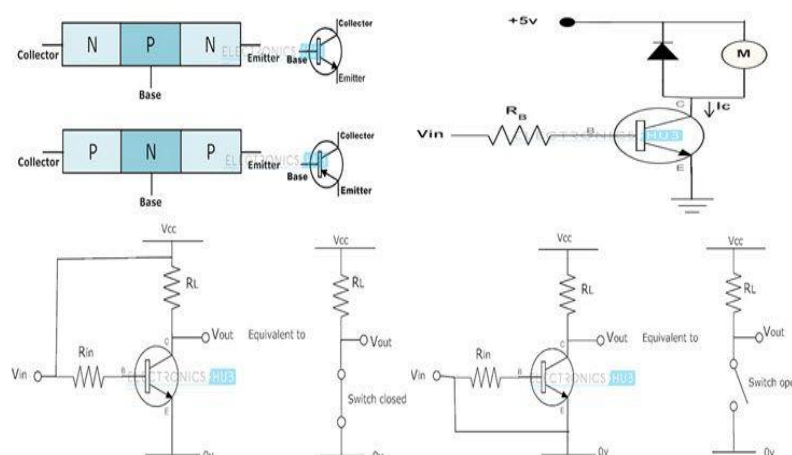
In our design project, we use the NPN BC547 transistor to succeed above function.

BC547 Transistor Pinout

TO-92 Package

NPN

BC547
D 131

1 Collector

2
Base

3 Emitter

1
Collector

3
Emitter

2
Base

www.componentsinfo.com
Electronics Components Uses, Features, Pinouts, Equivalents, Applications & More…
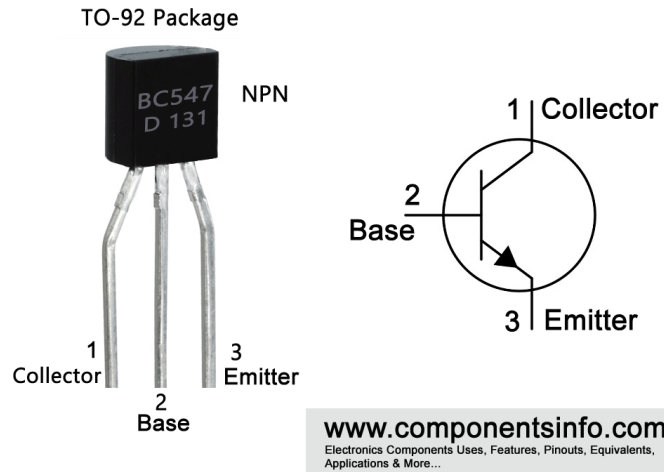
iv. Relay switch

Single Pole Double Throw SPDT Relay is a switching device that can be used for switching between two circuits. When a DC voltage is applied, as the input from the first system coil will be energized, then one circuit is activated while the second circuit is deactivated. Otherwise, the second one acts as a closed circuit and the first circuit acts as an opened circuit. Also, there is only one common for these circuits.

SPDT Relay

fan 1

fan 2

A

B

220V

figure 1

fan 1

fan 2

+12V A

B

220V

figure 2
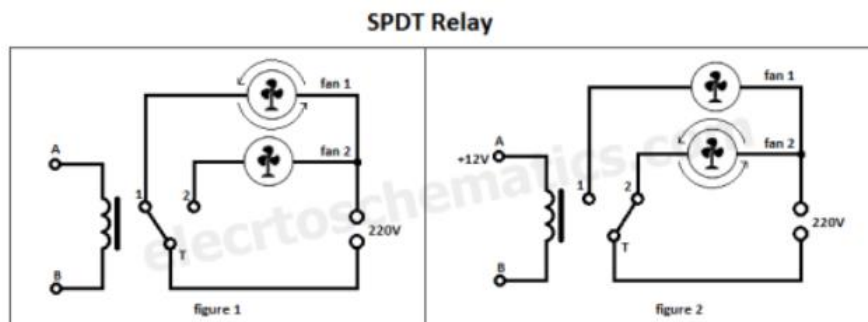
In an automatic water pump switch subsystem, the relay is used to connect the motor pump separately without an electrical connection between the water pump and this system. Therefore, when current flows through the collector of the transistor then due to this situation this current also flows through the inductance coil of the relay, the coil is energized, and the water pump switch acts as an "ON" switch to turn on the motor pump. It is important to mention that the water pump is powered by domestic electricity.

But something may go wrong. Let's consider the moment at which the collector current goes to zero. Therefore, the relay starts de-energizing, at that moment, it is possible to arise a huge voltage spike. It will cause damage to our PCB. Therefore, the IN4007 flyback diode is placed parallel to the relay's inductance coil with reverse polarity from the power supply
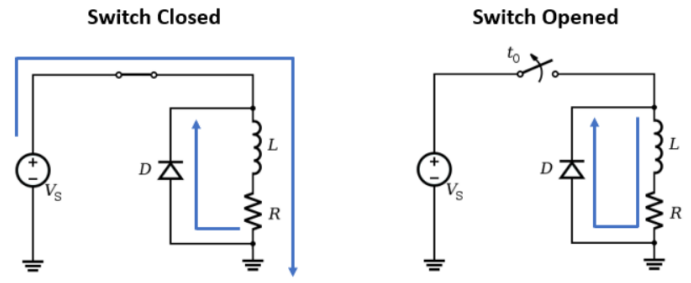
Current flow through the flyback diode wiring in a relay circuit.

Source: https://resources.altium.com/p/using-flyback-diodes-relays-prevents-electrical-noise-your-circuits

In addition to the above method, the relay can be operated by two more steps. Even though the water level increases up to the top threshold level, it will not turn off the relay.

1) By manual switch

When this switch turns on manually, then the noninverting terminal of op-amp that is connected to the bottom threshold level will get the value 0v. The output voltage value of this op-amp will be 0v. This situation produces a relay switch-on mode.

TURN ON THE RELAY BY MANUAL SWITCH
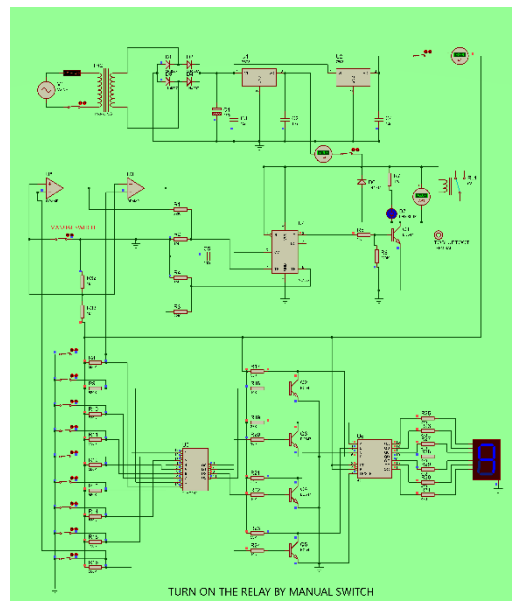
2) By any smart mobile phone via Bluetooth (any suitable mobile app is essential)

When we turn it on by mobile app then the transistors that are connected to the Bluetooth circuit will act as an "ON" switch. Also, this situation produces the relay switch-on mode. The Bluetooth module that has to use is HC-05.

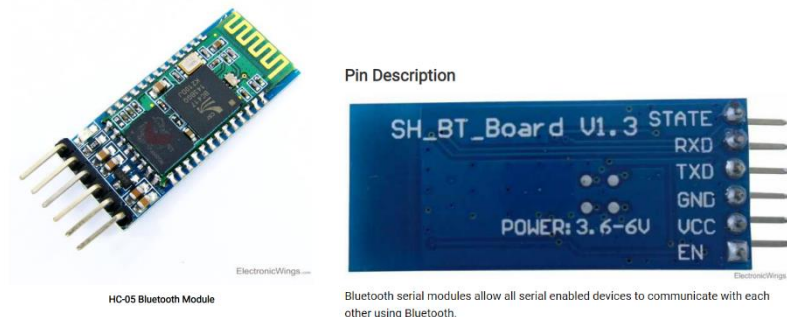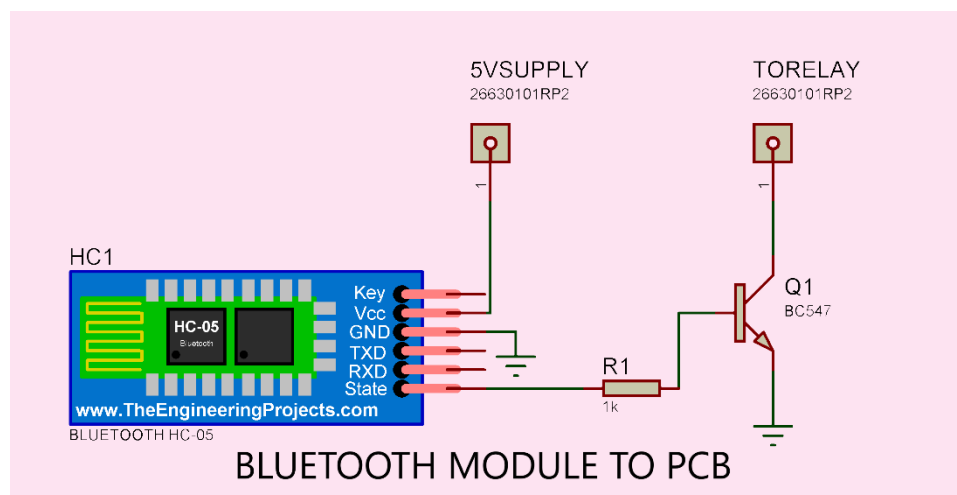## HC-05 Pinout Configuration

1. **Key/EN:** It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

    1. **Data mode:** Exchange of data between devices.

    2. **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.

2. **VCC:** Connect 5 V or 3.3 V to this Pin.

3. **GND:** Ground Pin of module.

4. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)

5. **RXD:** Receive data serially (received data will be transmitted wirelessly by Bluetooth module).

6. **State:** It tells whether module is connected or not.

❖ Water level indicator
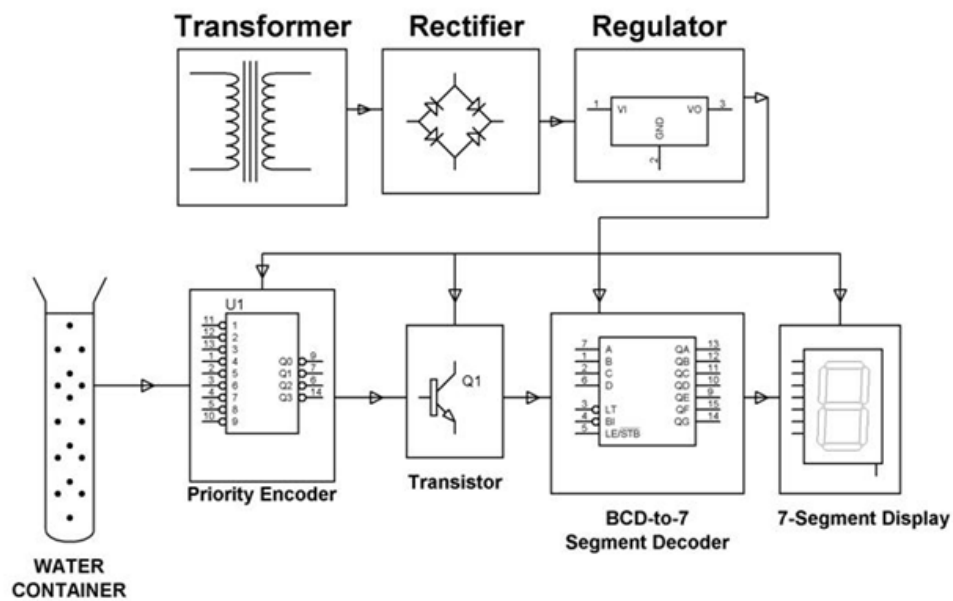
Water level indicator block diagram

The schematic diagram view of the Water level indicator

The PCB diagram of the Water level indicator

The 3D view of the Water level indicator

The function

The subsystem indicates the water level and displays the corresponding water level as a number from 0 to 9.
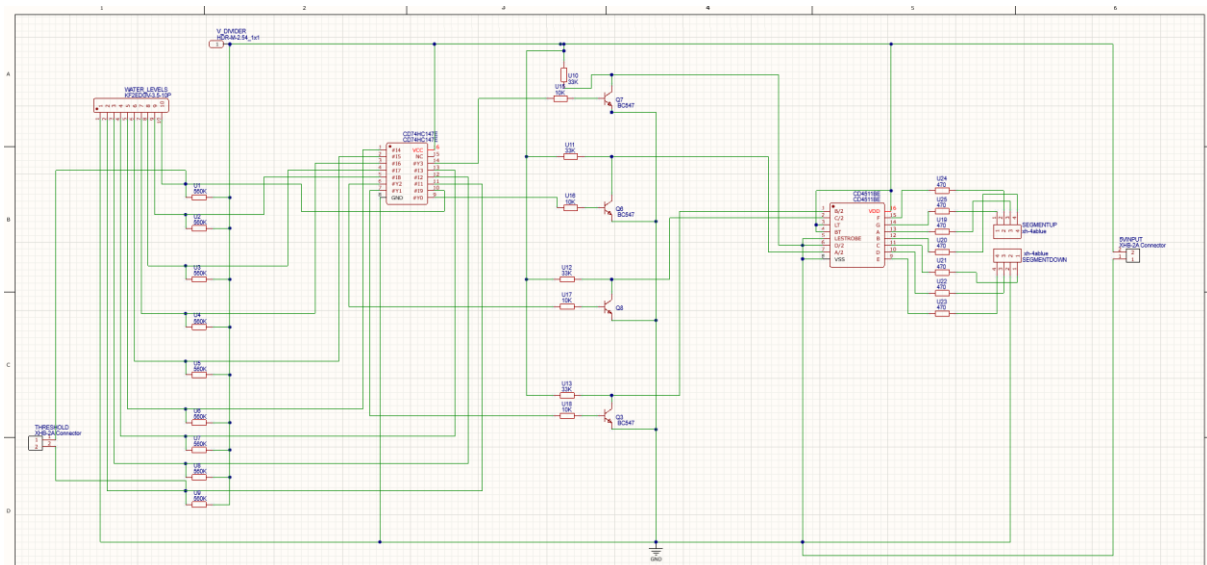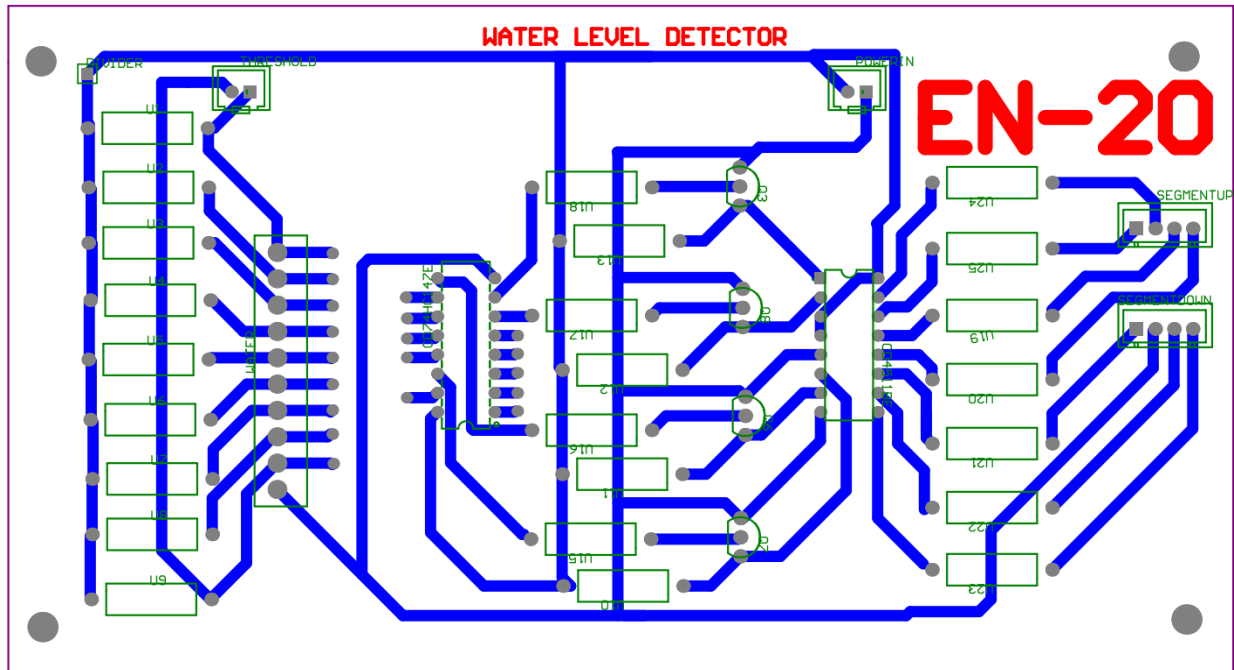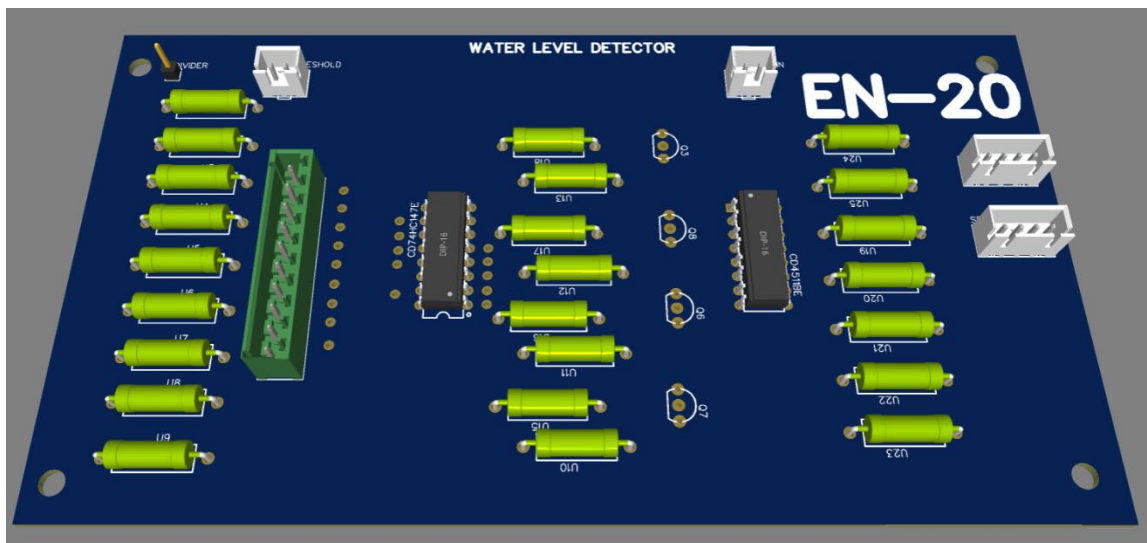
The main blocks of the above subsystem are,

- Priority encoder
- Transistor
- BCD to 7 segment decoder
- 7 segment display

i.   Priority encoder

Compresses the number of multiple inputs to a smaller number of outputs.

It will reduce the number of wires that are needed for a circuit.

This subsystem consisted of 74HC147 IC as the priority encoder. Also, the mentioned IC is a 9-input priority encoder which is possible for nine active LOW inputs and provides as outputs four active LOW inputs.

Functional Diagram
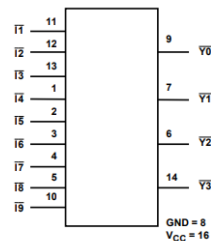
TRUTH TABLE

INPUTS									OUTPUTS			
I1	I2	I3	I4	I5	I6	I7	I8	I9	Y3	Y2	Y1	Y0
H	H	H	H	H	H	H	H	H	H	H	H	H
X	X	X	X	X	X	X	X	L	L	H	H	L
X	X	X	X	X	X	X	L	H	L	H	H	H
X	X	X	X	X	X	L	H	H	H	L	L	L
X	X	X	X	X	L	H	H	H	H	L	L	H
X	X	X	X	L	H	H	H	H	H	L	H	L
X	X	X	L	H	H	H	H	H	H	L	H	H
X	X	L	H	H	H	H	H	H	H	H	L	L
X	L	H	H	H	H	H	H	H	H	H	L	H
L	H	H	H	H	H	H	H	H	H	H	H	L

H = High Logic Level, L = Low Logic Level, X = Don't Care

ii.   Transistor

Simply four transistors act as NOT gates. Because if a high voltage is produced to the base-emitter junction, then the output voltage at the collector is low, and otherwise it will be the other way around.

.
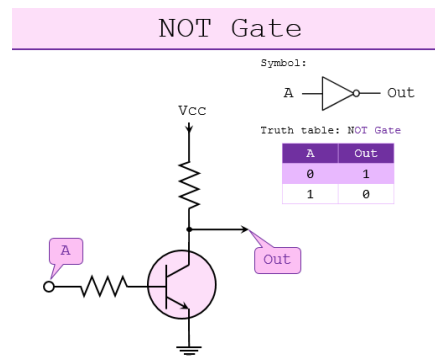
The outputs of the encoder are the inputs for those BC547 transistors, and then each transistor supplies voltage values as the inputs for the 4-bit adder IC.

iii.   BCD to 7 segment decoder

By taking 4 input values in the form of binary format, we then produce 7 output voltages to the corresponding 7 LEDs in 7 seven segment display for showing the numbers.
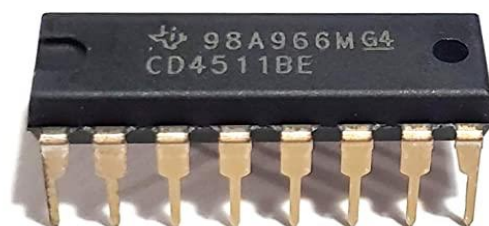
CD4511 IC is used as the decoder to fulfil the functionality of this subsystem.

https://circuitdigest.com/electronic-circuits/7-segment-display-driver-using-ic-cd4511

The 7 output values that correspond to 4 input values can be shown by a truth table as follows.

Binary Inputs				Decoder Outputs							7-Segment Display Outputs
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	1	0	1	1	9

Source: *https://www.electronicszone.it/testing/display_en.php*

iv. 7 segment display

7 segment display lights up any meaningful combinations of LEDs at the appropriate time for displaying the data or information.
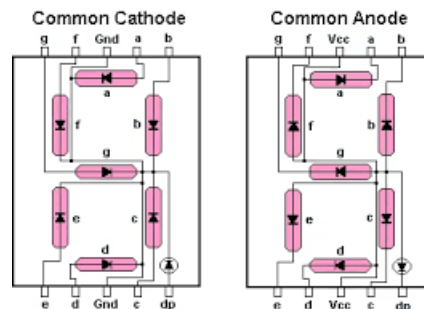
Source: *https://www.tthme.com/?category_id=3384282*

To succeed with water level indicating, a common cathode display is available, also 7 input that needs to be supplied is produced by CD4511 4-bit adder ICs output. Also, a 0.8-inch display can reach the purpose longer.
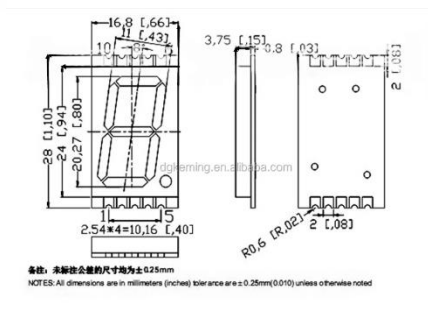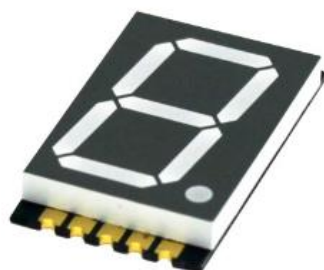
Source: *https://www.alibaba.com/product-detail/cathode-0-8-inch-single-digit_62019233105.html*

The 7 output DIGITs that correspond to 4 input values can be shown by a truth table as follows.

DIGIT	HEX Value	RB7	RB6	RB5	RB4		RB3	RB2	RB1	RB0
		D0	D1	D2	D3		D4	D5	D6	D7
		8	4	2	1		8	4	2	1
0	0x03	0	0	0	0		0	0	1	1
1	0x9F	1	0	0	1		1	1	1	1
2	0x25	0	0	1	0		0	1	0	1
3	0x0D	0	0	0	0		1	1	0	1
4	0x99	1	0	0	1		1	0	0	1
						www.alselectro.com				
5	0x49	0	1	0	0		1	0	0	1
6	0x41	0	1	0	0		0	0	0	1
7	0x1F	0	0	0	1		1	1	1	1
8	0x01	0	0	0	0		0	0	0	1
9	0x09	0	0	0	0		1	0	0	1
		a	b	c	d		e	f	g	dot
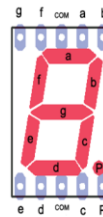
❖ THE SCHEMATIC DIAGRAM COMBINING OF ALL SUBSYSTEMS (Proteus 8.9)

THE SCHEMATIC DIAGRAM
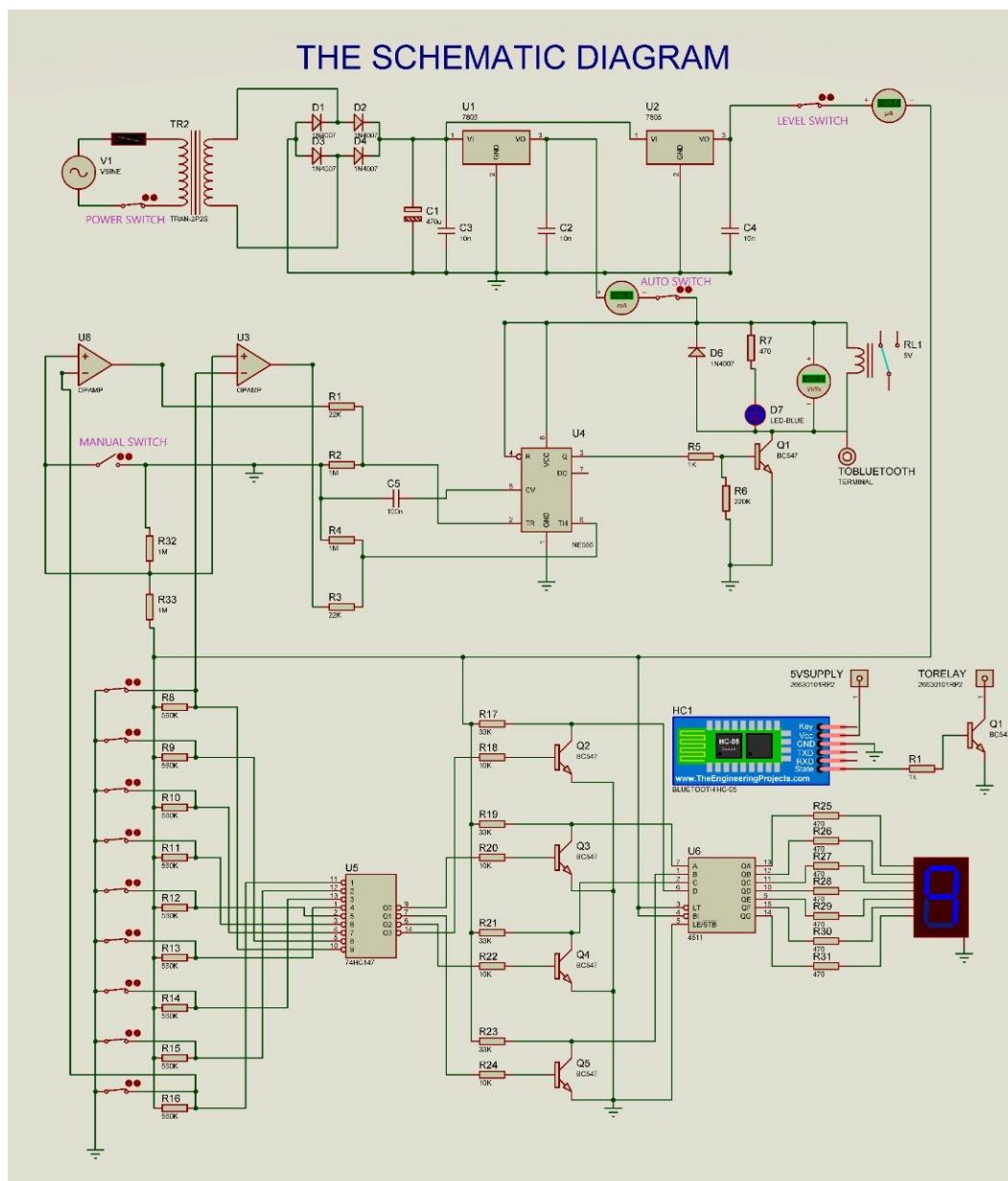
When each terminal that is put in the water tank touches the water, then that terminal will be connected with the common terminal of the system. Therefore, that terminal voltage is equal to the common voltage. But we are unable to achieve this purpose, with a simulator. However, we can fulfil the above situation from switches.

❖ The displayed DIGITs that correspond to each water level
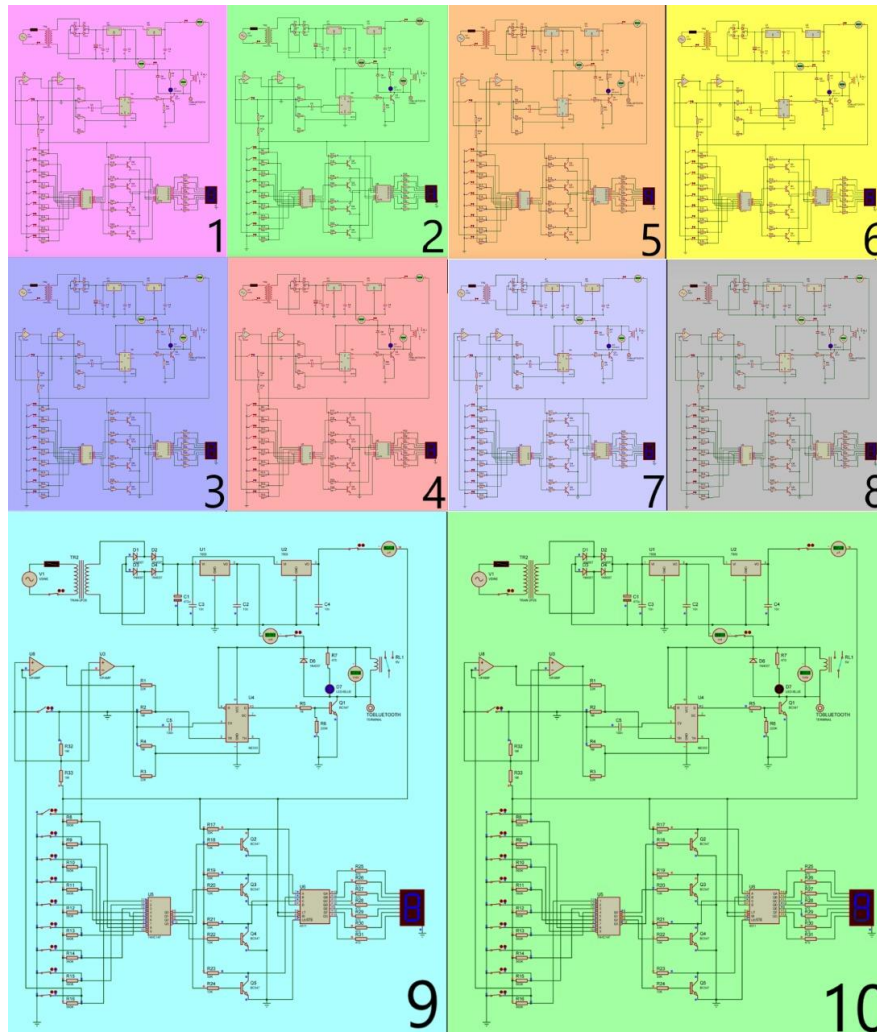
The following figure shows how automatic water pump relays are turned on and off due to the increasing water level. The left side of the figure shows a situation in which all 9 switches regarding the water level detection circuit section, are off, it means that the water is lower than the lower level. Therefore, a voltage between two terminals of the relay is built up. Also, practically we can run a water pump from this. The right side of the figure shows a situation in which all 9 switches are on, which means the water is higher than the upper level. The Volage between the relay will be equal to zero. So, the water pump should be turned off.

For the auto-on-off water pump switch, the uppermost terminal probe denotes the upper threshold level, while the lowest terminal probe denotes the lower threshold level.
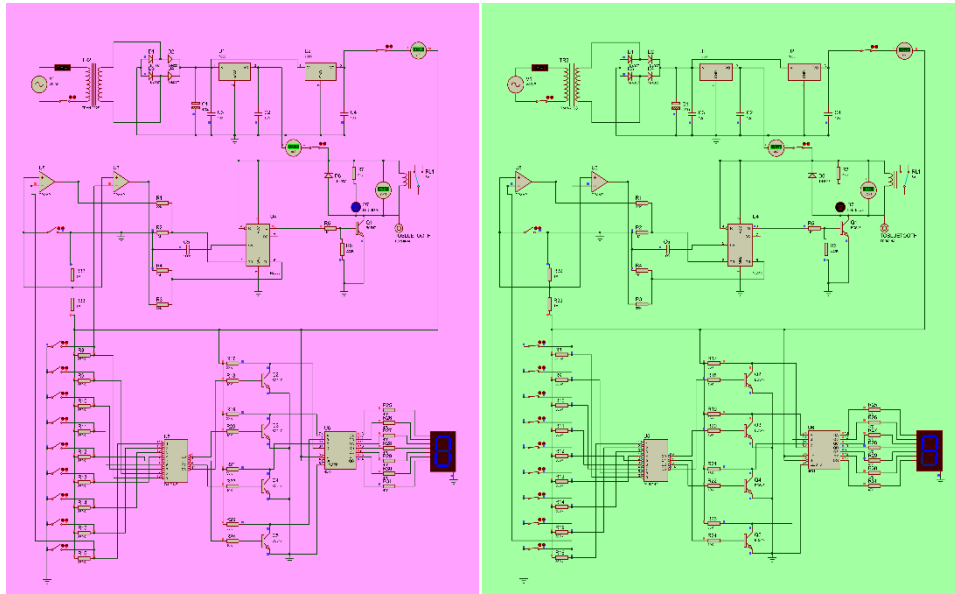
❖ How to install the cable coming out?

To measure the water levels, the 10 wires coming through the product should be placed at the correct level in the water. Each of these 10 ends is fixed with a clip. We also provide a non-conductive long tape with this product. Then, the user has to do is attach the 10 clips to the tape, by considering the height of the water tank and then fix it in the water vertically. The main purpose is to avoid the impact of water tank height. Because various water tanks have different heights. All 10 wires are combined as one cable. The figure below shows how they are connected.
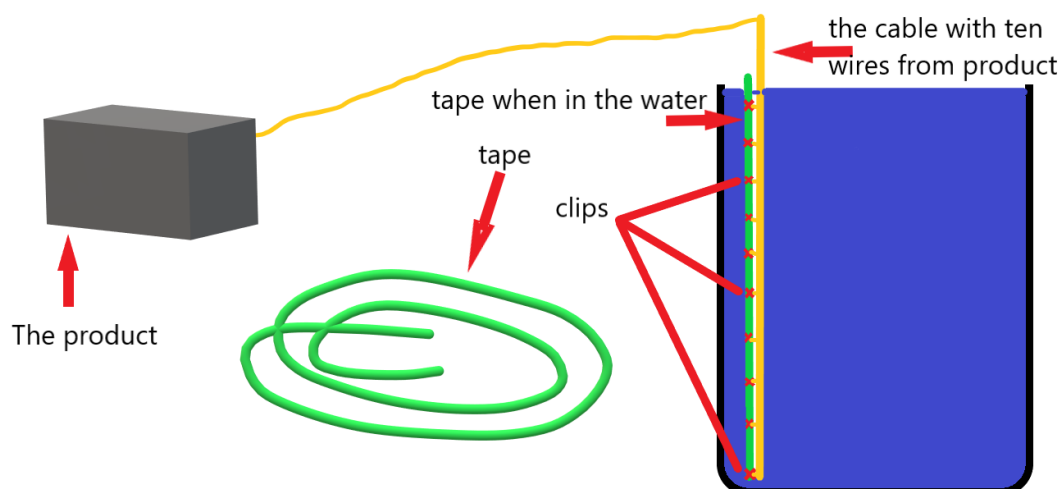
All of the above illustrations are obtained from simulating by Proteus 8 professional simulator.

In addition to our operand succeeding, we have accessed more simulators.

- **Drawing schematic diagrams** - Altium designer, EasyEDA online simulator, Proteus 8 professional simulator
- **Drawing PCB diagrams**   - Altium designer, EasyEDA online simulator
- **3D view**   - EasyEDA online simulators

Since we have decided to design PCBs separately from the subsystems, for connecting PCBs, LEDs, Switches, Plug Point, Power Cable etc. some types of connectors are selected

❖ The components list

Component	Amount	Component	Amount
Resistors			
1 M	4	Cathode 7 Segment Display	1
22 k	2	230 v/ 0-9 v sec 300mA Transformer	1
220 k	1	HC-05 Bluetooth Module	1
1 k	2	Relay SPDT 5v	1
470 ohms	8	0.5A Fuse	1
33 k	4	Switch	4
10 k	4	Plug Point	1
560 k	9	Power Cable	1
Transistors			
BC547 NPN Transistor (BJT)	6	**Connectors**	
Capacitors		2 Pin	7
100nF	1	10 Pin	1
470uF, 50V	1		
0.01uF Ceramic	4		
Diodes			
IN4007	5		
LEDs	4		
ICs			
555 Timer IC	1		
74HC147 7-Segment encoder	1		
CD4511 4-Bit Adder	1		
LM339 Operational Amplifier	1		
7806 regulator 6v IC	1		
7805 regulator 5v IC	1		

5. Initial and Finalized Sketches of the Product Enclosure

We know that the enclosure of the product is one of the most significant parts of the whole product. Because that gives the first impression of the product. Therefore, it should be designed in the way in which people are attracted. Color of the enclosure, how the buttons are placed in the interface, the shape of the product, what supportive parts can be used to mount the product in a suitable place and how it manages the heat are some of the key factors that are used when designing a product.

Below, you can see the initial sketch of the enclosure of the product.
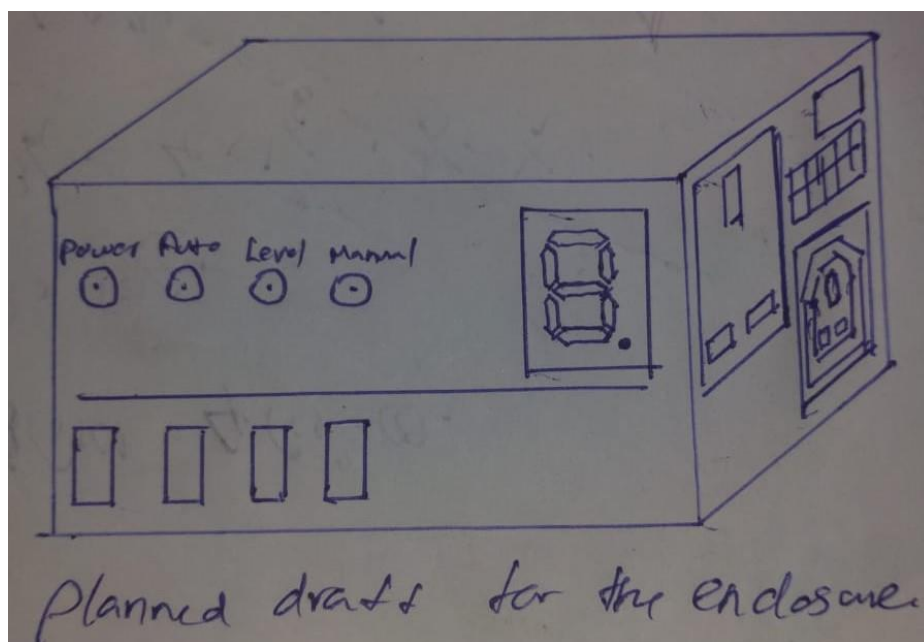
Figure 1

Here we can see the four LEDs which are allocated for indicating different functionalities of the product (that will be described under the below section where the final enclosure is described). Relevant switches have been placed under each LED respectively. Seven segment display has been placed in the right corner and power input, sensor sockets, fuses, and socket where the pump is connected have been placed on the right side of the enclosure. There is nothing on the left side. Because that side may cover when it is mounted to the wall. On the behind of the product, we can see air holes for the ventilation system.

❖ Each side of the enclosure (Sketches)

Figure 2.1   Front

Figure 2.2   Back

Figure 2.3   Up
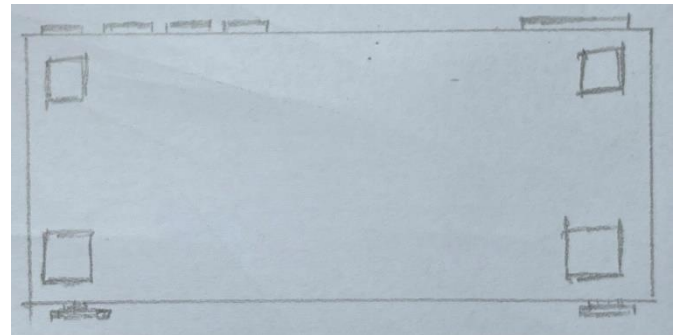
Figure 2.4 Down
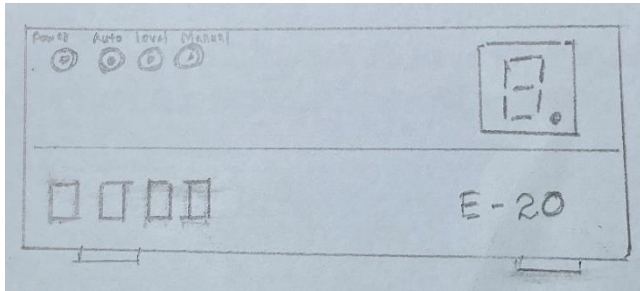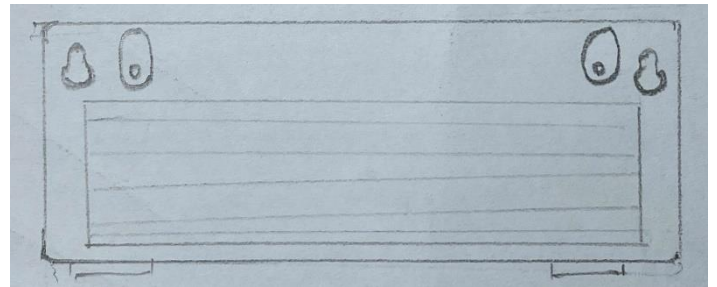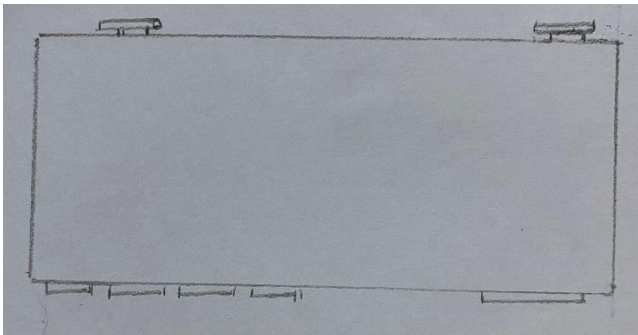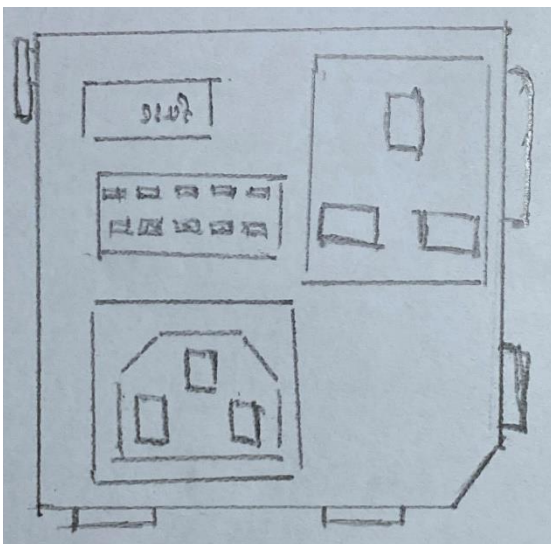

Figure 2.5   Right
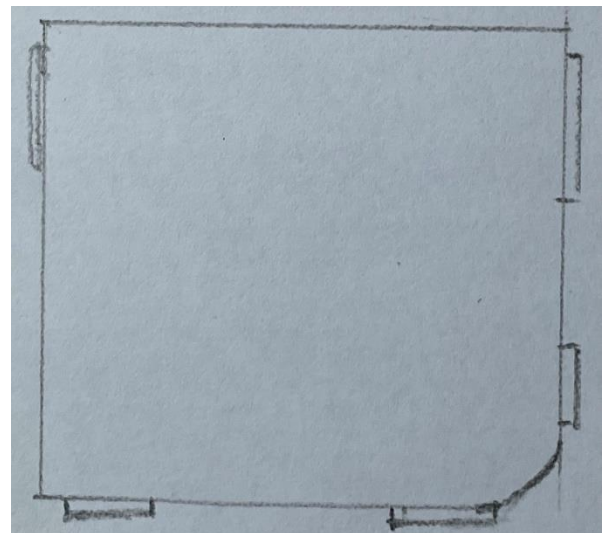
Figure 2.6   Front

That is how we drew the initial sketches and then we drew them in the workplace of **Solidworks** Software.
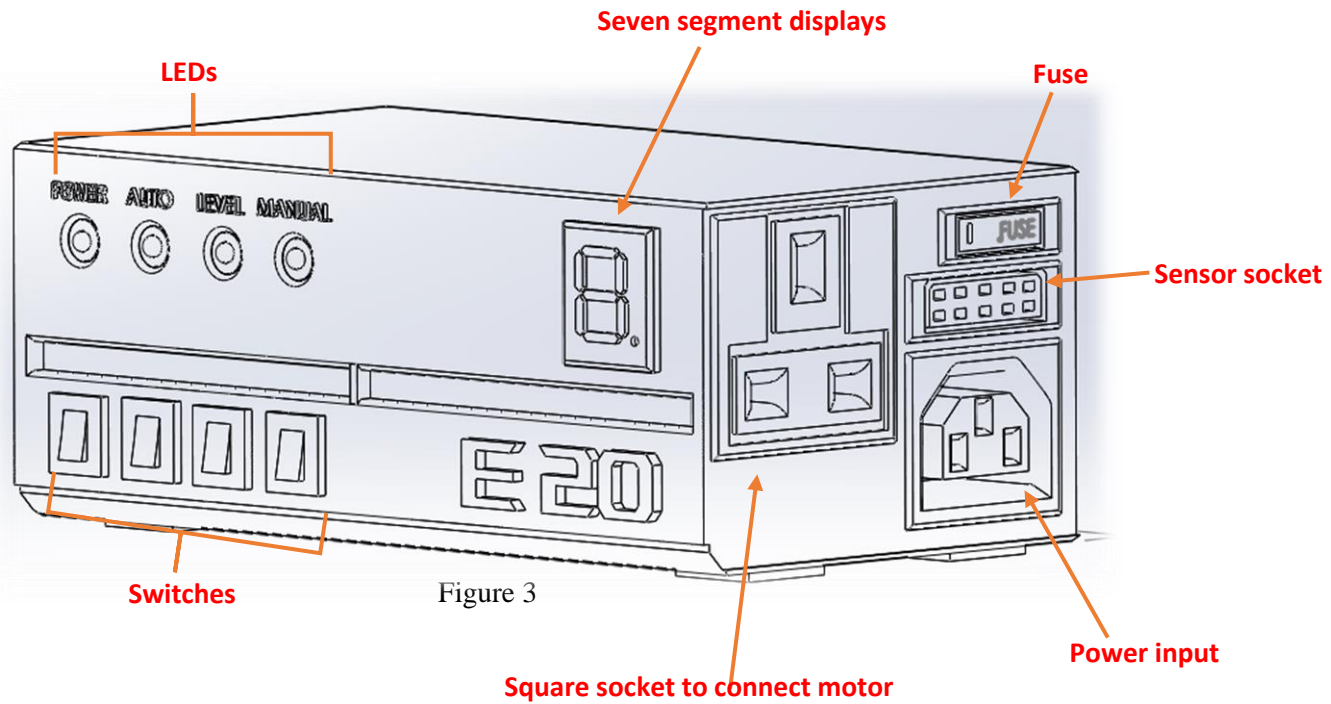
Figure 3

After sketching in **Solidworks**, we created the finalized 3D model of the enclosure of the level indicator and automatic switch.

Figure 4

➢ Front
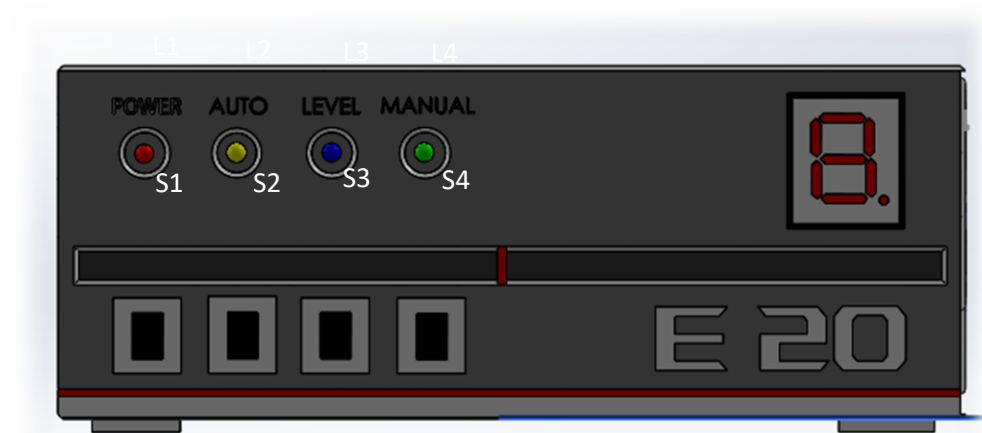
Figure 5.1

- Power LED (L1) indicates whether the product got the power, and the corresponding switch (S1) is used to turn "ON" the whole PCB.

- Auto LED (L2) indicates whether the PCB of the level detector circuit is turned "ON" and the corresponding switch (S2) can be used to turn "ON" or "OFF" that PCB separately.

- Level LED (L3) indicates the status of the level detecting PCB and the corresponding switch (S3) is for turning "ON" or "OFF" it.

- Manual LED (L4) indicates whether the manual switch has been turned "ON" and L4 is the manual switch.

- Seven Segment Display (D1) is used to indicate the level of the water in the tank. That shows 10 levels including the Upper threshold and Lower threshold.

➢ **Behind**
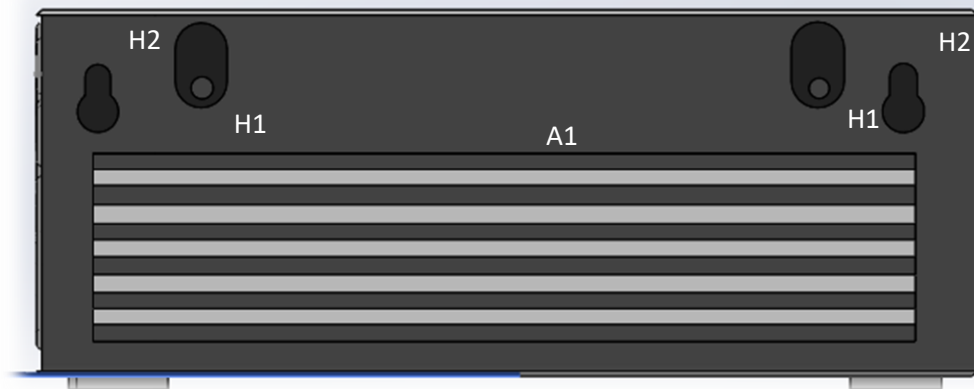
Figure 5.2

- H1 hanging pins are used to mount the module to the wall with screws and that part can be rotated and fixed in the up position.
- H2 holes have been created to hang the module by using hanging hooks which were mounted in a suitable place.
- Air ventilation window is located there to reduce the temperature of the PCBs by letting air flow through the module.

➢ **Left**
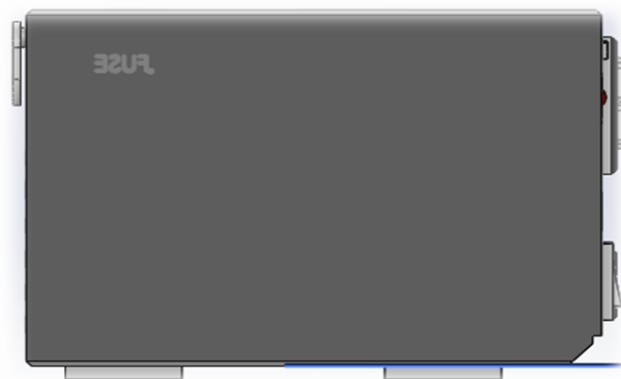
Figure 5.3

- This side has been created without any special feature. Because, when we are mounting this to the wall or suitable place, this side will be covered by the wall.

- ➢ **Right**
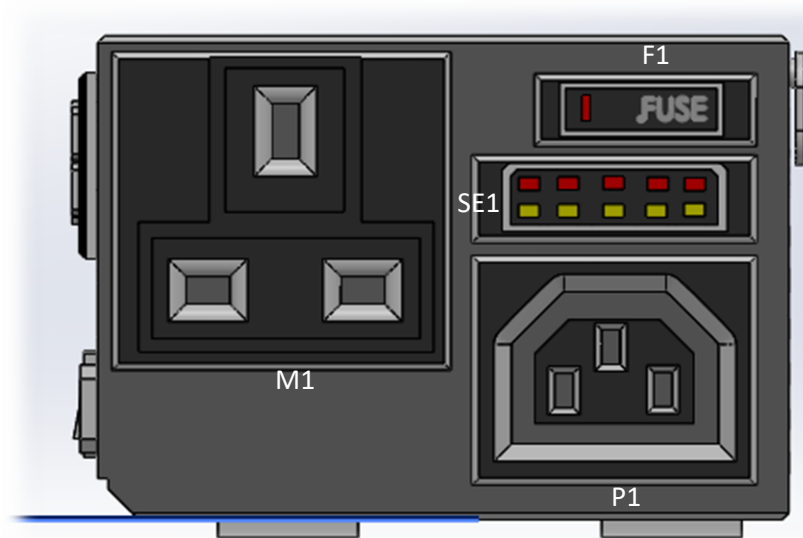
Figure 5.4

- • M1 socket is the place where the plug of the pump is connected. This kind of socket is very convenient for the user when they are going to connect each component by themselves.
- • P1 is the power input of the module, and that port is directly connected to the 230V.
- • F1 is a fuse box where the fuse is attached to protect the product.
- • SE1 is the sensor socket where the water level sensor is connected.

- ➢ **Up**

Figure 5.5

➢ **Down**
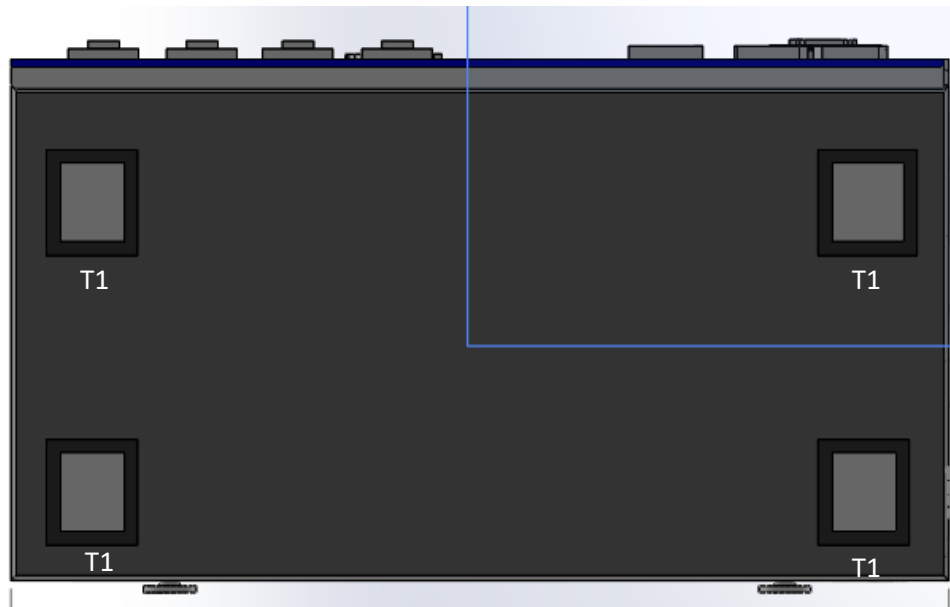
- T1 parts create free space between where the module is kept on and below part of the enclosure.

The material, which is used to create this enclosure, is plastic. Because, they are very light, durable and insulating electricity.

6. UI Design

The user interface is the place where the user manipulates the product to get expected results. To design the UI of the product, we must look at the point of view of the user who doesn't know the interior parts. So, then we can use the required symbols and signs to represent the status of the module or the implementing functions of the system. As well as that should be attractive to keep the interaction between the user and the product.

❖ **UI of the smart level detector and automatic switch**
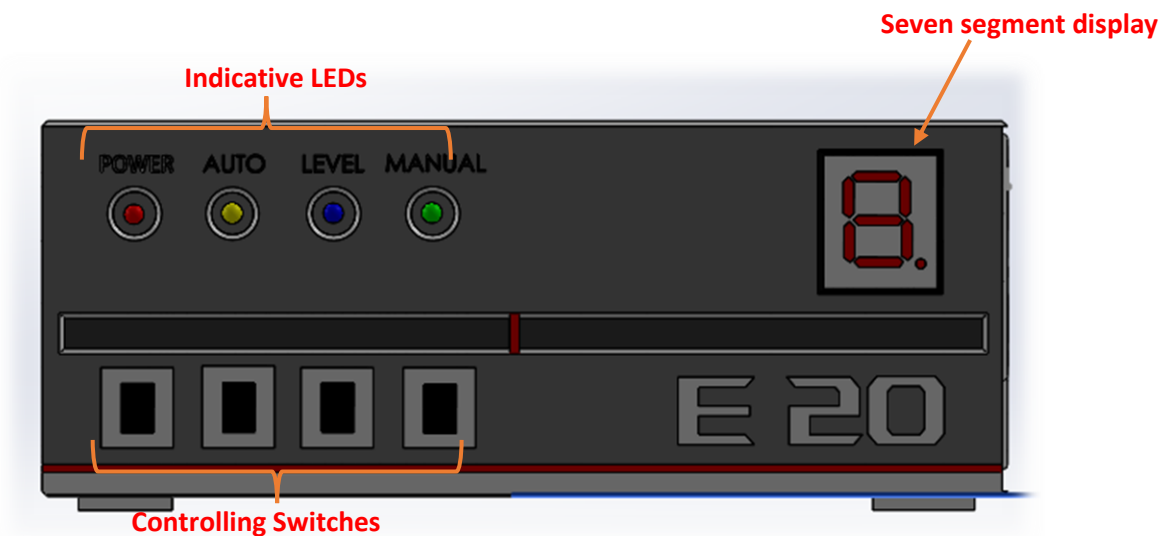
In our case, we decided to indicate the level of the water in the tank by using seven segment display. That is convenient to identify up to which level the tank has been filled. Because seven segment displays can show discrete 10 levels and it is obvious when the pump should be turned "ON" or "OFF" by the user manually.

Color LEDs represent the status of different modules inside the product. To differentiate each status of the component, we used four different color LEDs. Then, the user will quickly understand which part is working and which part is not working. According to that, they will be able to manipulate different functionality of the product. Moreover, over each LED, the text is placed to identify the status of the relevant component.

We have designed the switches in a convenient manner for users. The switches have been placed under the corresponding indicative LED. So, the user can easily understand and manipulate the process by just looking at the above LEDs. In addition to that, the enclosure has given the elegant look to the UI.

Fuse box

Pump socket

Sensor Output
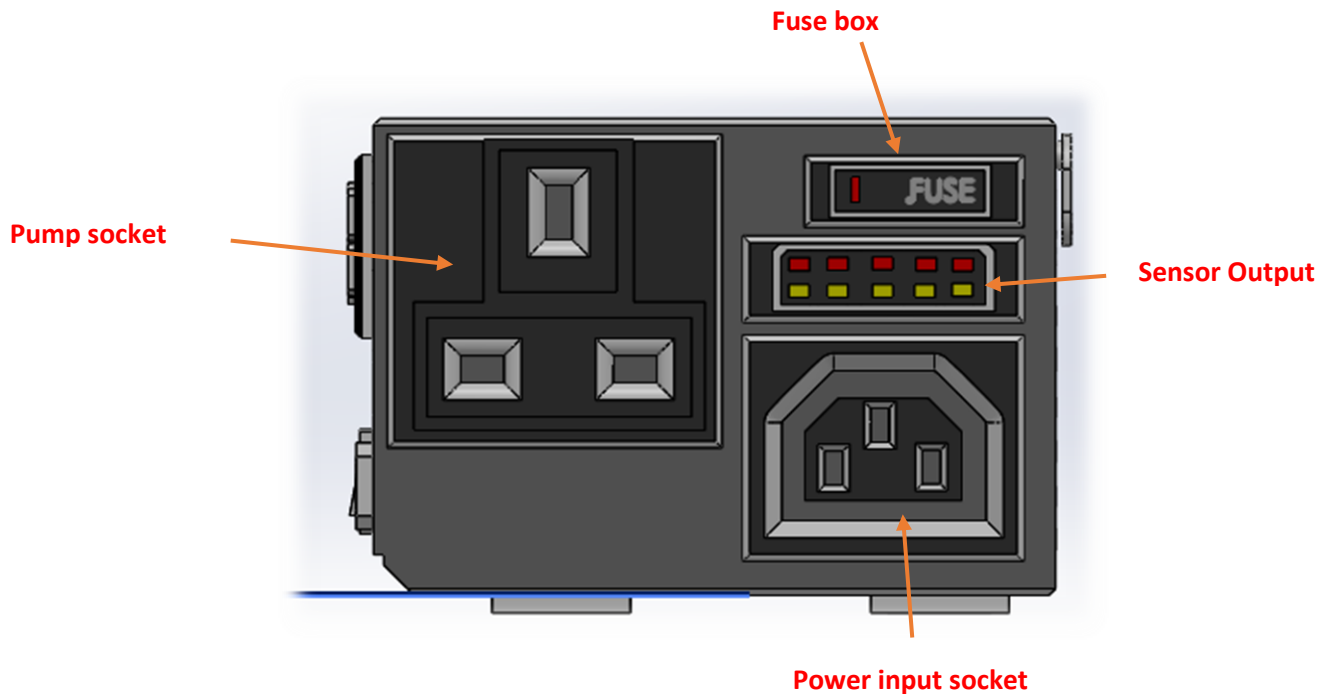
Power input socket

A pump socket is used to connect the pump to energize the pump. We have used a square socket and placed it on the left side. Then anyone can easily connect the pump without any technical knowledge. A power input socket has been placed on this side. That is also a very convenient way to place a power input.

The fuse box is the place where the fuse is mounted and when the fuse is burnt., then anyone will be able to replace that without facing any difficulties. Sensor Output is used to connect the sensor to the PCB. Then, the user will easily be able to connect that to that port.

We have used good material to give premium look to the user interface and the color combination of the UI has been designed intuitively.

7. Marketing, Sales and Beyond

❖ Product Packaging

The product will be packaged in a sealed box. It will be designed using recyclable corrugated single-wall cardboard. This will ensure the safety of the product as well as it is economical.

❖ Maintenance and Repair

Frequent maintenance is not required for the product. The packaging of the product will include a manual containing all the steps required clearly and a telephone number for technical support. For easy repair and to identify an error easily the PCB is divided into three parts.

❖ Reuse/Recycle

The easy repair of the product will provide the chance to reuse the product many times. The disposal of products will be collected by the selling agents and a discount will be provided for a new one.

❖ Disposal

The users will be informed of the effect of the disposal of electronic waste into the environment in the manual and users are motivated to return the old product for a new product with a discount.

❖ Marketing

The existing mechanical water pump switch only provides the switching mechanism for the pump. The automated water pump switch with a smart level indicator provides two more facilities than switching on and off the pump. This 3-in-1 switch will be distributed countrywide, especially in areas where a well is used in households as the water source. Advertising will be done to introduce the new product.

8. Project Budget

	Product Budget					
	Component	**Quantity**	**Unit Price**		**Total**	
Resistors	1M	4	Rs	1.00	Rs	4.00
	22K	2	Rs	2.00	Rs	4.00
	220K	1	Rs	2.00	Rs	2.00
	1K	2	Rs	3.50	Rs	7.00
	470Ω	8	Rs	2.00	Rs	16.00
	33K	4	Rs	2.00	Rs	8.00
	10K	4	Rs	1.00	Rs	4.00
	560K	9	Rs	2.00	Rs	18.00
Transistors	BC547 BJT	6	Rs	10.00	Rs	60.00
Capacitors	470µF 50V	1	Rs	40.00	Rs	40.00
	100nF	1	Rs	5.00	Rs	5.00
	10nF Ceramic	4	Rs	5.00	Rs	20.00
Diodes	IN 4007	4	Rs	5.00	Rs	20.00
	LED	4	Rs	5.00	Rs	20.00
ICs	555 Timer IC	1	Rs	30.00	Rs	30.00
	74HC147	1	Rs	60.00	Rs	60.00
	CD4511	1	Rs	60.00	Rs	60.00
	LM339	1	Rs	50.00	Rs	50.00
	7806 regulator 6v IC	1	Rs	50.00	Rs	50.00
	7805 regulator 5v IC	1	Rs	50.00	Rs	50.00
Others	Cathode 7 Segment Display	1	Rs	150.00	Rs	150.00
	HC-05 Bluetooth Module	1	Rs	1,300.00	Rs	1,300.00
	Relay SPDT 5v	1	Rs	100.00	Rs	100.00
	0.5A Fuse	1	Rs	10.00	Rs	10.00
	Switch (1)	3	Rs	30.00	Rs	90.00
	Switch (2)	1	Rs	80.00	Rs	80.00
	Transformer 9V 300mA	1	Rs	360.00	Rs	360.00
	Short 2-way PCB mount wire	6	Rs	30.00	Rs	180.00
	2 pins 2-way terminal block	1	Rs	30.00	Rs	30.00
	Long 10-way PCB mount wire	1	Rs	100.00	Rs	100.00
	Plug Point	1	Rs	250.00	Rs	250.00
	Plug Cable	1	Rs	250.00	Rs	250.00
	Enclosure				Rs	200.00
	Wire(1m)	10	Rs	40.00	Rs	400.00
	Clips	10	Rs	10.00	Rs	100.00
Cost Per Unit					**Rs**	**4,128.00**

Cost Per Unit   =   Rs 4128.00

20% Profit Margin   =   Rs   826.00

—————————

Product Price   =   Rs 4954.00

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No of Units to Be Manufactured at the Initial Stage = 75

The batch size will be changed considering the sales after one month.

9. Task Allocation

01. RANASINGHE R.D.P.M.   **200512B**

Designing the enclosure by SOLID WORKS 2020 software
Creating Schematic diagrams by Proteus 8.9 Professional, Altium Designer 2022 and EasyEDA and Tinkercad online simulators
Creating PCB diagrams and their 3D views by Altium Designer 2022 and EasyEDA online simulator
Simulating Schematic diagrams by Proteus 8.9 Professional and Tinkercad online simulator
Writing about product architecture

02. RANAVIRAJA R.W.H.M.T.A.   **200520X**

Problem research
Conducting survey
Involving in PCB designing
Writing about problem description and technical feasibility

03. RATHNASEKARA T.S.   **200529H**

Drawing schematic diagram of level indicator circuit and automatic switch
Involving in PCB designing
Drawing initial sketches
Circuit component selection
Writing about technical specifications, initial and finalized sketches of the product enclosure and UI design

04. RATHNAYAKE R.N.P.   **200537F**

Gathering information
Documentation
Involving in enclosure designing
Writing product budget and about marketing, sales and beyond