VIETNAM NATIONAL UNIVERSITY HO CHI MINH CITY
HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY
FACULTY OF COMPUTER SCIENCE AND ENGINEERING

Electrical Electronic Circuits (CO2038)

CLASS CC03

ASSIGNMENT REPORT

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1 Requiments Engineering

1.1 General Description

The water level indicator with LED lights is a useful and cost-effective tool for daily life, especially in managing water resources. This device shows the exact water level in storage tanks, helping to prevent overflow and water waste. With LED lights indicating different levels, users can easily check the current water level without needing a direct inspection. This system enhances safety and convenience in everyday activities, making it especially helpful in places with limited water resources or where careful monitoring is needed.

1.2 Requiments Specifications

Table 1.1: Main Specifications

General	
Input Power	5V DC (Battery 11A alkaline L1016 type 6V) 5V DC
Resistors (6 x 330 Ω.)	
Value	330 Ohm
Error	5%
Power	0.25 W, 1/4 W
Technology	Carbon Film
Max Temperature	+155°C
Min Temperature	-55°C
RoHS	Yes
LEDs (5 x 5mm)	
LED Color	Green/Red
Pins	2
Technology	Through-hole
Lens Type	Circle (5mm), Diffused (3mm)

Lens Color	Green
Operating Voltage	3 - 3.6 V
Current	10 - 20mA
Length	29 mm
LEDs (1 x 3mm)	
LED Color	Yellow
Pins	2
Technology	Through-hole
Lens Type	Circle (3mm), Diffused (1.5mm)
Lens Color	Green
Operating Voltage	2 - 3 V
Current	20 - 30mA
Length	29 mm
Chip Buzzer (5V 9.5x12MM)	
Resonant Frequency	2300 Hz $\pm$ 500 Hz
Operating Voltage	3 - 12VDC
Current Consumption	$<$ 25mA
Output Sound	Beeping
Operating Temperature	-20 to +70°C
Sound Amplitude	$>$ 80dB
Two poles	Negative and positive poles
Transistor (BC337))	
Type	NPN
Current Gain (hFE)	100-630
Constant Collector Current (IC)	800 mA
Collector-Emitter Voltage (VCEO)	45 V
Collector-Base Voltage (VCBO)	50 V
Base-Emitter Voltage (VBEO)	5 V

Frequency	100 MHz
Packaging	TO-92

2 Conceptual Design

2.1 Specification

This circuit that can indicate the water level (Or any other conducting liquid) in a tank. The circuit is made by five BC337 transistors, five 5mm LEDs, one 3mm LED, six 330 ohm Resistors and one Buzzer. Here we are using transistor as a Switch. Initially there is no voltage applied to the base of the transistor and the transistor is in OFF state (no current is flowing through collector and emitter) and LED is OFF. When the water level reaches to electrode in the tank, the positive side of the battery gets connected to the base of the Transistor through the water. So when a positive voltage has been applied to the base of the transistor, it gets into ON state and current starts flowing from collector to emitter. And the LED turns on.

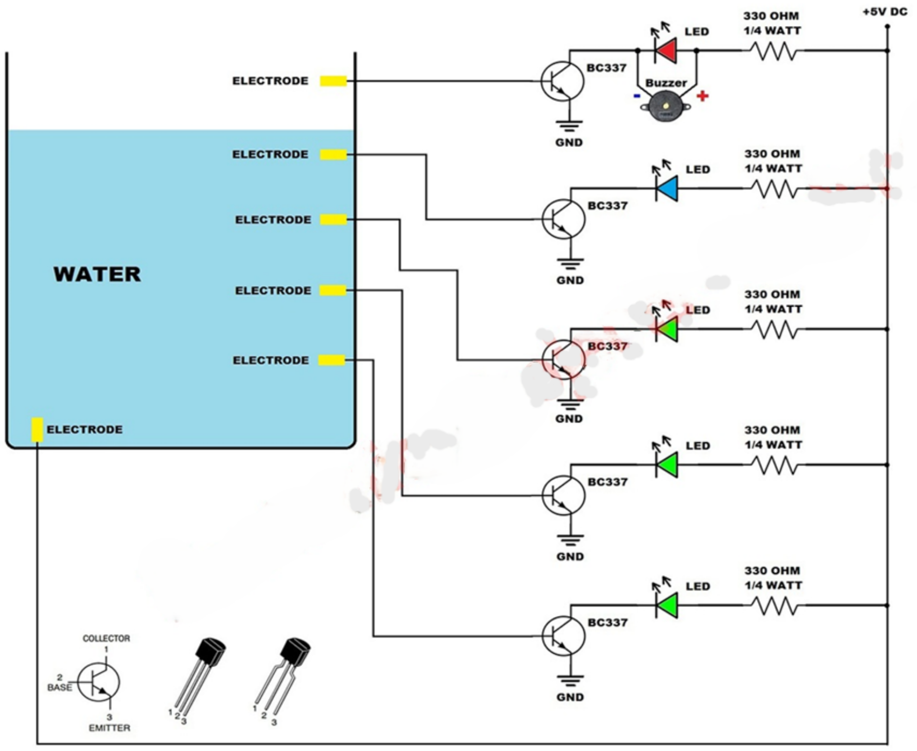

Figure 2.1: The main idea of a water level indicator

2.2 Block Diagram

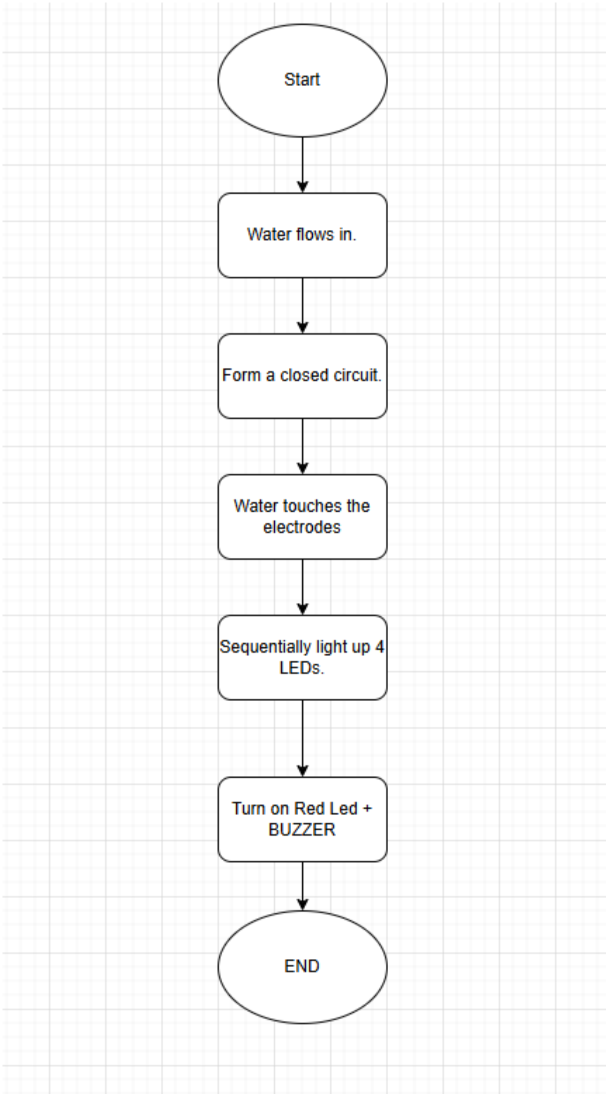

Figure 2.2: Block Diagram

2.3 Components

Table 2.1: List of Components and Product Link

COMPONENTS	LINK
VCC	https://toppin.vn/san-pham/pin-11a-alkaline-l1016-6v/
Resistors (330Ω)	https://banlinhkien.com/tro-vach-14w-5-3.3r-50c-p12867813.html
Transistors (BC337)	https://banlinhkien.com/bc33725-to92-trans-npn-0.8a-45v-dip-5c-p16000626.html
LEDs (5mm)	https://banlinhkien.com/led-5mm-phu-xanh-la-10c-p6651440.html
LEDs (3mm)	https://banlinhkien.com/led-3mm-vang-duc-10c-p12867523.html
Chip Buzzer	https://banlinhkien.com/coi-chip-5v-9.5x12mm-p6653467.html

3 Schematic Design

3.1 Schematic Diagram

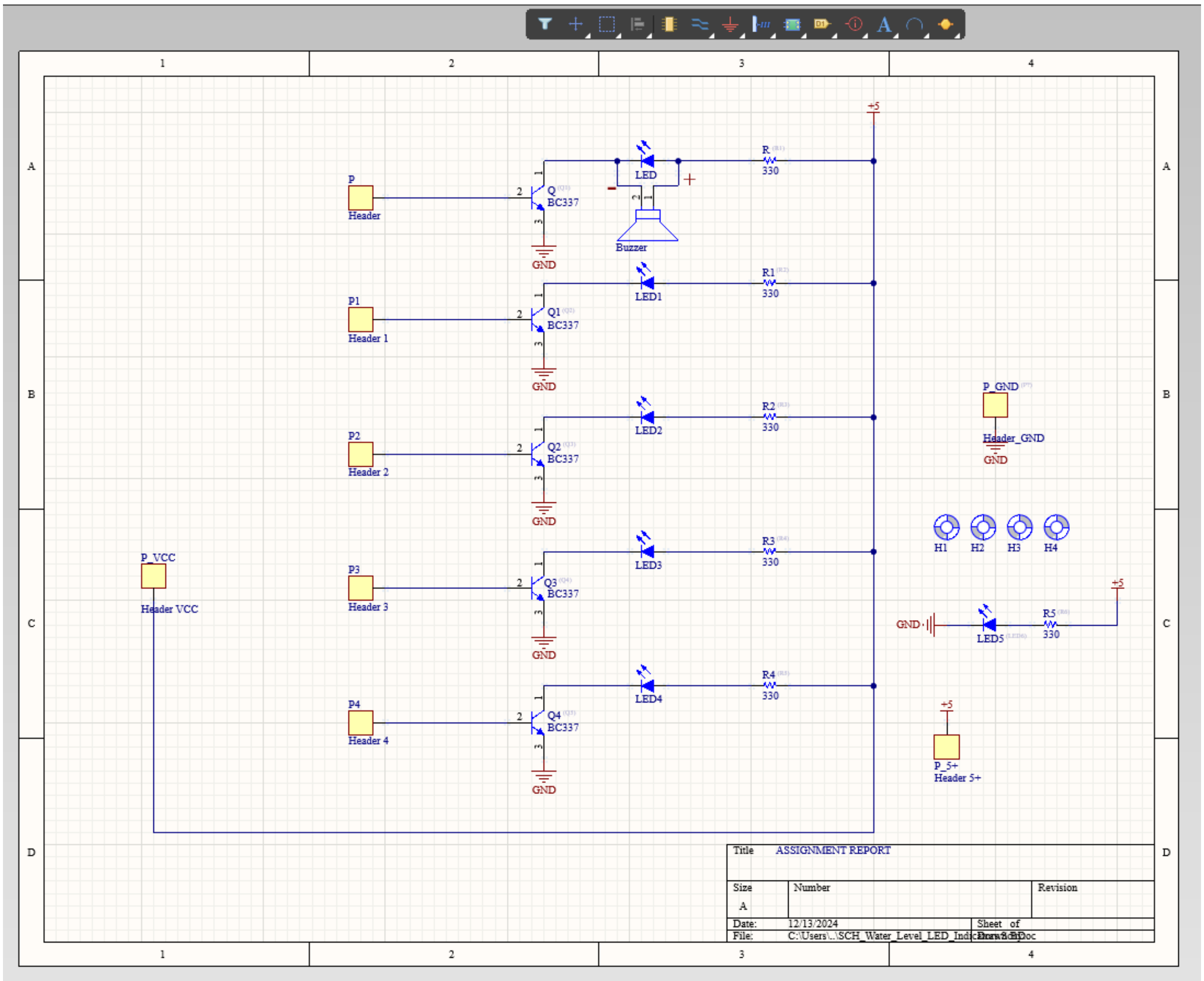

Figure 3.1: Schematic design of the system

4 Schematic Validation

In the design of the water level indicator circuit using BC337 and LEDs, the choice of a 330 ohm resistor is essential to ensure stable and safe operation of the electronic components. This resistor serves to limit the current flowing through the LED, thereby protecting the LED from potential damage due to excessive current.

Rationale for this choice:

Calculation

-**Source Voltage:** The supply voltage for the circuit is $V_{\text{VCC}} = 5V$. -**LED Voltage:** The operating voltage for the LEDs is $V_{\text{LED}} = 2V$ [common for green or yellow LEDs]. -**Safe Current through LED:** The safe operating current for the LEDs is between 15mA and 20mA.

The voltage across the resistor is calculated as follows:

$$V_R = V_{\text{VCC}} - V_{\text{LED}} = 5V - 2V = 3V$$

The desired current through the LED (and hence through the resistor) is 15mA, which translates to 0.015A. Using Ohm's law, the required resistance would be:

$$R = \frac{V_R}{I} = \frac{3V}{0.015A} = 200\Omega$$

Why Choose 330 Ohm Instead of 200 Ohm?

-**Safer Current:** With a 330-ohm resistor, the current through the LED will be slightly lower:

$$I = \frac{V_R}{R} = \frac{3V}{330\Omega} \approx 9mA$$

This current level is still adequate to clearly illuminate the LED but reduces the risk of damaging the LED, thereby increasing the durability of the circuit.

-**Standard Availability:** The 330-ohm resistor is a standard and commonly available value, widely used in LED circuits, making it easy to source and replace.

-**Precision Not Critical:** This circuit does not require the LED to operate at maximum brightness. Therefore, using a 330-ohm resistor ensures safety without significantly impacting performance.

Other Reasons

-**Common and Easily Available:** 330 ohms is a standard resistor value, widely used in applications involving LEDs, making it easy to find and replace.

-**Safety and Reliability:** This resistor value also ensures safety for the switching transistor, keeping the current passing through within safe limits for both the transistor and other components in the circuit.

Other Components

-The BC337 is chosen for the water level indicator circuit not only due to its high current handling capability, good current gain, high reliability, and ease of availability but also $R_{BC337} = 0,7 < 2V$
-Since the power source is 5V, we must choose a 5V buzzer to ensure the longevity of the component.

Conclusion:

The choice of a 330 ohm resistor, BC337, chip buzzer 5V in the water level indicator circuit is based not only on technical calculations but also on considerations of safety, LED durability, and component availability. This balance optimizes the circuit's performance while ensuring the long-term reliability of the electronic components.

5 PCB Design

5.1 Design Rule

5.1.1 Clearance Rule

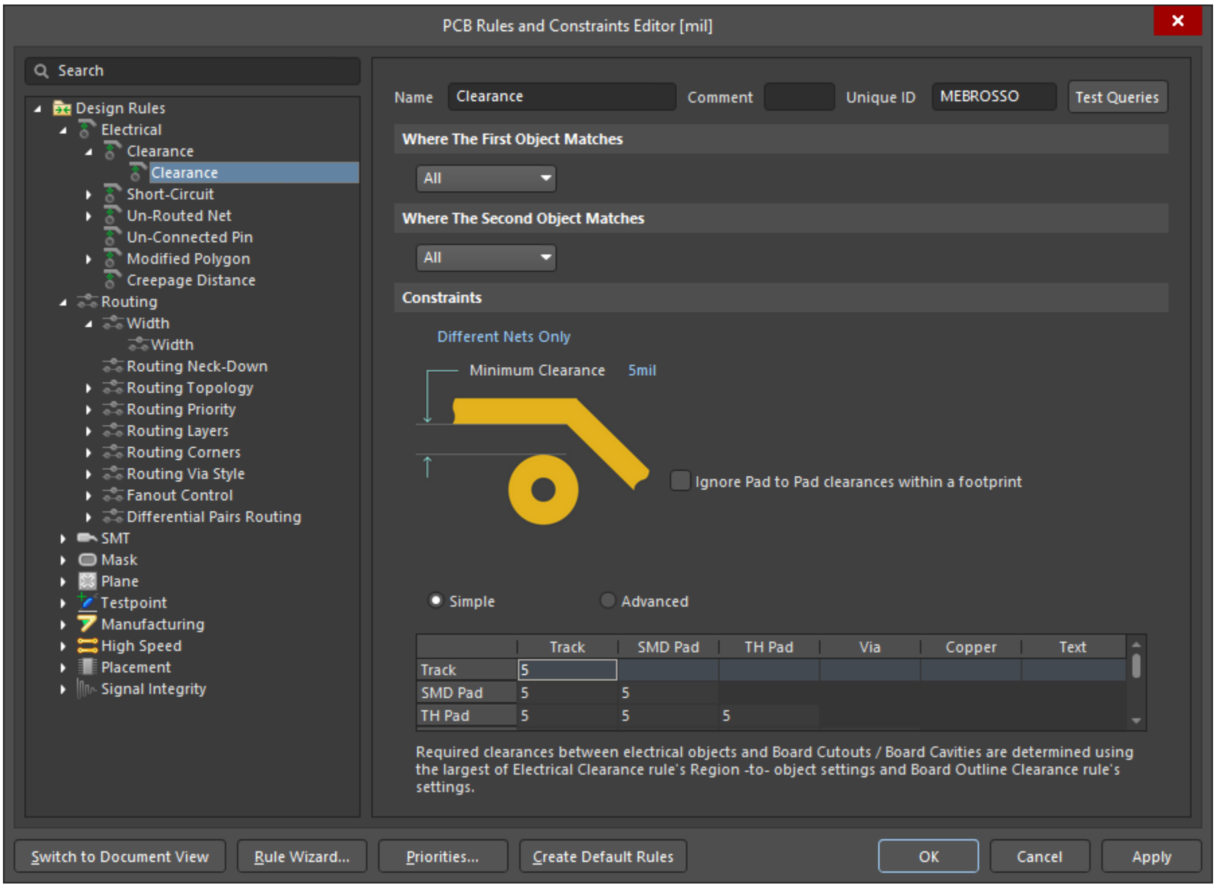

Figure 5.1: Electrical Clearance

1. Purpose: Ensures there is adequate spacing between different nets to prevent short circuits and to accommodate manufacturing tolerances.

2. Specified Rule: A minimum clearance of 5 mils between different nets.

3. Calculation Consideration: The rule is set based on potential high-voltage areas or manufacturing tolerances. Adequate clearance can also help prevent signal crosstalk in some designs

5.1.2 Width Rule

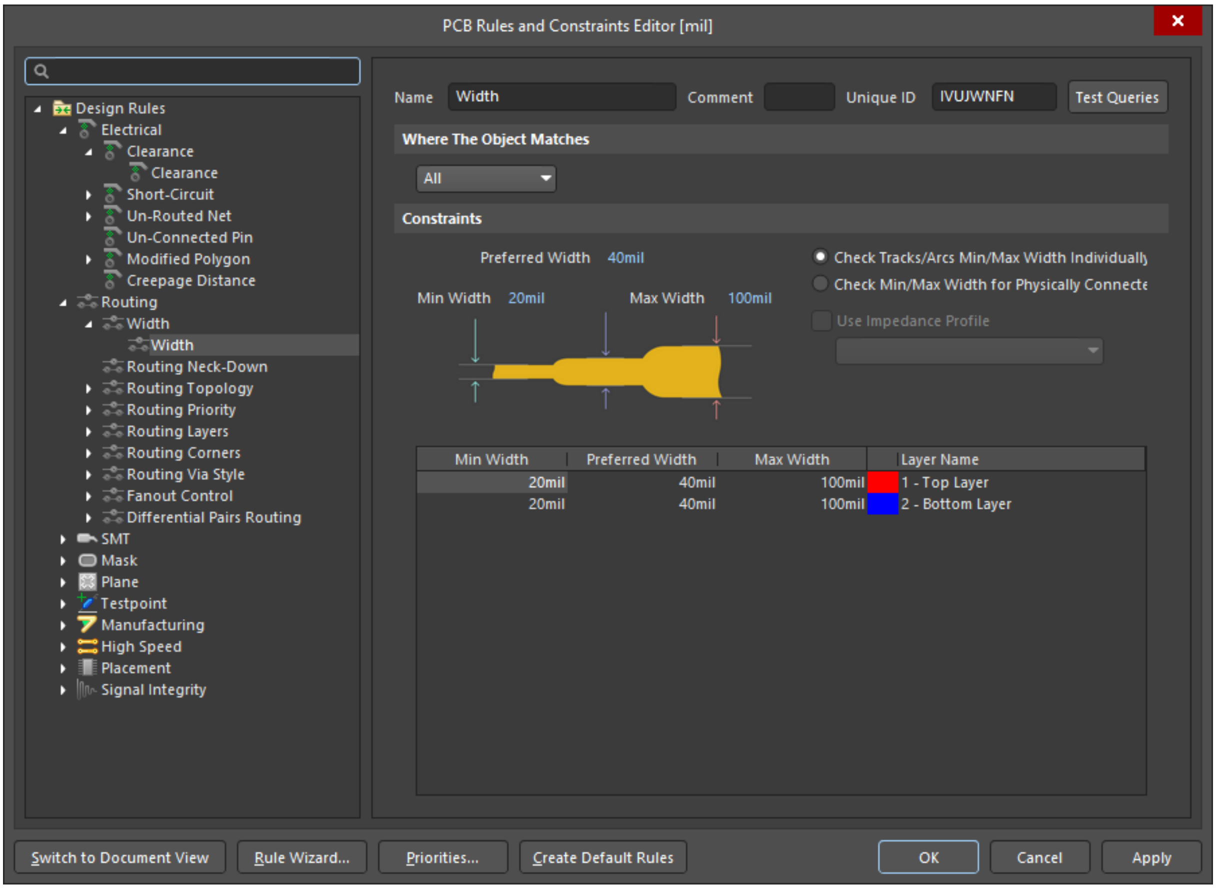

Figure 5.2: Routing Width

1. Purpose: Defines the minimum, preferred, and maximum width for traces to ensure they can handle the intended current without overheating and to maintain signal integrity.

2. Specified Rule:

- Min Width: 20 mils

- Preferred Width: 40 mils

- Max Width: 100 mils

3. Calculation Consideration:

- MinWidthensures current can be carried safely. The IPC-2221 standard could be used for calculating the minimum trace width for a given current.

- Preferred Width is often used for signal traces to balance performance and space.

- Max Width is used for power traces or specific high-current applications.

5.2 PCB Layout

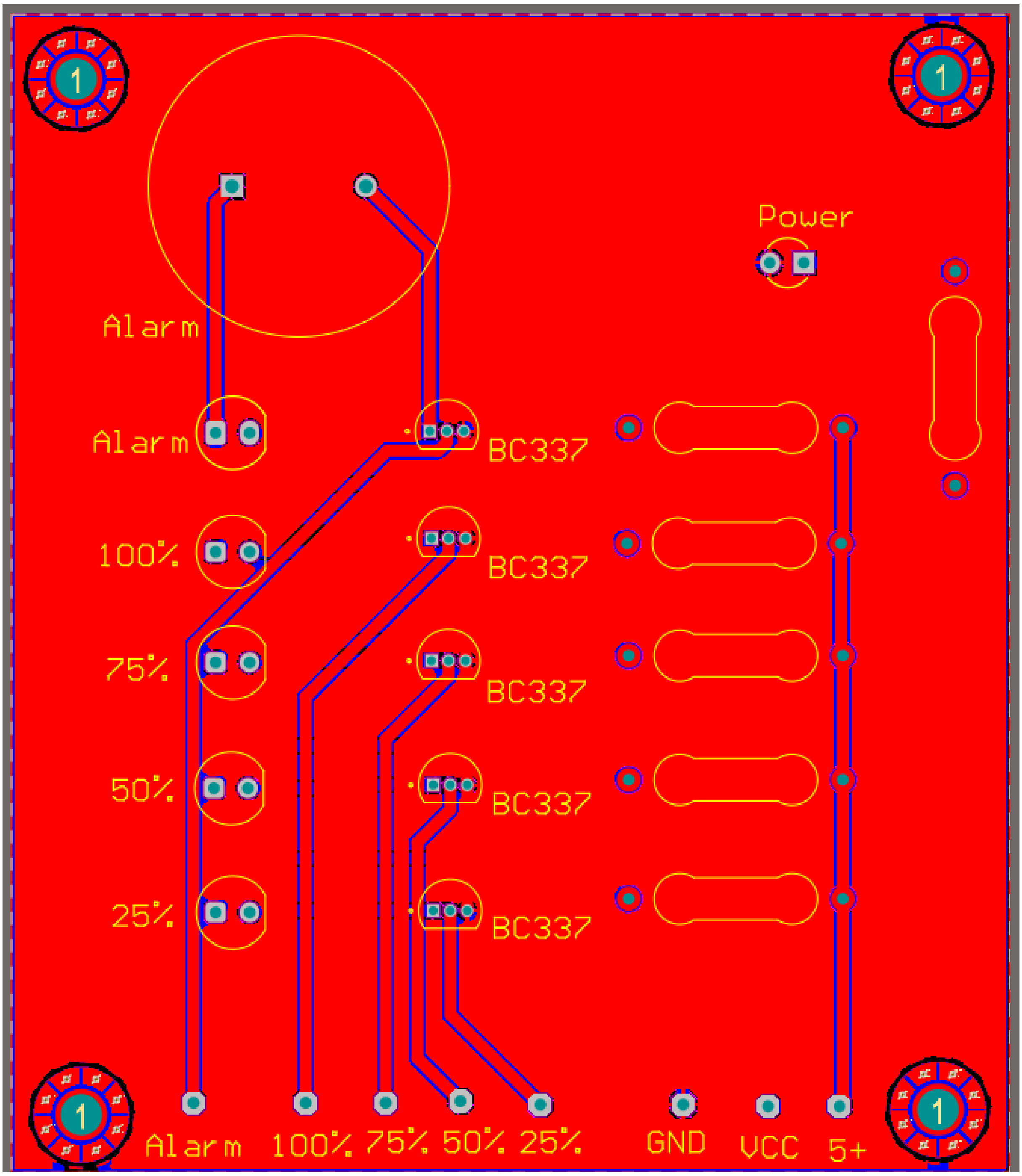

Figure 5.3: Top Layer

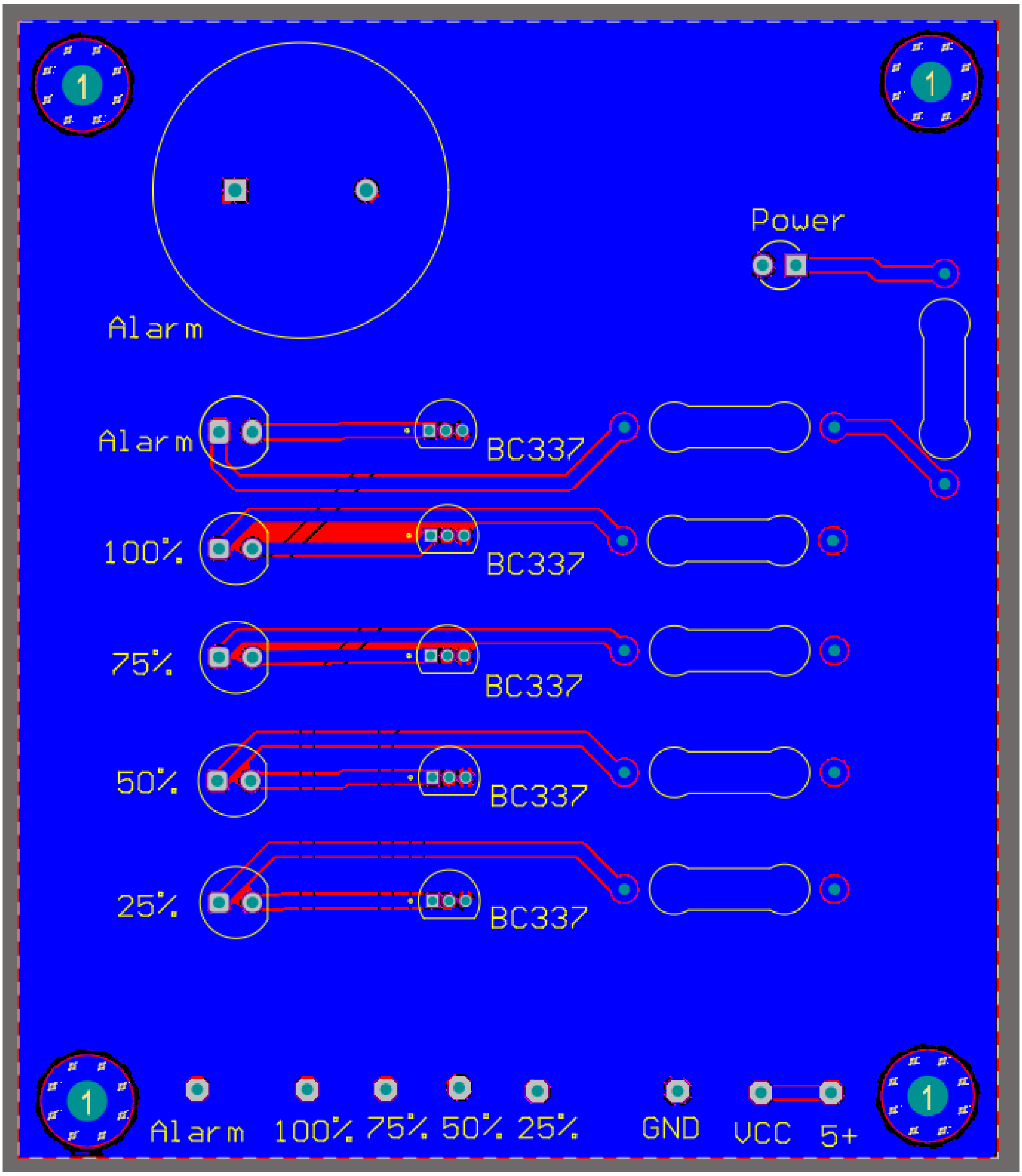

Figure 5.4: Bottom Layer

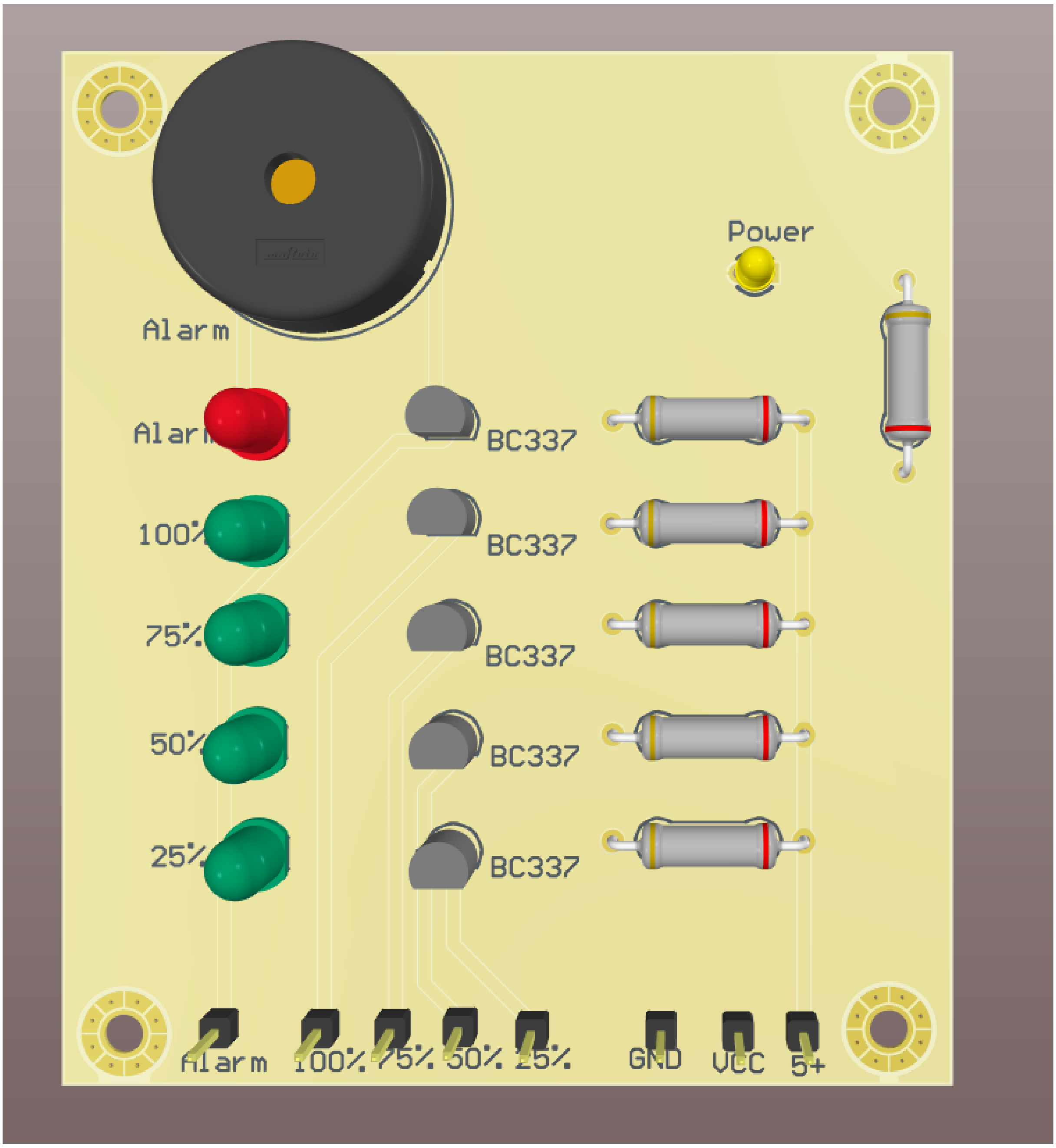

Figure 5.5: Top View of PCB Design

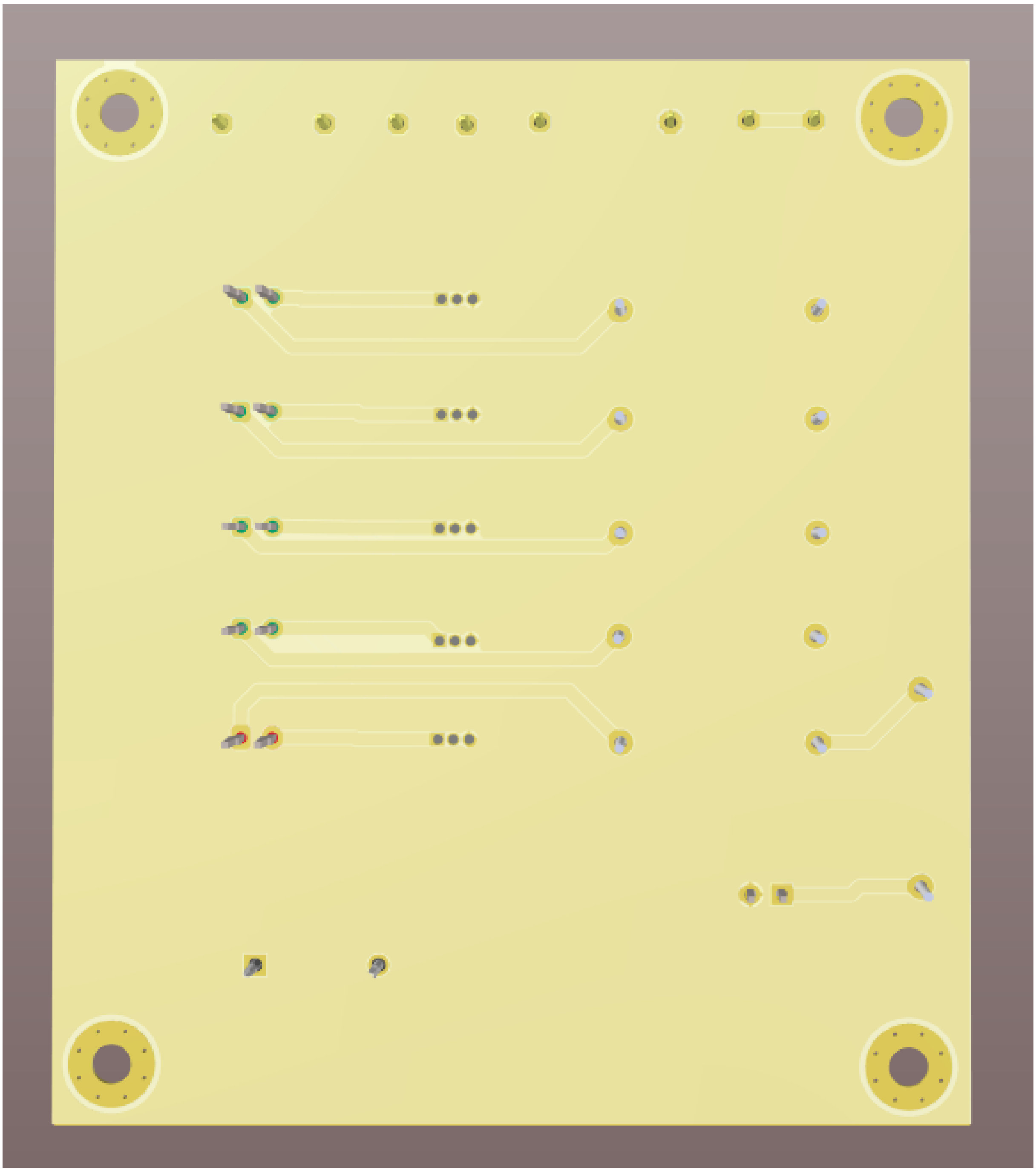

Figure 5.6: Bottom View of PCB Design

6 Fabrication & Assembly

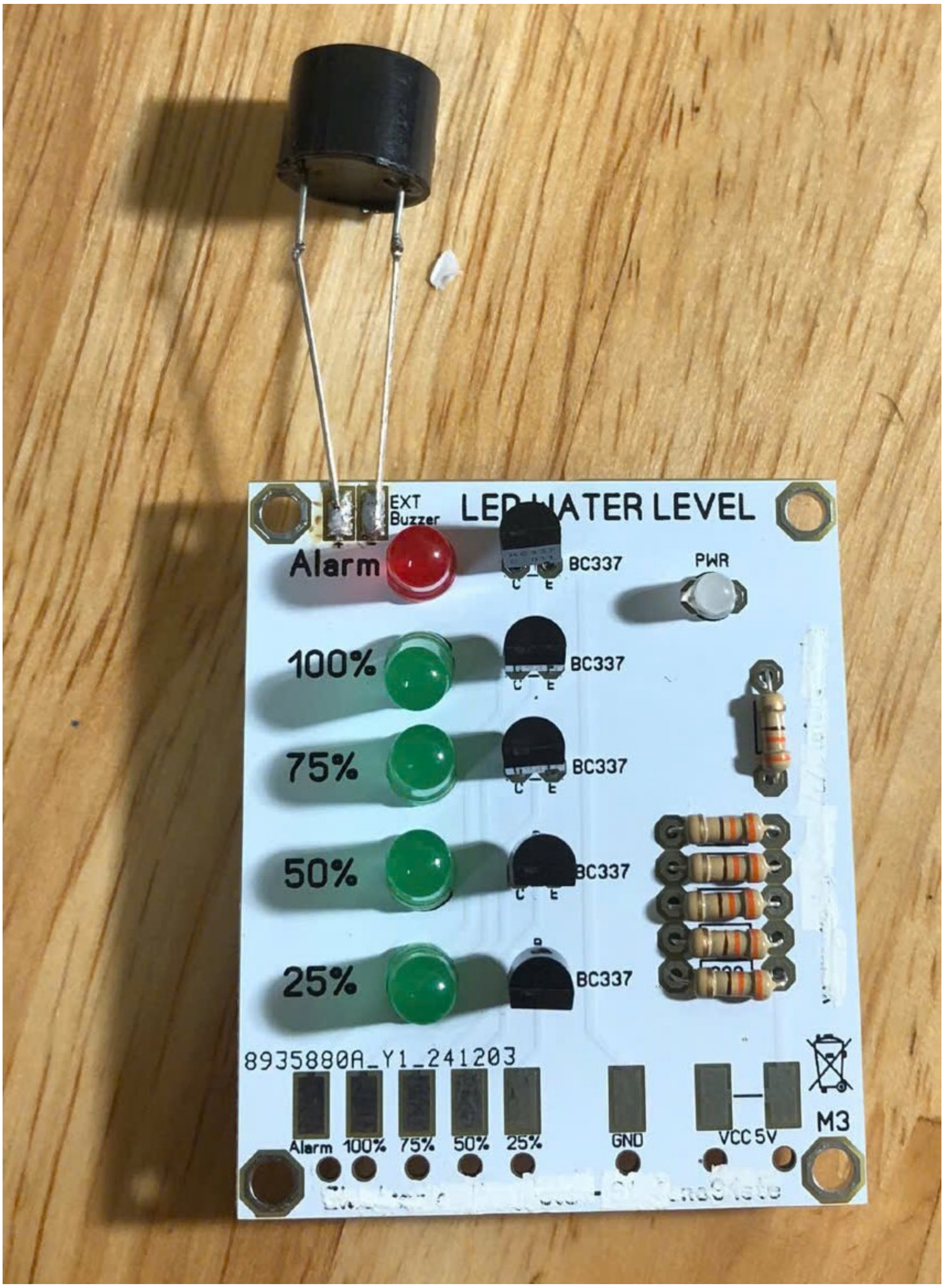

Figure 6.1: Font view of PCB

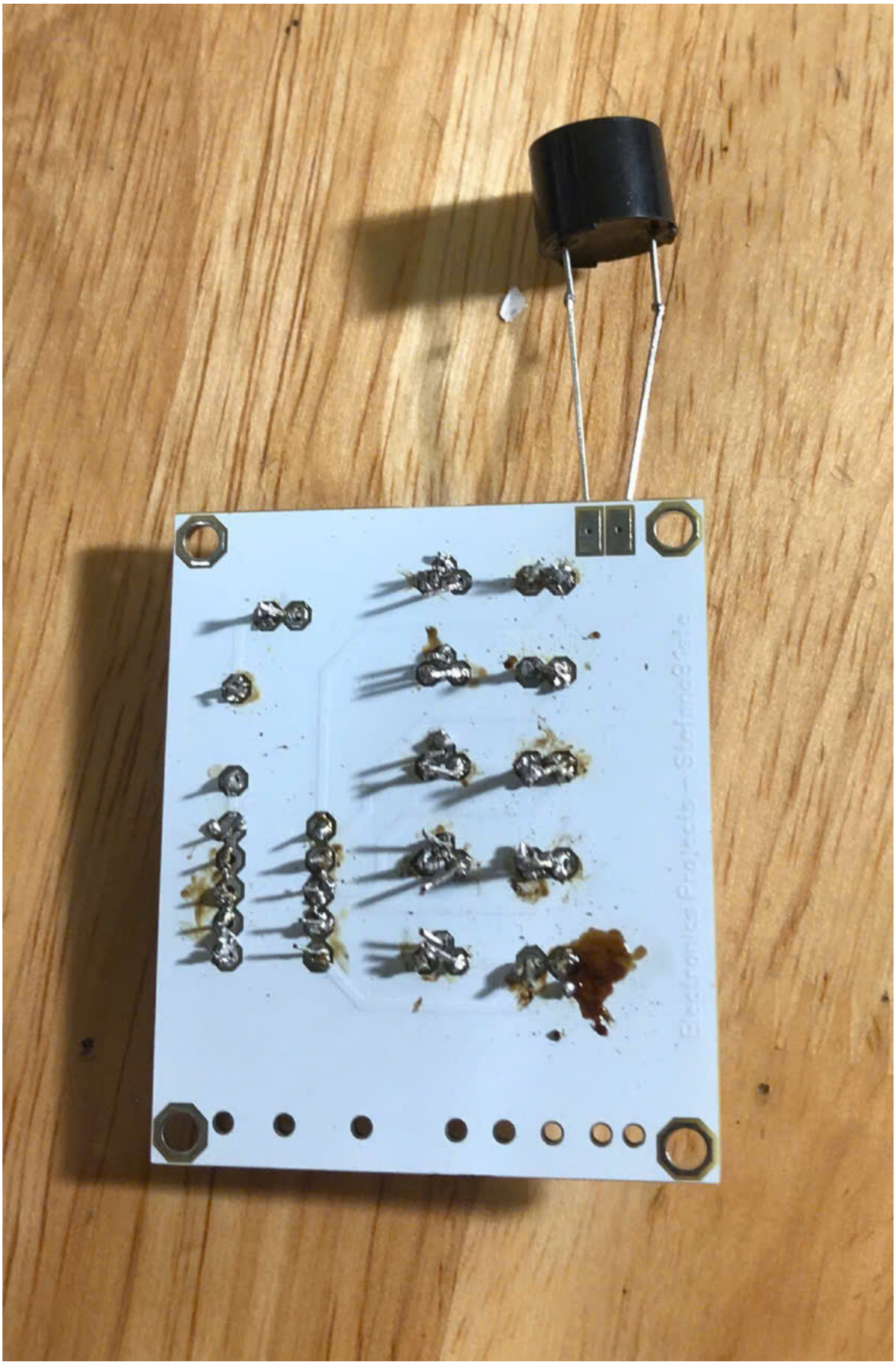

Figure 6.2: Back view of PCB