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Summary

Abstract

This project developed a PIC16F877A based electrical fault simulator for engineering training. The system safely reproduces common circuit faults using measurable test points and visual indicators, providing a practical tool for diagnostic fault-finding exercises aiding effective training of electrical students.

Aims

- Develop safe training simulator
- Enable voltage-based fault diagnosis
- Support student learning

Objectives

- Design a simple electrical circuit model suitable for teaching fault-finding techniques.
- Develop a system capable of simulating multiple electrical faults within the circuit.
- Implement a microcontroller-based control system to manage fault simulation.
- Provide accessible test points that allow voltage measurements during fault diagnosis.
- Display the active fault condition using a digital output interface.
- Simulate and evaluate the system using Proteus circuit simulation software.
- Assess the effectiveness of the system as a training tool for electrical engineering students.

Method

Design

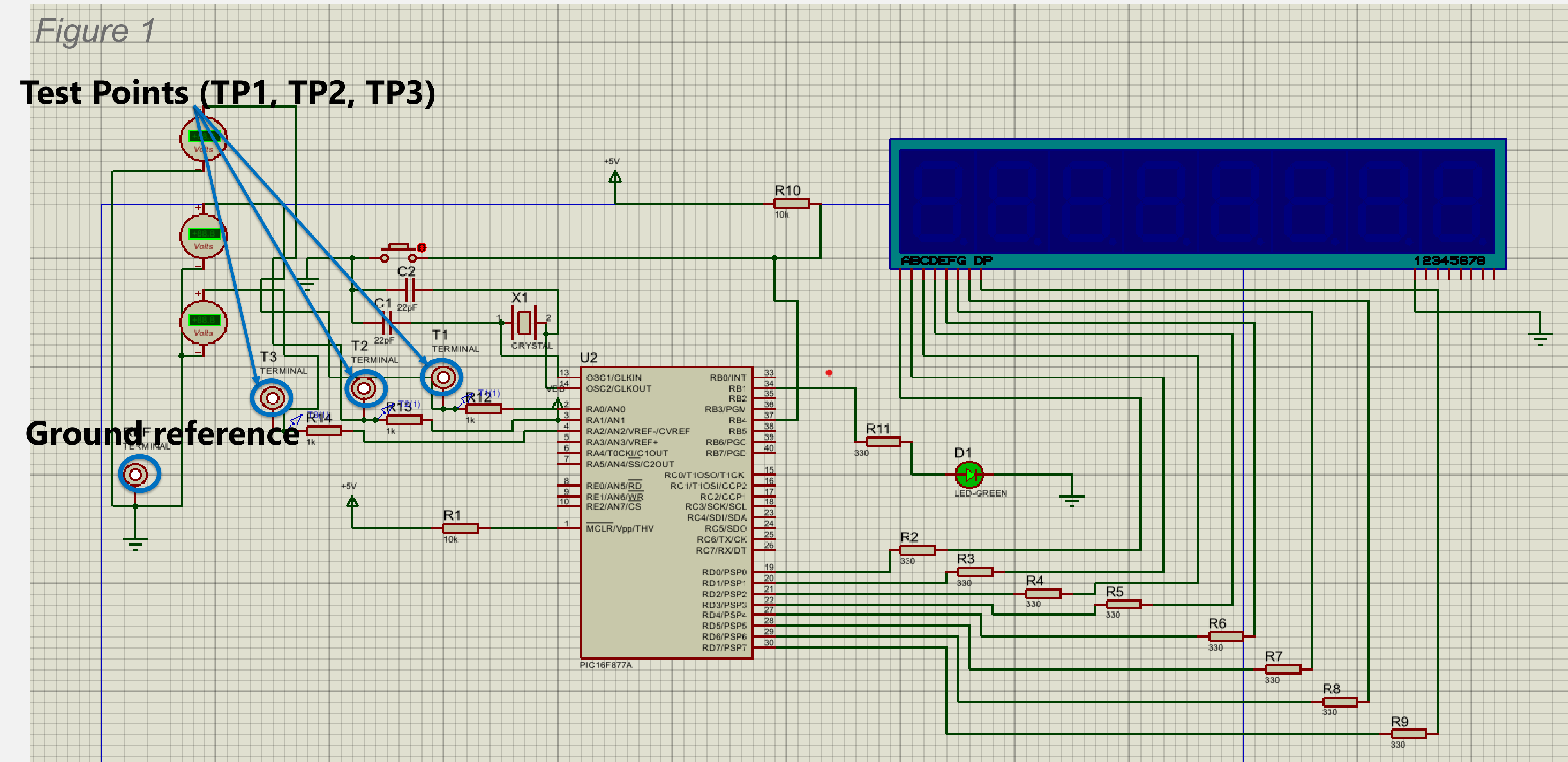


Figure 1 shows the Proteus simulation used for design verification and testing the microcontroller program to ensure consistency and accuracy. Table 1 below shows the expected results and explanation of each fault condition.

Fault Condition	TP1 (RA0)	TP2 (RA1)	TP3 (RA2)	LED State	Simulated Fault Description
Normal Operation	High (~5V)	High (~5V)	Low (~0V)	ON	Circuit operating correctly with power reaching the load
Power Supply Failure	Low (~0V)	Low (~0V)	Low (~0V)	OFF	Loss of supply voltage to the circuit
Open Circuit Fault	High (~5V)	Low (~0V)	Low (~0V)	OFF	Break in circuit path between TP1 and TP2
Load Failure	High (~5V)	High (~5V)	High (~5V)	OFF	Fault within the load component despite voltage presence

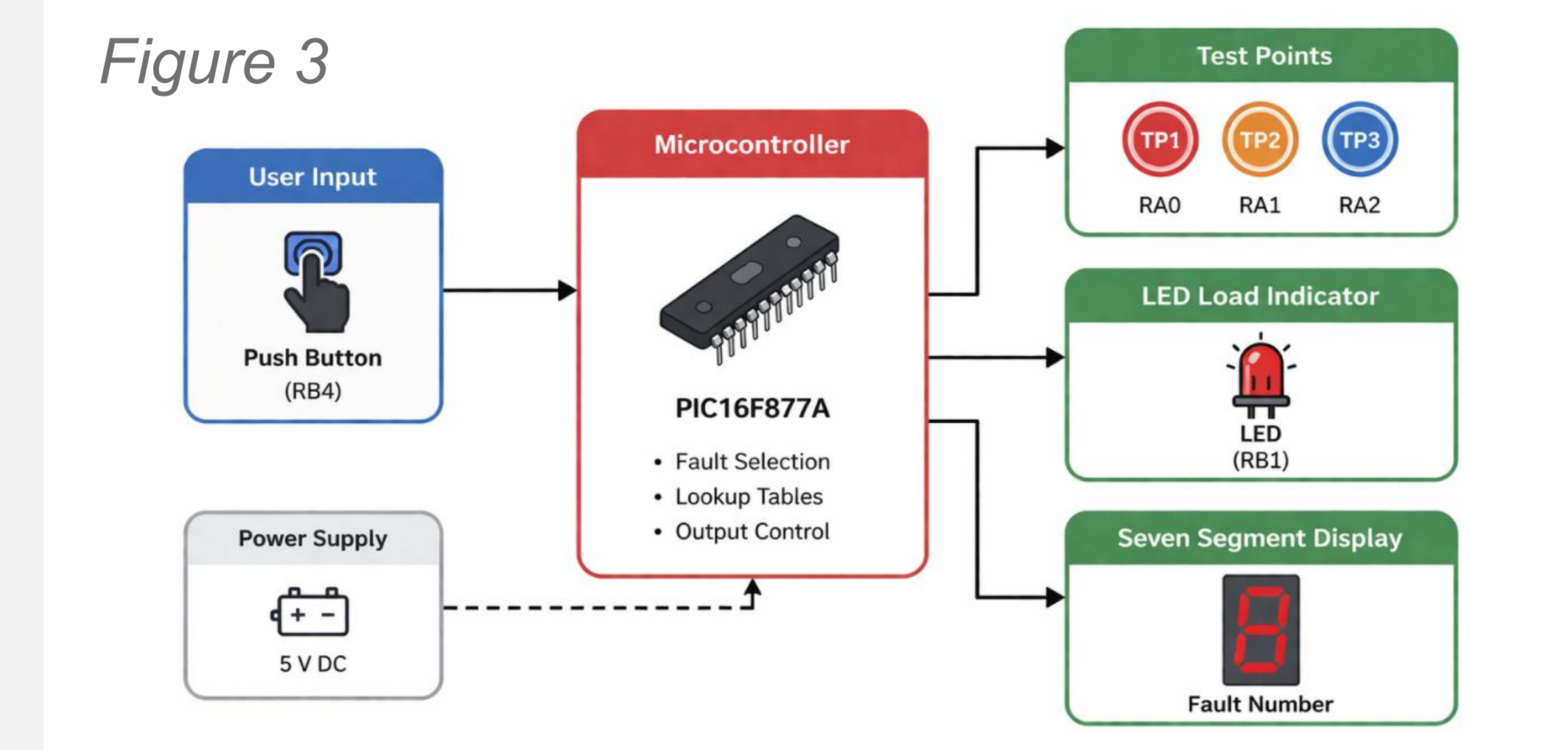
Table 1
Measured Voltage Patterns

Implementation

Components

- PIC16F877A – Processing unit
- 7 segment display – User interface
- Push button – User interaction
- LED load – LED acting as circuit load
- Test points – Accessible measurement terminals
- Power supply – AA batteries (4.5V)

Figure 3 shows the main components

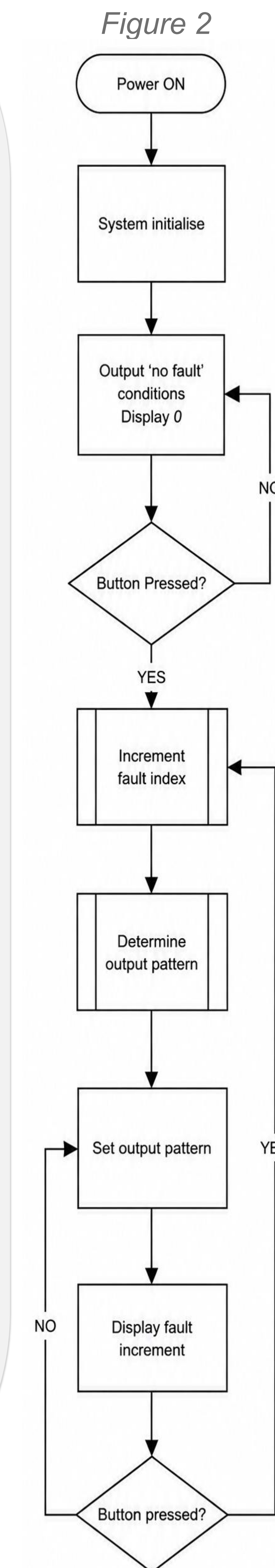
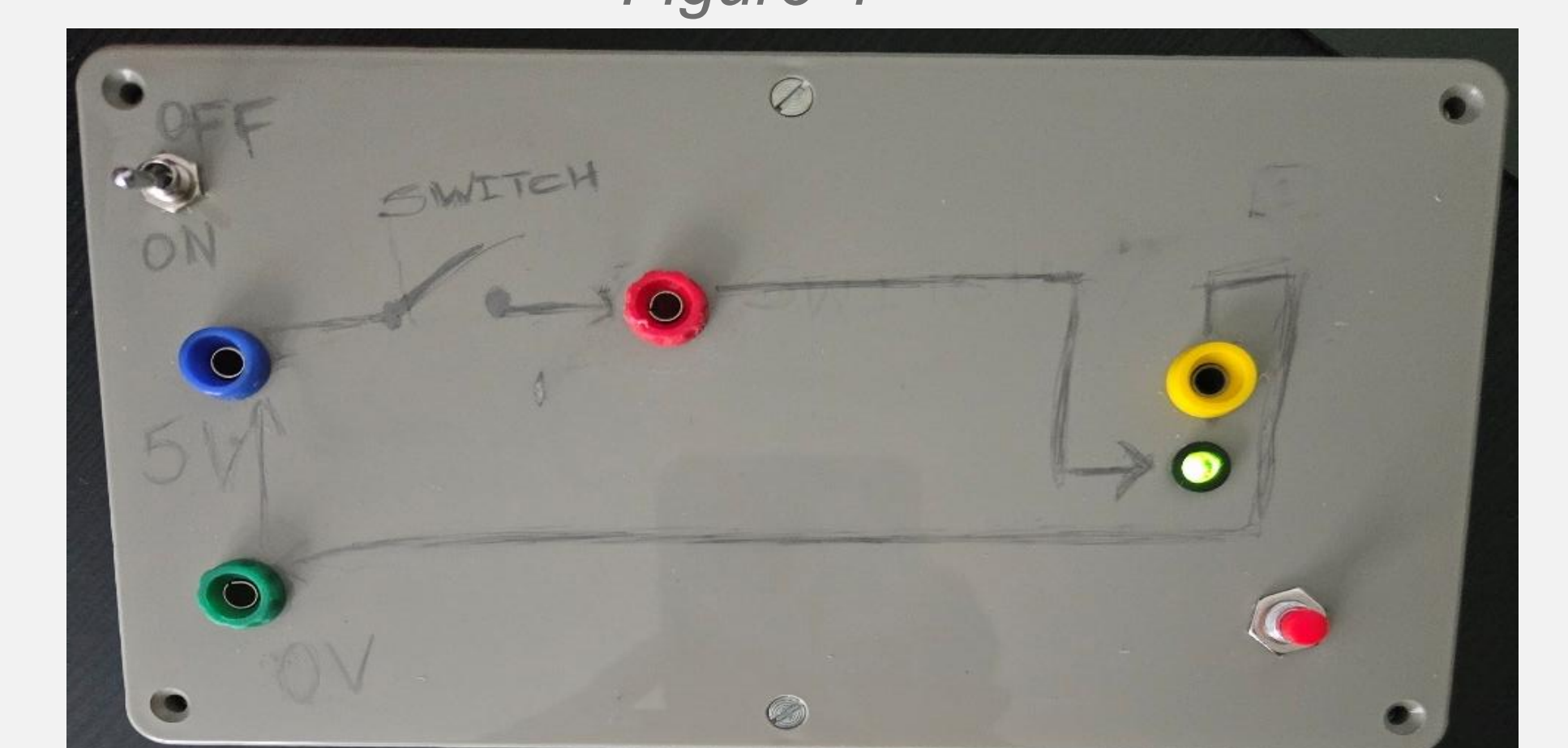


Operation

Figure 2 visualises the operational flow of the product and how the PIC operates including responding to user interaction.

Prototype

The circuit is housed within a container to restrict the user interaction with circuit components. The simulated circuit is overlaid on the cover with the components mounted to the container. Safe operation is ensured by only components intended for user interaction or accessible.



References

- [1] M. E. Auer, D. Guralnick and I. Simonics, "Teaching electrical engineering through practical and simulation-based approaches," *International Journal of Online and Biomedical Engineering*, vol. 14, no. 4, pp. 4–17, 2018.
- [2] S. Bennett, "Realistic fault simulation techniques for engineering education and training," *IEEE Transactions on Education*, vol. 46, no. 1, pp. 16–21, Feb. 2003.