

# Portable Buzzer Circuit Design for Reform of Electronic Technology Experiments

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**Abstract:** As an important practical course in the field of electrical and electronic engineering, Electronic Technology Experiments not only reflect the students' familiarity with theoretical courses but also lay a solid foundation for subsequent specialized courses and post-graduation work. At the same time, it allows students to practice and test their theoretical knowledge of analog and digital electronic technologies. Through a complete project-based experimental approach, our Information Engineering Experiment Center has targeted comprehensive and exploratory reforms for both analog and digital electronic technology experiments. From the perspective of the reform outcomes, students' interest in experimental learning, project thinking skills, practical abilities, and innovative capabilities have all been significantly enhanced. This article uses the design of a pocket-sized quiz buzzer circuit as an example to elaborate on the basis of the reforms.

**Keywords:** Project-based Experiment; Autonomous Learning; Buzzer Circuit Design.

## 1. Introduction

As the new round of scientific and technological revolution and industrial transformation accelerates, the reform of higher engineering education has become a broad consensus and active action among universities worldwide [1-3]. After years of development, although previous electronic technology experiments have had good effects in practical teaching, there are still many problems. Specifically, these include: first, students lack initiative and enthusiasm for participating in experiments. For example, the content and procedures of experiments are often pre-planned by teachers, and the main task of students in the experiment class is to listen to the teacher's explanation of the experiment, follow the experimental guidebook to connect circuits, verify the experiment, and complete the experiment report after class. This is mostly teacher-centered, with students not having much time to think and act on their own; second, each experiment is generally set up in conjunction with theoretical courses on analog and digital electronic technologies, experiments are numerous and complex, lack comprehensive strength, and each experiment is mostly fixed at 2 hours, with insufficient experimental time. Third, because many physical components are inside the equipment, students have few opportunities to come into contact with the physical components, lacking a direct sensory experience. Based on this, the Information Engineering Experimental Center has carried out a series of reforms on electronic technology experiments, focusing on improving students' hands-on abilities, fostering learning interest, and cultivating project-based thinking. The previous approach of "teachers teaching and students passively learning" has been transformed into a new method of "students actively learning with teacher guidance," using project-based experiments as a vehicle. Through practical reforms, students are encouraged to develop project-based and engineering-oriented thinking early, guiding the development of electronic technology experiment teaching towards engineering and application-oriented directions [4]. This paper uses the example of the buzzer circuit design experiment to elaborate on the measures

taken in the reform.

## 2. Reform Measures

### 2.1. Reform Experiment Content

Integrate the content of analog and digital electronic technology experiments, adjust and select representative experimental content, provide students with ample time to understand and master the entire experimental circuit design process, starting from the design of practical project ideas, to cultivate students' project engineering thinking. Before the reform, there were 6 experiments in the analog part and 5 in the digital part, and most of the experiment hours were 2 hours. After ensuring that the content of the experiments was not reduced, integration was carried out. After the reform, there are a total of 7 experiments in electronic technology experiments, including 4 analog electronic technology experiments and 3 digital electronic technology experiments, totaling 32 hours. For example, the design of the buzzer circuit for the portable pocket experiment box.

### 2.2. Requirements for Reform Experiments

**Design requirements:** According to the requirements, learn how to select electronic components, solder a pocket-sized circuit experiment board, make a DIY pocket-sized electronic technology experiment box, and design a four-way buzzer circuit. The circuit should allow four people to buzz in response, with a host controlling the start button. After the start command is given, contestants can buzz in, but not before. Once a contestant successfully buzzes in, their number or light should be displayed, the circuit should lock, and further buzzes from other contestants should be invalid. **Experimental tasks:** Functional indicators: Complete the making of the pocket-sized circuit experiment board, implement a basic four-person buzzer circuit, the circuit should be able to display the result and number of the buzz, and the circuit should achieve interlocking and stable buzzer functionality. Technical indicators: Based on knowledge of combinational logic circuits, encoding and decoding, and sequential logic circuits in digital electronics technology,

complete the design of the buzzer circuit. Achieve simulation through Multisim software, ensuring normal functionality, stable performance, and the construction of the circuit on the pocket-sized circuit experiment board. The experiment is set for 6 academic hours, and this reform is based on project-based experimental ideas. The teacher first reviews and explains the knowledge of combinational logic circuits and sequential logic circuits in 2 academic hours, then proposes requirements for students to design a buzzer circuit using the knowledge they have learned. Students are provided with comprehensive experimental equipment and materials, the experiment center has specially set up three laboratories for electronic technology experiments for teaching purposes, each laboratory is equipped with 50 workstations, providing each student with an experimental workstation and equipment, and simulation software such as Multisim and QuartusII are pre-installed on the experimental computers, while each student's seat is equipped with a component box, breadboard, toolbox, and other tools.

### 3. The Specific Practice of Reform Experiments

Based on the students' progress in theoretical classes, teachers timely release experimental design tasks. Students pre-study according to the task sheets, familiarize themselves in advance with the schematic structure of pocket-type circuit experiment boards, and the theoretical knowledge related to combinational logic circuits and sequential logic circuits associated with the buzzer circuit. After receiving the experimental task from the teacher, students select components for the circuit board and solder them using a soldering iron, learning the relevant knowledge of soldering. They also prepare in advance by searching for theoretical knowledge and related materials, breaking down the design task according to requirements, starting from the overall functional module and breaking it down into the function of each chip and unit, such as overall design module, component layout on breadboards, and the working principle of the buzzer. At the same time, students divide the task into modules based on the content of the task sheet. This experimental process is a relatively complete comprehensive design experiment involving the design, production, schematic drawing, software simulation, and breadboard interconnection of an experimental box. It requires going through processes such as theoretical knowledge learning, circuit soldering, scheme design, chip manual consultation, software simulation, circuit assembly, and design summary. During the experiment, students are guided to first design in modular parts: for example, the buzzer number display module, the contestant buzzer latch module, and then simulate the overall buzzer circuit. At the same time, students build the circuit on a breadboard. The process of building the circuit is divided into: searching for and selecting components → connecting the circuit → circuit debugging → circuit function testing → circuit analysis → summary report. The experimental process is divided into the following steps:

1. Task release. The experimental task is released in advance through the learning platform, allowing students to review the theoretical knowledge they have learned and understand the working principle of the buzzer circuit.

2. Familiarize with the circuit board structure, select electronic components, solder the pocket-type experimental box, and draw the schematic of the buzzer circuit. Each

student is required to design one sheet of paper according to the requirements. The design requirements for the paper are: 1. A4 paper with a border and a title bar (write the design title, class, name, student number, instructor, etc.). 2. The final simulation-correct design paper must be submitted (must be consistent with the design report). 3. The layout should be reasonable, the components should be appropriately spaced, and the size of the same type of components should be consistent, etc., while checking the circuit board structure and soldering precautions, etc.

The buzzer is a necessary device commonly used in competitive questions. In principle, it is a typical digital circuit. A flip-flop is the basic logic memory unit in digital circuits, with two stable states to represent the logical states "1" and "0". The four-person competition buzzer device circuit is used to determine the priority of the buzzer. It consists of three parts: 1 D flip-flop 74LS175, which has a reset terminal, a set terminal, and a CP terminal; 1 four-input AND gate, 1 two-input AND gate; four tactile switches, which form the CP clock pulse source in the buzzer circuit. When the buzzer starts, the host clears the signal and presses the reset switch S, and the outputs Q1, Q2, Q3, and Q4 of 74LS175 are all 1, all light-emitting diodes (LEDs) are extinguished. When the host announces "Buzzer start," the first contestant to make a judgment immediately presses the switch, the corresponding LED lights up, and at the same time, the signal is sent through the AND gate to lock the circuits of the other three contestants, no longer accepting other signals, until the host clears the signal again. If there are only four contestants, the input of the circuit can use simple combinational logic gate circuits. If there are 8 or more contestants, considering economy and practicality, an encoder chip + CD4511 form can also be used to achieve.

### 4. Conclusion

Through reforming and practicing electronic technology experiments with design projects as the goal, students have essentially gone through processes such as familiarization with experimental instruments, analysis and design of circuit principles, component selection, circuit simulation and testing, and breadboard circuit assembly. With the experimental reforms, students have ample time to complete each step, and the selection of experimental content is closer to engineering practice. Coupled with complete experimental equipment, students gradually shift from passive learning to active learning, enhancing their interest in experiments as well as their hands-on and innovative abilities. However, there are still areas that need improvement in the experimental reforms. The creation of self-made pocket-sized electronic technology experiment kits aims to improve students' abilities in component selection, soldering, and debugging. This experiment integrates combinational and sequential logic circuit content, elevating the previous discrete component verification experiments to integrated circuit and design comprehensive experiments. By setting hierarchical tasks, students can make reasonable choices, further exploring their potential on the basis of mastering basic knowledge, and enhancing their comprehensive abilities.

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