

Design of a Relay Circuit Based LCC Bell for the IAIN Pontianak Quiz Competition

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Abstract

In order to commemorate its second anniversary, the Mathematics Tadris Study Program at IAIN Pontianak organized a quiz competition between West Kalimantan schools in December 2022. The difficulty in obtaining the Quiz Buzzer, despite the fact that it is a crucial component in conducting the Quiz Contest, was one of the challenges encountered when attempting to carry out the event. Without the Quiz Buzzer, the contest question session would not have been held. This study was done to develop a quiz buzzer for a Tadris Mathematics Study Program quiz competition based on a DC 12V relay circuit. The needs identification, design, development, and testing phases make up the four phases of the methodology used in this study. A truth table, which represents the operation or functionalities of the quiz buzzer circuit, and a wiring plan known as a ladder diagram were produced during the design phase. A comprehensive schematic for the quizz buzzer circuit was created throughout the development stage. While the Proteus software's simulation capability is used to do testing. The software simulation test results demonstrate that the quiz buzzer circuit is functioning correctly in accordance with the requirements of quiz competitions.

Keywords: LCC Bell, Clever Smart Button, Relay Circuit

Abstrak

Pada bulan Desember 2022 Prodi Tadris Matematika IAIN Pontianak menggelar acara Lomba Cerdas Cermat antar sekolah se-Kalbar dalam rangka merayakan Milad yang ke2. Salah satu kendala yang dihadapi ketika akan melaksanakan acara tersebut adalah sulitnya mendapatkan Bel Lomba Cerdas Cermat, padahal perangkat ini merupakan unsur utama dalam penyelenggaraan Lomba Cerdas Cermat, karena jika tidak terdapat perangkat ini maka sesi pertanyaan rebutan dalam lomba tidak akan dapat dilaksanakan. Penelitian ini dilakukan untuk merancang perangkat Bel LCC berbasis rangkaian relay DC 12V untuk perlombaan cerdas cermat yang digelar Prodi Tadris Matematika. Metode yang digunakan dalam penelitian ini terdiri atas 4 tahap, yaitu identifikasi kebutuhan, perancangan, pengembangan, dan pengujian. Tahap perancangan menghasilkan sebuah tabel kebenaran yang merepresentasikan cara kerja atau fungsi dari rangkaian bel LCC, dan sebuah diagram ladder yang merupakan gambar pengawatan dari rangkaian bel LCC. Tahap pengembangan menghasilkan gambar rangkaian lengkap dengan menggunakan software Proteus. Tahap pengujian dilakukan melalui fitur simulasi dalam software Proteus. Hasil pengujian melalui simulasi software menunjukkan bahwa rangkaian Bel LCC yang telah dibuat dapat berfungsi dengan benar sesuai dengan kebutuhan dalam perlombaan cerdas cermat.

Kata kunci: Bel LCC, Tombol Cerdas Cermat, Rangkaian Relay

Introduction

Bell LCC is short for Bell Smart Competition. The Faculty of Tarbiyah and Teaching Science at Pontianak State Islamic Institute, along with the Tadris Mathematics Study Program, hosted a quiz competition between West Kalimantan schools as part of the celebrations for the program's second anniversary. The LCC bell, commonly referred to as the LCC button, is a necessary component of quiz contest events. As a result, the authors decided to develop an LCC bell using a DC relay circuit.

According to the study's findings [1] kids can become more motivated to learn and more confident by participating in mathematics LCC activities. The Student KKN, which was conducted by [2], aims to give students a new learning experience, improve their knowledge, skills, and social awareness, and enable them to study more actively, enthusiastically, and comprehend questions and mathematical problems. According to the study's findings [1] kids can become more motivated to learn and more confident by participating in mathematics LCC activities. The Student, which was conducted by [2], stated that important to give students a new learning experience, improve their knowledge, skills, and social awareness, and enable them to study more actively, enthusiastically, and comprehend questions and mathematical problems.

Literature Study

a. Push Button

When electricity is connected or disconnected from one point from another with an unlocked system, one of the electronic components (button/switch) that performs this function is called a push button. When the button is pressed, one point will be connected to another point (NO button) or disconnected (NC button), and when the button is released, the condition returns to normal as before. Depending on its purpose and usage, push buttons come in a wide variety of shapes and sizes. One of the button versions and its symbol are shown in Figure 1.

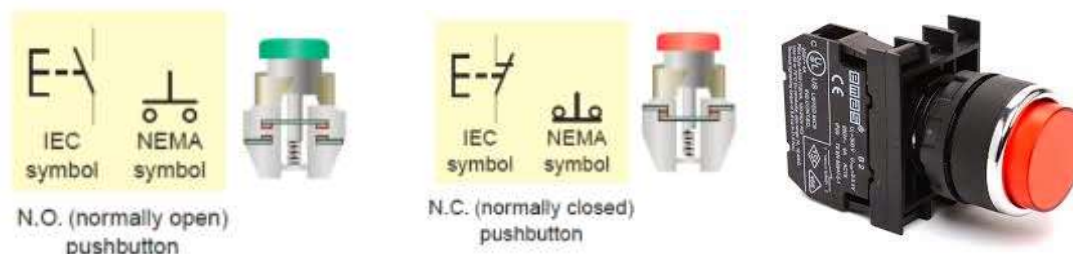


Figure 1. Symbol and Push-Button Body Form

source: <https://akhdanazizan.com/tombol-tekan-push-button/> dan [3]

b. Relay DC

Relay is an electronic component that uses electromagnet technology to resemble a switch (NC & NO). A supply voltage is required to change the switch contact's position from NC to NO or vice versa. Relays often come in two varieties: AC relays and DC relays. While DC relays often operate on a DC voltage of 5V, 12V, or 24V, AC relays operate on a 220V/AC voltage. Figure 2 depicts the relay symbol and one of the physical relay DC variations.



Figure 2. Symbols and Forms for DC Relays

c. Buzzer

Electrical oscillations are transformed into sound vibrations by the buzzer. Essentially, the operation and function of a buzzer are similar to those of a loudspeaker; nevertheless, they are simpler to use. The buzzer can be used as an indicator or a transducer (it has a built-in driver circuit but no driver circuit itself). When operating, a buzzer intended as a transducer needs an input voltage in the form of a square wave with a specific frequency, whereas a buzzer designed as an indicator merely needs a constant DC voltage or current source. While indicator buzzers and transducer buzzers can both be operated to produce a continuous tone or sound in the form of fast or slow pulses, only transducer buzzers are capable of producing noises with high or low tones, sirens, or specific melodies. [4], undated Figure 3 displays the buzzer's symbols in many shapes. .



Figurer 3. The Buzzer Symbol and Several Variations Form

Methodology

The four stages of this research methodology are need identification, design, development, and testing. Finding needs is the first step; why should this tool be created? The second stage is design, which entails creating a preliminary design and set of calculations on paper. Development, or creating tools based on documented designs, is the third stage. The fourth stage is testing, which involves putting the tool through its paces to see if it meets requirements or is designed as intended. In this last step, changes can also be made to the tool's design, for as by adding or removing components or changing the system configuration.

a. The Need Investigation

Several events were held during the 2nd Anniversary of the Mathematics Tadris Study Program, FTIK IAIN Pontianak, one of which was the Quiz Competition (LCC) between schools in West Kalimantan. The quiz contest bell (LCC) is one of the essential components required to make this quiz contest successful. Three groups (groups A, B, and C) will participate in each session of this competition, therefore this number will have an impact on how the system is configured when creating the LCC bell circuit in the future.

b. Designing

The relay circuit serves as the foundation for the forthcoming Careful Smart Bell. One 12Vdc Relay, two Push Buttons, three 12Vdc Indicator Lights, four 12Vdc PSU Switches, and one 12Vdc Active Buzzer make up the primary parts. LAN cables, single cables, fiber cables, and various supporting components are examples.

To provide a safety factor, the chosen relay is a type of DC relay with a voltage specification of 12V, up to 3 relays, and each relay having a minimum contact of 2 NC and 3 NO. There are 4 buttons required: One button for judging with small specifications of type NC and 3 buttons for competitors with extensive specifications of type NO. The necessary indicator lights consist of three separate components of different colors (red, yellow, and green) to show which group was successful in hitting the button first to provide the response. To provide a power source to the LCC Bell device, a switching power supply unit is necessary. The last one is a 12 Vdc active buzzer with loud enough sound characteristics for indoor application.

The relay circuit for the LCC Bell operates so that when one person presses a button, the buzzer, the group indicator light, and the other two group indicator lights all light up. The other two participant's buttons are inoperative throughout this process. The judge presses the button to reset the relay circuit system because the situation won't change. Similarly, if a different player touches the button on the table first, neither of the other two buttons will function, and once the judge presses the reset button, the situation will return to normal or neutral. The truth table (table 1) illustrates this idea. In the meantime, Figure 4's ladder diagram might be used to explain the succession of LCC Bells.

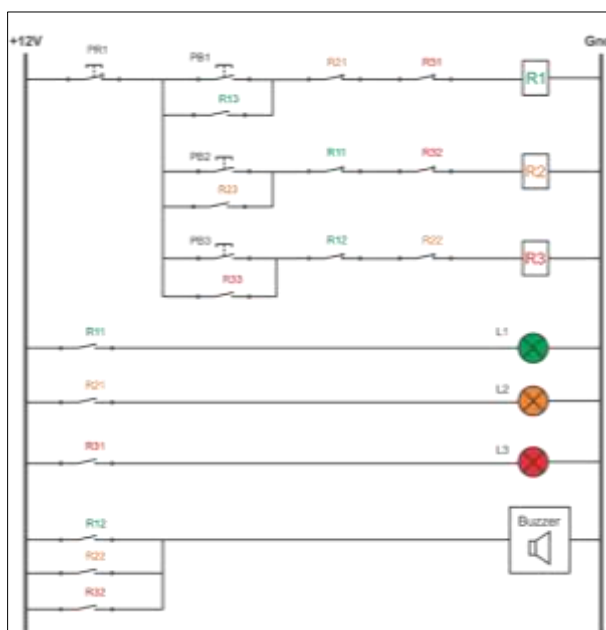


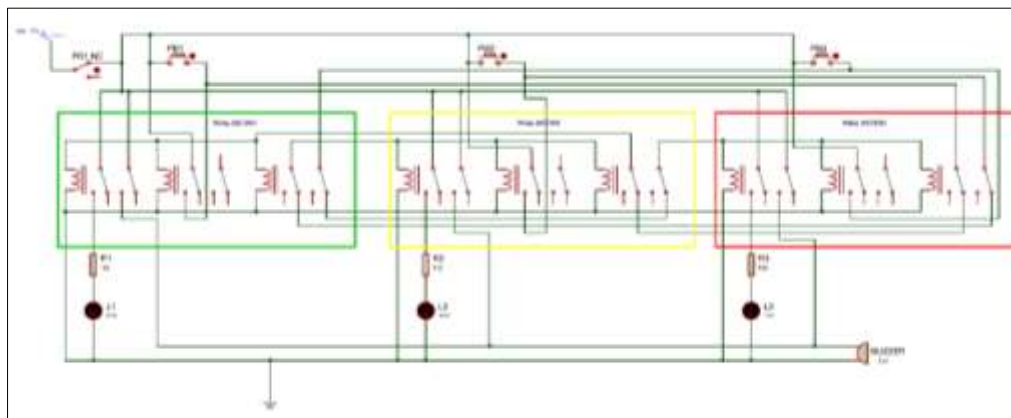
Figure 4. LCC Bell Circuit Represented as a Ladder Diagram

Table 1. Bell LCC system table of truth

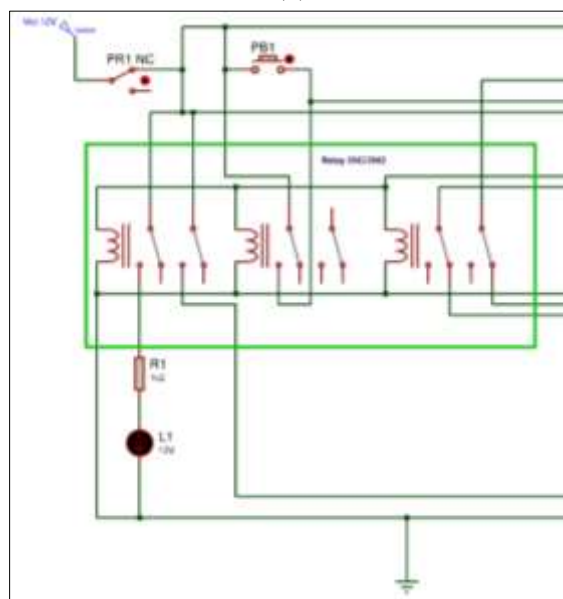
Condition	PB1	PB2	PB3	L1	L2	L3	Buzzer	PR1
Group A	1	0	0	1	0	0	1	0
Group B	0	1	0	0	1	0	1	0
Group C	0	0	1	0	0	1	1	0
Judges	0	0	0	0	0	0	0	1

c. Development

The process of constructing a tool or gadget that has already been designed is called development. In this study, Proteus 8.15 software is used to run a simulation model during the development phase. Since the 2NC/3NO relay component is absent in Proteus, a replacement circuit for the 3NC/3NO type relay is created using 3 DC type 2 Pole relays. Figure 5a depicts the replacement circuit and entire LCC bell system circuit, while Figure 5b provides a more detailed view of group C, also known as the red group, which is a component of the LCC bell circuit.



(a)

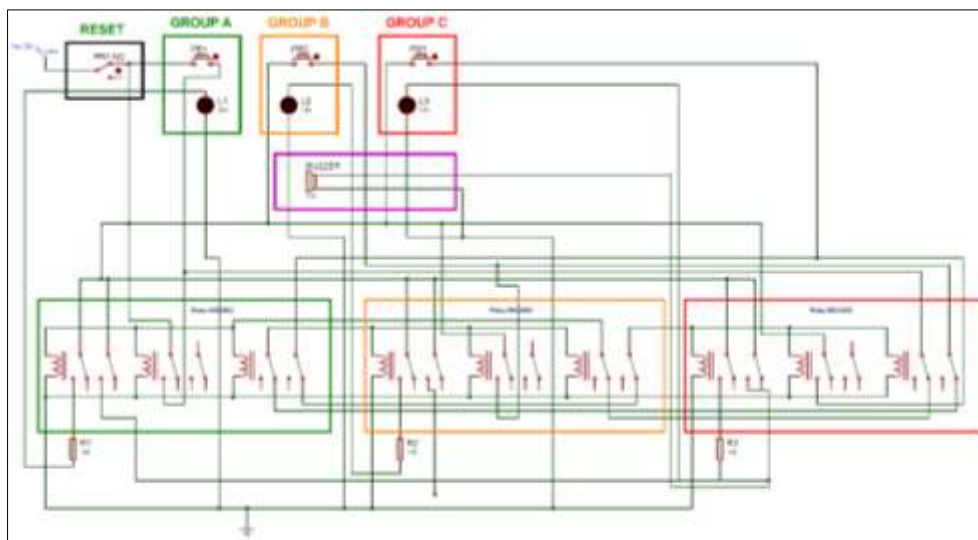


(b)

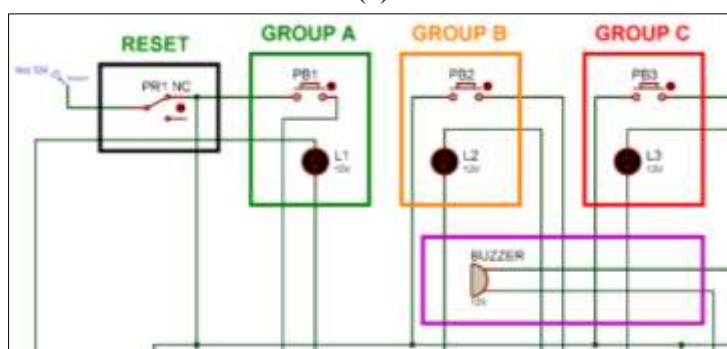
Figure 5. (a) LCC Bell Circuit, (b) A component of the LCC Bell Circuit (Red/Group C)

d. Testing

The Proteus program is used for simulations during the circuit testing process. The components in Figure 5 have been rearranged in accordance with their designation or group in Figure 6 to make it simpler to observe how this LCC bell series operates. Figure 6b demonstrates the presence of a judge button (RESET), three contestant buttons (GROUP A, B, and C), and a buzzer. The buzzer will sound, the linked participant's bulb will immediately light up, and the other participant's buttons won't work or be active if one of their buttons has been depressed. The judge button (RESET) can, in the meantime, turn off the buzzer and all participant buttons, or it can return the system to its basic settings (before the participant button is depressed).



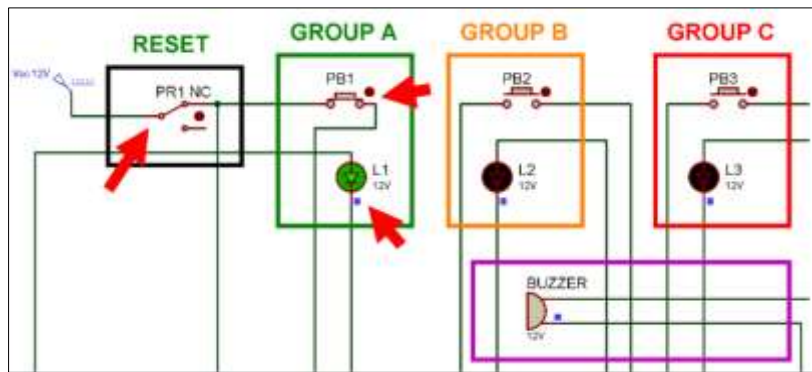
(a)



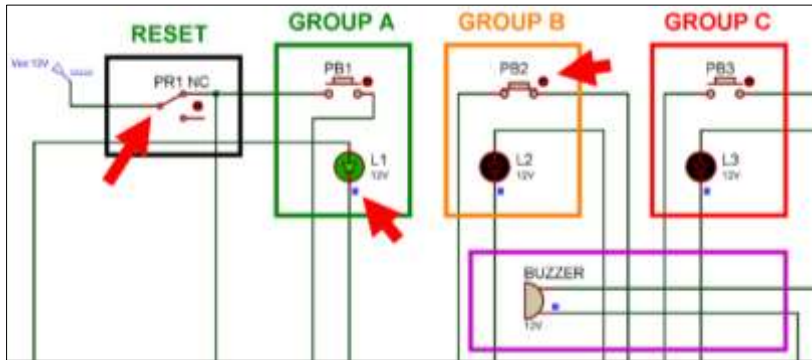
(b)

Figure 6. (a) Judge Button (Reset), Contest Participant Button (GROUP A, B, C), and Buzzer. (b) LCC Bell Circuit with New Layout

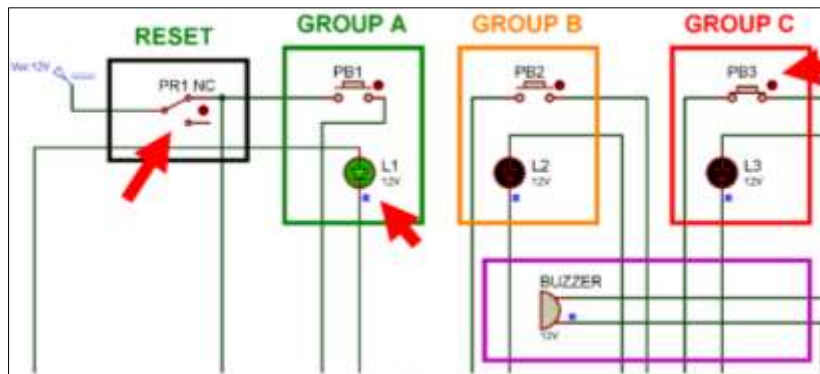
The simulation outcomes demonstrate that the LCC bell circuit created with Proteus software performs in accordance with the way that it is intended to (table 1). This is demonstrated in Figure 7. In Figure 7a, when the participant button 1 (GROUP A) is touched for the first time, the buzzer and L1 lamp (the participant indicator light for Group A) light up right away. Figures 7b, 7c, and 7d demonstrate how the participant buttons 2 (GROUP B) and 3 (GROUP C) are inoperative as a result of the participant button 1's prior use. Figure 6e demonstrates how the system instantly resets to its initial state when the judge button (RESET) is hit, bringing all participant buttons, indicator lights, and buzzers back to their usual, inactive states. Figure 7f, on the other hand, depicts the state (position) of the relay contact child that controls the wiring of Participant 1's (GROUP A) button. The GROUP B button and GROUP C button functions will be locked and rendered inactive by the position of this relay contact child. Compare the location of the relay contact kid when it is in normal condition to the position of the relay contact child when the component in GROUP A is active (figures 5 and 6a).



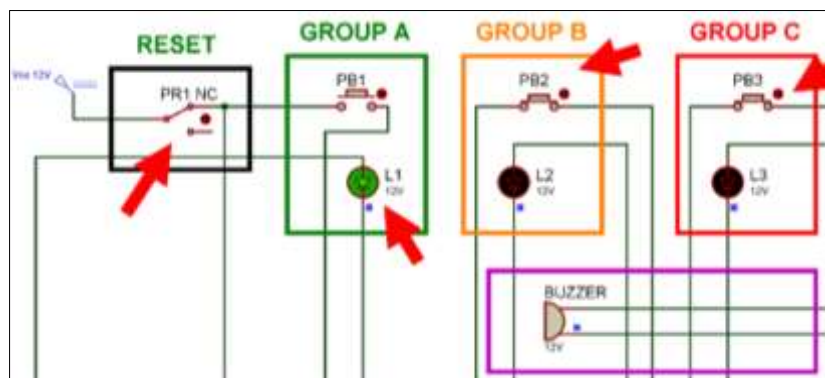
(a)



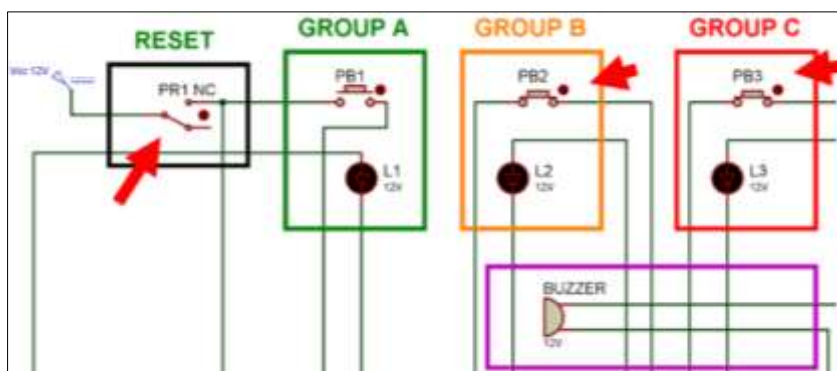
(b)



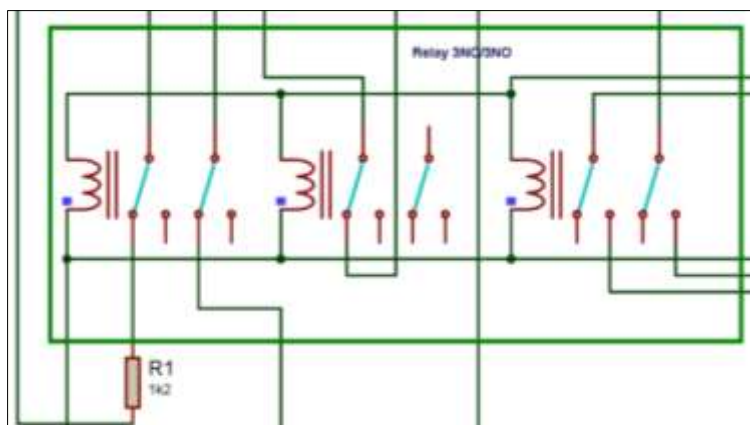
(c)



(d)



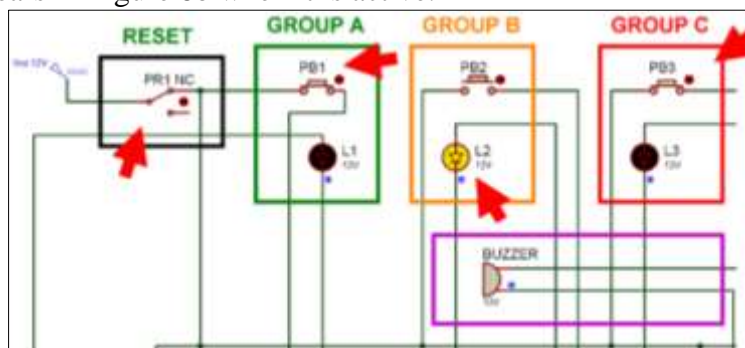
(e)



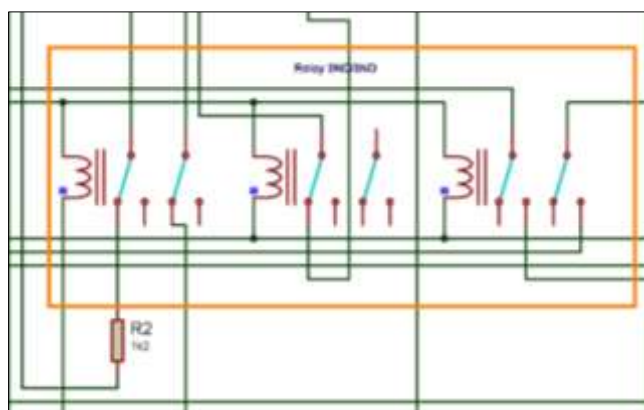
(f)

- Figure 7. (a) Pressing the PB1 (GROUP A) button
 (b) Pressing the PB2 (GROUP B) button has no effect.
 (c) Pressing the PB3 (GROUP C) button has no effect.
 (d) Pressing the PB2 and PB3 buttons at the same time results in an error
 (e) Pressing the PR1 (RESET) button Position of the GROUP in
 (f) a kid relay contact

Pressing the participant 2 button (GROUP B) will start the next test. According to the findings, participant 2 (L2)'s light turns on right away, the buzzer is operational, but participant 1 (L1)'s and participant 3's buttons are unable to turn on their respective light sources or buzzers. Figure 8a illustrates this. The condition of the GROUP B relay contact child then appears in Figure 8b when it is active.

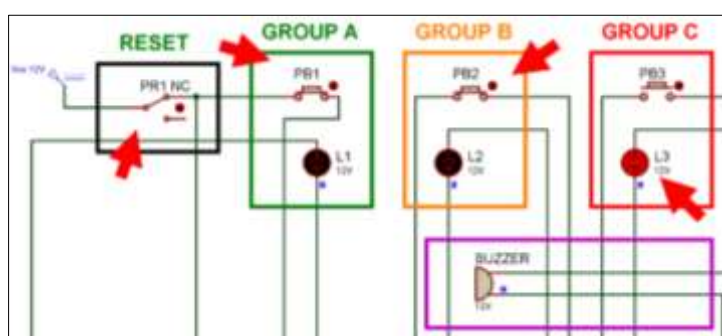


(a)

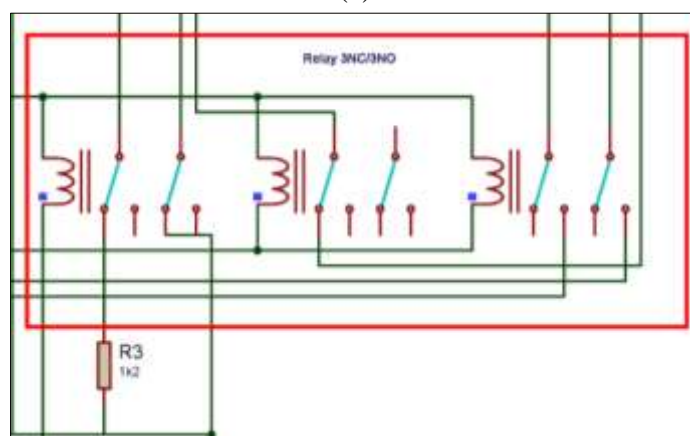


(b)

Figure 8. (a) the circumstances that exist after pressing the PB2 (GROUP B) button
(b) the location of the GROUP B relay contact child while it is activated



(a)



(b)

Figure 9. (a) the circumstances that exist after pressing the PB3 (GROUP C) button
(b) the location of the GROUP C relay contact child while it is activated

Conclusion

Because it is simpler and better suited for systems made from NC/NO contact components, the LCC bell's design, which is based on this DC relay circuit, uses a ladder diagram model. The design is carried out using the truth table's (table 1) established rules, which are mentioned. According to the ladder diagram, this LCC buzzer circuit has three different output kinds (DC relay, indicator light, and buzzer), with the indicator light and buzzer serving as the primary output devices under control.

The process of creating the designed tool is known as the development stage. Proteus software is used to draw circuits for the development in this paper. Due to the fact that there were no 2NC/3NO relay components, a number of equations utilizing 3 3

Pole type relays were created. Although it will require extra upkeep, this can solve the issue. Proteus uses a momentary action type SPDT switch instead of the NC type push button that is required by the judge/reset push button component (PR1). Used red, yellow, and green 12V LEDs along with current-limiting resistors for the indication lights. Proteus has a component for a 12V buzzer.

By using Proteus' simulation capability, the testing process is carried out. The simulation results demonstrate that the constructed circuit can function correctly in accordance with the truth table's rules. The buzzer, participation buttons (PB1, PB2, PB3), indicator lights (L1, L2, L3), and reset button (PR1) all function as intended.

This LCC bell series' primary purpose is to ensure that the buttons, indicator lights, and buzzers used by the contestants can all operate as intended. This allows the contestants' buttons to interlock or break contact with one another, the indicator light to show which group pressed the button first, and the buzzer to sound when a contestant has pressed a button. In order to be implemented under real-world circumstances, fewer parts and circuits are required. For example, indicator lights don't need external current-limiting resistors, and only three relays are employed, with the bare minimum of 2NC/3NO contacts. The method of wiring or assembling the circuit to fit the ladder diagram image is all that needs to be taken into account because all devices directly operate with a 12Vdc voltage supply.

The amount of relay components, indicator lights, and circuit drawings in the ladder diagram can all be increased to accommodate more than three groups of race participants in this series of relay-based LCC bells. By choosing the right buzzer type, the buzzer's high or low sound can be adjusted as necessary. Keep in mind, however, that the weakness of the LCC bell device based on this relay circuit is that when the number of participants increases (more than 3 participants), the cable wiring on the relay component will be complex, and the relay must have a large number of contact children, so the number of participants certain there will no longer be available relays with a specification of the number of contacts required. If numerous relays are combined in order to increase the number of relay contact children, the resulting wiring will be extremely complex, making maintenance difficult in the event that a loose, broken, or leaky wiring situation arises.

The relay component can be replaced with a microcontroller that has a lot of input and output ports as a substitute for relay contact children as a solution to this issue, for the development of additional study. Utilizing a microcontroller eliminates the need for intricate wire wiring on the relay side and replaces it with microcontroller program codes. Additionally, by including a WiFi module to the microcontroller, the wired connection between participant buttons can be replaced by wireless communication media.

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