

GRAPHICAL TEACHING AID FOR ASTABLE AND MONOSTABLE CIRCUITS UTILIZING ARDUINO MEGA

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Abstract

An electronic device is created and constructed. It is intended to become a kind of teaching aid for electronic lecturers and students. The circuit was designed to help calculating various outputs of the 555 timer ICs in Astable mode and Monostable mode. Calculations can be easily made for frequency, period, duty cycle, and delay time outputs. Moreover, schematic displays and input values of the components can be display with graphical colorful images. The circuit design consists of Arduino Mega development board, a few input switches, a 3.5in TFT color LCD display, a piezo buzzer, and two 3.7V li-ion batteries. The whole circuit is operated by a program code created by using Arduino IDE software. The complete circuit was constructed on a specially created printed circuit board.

Keywords: Arduino MEGA, LCD, Buzzer, 2 x 3.7V Li-ion Batteries

Introduction

Education plays an important role in both development of our country and living standard. Ministry of education is making researches to develop the quality of education in Myanmar, such as adding the new courses and subjects, removing the unreasonable lessons. While preparing the courses, it is important to consider the application of various teaching aids. Teaching aids are objects (such as a book, picture, or map) or devices (such as a projector, DVD or computer), 3D models, or instruments used by a teacher to enhance understanding a lesson in a classroom or in a practical room. Therefore, research on development of teaching aids becomes important in modern education.

Therefore, a kind of teaching aid is designed for electronic students. It is intended to help in learning 555 timer IC in electronic lab or studying electronic circuits. The circuit is designed to be visually illustrate the schematic and components. Moreover, calculation can be made by using input data for various output results within a few seconds. The circuit design utilized a microcontroller development board (Arduino Mega), a 3.5 inch tft LCD display, a piezo buzzer, a few input switches and two li-ion batteries. The processing of input data and calculations were made with a program code. It is the most difficult part in the design. The program coding was created with Arduino IDE software. The basic structure of the circuit design is illustrated with a block diagram in Figure 1.

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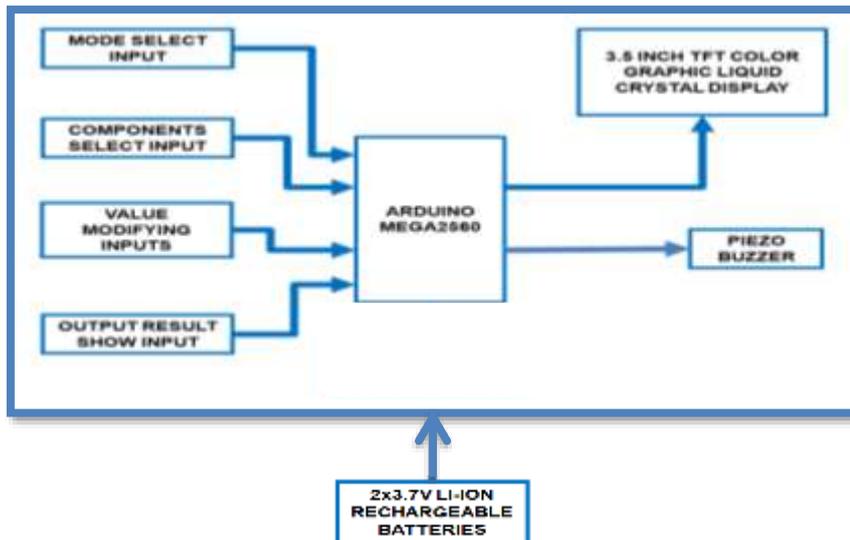


Figure1 Block diagram of astable and monostable training aid system

Arduino Mega2560 Module

The Arduino Mega2560 board is a microcontroller board included in the ATmega2560 microprocessor. It has 54 digital input/output pins, 14 pins of these 54 pins are used in PWM output. 16 analog pins and 4 UARTs pins to hardware serial ports are also included. The crystal oscillator in the Arduino Mega is 16MHz and includes everything to support a microcontroller, such as a USB connection, reset button, ICSP header, and a power jack. The Arduino Mega2560 board is shown in Figure 2.

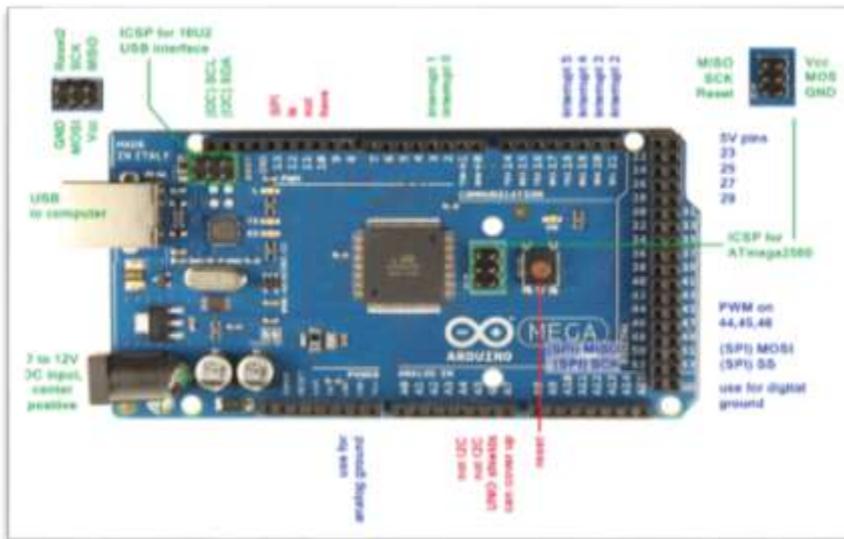


Figure 2 The Arduino Mega2560 Board

3.5 Inch TFT LCD Module

The 3.5 inch TFT LCD module is available in 320x480 resolutions and 65K color display. It uses 8-bit line parallel port communication, and the driver IC is ILI9486. The module includes an LCD display, 5V to 3.3V level conversion circuit, which can be directly, plugged into the Arduino Uno and Mega2560 development boards.

Moreover, the board consists of built in SD card expansion function. Front view photo of 3.5 inch TFT LCD Shield and pin out diagram of 3.5 inch TFT LCD shield as shown in Figure 3 and 4. The module can be directly inserted into the Arduino Mega2560, without adding manual jumpers or wires as shown in Figure 5.



Figure 3 Front view photo of 3.5 inch TFT LCD Shield



Figure 4 Pin out diagram of 3.5 inch TFT LCD Shield



Figure 5 The LCD is connected with Arduino Mega2560 board

Circuit explanation

The schematic of Astable and Monostable Teaching Aid circuit is shown in Figure 6. In the schematic there are some electronic components and modules. They are Arduino Mega2560, a 3.5inch TFT Color LCD display module, a few input switches, a piezo buzzer, and two 3.7V rechargeable li-ion batteries. The microcontroller development board Arduino Mega is the heart of the circuit in this design. The board was chosen for consisting a large amount of program memory and plenty of I/O pins.

Moreover, the board was combined together with programmer and regulated power supplies. But the controller board itself cannot operate the circuit of Astable and Monostable Teaching Aid. The LCD-RD pin is connected with A0, the LCD-RW pin is connected with A1, the

LCD-RS is connected with A2, the LCD-CS is connected with A3 and finally the LCD-RST pin is connected with connected with A4 as shown in Figure 7. A piezo buzzer is used in the circuit.

The positive side of the piezo buzzer is connected with the digital input pin 18 of the microcontroller and negative side of the buzzer is connected with the ground line as shown in the schematic. The last part in the circuit is power supply. The input of arduino mega can be range from 7 to 12V dc. Therefore, a pair of 3.7V rechargeable li-ion batteries is used in the circuit. But there is a power on/off switch between the battery and VIN of the Arduino Mega. There are 5V and 3.3V regulator outputs on the Arduino Mega and they can be used to power the other components on the circuit.

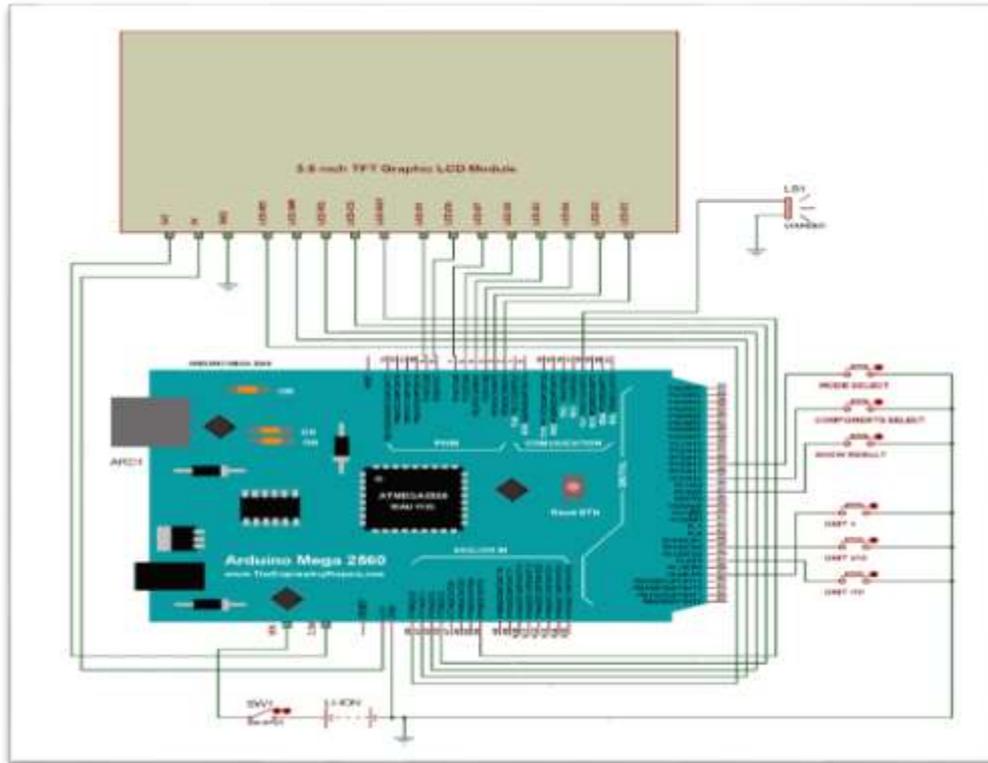


Figure 6 Schematic diagram of teaching aid for astable and monostable circuit

Program Explanation

A flowchart diagram is created to help during program development and to explain. It is shown in Figure 7. The flowchart is started by adding library files for 3.5 inch TFT LCD displays. Then the names of color are defined with 16 bit numerical values. At the same time pin naming, defining variables and sw input state variables are made for the program. Then the Input/ Output pin settings are made and libraries are initializing in the void setup routine.

Moreover, some default settings are made in this routine. The title of the circuit is display with large white color fonts on dark blue screen in the same routine. Then the program looping started by checking the ASTABLE or MONOSTABLE mode select input switch. Then the program checks for press of show results input switch. If the switch is not press, the program will loop back to modify the input values. If the show result switch is pressed, the calculations will be made for the periods, frequency and duty cycle values and display on the LCD for five seconds. After five seconds, the values are hidden again and only the component values are display on the LCD.

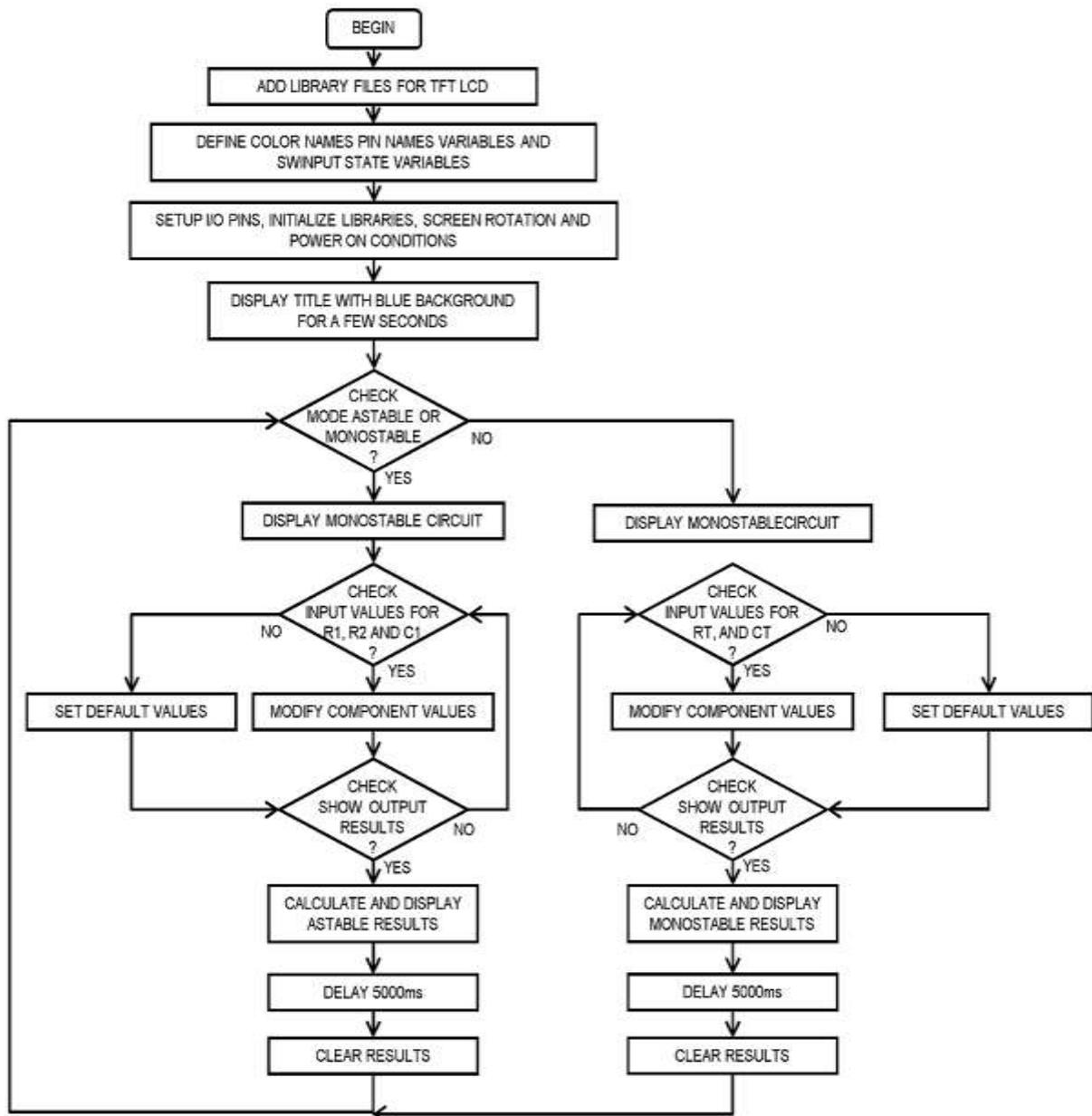


Figure 7 Flowchart diagram of the program

Circuit Operation

The operation of circuit is design to be user friendly. But there will be difficulties in changing required values for resistors and capacitors. The whole circuit operation can be modify and operate by editing the program code which is created with Arduino IDE software. The size of compiled program code is larger than 32K byte, therefore, Arduino Mega is chosen instead of Arduino Uno. The compiled size of program code is 35.6K bytes and RAM memory usage is 920 bytes.

When the power supply is connected or USB connection is made with the Arduino Mega board. The program code uploaded in the microcontroller starts executing the program. In the very first state of programming, title displays are created on the LCD display for a few seconds. The title display consists of two pages. The font size is 3 and the colors of characters are white, but the

background is blue color. The teaching aid for astable and monostable circuit is shown in Figure 8. The result of title display is illustrated with Figure 9 and 10.

Then the astable circuit diagram and monostable circuit diagram and created for the program and tested. In this case, the default selection of circuit is astable circuit. But the circuit selection can be change to monostable circuit by pressing mode select input switch. Pressing the mode select input switch will toggle the two circuit. The selection of each circuit photos are illustrated in Figure 11 ,12 13 ,14,15 and 16.



Figure 8 The teaching aid for astable and monostable circuit

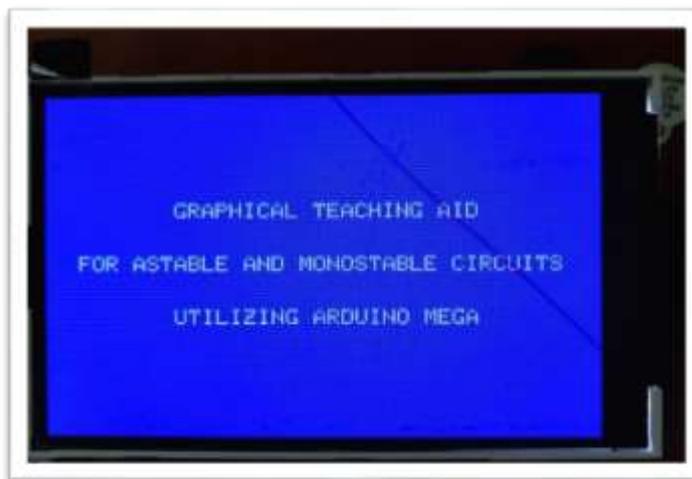


Figure 9 The graphic LCD display illuminating the first page of title

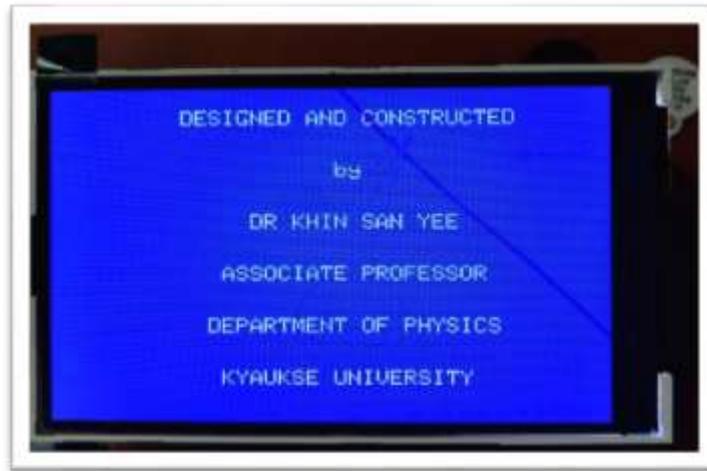


Figure 10 The graphic LCD display illuminating the second page of title

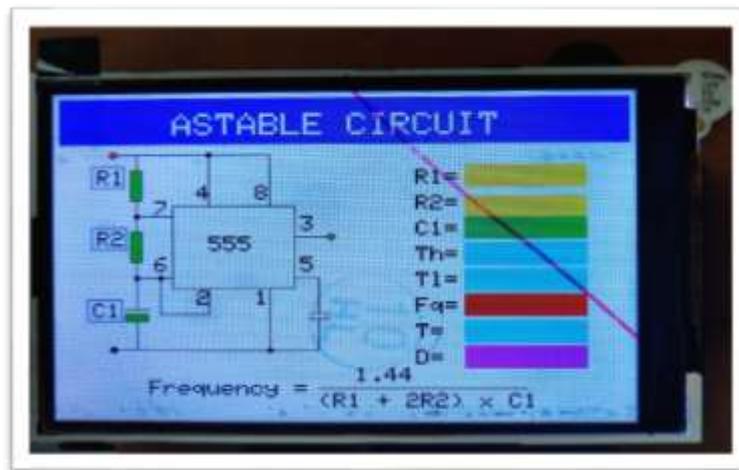


Figure 11 The operating mode selected for astable circuit



Figure 12 The calculated results for astable circuit

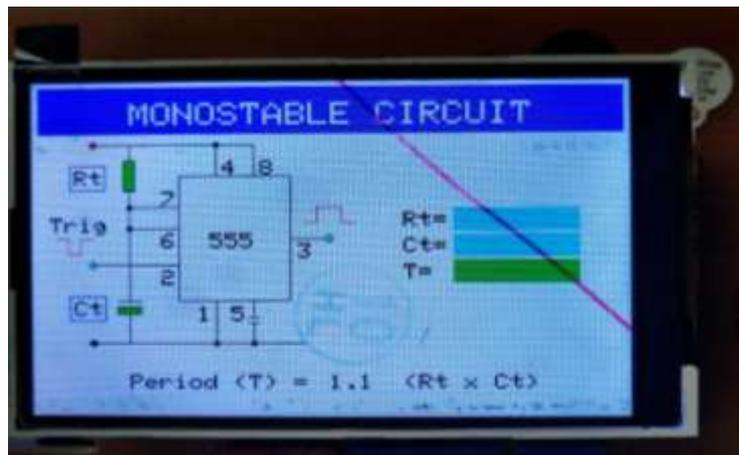


Figure 13 The operating mode selected for monostable circuit

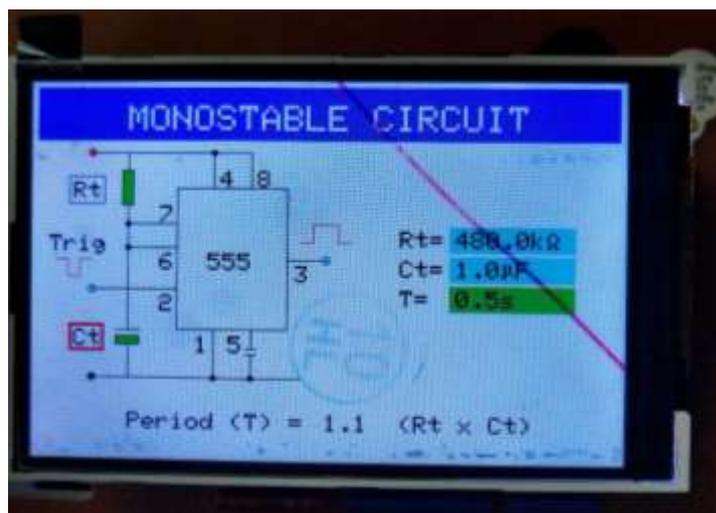


Figure 14 The calculated results for monostable circuit

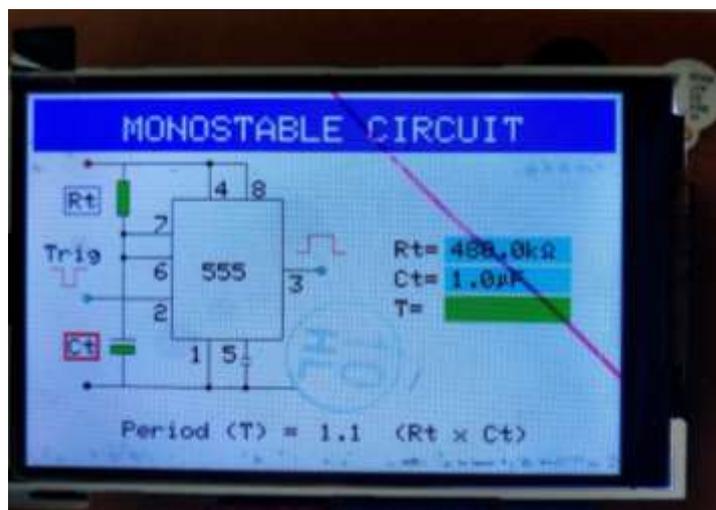


Figure 15 The Ct component was selected for monostable circuit

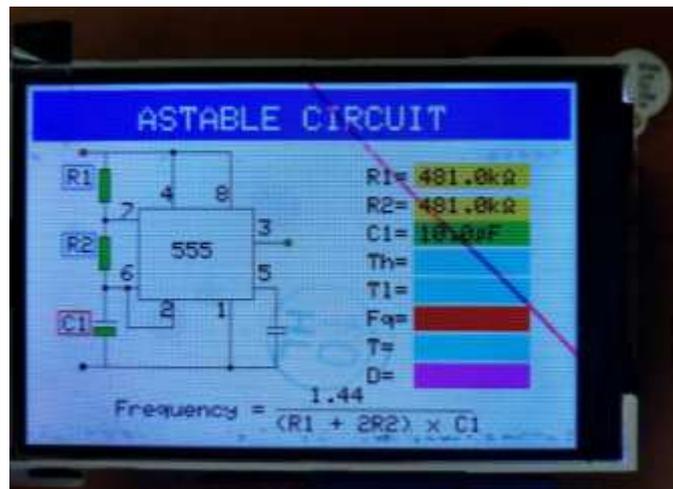


Figure 16 The C1 component was selected for astable circuit

Conclusion

The graphical teaching aid for astable and monostable circuit is tested and the output results are illustrated with photos. Practicing and understanding to the operation of the circuit will be very helpful to the users. In electronic practical, the experiments of astable circuit wiring and construction on project board output results can be easily tested with the help of constructed training aid circuit. The manual calculation for the output values of resistors and capacitors in various parameters in astable and monostable circuit confuse with the multiplier and divider units.

The application of the training aid will calculate correct value outputs for each circuit within a second by just pressing show result switch. For the further development in the training aid, the explanation of each pins and operations can be added in the design. The extra switches are used to upgrade or modify the circuit operations. More and more teaching aid or training aid are required to research and develop to upgrade the quality of education.

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