

Boolean Display Circuit

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This application note will describe how to design and construct a Boolean display circuit. Upon completion this circuit will take one of two signals from a microprocessor to give a pass/fail or yes/no decision. The described circuit will be capable of giving a clear indication of the decision even outside conditions with bright sunlight with an incorporated piezoelectric buzzer that requires an oscillating signal. This oscillating signal will be the main part of the design using a 555 IC.

Keywords: LED, 555, piezoelectric buzzer

Introduction:

Many sophisticated devices are now being designed for unskilled operators; displays are being built to leave little interpretation to the user for definitive answers decided by the design engineers. Simplifying displays leads to Boolean readouts mostly using common colors red, green, or yellow as indicators. Non-destructive flaw detectors are either automated and mounted or portable with an LCD display indicating the depths of detected flaws however this leaves interpretation to the portable operator to decide whether the depth of the detected flaw is indeed pertinent. Portable devices are further hampered by environmental conditions such as bright sunlight that will make displays difficult to read, adding an auditory element rectifies this problem.

Objective:

For this application display will be robust and draw very little power since it is to run on the 5 volts provided by the ports of the microcontroller. Two ports of the microcontroller are to be used to send the decision, one for yes/good and one for no/bad; this means that there will be two 5 volt inputs and a common ground. The device that this display will be used with is to be used in all weather conditions so must be used in bright sunlight; a piezoelectric buzzer will be used on the no/bad circuit to satisfy this requirement. Many piezoelectric buzzers that you can order have an oscillating circuit built in but this one does not. An oscillating circuit using a 555 IC must be designed for the buzzer.

Boolean Display Circuit:

The first step is to configure the 555IC to the proper layout to generate a square wave around 2.48 kHz using the astable operation of the IC.

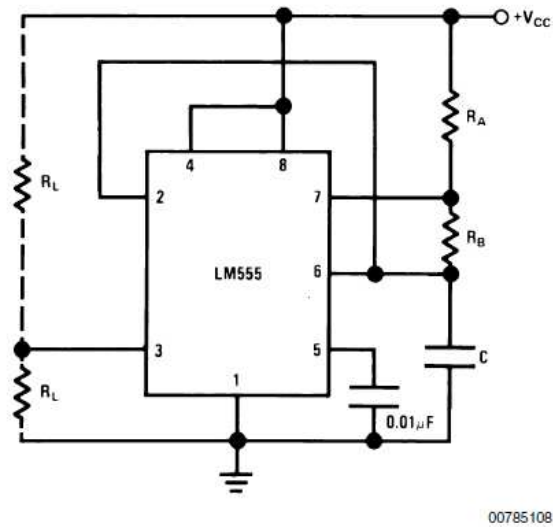


Figure 1: Astable Schematic

Using the equations:

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B)C} \quad D = \frac{R_A + R_B}{R_A + 2R_B}$$

and the table:

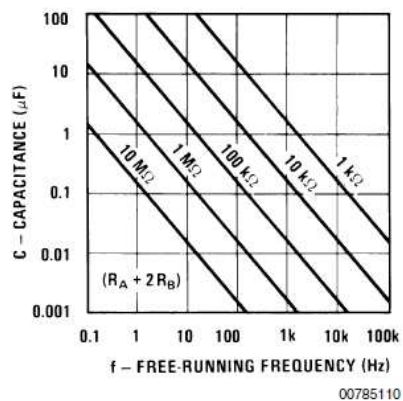


Figure 2: Free running frequency

I selected a Capacitor value of $.01\mu\text{F}$ and a R_A value of $15\text{k}\Omega$ and R_B value of $12\text{k}\Omega$ using a 50% duty cycle. R_L is ignored for this circuit since there will be a piezoelectric buzzer connected to pin 3. The buzzer then has the positive terminal wired to pin 3 the 555IC and the other terminal wired to ground. This circuit created an audible noise from the buzzer operating at 5 Vpp and 3.58 kHz, 1.1 kHz above the target frequency but still a high pitch noise to indicate a flaw within the parameters. A red LED is then connected in parallel to this circuit using the same Vcc as the IC with a 330Ω resistor to ground. A circuit with its own Vcc line will serve as the yes/pass indicator with a green LED with a 330Ω resistor to ground. The whole circuit now requires only three wires: a common ground wire, Vcc for the fail circuit, and Vcc for the pass circuit.

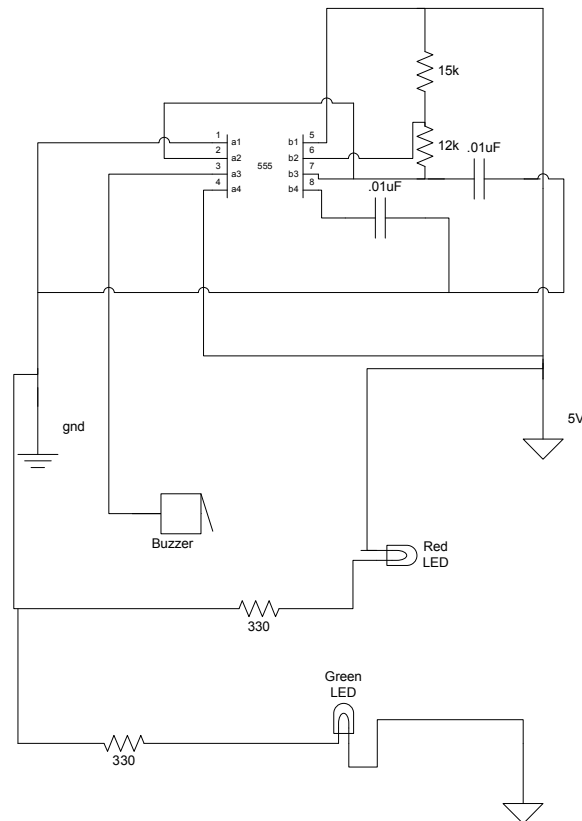


Figure 3: Final schematic

Conclusions:

The end result was a circuit that drew little power and provided a definitive and highly discernable display. The LEDs were bright and the buzzer provided a high pitched sound to indicate a flaw in the event that the LEDs were hard to see. I used a buzzer with a maximum voltage of 6V knowing that I would be providing 5V providing safety to the buzzer. The only recommendation that I have is to use a louder buzzer, though this one is highly audible, it may become muffled when encased.

References:

<http://www.national.com/ds/LM/LM555.pdf>

www.mouser.com/projectsunlimited