Research Journal of Applied Sciences 2 (11): 1156-1160, 2007
ISSN: 1815-932X

An Electronic Reception Queue Controller

J.C. Osuwa and E.S. Nwaokorie
Department of Physics, Michael Okpara University of Agriculture,
Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria

Abstract: Control and management of visitors at heavily patronized public offices can be problematic, especially in developing countries. Construction of Electronic Reception Queue Controller (ERQC) provides a system for ordered reception sequence, through the use of light signals, akin to that of traffic control light. The ERQC consists of sets of switching circuits and LEDs, among other components and utilizes a semi-automated process to signal visitors entry into public offices. The construction details and operation mode of the ERQC are presented in this study.

Key words: Electronic reception, EQC, LED, components, design

INTRODUCTION

The concept of Electronic Reception Queue Controller (ERQC) is to serve the need of those public offices that attend on daily basis, large number of visitors and thus require a means of orderly reception and control. Such public offices include hospitals, licensing offices, customs clearing house, immigration centres, ticketing offices etc.

ERQC can also be used in any office in a timely and convenient fashion, to signal entry of visitors from a waiting room into the office. The device further incorporates a buzzer component for calling the attention of a secretary or receptionist in an adjoining office.

The ERQC system makes use of three colours signals (yellow, red and green) similar to that of a traffic light, with the yellow light contained in a separate casing. The operation of the ERQC is partly manual and partly automated and utilizes switching circuits, 555 timer, LEDs and a power pack among other components.

COMPONENTS AND DESIGN SPECIFICATIONS

Rectifier and filter circuit: The rectifier circuit in ERQC is the full wave bridge type. It is made up of four diodes connected to the transformer output and the other terminals to filter circuit. This is the most obvious method of improving the efficiency of any rectifier (Menkiti *et al*., 2001).

The filter circuit in ERQC is the capacitor type. It is a connection of 1000 μf capacitor parallel to the rectifier circuit. This capacitor removes the a.c. component of rectifier output, but allows the d.c. component to reach the regulator. The regulator reduces the voltage to 9 volts pure d.c. which is used for the circuit. Filter circuit design has been revolutionized and revitalized in recent times by the use of transistors, capacitors and operational amplifiers (Onuu and Anso, 2005). Figure 1 shows the rectifier diodes arrangement of the filter circuits.

ERQC switch selection: ERQC makes use of three types of switching circuits. The function of these circuits is to turn ON and OFF the current in the circuit. Mechanical switches used in the ERQC circuit are four micro-switches used at various positions to turn ON the power, LED's and putting on the buzzer.

A 9-volt relay is used to sustain the yellow indicator light once the micro-switch is released. Diodes are connected to the relay to control the movement of the relay and to protect it from negative feedback. Figure 2 is the representation of relay switch in ERQC circuit.

Transistors (NPN) are also used as switch in ERQC circuit design. This operates between two states namely: saturation and cut off states. The saturation state occurs when both emitter-base junction of a transistor is forward biased. The cut-off state occurs when both junctions are reverse biased.

The 555 timer: Five hundred and fifty five timer uses a maze of transistors, diodes and resistors (Tony, 2006). Inside the 555 timer are the equivalent of over 20 transistors, 15 resistors and 2 diodes depending on the manufacturer. It's supply voltage is about 4.5-18V, supply current of 3-6 mA and a rise fall/time of 100 ns (nano sec).

Corresponding Author: J.C. Osuwa, Department of Physics, Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia State, Nigeria

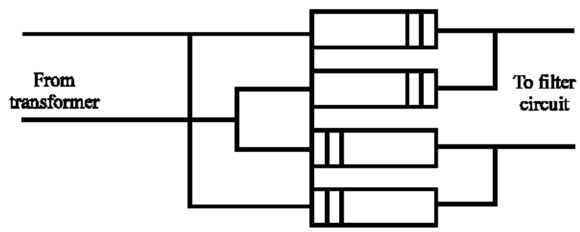

Fig. 1: Rectifier diodes arrangement on the ERQC circuit

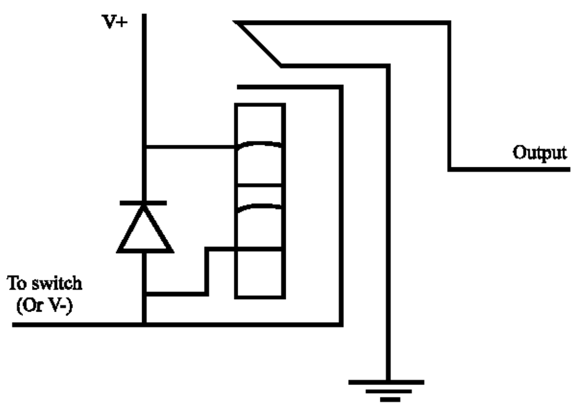

Fig. 2: A relay switch representation in the ERQC

It depends upon an external capacitor for the off-on-time intervals of the output pulse; due to the time it takes a Capacitor (C) to charge or discharge through a Resistor (R). The time for the capacitor to charge 63.7% of the applied voltage known as the Time constant (T), in seconds:

$$T = R \times C \qquad (1)$$

The operational modes of the 555 timer are as follows:

One shot: Here the 555 timer acts like a monostable multivibrator, i.e., has a stable state. Figure 3 is 8-pin package 555 timer.

Astable multivibrator: This generates a continuous stream of rectangular OFF-ON pulses that switch between two voltage levels. The frequency of these operations depends on the RC network.

Transformer selection: The ERQC uses a low voltage for its operation and therefore requires a transformer that can supply such low voltage. The transformer circuit used for this design is a 220V primary and 12V secondary step down transformer.

Light Emitting Diodes (LED): An LED is a diode that gives off visible light when forward biased. It is made from

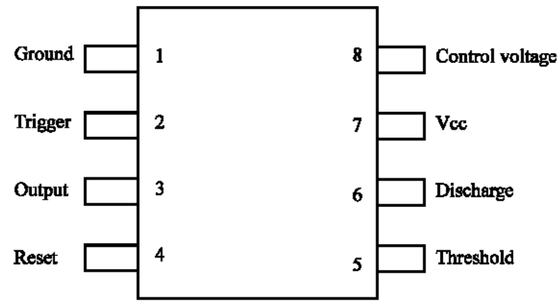

Fig. 3: Eight-pin package 555 timer

elements like Germanium, Phosphorus and Arsenic. The emission of light in LED is as result of free electrons recombining with holes in the p-type material thereby releasing energy in form of heat and light.

LED is most useful as an indicator and not good for illumination. Hence, its application in power indicators and seven segment displays (John, 2006).

CIRCUIT CONSTRUCTIONS AND ERQC OPERATION

The timing circuit: The ERQC green indicator and the alarm associated with it is turned in a monostable way. That is 12 sec ON time after which it goes OFF. The delay time of the 555 timer is determined by the combination of external resistor and capacitor in parallel to the 555 timer. This delay time is determined (Tony, 2006) by:

$$T = 1.1 \times R_T C_T \qquad (2)$$

The capacitor used is a 1000 μf electrolytic capacitor and the resistor is 10.9kΩ.

$$\therefore T = 1.1 \times 10900 \times 1000 \times 10^{-3}$$
$$= 11.99 \text{ sec.}$$
$$\approx \tilde{\ } 12 \text{ sec.}$$

Figure 4 shows the connection for the 555 timer to the circuit.

Power pack circuit: The power pack of Fig. 5 consists of a 220V a.c. input transformer at the primary and a 12V at the secondary coil. The transformer is a voltage step down transformer. The 12V a.c. flows into the full wave bridge rectifier made of four diodes. The work of this four-diode rectifier is to convert a.c. voltage to d.c voltage (rectification), by one direction current flow of the diode.

The 12V d.c. flows through the capacitor by filtration. Diode, D_1 prevents current from the battery to flow back into the a.c. source while D_2, prevents current from the a.c.

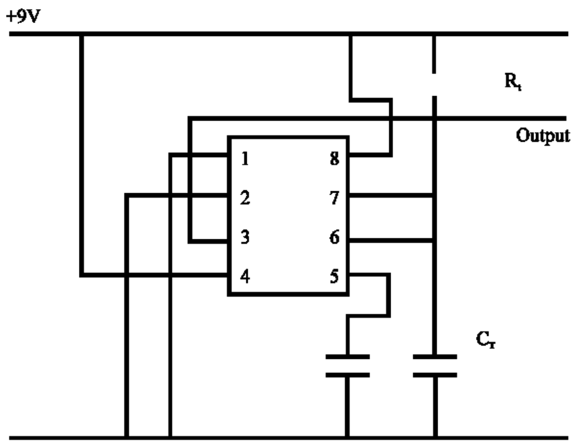

Fig. 4: The connection of the 555 timer

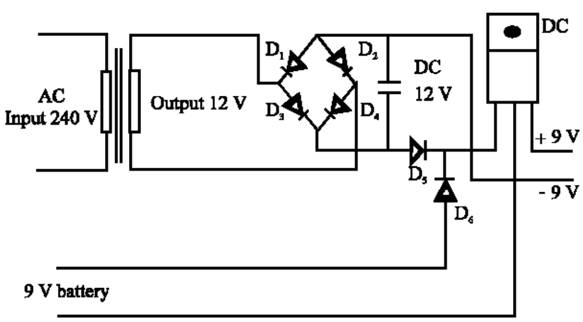

Fig. 5: Power Pack Circuit of ERQC

source from damaging the battery (since the battery is not rechargeable). Diode, D_2 can be removed if we are using a rechargeable battery to allow current from a.c. source to charge the battery.

The filtered voltage and the voltage from the battery flow into a regulator that reduces the voltage from 12 to 9 V that the ERQC circuit requires. Power supply in every electronic device, is one of the components that foil most often and hence need extra care in its design. This is the reason for its extra cost (Faissler, 1991).

ERQC main circuit: The circuit in Fig. 6 is the complete circuit diagram of the ERQC. The positive is connected on top and the ground is the negative terminal. All the transistors used in this circuit design is for switching and they conduct only when positive voltage enters the base (NPN transistor).

Mode of operation of ERQC: When positive voltage from the power source enters transistor C, through the base, it conducts current to the red LED. This is achieved once the circuit is closed. To activate the yellow LED, switch S_1 is closed and transistor D conducts, thereby ground the base of transistor E making it inactive. This carries positive signal into the base of transistor F, through the positive pole of the circuit. Transistor F conducts and sends signal to the relay thereby putting it on. The contact inside the relay opens to the other side thereby removing negative voltage from the base of transistor G and this allows positive signal to flow into transistor G, thereby switching on the yellow LED.

When switch, S_2 is closed, pin 2 of the 555 timer is grounded thereby activating the timer which remains on for a preset time (about 12 sec). Positive signal is sent to the base of transistor H, therefore making the green LED to be lit and also puts on the buzzer. Positive signal is also sent to the base of transistors C and B. This causes these transistors to conduct and ground the bases of transistors A and D which puts off the red LED and the relay sustaining the yellow LED.

The implication of the above arrangement is that whenever the switch S_2 is pressed (which puts on the green LED and buzzer), the red and yellow LEDs go off. The red LED comes on when the period of the 555 timer elapses (555 timer goes off), but the relay which puts on the yellow LED remains off until the switch S_1 is pressed again.

The ERQC circuit also has another switch S_3 that puts on the buzzer only. This is achieved by putting a diode between the switch S_3 and the line going to the green LED through a resistor. It is pertinent to note that the resistor connected to the base of each transistor determines the amount of current that flows into the base. The capacitor connected to the legs 5, 6, 7, of the 555 timer determine the period of the timer. Figure 7 is the schematic of the coupled ERQC circuit.

The power pack and the complete circuit of a prototype ERQC is on a board of about 24.5 cm long and 10 cm wide. It is on this board that the whole components used for the design are soldered except the LED's, the buzzer and the micro switches which are connected on separate boards linked together by connecting cables. The lengths of cables used depend on the distance from the center box (containing the complete circuit board) tot eh micro switches and position of the LED boxes. The yellow Led is on a separate box (placed inside the office to alert the boss) and the switch box with two buttons uses S_2 to switch on the green LED and buzzer together S_3 is used to switch on the buzzer only. The battery can be placed inside the box and a connection to an a.c mains supply is also provided.

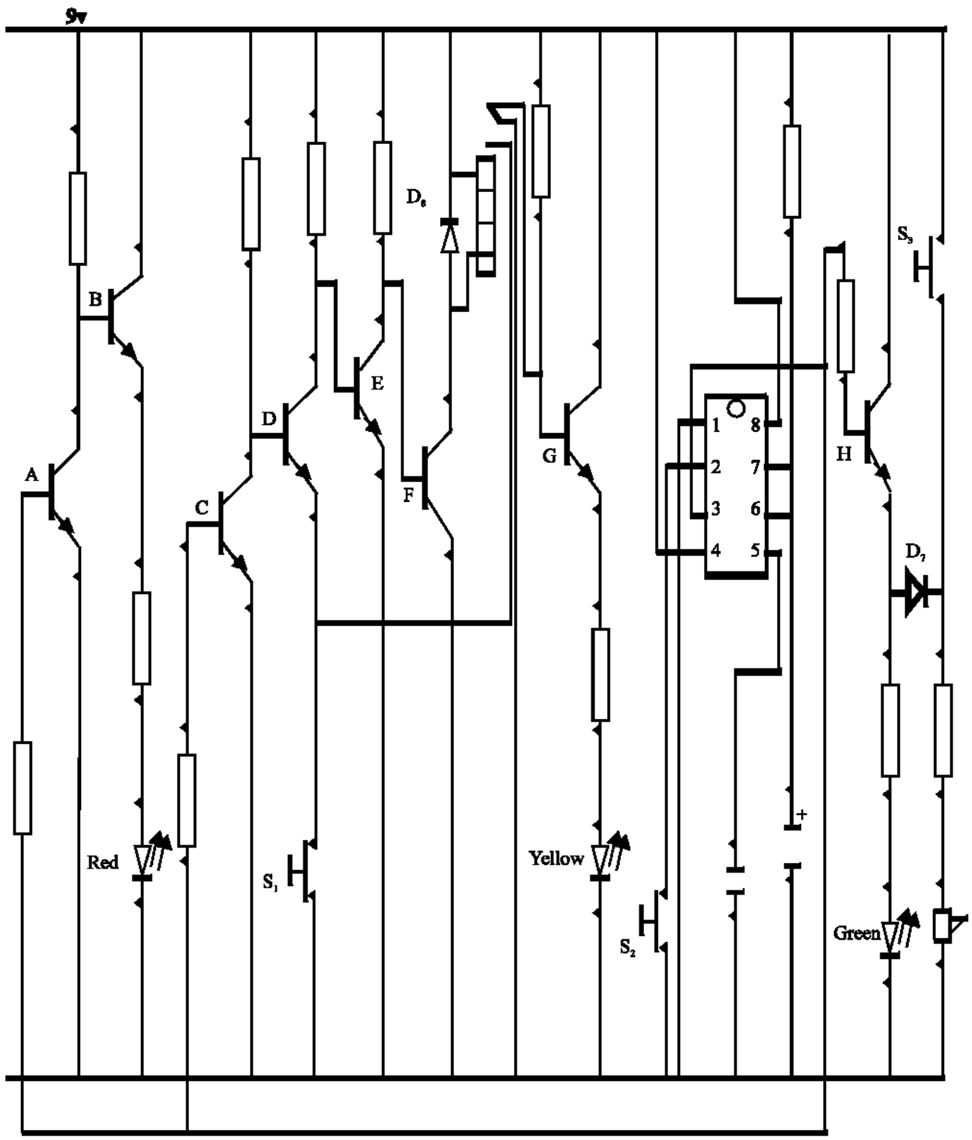

Fig. 6: The ERQC circuit diagram

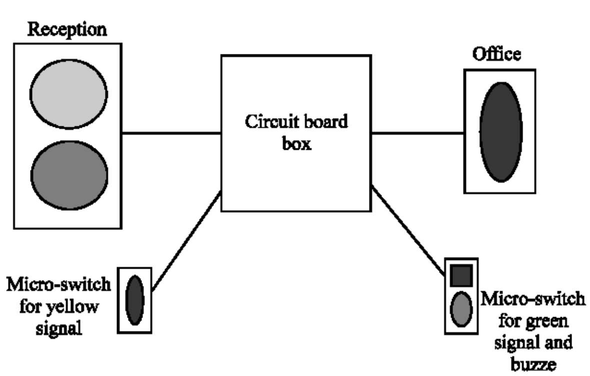

Fig. 7: Schematic diagram of the coupled ERQC

CONCLUSION

ERQC power pack is efficient and can be used for a very long time provided the right input voltage (220 V for a.c. and 9 V for d.c) is applied. The use of LED's indicator for this circuit is preferable to ordinary incandescent bulbs with filament due to heat dissipation of the filament bulb. Therefore, heat loss is conserved in the device except a little loss in the transformer when used for a long time (Table 1).

Maintenance of ERQC is very easy because faulty components on the circuit board can be easily detected and replaced. The electronic components used are readily available and can be sourced locally. It can run for a very long number of working hours without interruption of power supply, since it has provision for 9-volts d.c. battery in the case of failure from a.c. mains supply.

Table 1: Complete lists of components used

Components	Ratting/type
Resistor × 5	8.2kΩ
Resistor × 5	1.6kΩ
Resistor × 3	560kΩ
Resistor	1.9kΩ
Transistor × 8	C316
Relay	9V
555 Timer	
Capacitor × 1	103 μf
Capacitor × 2	1000 μf
LED	
LED	
LED	
Diode × 8	
Transformer (Iron core)	220-240V/12V
Regulator	9V
Buzzer	
Micro-switch × 4	Push-button type

ERQC is designed to provide good reception control for any user and it is very easy to use because it involves only knobs just like the doorbell.

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