GOVERNMENT TECHNOLOGICAL COLLEGE (KALAY)

DEPARTMENT OF ELECTRONIC ENGINEERING

LEDs DANCING LIGHT

BY:

GROUP (II)

A.G.T.I. (EC); Year II

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GOVERNMENT TECHNOLOGICAL COLLEGE (KALAY)

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TABLE OF CONTENTS

CHAPTER 1

THE 555 CIRCUIT

1.1 The 555 Circuit

The 555 monolithic integrated circuit timer was first introduced by Signetics Corporation in 1972 using bipolar technology. It quickly became an industry standard for timing and oscillation functions. Many manufactures produces a version of a 555 IC, some in the CMOS technology. The 555 is a general-purpose IC that can be used for precision timing, pulse generation, sequential timing, time delay generation, pulse width modulation, pulse position modulation, and linear ramp generation. The 555 can operate in both astable and monostable modes, with timing pulses ranging from microseconds to hours. Its also has an adjustable duty cycle and can generally source or sink output currents up to 200mft.

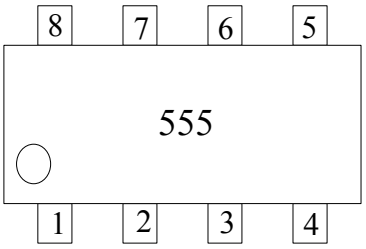


Figure: Block Diagram of 555 IC Timer

1.2 Basic Operation

The basic block diagram of the 555 is shown in Figure. The circuit consists of two comparators which drive an RS flip-flop, and output buffer, and a transistor that discharges an external timing capacitor. The actual circuit of an LM 555 timer is also shown.

The RS flip-flop is a digital circuit that will be considered in detail. Here, we will only describe the basic digital function of the flip-flop with an internal voltage reference set at (2/3)V by the voltage divider comparator output goes high, producing a high output at flip-flop terminal $\overline{Q}$. This turns the discharge transistor on and an external timing capacitor starts to discharge.

The internal control voltage node is connected to an external terminal. This provides external control of the reference level, should the timing period need to be modified. When the output trigger level is reduced below this reference level, the trigger comparator output the discharge transistor turns off. This comparator triggers on the leading edge of a negative-going input pulse.

The output stage of the 555 IC is driven by output $\overline{Q}$ of the RS flip-flop. This output is usually a totem-pole push pull circuit, or a simple buffer, and is generally capable of sourcing or sinking 200mA.

An external reset input to the RS flip-flop overrides all other inputs and is used to initiate a new timing cycle by turning the discharge transistor on.

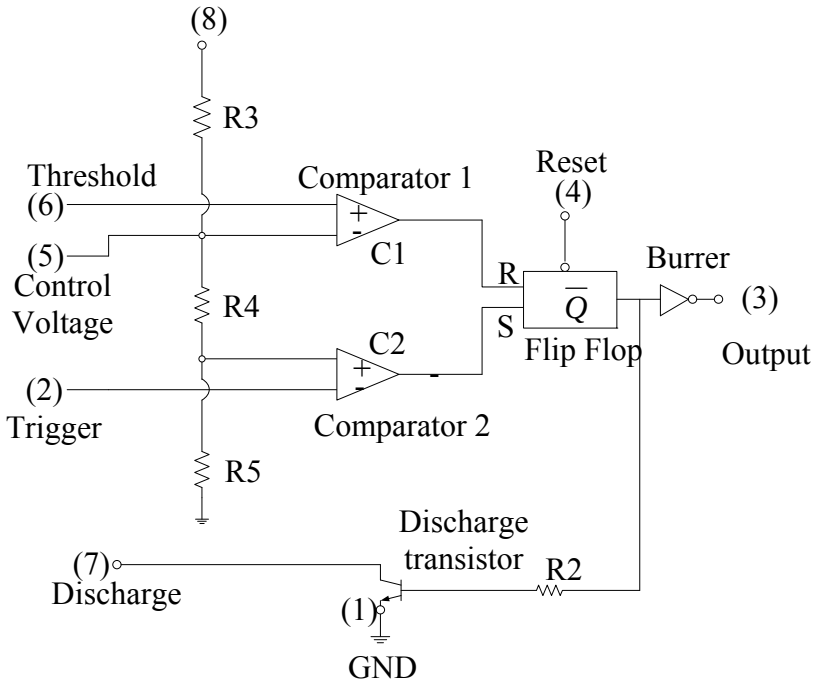


Figure: Circuit Diagram of 555 IC

1.3 555 Specification

- Supply voltage (Vcc) (5 to 15V)
- Supply current (Vcc = +5V) 3 to 6 mA
- Supply current (Vcc = +15V) 10 to 15 mA
- Output current 200 mA (Maximum)
- Power Dissipation 600 mW
- Operating Temperature 0 to 20 c

CHAPTER 2
CD 4017 IC

2.1 CD 4017 IC

4017 IC is a common useful digital IC. [From input pin (14 nodes)]. This is called divided by 10 counter because it produces one tenth of square wave frequency provided from input pin (pin 14) to output pin (on pin 12).Counter circuit is a digital circuit. Generally, counter is the circuit that counts the number of the square wave entered to the circuit.

In CD 4017 IC means the symbol of the company that produces the IC. There are IC, with other letters, this IC is called 4017 IC is the form of 14 pin DIP which includes 16 pins. Block diagram of IC pin and the application of IC are shown in Figure (a) and (b) respectively. The function of each pin is shown in the following.

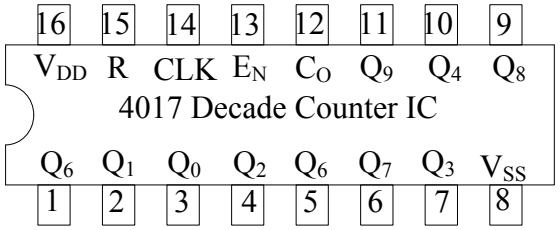


Figure : Pin Out Diagram of CD 4017 IC

2.2 Input Pins

CLK-clock input (pin 14)

Pin 14 is input which is connected with the square wave. If 10V is supplied to IC, the frequency of the input square wave must be below 5MHz. Similarly, the supplied voltage is 5V, the frequency of the input square wave must be below 2.5 MHz.

En- clock Enable input (pin13)

Pin 13 is grounded to alternate the high-state of the output pin (Qo - Q9) of 4017 IC regularly. If pin 13 is connected to positive supply, the counter will stop.

R- Reset input (pin 15)

Pin 15 is grounded to alternate the high-state of the output pin (Qo - Q9). In practice, pin 15 is connected to the positive supply and time directly reconnected to the ground to reset it.

V_{DD}, V_{SS} Supply pins (pin 16 and pin 18)

In 16 is connected to the positive supply and illustrated with V_{DD} as shown in figure pin 18 is the pin to be connected to the ground is described with V_{SS}.

2.3 Output Pins

Q0 – Q9

The output pins are from Q0 to Q9. When the square wave is supplied to input pin 14, each pin from Q0 to Q9 changes to high state in its every positive going edge. Only one of the 10 output pins is in high-state and other 9 output pins are all low-sate.

C_O- Carry Out

C_O is also output pin. But, the frequency of square wave from output pin is one tenth of the frequency supplied from pin 14.

CD 4017 IC Specification

- Supplied voltage 3V – 15V
- Max: out current 10 mA Max:
- Power absorbed by each pin 100 mW.

4017 IC can work very well with supplied voltage 3V to 5V. Although the maximum supplied voltage is 15V, practically only 12V usually used.

CHAPTER 3
LIGHT EMITTING DIODE (LED)

3.1 Principle of Operation (light emission)

In order for an electron to move from one energy level to another, it must be either gain or loose the exact energy different between the two levels.

- E1 is the ground state and atom is not excited.
- Applying energy to atom with electron in E1.
- If light applied is UV(λ = 122 nm) whose photon collide with the atom's electron, the electron would absorb the photon and jump to the higher orbit.
- This atom is said to be excited but can only remain in this state par a short while before returning to its natural state (E1).
- In returning to E1, it must shed off its energy by emitting a photon of UV light at 122nm.
- When a UV light of 103 nm strike an atom, it will excite an electron to move to E3.
- The LED uses this principle.
- LED must be forward – biased.
- These electron and holes will recombine near the PN junction. Each recombination of hole and electron will produce a photon of light energy which is approximately equal to the bandgap energy Eg and therefore.

$$Eg = hF = \frac{he}{\lambda}$$

3.2 LED Materials

- Led materials contains binary semiconductor and Ternary semiconductor.
- Binary Semiconductors.
- Semiconductors containing a single anion and a single cation.
- Green emitter uses lightly nitrogen-doped material.
- Yellow emitter uses heavily nitrogen-doped material.
- Red emitter is made by doping with Zinc and Oxygen.

- Ternary semiconductors.
- Combination of different binary semiconductor together.

  Eg: Ga As P, Ga A1 As and In Ga As

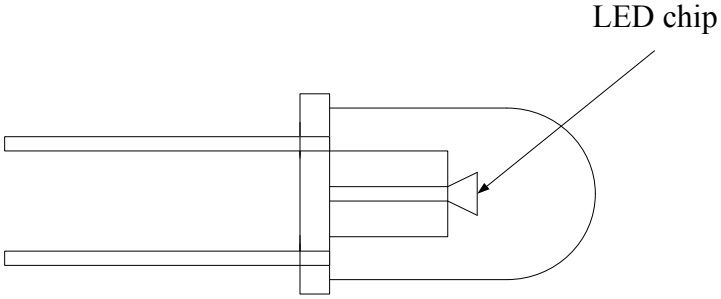


Figure : Structure of LED

A component that converts electrical signal into light that can be irrejected into the fiber.

3.3 Operation Characteristics of LEDs

(a) Output power

The output power radiant increases linearly with the forward current, thus making it more suitable for amplitude than pulse modulation.

(b) Wave length

- Early LEDs transmitted at wave lengths between 815 nm and 910 nm using GaAs and GaAlAs.

- Loss attenuation 'window' at those wavelength is about 3 to 8 dB/km.

- Later state devices were designed to operate at 1300 to 1550 nm as loss is about 0.1 to 1dB/km using indium-gallium –arsenide-phosphide and GcInAs.

(c)Lifetime

Lifetime of LEDs are of the order of 105 to 106 hours. In practice, it is rare for LED to fail in the system.

3.4 Advantages of LEDs

- Operation at low current densities than the injection laser (ILD).
- Give linewidths of 30 to 40nm for GaAs based devices.
- Simpler fabrication.
- Reliability.
- Less temperature dependent compare to ILD.

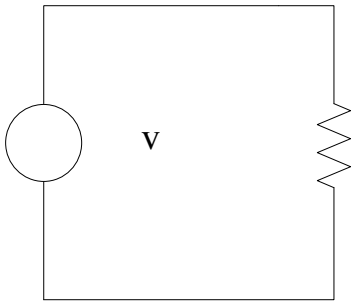
- Simpler drive circuit.
- Linear output against current characteristics unlike the ILD.
- Cheap.

CHAPTER 4

CIRCUIT COMPONENT

4.1 Resistor (R)

A component is used for its resistance. In the past, most resistors were manufactured from carbon composition, a baked mixture of graphite and clay. These have been almost completely superseded by carbon or metal film resistor. Wire-wound resistors are used for comparatively low values of resistance where precise value is important, or for high dissipation. They are unsuitable for RF use because of their reactance.

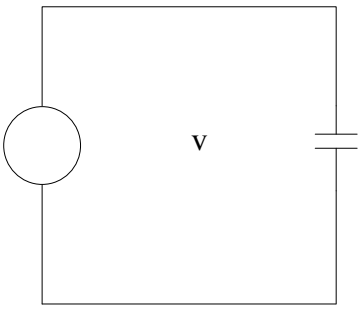


4.2 Capacitor (C)

A passive circuit component is a capacitance. A capacitor is formed from a pair of conducting surfaces separated by a layer of insulator. A capacitor made from a pair of parallel conducting plates of area S separated by a distance d, with the gap between the plates filled by a dielectric of relative permittivity E, will have a capacitance C given by

$$C = \frac{\varepsilon_r \varepsilon_o S}{d}$$

where ε_o is the permittivity of free space.



4.3 Diode

Diode can be made of either two of semiconductor materials, silicon and germanium. Power diodes are usually constructed using silicon and germanium. Silicon diode can operate at higher current and at higher junction temperature, and they have greater reverse resistance.

The structure of a semiconductor diode and it symbol are shown in Figure. The diode has two terminals, an anode, A terminal (P junction) and a cathode K terminal (N junction). When the anode voltage is more positive than the cathode, the diode is said to be forward biased and it conducts current readily with a relatively low voltage drop. When the cathode voltage is more positive than the anode, the diode is said to be reverse biased, and it blocks current flow. The arrow on the diode symbol shows the direction of convection current flow when the diode conducts.

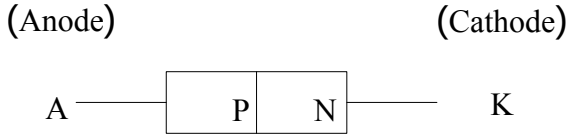


Figure: Structure of a Diode

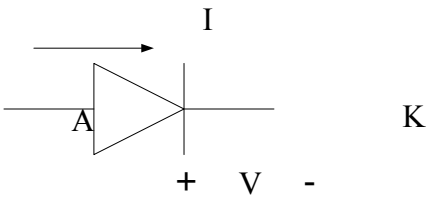
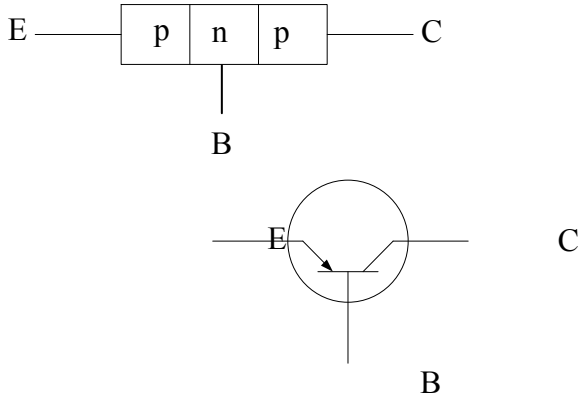


Figure: Symbol of a Diode

4.4 Transistor

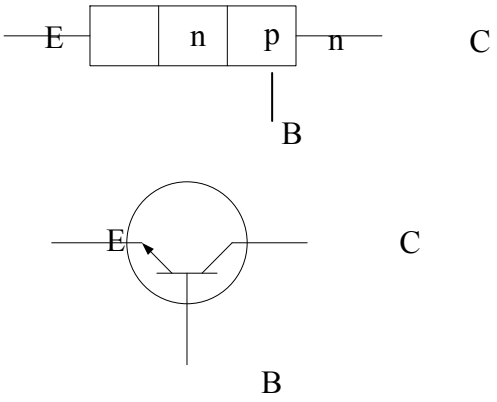
A multielectrode semiconductor device in which the current flowing between two specified electrons is controlled or modulated by the voltage applied at third (control) electrodes. The term transistor was originally derived from the phase transfer resistor, as the resistance of the output electrode was controlled by the input circuit. Transistors fall into two major classes: the bipolar junction transistor (BJT) and the field-effect transistor (FET).We used bipolar junction transistor (BJT).Bipolar junction transistor consists of (a) pnp transistor and (b) npn transistor.

(a) pnp transistor circuit symbol



In a pnp transistor, a thin layer of n-type semiconductor is sandwiched between two layers of p-type semiconductor.

(b) npn transistor circuit symbol



4.5 Power Supply

Figure: Block Diagram of Rectifier Circuit

The transformer is probably one of the most useful electrical device. Transformer provides a simple means of changing an ac voltage or current from one value to another.

A simple transformer consists of twp coils (windings). The coil connected to the source is called primary winding and are insulated from each other and from the core. If a transformer receives energy at a low voltage and delivers it at a higher voltage, it is called step up transformer. When a transformer is supplied energy at a given voltage and delivers it at some lower voltage, it is called step-down transformer. We used step-down transformer in the circuit.

For an autotransformer, the secondary winding is actually part of the primary winding. Rectifier circuit is the process of converting an alternating (ac) voltage into one, that is limited to one polarity.

Rectifier circuit that contains diode is called rectifier diode. Diode can pass current easily in one direction only.

Rectifier diode can be used to charge a RESERVOIR CAPACITOR in order to obtain smooth DC. Rectifier circuit is classified as half-wave and full-wave rectifier.

The output voltage appears only during the positive cycle of the input signal, the circuit is called a half-wave rectifier.

A rectifier output voltage occurs during both the positive and negative cycles of the input signal, this circuit is called a full-wave rectifier.

Full-wave rectifier consists of

(a) Central-tapped full-wave rectifier; and

(b) Bridge full-wave rectifier.

We used Bridge full-wave rectifier.

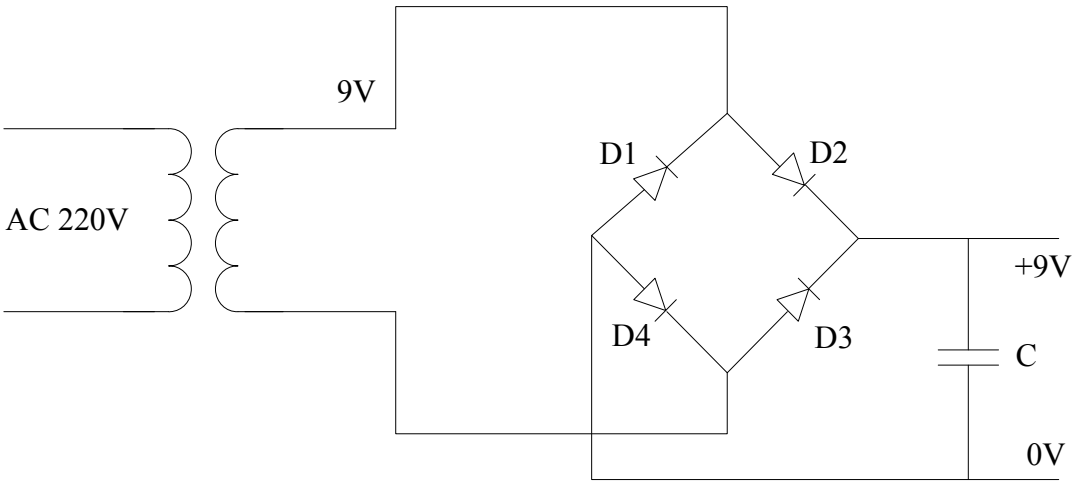


Figure: Schematic Circuit Diagram of Bridge Full-Wave Rectifier

CHAPTER 5
CIRCUIT OPERATION

5.1 Operation of LEDs Dancing Light

CD 4017 IC requires pulse input for counter operations. This pulse input can be permitted from 555 timer circuit. For operations, we use CD 4017 ICs which have sequential outputs. The number of output is limited to ten. For this circuit, we used only nine sequential outputs. This nine counter outputs make the pin 7 to connect pin 15 for termination. According to the requirement of the outputs, we used many LEDs like red, green, and yellow.

Many transistors are used to amplify the signal from 4017 through IN 4148 to the LEDs connection. C828 and C1383 are available for this amplification.

LEDs are connected in parallel and also connected in series with available resistor. This resistor is used to prevent the large current flow. The output is to display " EC-Dept:" with the light of LEDs. The output is nine sequences because each of the symbol " EC-Dept:" are formed nine lines (straight or poly). The first sequence is the first line of each nine symbols and it is the second line next sequence and so on.

If the first pin of CD 4017 ICs is ON, the other pins are OFF. If second pin is ON, the other pins are OFF, and so on. We need the sequential output, so the diode (IN 4148) connection is modified. The output is sequential due to this diode connection. This is the function of runner. The runner is controlled by the counter. The counter is CD 4017 IC with 555 IC for required input. Nine outputs of 4017 IC is

controlled element for applying the transistors of runner to ground. Therefore, only one group of nine outputs can be permitted for one cycle.

The length of time for one group is dependent on the 555 timer output because the 4017 output is controlled by 555 output. So the output sequence is;

1st sequence	**E**	6th sequence	**p**
2nd sequence	**C**	7th sequence	**t**
3rd sequence	**-**	8th sequence	**.**
4th sequence	**D**	9th sequence	**.**
5th sequence	**e**		

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- Electronic Project I
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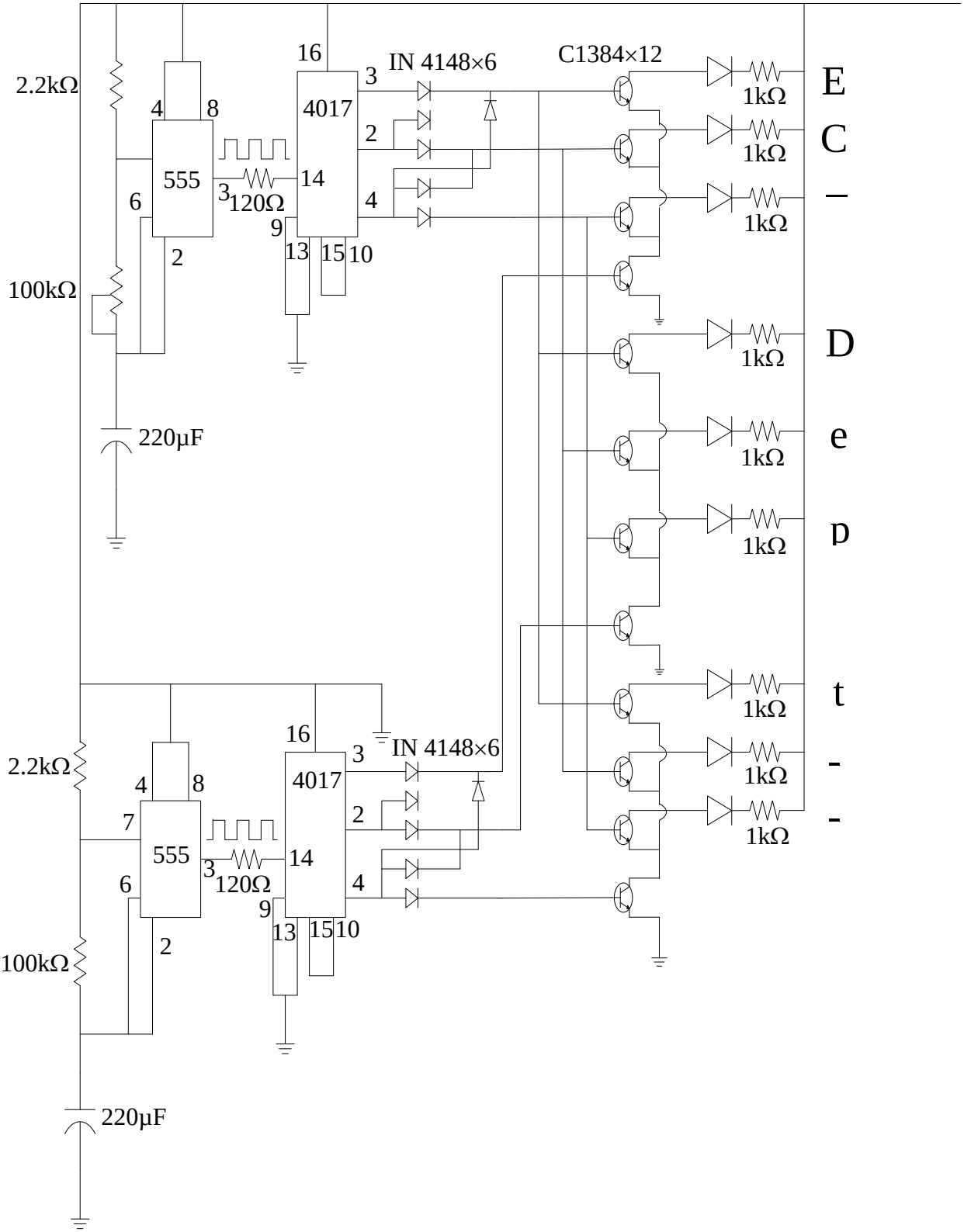

Figure: Circuit of LEDs Dancing Light