DESIGN AND CONSTRUCTION OF LED SCOREBOARD FOR MINNA TOWNSHIP STADIUM

BY

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
NIGER STATE, NIGERIA.

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PROJECT SUBMITTED FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN THE ELECTRICAL / COMPUTER DEPARTMENT OF THE FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA-NIGER STATE, NIGERIA.

NOVEMBER 2005

DECLARATION

I ECHODA NGBEDE JOSHUA ADA hereby declare that this work "Design and construction of LED score board for Minna Township stadium" presented for the award of Bachelor of Engineering has not been presented either wholly of partially for award of any other any other degree else where.

Information derived from published or unpublished works have been dully acknowledged.

5-12-2005

Signature Date

CERTIFICATION

This is to certify that this work "Design and construction of LED score board for Minna township stadium" is the original work of ECHODA NGBEDE JOSHUA ADA (99/8143EE) carried out under my supervision. I found the work adequate both in scope and quality for the partial fulfillment of the requirement for the award of Bachelor of Engineering (B. Eng.) in electrical computer engineering.

.... 5-12-2005

Mr. E.M ERONU Date

Project supervision

.... 27/07/06

ENGR. M.D. ABDULLAHI Date

H.O.D Elect/Comp Eng.

....

EXTERNAL EXAMINER Date

DEDICATION

This project is dedicated to the entire family of Mr. and Mrs. Francis Ada Ibrama who never ceased believing in me and to God Almighty who made it possible for me not to disappoint them.

ACKNOWLEDGMENT

I will like to begin by thanking God for his unparalleled, unequal and unconditional love, protection, care and wisdom he granted me through out the course of my study, I say "Thank you father". This work wouldn't have come to existence without the immense contributions of various individuals, though too numerous to mention but a few among who are:

Mr. F. A. Ibrama (My father; for there could be no better father than you) his wife Mrs. J.I. Ada Ibrama (my mother; who would wish for a more caring, loving mother; your are just simply wonderful). For both of you I say your faith and confidence in me coupled with your insight, foresight and farsightedness about life and all your endless sacrifices has made this work a success. May God in his infinite mercy never cease to bless you and your household. (Amen).

To my brothers and sisters.

Adegbe – thanks for all your prayers, encouragement and all the outings and gist we shared.

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To my parents Mr. and Mrs. Joseph Echoda and my siblings I say thank you for all your prayers and understanding.

To my friends; Peter- is there a better way to show the world hoe brothers should be than what we share? Thank you for your brotherly love and support.

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My heart remember Teresa Omeyi your prayers, support and encouragement is beyond compare thank you.

Uncle Pius, Uncle Sule Oblama Ene and Oyiwodu Adejor, Ene Ebele , thanks for your prayers.

At this point, I tender my unreserved apology to every person whose name ought to appear but have not; your effort is highly recognised. Thanks for being part of the investors in my life.

To crown it all, one more time, I give God all the glory and adoration, for this great success.

ABSTRACT

This project provides of model design of a light emitting diode (LED) display score board for Minna township stadium. The use of numbers written on plywood to show the scores during a football match is stressful, (since it is more of a mechanical process), unreliable and not visible for night conditions.

The design provides an illuminated, reliable and user friendly device to output scores during a football match. It employs the use of integrated circuits (ICs) which are predominant in the main board of the device and the use of LED in the display unit.

It displays a double digit for each team in a football match, increment in any of the double digit score is achieved by pressing any of the two available score button associated to any of two teams. The scores can be reset after each game by pressing the reset button.

A "GOAL" is also displayed each time there is an increment in score. The incremented score flashes or blinks for dome seconds before staying steady or ON. Each score counts from 00 to 99.

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CHAPTER ONE

GENERAL INTRODUCTION

1.0 INTRODUCTION

The power of digital circuits is not very useful if we cannot input data and output results. Over the years, digital circuits have proven to be an indispensable replacement for analogue and mechanical operations, the reason being digital circuits have a high degree of accuracy, reliability, speed and stability in their operations. For example a process that involves the usage of energy or power by humans can be simplified to just pressing or pushing a button.

In stadiums, digital circuits have also found their uses e.g. in the case of a score board for a football march. A score board may be defined as an opto-electronic device that makes use of light emitting diode (LED) [12] to display numerical information or the scores of an event (football in this case) in a stadium. In Minna township stadium where the use of slates or plywood is employed to show the scores of a better display for both day and night conditions as brought by this project plus the simplicity and easy of implementation is seen in this model of LED score board.

The model provides a circuit which is designed to output or display the scores of match.

It mainly consists of complementary metallic oxide semiconductor (CMOS) integrated circuits (ICs). The logic provides merits such as low power consumption, high compatibility etc. also the use of the buffered version of ICs provides greater output drives and some protection against static electricity. The design also comprises of a display unit, and 3 buttons (i.e. score button 1, score button 2, and reset button).

1.1 MODE OF OPERATION

The operation is such that when any of the two available score buttons is pressed, the double – digits for a particular team score increments. The incremented digit also cashes or blinks for some seconds before going steady or ON.

A feature such as "A GOAL" display can be included to blink each time there is need to increment a particular team score. The maximum score count is 99 per team.

However, the history of digital or electronic display boards could be traced to November 1982 when it was installed at the base of the Now York Times (an American newspaper company) building a.k.a one time square. The electronic board was used to display the words "HUGE TIMES SIGN WILL FLASH NEWS". Meaning "letters will move around Times Building telling of events in all part of the world". Therefore the world's first public popular electronic display board was about 5 feet high and 880 feet long completely surrounding the base of the New York Times Building. The display board then immediately caught the interest of the American nation as it was used to announce the results of the Herbert Hoover – Al Smith presidential election of that year. The electronic display board made more impact when it used some years later to display president Roovelt's fireside charts nationwide to the American citizens; as cub drivers and passer –bys would stop over at Times Square while simultaneously reading the headlines of the chart effect in sensory surround, hence the first true multi media event in Times Square.

As time progresses, the streaming news headlines display board eventually evolved into content display such as; time and temperature signs stock tickers and score boards which became popular additions to banks, petrol stations, airports, hospitals, stock houses and stadiums etc.

Having gained as a desired sign format, the digital display board offers many features including its variable size, flexibility in design, easy use and real time response in changing and passing information.

In 1996, a more sophisticated design of display boards was turned from just signage display to a spectacular package consisting of three display boards streaming different financial data outputs simultaneously. The manufactures were Darktronics (an electronic sign manufacturers and world supplier of LED and incandescent electronic score boards and computer programmable display) [12] and art Kraft Strauss (an American Firm that specializes in building board encompasses; an international time zone display and a triple – header "stock ticker" digital board, display of financial news headlines, stock quotations, commodities prices and foreign exchange rates right in the heart of times square.

The Dartronic/Artkraft device was sponsored by Morgan startly (a financial service company, in America) and it comprises of three horizontal digital display boards that stretched the length of an entire city block from 47th street to 48th street along Broadway. The top board, which was the financial headlines news ticker, was 10.5 feet high and 155 feet long, the design was illuminated with amber LEDs with s resolution of 28 pixels. The two lower boards were also amber LEDs and slightly higher at 72.5 feet and 584 pixels wide. The middle board is an output of New York stock exchanging data and the bottom board displays current NASDAQ information. This device enhanced the evolution of the digital the evolution of digital display board and introduced the complexity of multiple messages with three display boards streaming different financial data simultaneously.

In 1999, the digital display board was once again elevated into a new generation of designed from just steaming text; to a board that called transmit colour graphics or video information as well. In a classic design enhancement, it was the sum of all parts being greater than the output of any single display board of its group. Here the sign design called for nine display boards with seven of them as curvilinear with a look like a flag being waved by a breeze.

Created by multimedia of Rancho Cordova California,[11] the full colour, LED spectacular was commissioned by the Disney Corporation to create a state of the art sign viewing system for its new studios in times-square to be its ABC television network division. The resultant sign system included nine separate horizontal ribbons of full colour, programmable LED display. Each ribbon was approximately 133 feet of horizontal bends and curves all undulating around the front of the time square studios building.

2.1 ICs TECHNOLOGY; AS IT AFFECTS ADVANCEMENT IN ELECTRONIC OR DIGITAL DISPLAYS.

The LED score board in this work was constructed using predominantly CMOS logic ICs. The early illuminated display boards were constructed from vacuum tubs and later with transistors. Active display boards built from vacuum tubes were fragile, bulky and consumed much power that must be replaced from time to time. When the transistors were discovered in 1974, it rapidly replaced the vacuum tubes in many field of electronics [9]. Digital display boards made from transistors were faster, non-fragile, hence the name "solid state". They occupy less space and consume much less power when compared to vacuum tube.

With technological advancement, IC fabrication was possible. IC has a number of advantages over discrete unit as a result of proximity of components within the IC. In fabrication, adjacent transistors receive almost identical processing thus is closely matched in characteristics which are not the case with ICs.[11].

IC occupies less space; they are light in weight, consume less power and are more reliable and relatively cheaper than discrete components. ICs can provide multiple circuit function at performance level equal of greater than those of their discrete counterparts. This characteristics features of IC encourage the electronic score board in this work.

2.2 LED (LIGHT EMITTING DIODE) AND THE ELECTRONIC DISPLAY OR SIGN INDUSTRY.

2.2.1 WHAT IS LED?

Simply put, the light emitting diode is a solid state device, much different than an incandescent lamp. It comprises of an alloy crystal placed into a reflective cup and chemically bounded to tiny wires then encapsulated in epoxy. When current runs through those wires, the crystal material is excited. That excitement is dissipated in the form of energy, a small part of which is heat, most of which is in the form of light.

Different alloys produce colours each has its own life span and brightness LED's potential as a sign medium and display light source has been known from the start, sourcing the proper chemicals and alloys has triggered intense research for many years.[6].

2.22 LED HISTORY; AS IT AFFECTS ADVANCEMENT IN DIGITAL DISPLAY

Electronic signs and electronics in general have been advances in the past two decades to ease our way of life for the clock, score board and sign industry. Since 1976 (the founding of LED technology) evolution has taken shape; LED were not as attractive or useful as today. LED first appeared in the form of scrolling red massages on a black background they were characterized matrix displays. In the 80's they evolved into three colours red, amber, green or tri – colour or a combination of the three colours. These types of designs or signs provided cartoon, animation. LED were more readily available as in door signs and out door units were not as economical as incandescent displays (light bulbs or wedge based display). Not until the red pixels, and later in the three colour format. As time passed, production numbers increased, to generate the need for higher quantities of LED's, the price and applications of LEDs began to drop.

The 90's brought about the first true colour LED displays with the development blue and true green LEDs. Video screens began to pop up with LED technology and jumbo ton type screens began to fall the face of the earth. Colour LED components were the missing link that prevented LEDs from serving as a suitable video medium. By 1996, blue and green LEDs, had developed sufficient brightness for LED video screens and full colour animation display to became practical. By 1998, more than 50 companies produced these products. Just like any other technology, at first LED signs were very expensive until advances were made to bring prices down the incandescent level.

In conclusion, the power of digital circuits with the vast growth of ICs backed by more researches into LED, the future of all forms of illuminated signs or displays is indeed at stake. [6]

CHAPTER THREE

3.0 MATERIAL AND METHODS

The various materials used and methods in which these materials interest to produce the desired function of this project are described. First the project layout or block diagrams of the project are discussed then the materials are later described.

3.1 PROJECT LAYOUT

The design comprises of five (5) sections viz;

i. The control unit

ii. The counter unit

iii. Multiplexing unit

iv. Display unit

v. The power section.

3.1.1 BLOCK DIAGRAM

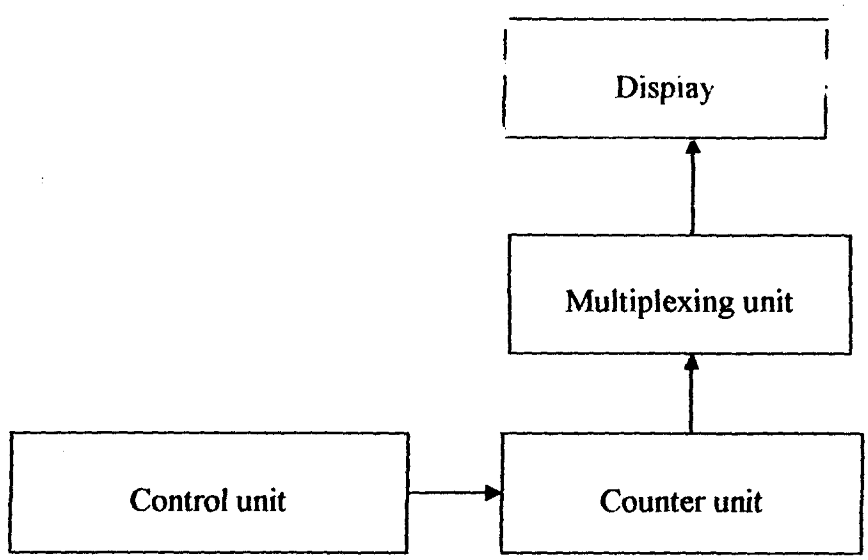


Fig. 3.0 Block diagram

i. Control unit

This consists of two SR latches ICs (4013B), a timer IC (4017B) and transistors. There are 3 buttons (i.e. the two score buttons and a reset button) which are also part of the control unit. The score buttons are used to increment the scores while the reset button is used to reset the display after each game. The oscillator (4060B) IC which function s the heart of the design provides a pulse frequency from one of its two pulse outputs that is used by the transistor in the control unit for display switch and blinking of the incremented scores.

ii. Counter unit.

This comprises of 4 BCD counters (4518B) ICs. These ICs provides the binary codes for each related digital character on the display they function as set of 2 with each set handling the related double digit for each team.

Each set of the BCD counters are controlled by corresponding SR latch ICS from the control unit such that one of the two outputs from unit such that one of the two outputs from the latch is connected to the clock input of the particular counter group hence a high logic at the output causes a positive edge clock to increment the group digital output.

iii. Multiplexing unit

The concept of the multiplexing unit is to avoid high power usage and error by the use of fewer components. The components in this unit are stepper (4017B) IC, four (4) tristate buffer (4503B) ICs (opening as a set of 2 for the BCD counters), and a (4511B) 7–segment decoder IC. The hallmark of this unit is the usage of a single seven segment display IC against using four. Each counter is connected to a 4 – bit tristate buffer. The buffers are designed to allow flow of 4 – bit code and to cut – off or restrain the flow of the codes when its control input is deactivated. The output from each buffer are then connected to a particular 4 – bit channel to the 4 – inputs of the (4511B) seven segment decoder.

One of the frequencies from the oscillator is used in the multiplexing operation. This frequency drives the stepper are in turn connected to each buffer via inverted gates. The stepper scans the buffer at a very high speed so that a particular channel from a counter to the seven segments is made one at a time. Hence the four counters all share the seven segment decoder, the decoder then logically display the content of the counters.

iv. Display unit

This unit comprises of a total of 56 LED (14 for each digit). Each segment of a decimal character. The LEDs are designed to switch ON whenever the corresponding BCD codes from the counter via the 7–segment decoder fed to it.

The power section is treated as different parts of the main circuit therefore its diagram and components are described as a single entity.

3.2 THE POWER SECTION AND ITS COMPONENTS

The power source is from a 220v a.c mains supply, it is then step down by a 220/12 transformer. Besides stepping down the voltage, the transformer also provides isolation from the supply line (this provides great deal of safety). The voltage from the transformer is then rectified by a 1w4001 bridge rectifier. The output from the rectifier is fed into a regulator which regulates the voltage to 9v (the regulator is 7805).

The output from the regulator is then fed to the circuits and to all ICs. Very IC highest pin is a (+) terminal and medium pin is a (-) terminal. [2]

The block diagram of the power section is shown below.

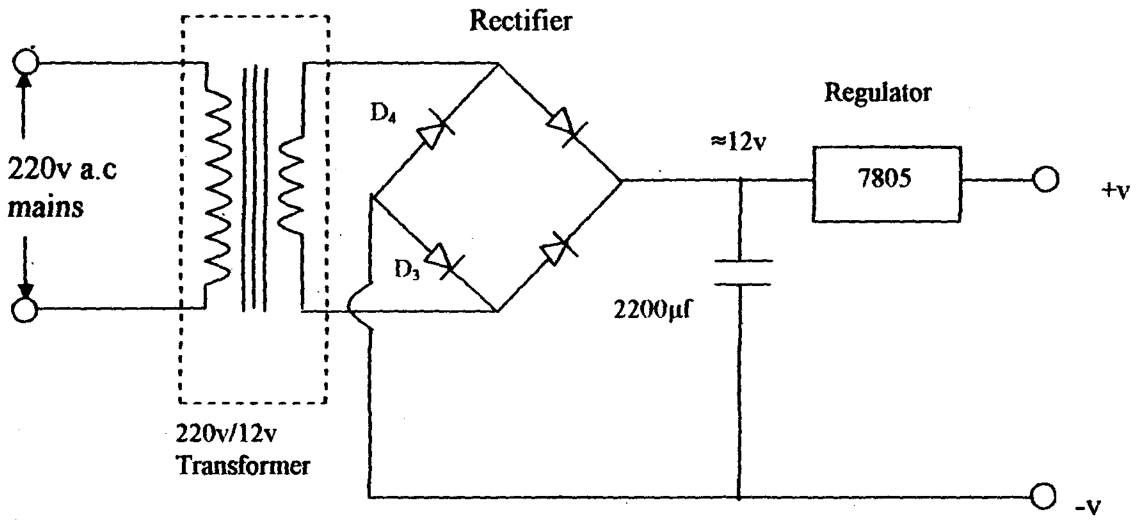


Fig 3.2 Power section

A brief description of some of the components is discussed.

Transformer

A transformer is a stationary device which transfers electric power in one circuit into electric power of the same frequency in another circuit. It can raise or lower the voltage in a circuit but with a corresponding decrease or increase in circuit. The transformer works based on the principle of mutual inductance between two circuits linked by a common magnetic flux. As shown in the fig. below, in its simplest form, it consists of two coils which are electrically separated but magnetically linked through a path of low reluctance. The two coils possess high mutual inductance. If one coil is connected to an a.c source, an alternating flux is set up in the laminated core, most of which is linked with the other coil in which it produces mutually – induced e.m.f (according to Faraday's laws of electromagnetic induction ℓ = M (dI/dt). If the second coil is closed, a current flows in it and so electric energy is transferred (entirely magnetically) from the first coil to the second coil. The first coil, in which electric energy is fed from the a.c. supply from which energy is drawn out, is called secondary winding.[5]

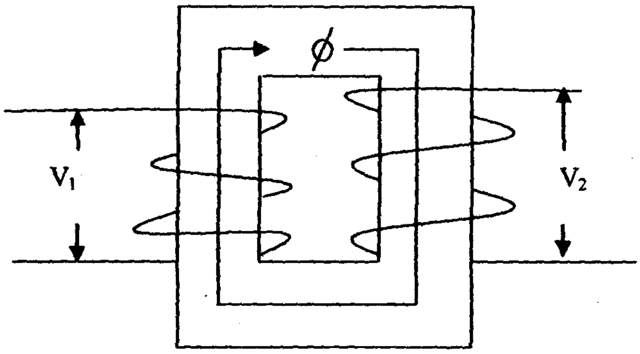


Fig. 3.3 Primary and secondary winding of transformer

The e.m.f equation of a transformer is given thus for the voltage transformer ratio (K) we have

$$E_2/E_1 = N_2/N_1 = K$$

Where

E_1 = e.m.f produced in the primary coil

E_2 = e.m.f produced in the secondary coil

N_1 = No of turns in primary

N_2 = No of turns in secondary

If $N_2 > N_1$ i.e. $K < 1$, then transformer is a step down transformer

Similarly for a ideal transformer:

Input power = Output power

$:- \quad V_1 I_1 = V_2 I_2$

$\rightarrow I_2/I_1 = V_1/V_2 = 1/K$

The transformer used in this case is a 220/12v step down transformer.

Rectifier

A rectifier is a circuit which employs one or more diodes to convert a.c. voltage into d.c. voltage. The rectifier used in this case is a full wave bridge rectifier. As shown below, the full wave rectifier circuit uses four diodes i.e. two diodes work alternatively for both half – cycles of the input a.c. supply.

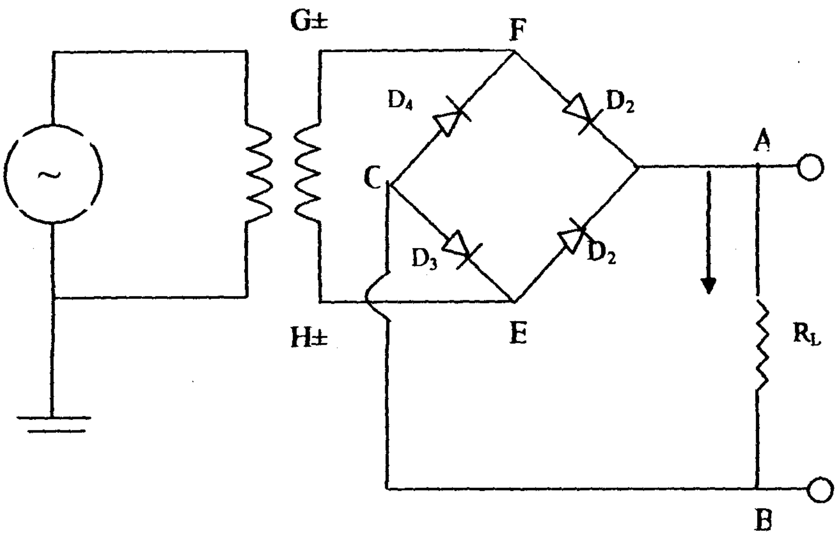


Fig. 3.4 Full-wave rectifier circuirt using diodes

When input a.c. supply is switched on, ends G and H of the transformer secondary become +ve and –ve alternatively. During the positive half cycle of the a.c. input, terminal G is +ve and H is at – ve potential. Consequently diode D_1 and D_3 conducts (since they are forward bias) and D_2 and D_4 are reversed bias therefore they don't conduct. Current flows along G D_1 ABCEH. As a result, positive half cycle of the voltage appears across R_L.

During the negative half – cycle, when terminal H becomes + ve, D_2 and D_4 conducts while D_1 and D_3whch are reverse bias will not conduct. Hence, current flows along HD_2 ABCEG. Therefore current still flows across through R_L. as shown in the waveforms, current flows across R_L during both half – cycles of a.c. input. This means that the frequency of the rectifier voltage is twice that of the supply frequency.

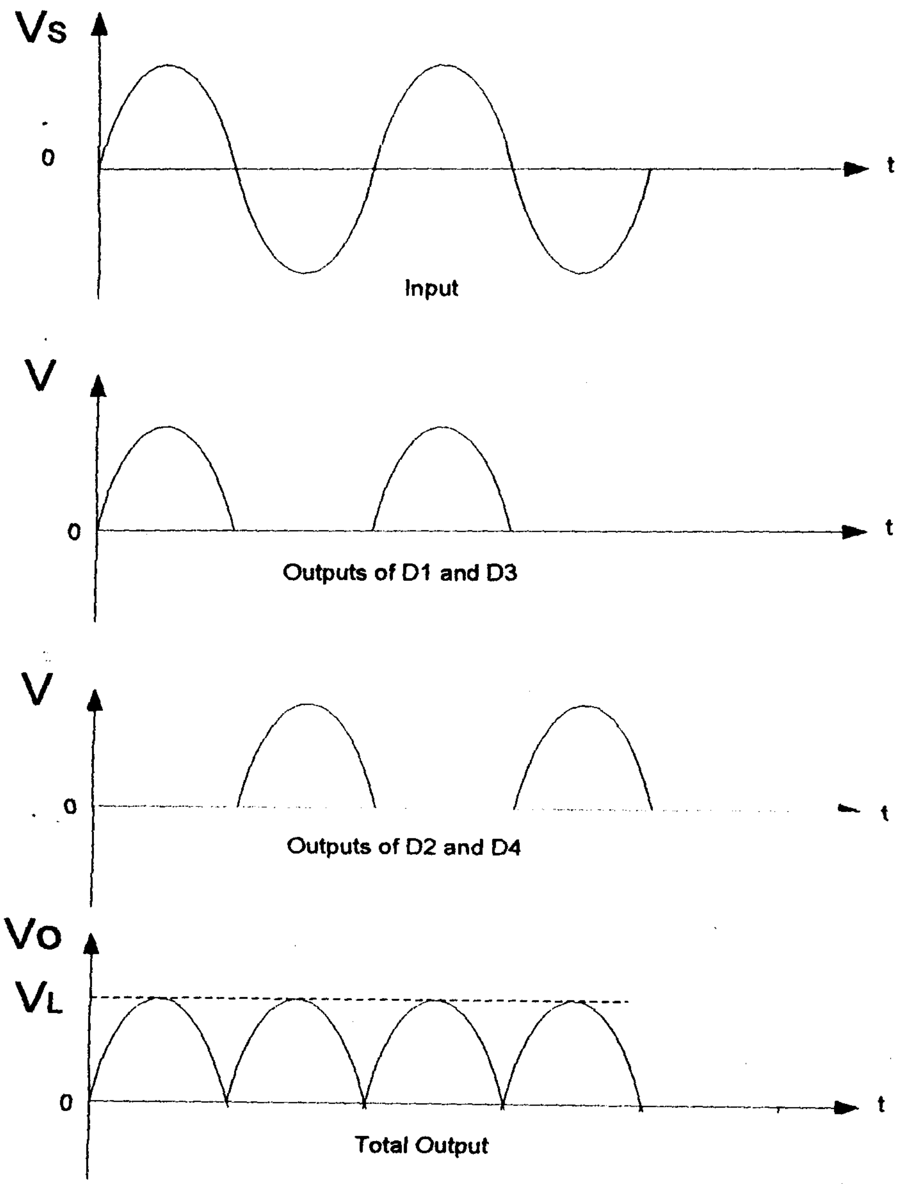


Fig. 3.5: wave diagrams of full- wave rectification process

Voltage Regulator

The voltage regulator (7809) main function is to keep the terminal voltage of the d.c. supply constant even when a.c. supply to the transformer varies (deviations from 220v are common) or when the load varies. The output from the rectifier is regulated to 9v. The output from the regulator is then connected to the circuits.

3.3 CIRCUIT DIAGRAM

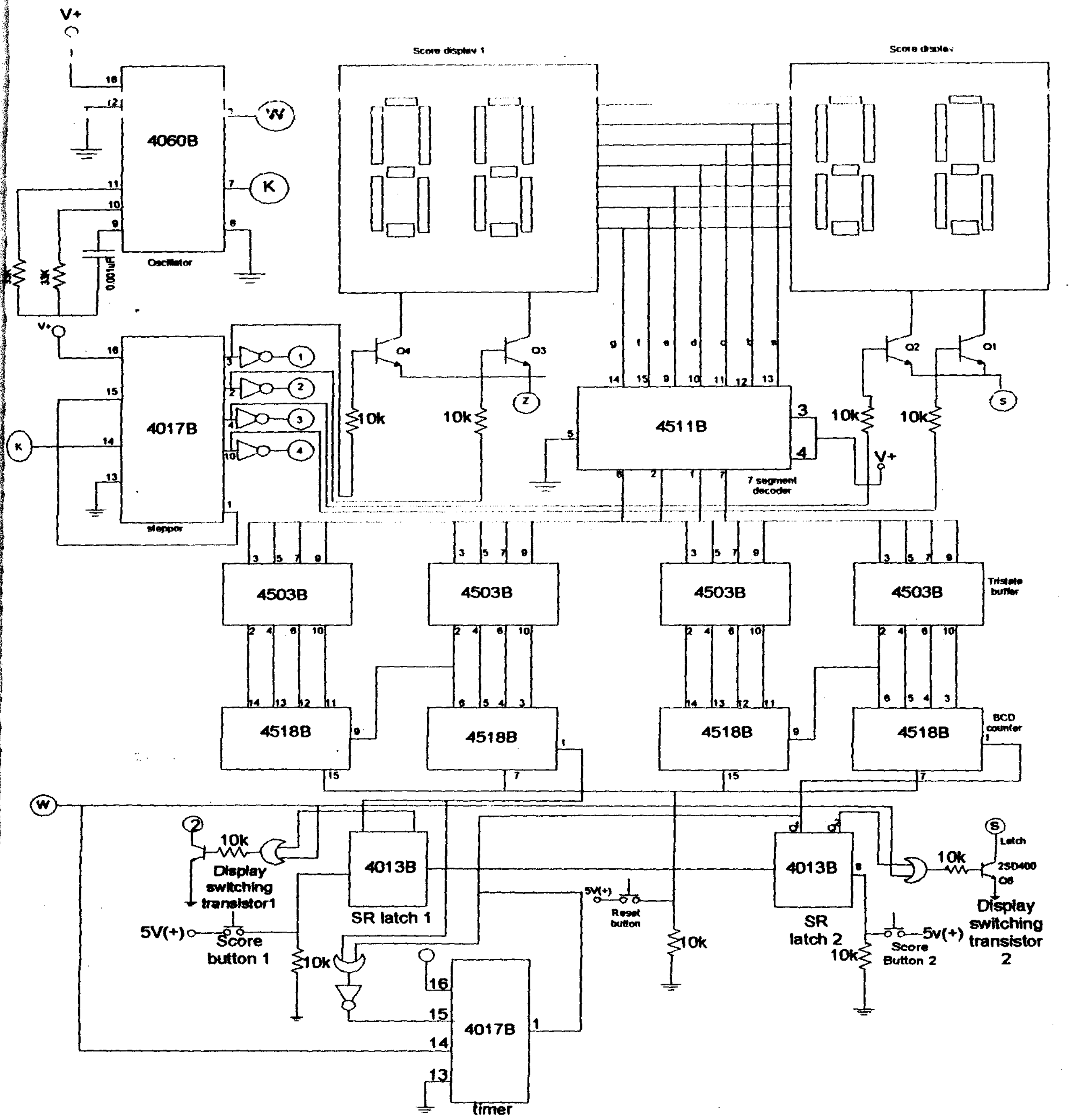


Fig. 3.3 circuit diagram

3.4 INTERACTIONS/THEORY OF OPERATION

The display circuit is a multiplexed type, in the sense that the output is done by a single seven segment display decoder. Each of the outputs from the tristate buffer shares the decoder at a very high speed.

There are four binary – coded decimal (BCD) outputs involved in the circuit which are attributed to the four (4) binary – coded decimal counters (4518B). the outputs of these counters are fed to a single seven segment decoder (4511B) via a set of tristate buffer is a switching device which allows the flow of a binary code either 1 or 0, it also has a cut – off state or as it behaves as if it were not part of the circuit (when the enabling input is at a LOW logic level; hence it I an active LOW device.

The (4017B) is usually called a "stepper". It has ten (10) decoder–like outputs. This means that only one of the outputs is HIGH at a given instance while the rest are at a LOW logic level. When a clock input is connected to pin 14 of the integrated circuit, the HIGH logic level flows through the output i.e. for each clock pulse, one output holds a HIGH logic and the others are LOW, therefore a cycle of HIGH logic steps across the 4017B outputs.

The 4017B is used for selecting one particular counter output through the buffer then to the seven segment display decoder or driver. Since output of the 4017B are active HIGH, the use of inverter (4069VB) are incorporated to each corresponding output so that the output are compactable with the enabling inputs or terminals of the 4503B (tristate buffer) which are active low.

The seven segment display outputs are connected in parallel so they have a common input line for each segment of the display digits.

The rate of switching of the (40173B) is determined by the clock input of the stepper (4017B) which is generated by the oscillator. The frequency from the oscillator is given by:

$$F = \frac{1}{2.3 \times R_{tc} \times C_{tc}} \quad \text{...Eqn 3.0}$$

Where $R_{tc} = 33 \times 10^3 \Omega$; $C_{tc} = 0.001 \times 10^{-6}$

$$\therefore \quad F = \frac{1}{2.3 \times 33 \times 10^3 \times 0.001 \times 10^{-6}}$$

$= 13.18$ KHz ≈ 13.2 KHz

The frequency of terminal (K) is determined by: $\frac{\text{Oscillator frequency}}{2\,\hat{}\,Q}$ .... Eqn 3.1

Where Q = value of the terminal.

$F_{pin}3 = 13.18 \text{ KHz} / 2^3 = 1.65$ KHz

Similarly, frequency of terminal (W) is

$F_{pin}13 = 13.18 \text{ KHz} / 2^{13} = 1.61$ Hz

Signal (K) is used to clock the stepper.

Therefore the multiplexing rate of display is

$1/1.65 \times 10^3 = 6.060 \times 10^{-4}$seconds

This implies that the 4017B carries out its operation in about 6×10^{-4} of a second. The operation which is to switch on a particular data line from a counter and at the same time switch on a corresponding transistor (i.e. of the display transistor as seen in the circuit diagram) so that a 4 – bit data from the counter is fed to the 4511B (decoder) through a particular 4503B from which the output is displayed in the switched seven segment display. This whole operation occurs at a high speed (6×10^{-4} sec.), so it appears as if the digits displayed are working at the same time although the work individually but this is unnoticed to the human eye.

The counters are the binary-coded decimal (BCD) type and they are of two grouped (with each group containing 2 counters each), each group controls a particular score and they are clocked independently through logic circuit involving SR latch. The SR latch helps to eliminate multiple clocking of the counters, by a spasmodic response owing to mechanical switch. To increment a score, the corresponding counter to the score digit has to be first incremented. When a score button is pressed, the output Q of the associated SR latch is set to a "HIGH" logic and Q is set to the opposite. The Q output is connected to pin 1 of the related 4518B, now a HIGH logic at pin 1 of the counter causes the assuming the initial count is 3 (0011) it increments to 4 (0100).

The output Q serves as one of the two inputs to the OR gate the second input being the 1.6Hz pulse (W), from the oscillator. The output from the OR gate serves as a pulse input to the 250400 transistor which is used to cause a blinking action each time a displayed score is incremented. The display blinking is effected because the transistor is connected to two other display drivers (which are also transistors) of the corresponding set of display. The leading display digits blinks for some time the blinking time is determined by a timer which feeds backs a high logic level to reset or invert the conditions of the latches.

The timer is activated through pin 15, which a LOW logic to enable it. Now to achieve a Low Logic at pin 15 a NOR gate (combination of both OR and Not gate) is incorporated. The two inputs to the NOR gate are from each Q outputs of the SR latch. In this way a high logic level at one of the inputs supplies a low logic to the leading pin.

And as such an output from the NOT is reached only when any of the score inputs button is pressed. The timer is also a 4017B therefore its pin 1 becomes high after some time to reset the latch consequently pin 15 will then be high since both Q outputs of the latches are now LOW. To reset the counter back to zero or ground count, the reset button has to be pressed. When the button is pressed, a HIGH logic is applied to the reset pins of the counters. Hence all counters will be zero (0).

3.5 DESCRIPTION OF COMPONENTS

3.5.1 TRANSISTOR

This project employs the use of an n-p-n bipolar junction transistor (BJT). BJT$_s$ are generally used as; a linear amplifier to boost an electrical signal and to be used as an electronic switches.

A BJT can be defined as a three layer semiconductor device that consists of two back-to-back PN junctions which is manufactured in a single price of semiconductor crystal.

These three layers gives rise to the emitted (E) base (B) and collector (C) regions. The circuit symbol of an n-p-n transistor is shown below.[6],[3].

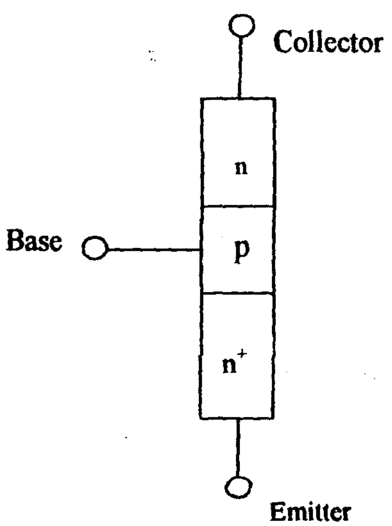
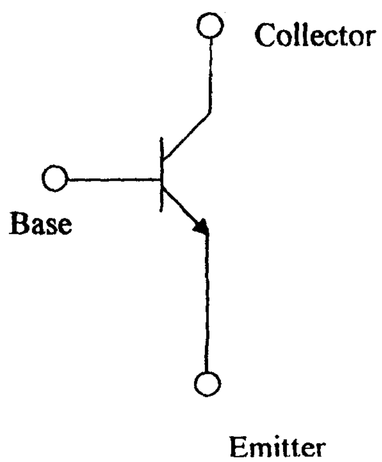


Fig. 3.5a npn transistor



b. Circuit symbol

As shown in the figure, the outer layers are n-type material separated by a p-type base region. The emitter region is more heavily doped than any of the regions, because it's main function is to supply majority change carries (electrons in this case) to the base. The base and emitter forms a p-n junction indicated by the arrow head.

For normal operation of a transistor, two conditions must be met;

i. Emitter – base junction is always forward bias.

ii. Collector – base junction should be reverse bias

The proper n-p-n biasing and current flow is shown below.

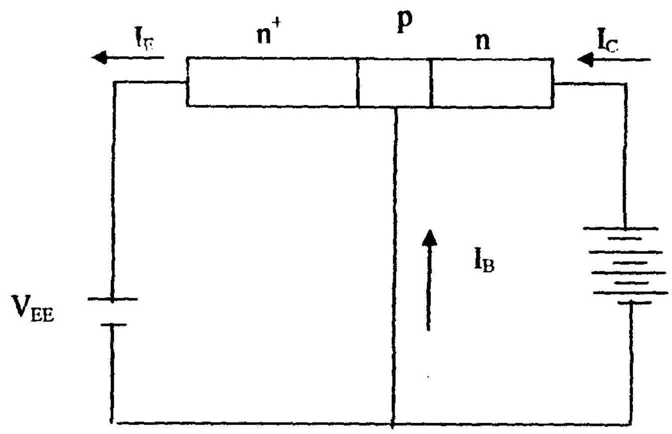


Fig. 3.5.1 Biasing of npn transistor

The collector circuit I_c is slightly less than emitter current I_E. The difference between these currents is responsible for the small base current I_B. thus

$$I_B = I_E - I_C \quad \ldots\ldots 1$$

The forward current gain (α)i.e. the ration of I_C to I_B is given as

$$\alpha = I_C/I_E \quad \ldots\ldots 2$$

And is typically in the range 0.95 to 0.99

In the common emitter connection, where base current (I_B is the input current that controls the collector current (I_C) at the output, the ratio of I_C to I_B which is the forward current transfer ratio or current gain,

$$\beta = I_C/I_B \qquad \text{.....................................3}$$

A combination of equation (2) and (3) gives

$$\beta \quad = \quad \alpha/1 - \alpha$$

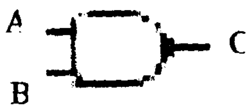
Consequently for values of α between 0.95 and 0.99 β falls approximately in the range of 20 to 100.

3.5.2 LOGIC GATES

The term "logic" is usually used to refer to a decision making process. A logic gate then is an electronic circuit that can decide to say yes or no at the output based upon the inputs. Those circuits implement the logic function based on logical algebra developed by George Boole (which is called BOOLEAN ALGEBRA). The unique characteristic of the Boolean Algebra is that the variables used can assume only one of the two values i.e. 0 or 1 (on or off). The logic or gates used in this project are OR and NOT (inverter) gates.[1]

3.5.2.1 OR GATE

The electronic symbol of the OR gate is shown below, it consist of a 2 inputs A and B) and output (C). The gate is often referred to as "any or all" gate because it has an output of 1 when either A or B are 1 i.e. the output occurs when any or all the inputs are present, as shown in the truth table.



Circuit symbol

Truth table

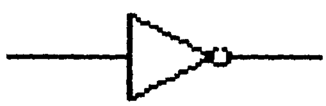
Inputs		output
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

Fig. 3.5.2.1: circuit symbol and truth table of OR GATE

3.5.2.2 NOT GATE

The NOT circuit is a one input one output device. The NOT circuit is often called an inverter. The job of the NOT gate is to give an output that is not the same as the input. The logic symbol an truth table are shown below.

If the output is a logic 1 the output will be the opposite logic 0. Therefore the NOT gate compliments or inverts the output.[2],[1].



Circuit symbol

Input A	Output B
0	1
1	0

truth table

Fig. 3.5.2.1 circuit symbol and truth of OR GATE

3.5.3 THE OSCILLATOR

An oscillator is an electronic circuit which is designed to produce an alternating electromotive force of known frequency and wave form. An oscillator differs from an amplifier in the sense that the oscillator does not require an external signal either to start or maintain energy conversion so long as he dc power source is connected.

When an oscillator is first switched on, a current surge in the frequency determining network produces a voltage at a required frequency of oscillation, across the network. A fraction of this voltage is fed back to the input terminals of the amplifier and is amplified to reappear across the network. A fraction of this larger voltage is then fed back to the input to be further amplified and so on. Consequently, the amplitude of the signal voltage reduced in some way to make the loop gain unity.

The frequency determining section of an oscillator may consist of L – C turned circuit, a resistance – capacitance network or a piezo-electrical crystal. The important characteristic of an oscillator are its frequency or frequencies (if variables) of operation. Its frequency stability its amplitude stability and the percentage distortion of it output wave form.

3.5.3.1 THE 4060B OSCILLATOR

The MC14060B is a 14 – stage binary ripple counter with an on – chip oscillator buffer. The oscillator configuration allows design of either RC or crystal oscillator circuits. Also included on the chip is a reset function which places all inputs into the zero state and disables the oscillator. A negative transition on clock will advance the counter to the next state. Schmitt trigger action on the input line permits very slow input rise and fall times. Applications include time delay circuits, counter control and frequency dividing circuits. The truth table below shows the output states for both positive and negative clock pulse combining with the reset.

TRUTH TABLE

Clock	Reset	Output State
$\uparrow$	L	No Change
$\downarrow$	L	Advance to next state
X	H	All Outputs are low

X = Don't Care

The pin assignment of the IC is also

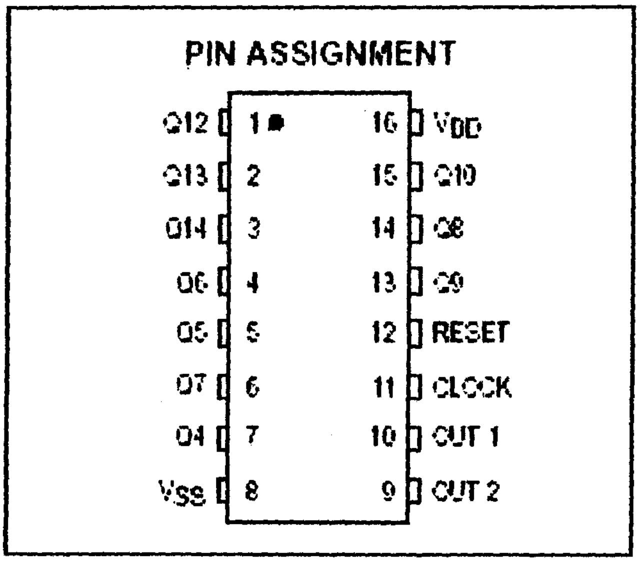


Fig. 3.5.3a: truth table and pin assignment of 4060B IC

The frequency determining section of the IC is shown below; the network is a RC (Resistance – capacitance) type and the respective formula for the frequency is also shown.[7],[8].

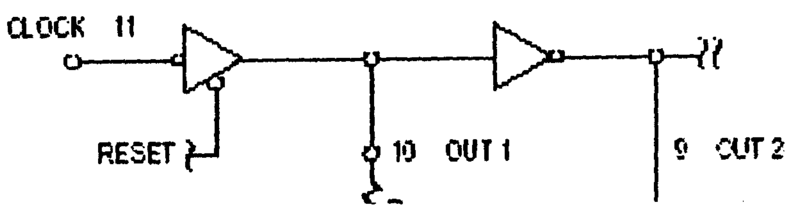


Fig. 3.5.3b: Oscillator circuit using RC configuration

$$f = \frac{1}{2.3R_{tc}C_{tc}}$$

if 1 kHz $\leq$ f $\leq$ 100 kHz
and $2R_{tc} < R_S < 10R_{tc}$
(f in Hz. R in ohms. C in farads)

The formula may vary for other frequencies. Recommended maximum value for the resistors in 1 MΩ.

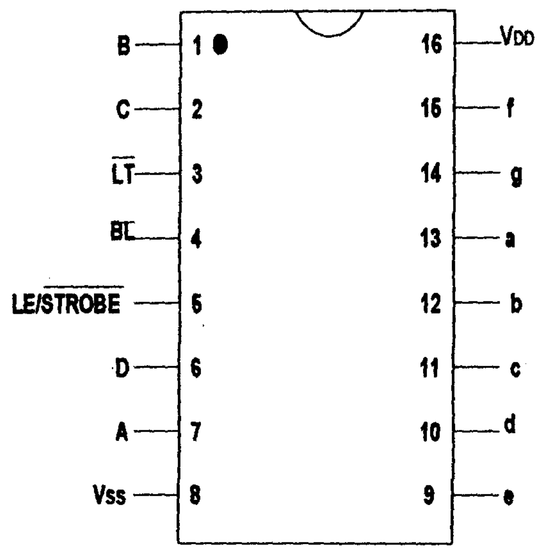
3.5.4 CMOS BCD – to – 7 – SEGMENT LATCH DECODER /DRIVER

The CD 4511B IC is a BCD – to – 7 – segment latch decoder driver constructed with CMOS logic n-p-n bipolar transistor output device on a single monolithic structure. This device combines the low quiescent power dissipation and high n-p-n bipolar output transistors capable of sourcing up to 25mA. This capability allows the CD4511B type to drive LED's and other displays directly.

Lamp Test (LT), blanking (BL) and Latch enable (LE) or strobe inputs are provided to test the display, shut off or intensity – modulate it and store or strobe a BCD code, respectively. Several different signals may be multiplexed and displayed when external multiplexing circuiting is used. The CD4511B is supplied in 16 – lead hermetic dual – in –line plastic package (E suffix), and in chip form (H suffix).

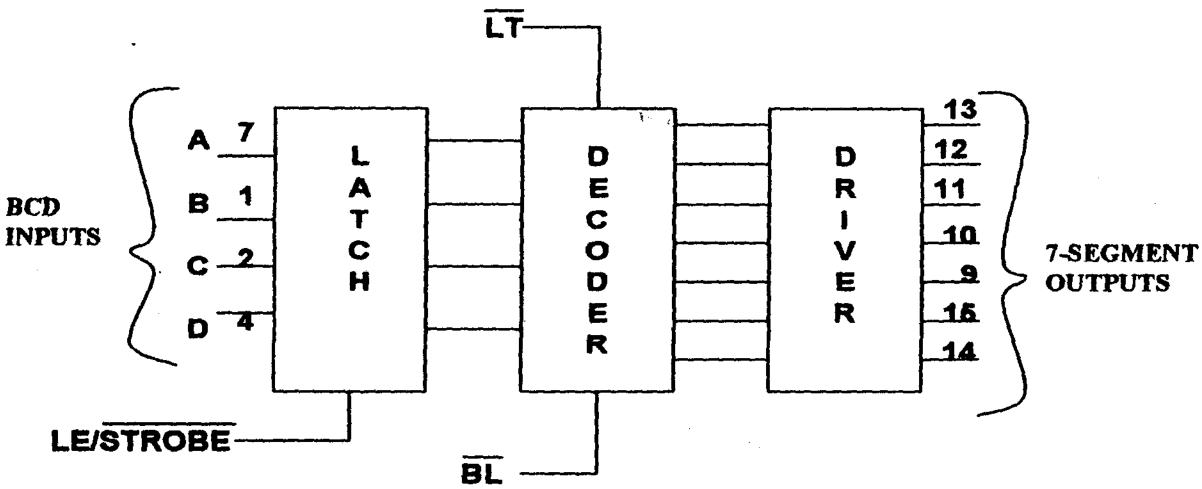
Major applications of the CD4511B includes; driving common – cathode LED display; multiplexing with common – cathode LED displays; driving incandescent displays; driving low – voltage fluorescent displays. [7],[8].

The terminal assignment and functional diagrams are shown.



TOP VIEW

a) **TERMINAL ASSIGNMET**



VSS = 8v; VDD = 16v

b) **FUNCTIONAL DIAGRAM**

Fig. 3.5.4: Terminal assignment and functional diagram of 4511B IC

TRUTH TABLE

LE	$\overline{BI}$	$\overline{LT}$	D	C	B	A	a	b	c	d	e	f	g	Display
X	X	0	X	X	X	X	1	1	1	1	1	1	1	8
X	0	1	X	X	X	X	0	0	0	0	0	0	0	Blank
0	1	1	0	0	0	0	1	1	1	1	1	1	0	0
0	1	1	0	0	0	1	0	1	1	0	0	0	0	1
0	1	1	0	0	1	0	1	1	0	1	1	0	1	2
0	1	1	0	0	1	1	1	1	1	1	0	0	1	3
0	1	1	0	1	0	0	0	1	1	0	0	1	1	4
0	1	1	0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	1	0	0	0	1	1	1	1	1	6
0	1	1	0	1	1	1	1	1	1	0	0	0	0	7
0	1	1	1	0	0	0	1	1	1	1	1	1	1	8
0	1	1	1	0	0	1	1	1	1	0	0	1	1	9
0	1	1	1	0	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	0	1	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	0	1	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	0	0	0	0	0	0	0	0	Blank
0	1	1	1	1	1	1	0	0	0	0	0	0	0	Blank
1	1	1	X	X	X	X				•				•

X = DON'T CARE; • DEPENDS ON BCD CODE PREVIOUSLY APPLIED WHEN LE = 0
NOTE: DISPLAY IS BLANK FOR ALL ILLEGAL INPUT CODES (BCD > 1001)

Fig. 3.5.4c: Truth table of seven segment decoder IC

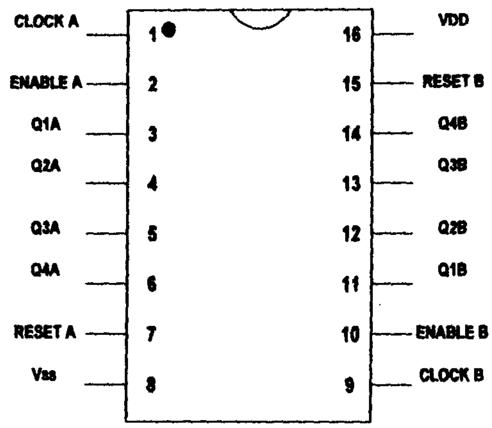
3.5.5 CD4518B (CMOS DUAL BCD UP – COUNTER)

The IC is a dual BCD up – counter which consists of two identical, internally synchronous 4 – stage counters. The counters stages are D – type flip – flops having interchangeable CLOCK and ENABLE lines for incrementing on either the positive – going or negative – going transistor. For single unit operation the ENABLE input is maintained high and the counter advances on each positive – going transition of the CLOCK. The counters are cleared by high levels on their RESET lines.

The counter can be ascended in the ripple mode by connecting Q_4 to the enable input of the subsequent counter while the clock input of the latter is held low.

The CD4518B is packages (D and F suffix), 16 – lead dual in line plastic packages (E suffix), and in chip form (H suffix). [7], [8], [10].

The truth – table are terminal assignment are shown:



a) TERMINAL ASWSIGNMENT

TRUTH TABLE

CLOCK	ENABLE	RESET	ACTION
↑	1	0	Increment Counter
0	↓	0	Increment Counter
↓	X	0	No Change
X	↑	0	No Change
↑	0	0	No Change
1	↓	0	No Change
X	X	1	Q1 thru Q4 = 0

x = Don't care   1 = High state   0 = low state

Fig. 3.5.5: Pin assignment and truth table of 4518B IC

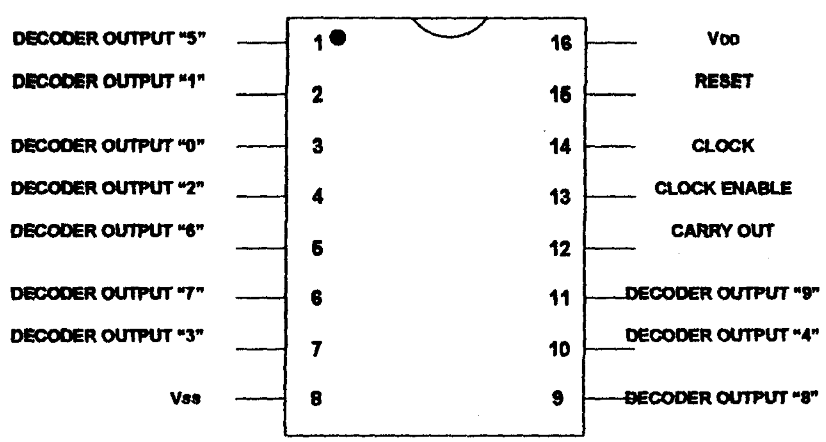
3.5.6 CD4017BC (DECADE COUNTER/DIVIDER WITH 10 DECODED OUTPUTS)

The CD4017BC is a 5 – stage divide by 10 Johnson counter with 10 decoded outputs and a carry out bit.

The counter is cleared to zero count by a logical "1" on the reset line. The clock is advanced on the positive edge of the clock signal when the clock enable signal is in the logical "O" state.

The configuration of the CD4107BC permits medium speed operation and assures a hazard free counting sequence. The 10 decoded outputs are normally in the logical "O" state and go to the logical "1" state only at their respective time slot. Each decoded output remains high for 1 full clock cycle. The carry – out signal completes a full cycle for every 10 clock input cycle and is used as a ripple carry signal to any succeeding stages.[9],[10].

The pin assignment and timing diagrams are shown:



a) PIN ASSIGNENT

Timing Diagrams

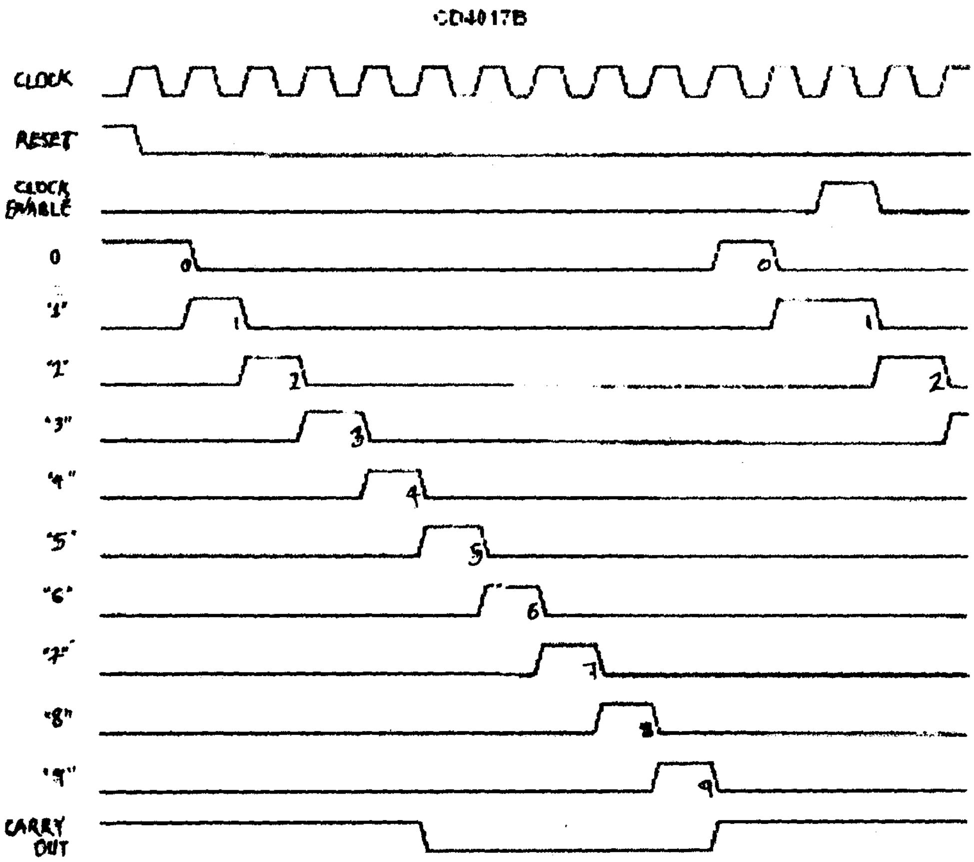
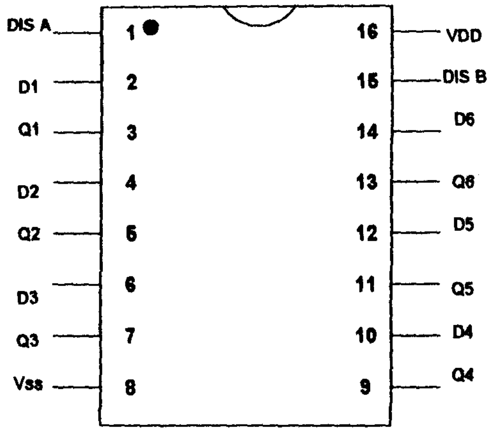


Fig. 3.5.6: Pin assignment and timing diagram of 4017B IC

3.5.7 CD 4503B (CMOS HEX BUFFER)

The CD4503B is a hex non-inverting buffer with 3 – state output having high sink and source – current capability. Two disable controls are provided, one of which controls four buffers. The CD4503B types are supplied in 16 – lead hermetic dual – in –lin deamic packages (D and F suffixes), 16 – lead dual – in – line plastic packages (E suffix), and in chip dorm (H suffix).[7],[8].

Its terminal assignment and truth table are provided below:



a) TERMINAL ASSIGNMENT

DN	DIS A (B)	QN
0	0	0
1	0	1
X	1	HIGH Z

X = DON'T CARE

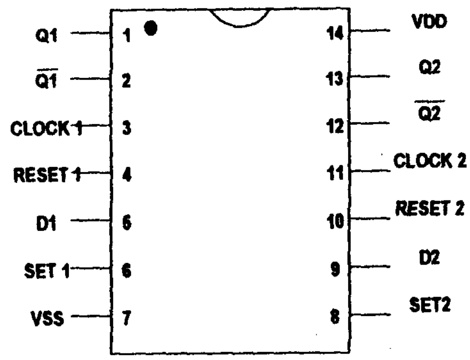
b) TRUTH TABLE

Fig. 3.5.7: Terminal assignment and truth table of 4503B IC

3.5.8 4013B (CMOS DUAL 'D' FLIP-FLOP)

The CD4013B (i.e. CMOS Dual 'D' Type flip – flop) consist of two identical independent data – type flip-flops. Each flip – flop has independent data, set, reset and clock inputs Q and Q outputs. These devices can be used for shift register application and by connecting Q output to the data input, for counter and toggle application. The logic level present at the D input is transferred to the Q output during the positive – going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set and reset, respectively. Some of its feature includes; the set – reset capability; static flip – flop operation – retains state indefinitely with clock level either “high” or “low”. [7],[9].

The terminal assignment and truth – tube are shown below:



a) TERMINAL ASSIGNMENT

CLK	D	R	S	Q	$\overline{Q}$	
	0	0	0	0	1	
	1	0	0	1	0	
	X	O	O	Q	$\overline{Q}$	NO CHANGE
X	X	1	0	0	1	
X	X	0	1	1	0	
X	X	1	1	1	1	

LOGIC 0 = LOW; LOGIC 1 = HIGH; ● = LEVEL CHANGE; X = DON’T CARE

b) TRUTH TABLE

Fig. 3.5.8: Pin assignment and truth table of 4013B IC

CHAPTER FOUR

CONSTRUCTION, TESTING AND RESULTS

4.0 CONSTRUCTION

The construction can be broken down into two phase;

i. Construction of the main board or control board

ii. Construction of the LED display screen

4.0.1 CONSTRUCTION OF THE MAIN BOARD

The basic idea in the construction of the main board was to make the compartment as compact as possible; so as to make it portable. The components were then connected as indicated in the circuit diagram. Proximity of the related units (i.e. control unit, multiplexing unit, counter unit etc) was considered. All extended copper stripes of wires and lead from soldering were scrapped to avoid short circuiting.

4.0.2 CONSTRUCTION OF THE LED DISPLAY SCREEN

The display was constructed with light emitting diodes (LED) mounted on a plywood. All the LED's were connected in parallel also a glass frame was used to add to its elegance.

4.1 TESTING

The device was tested in the following manner.

i. When score button 1was pressed

ii. When score button 2 was pressed

iii. When the reset button was pressed.

4.2 OBSERVATION/RESULTS

When score button 1 was pressed, the double digit associated with the score button incremented from its initial score (00) to (01) the augmented score flashed for some seconds and the score remained steady. The score button was pressed again and again for further testing.

When the rest button was pressed, all the double digits for both team scores returned back to zero i.e (00, 00).

4.3 DISCUSSION OF RESULTS

The modeled display board worked according to the designed, this makes it suitable for use in football matches.

CHAPTER FIVE

CONCLUSION

5.0 CONCLUSIONS

The design and construction of the light emitting diode (LED) electronic score board was successful. The device provides a reliable and easy way to display the scores of a football match. The illumination from the LEDs makes it suitable for night conditions.

5.1 RECOMMENDATIONS

1. I recommend that the device be made bigger to match the size of a stadium

2. I recommend the use of microcontrollers in the main board to provide a device with fewer components hence making it economical and this will increase its flexibility.

3. I recommend the provision of a device to interface the score board with a computer to make it more users friendly.

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