DESIGN AND CONSTRUCTION OF A DIGITAL L.E.D DISPLAY BOARD

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL/COMPUTER ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY.

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR DEGREE IN ENGINEERING (B.ENG).

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

NOVEMBER 2004.

DEDICATION

This project is dedicated first and foremost to Almighty Allah and to my parents for their undying love, care and support, the rest of my family and my friends.

ACKNOWLEDGEMENT

My sincerest appreciation goes to Almighty Allah under whose guidance and protection saw me through this academic sojourn.

My special thanks goes to my supervisor Engr. M. D. Abdullahi for his guidance, fatherly advice and assistance in ensuring a successful completion of this project work.

My profound gratitude goes to my parents Alh. and Haj. M.M Alabi who were always there to support me both morally and financially, may Allah in his infinite mercies reward them abundantly.

Next, are my siblings whom i am very fond of, and are a source of encouragement, my aunts and uncles especially Miss Ruqayat Abdulsalam and Alh. Fatai Alabi, thanks a million, I appreciate you all.

Lastly are my friends Abdul(dudu), Ahmedo, Ajani Oyo, Roy, Baba T, Obong Eddie, the whole El-casa crew, Lee, Olisah, Kabir, Kazim and a host of others too numerous to mention who were there for me when I needed them most, thank you all for being there.

CERTIFICATION

This is to certify that I have supervised, read and approved of this project report, which I have found adequate both in scope and quality for the partial fulfillment of the requirement for the award of bachelors degree in Electrical/Computer Engineering.

------------------------------ 6/12/2004

PROJECT SUPERVISOR DATE

(ENGR.M.D. ABDULLAHI)

------------------------------ 6/12/2004

HEAD OF DEPARTMENT DATE

(ENGR.M.D. ABDULLAHI)

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EXTERNAL SUPERVISOR DATE

DECLARATION

I hereby declare that this project is my original work and has never to the best of my knowledge been submitted either wholly or partly anywhere before. All literature used in this project has been duly cited in the reference.

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ALABI, NAJEEMDEEN OLAWALE **DATE**

ABSTRACT

This project is based on scrolling LED message display using the CMOS (Complementary Metal Oxide Semi-conductor) logic family IC's. It consists of six major sections which are: the 4060B oscillator which produces pulses used for clocking, the 4017B decade counter which acts as a ROM and is used to generate 5 bit codes that represent the characters used, the 4015B shift register section which shifts the codes from stage to stage, the multiplexing logic unit which is a combination of a 4017B multiplexer and 4503B buffers that allocates the position the codes will assume on the display board and the 4515B alpha display decoder (with in-built latch) which selects the displayed character corresponding to a particular code and latches it for a very short time. Lastly, therein the LED display unit that displays the characters the codes represents.

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CHAPTER ONE

1.0 INTRODUCTION.

Before the world went digital, individuals, large companies and Institutions that wanted to pass vital information to its customers and the general public at large used signboards. The signboard as the name implies means a board (either metallic or wooden) with signs on it to relay information to the general populace.

It started with very brief signs like directions for road users and pedestrians, to commuter bus routes and their times of arrival and departure at a station. For a signboard to be clearly visible and understood and hence effective, the board must be considerably large and the writings very bold. These issues led to the problem of the cost of production of a signboard, which soon became only possible for wealthy individuals and companies to afford.

The issue of always changing the message on the signboards as new events occurred became quite a problem, as new ones will always have to be constructed. All these problems led to the birth of the LED message display or the digital display board, as it is commonly known.

1.1 THE LED MESSAGE DISPLAY.

The first popular public message board dates back to the last century's 20's when it was installed at the base of the New York Times building now known as One Times Square. Its debut was announced by New York Times (an American Newspaper) in its November

1928b edition, which read **"HUGE TIMES SIGN WILL FLASH NEWS"**. The world's first public text messaging system was loudly celebrated with a reader board that was 5ft high and 880ft long, which completely surrounded the base of the New York Times building.

It was used to announce the Herbert Hoover and Al Smith presidential election of that year. The streaming news headline reader board eventually evolved into other content displays such as time and temperature signs, banks, gas station and retail stores. Having gained ground as a desirable sign format, the message reader board offers many features such as variable sizes, flexibility in design, ease of use and real time response in changing messages.

The message display board was fondly called the **"Town Crier"** of the modern age.

1.2 PRINCIPLE OF OPERATION OF A LED MESSAGE DIPLAY.

A block diagram showing the units integrated to form a LED message display is shown in fig1.1, where a crystal powered oscillator (4060B) is used to generate three pulses one after the other. The first pulse to clock the Diode/resistor logic ROM, another to clock the shift Register (4015B) and the last pulse to latch the codes for the multiplexing logic unit.

The Diode / Resistor Logic ROM is an IC (integrated circuit) with 10 outputs, but only 8 of them are in use. This IC generates the characters, which are 5 bits long. The corresponding character code is shifted in to the shift register and latched. When the

The multiplexing logic unit is designed to allocate the position the codes will take on the 7 x 6 LED display board and it makes the Alpha - logical display Decoder to be linked to a particular code for a very short time. (E.g 1/1000 = 1 x 10^{-3} secs) and this combined effect makes the letter appears on the display at the same instance, which is not really so.

For each letter appears one after the other , but the speed makes the eyes see them at the same time it is this process that is repeated for all the characters hence their movement across the display.

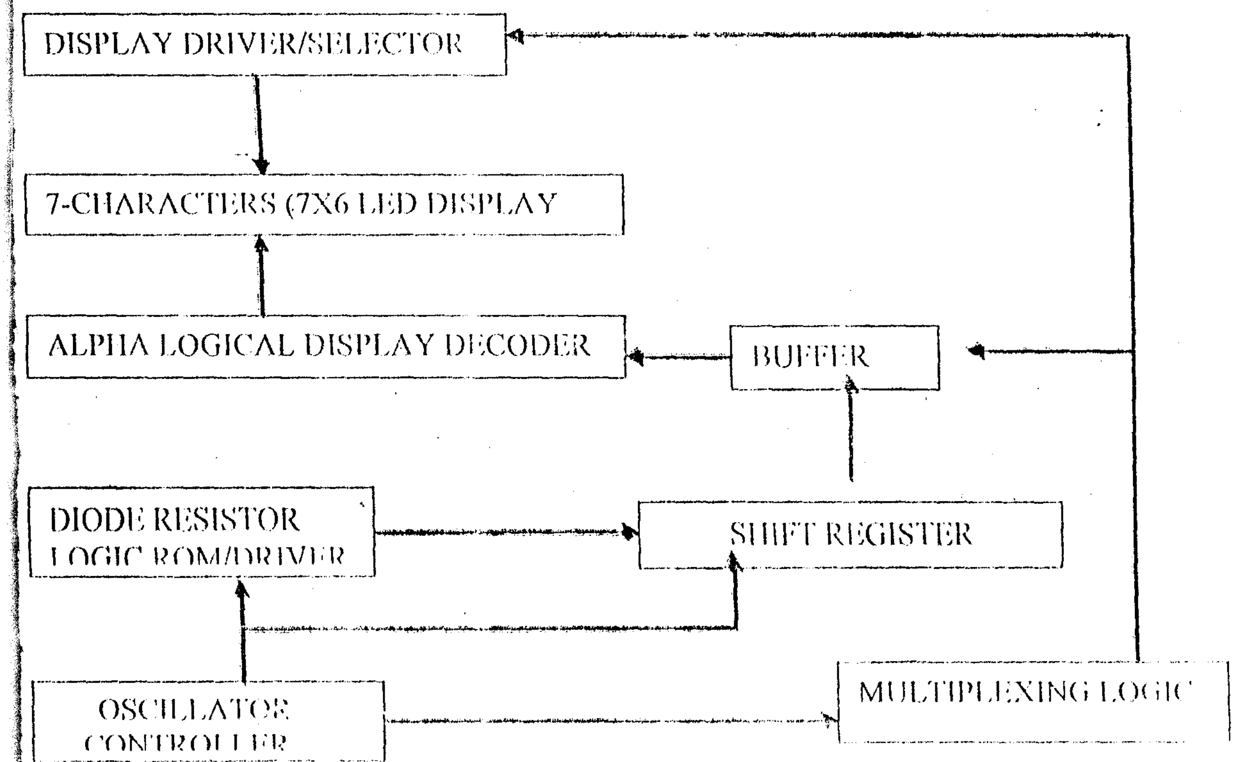


FIG.1.1 BLOCK DIAGRAM OF A LED MESSAGE DISPLAY

1.3 AIM AND OBJECTIVE.

The aim of this project is to encourage all other schools or departments on campus to place displays or signposts that can be seen from afar on their workshops, labs and offices to ease the problem of having to go round the school premises looking for a department or office, by both students and outsiders alike.

The objective of the project therefore is to construct a LED display board (digital) that can be read from a long distance both during the day and at night by an observant person. The display lights will also be colorful. So as to attract people's attention to it, hence the LED's (light emitting diodes).

1.4 PROJECT OUTLINE.

This project outline is a technical report which describes in detail the construction of a digital LED display board. The report consists of five chapters as follows:

Chapter one gives the general overview of the project, general introduction to the project, and improvements on the previous works. Aim and objectives of the project is also included.

Chapter two contains the literature review and basic introduction on how each component works. The power supply unit is fully discussed in chapter three.

Chapter four has to do with the construction and design with explicit detail on how the various components were connected to each other.

Chapter five is the conclusion drawn from the results of testing and recommendations, with reference to the objectives and goals of the project

CHAPTER TWO

2.0 LITERATURE REVIEW

According to the Longman's Dictionary of contemporary English, the word "display" means an attractive arrangement of objects for people to look at or buy, or a piece of equipment that can show changing information. In this context we are concerned with the equipment showing changing information.

A LED message display board can then be said to be equipment that can be used to display information either changing or stationary as the case may be, or as intended by the user. The display board in this project work displays the statement **"WELCOME TO DEPARTMENT OF ELECTRICAL/ COMPUTER ENGINEERING"**. LED message displays can be configured to be used in either an indoor application or an outdoor application, and can be used for both commercial and industrial purposes.

LED message displays are segmented or dot-matrix displays that allow for numeric and alphanumeric character representation.

In character representation, the display consist of an array of LED's that display only characters which are programmed with binary codes into the PROM (Programmable Read Only Memory). Some special features that make the LED message display unique and more widely used above the signboards are: programmability (rewriting the program whenever the message displayed needs to be changed). Selectable fonts (selecting the size and the style of writing the message to be displayed), adjustable intensity (the degree of brightness or dimness of the LED's) and so on. It can therefore be seen that LED message displays are preferable and more effective where information dissemination is concerned.

2.1 REVIEW OF COMPONENTS.

(A) SHIFT REGISTER

A shift register is basically a collection of flip-flops connected in series of cascade. In shift registers, data is shifted through the register by the positive going edge of the clock pulse. The flip-flops are clocked together (synchronous) and all the resets are interconnected, making it possible to clear the memory of all the devices at the same time

The number of bits that a shift register can store is equal to the number of flip-flops in the register. When data is needed it is shifted one bit at a time across the outputs of the register either to the left or right. A schematic shift register is shown in Fig.2.1a below while the logic diagram is shown in Fig 2.1a.

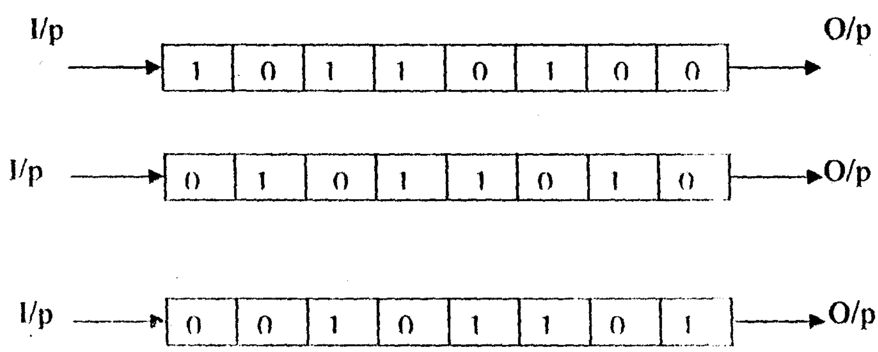
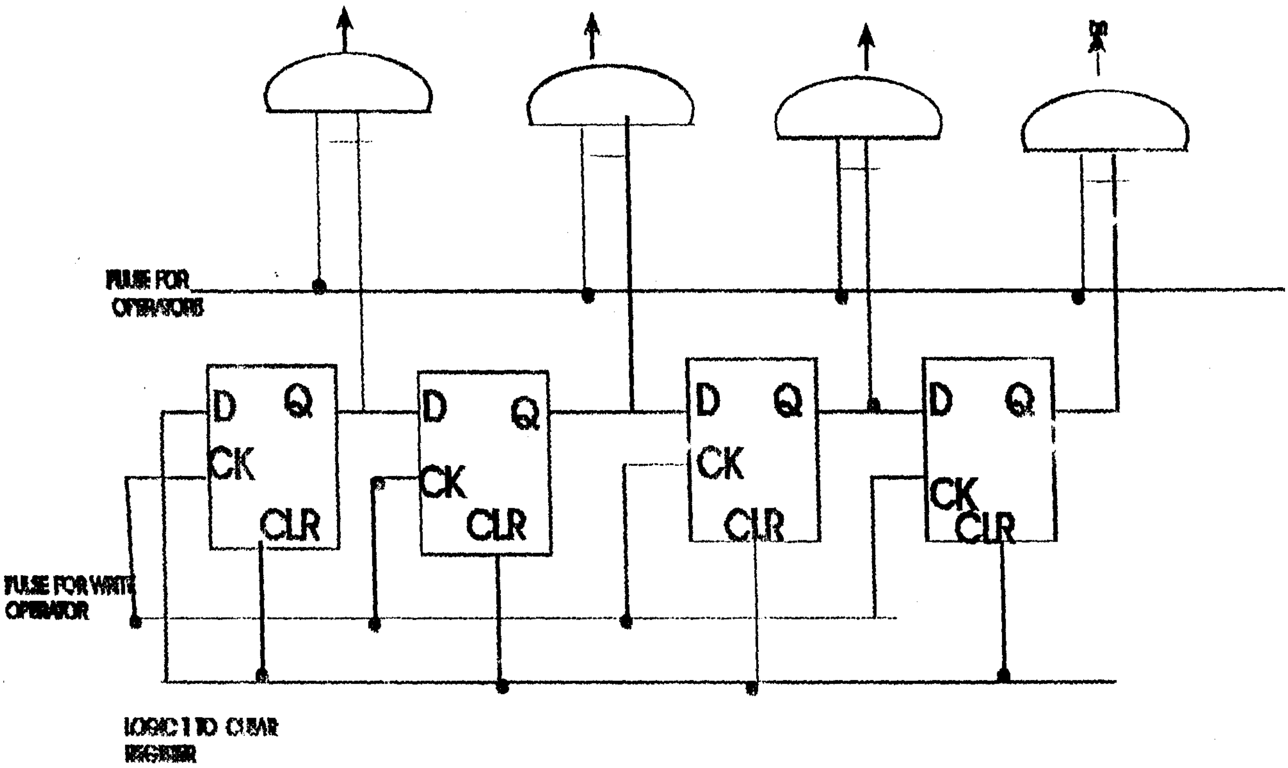


FIG 2.1A A SCHEMATIC SHIFT REGISTER



SERIEL - IN PARRALEL - OUT SHIFT REGISTER

FIG 2.1B LOGIC CIRCUIT OF A TYPICAL SHIFT REGISTER.

(B) OSCILLATORS.

These are electronic circuit designed to produce an alternate e.m.f of known frequency and waveform. It is an amplifier that provides its input signal, which is derived from the output signal. A crystal oscillator is an oscillator circuit in which the frequency determining network is provided by a piezo-electric crystal.

A piezo- electric crystal is a material such as quartz having the property that, if subjected to mechanical stress, a potential difference is developed across it, and if the stress is reversed a potential difference of opposite polarity is developed. The frequency of the crystal depends on physical properties such as size, pressure and temperature. With advances in technology, crystals that are insensitive to thermal and mechanical variation are now available. The oscillator used in this project was based on the crystal technology. A block diagram of how the oscillator works is shown in Fig.2.2B below.

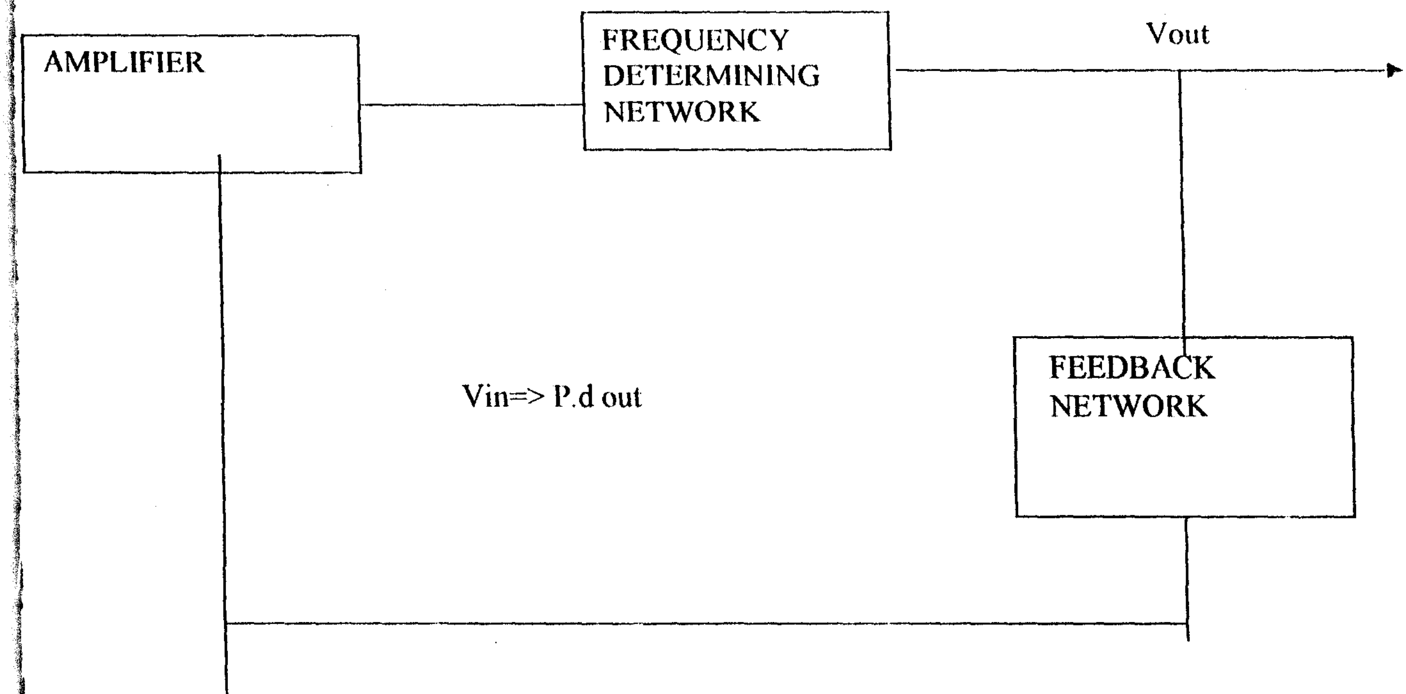


FIG 2.2B BLOCK DIAGRAM OF AN OSCILLATOR

\© MULTIPLEXER UNIT:-

This is an electronic or scanning circuit that has a number of inputs and a single output. It is represented as shown below.

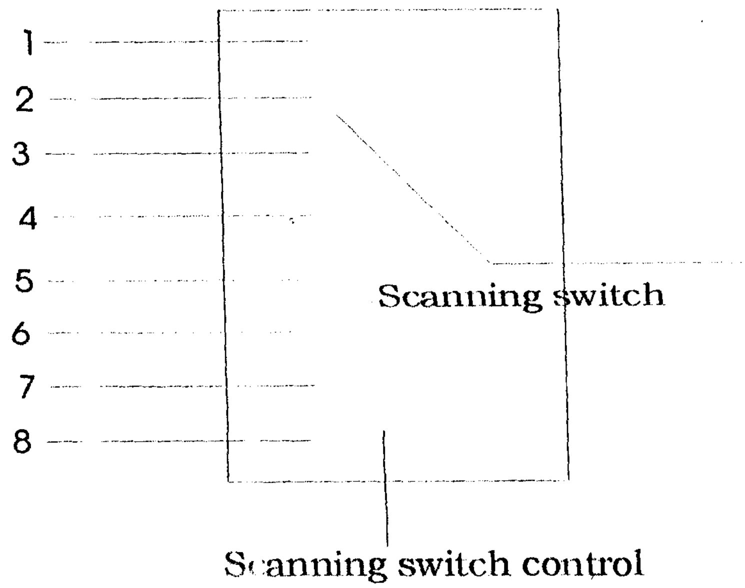


FIG. :.1B A SIMPLE MULTIPLEXER

Any of the eight inputs can be connected to the output simply by switching the scanning switch to the appropriate position. It allows one of a number of available inputs to be selected by using a digital code word. For a 4 input multiplexer, a two-bit code is required, for an 8 input device, a three-bit code is required. Therefore the number of input lines that can be multiplexed is 2^m. Where m= no of control lines.

(D) THE LED DISPLAY

These are solid state devices with pn junctions that emit light energy when stimulated by a low voltage direct current. They can be designed to emit light from ultraviolet, through the visible spectrum to infrared. The most efficient LED is in the visible spectrum and emits red light.

When a semiconductor diode is forward biased, carriers are injected from the emitter region into the base region. The injected electrons recombine with the holes of the p-region which are the majority carriers in the circumstances. There are also LEDs capable of emitting any one of two colors. They are built with two light-emitting junctions one of which has the spectral response peak in one region(red) of the spectrum, and the other in another region (say green). The color emitted will depend on the relative magnitude of the currents flowing through the junctions.

The key parameters of LEDs include luminous intensity which is measured in candela, brightness (ratio between the luminous intensity and the area of the light-emitting surface), direct forward voltage, emission color and wavelength at the peak luminous flux.

LED's are popular display devices because they can be operated from low voltages; they are compatible with systems that use integrated circuits. They are also small, light in weight and mechanically rugged. As solid-state devices, they are highly reliable and have an operating life of more than 100.000hrs. The circuit symbol of a LED is shown in the Fig 2.1C below.

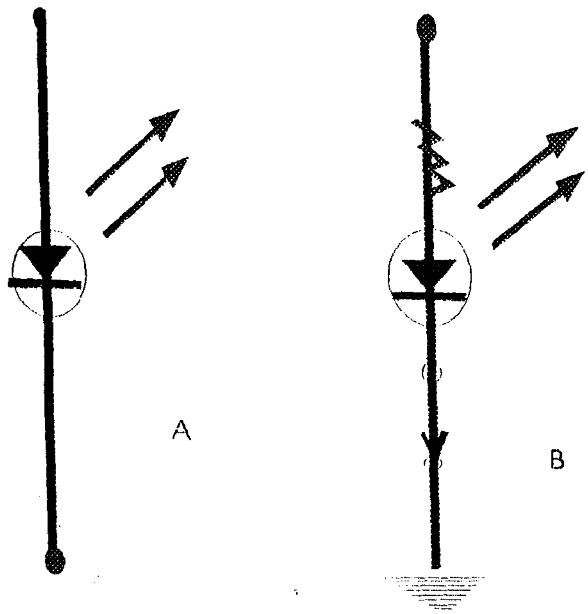


FIG. 2.1C CIRCUIT SYMBOL OF A TYPICAL LED

(E) THE BUFFER

This is an electric circuit or component that prevents undesirable electrical interaction between two circuits or components. It could also be called an interface circuit because it allows signals to pass from one circuit to another when these circuits are incompatible. The term buffer may also be applied to any logic gate that provides relatively large output currents. The TTL (Transistor-Transistor Logic) gates, particularly inverters, are often used as buffers in MOS (Metal-oxide Semiconductors) circuits. Unlike inverters, buffers don't alter the logic values being transmitted through it. It does however increase their propagation delay time.

CHAPTER THREE

3.0 THE POWER SUPPLY UNIT

3.1 INTRODUCTION

Like any other electronic circuit, a power supply unit was included in the design of the digital display board. This is perhaps the backbone of any electronic equipment, thus my decision to use a whole chapter to discuss it. The design specification of a power supply is determined by the requirements of the electronic equipment which it feeds.

The important features to be considered in a power supply unit are maximum and minimum voltage demand of the circuit, regulation, ripple factor, efficiency, noise rejection, and maximum and minimum current demand of the circuit. The major stages involved in the AC / DC power conversion is shown in the block diagram in fig 3.1.

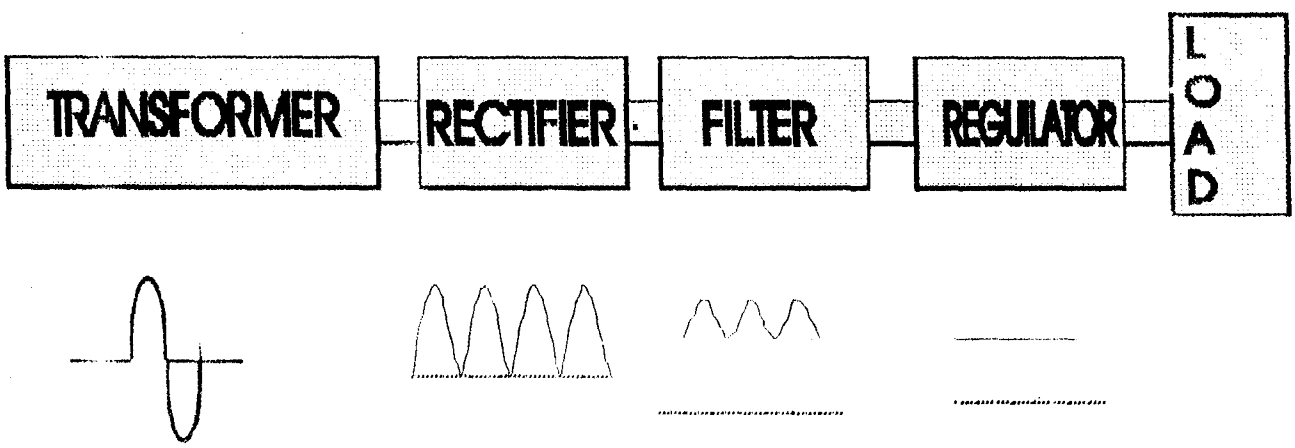


FIG 3.1 THE BLOCK DIAGRAM OF THE POWER SUPPLY UNIT

3.2 TRANSFORMER

They are basically made up of two coils, electrically insulated from one another, which are wound over a common core material formed into a closed magnetic circuit, so that the two coils are mutually coupled. There are different types of transformers, where their differences are determined by the variation in coil winding. The single phase transformer which has centre tapped winding and the multiple phase transformers which also has star or delta connected winding. A single phase transformer of 12 V rating is used in this design.

The main use of a transformer in any circuit either digital or analog is to either step-up or step-down AC power supply to suit the needs of the circuit fed by the DC supply. Transformers are mainly specified by their power ratings in volt-ampere i.e. KVA, MVA for high powered transformers. Depending on their applications, transformers could be single phase or multiple phases.

3.3 RECTIFICATION.

Rectification is the process of converting A.C voltage into a DC voltage. A device called a rectifier (semiconductor diode) is used for this purpose. It conducts current in one direction only. A rectifier designed for +ve current will allow the +ve half of each AC waveform to pass and vice-versa for that designed for –ve current.

A transformer was used to step down the main voltage to the required r. m. s value before the rectification process .Fig 3.2a shows a 12V AC transformer connected to a full wave bridge rectifier circuit. The two commonly used methods of rectification are the half wave and full wave bridge rectification.

The full wave bridge rectifier is used preferably because it uses both the +ve and –ve parts of the AC waveform and there fore the frequency of the pulsating DC output is high. The half wave bridge rectifier on the other hand uses only either the +ve or the _ve parts of the AC waveform. Hence it is of low frequency and requires more filtering. During the positive half circle, the terminal M of the secondary is positive and N is negative. Diodes D1 and D3 are forward biased (ON) whereas D2 and D4 are reverse biased (OFF), hence current flows to the positive terminal.

During the negative half cycle, secondary terminal N becomes negative and M becomes positive. This time D2 and D4 are forward biased, while D1 and D3 are reverse biased, consequently current flows to the positive terminal as before.

The output of the full wave bridge rectifier is a DC current and always flows in the same direction. Fig 3.2b shows the output waveform.

3.4 FILTERING

The D. C voltage produced by the rectifier circuit has a pulsating waveform or ripples which is not desirable. To reduce or totally remove these ripples, a filter capacitor is connected across the output of the rectifier circuit. Since electrons are stored in the filter capacitor in pulses, the larger the capacitor, the more electrons it can store and the smoother the D. C supplied to the load.

In this design a (1000 F, 25V) capacitor was used to provide acceptably low harmonics.

3.5 CONSTRUCTION

The transformer used for this construction was readily purchased and it was a 220/12V rated transformer which is to be powered from the AC mains. Due to the advancement in the manufacture of semiconductor devices, a single component that has the full wave bridge rectifier circuit (shown in Fig 3.2a), enclosed in it was used for the rectification unit.

This component consists of four pins; one negative and positive terminal (for outputs), and two input terminals. The primary and secondary terminals of the transformer were connected to both inputs of the rectifier. A filter capacitor of value (1000 F, 25V) was joined across the negative output of the rectifier and earth. While the positive output carries the 12V output that is used to power the whole circuit.

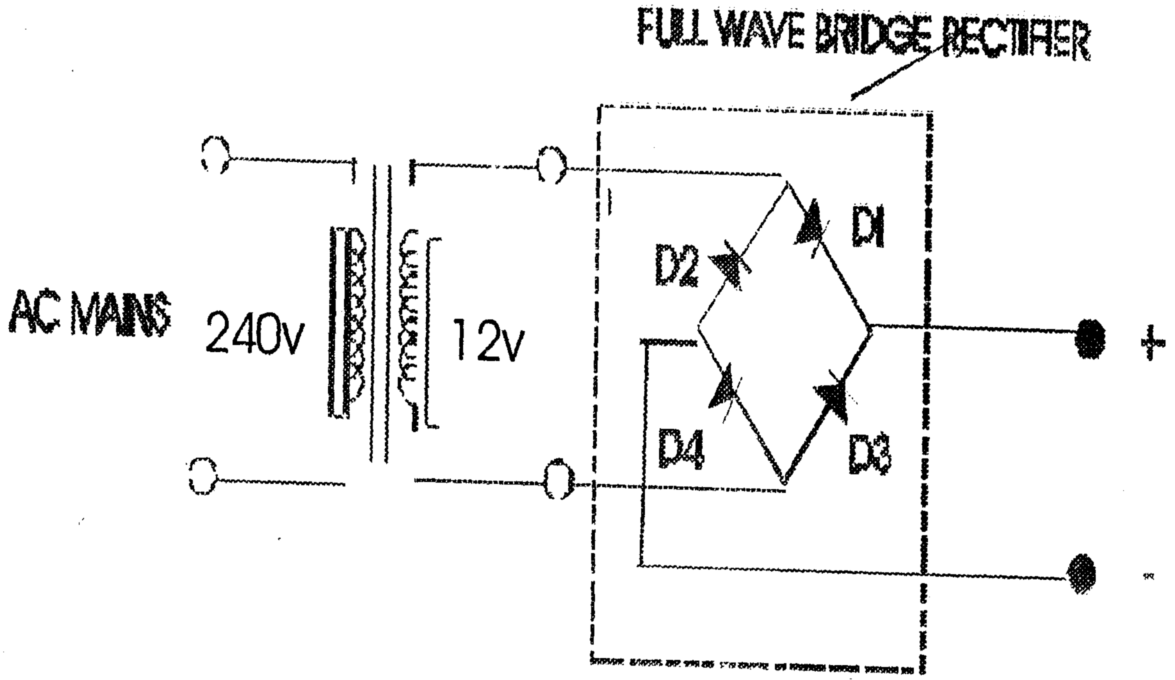


FIG 3.2a A TRANSFORMER CONNECTED TO A FULL BRIDGE RECTIFIER

CHAPTER FOUR

4.0 DESIGN and CONSTRUCTION

4.1 THE DESIGN

In the design of this digital display board, the major components used were as follows.

4060B Oscillator/Controller	1 piece.
4017B Diode-Rectifier Logic ROM	7 pcs.
4015B Shift Register	5 pcs.
4503B Buffer	7 pcs.
4515B Alpha-decoder	1 piece.
Light Emitting Diodes (LED's)	

4.1.1 4060B OSCILLATOR

The 4060B oscillator/controller is a 14-stage binary ripple counter with an on-chip oscillator buffer. The oscillator configuration allows design of crystal oscillator circuits. Included on the chip, is a reset function which places all outputs to zero state and disables the oscillator. When the clock is set to a low, the counter advances to the next stage.

The oscillator produces ten frequencies out of which only two are used, one from pin 3 (that produces about 2.0 Hz) is used for the main control or addressing the diode resistor logic unit and the second frequency from pin 5 which is about 1 KHz is used for the multiplexing unit.

The frequency from pin 3 is used in two places as (q) and (k), where (q) is connected to (z) on the diode resistor logic ROM to give a common clock and (k) is connected to a

NOT gate and fed to the shift register also for clocking purpose. The NOT gate is essential because the 4060B oscillator operates at an active high state, so it makes the output a low.

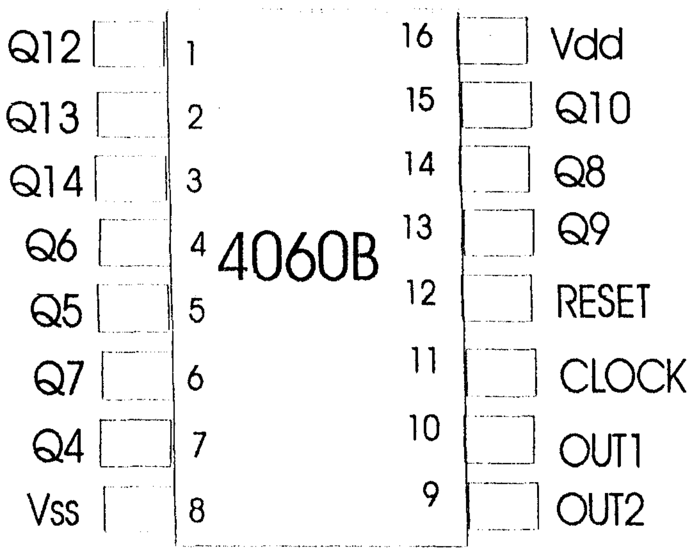


FIG 4.1a: **<u>PIN ASSIGNMENT FOR 4060B OSCILLATOR.</u>**

4.1.2 4017B DECADE COUNTER

The 4017B diode-resistor logic is a 5-state counter having 10 decoded outputs. The inputs include the **CLOCK, RESET** and **CLOCK INHIBIT** signals. When the **CLOCK INHIBIT** signal is low, the counters are increased by one count at the positive clock signal transition, and a high RESET signal clears the counter it its zero count.

The Diode Logic is designed to perform the operation of a ROM. The logic circuit produces the statement **"WELCOME TO DEPARTMENT OF ELECTRICAL/COMPUTER ENGINEERING "** in coded format with each pin of the 4017B producing a 5 bit code representing every character to be displayed. The total number of characters involved in this display is 56 i.e. including spaces, therefore 56 pins are required. Since the 4017B has 10 decoded outputs, one of which is used for clocking and another one for cascading, 8 pins are left, so a total number of seven 4017B's are required in order to get the required number of address lines which is 8 * 7 = 56. Another 4017B (auxiliary) which has a NOT gate connected to its outputs is used to shift the 4017B activation, so that one 4017B is high at a particular time, and each of its pins connected to a number of diodes that correspond with the high bits of the code that particular pin represents. E.g. U= 10110 therefore three diodes will be connected to the pin that produces the code for the character "U".

Five resistors are connected across all the diodes to serve as a grounder such that when the diodes connected to the enabled pin is at a high all the other diodes on that particular chip are at a low or disabled. The diodes allow the flow of signals in one direction only. It is from these resistors that the five signals are fed into the shift register section.

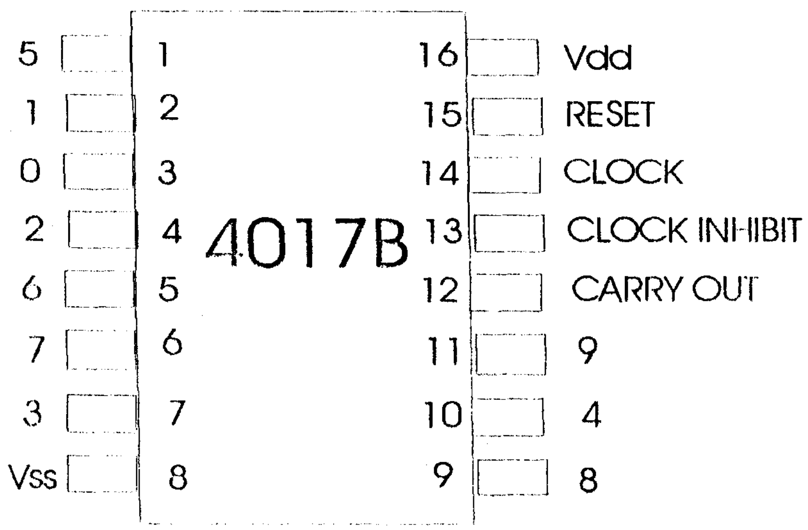


FIG 4.1b PIN CONNECTION FOR 4017B DECADE COUNTER.

4.1.3 4015B SHIFT REGISTER

The 4015B shift register consists of two identical and independent 4 stage registers. Each of these registers has its own CLOCK and RESET inputs as well as a single serial DATA input. "Q" outputs are available from each of the four stages on both registers. The logic level present at the DATA input is transferred into the shift register stage and shifted over, one stage at each +ve going clock transition. All the stages can be RESET when the RESET line is high. All registers are D-type, MASTER-SLAVE and S.I.P.O (Single Input Parallel Output) registers.

Since the output from each 4017B are 5 bits, five 4015B registers are required to shift the codes representing an alphabet for 7 stages because there are 7 different 4017B's. When the 5bit code arrives at the shift register, pulse (k) from the controller section shifts the 5bit code into the first stage, and at another pulse shifts the first code to the second stage while another code takes its place in the first stage and so on until all the seven stages in each shift register has been traversed. The circuit is designed to have a common CLOCK and RESET since the 10^{th} and 13^{th} pins were cascaded to make the shift register a 7 stage one instead of the normal eight.

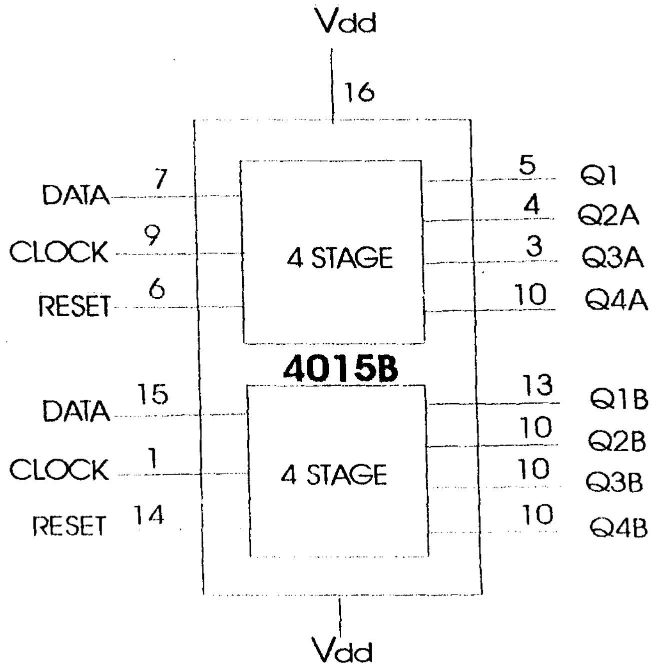


Fig 4.1c <u>**FUNCTIONAL DIAGRAM OF A 4015B SHIFT REGISTER**</u>

4.1.4 4503B BUFFER

The 4503B buffer uses its tri-state ability to direct a single 5-bit data or code into a single alpha-decoder character display. A multiplexer unit is included in this buffering circuit so as to reduce the number of alpha-decoders used to one, instead of seven that would have been used normally since seven 5bit codes were fed from the shift register output into the buffers. This single 4017B acting as free-running stepper, operates at 1 KHz and selects one particular 4503B (buffer) while the rest are cut off or at a high since the 4503B is active in the low state.

Only one 4503B buffer can function at a particular time therefore only one alpha-decoder is shared amongst them. This also means that only one 5 bit code is connected to the decoder at a time then one after the other depending on the buffer enabled by the free-running stepper. A NOT gate is connected to the 4503B's control input to activate it because it is active in the low state.

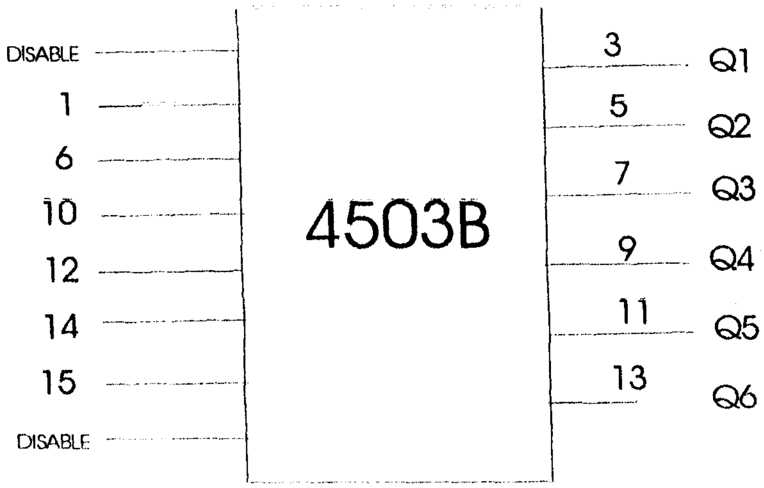
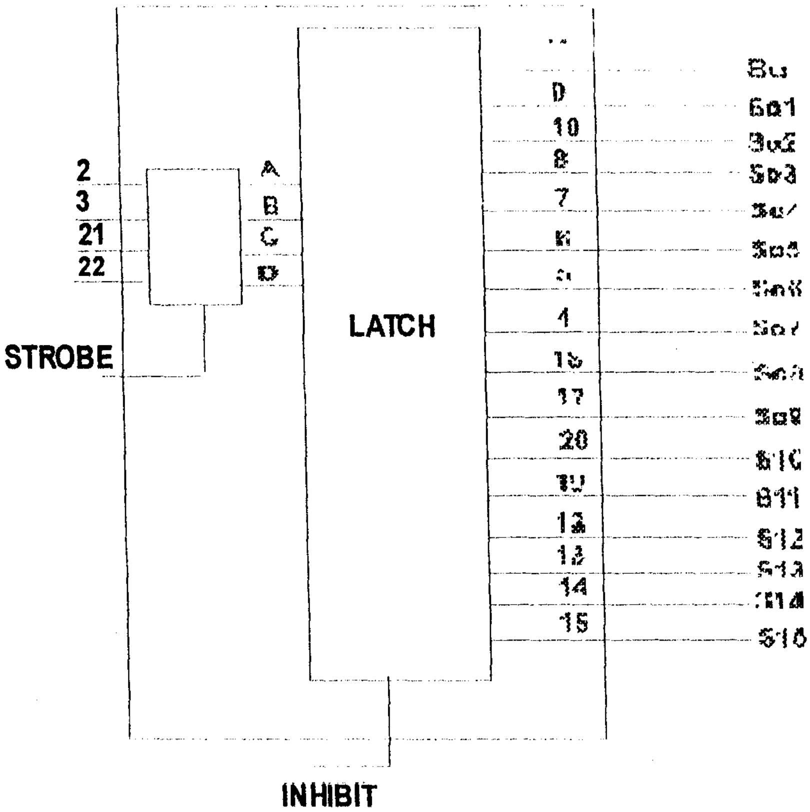


Fig 4.1d. PIN ASSIGNMENT FOR 4503B BUFFER.

4.1.5 THE ALPHA- DECODER UNIT

The 4515B consist of 4-bit strobes catch and a 4 to 16-line decoder. The latch holds the last inputs data presented prior to the strobe transistor from 1 to 0. inhibit control allows all outputs to be placed control allows all outputs to be placed at 1 regardless of the state of the data or strobe inputs fig 4.1e shows the functional diagram of the 4515B.



4.1e THE FUNCTIONAL DIAGRAM OF THE 4515B ALPHA DECODER.

4.1.6 THE LED DISPLAY BOARD

The LEDs used in this design are the normal red Light Emitting Diodes, and are 294 altogether, since there were seven groups of 42 LEDs (6 rows and 7 columns). The LEDs were connected in a common cathode fashion where all the cathodes (+ve terminals) of the LEDs were connected together. Each group of 42 LEDs representing a character has an NPN transistor (2SD400) connected to it.

These transistors are fed from the outputs of the 4017B (free running stepper) and it is used to switch the display to a different set of LEDs any time the free running stepper selects a buffer that represents a character. This implies that since only one buffer can function at a time, the transistors make sure that only the groups of LEDs they are connected to are enabled to display a character. This means that if a particular group of LEDs are not selected, all the LEDs on the board are lighted up.

4.2 CONSTRUCTION

In order to avoid mistakes and for safety reasons, all circuit connections were first done on a breadboard before being transferred onto the Vero-board. IC sockets were first soldered on the Vero-board before all the individual IC's were then plugged in, this was done to prevent damage of IC's by heat from the soldering iron, and from the IC's being short circuited. Also IC sockets are used to avoid breaking of the pins of the IC's. A digital multi-meter was used to test for continuity between interconnected points. The constructed circuits were enclosed in a wooden casing.

4.2.1 4060B OSCILLATOR

Since the 4060B oscillator has 8 pins (on both sides) as shown in Fig 4.1a, it has a total of 16 pins altogether with the configuration shown. A 100k and 33k resistors were connected across pins 10 and 11 respectively while a 0.001 F capacitor was soldered across pin 9, all three of them being in parallel. Pins 8 and 12 were connected together and earthed while pin 16 being Vdd supplies the unit with D.C voltage from the power unit. From the pin diagram shown in Fig 4.1a, all the pins labeled "Q" are frequency output pins, but since just two frequencies are needed in this design only pins 3 and 5 are used while pins 1, 2, 4, 6, 7, 13 & 14 are left idle. This connection is shown in Fig.4.2.1 below.

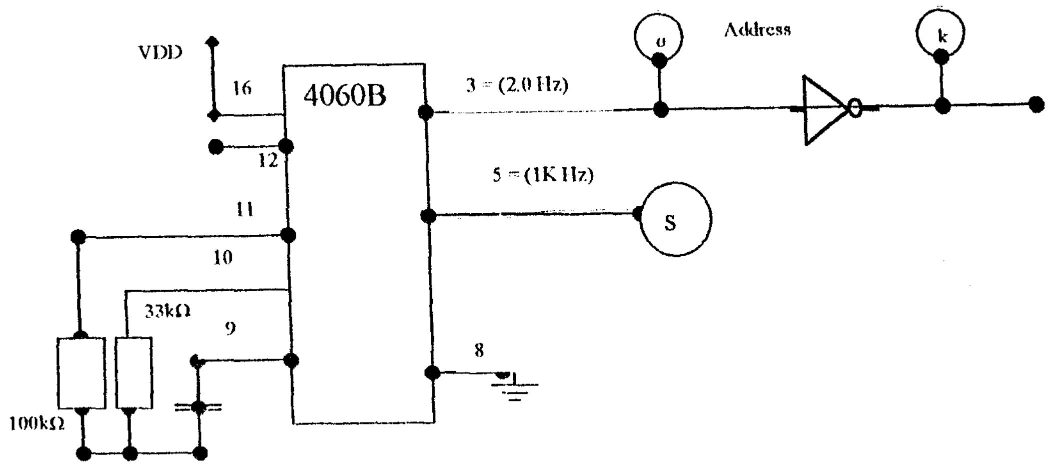


FIG 4.2.1 THE OSCILLATOR CONTROLLER

4.2.2 4017B DECADE COUNTER.

In this unit, seven 4017B's were used with an extra one for cascading. From the pin connection shown in fig 4.1b, pins 3, 2, 4, 7, 10, 1, 5, 6, 9, 11 and 12 carry the decoded outputs. But since only eight outputs are needed for this design, all pin 11's were soldered to an OR gate for cascading, and pins 3 and 12 are left idle. Pin 16 supplies power to the circuit, pin 14 is connected to pin 15 of the 4060B whose frequency is used for clocking the unit.

The various outputs of the extra 4017B is connected to pin 15 of the remaining seven 4017B's through a NOT gate for the purpose of resetting. I.e. returning all the 4017B's to the inactive state. Each pin of the 4017B was then soldered to diodes that are equal to the number of high bits of that code. E.g. the 3rd pin of the 1st 4017B represents character "L" whose code is 1 0 0 1 1 hence just three diodes were soldered to it and so on for the other pins. All these diodes then share a number of five resistors (because there are five codes). Each diode was soldered to its corresponding resistor, so that when one diode is at a high state, the rest are at a low. The above described connection was done for all the individual 4017B's. Fig. 4.2.2 below shows this connection.

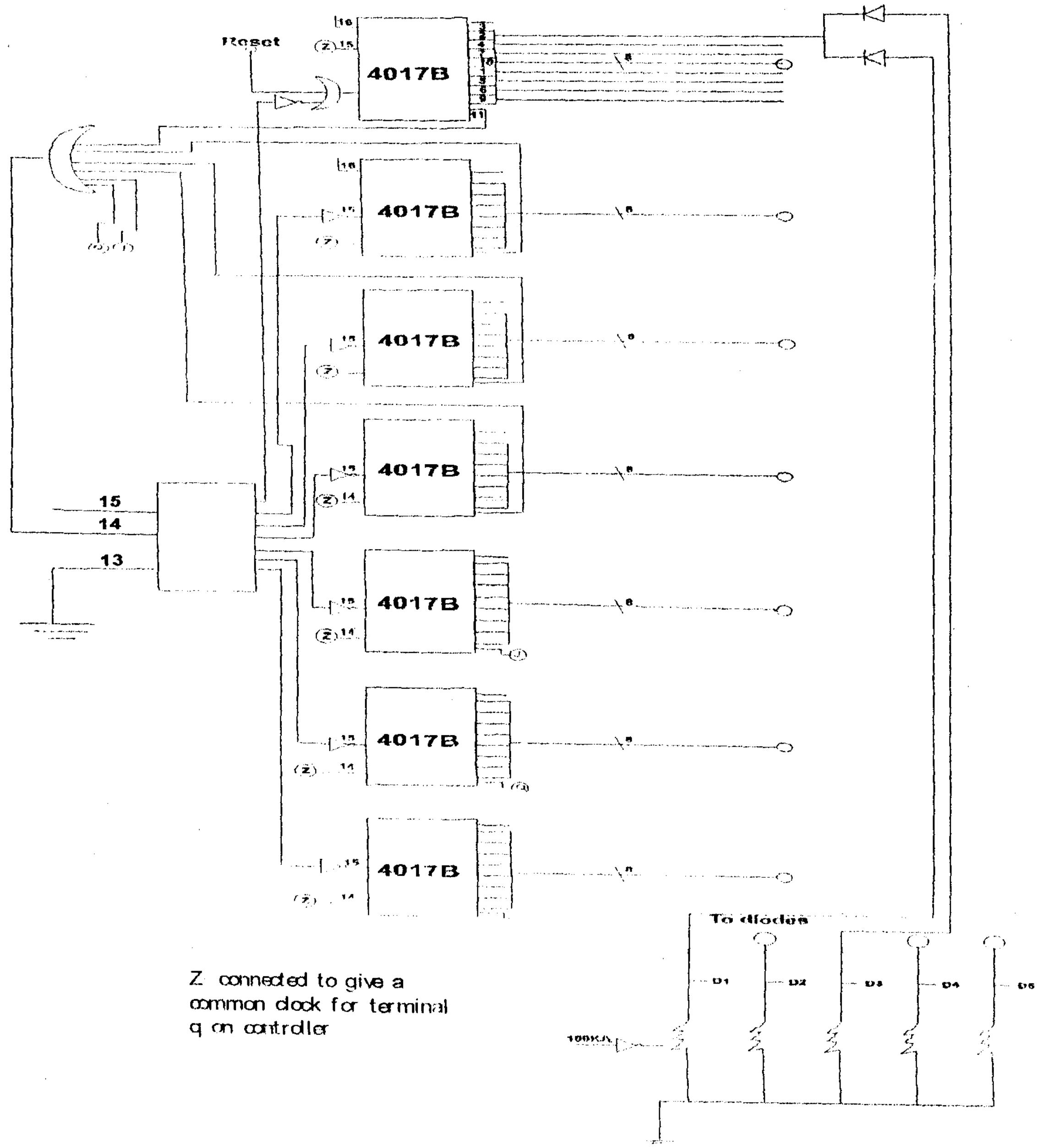


FIG.4.2.2 CONSTRUCTION OF THE DIODE RESISTOR LOGIC ROM/DRIVER

4.2.3 4015B SHIFT REGISTER

The 4015B shift registers with pin connection as shown in fig 4.1c are five in number. Each 4015B's pin 7 is connected to the outputs D1 to D5 from the diodes connected to the 4017B's outputs respectively. Pins 6 and 14 are connected together and are both used for RESET. Pins 1 and 9 are also connected together and are fed by the frequency from pin 15 of the 4060B oscillator through a NOT gate since the 4015B is active in the low state. This frequency is used for clocking. Pin 5 is cascaded with pin 10 to reduce the number of 5 bit outputs to seven instead of eight. As usual, the pin16 was connected to the power supply unit. The construction is shown in Fig 4.2.3.

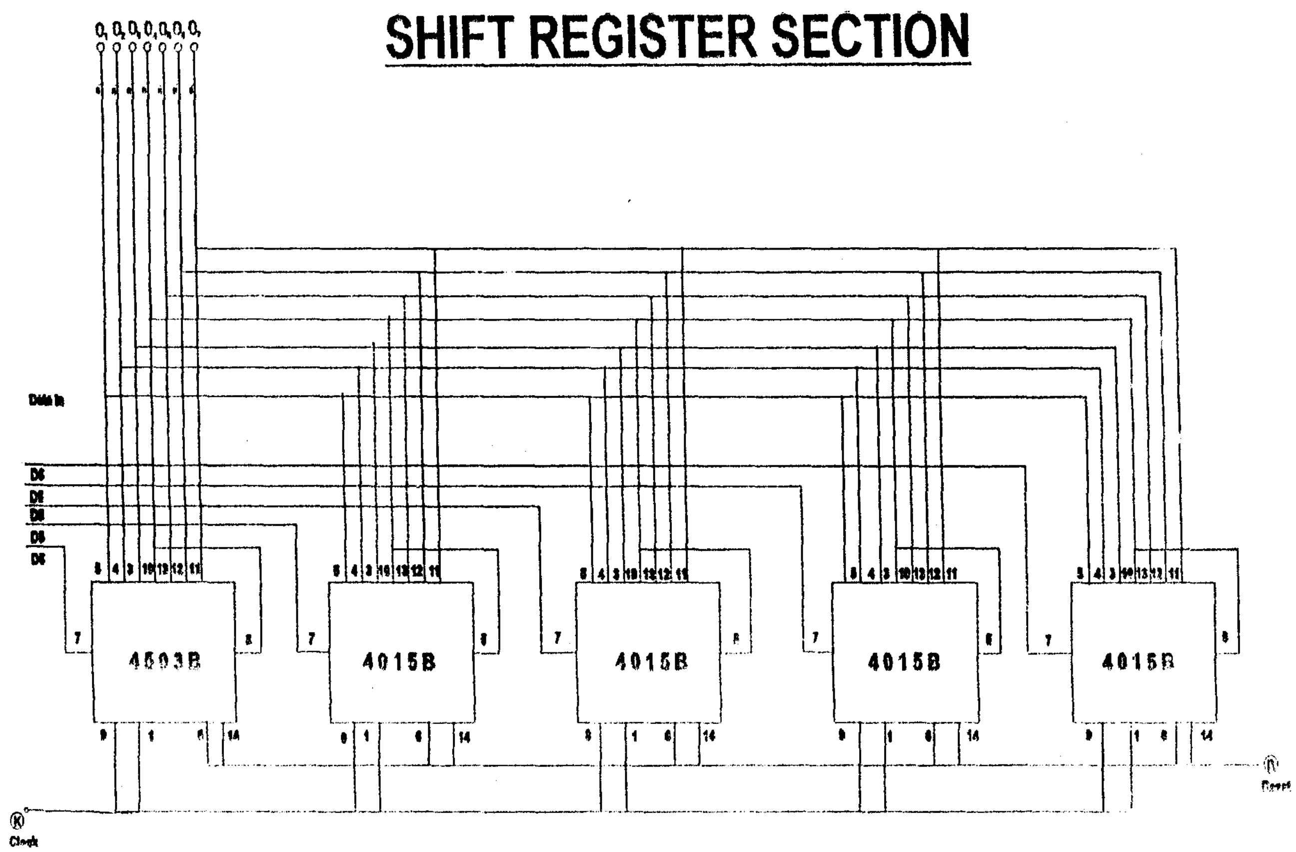


FIG 4.2.3 CONSTRUCTION OF THE SHIFT REGISTER SECTION

4.2.4 4503B BUFFER/4017B FREE RUNNING STEPPER.

Each output from the shift register section is connected to a 4503B tri-state buffer through the buffers' pins 2, 4, 6, 10 and 12 which are data pins and are connected together. Pins 1 and 15 are connected together and fed by the outputs of a 4017B (free running stepper) through a NOT gate. Since the 4503B buffer is active in the low state, a NOT gate is used to change the output of the free running stepper from a high to a low so as to enable it.

The 4017B is the same as that used initially, only that it serves a different purpose. The output frequency from pin 7 of the 4060B oscillator is connected to pin 14 of the free running stepper to clock it. Instead of eight outputs this time, only seven are needed so pin 6 and pin15 are cascaded while pins 3,2,4,7,10,1 and 5 are connected to each 4503B buffer respectively through NOT gates. Pin 16 is used to power the device. This connection is shown in Fig. 4.2.4 below.

BUFFER/MULTIPLEXER SECTION

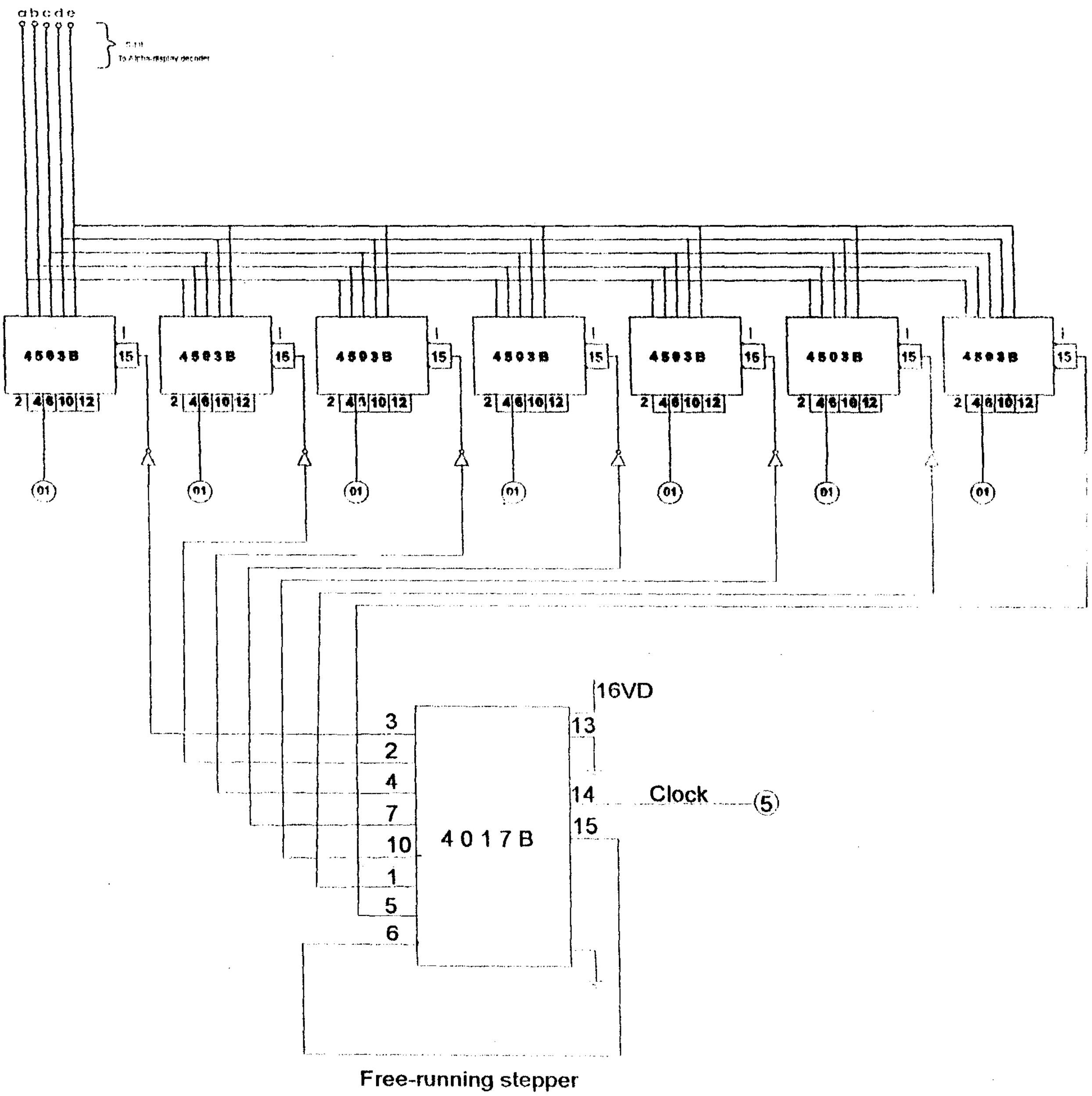


FIG 4.2.4 CONSTRUCTION OF THE BUFFER/MULTIPLEXER SECTION

4.2.5 4515B ALPHA DECODER

This unit consists of the 4515B 4 to 16 line decoder, OR gates, PNP transistors and diodes (LN4001). When the 5-bit codes arrive at the 4515B, for characters that have their first four bits similar an OR gate is used to switch the fifth bit to either a "0" or a "1" depending on the character to be displayed e.g. "R" and "P" have their first four bits as the same, but if the fifth bit is a "0" character "R" is displayed and if it is a "1" character "P" is displayed.

Only twelve of the sixteen output pins of the 4515B are used, the remaining four are left idle. A PNP transistor is connected to each output pin, and an extra five transistors are used for the characters that are the outputs of the OR gates, bringing the total number of transistors used to seventeen. Each transistor produces a particular character used for the display.

In turn, each transistor is connected to a number of diodes that are equivalent to the number of LEDs lighted up to form a particular character. For instance, when character "M" is displayed, a total of twenty-four LEDs are lighted up which means that twenty-four diodes are connected to the transistor that produces "M".

4.2.6 THE LED DISPLAY BOARD

The display board was made of chip board with dimensions 150cm by 25cm. A hand drill was used to bore a number of two hundred and ninety-four holes into the chip board with an inch space between each LED and two inches between each group (42 LEDs) of LEDs. All the LEDs cathodes (positive terminal) were soldered together while the anodes (negative terminal) were fed from the diodes in the display decoder section. All the cathodes soldered together formed a single output to which the NPN transistor was soldered which acts as a driver. This was done for all the seven groups of forty LEDs.

A limiting 1K resistor was soldered between each transistor and the outputs from the 4017B free running stepper so as to ensure that the right level of voltage enters into the transistors.

The casing of the display board was made of plywood with dimensions (151 * 26 * 13) cm while the front panel was made of tinted glass so as to enhance the display's output. The arrangement of the LEDs on the board is shown in fig 4.2d.

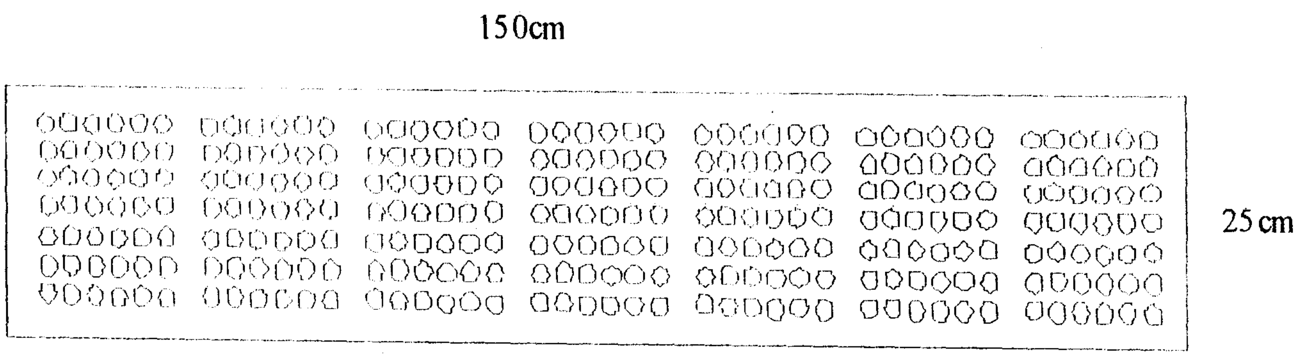


Fig 4.2d ARRANGEMENT OF LEDs ON THE DISPLAY BOARD

CHAPTER FIVE

5.1 CONCLUSION

Having tested the finished construction, it can be concluded that the aim of the design was achieved. Although some bottlenecks were encountered along the line where the transistors in the display unit module were found to be incompatible with the logic family of the IC used. It took a lot of money and time to finally get the appropriate one as various ones were used to day with a lot of perseverance, a transistor that yielded satisfactory results was found.

It will be seen that the resulting instrument or appliance is bigger than that available for commercial purposes. This is because commercial manufacturers use LSI (Large Scale Integration) circuits and components which are not readily available in the market, and even when available are too expensive for a project design such as this.

5.2 RECOMMENDATIONS

After all that's said and done, it will be advised that in future projects of this nature, as much as possible CMOS (Complementary Metal-Oxide Semiconductor) logic family IC's should be used, as they have several advantages over other logic family circuits which include:

- Low power consumption (3-15) V
- Better Noise Immunity
- Maximum Fan Out
- Low Nose Generation

- Simple Internal Circuitry

All the above listed features make the CMOS logic family ideal for project designs of any kind. Also for students or organizations that are buoyant that intend to embark on this project or something similar, LSI IC's should be used so as to reduce the physical size of both the circuitry and the board. Using LSI circuits will also enhance programmability and the display of texts that contain more characters, and probably images.

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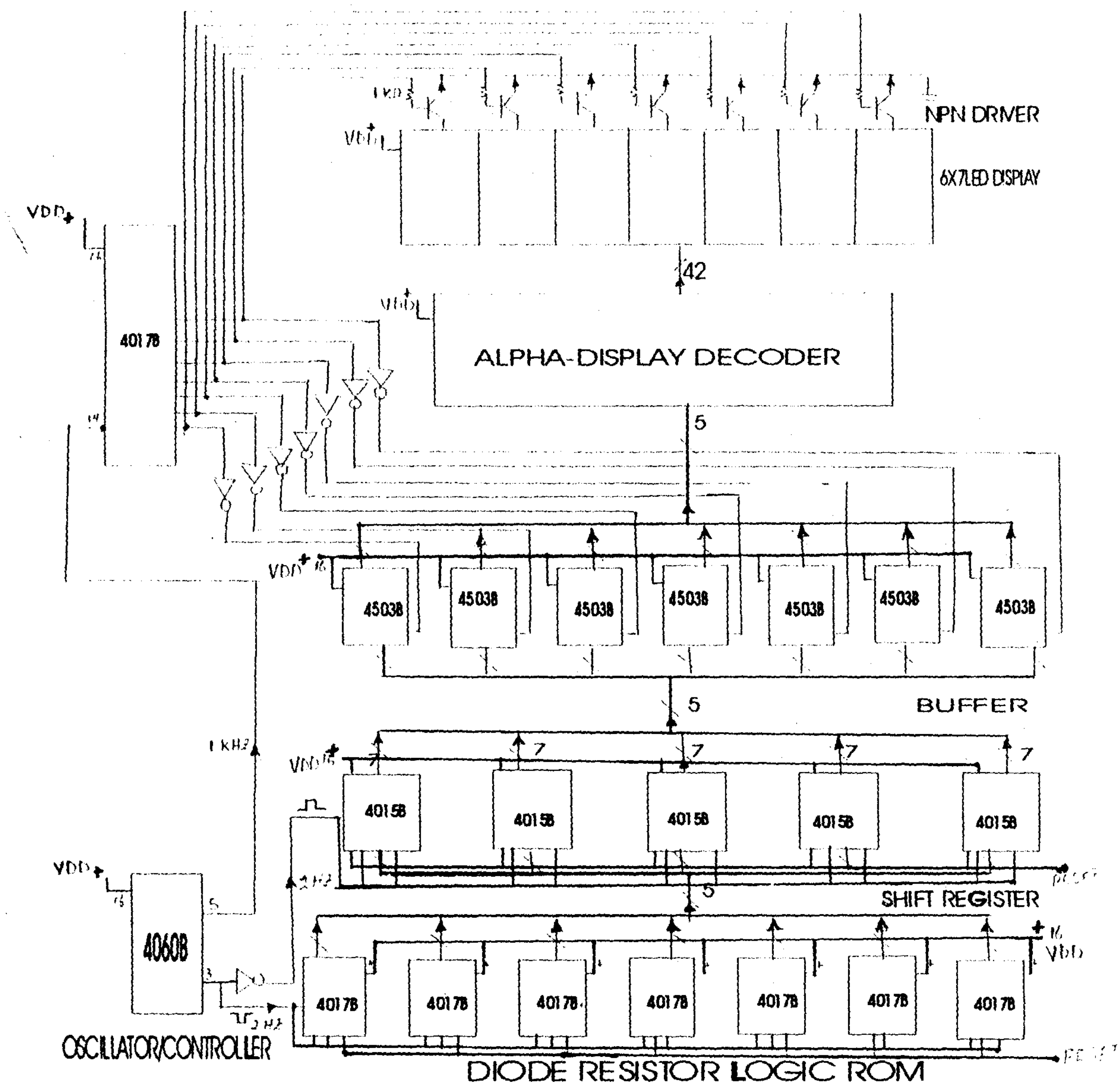
APPENDIX 1

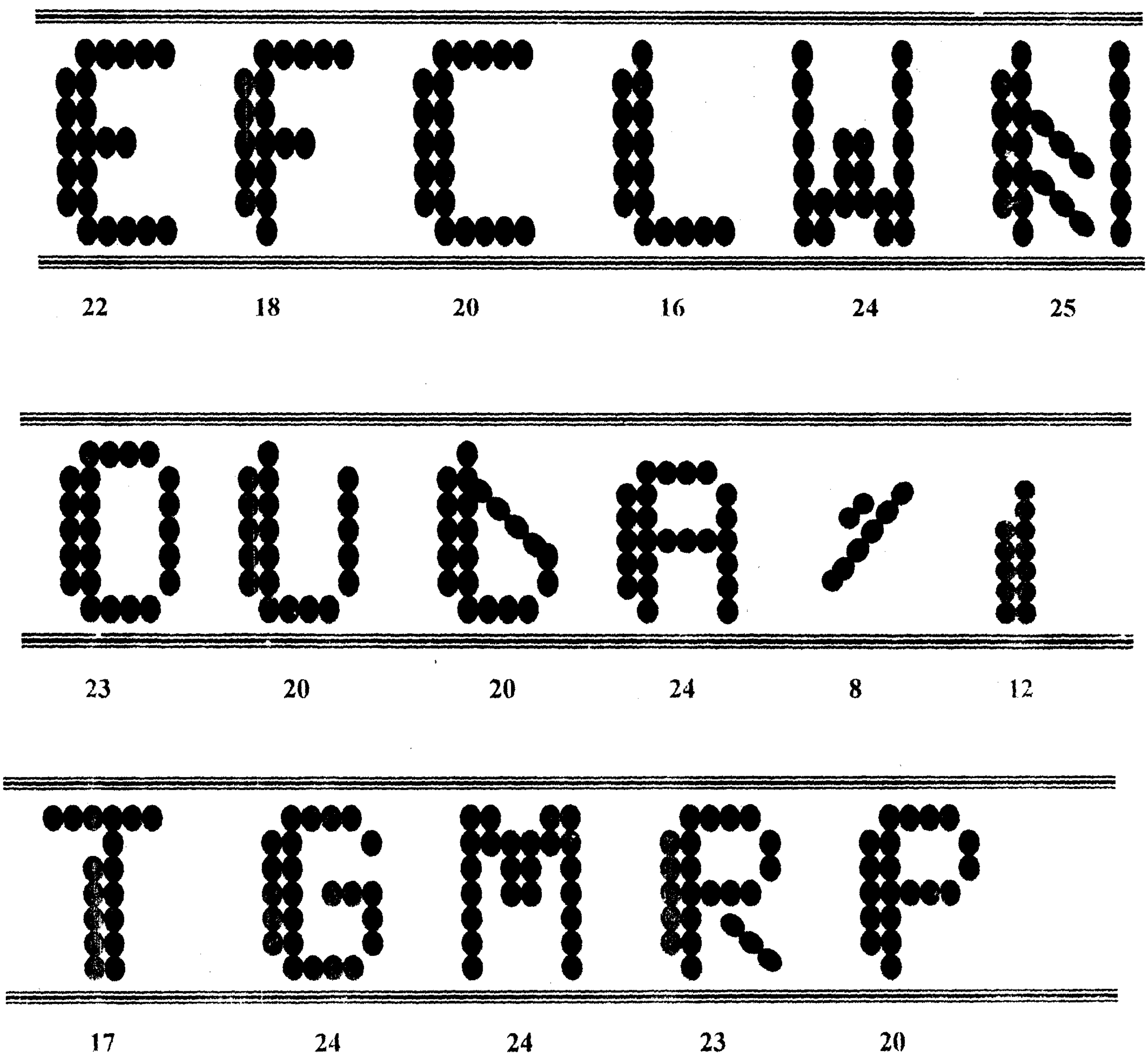


THE FUNCTIONAL DIAGRAM OF THE WHOLE CIRCUIT

APPENDIX II

1. W – 01101
2. E – 00001
3. L – 10010
4. C – 00010
5. O – 10110
6. M – 01011
7. E – 00001
8. SPACE
9. T – 01000
10. O – 00110
11. SPACE
12. D – 01001
13. E – 00001
14. P – 10100
15. A – 01010
16. R – 00100
17. T – 01000
18. M – 01011
19. E – 00001
20. N - 00101
21. T - 01000
22. SPACE
23. O 00110
24. F – 10001
25. SPACE
26. E – 00001
27. L 10010
28. E - 00001
29. C – 00010
30. T – 01000
31. R 00100
32. I – 11000
33. C - 00010
34. A - 01010
35. L - 10010
36. / - 00111
37. C - 00010
38. O – 00110
39. M – 01011
40. P – 10100
41. U - 10110
42. T – 01000
43. E – 00001
44. R - 00100
45. SPACE
46. E 00001
47. N 00101
48. G - 01100
49. I - 11000
50. N 00101
51. E – 00001
52. E 00001
53. R 00100
54. I – 11000
55. N - 00101
56. G - 01100

APPENDIX III



THE CHARACTERS AND THE NUMBER OF LEDS