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Design and construction of a dot matrix information display for the office of the vice chancellor, Anambra State University, Uli

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ABSTRACT

This is a project work done at Anambra State University, Uli. It was done in three stages namely the design, construction and working of a Dot Matrix Information Display. The project covered a fairly comprehensive study of a Dot Matrix Information Display. Digital instruments, signals, and related numbers and codes were discussed. The two possible voltage levels characterized by HIGH or LOW, ON or OFF, TRUE or FALSE, PRESENT or ABSENT were represented abstractly by the digits 0 and 1. Electronic information board, logical operations, integrated circuit, microcontroller, etc were discussed. Basic sequential and combinational digital systems were dealt with. Choices of components were made. Such components as the 8051 processor, the AT89C52 microcontroller, the LM 7805 regulator, the light emitted diode (LED), the latch 74374 IC, etc., were employed. The project has been carefully designed such that the Dot Matrix Information Display operates with electrical power from any source-alternate or direct current. Program written in Assembly language was burned into the EPROM (Erasable Programmable Read Only Memory) of the system. The operation and working were enunciated. There are recommendations as the project is of outstanding quality. The feature of multiple colour makes it unique from other single colour display. It was thereafter installed at the vice chancellor's office free from mechanical shock and vibration.

INTRODUCTION

In this modern time, solid state materials have helped man to show that he really exists by doing wonders in the world of electronics. One major development, made possible by the enormous advances in solid state technology, is the "digital revolution". Circuits are designed to implement the basic digital logic functions fundamental to all digital systems. Digital electronics therefore compasses the design, manufacture, and use of circuits for processing information in digital form [1]. Since the early 1990s schools have been on the frontline of the Information Communication Technology (ICT) revolution. The extent of development in information dissemination has made it possible that the well known method of displaying information using sign posts, placards, notice boards, etc has to be modified by using electronic information board. In the previous years, the means by which adverts, information, etc., are made has been through the method of the digital display board. But the use of static mode of sign display such as banners, flyers etc are becoming boring and unattractive. The new technologies of the digital age have made possible the use of programmable and reprogrammable electronics display to provide solutions to this kind of problem.

This piece of technology can be found in a number of places and are being used for different purposes. In banks, it is used to display interest rates as well as exchange rates. In hotels and pubs, it is used to display the menu and prices. Actually there are different areas of application of this project, numerous to mention [2]. A dot matrix display is an array of light emitting diodes (LEDs) arranged in a 7 X 7 matrix that is used to display a programmed data/information.

1.1 DIGITAL SIGNALS

The main purpose of electronic circuits is to process electrical signals whose amplitudes or vibrations with time contain useful information. By processing we mean the circuit accepts the signal at one point (called the input), performs certain operations on this signal, and then delivers it to another point (called the output). The characteristic of the output signal in some sense is more desirable to the user than that of the input signal. Electrical signals are voltages and currents that vary with time. These signals can be one of the two basic types: continuous-time (analog signal) and discrete-time (digital signal). In analog signal, the height of the column varies continuously with temperature, and its value is analogous to the temperature. The discrete-time signal, on the other hand, is defined only at prescribed discrete instants of time. It is one that is by nature discrete or discontinuous, such as a voltage that can only be either HIGH or LOW.

1.2 BCD System

The term Binary Coded Decimal (BCD) code is used when the digits of decimal number are individually subcoded in binary code. It is interesting to note that there are 8008 ways to form BCD codes. This is the number of ways one can select 16 things ten at a time. Since there are only $2^3 = 8$ combinations of three –bits binary numbers available and there are ten decimal digits, any BCD system must consist of binary numbers having at least four bits. The most common form of BCD is the one in which the ten decimal digits are simply represented by their binary equivalents. This system is sometimes called the Natural Binary Coded Decimal (NBCD). In this natural cases the place values, or weights, of the bits in the code are 2^3, 2^2, 2^1, and 2^0 or 8, 4, 2, and 1. The NBCD is also called the 8421 BCD or simply BCD. It is shown in the second column of Table 1.1 along with other BCD codes. Because the bits represent weights the NBCD code is sometimes called a weighted code.

Table 1.1 BCD Codes

Decimal Digit	8421 straight BCD Code	2421 BCD Code	7421 BCD Code	Excess 3 Code
0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1 1
1	0 0 0 1	0 0 0 1	0 0 0 1	0 1 0 0
2	0 0 1 0	0 0 1 0	0 0 1 0	0 1 0 1
3	0 0 1 1	0 0 1 1	0 0 1 1	0 1 1 0
4	0 1 0 0	0 1 0 0	0 1 0 0	0 1 1 1
5	0 1 0 1	1 0 1 1	0 1 0 1	1 0 0 0
6	0 1 1 0	1 1 0 0	0 1 1 0	1 0 0 1
7	0 1 1 1	1 1 0 1	1 0 0 0	1 0 1 0
8	1 0 0 0	1 1 1 0	1 0 0 1	1 0 1 1
9	1 0 0 1	1 1 1 1	1 0 1 0	1 1 0 0

If a decimal number

$M= g_3 A_3 + g_2 A_2 + g_1 A_1 + g_0 A_0$ 1.9

Where g_i = weight. Selecting:

$g_3 = 8, g_2 = 4, g_1 = 2, g_o = 1.$

The BCD is called 8-4-2-1 code.

i.e $M = 8.A_3 + 4.A_2 + 2.A_1 + 1.A_0.$

so that

$M = 5 \longrightarrow$

$8.0 +4.1+2.0+1.1$

$= 0 +4 + 0 + 1$

$M = 8 \longrightarrow 8.1 + 4.0 +2.0 +1.0$

$= 8 +0 + 0 + 0$

$M= 9 \longrightarrow 8 +0 + 0 + 1$

And so on.

Thus, the BCD code of a decimal number of more than one digit is obtained by replacing each digit by its four – bit BCD code. For example, the BCD representation of 23 is 0010 0011, since 0010 is the BCD code for 2 and 0011 is the BCD code for 3. It should be noted that the BCD code for a decimal number larger than 9 is not the straight binary equivalent. In the example just considered the binary equivalent of 23 is 10111, which is not its BCD code. In fact, the six binary numbers that are the equivalents of the decimal numbers 10 through 15 are not valid BCD numbers; they do not represent decimal digits but HEX A, B, C, D, E, F.

1.3 ELECTRONIC INFORMATION BOARD

This is a digital device that operates with just 0's and 1's. It is a microcontroller based device which uses a popular microcontroller (AT89C52). Our thoughts or desire, the data, is unprocessed information. Information is the meaningful content of a data-bearing signal. The data in which we want to publicize is written down in form of a program which will now be assembled into the memory. A program is a sequence of instructions properly ordered to perform a particular task. Thus, data are sent into the processor via the memory and latch (although a keyboard can be used if the output display is interfaced with a computer). The programs in the memory serve as an input to the processor. The glowing LEDs are controlled basically by microprocessor. Microprocessor is the heart of the embedded system. The processor being able to understand the program will now execute the content of the input by sending 0's and 1's to the decoders. It is with the help of logic configuration of the decoders that our desire is being manifested at the output display board. The situation where by the entire write up or even the notice board has been changed in attempt to add a little information to the existing one is solved by electronic information board. This problem is solved simply by erasing the content of the memory and replacing it with latter information and the output display will automatically begin to respond to the recent memory content. This process of erasing and replacing it with a recent program can be achieved under few minutes, hence in the case of business centers; customers will not lose sight of the business day-to-day activities.

This information board is very flexible in operation in the sense that it can be used to display numerals, alpha numerals, sketches of both static and moving images, etc. The functionality of a display board is shown in figure 1.1.

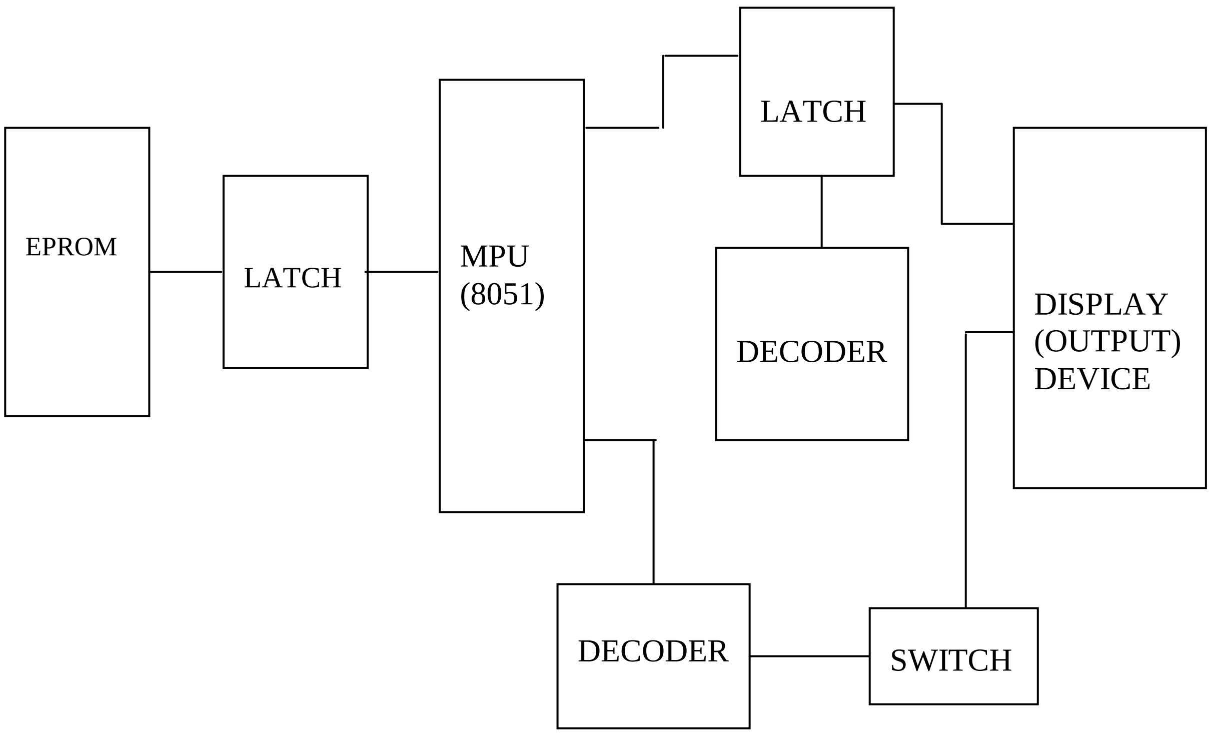


Fig. 1.1 Block Diagram of an Electronic Information Board

2.0 THE PROCESS OF DESIGN AND CONSTRUCTION

The assembly drawing of the dot matrix information display designed is a complete circuit that gives part number, pin numbers, and physical locations for all the components.

2.1 CIRCUIT BOARD DESIGN AND IC CHIPS

The whole design was done on two separate Vero boards. The positions meant for the 1C chips were cut open longitudinally to disconnect the pins from each other. The purpose was to avoid the pins being at the same potential since the board was of the type whose centre holes were connected together in single column by copper conducting material. The IC bases or holders (for plugging in the IC chips) were mounted in the holes upon the longitudinal cuts. The chips were then connected to the appropriate pins of the holder using fine wires, the tiny jumper wires. These connections were carried out using soldering techniques:

Soldering iron, lead (solder), long nose pliers, cable cutter, file, were used. The surfaces to be soldered were properly cleaned of any oxide coating by filing. The surfaces were tinned so that soldering applied adhered to them. The pieces were brought together in the form of a hook. The hot soldering iron was equally filed clean to remove any oxide film and tinned or coated with solder so that solder applied adhered to it and flowed freely from it. The hot soldering iron was then placed on the joint and fresh solder applied. The solder was allowed to melt and run smoothly over the surfaces, preventing atmospheric oxygen from attacking the joint. The soldering iron was then withdrawn and the joint allowed to cool. Care was taken during the soldering to eschew short circuitry. Sequel to the above unpredictable situation, IC sockets was soldered first and was tested satisfactory before inserting the ICs.

2.2 LOADING THE ROM

The written program is loaded into a ROM using a ROM writer. Then the microcontroller and the latch were installed. Inside the 8051 we have the crystal that synchronizes the operation of the microcontroller. This crystal is an electrical device which when energy is applied, emits pulses at a fixed frequency. One can find crystals of virtually any frequency depending on the application requirements. The more common crystal frequencies are 12 MHZ and 11.059 MHz with 11.059 MHZ the most common and that was the one used in this project. The crystal oscillator is unstable and has 11.095 MHz for clocking the microcontroller for 11.095 million times per second.

2.3 FABRICATION

A slide from a sheet of Perspex, a tough plastic material which was perforated by a drilling machine to the diameter of the LED, was used to put the LEDs in place. The LED was fixed, connected and also soldered.

2.4 THE POWER SUPPLY

Electronic devices and circuits require energy in the form of electricity to work. However, almost all of them work with low dc voltage, hence, need arises to step down the high ac voltage and convert it to electronic useable dc voltage. The circuit that does this work is known as rectifier circuit and all of them fall under the power supply circuit. The system is meant to use 6.5V max and 3.5V min, the average of which is

$$V_{av} = \frac{10V}{2} \qquad 1.1$$

= 5V as best option

2.4a RECTIFICATION

The rectification stage is usually preceded by a transformer, which is equipment that steps down line voltage down to safer and lower levels that are more suitable for rectifier diode to handle. The transformer is composed of three important elements; a primary winding, a secondary winding, and a core structure of some type as shown in figure 1.2.

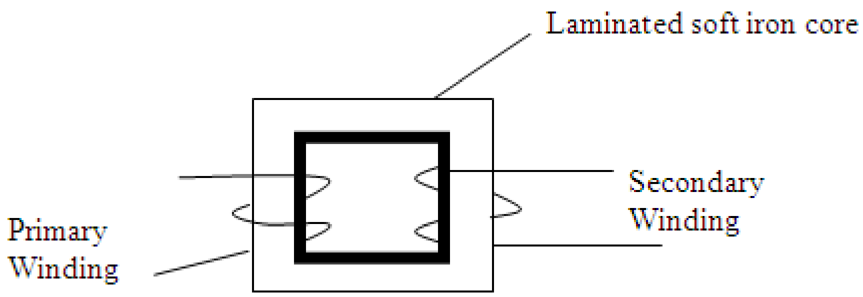


Fig 1.2: Transformer

When the transformer has stepped down the voltage to the required level, the rectifier diode are then used to convert the alternating current to dc voltage. There are half wave rectification and full wave rectification. In this work full wave rectification is employed as shown in figure 1.3.

In the circuit shown on figure 1.3, diodes D_1 and D_3 conduct at the positive half cycle of the ac input while diodes D_2 and D_4 conduct at the negative half cycle. The output voltage from this circuit is smoother than the output voltage from the half wave rectifier. The ripple factor of the full wave rectifier of this sort is 48%. Hence, it is clearly much better than the half wave rectifier since the full wave signal has twice as many positive cycles as the half wave signal, the dc or average value is twice the peak voltage;

$$V_{av} = \frac{2V_p}{\pi} \qquad 1.2$$

Where V_p is peak voltage

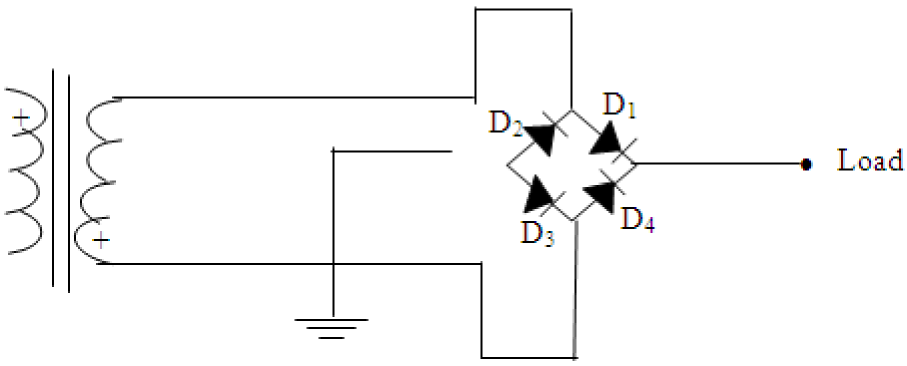


Fig 1.3 (a) A Full Wave Rectified Circuit

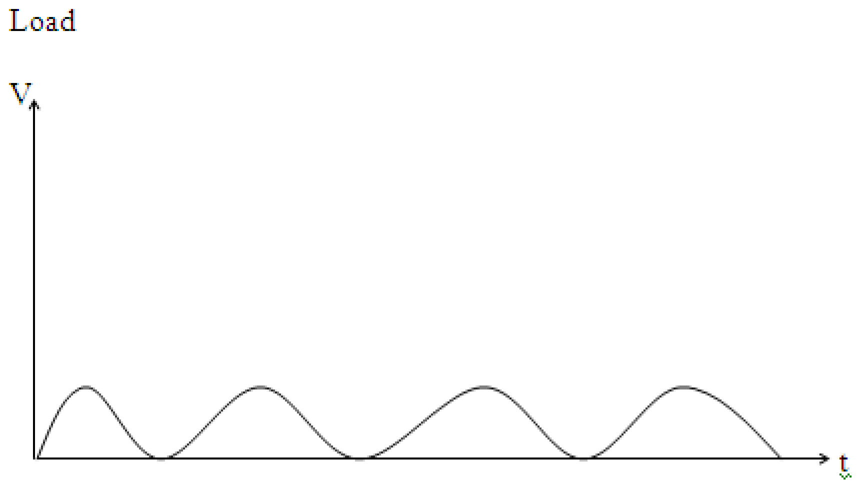


Fig. 1.3(b) Output Voltage Wave Form

2.5 FILTRATION

After rectification, the dc obtained is usually filled with ripples which are very harmful to the electronic devices that will use it especially the microcontroller. This calls for the filtration of the rectified output to produce a smooth voltage. The smoother the voltage the more lasting is the ICs. When a full wave or bridge rectifier is connected to a capacitor, the peak to peak ripple is cut in half. When a full wave voltage is applied to the RC circuit, the capacitor discharges half a cycle. Therefore, the peak-to-peak ripple is half the size it would be with a half rectifier. The peak –to- peak ripple voltage;

$$V_R = \frac{I}{fC}$$

I = dc load current
f – ripple frequency
C- capacitance

To get a good filtration, it is advisable to use a capacitor of voltage about twice the value of the expanded input voltage. In this work, a capacitor of 400V at 3300 µf was used.

2.6 REGULATION

After the stepping down the voltage using transformer, rectification by the rectifier and filtration by the capacitor, the voltage is ready to be used though the faithfulness of the voltage cannot be predicted. In order to make the voltage constant, a regulator is needed. A zener diode could be used for this purpose; however, in this work 7805 IC regulator was used as shown on figure 1.4. In figure 1.4, +5V point terminals were connected to a point and the ground point terminals grounded to a point.

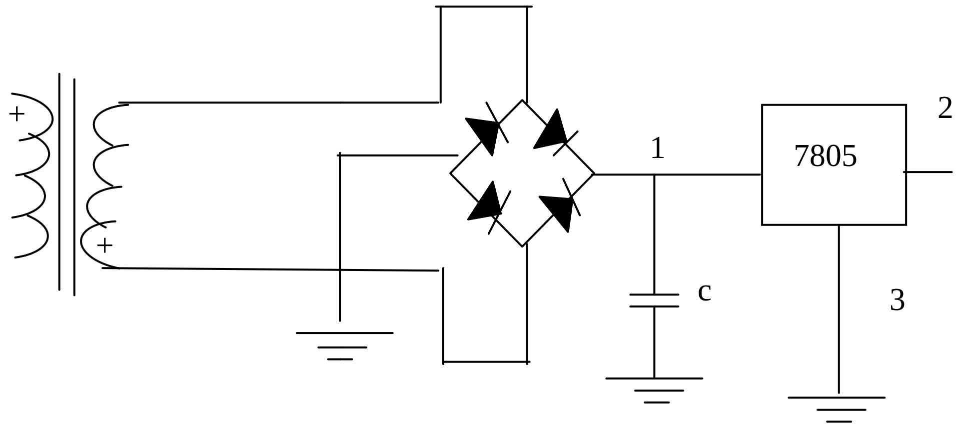


Fig. 1.4: A 5 Volt Power Supply Circuit

2.7 THE DISPLAY SYSTEM

It is often desirable to monitor the activities going on with the microcontroller. In a PC, the video monitor does the job but in a system like this project, the dot matrix display is preferable. Most often the connection we use is what we call matrix addressing techniques where a display element must receive two or more gating signals before it is activated. Matrix addressing requires that the picture elements of a panel be arranged in rows and columns, as shown on figure 1.5 below for the 7x7 matrix. Each element in a row or column is connected to all other element in that row or column by active device (typically transistors). Thus, it is possible to select the drive signals so that when only a row or column is driven, no elements in that row or column will be activated

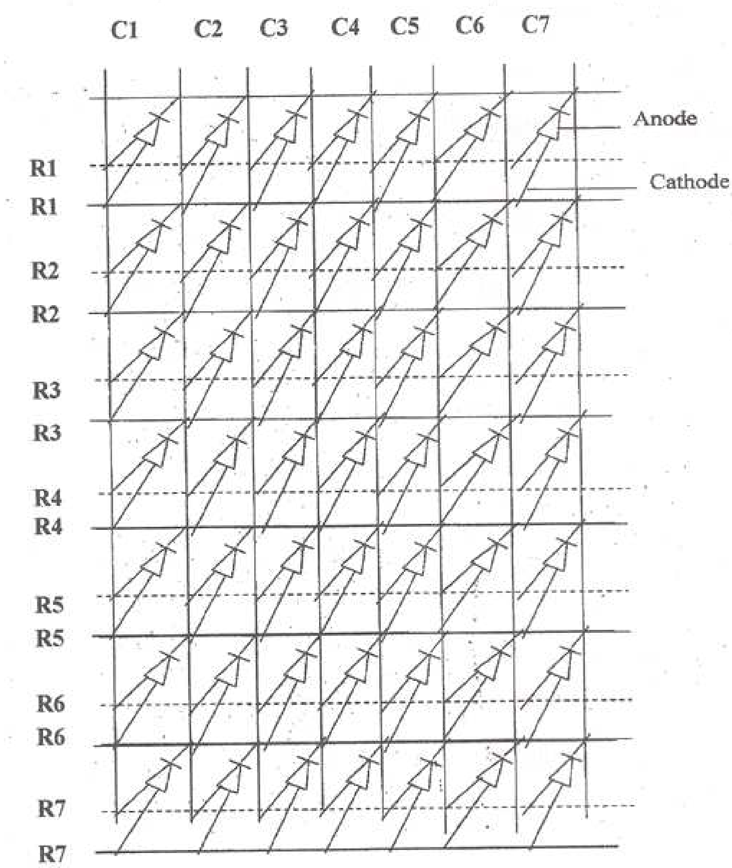


Fig. 1.5: 7x7 Dot Matrix Array

2.8 THE SOFTWARE

This is the written program that contains the bearer's intention. The screen displays the content of this program. In this work, the content of this display is as follows:

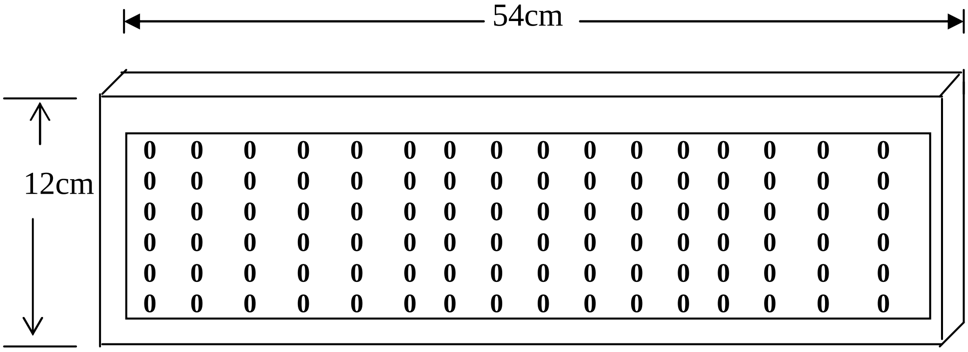
WELCOME TO OFFICE OF THE VICE
CHANCELLOR, ANAMBRA STATE UNIVERSITY,
ULI. UNIVERSITY OF THE MOMENT. COURTESY
OF F.O. OBIECHINA, DEPARTMENT OF INDUSTRIAL PHYSICS.

This is the part of the work that gives life to the entire system and differentiates it from other displays constructed in the past. In it is embedded the desired function of the entire hardware.

2.9 TESTING/COUPLING

The completed work was tested before assembling them. This was necessary since microcontroller is a voltage sensitive component that gets damaged easily. The aim was to make sure that all the LED on the display panel or board was lighting correctly. The link to the microcontroller ports was also confirmed. When the output from the power supply was connected to Vcc terminals, the LED started displaying. The whole assemblage was carefully fitted on an aluminum sheet, screwed tightly and cased as shown on figure 1.6.

Fig. 1.6: The Framed Circuit



2.10. MODE OF OPERATION

In figure 1.6, once the system is powered, it will first carry a shift operation which will now clear the screen. Hence, it will start to display the information. It produces so many effects on the write up depending on the program written. The electronic information display board is a digital device that is replacing the conventional way of disseminating information through notice board, posters, placards, etc.

CONCLUSION

In conclusion, the display board was designed, constructed, tested satisfactorily and was found worthy of mass production. It was designed from inexpensive components. It has features that made it unique from other display boards in the market; the presence of multiple colour makes it preferable to other single colour display and the fact that it displays information on the office of the Vice Chancellor, Anambra State University, Uli, Anambra State, Nigeria.

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