DESIGN AND CONSTRUTION OF A DIGITAL THREE-CHANNEL AUDIO/VIDEO SELECTOR

BY

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DEDICATION

This project is dedicated to Almighty Allah (S.W.T.) who has spared my life through the programme and also my dear parents for their total support in prayers and love for me in all aspects of my life.

DECLARATION

I, Baba Ibrahim, declare that this work was done by me and has never been presented elsewhere for the award of a degree. I also hereby relinquish the copyright to the Federal University of Technology, Minna.

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ABSTRACT

This project involves design and construction of a digital three- channel Audio / Video Selector. It is a general purpose selector projector that can be modified to meet future requirements.

The Audio / Video selector (AV) selector is a device or equipment that is used to select a particular AV signal or channel from available channels.

The project aim is to provide a device that can select a particular Av signal from three available signals for video studio, close circuit television (CCTV) and other home – use applications.

The project deals essentially with the design and construction of a digital three- channel Audio / Video Selector. Therefore, complementary metallic oxide semi-conductor (CMOS) integrated circuit (IC's) are used to achieve the desired goals of the design and construction.

Both the design and construction and testing were carried out successfully by me.

The project consists of the following modules;

- AV input terminal
- AV output terminal
- Analogue switching unit
- Digital control unit
- Indicator unit
- Power supply unit

Table of content

CHAPTER ONE

1.1 INTRODUCTION

This project is all about a digital 3-channel AV selector for video studio, Close Circuit Television (CCTV), and other home-use applications.

The design involves the smooth digital selection of a particular channel of an Audio/Video signal from three available ones.

1.2 AIMS AND OBJECTIVES

The main objective of this project is to design and construct a digital 3-channel Audio/Video selector.

Other aims are as follows:

- Ability to identify the various components necessary and their alternatives for the design.
- Select various (three) input signal to view at a time.
- Relating various electronic components functions.
- It is ought to operate both manually and automatically.

The use of Complementary Metallic Oxide Semiconductor (CMOS) integrated circuits (IC) is quite evident in the involved circuit which is justified by the merits of the logic as compare to the common other alternative, Transistor- Transistor Logic (TTL).It is known for its high density content, high flexibility, low power consumption, wide voltage supply range, low cost, and large features. The design is aimed for considerable level of simplicity.

1.3 METHODOLOGY

The design of the leading device, certain factors must be put into close consideration.

These includes:-

i. Minimum circuit complexity
ii. Circuit efficiency
iii. Cost effectiveness
iv. Power dissipation
v. Availability of components\

Most of these factors are achieved by the selection of CMOS integrated circuits.

The requirement for this project work is:

i. Some means of providing power to the circuit
ii. Control input buttons.
iii. AV Input sockets
iv. AV output sockets
v. The provision and incorporation of a digital-analogue switching circuit.
vi. Select indicators

The back bone of the work is relevant information from numerous sources.

1.4 PROJECT OUTLINE

The project set out to present an orderly account of work done. It consists of five chapters:

Chapter one; this chapter gives an insight into the project from an introductory point of view and present the stated objectives of the project.

Chapter two; this gives a historical review of the project, theoretical background and also expatiate on some of the fundamental which applied in carrying out the task.

Chapter three; this chapter shows all the steps carried out in setting up the circuit element and report on the construction and testing of the circuit.

Chapter four; this contains steps taken to test the. Shortcomings or limitations of the work are also explained

Chapter five; this chapter gives the conclusion of the work, summary of the work is presented and result obtained and problems encountered.

1.5 MERIT AND LIMITATION

The simplicity of the work as compare to its huge importance is quite a merit but, the only three channels feature of the design is indeed a limitation.

CHAPTER 2

LITERATURE REVIEW

2.1 HISTROY AND DEVELOPMENT OF VIDEO /AUDIO GAUGETS

Any thing "video" originated from the invention of television. The term video means "I see" in Latin. Television (often abbreviated to TV, T.V.; sometimes called , telly or the tube in British English) is a widely used telecommunication system for broadcasting and receiving moving pictures and sound over a distance. The word is derived from mixed Latin and Greek roots, meaning "far sight": Greek tele (τῆλε), far, and Latin vision, sight (from video, vis- to see) [5].

Since it first became commercially available from the late 1930s, the television set has become a common household communications device in homes and institutions, particularly in the first world, as a source of entertainment and news. Since the 1970s, video recordings on VCR tapes and later, digital playback systems such as DVDs, have enabled the television to be used to view recorded movies and other programs. This device deals with both Video and Audio signal.

Available development in video technology embodies: digital video formats, including DVD, QuickTime, and MPEG-4; and analog videotapes, including VHS and Betamax. Video signals go along with corresponding audio signals, expect in rare cases [5].

Video can be recorded and transmitted in various physical media: in magnetic tape when recorded as PAL or NTSC electric signals by video cameras, or in MPEG-4 or DV digital media when recorded by digital cameras. In the UK, Australia, The Netherlands and New Zealand, the term video is often used informally to refer to both video recorders and video cassettes; the meaning is normally clear from the context.

2.2 VIDEO SIGNAL

Video signals are electrical waveforms which allow moving pictures to be conveyed from one place to another. Observing the real world with the human eye results in a two-dimensional image on the retina. This image changes with time and so the basic information is three-dimensional.

An electrical waveform is two-dimensional in that it carries a voltage changing with time. In order to convey three-dimensional picture information down to a two-dimensional cable it is necessary to resort to scanning. Instead of attempting to convey the brightness of all parts of a picture at once, scanning conveys the brightness of a single point which moves with time. The result of scanning the electrical waveform gives a composite signal [9].

Composite signals are the most commonly used analog video interface. Composite video is also referred to as CVBS, which stands for Color, Video, Blanking, and Sync, or composite video base-band signal. It combines the brightness information (luma), the color information (chroma), and the synchronizing signals on just one cable. The connector is typically an RCA jack [4]. This is the same connector as that used for standard line level audio connections. The combine connection is usually called AV line.

Composite video cannot easily be directed to any broadcast channel simply by modulating the proper RF carrier frequency with it. Most analogue home video equipment records a signal in (roughly) composite format: Laserdiscs store a true composite signal, while VHS tapes use a slightly modified composite signal. These devices then give the user the option of outputting the raw signal, or modulating it on to a VHF or UHF frequency to appear on a selected TV channel. In typical home applications, the composite video signal is typically connected using an RCA jack, normally yellow (often accompanied with red and white for right and left audio channels respectively).

BNC connectors and higher quality co-axial cable are often used in more professional applications [4].

2.2.1 Digital video

One of the vital concept to grasp is that digital video is simply an alternative means of carrying a video waveform using a digital system.

Digital video is a type of video recording system that works by using a digital, rather than analog, representation of the video signal. This generic term is not to be confused with the name DV, which is a specific type of digital video targeted at the consumer market. Digital video is most often recorded on tape, and then distributed on optical discs, usually DVDs. There are exceptions, such as camcorders that record directly to DVDs, Digital8 camcorders which encode digital video on conventional analog tapes, and camcorders which record digital video on hard disks [5].

2 .3 APPILACATIONS OF THE PROJECT

One of the most importance applications of the device is for security monitoring, such as Closed-circuit Television (CCTV).It is applicable for home use in which one of three AV output devices is selected to a television through the device.

2.3.1 Closed-Circuit Television

Closed-circuit television (CCTV) is the use of video cameras to transmit a signal to a specific, limited set of monitors. It differs from broadcast television in that the signal is not openly transmitted, though it may employ point to point wireless links. CCTV is often used for surveillance in areas which need security, such as banks, casinos, and airports or military installations. Increasing use of CCTV in public places has caused debate over public security versus privacy. In industrial plants, CCTV equipment may be used to observe parts of a process that are remote from a control room, or where the

environment is not comfortable for humans [6]. CCTV systems may operate continuously or only as required to monitor a particular event.

The first CCTV system was installed at Test Stand VII in Peenemünde Germany in 1942, for observing the launch of V2-rockets. CCTV recording systems are often used at launch sites to record the flight of the rockets, in order to find the possible causes of malfunctions. Film cameras are also used for this purpose. Larger rockets are often fitted with CCTV allowing pictures of stage separation to be transmitted back to earth by radio link. CCTV is also used to observe the launch pad before the launch, especially when no person may be there because of safety reasons [6].

2.4 THEORICAL BACKGROUND

2.4.1 Principle of operation

The main part of the circuit involves two quad bilateral switches (4066B) with three sub-units each. One of the integrated circuit works for the video channel and the other, audio side. The devices posses an active high control. That is, they can be digitally switched ON or OFF through three logical signals from other compatible device, 4017B decade counter.

The latest integrated circuit is clocked through a single soft touch button. By pressing the button the device selects a particular AV channel to the output. This is the manual operating mode.

The automatic mode involves a 4060B integrated circuit, a RC configured oscillator, whose frequency output can be controlled through a variable resisor. This output can vary the rate of output switching.

CHAPTER 3

DESIGN ANALYSIS

3.1 CIRCUIT DESIGN

The circuit design embodies the following circuit modules:

- Power supply unit
- AV Input terminal
- Analogue switching unit
- Digital control unit
- Indicator unit
- AV output terminal

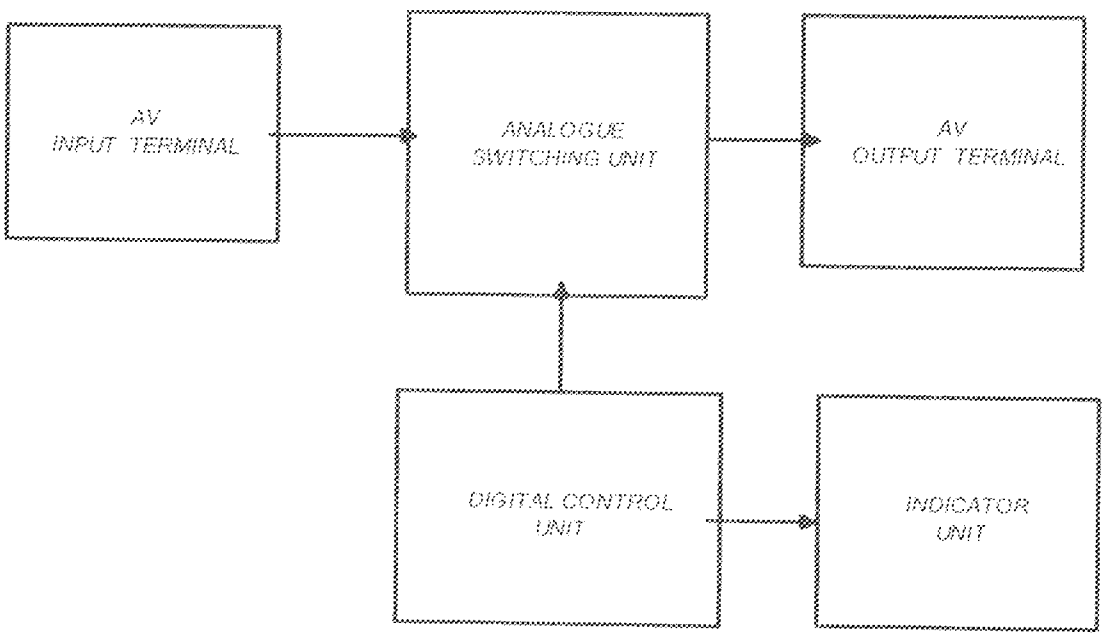

Fig The main block diagram

The above block diagram is explained below.

3.2 POWER SUPPLY UNIT (PSU)

The power supply unit (PSU) is meant to provide a suitable electrical power to all units of the device.

The power unit embodies the following components:-

- A 220V/12V step-down Transformer
- Bridge Rectifier
- Voltage regulator

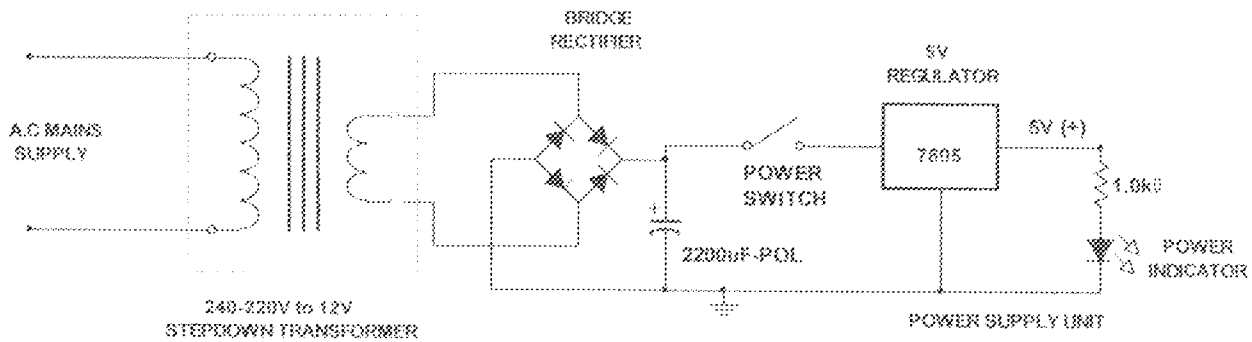

Fig3.20 The Power Unit

3.2.1 Transformer

The transformer used in this circuit is a 220/12V type A.C step-down type with 500mA current rating. It provides a power of about 6 watts.

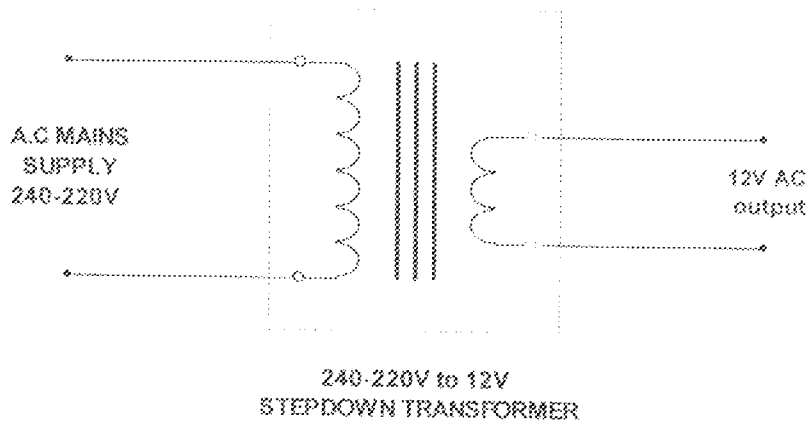

Fig 3.2.1 The in-use step-down transformer

3.2.2 Rectifier

This type of circuit works with D.C voltage, the stepped down AC voltage from the transformer must be rectified to DC for that purpose. The rectifier is made up of four rectifying diodes, connected in a bridge.

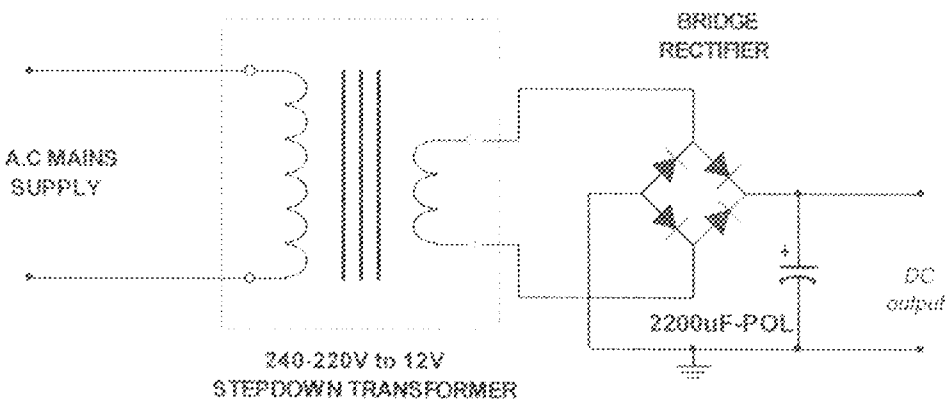

Fig 3.2.2 The Transformer/rectifier circuit

A filtering capacitor (2200uF 35V) in the above diagram is used to remove ripple from the output DC output voltage of the bridge rectifier for better efficiency [7].

3.2. 3 Voltage regulator

The voltage regulator is the 7805 (5V regulator) with 1A current rating. It is incorporated into the circuit for 5V stability [8].

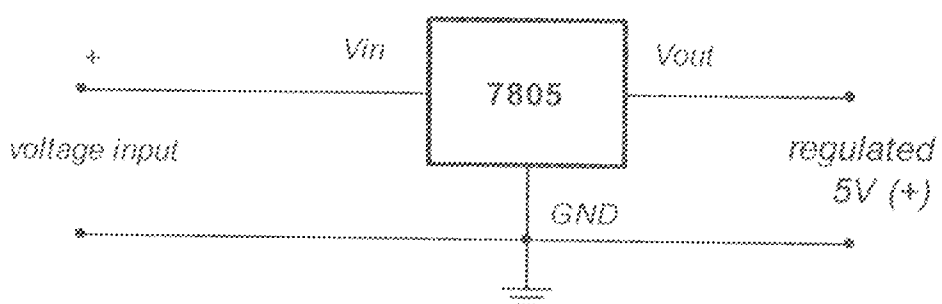

Fig 3.2.3 The 7805 connection

3.2.4 Power indicator

The circuit below is meant to indicate the presence of electric current in the circuit. This circuit comprises of a current limiting resistor and Light Emitting Diode (LED) which requires a voltage of about 2.7V [7].

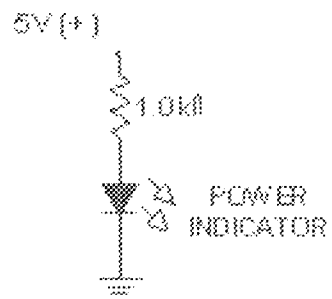

Fig 3.2.4 The Power indicator Circuit

Assuming a current of 2.5mA is expected to flow in the circuit.

Therefore,

$$R = \frac{2.7}{2.5 \times 10^{-3}} = 1080\Omega$$

1000 ohms is used in the circuit.

3.3 AV INPUT TERMINAL

This terminal is where the video and audio (AV) signals are connected to the device or circuit. There are both three audio and video signals. The convectional AV sockets are incorporated into the circuit.

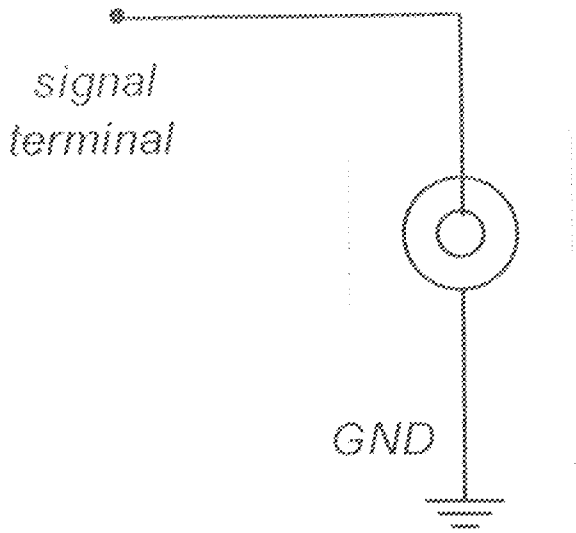

Fig 3.3.0 A Audio/Video input Terminal

The above terminal is used for both the input and output in a corresponding connection.

AV sockets consist of two contacts, one for ground (negative terminal) the other for signal link.

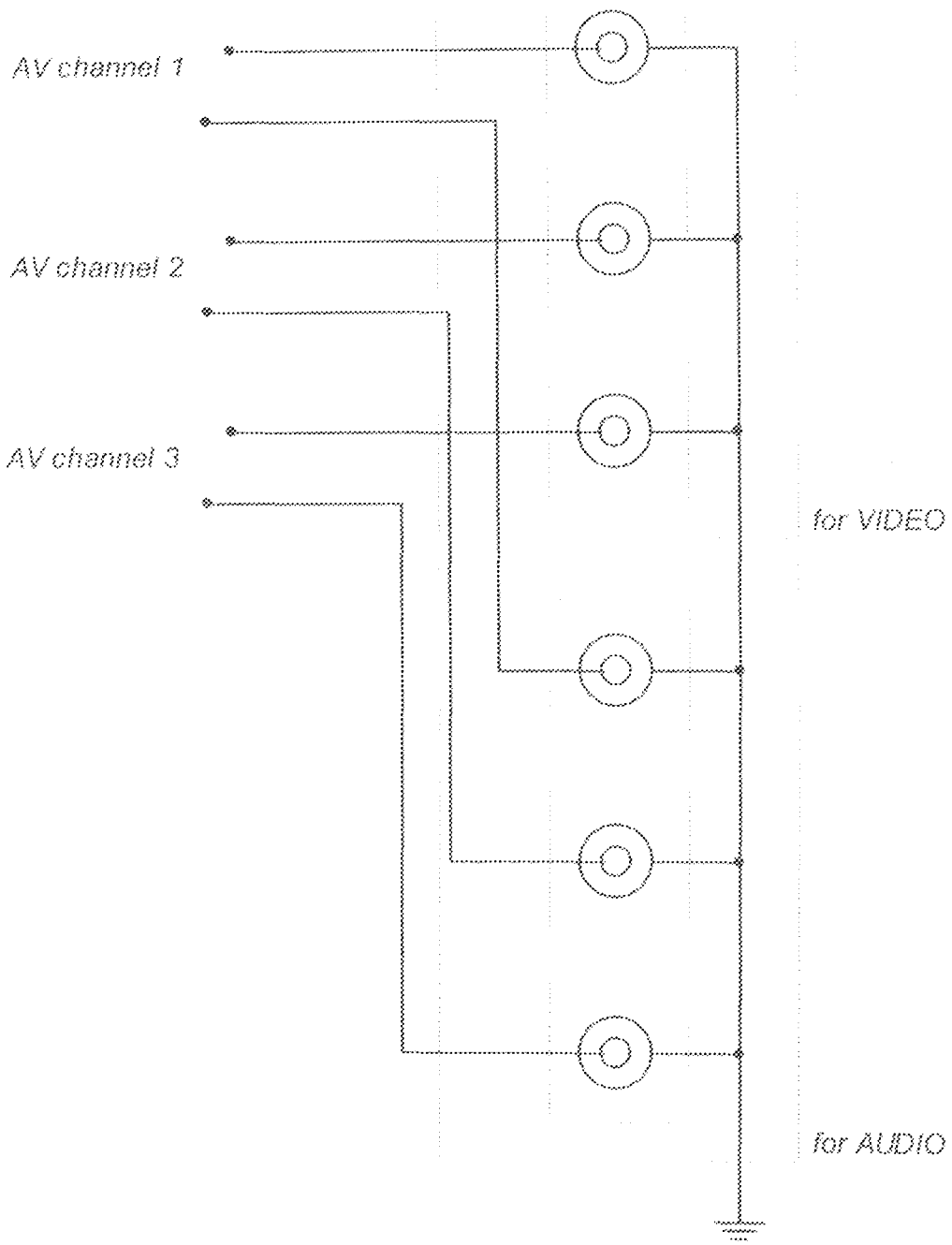

Fig 3.3.1 The AV Input Terminal

3.4 ANALOGUG SWITCHING UNIT

This unit is made of two 4066B Integrated Circuits (Quadrupie bilateral switches); one for the video signals and the other for audio switching.

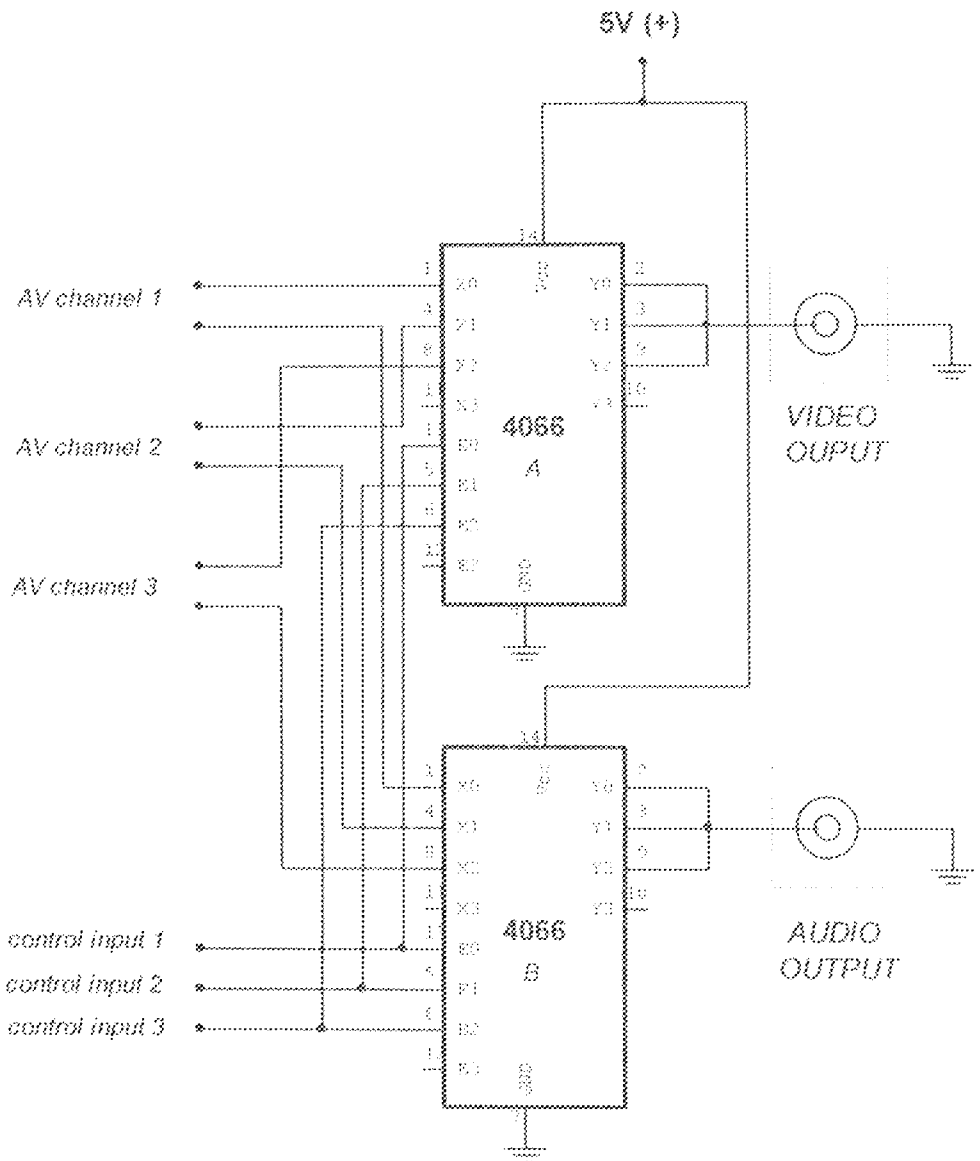

Fig 3.4.0 The analogue switching unit

The 4066B has four independent bilateral analogue switches (transmission gates). Each switch has two input/output terminals (Y/Z) and an active HIGH enable input (E). When E is made positive a low impedance bidirectional path between Y and Z is established (SWITCH-ON condition). When E is connected to ground or negative power terminal the switch is disabled and high impedance between Y and Z is established (SWITCH-OFF condition). In addition, the ON resistance is relatively constant over the full input signal range [2].

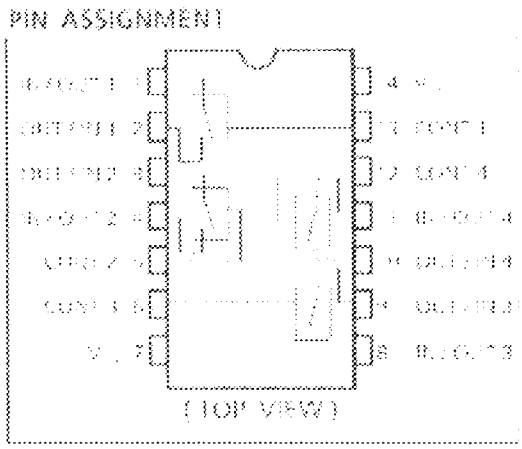

Fig 3.4.1 A 4066B IC switch

Moreover three switches each deal with the video and audio signals. For instance, the signals are connected through YZ line so that through terminal E ON-OFF switching is achieved. Moreover there are three control terminal, one for each AV channel. These control points are connected to the digital switching unit for coordinated operations [2].

3.5 DIGITAL CONTROL UNIT

The Digital control unit controls the main analogue switching operation of the device. It mainly consists of the following Complementary Metallic Oxide Semiconductor (CMOS) integrated circuits:

- 4060B
- 4017B

These devices are connected in a way that allows digital selection of a particular AV channel to the output both manually and automatically.

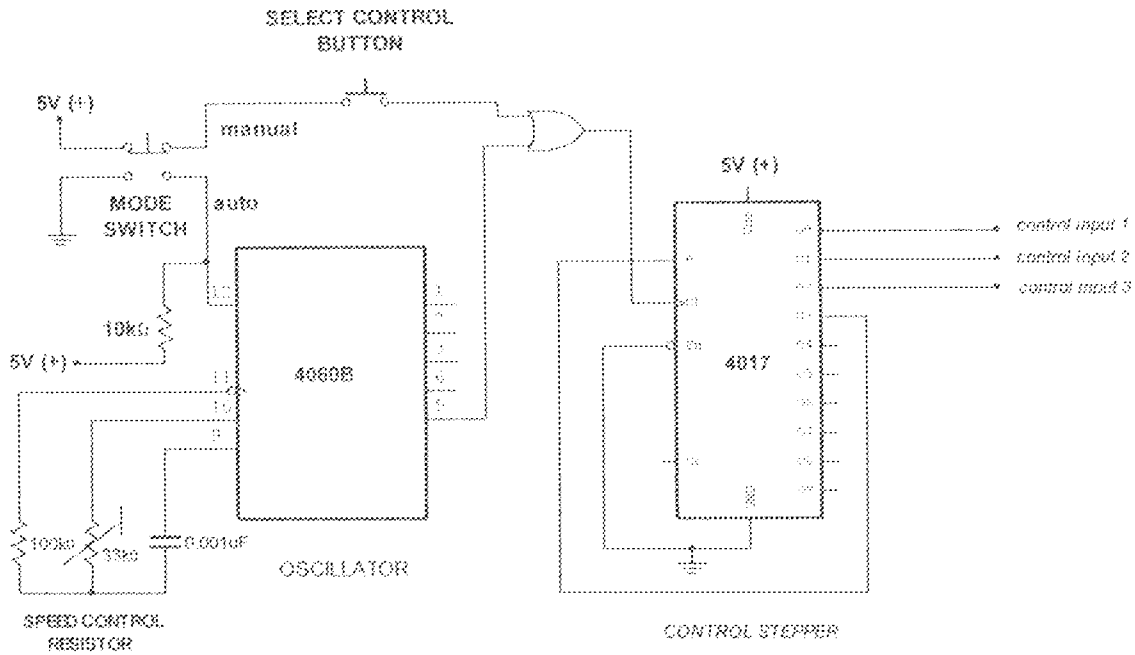

Fig 4.5.0 The Digital Control Unit

3.5.1 4060B (Control Oscillator)

The 4060 is a high speed CMOS 14-STAGE BINARY COUNTER/OSCILLATOR fabricated in silicon gate CMOS technology. It has a better performance then the common 555 timer/oscillator along with its low power consumption. The oscillator configuration allows design of either RC or crystal oscillator circuits. A high level on the CLEAR accomplishes the reset function, i.e. all counter outputs are made low and the oscillator is disabled. A negative transition on the clock input increments the counter. Ten kinds of divided output are provided; 4 to 10 and 12 to 14 stage inclusive. The maximum division available at Q12 is 1/16384 times the frequency of the oscillator. The O1 input and the CLEAR input are equipped with protection circuits against static discharge and transient excess voltage [11].

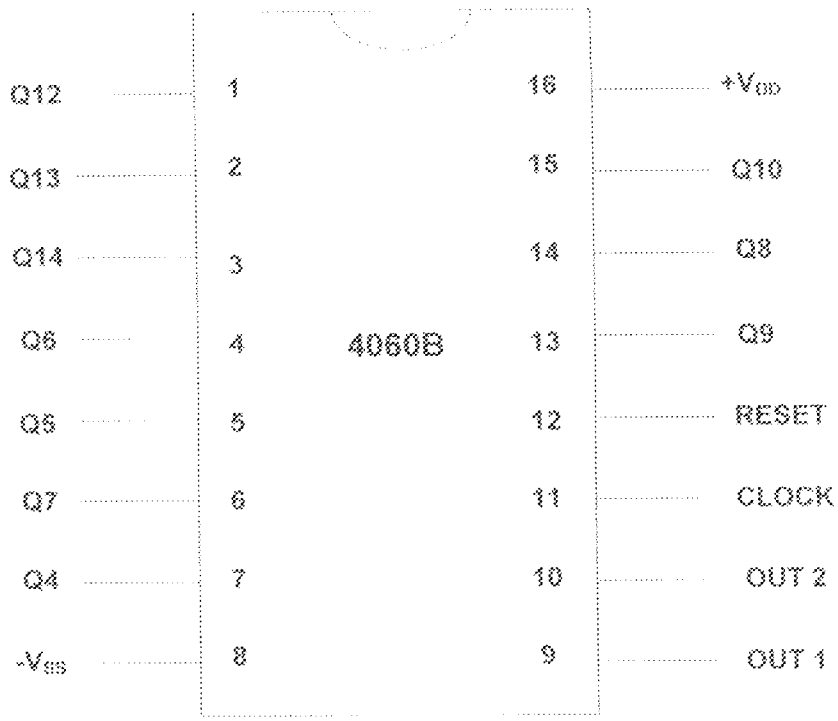

Fig 3.5.1 The pin configuration of the 4060B

The oscillator is configured in the RC mode. And with a variable resistor the frequency output can be adjusted.

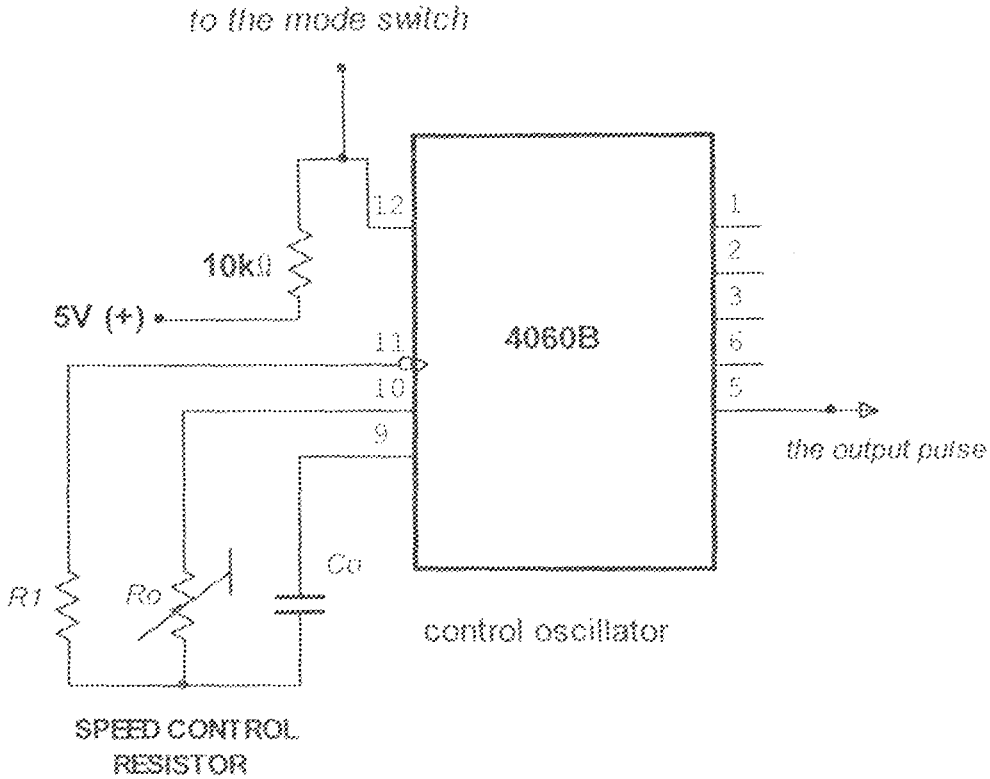

Fig 3.5.2 The control oscillator circuit

The output pulse from pin 5 of the 4060B is given by the following formula, from related data sheet [1]:

$$f_{pin5} = \frac{\left(\frac{1}{2.3 \times C_o \times R_o}\right)}{2^5}$$

$C_o = 1\mu F$, and the resistance value can be between 33KΩ and 10KΩ.

(For $R_a = 33K\Omega$)

$$f_{pin3}A = \frac{\left(\frac{1}{2.3\times1\times10^{-6}\times33\times10^{3}}\right)}{32} = 0.4117Hz$$

(For $R_a = 10K\Omega$)

$$f_{pin3}B = \frac{\left(\frac{1}{2.3\times1\times10^{-6}\times10\times10^{3}}\right)}{32} = 1.358Hz$$

Therefore the frequency is between 0.4 to 1.36Hz.The frequencies in this range is used to set automatic switching mode in the circuit.

3.5.2 4017B (Control Stepper)

The 4017B is a Complementary Metallic Oxide Semiconductor (CMOS) integrated circuit. The device is designed with a 5-stage Johnson counter having 10 decoded outputs [3]. Inputs include a CLOCK, a RESET, and a CLOCK INHIBIT signal. This counter is advanced one count at the positive clock signal transition if the CLOCK INHIBIT signal is low. Counter advanced via the clock line is inhibited when the CLOCK INHIBIT signal is high.

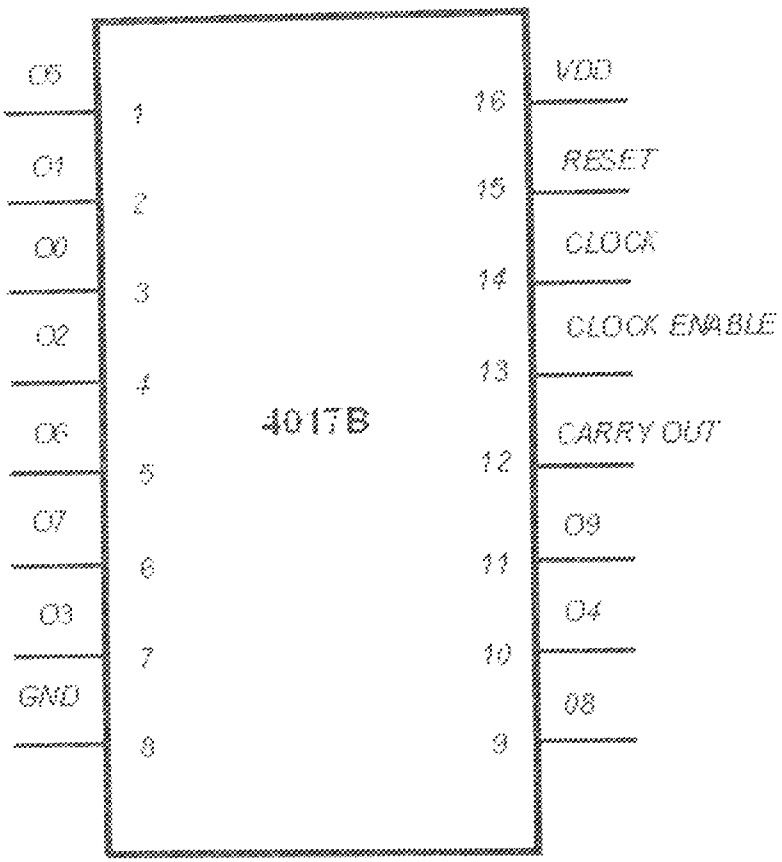

Fig 3.5.3 The Pin configuration of the 4017B

A high RESET signal clears the counter to its zero count. Use of the Johnson decade-counter configuration permits high speed operation, 2-input decimal decode gating and spike-free decoded outputs. Anti-lock gating is provided, thus assuring proper counting sequence. The decoded outputs are normally low and go high only at their respective decoded time slot. Each decoded output remains high for one full clock cycle. A CARRY - OUT signal completes one cycle every 10 clock input cycles and is used to ripple-clock the succeeding device in a multi-device counting chain [3].

in the circuit, it does the logical switching of the output stage, in which three control lines are involved.

3.6 INDICATOR UNIT

The circuit involves three LED indicators that show the selected output.

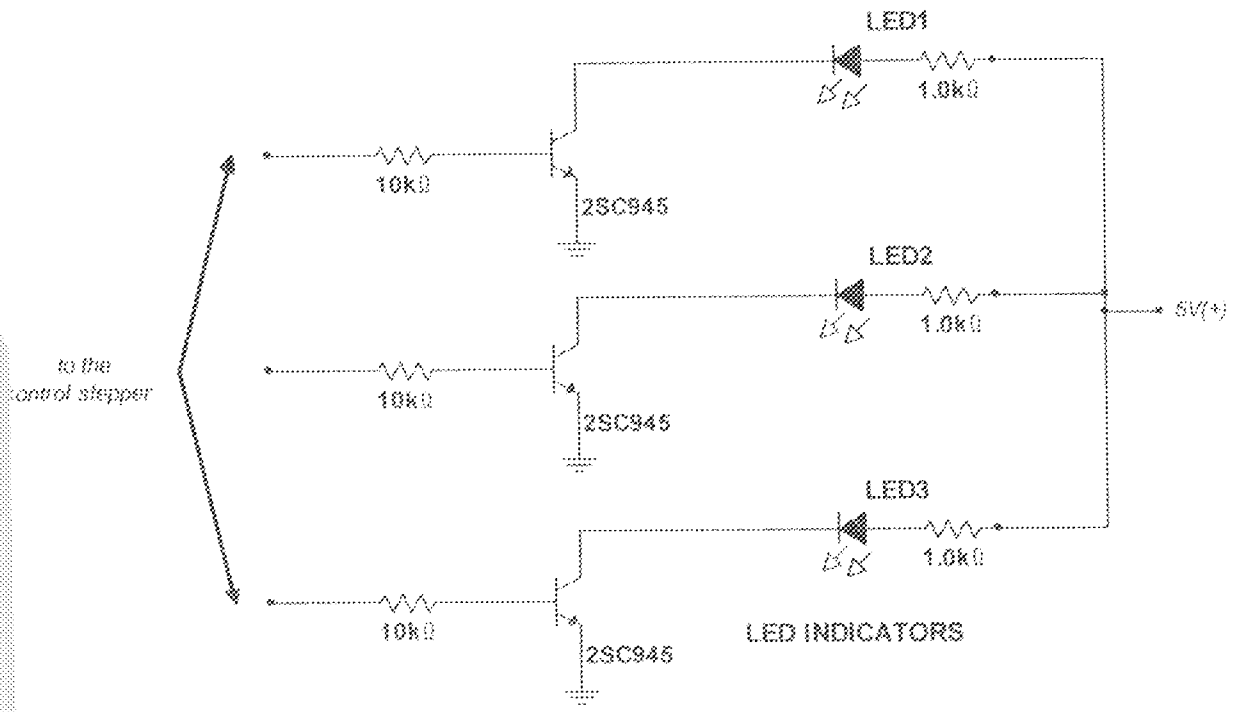

Fig 3.6.0 The signal indicator unit

The above diagram, the three base terminals are fed to the output of he control stepper so that whenever any of the terminals is logical 1 the corresponding LED indicator comes on.

Assuming a current of 2.5mA [4] is expected to flow in the circuit.

Therefore at the completely ON state of the NPN transistors the value of the current limiting resistors for each of the three is given as:

$$R = \frac{2.7}{2.5 \times 10^{-3}} = 1080\Omega$$

1000 ohms is used in the circuit.

When the current gain of each of the transistors is 100, their base current each is given as [5]:

$$I_B = \frac{I_c}{hfe}$$

$$I_B = \frac{2.5 \times 10^{-3}}{100} = 25\mu A$$

3.7 AV OUTPUT TERMINAL

This is merely a AV socket that is intended for connection to a television. It is the point the selected signal comes out.

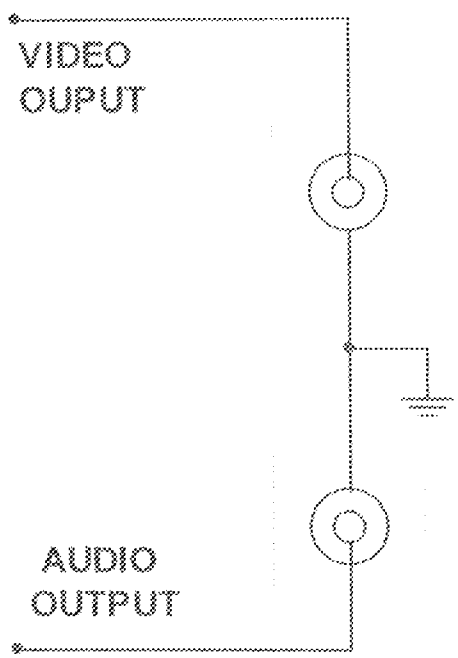

Fig 3.7.0 The AV output terminal

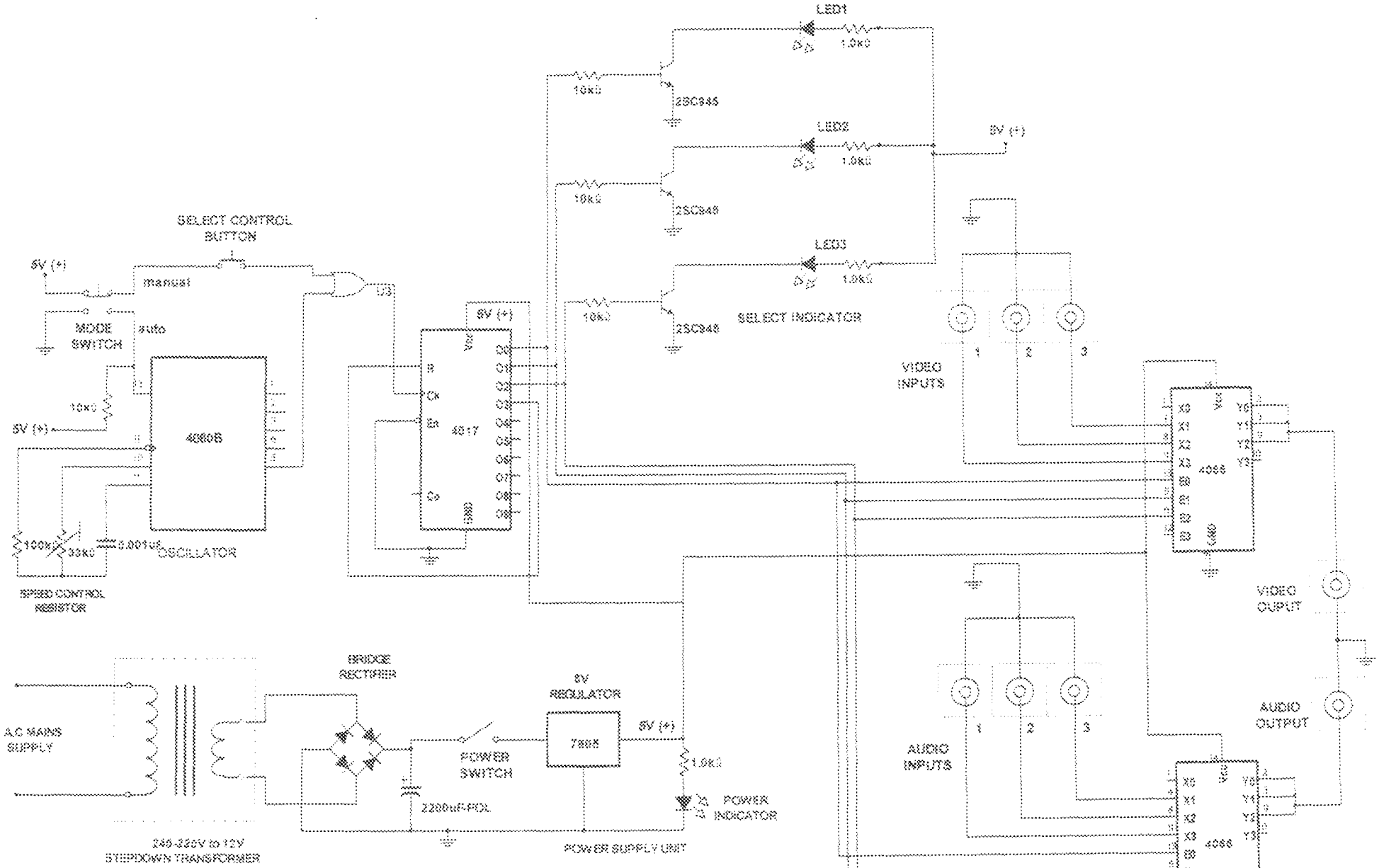

FIGURE 3.8: CIRCUIT OF A DIGITAL 3-CHANNEL VIDEO SELECTOR

CHAPTER FOUR

CONSTRUCTION, TESTING AND DISCUSSION OF RESULT

4.1 CIRCUIT CONSTRUCTION

This circuit construction is all about the soldering of the involved electronic components with guideness to the circuit diagram. The work was done in modules. The completed modules were then joined together for the complete circuit.

The first task in the construction was the testing of the involved components independently. The test is for malfunction or defect. Due to the apparent workability of the design and along with my initial experience in electronics, the construction started on the Vero board and not the bread board.

Vero board connection is done for the construction. Jumper wires were extensively used for connecting the components together in line with the circuit diagram.

4.2 CASING CONSTRUCTION

The casing is mainly made of plastic and leather materials. The plastic is selected for easy mount or attachment of external components such as control switches and variable resistor.

4.3 TESTING

Testing is normal before and after the main connection work of the circuit. The involved electronic components were properly tested before any connection is made. The circuit connections were properly tested for any wrong or error after the complete soldering work. Short circuit was quite avoided and properly checked before the circuit was plugged to electricity. After such tests, the circuit was set for the workability test.

The main testing of the constructed device involves the use of three different Av input devices such as DVD or VCD players and an output device usually a television. The devices were connected together as shown in the block diagram below.

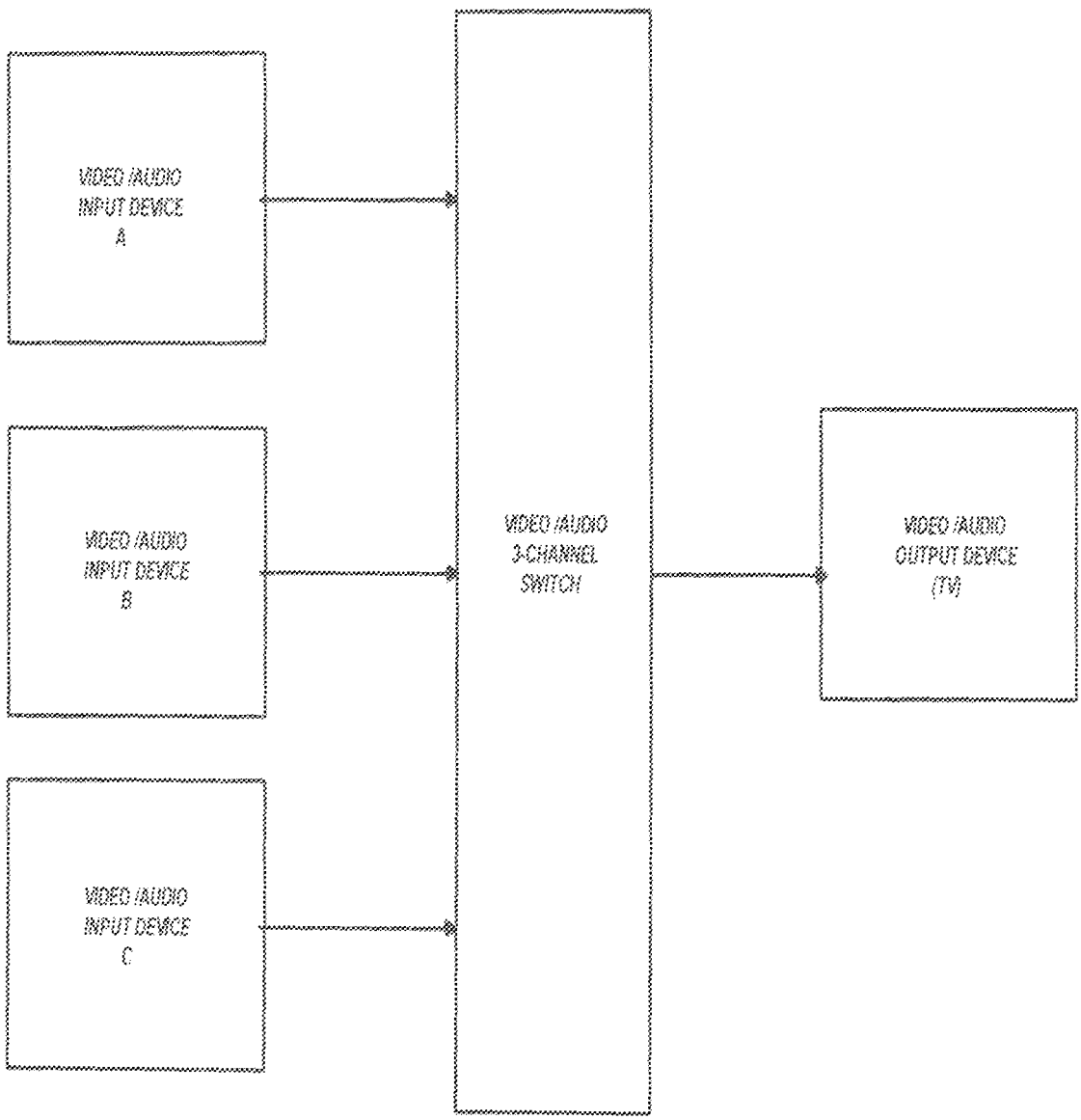

Fig 4.3 The test connection

The AV signal from every input devices was carefully identified before the test.

The shift control buttons was use to switch to the different available AV inputs; one after the other. The operation was quite monitored on the involved television.

The mode switch was set automatic and the selection or switching of channel was achieved with any manual input.

Moreover the speed control dial was turned to change the automatic mode speed of operation.

4.4 RESULT AND DISCUSSION

The result was quite encouraging. During the manual control testing the signal of selected AV input was fed to the output, the monitoring television. The automatic mode and speed dial provided a means of time- base switching on of the AV inputs to the output one after the other.

The picture and sound quality of the output were quite good and acceptable.

CHAPTER FIVE

CONLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The project is a success. The smooth switching of analogue signals such as that of AV was merely achieved through digital means.

Altogether, a lot of problems were encountered during the work but the access to useful information and knowledge is attributed the success of the work.

5.2 RECOMMENDATIONS

- The design could more advance through the use of microcontroller in switching available AV inputs.
- The device could serve better application through the increase of he available AV channels.
- The device could be interfaced to a computer system.
- It could be redesigned to have more then one AV output so that more input can be monitored at the same time.

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APPENDIX

OPERATIONAL MANUAL FOR DIGITAL THREE CHANNEL AUDIO/VIDEO SELECTOR

Follow the outlined steps below to operate the device:

1) Connect the device to Ac power supply and turn on the power switch to on the device.
2) Connect the output of AV line from VCR or VCD to the input terminal of the device. These are AV sockets with red and yellow colour.
3) Connect the output AV line from the device to a TV set.
   The connections are depicted in the figure attached

   Two modes of operations are involved;

   a) Manual
   b) Automatic

4. To select mode of operation, press the blue button by the side to switch from one mode of operation to another.
5. To select channel manually, perform (4) above and press the black button to switch from one channel to another.

THE OPERATIONAL CONNECTIONS OF THE DEVICE