DESIGN AND CONSTRUCTION OF A TV TRANSMITTER WITH TIMED TURN ON/ TURN OFF

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NOVEMBER, 2OO7

DEDICATION

This project is dedicated to Almighty God, whose Grace has been abundantly available in my life and more so during the course of this work. And also to all parents whose heart desire is to give their kids a proper up-bringing.

DECLARATION

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

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I would also like to acknowledge my Supervisor, Dr. E. N. Onwuka, your unrelenting effort and dedication towards our success, not only in this project, but also in life, is well appreciated.

Not left out are the lecturers of the Department of Electrical Engineering, especially the H.O.D. Engr. M. D. Abdullahi, keep up the good work.

Last but in no way the least are all my friends, some of whom are: Akula Paul, Igoche Gabriel, Abgese Oche, Charles Okponaviobo, Longjan George and my Princess, Catherine Onyeche Igoh, thank you all for your companionship.

ABSTRACT

Direct access of kids and/or underage to VCD, decoder machines and satellite TV receivers can lead to unwholesome programs being watch, which ultimately results to character degradation and deformation. As such this project is aimed at restricting the access of such persons to these machines. This project, which is a TV transmitter with timed turn on /turn off, basically transmits what is being played on a VCD or decoder machine in a restricted region to a television kids have access to for a preset duration. This project consists of three main blocks or modules namely the power supply, the timer and the transmitter. The timer condition determines whether power is being supplied to the transmitter or not, which in turn determines whether it is on or off. The timer also puts on or off the source VCD or decoder simultaneously with the transmitter. The timer can also be disabled to give a normal TV transmission without auto turn on or turn off.

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CHAPTER ONE

INTRODUCTION

1.1 GENERAL INTRODUCTION

In this present day, technology has grown to the level that information dissemination has been made easy and relatively cheap to such an extent that most homes these days have access to cable TV and/or a VCR machine. As a result, the level of information at our disposal has increased dramatically with time.

Television can be a powerful learning/teaching tool. By means of it, we learn about lands and peoples we may never visit, we watch news as it happens on the other side of the globe and insights are gained into politics, history, current events and culture. Infact television entertains, instructs and inspires.

However most of the programs are neither wholesome nor educational with most portraying scenes of violence, sex and the use of strong language which might be detrimental to character development in kids in particular and under-aged in general. These scenes of violence are believed to induce acting aggressively and to be less sympathetic towards victims of real life violence. Scenes of sex are also believed to promote promiscuity and undermine moral standards.[1]

As a result of the variance in the content of programs, a classification/rating system was designed to give parents more information about the content and age-appropriateness of TV programs.[2] But this rating system has not being effective in this environment (Nigeria) where most at times parents are out seeking for means of catering for the upkeep of the family, and kids are left at home with direct access to VCR machines and satellite decoders with almost no control as to what to watch. According to the American Academy of Pediatrics:

- The average child watches 3 hours of TV a day -- 2 hours of quality programming is the maximum recommended by the Academy.
- Active play time is needed to develop mental, physical and social skills. [3]

Therefore, alongside the content of programs, time spent watching these programs can also affect the normal development of a child. This project seeks to address these problems.

1.2 OBJECTIVES OF PROJECT

This project seeks to meet the following objectives:

i) Provide parents with a means of controlling the time spent by their kids watching cable TV in their absence.

ii) Making it possible for parents to pre-fix the channel that kids can watch in their absence.

iii) Like other low power transmitters, it introduces portability and greater convenience in a system where more than one TV set needs to be hooked/connected to either a VCR, a satellite decoder or video game [4].

1.3 BRIEF DESCRIPTION OF PROJECT

This project consists of an audio/video signal transmitter with a specific range/radius of operation. It operates at a particular range of frequencies. Also incorporated into the circuit is a timer circuit to do the following:

i) Turn on the transmitter after a particular preset duration of waiting (1min, ,30mins, 1hr, 1hr 30mins).

ii) Turn off the transmitter after a particular preset duration of transmission (1 min, 30mins, 1hr, 1hr 30mins).

The circuit is connected to the source (decoder, VCR machine) and both are kept in a secured place from kids who have access to only the receiver (TV set). The decoder is then put on and tuned to the particular channel of interest, the transmitter put on or instructed to come on after a particular duration. It can also be instructed to go off after a particular duration.

1.4 SCOPE OF PROJECT

This project covers the following fields in electronics/electrical engineering:

i) Rectification of AC to DC in the power supply unit.

ii) Modulation – both FM (for the audio signal modulation) and AM (for the video signal modulation) [5]

iii) Electromagnetic radiation of the modulated signal using antenna. [6]

CHAPTER TWO

LITERATURE REVIEW/THEORETICAL BACKGROUND

2.1 HISTORY OF TELECOMMUNICATION.

Telecommunications refers to the science and technology of transmitting information electronically by wires or radio signals from a source to a destination. Traditionally, telecommunication was based on analog signals, which vary in a continuous wave proportional to the original information. Although analog signals are still used, digital technology is now used for virtually all backbone links of the telephone network, in all specialized data networks such as banking networks and reservations systems, for direct satellite broadcasting, and on the internet. Digital technology is already used in many telephone subscriber lines, cable systems, and cellular wireless systems.

The terminals at the end points of a communication session may be wired and wireless telephones, facsimile (fax) machines, personal computers, televisions, voice response systems, factory machines, environmental sensors, and communicating appliances of many other kinds.[7]

2.1.1 WIRELESS COMMUNICATION

Early efforts at wireless communication by means of electric signals date back to at least the mid-19th century, when experiments were performed in transmitting signals by conduction through the earth and water. The concept of using electromagnetic waves for the transmission of messages from one point to another was not new; the heliograph, for example, successfully transmitted messages via a beam of light rays, which could be modulated by means of a shutter to carry signals in the form of the dots and dashes of the Morse code.

But the history of radio in the sense of wireless transmission by electromagnetic waves really began in 1873, with the publication by the British physicist James Clerk Maxwell of his theory of electromagnetic waves. Maxwell's theory applied primarily to light waves.

About 15 years later the German physicist Heinrich Hertz actually generated such waves electrically. Hertz measured several of the properties of these so-called Hertzian waves, including their wavelength and velocity.

Hertz's work on electromagnetic waves prompted a number of scientists and inventors to contemplate using them for communication. Many, including Lodge and the Indian Jagadis Chandra Bose (1858–1937), experimented with apparatus for producing and/or receiving radio waves. But credit for the "invention" of radio is commonly given to one or more of three pioneering individuals: the Croatian-born American Nikola Tesla, the Russian Aleksandr Popov, and the Italian Guglielmo Marconi.

Marconi seems to have been the first to obtain a radio patent, in Great Britain in 1896, and he clearly was the first to achieve extremely long-distance radio communication—in 1901 when the letter S of the Morse code, transmitted at a pre-arranged time from Poldhu in

Cornwall (United Kingdom), was heard across the Atlantic (a distance of some 3200 km or 2000 mi). in New Foundland (United States).

During this time various technical improvements were being made. Tank circuits, containing inductance and capacitance, were used for tuning. Antennas were improved, and their directional properties were discovered and used. Transformers were used to increase the voltage sent to the antenna. Developed also was a magnetic detector that depended on the ability of radio waves to demagnetize steel wires; a bolometer that measured the rise in temperature of a fine wire when radio waves are passed through the wire; and the so-called Fleming valve, the forerunner of the thermionic tube, or vacuum tube.

The modern vacuum tube traces its development to the discovery made by Edison. The Fleming valve was not essentially different from Edison's tube. It was developed by the British physicist and electrical engineer John Ambrose Fleming (1849–1945) in 1904 and was the first of the diodes, or two-element tubes, used in radios. This tube was then used as a detector, rectifier, and limiter.

A revolutionary advance, which made possible the development of the science of electronics, occurred in 1906 when the American inventor Lee De Forest mounted a third element, the grid, between the filament and cathode of a vacuum tube. De Forest's tube, which he called an audion but which has since come to be called a triode (three-element tube), was first used only as a detector, but its potentialities as an amplifier and oscillator were soon developed, and by 1915 wireless telephony had developed to such a point that communication was established between Virginia and Hawaii and between Virginia and Paris.

The rectifying properties of crystals were discovered around 1912 by the American electrical engineer and inventor Greenleaf Whittier Pickard (1877–1956), who pointed out that crystals can be used as detectors. This discovery gave rise to the so-called crystal sets popular about 1920. In 1912 the American electrical engineer Edwin Howard Armstrong discovered the regenerative circuit, by which part of the output of a tube is fed back to the same tube. This and certain other discoveries by Armstrong form the basis of many circuits in modern radio sets.

In 1902 the American electrical engineer Arthur Edwin Kennelly (1861–1939) and the British physicist and electrician Oliver Heaviside, independently and almost simultaneously, announced the probable existence of a layer of ionized gas high in the atmosphere that affects the propagation of radio waves. This layer, formerly called the Heaviside or Kennelly-Heaviside layer, is one of several layers in the ionosphere. Although the ionosphere is transparent to the shortest radio wavelengths, it bends or reflects the longer waves. Because of this reflection, radio waves can be propagated far beyond the horizon. Propagation of radio waves in the ionosphere is strongly affected by time of day, season, and sunspot activity. Slight variations in the nature and altitude of the ionosphere, which can occur rapidly, can affect the quality of long-distance reception. The ionosphere is also responsible for skip, the reception at a considerable distance of a signal that cannot be received at a closer point. This phenomenon occurs when the ground ray has been absorbed by the intervening ground and the ionospherically propagated ray is not reflected at an angle sufficiently steep to be received at short distances from the antenna. [8]

2.2. HISTORY OF TIMERS

Time can be defined as the limited period during which an action, process or condition exists or takes place. The fact that time is finite and non renewable (irreversible) makes it imperative for an efficient and effective method of time control be adopted for various processes. Engineers work on control systems ranging from the everyday, passenger-actuated, as those that run an elevator, to the exotic, as systems for keeping spacecraft on course. Control systems are used extensively in aircraft and ships, in military fire-control systems, in power transmission and distribution, in automated manufacturing, and in robotics. [9]

A timer is a specialized type of clock. A timer can be used to control the sequence of an event or process, or for measuring the duration and signaling the end of an event. Timers can be mechanical, electromechanical, electronic or even software.

In time past, different model of time devices have been used by man to achieve a reliable and accurate time reference base for scheduling one or more domestic and industrial event with reference to time. However, with man's quest to make life more comfortable and safe, effort is being made to move from old method to inventing the best techniques.

The oldest and the most common type of timed-turnoff switch is the "dial timer", a sprung-wound mechanical timer that is set by twisting the knob to desired time. Typical units of this type are vulnerable to damage because the shaft is weak and the knob is not securely attached to the shaft. More so it cannot automatically switch on any device. Other earlier means include pneumatic device, inert devices etc. Some later technologies uses the day break or night fall to activate operation which in most cases affected by weather and makes them season dependent.

These days, there are electronic designs of timers which have very short duration lasting for few minutes, the highest which is 99 minutes, which them not applicable in area where long timing period is required. Other designs are computer aided design, which involve writing of programs, and other designs use time pulses like the 60Hz frequency generator. Any design used is aimed at being either compact, portable, maintainable, reliable and affordable in terms of cost.

2.3 THEORETICAL BACKGROUND

In electrical engineering terms, communication refers to the sending, processing and reception of information using electrical means. A communication system is therefore a technique or equipment that is used to send, process and receive messages. [10]

Information is generally presented in two broad categories of message format namely analog and digital. The form of message determines the nature of communication system for successful transmission. [11]

This information can be audio, images (photos and drawings), video, data files, messages, and executable computer software. Television is a system of sending and receiving pictures (video) and sound (audio) by means of electronic signals transmitted through wires and optical fibers or by electromagnetic radiation. The source of the audio/video signal could be VCR, VCD, Cable or a broadcast station. [12]

2.3.1 BLOCK DIAGRAM OF A COMMUNICATION SYSTEM

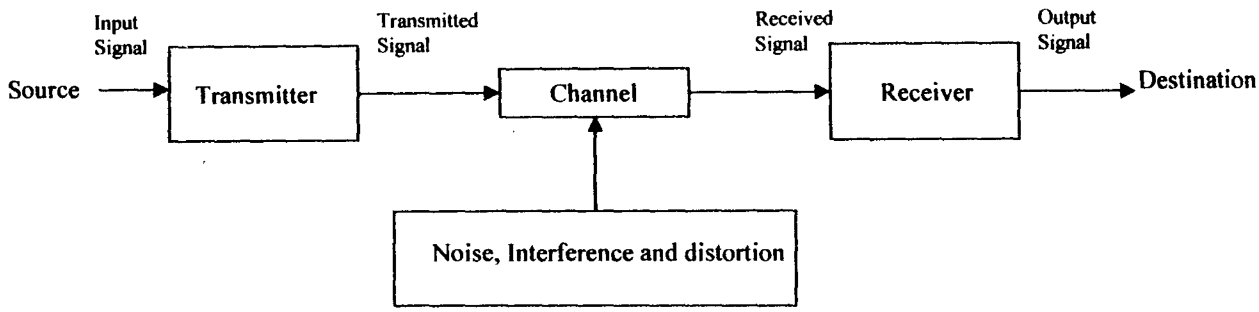


Fig 2.1 Block diagram of a communication system.[13]

As can be seen in the above block diagram, for successful transmission of a signal by use of radio waves, two processes are essential: modulation and demodulation and these processes takes place at the transmitter and receiver respectively.

2.3.2 MODULATION

This refers to the non-linear process where two sinusoids are combined in such a way that one of the waves (the message signal of low frequency) is impressed on to the other (known as the carrier wave of a higher frequency). It can also be said to be the process whereby one signal (the message signal) is used to control some parameter of another signal (the carrier signal). [14]

The reasons for modulation include the following:

i. To reduce noise and interference present at low frequencies.

ii. For easy radiation and reception of signals by using practically realizable antenna sizes.

iii. For channel assignment to enable to avoid transmitted signals mixing up.

iv. To enable multiplexing so that several messages can be transmitted through the same single channel.

v. To overcome equipment limitations. [15]

There are basically three types of modulation. The parameter of the carrier modified by the message signal determines the type of modulation and the type of modulation used depends on the system requirements. Types of modulation include:

i. Amplitude Modulation:

This refers to the modulation technique whereby the amplitude of the carrier is varied with respect to the amplitude of the modulating signal. This can be stated mathematically as:

Let the modulating signal, $V_m(t) = V_m \cos\omega_m t$

and the carrier frequency, $V_c(t) = V_c \cos\omega_c t$

after the amplitude modulation, the modulated signal becomes,

$$V_{AM} = V_c + V_m(t)$$
$$V_{AM} = [V_c + kV_m(t)]\cos\omega_c t$$
$$V_{AM} = [V_c + k(V_m \cos\omega_m t]\cos\omega_c t$$
$$V_{AM} = V_c\left[1 + \frac{kV_m}{V_c}\cos\omega_m t\right]\cos\omega_c t$$

and the modulating factor, $m = \frac{kV_m}{V_c}$

The AM wave is obtained by superimposing the modulating signal on the carrier. Therefore the modulating signal forms an envelop to the AM wave provided the modulation factor is less than unity. This process is depicted in the figures below:

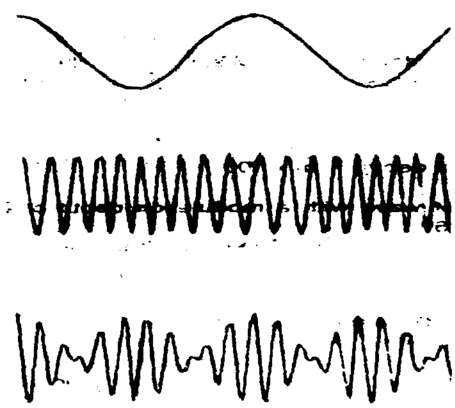


Fig 2.2 Amplitude Modulation.

ii. Frequency Modulation:

This entails the variation of the frequency of the carrier wave in accordance with the instantaneous value of the message signal with the amplitude and phase kept constant. Mathematically, the FM process can be represented thus:

This is depicted in the figure below

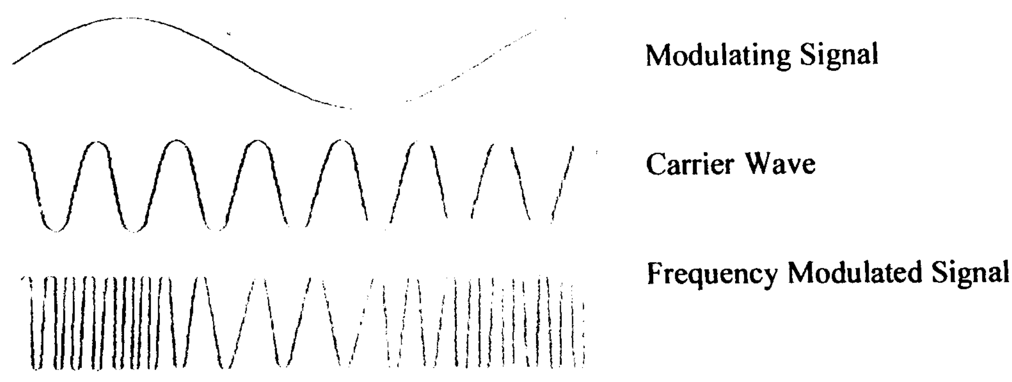


Fig 2.3 Frequency Modulation.

iii. Phase Modulation:

Here the message signal changes the instantaneous phase of the carrier wave with both the amplitude and frequency kept constant. This process was not made use of in this project.

2.1.3 TIMER

A timer is an electronic device used to control the sequence of an event or process, or for measuring the duration and signaling the end of an event. An electronic timer used to restrict the duration of or the on time of a particular device, makes use of the fact that if the power supply to the device is cut off, then the device goes off. Also when power is supplied to the device, it comes on. Therefore the timers are designed in such a way that their condition determines whether power get to either the whole device or a part of it.

There are electronic designs of timers which have very short duration lasting for few minutes, the highest which is 99 minutes, which them not applicable in area where long timing period is required. Other designs are computer aided design, which involve writing of programs and other designs use time pulses like the 60Hz frequency generator. Most designs of timers make use of the 555 timer IC. Any design used is aimed at being either compact, portable, maintainable, reliable and affordable in terms of cost.

2.1.4 555 TIMER IC

The 555 timer is one of the most popular and versatile integrated circuits ever produced. It includes 23 transistors, 2 diodes and 16 resistors on a silicon chip installed in an 8-pin mini dual-in-line package (DIP-8). Shown below is the 555 timer

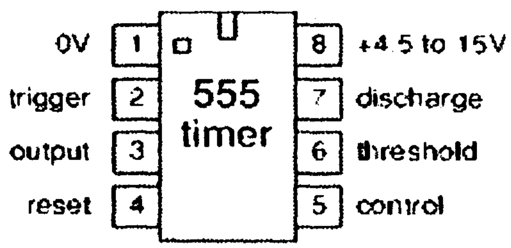


Fig 2.4a 555 Timer physical appearance

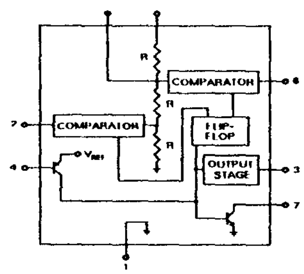


Fig 2.4b 555 Timer physical appearance

The IC as shown above has 8 pins whose functions are outlined below

Pin 1 (Ground): The ground (or common) pin is the most-negative supply potential of the device, which is normally connected to circuit common (ground) when operated from positive supply voltages.

Pin 2 (Trigger): This pin is the input to the lower comparator and is used to set the latch, which in turn causes the output to go high. This is the beginning of the timing sequence in monostable operation. Triggering is accomplished by taking the pin from above to below a voltage level of 1/3 V+ (or, in general, one-half the voltage appearing at pin 5).

Pin 3 (Output): The output of the 555 comes from this terminal. The output voltage available at this pin is approximately equal to the Vcc applied to pin 8 minus 1.7V and can supply a maximum output current of 200mA.

Pin 4 (Reset): This pin is also used to reset the latch and return the output to a low state. The reset voltage threshold level is 0.7 volt, and a sink current of 0.1mA from this pin is required to reset the device.

Pin 5 (Control Voltage): This pin allows direct access to the 2/3 V+ voltage-divider point, the reference level for the upper comparator. It also allows indirect access to the lower comparator, as there is a 2:1 divider from this point to the lower-comparator reference input. Use of this terminal is the option of the user, but it does allow extreme flexibility by permitting modification of the timing period, resetting of the comparator, etc.

Pin 6 (Threshold): Pin 6 is one input to the upper comparator (the other being pin 5) and is used to reset the latch, which causes the output to go low. Resetting via this terminal is accomplished by taking the terminal from below to above a voltage level of 2/3 V+ (the normal voltage on pin 5).

Pin 7 (Discharge): . Usually the timing capacitor is connected between pin 7 and ground and is discharged when the transistor turns "on". In both the monostable and astable time modes, this transistor switch is used to clamp the appropriate nodes of the timing network to ground.

Pin 8 (V +): The V+ pin (also referred to as Vcc) is the positive supply voltage terminal of the 555 timer IC. Supply-voltage operating range for the 555 is +4.5 volts (minimum) to +16 volts (maximum), and it is specified for operation between +5 volts and +15 volts. [16]

The 555 has three operating modes:

i. Monostable mode: in this mode, the 555 functions as a "one-shot". Applications include timers, missing pulse detection, bounce free switches, touch switches, Frequency Divider, Capacitance Measurement, Pulse Width Modulation (PWM) etc

ii. Astable - Free Running mode: the 555 can operate as an oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, pulse position modulation, etc.

iii. Bistable mode: the 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bounce free latched switches, etc. [17]

2.1.5 MONOSTABLE MODE (TIMER MODE).

Shown below is the 555 timer in the monostable mode

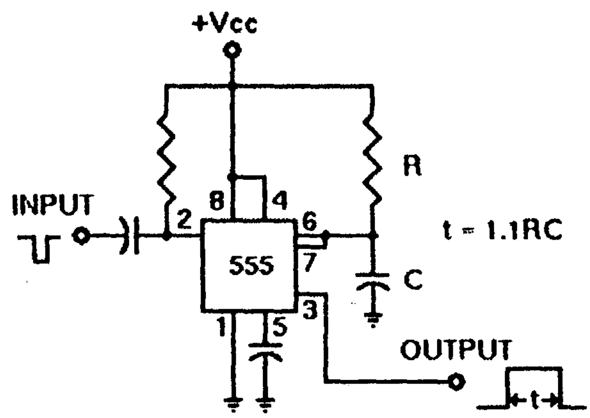


Fig 2.5 555 Monostable mode

The timing interval, t, is set by a single resistor and capacitor, R and C. Both the threshold input and the discharge transistor (pins 6 & 7) are connected directly to the capacitor, while the trigger input is held at $+V_{CC}$ through a resistor. In the absence of any input, the output at pin 3 remains low and the discharge transistor prevents capacitor C from charging.

When an input pulse arrives, it is capacitively coupled to pin 2, the trigger input. At this point, the output rises to $+V_{CC}$ and the discharge transistor turns off. Capacitor C charges through R towards $+V_{CC}$.

The standard equation for a charging capacitor applies here:

$$e = E\left(1 - \varepsilon^{\left(-t/RC\right)}\right)$$

where e = capacitor voltage at some instant in time

ε = base for natural logarithms, approximately 2.718

E = supply voltage, V_{CC}

t = time that has passed, in seconds, since the capacitor started charging

The capacitor will charge until its voltage reaches $(2/3)V_{CC}$, this is then used to compute the time, t, required to charge capacitor C to the voltage that will activate the threshold comparator:

$$2/3 = 1 - \varepsilon^{(-t/RC)}$$

$-1/3 = -\varepsilon^{(-t/RC)}$

$1/3 = \varepsilon^{(-t/RC)}$

$ln(1/3) = -t/RC$

$-1.0986123 = -t/RC$

$t = 1.1RC$

The value of 1.1RC isn't exactly precise, of course, but the round off error amounts to about 0.126%. The timing interval is completed when the capacitor voltage reaches the $(2/3)V_{CC}$ upper threshold as monitored at pin 6. When this threshold voltage is reached, the output at pin 3 goes low again, the discharge capacitor (pin 7) is turned on, and the capacitor rapidly discharges back to ground once more. The circuit is now ready to be triggered once again. [18]

The 555 timer IC can be used for timing from micro seconds to hours, depending on the values of R and C used. [19]

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.1 GENERAL OVERVIEW /BLOCK DIAGRAM OF CIRCUIT

The project consists basically of electronic and electromechanical components which were combined in a unique way to form the final circuit which is a functional system comprising of several functional units or blocks. The functions and justification of use of each of the components is contained in the explanation of the functional block where they are found. Shown below is the block diagram of the circuit.

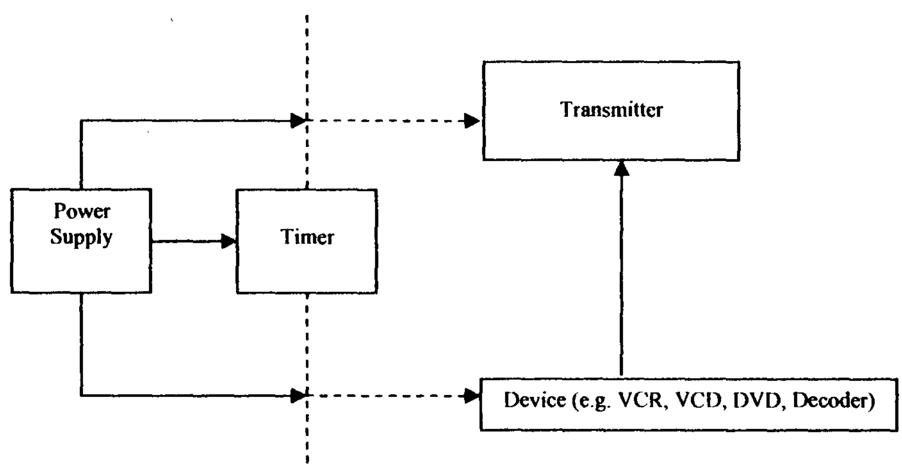


Fig. 3.1 Block diagram of circuit

The project as shown above consists of three basic blocks viz: the power supply, the timer circuit and the transmitter. The power supply conveys electrical energy to the timer circuit, the transmitter and the device. The timer circuit condition determines whether this supplied power gets to both the transmitter and the device, this is connoted by the dotted lines in the block diagram above.

3.2 POWER SUPPLY

A power supply provides the proper voltage and current for electronic devices. The project due to the sensitivity of the transmitted image to the power supply voltage, uses a variable voltage power supply. As such a variable resistor is fixed after the regulator in the figure above to form a voltage divider network. Shown below is the circuit of the power supply circuit:

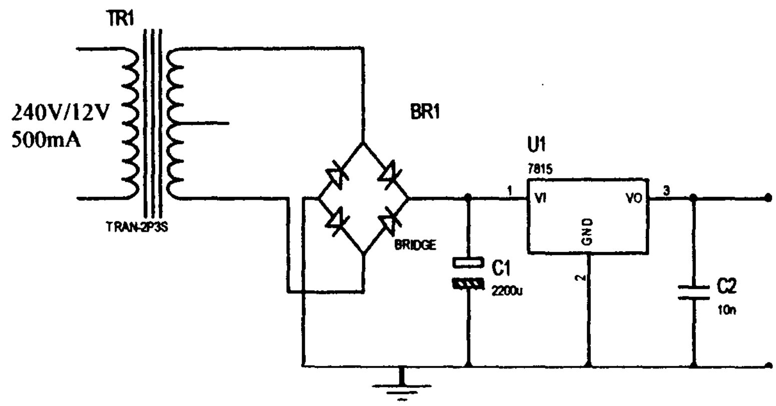


Fig. 3.2 Power supply of circuit

The functions of the components which were used in the design of the power supply can be depicted by the following block diagram.

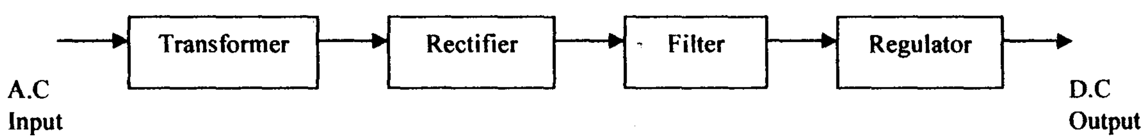


Fig 3.3 Block diagram of power supply

The electronic devices used to achieve the above power supply circuit include the following:

3.2.1 TRANSFORMER

This is the first stage of the power supply and is required to step down the ac supply mains from 220V to an acceptable range of voltage. In this case, a 12V centre tap transformer was used and the output taken across the two outer terminals of the transformer to give a total output voltage of 24V. A 500mA transformer was used due to the fact that the current drawn by the circuit would not exceed 500mA.

3.2.2 RECTIFYING DIODES

A diode is an electronic device that allows the flow of current in only one direction through it. It is uses for the conversion of alternating voltage to direct voltage, a process known as rectification. The constraints on this behavior are the forward break over and avalanche voltages. The rectifier diodes used were the 1N4001, though any of the 1N400X series would have served [20]. Four of these diodes were used to form a network known as the bridge.

3.2.3 FILTER CAPACITOR

The essence of a filter circuit is to minimize ripple content in the rectifier output which is a pulsating dc, therefore it has a dc value and some ac components called ripples. The shunt capacitor acts as the filter element of the power supply. A 35V, 2200µF capacitor was used as the filter.

3.2.4 REGULATOR IC (7815)

This is an IC that produces a fixed and regulated output voltage. The IC has the advantage of unique build-in current limiting, self protection against over temperature, remote control operation over a wide range of input voltage (from 0 – 35V or 40V) and feedback current limiting [21]. The 7815 gives a regulated output of 15V.

3.3 THE TIMER

There are various designs and ways of achieving an electronic timer circuit, some of these include the use of timer ICs like the 555, and also the use of microcontrollers. This design employs the use of the 555 timer IC in the monostable mode. This choice was made so as to make limit the cost and simplify the design. Shown below is the circuit diagram of the timer.

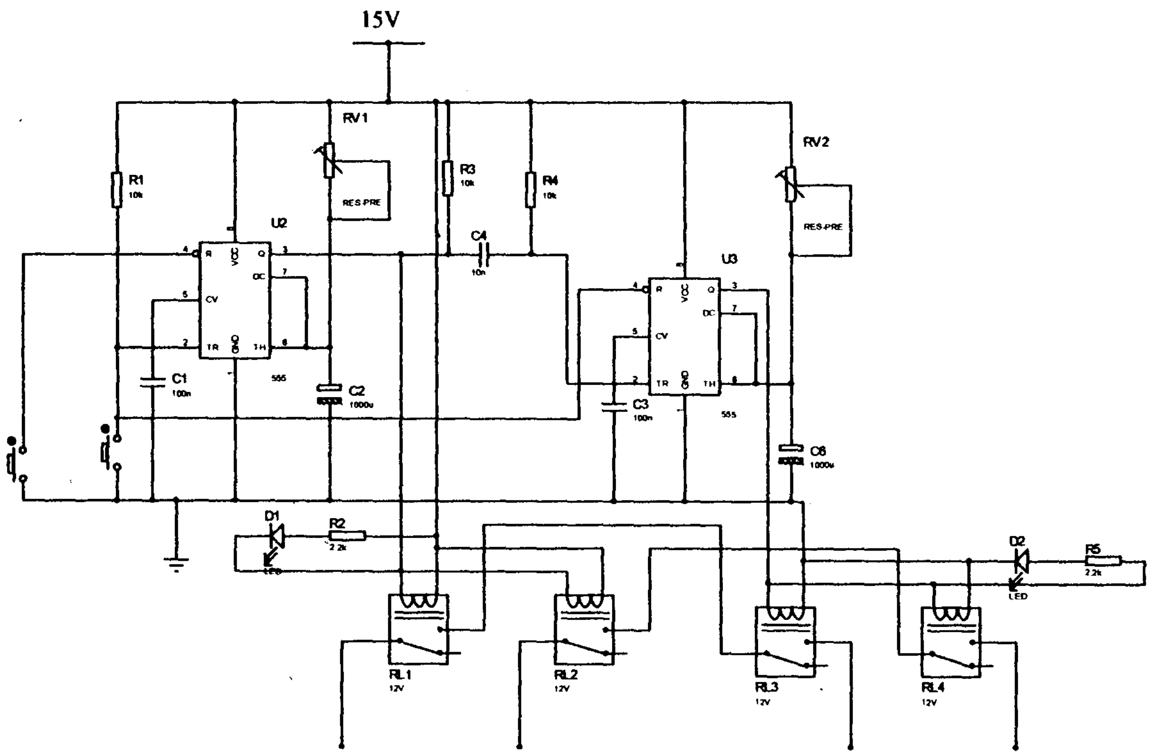


Fig 3.4 Circuit diagram of timer

The timer circuit is made up of the following blocks:-

i) The wait duration timer.

ii) The transmit duration timer

iii) The switching relays

iv) Displays

3.3.1 WAIT DURATION TIMER

The wait timer which is responsible for automatically turning on the transmitter and base band source after a set wait duration is shown below.

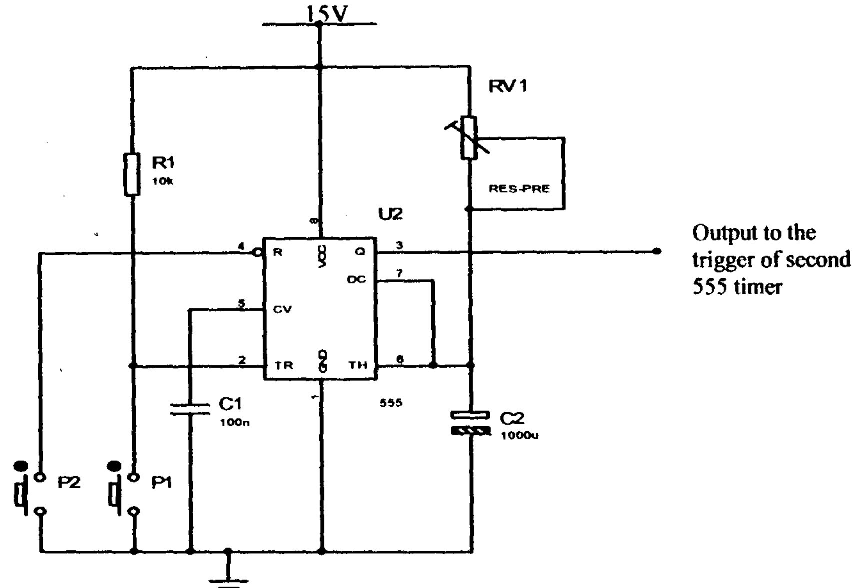


Fig. 3.5 The wait duration timer

The time duration of wait is determined by the value of the variable resistor RV1 and capacitor C2. It was desired to have wait durations of 1minute, 30 minutes, 1 hour, 1 hour 30minutes. The 1 minute duration is to act as a test to confirm that the timer is in good condition. Using the expression for the time duration for a 555timer IC in monostable mode, and setting the value of C2 at 1000μF,

$$t = 1.1RC$$

Therefore RV1 takes the following values for the desired time, $R = \frac{t}{1.1C}$

For t = 1 minute, R_1 = 54 545 Ω ≈ 6.9K + 47K

t = 30 minutes, R_2 = 1 636 364Ω ≈ R_1 + 1.5M

t = 1 hour, R_3 = 3 272 727Ω ≈ R_2 + 1.5M

t = 1 hour 30 minutes, $R_4 = 4\,909\,091\Omega \approx R_2 + 1.5M$

Push button P1 starts the timer, while P2 resets or stops the timer. The output is coupled through a resistor-capacitor network to pin 2 of the transmit duration timer to achieve edge triggering.

3.3.2 TRANSMIT DURATION TIMER

This is similar to the wait timer except that it is edge triggered (comes on the instant the input to pin 2 goes low) by the output of the wait timer as shown below.

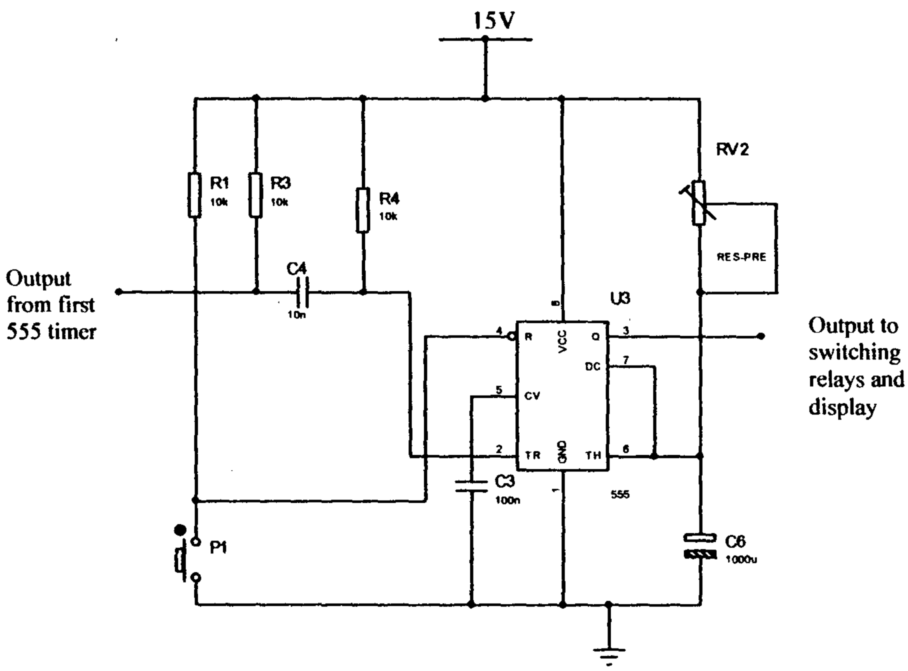


Fig 3.6 The transmit duration timer

The time duration of transmission is similar to that of the wait timer analyzed above with variable resistor RV2 having the values as RV1. The reset pin is connected to push button, P1 that triggers and starts the wait timer, as such the transmit timer is put off when P1 is depressed.

3.3.3 SWITCHING RELAYS

This is made up of four relays, RL1, RL2, RL3 and RL4. The first two relays constitute the delay relays and there configuration is shown below

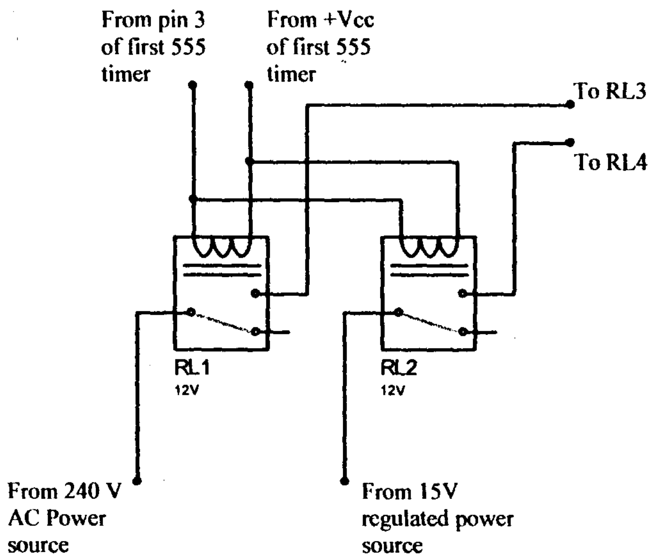


Fig. 3.7 Wait duration switching relays

These two relays are normally open and become closed only when there coils are excited by a voltage greater than their excitation voltage of 12V. The coils are connected to the Vcc and Pin 3 (output) of the delay timer. As such these relays become activated only when delay timer output goes low. At this instant power is fed to the other two relays.

The two other relays are also normally closed, but these are activated as the transmit timer comes on because the coils are connected between pin 3 (output) of second 555 timer and the ground. When activated, RL3 and RL4 supplies power to the Device (VCD, Decoder etc) and the transmitter respectively. This is shown below.

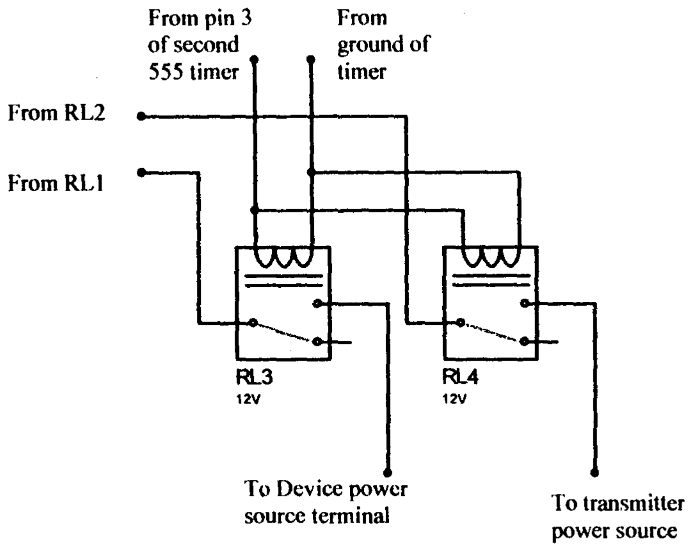


Fig 3.8 Transmit duration switching relays

3.3.4 DISPLAYS

The timer was designed with two LEDs display, one red LED for the delay duration and a green LED for the transmit duration. The configuration of these LEDs in circuit are shown below

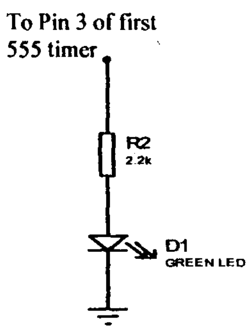


Fig 3.9a Wait duration display

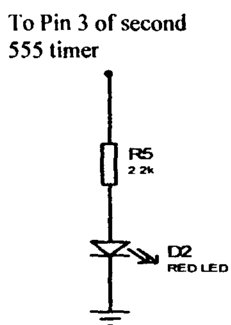


Fig 3.9b Transmit duration display

D1 lights up during the delay period and D2 lights up during the transmission period. Resistors R2 and R5 are limiting resistors aimed at limiting current flow through the LEDs.

3.4 TRANSMITER

3.4.1 INTRODUCTION

A transmitter is an electronic device that is used to send signals from one location to another location via electromagnetic waves. The transmitter superimposes the information signal (ie sound and audio) onto carrier waves by modulating (varying) either the wave's amplitude or frequency. [22]

There are various ways of achieving TV transmission. The particular method used depends on so many parameters amongst which are the frequency of transmission, the range to be covered and the power consumption of the particular device to be designed. This project is aimed at coming up with a design that is very cost effective, easy to use and highly efficient.

3.4.2 BLOCK DIAGRAM OF TRANSMITTER

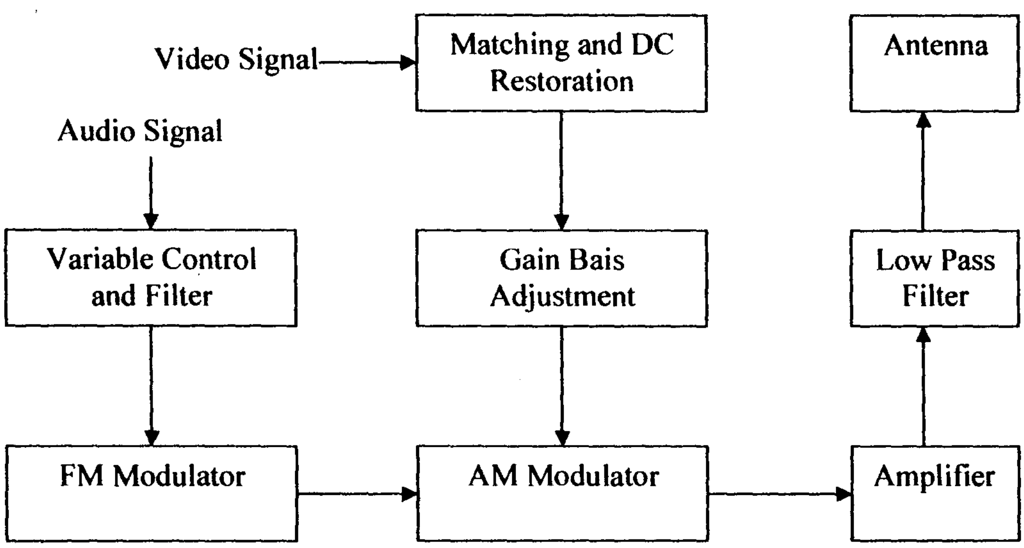


Fig. 3.10 Block diagram of Transmitter

3.4.3 CIRCUIT DIAGRAM

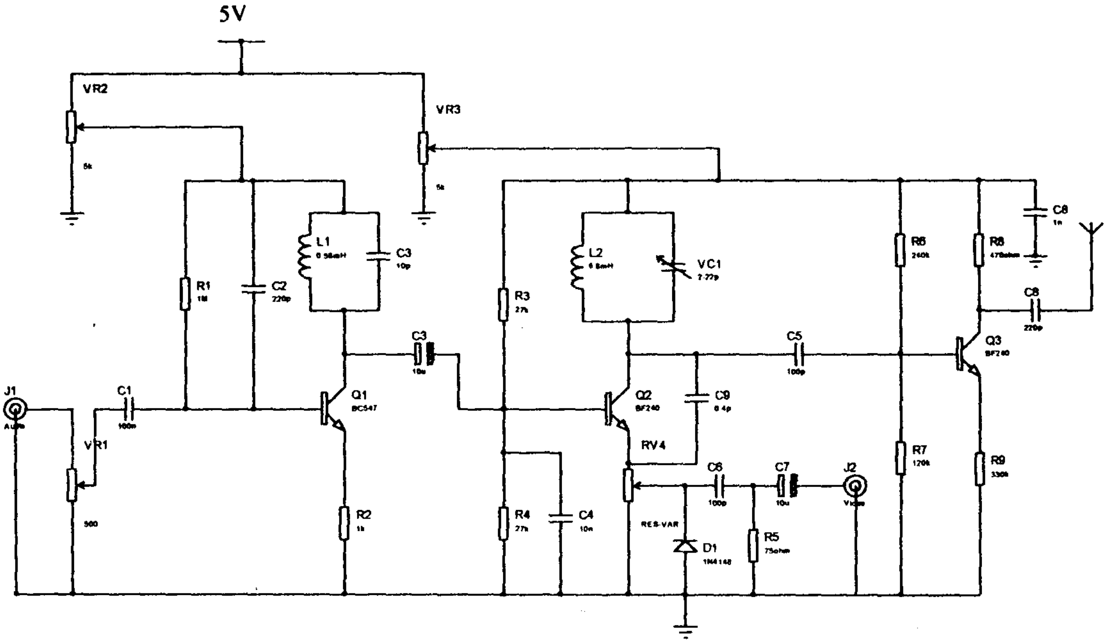


Fig 3.11 Circuit diagram of transmitter

The transmitter as shown above is made up of various blocks of component. These blocks can be grouped into the pre-modulation module, modulation module and the post modulation module.

3.4.4. PRE-MODULATION MODULE

Before modulation of the signal, it is required that some signal processing be carried out on the signal in order to achieve efficient radiation of the e.m.f. generated at the end. This module takes care of both the filtering of the input signals (for both the audio and video signals), load matching and DC restoration of the video signal and finally the variable control for the audio. These are analyzed below:

i) **Filtering:** Before the modulation, the DC component in the signal from the input source is filtered out. This is necessary to prevent the DC current from interfering with the bais conditions of the transistors. This is achieved with the help of electrolytic capacitors C7 for the video input and C1 for the audio input. For the values:

$$C1 = 10\mu,16v$$
$$C7 = 470\mu,16v$$

The capacitance values are not critical, any large value decoupling (electrolytic) capacitor C_1 shunts the resistor R_E at audio frequencies so that it does not form part of the input and output circuits.

ii) Load Matching and DC Restoration: For there to be maximum power transfer from the composite video base band source, the output impedance must be matched with the input impedance of the transmitter. The two impedances are said to be matched for maximum power transfer when they are equal. The output impedance of the source is 75Ω, therefore R5 is made to also be 75Ω.

The efficiency of the transmission is increased if the input signal is clamped at a prescribed potential. This is achieved by a DC restoration circuit. This DC restoration is implemented by Capacitor C8 and Diode D1. [23]

iii) Variable Control: A voltage divider network was introduced at both the video and the audio input. This is to act as a variable control of the amount of the output of the source that is been feed into the transmitter. Variable resistors, VR1 (500Ω) and VR2 (5KΩ) acts as the variable input control for the audio and the video signals respectively. The value of VR1 is of little consequence, while that of VR2 was made to be 5KΩ.

The three processes outlined were achieved at the pre-modulation stage. These processes are depicted below.

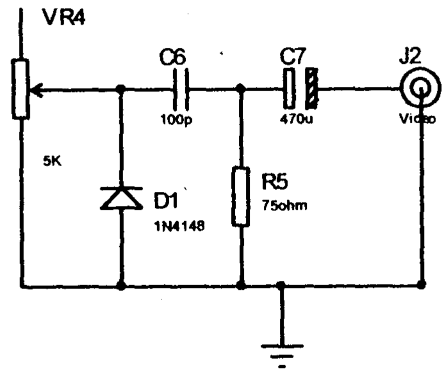


Fig 3.12a Pre-modulation module for video signal

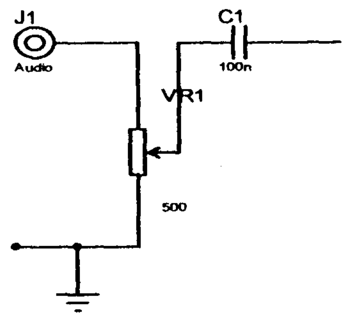


Fig 3.12b Pre-modulation module for audio signal

3.4.5 MODULATION MODULE

The main function of a transmitter is to deliver enough radio frequency (RF) power for radiation by the transmitting antenna. This process includes modulating a high frequency carrier with the message signal and this process occurs in the modulator.

This transmitter design incorporates two modulators, one for the audio (at a much lower frequency of 4.5MHz) and the other for the video and the already modulated audio at a much higher frequency range of 170MHz to 560MHz.

(i) Audio Modulation

The audio signal is frequency modulated. The carrier frequency is generated with the use of an oscillator with an LC tank circuit. A tank circuit consists of an inductor and a capacitor connected in parallel. Inductors and capacitors are both energy storage devices and in a tank circuit they exchange energy back and forth at a rate fixed by the values of inductance and capacitance. The frequency of oscillation is given by: $f_c = \frac{1}{2\pi\sqrt{LC}}$

where L = inductance and C = capacitance [24]

According to standards, the audio signal is required to be frequency modulated at 4.5MHz. Using a ceramic capacitor, C3 of capacitance 1n, the value of the inductance of L1 can be calculated by making L the subject of the formula for the frequency above,

$$L = \frac{1}{4\pi^2 f_c^2 C}$$

$$= \frac{1}{4\pi^2 \times (4.5\times10^6)^2 \times 1\times10^{-9}}$$

$= 1.25\mu H$

This inductance was obtained by coiling an SWG 24 coil which has a diameter of 0.56mm. The formula for calculating the inductance of a certain number of turns of a coil of wire is given as:

$$L = \frac{\mu_0 \mu_r N^2 A}{l}$$

Where L = Inductance in henries

μ_0 = permeability of free space = $4\pi \times 10^{-7}$ H/m

μ_r = relative permeability of core material

N = number of turns

A = area of cross-section of the coil in square metres (m^2)

l = length of coil in metres (m)

the Area of the coil with diameter 1mm was calculated as

$$A = \frac{\pi d^2}{4}$$

$$= \frac{\pi \times (1\times10^{-3})^2}{4}$$

$= 7.854\times10^{-7}m^2$

For air, $\mu_r = 1$, and fixing length of coil, l at 1cm (0.01m), the number of turns that would be required to get the desired inductance of 0.56mH was calculated thus:

$$N = \sqrt{\frac{Ll}{\mu_0 \mu_r A}}$$

$$= \sqrt{\frac{1.25\times10^{-6}\times0.01}{4\pi\times10^{-7}\times1\times7.854\times10^{-7}}}$$

$= 112$ turns.

The oscillator was therefore designed as shown below

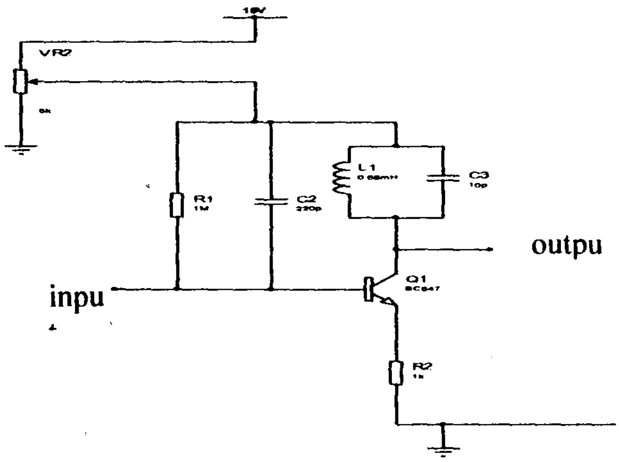


Fig. 3.13 Audio modulation circuit

The amplifier provides the gain required for the oscillation due to degradation of the feedback through capacitor C2, while the input audio signal from the pre-modulation module frequency modulates the oscillating carrier frequency. The variable 15V power supply is to reduce the amount of interference of the output frequency modulated signal with the second modulator. The resistor values R1 and R2 are not critical, they are required to provide the bias for the transistor to act as an amplifier.

(ii) Video Modulation

At this stage of the design, it was intended to amplitude modulate the main carrier frequency with the video signal. The radio frequency, i.e r.f vision channel has a bandwidth of 7.625MHz (with an attenuation of 20dB at 1.25 and 6.375MHz).[25] Due to the large bandwidth of the visual signal, it would be unwise to use frequency modulation. This is the reason for the amplitude modulation been used.

The carrier frequency was generated by a tank circuit comprising of inductor, L2 and variable capacitor, VC1. A variable capacitor was used so as to make to frequency of transmission variable. A variable capacitance of 2-22pF was used and an already wound inductor of inductance of 0.04uH was purchased and used. This gives a carrier frequency varying from *f1* to *f2* which are calculated thus:

$$f_1 = \frac{1}{2\pi\sqrt{LC_{max}}}$$

$$= \frac{1}{2\pi\sqrt{0.04 \times 10^{-6} \times 22 \times 10^{-12}}}$$

$$= 169\ 659\ 739.4 \text{ Hz}$$

$$= 170 \text{ MHz}$$

and $$f_2 = \frac{1}{2\pi\sqrt{LC_{min}}}$$

$$= \frac{1}{2\pi\sqrt{0.04 \times 10^{-6} \times 2 \times 10^{-12}}}$$

$$= 562\ 697697.6 \text{ Hz}$$

$$= 563 \text{ Mhz}$$

Therefore the carrier frequency can be varied from approximately 170Mhz to 560Mhz. This makes the transmitter capable of operating in Band III (174-230MHz comprising of r.f channels 6-12) and Band IV (470 – 582MHz comprising of channels 21-34). [26]

The oscillator was therefore designed as shown below

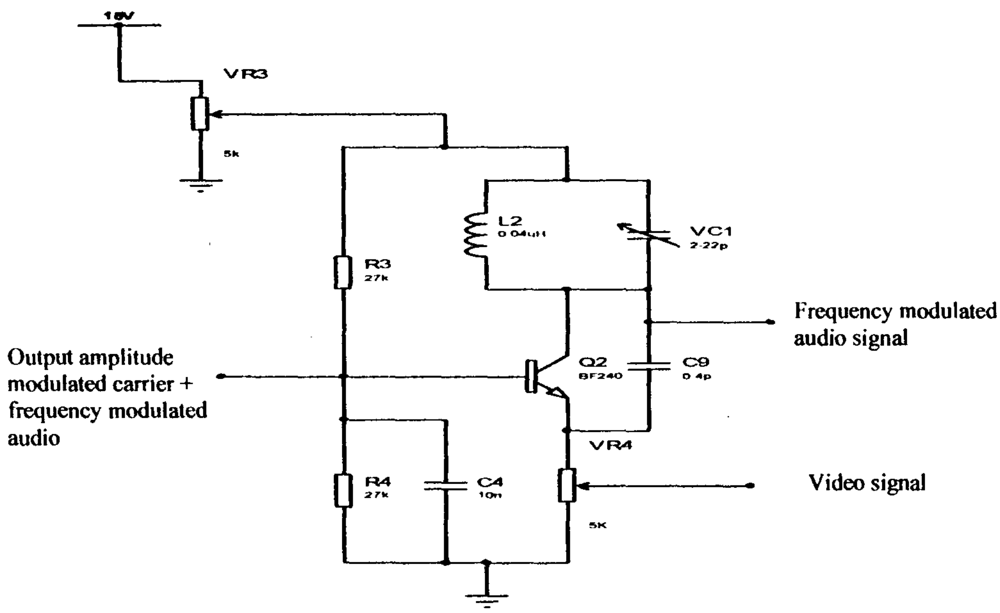


Fig. 3.14 Video modulation circuit

The tank circuit generates the carrier frequency, while the amplifier circuit provides the required gain to sustain the oscillation of the carrier frequency and at the same time modulates or varies the amplitude of the carrier with respect to the video signal which is fed into the emitter via VR4.

A variable power supply was used to power the oscillator, this is to make it possible to adjust the amplitude of the carrier which has an effect on the quality of the reception of the transmission. Resistors R3 and R4 each 27k biases the base of the transistor at ½ V_{cc} . Capacitor C5 (0.4p) provides the feedback path for the oscillator.

The output comprises of the carrier wave which is amplitude modulated by the video signal and the already frequency modulated audio at a frequency of *fc* + 4.5MHz.

3.4.6 AMPLIFIER

Before the r.f is radiated, it is amplified and this was achieved using a common emitter amplifier as shown below.

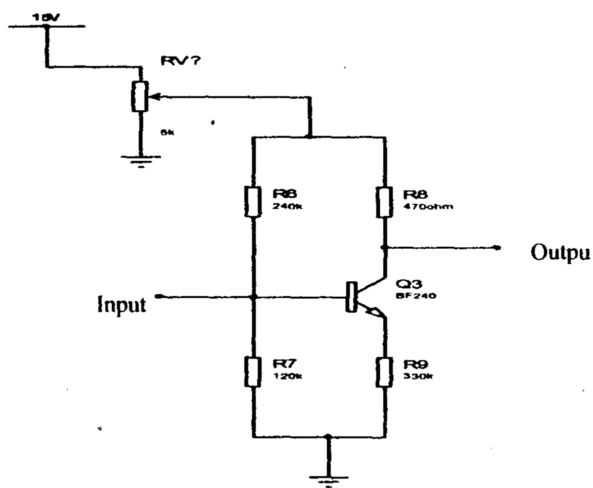


Fig. 3.15 Amplifier

Resistors R5 and R7 biases the base of transistor Q3, resistor R9 sets the emitter current, I_E and R8 acts as the load resistance.

The gain of the amplifier, $A = \frac{output}{input}$

3.4.7 FILTER

A low pass filter is able to pass, with zero attenuation, all the frequencies from zero up to a certain particular frequency which is known as the cut off frequency. At frequencies greater than the cut off frequency, the attenuation of the filter will increase. A π low pass filter was used. This is shown below

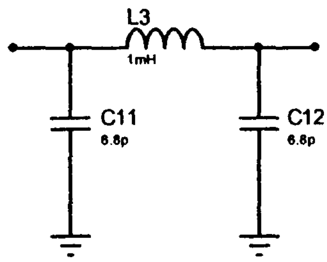


Fig 3.16 π low pass filter

At a low frequency, the reactance of the series inductor, L3 (1mH) is low and the reactance of the shunt capacitors C11 and C12 are high; at these frequencies therefore the inductance offers little opposition to the flow of current while the capacitance has zero shunt effect. As a result low frequency signals are propagated without losses. As the frequency increases, the inductance of the inductor increases while the reactance of the capacitor decreases thus increasing attenuation which reaches the peak at the cut-off frequency of the filter.[27]

CHAPTER FOUR

TESTING, RESULTS AND CONCLUSION

The designed and constructed circuit was subjected to a series of tests and the results obtained were analyzed and relevant deductions made.

4.1 TESTS

The following tests were carried out

i) Frequency selection test

ii) Range of coverage test

iii) Time duration test

4.1.1 FREQUENCY SELECTION TEST

This test was performed to determine the frequency at which the transmitted signal was strongest. The following procedure was carried out:

i) The VCD was connected to the designed circuit and then powered.

ii) A television set at some distance away was tuned until the best picture and sound was obtained.

iii) The frequency at which the best picture and sound was obtained was saved on the set and taken as the frequency of transmission.

4.1.2 RANGE OF COVERAGE TEST

This test was carried out to. determine the range of transmission of the transmitter. The following procedure was carryout out:

i) The VCD was connected to the designed circuit and then powered.

ii) A television set tuned to the frequency of transmission of the transmitter is then moved gradually away from the point of transmission until the maximum distance at which an acceptable image/audio is received at the television.

4.1.3 TIME DURATION TEST

This test was performed to determine the actual time at which the device automatically comes on or off as the case may be. This test was achieved in the following way:

i) The VCD was connected to the designed circuit and then powered.

ii) A television set was tuned to the frequency of transmission and placed within the range of transmission.

iii) The timer knob for both the wait duration and the transmit duration was gradually increased from the 1 minute to the 1 hour 30 minutes duration and the actual time of trip on and off measured with the stopwatch.

4.2 DISCUSSION OF RESULTS

4.2.1 RESULTS OF FREQUENCY SELECTION TEST

From the frequency selection test, the following images were obtained at various frequencies of transmission.

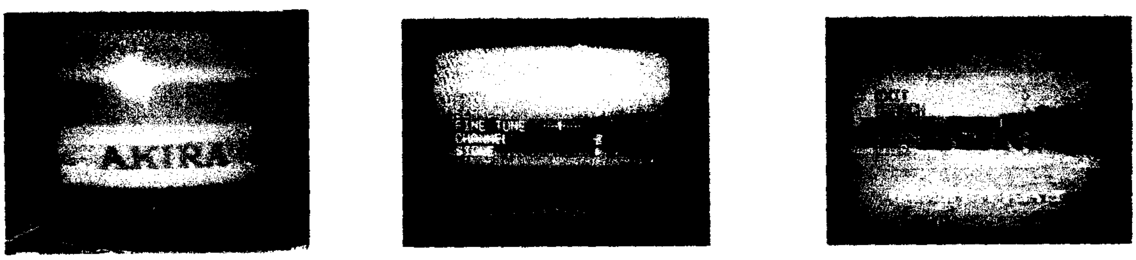
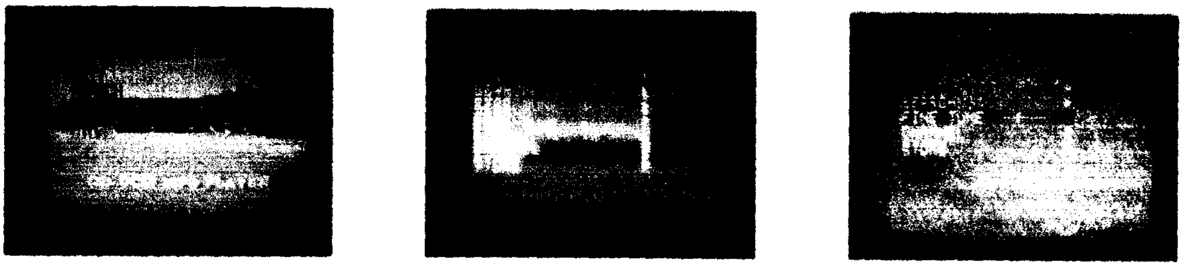


Fig 4.1 Images received at various transmission frequencies.

4.2.2 RESULTS OF RANGE OF COVERAGE TEST

The following images were obtained at the stipulated distances/ranges from the transmission point.



(a) R<10m (b) 10m<R<25m (c) R>25m

Fig 4.2 Images received at various transmission ranges

From the above pictures, it can be concluded that XX can be taken to be the effective range of transmission of the transmitter.

4.2.3 RESULTS OF TIME DURATION TEST

Tabulated below are the various results on the measured wait and the transmission times as against the calculated or theoretical time.

Table 4.1 Times of wait of timer.

THEORETICAL TIME(HR:MM:SS)	WAIT DURATION (HR:MM:SS)	TRANSMIT DURATION(HR:MM:SS)
0:01:00	0:01:02	0:01:00
0:30:00	0:35:01	0:38:38
1:00:00	1:08:40	1:12:20
1:30:00	1:45:10	1:49:05

It can be observed that the actual times of the timer differs from the calculated values. This is due to deviances in the values of resistors R and capacitance C, which determine the time, from their stipulated values.

CHAPTER FIVE

CONCLUSION

5.1 CONCLUSION

This project which is design and construction of a TV transmitter with timed turn on and turn off is a feat that was made possible by the training acquired over the years in this institution. The project makes use of very simple design procedures to achieve an intricate design. The project consist basically of three modules:- the power supply, the timer and the transmitter. Each module consists of blocks made up of basically electronic components, with each performing a specific function.

At the end of the project, it can be concluded that it is possible to achieve wireless transmission of both the audio and video signals of a base band source (e.g. VCD, decoder) to a television. The duration of transmission can also be controlled by cutting of or putting on the power supply to the transmitter. This project can be concluded to be a success.

5.2 RECOMMENDATIONS

The designed circuit was relatively simple, and this has an adverse effect on the efficiency of both the timer and the transmitter. As such the following recommendations are necessary:

i. A crystal should be used to generate the main carrier for stability.

ii. The RF oscillator should be followed with a buffer to reduce loading effect of succeeding circuits.

iii. A microcontroller should be used to achieve more accurate and reliable timing.

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APPENDIX A: Data Sheet of BF240

FAIRCHILD SEMICONDUCTOR

BF240

BF240

NPN RF Transistor

TO-92

1 Collector 2 Emitter 3 Base

Absolute Maximum Ratings* T_a=25 C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	4.0	V
I_C	Collector Current - Continuous	50	mA
T_J, T_{STG}	Operating and Storage Junction Temperature Range	-55 ~ 150	C

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Electrical Characteristics T_a=25 C unless otherwise noted

Symbol	Parameter	Test Condition	Min	Max	Units
Off Characteristics					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage *	I_C = 1.0mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 100μA, I_E = 0	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10μA, I_C = 0	4.0		V
I_{CBO}	Collector Cut-off Current	V_{CB} = 20V, I_E = 0		100	nA
On Characteristics					
h_{FE}	DC Current Gain	I_C = 1mA, V_{CE} = 10V	65	225	
V_{CE}(sat)	Collector-Emitter Saturation Voltage	I_C = 1mA, I_B = 0.1mA		0.65	V
V_{BE}(sat)	Base-Emitter Saturation Voltage	I_C = 1mA, I_B = 0.1mA		0.74	V
Small Signal Characteristics					
f_T	Current gain Bandwidth Product	I_C = 7.0mA, V_{CE} = 10V, f = 100MHz		1100	MHz
C_{re}	Common-Emitter Ruerse Transfer Capacitance	V_{CB} = 10V, I_E = 0, f = 1.0MHz		0.34	pF

* Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2.0%

Thermal Characteristics T_A=25°C unless otherwise noted

Symbol	Parameter	Max	Units
P_D	Total Device Dissipation Derate above 25 C	350 2.8	mW mW/ C
$R_{θJC}$	Thermal Resistance, Junction to Case	125	C/W
$R_{θJA}$	Thermal Resistance, Junction to Ambient	357	C/W

APPENDIX B: **Costing of Project**

S/n	Item	Qty	Unit Cost(N)	Total cost (N)
1	12V Relay	4	70	280
2	12V, 500mA step down transformer	1	100	100
3	Variable Resistors	6	30	180
4	555 timer	2	70	140
5	Resistors	13	10	130
6	Diodes	4	10	40
7	LED	2	10	20
8	Casing	1	200	200
9	Veroboard	1	50	50
10	Capacitors	16	30	208
11	Inductors	2	60	120
12	7815 Regulator	1	60	60
13	Variable Capacitors	1	80	80
14	Switches	2	20	40
15	Input Jacks	1	30	30
16	Push buttons	2	10	20
17	**TOTAL**	**59**		**1, 698**

APPENDIX C: Manual of Operation

Follow these steps:

1. Connect the playing machine (VCD, Decoder machine etc) to the power output of the TV transmitter.

2. Connect the audio and video output of the playing machine to the respective inputs of the TV transmitter.

3. Connect the TV transmitter to the mains power supply and put it on.

4. Select the 1 minute test duration for both the wait and transmit durations, press the start button wait button, and observe indicator lights to test the timer operation.

5. Tune a television set within 25m of the transmitter to the frequency of transmission of the transmitter (this can be achieved by searching for the signal on the television).

6. Now select the appropriate wait and transmit durations.

7. Press the start button wait button to start waiting and the start transmit button to start transmitting.

PLEASE REFER ALL SERVICING TO QUALIFIED PERSONEL ONLY.

APPENDIX D: Complete Circuit Diagram