DESIGN AND CONSTRUCTION OF RADIO (FM) REMOTE CONTROLLED GATE

BY

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DECLARATION

This is to certify that this project REMOTE CONTROLLED GATE was designed and constructed by OMOTOSHO OLAYEMI OMOTOLA and supervised by Mr. U.S Dauda in the Electrical/Computer Engineering Department.

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Project supervisor — 7/12/05 DATE

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(Head of Department) — 16/02/06 DATE

EXTERNAL EXAMINER — DATE

ACKNOWLEDGEMENT

With deep sense of appreciation, I am grateful to God for being there for me through out the course of my study.

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Much appreciation also goes to my friends especially seun (Royce) who help in the construction. Adele, Yamai and Yerima, you are great guys.

My appreciation goes to my family in Minna Dn and Dns Oyedepo, Wole, Kemi, Gboyega and Muyiwa. I cherish our relationship, parental and brotherly care.

DEDICATION

This project is dedicated to Almighty GOD for it's in Him we live, move and have our being.

ABSTRACT

The device has two sections; The FM transmitter and receiver. The transmitter is linked to the receiver circuit through the carrier wave generated at the transmitter circuit.

Noise or signal injected into the carrier wave is consequently modulated. The FM transmitter is meant to operate at a frequency range of 60-70 MHZ.

At the receiver circuit the RF oscillator is ganged so as to generate a constant output intermediate frequency which is varied through a gang capacitor. Output signal is amplified through a signal amplifier and passes through a RC filter.

The control logic is designed to toggle switch the output control latch that drives two set of relay and the transistor 2SC945 are designed to switch the relay. The relays are connected to interchange power terminals supply on the motor which opens and closes the gate.

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CHAPTER ONE

1.1 Introduction

Radio Control (RC) is basically the building block for remote controlled devices among others such as infra-red transmitters or receivers. This write up will focus on remote control operated device using radio wave propagation.

Radio Control is an offshoot of space-age electronics. It has benefited from the technology of space rockets and vehicles, for which high-quality miniature electric motors, rechargeable batteries and remote guidance system have been developed. The sophistication of Radio control (RC) enables a modeler, using professional equipment, to stimulate accurately the movement of a large number of full-sized machines. It brings a new realism to the miniature word of aircraft, cars, brats or other models.

Radio control relies on the conversion of mechanical signals into radio signals that effect the controller's intension. It uses repeated patterns of radio signals (called framer) comprised of pulses or pauses. Each frame of signal that contain the pulsed information for each radio channel (function) and an off period, known as a synchronization pause, to reset each frame at the receiver. By sending out these frames of information at a high rate (typically, so a second) a smooth control movement that increases uniformly with signal strength is achieved. The system can be compared to that of a movie projector, which sends out a series of still picture frames at a speed sufficient to give the appearance on a screen of a continuous movement. Like a movie, radio frames are of equal duration but the contents vary with succeeding frames.

Information to be transmitted is generated when the controller moves the control sticks, lever or switches on the control box (the transmitter). As each control is moved, the corresponding information pulse in the frames. The control movements are translated into output pulse by an encoder in a master clock, which constantly times the frame rate. From the encoder, the output pulses are passed to a modulator, where they are converted to precisely shaped pulse suitable for transmission.

Radio frequencies are strictly allocated by radio transmission authorities, as several modelers use the same frequencies. Interference between frequencies as between equipment on the same frequency is prevented by insuring that signal accurately processed before transmission, and by restricting signal strength. Low-power transmission of about 1watt-limits the range of radio, so that models as close as 2 miles (3km) apart can be controlled without interference.

Equipment controlled by radio varies according to application, mainly in the number of its control functions. A two-channel system is sufficient for controlling the steering as motor speed on a model car, but would not be capable of coping with the complexity of an RC helicopter. Radio set can have from two to eight functions. A detailed model with a built in engine self-starter, retracting undercarriage, flaps functional navigational light as the usual function of rudder, elevator, throttle and aileron control would require an eight-channel radio to operate all these controls remotely.

The number of electron components used in RC equipments is being reduced as the use of miniature electronics increases. Already, RC equipment has become sophisticated. Some equipment features variable control movement rates, automatic roll for aircraft, mixing of different channels, serro-output direction reversing and digital clocks for timing the operation of the model. Microprocessors have been used to control electric railway systems, but to incorporate them in RC equipment for aircraft, boats as could be self-defeating.

Radio control among other things discussed above have many applications especially in industry. RC aircrafts for instance are use for over flying electricity power plant cooling towers to measure temperatures and humidity and to carry cameras for survey work. In the film and TV business, RC models of aircraft, trains, trucks and other vehicles are used to represent full-size machines. New uses are being found every day for RC application not all for peaceful purpose and the lobby of RC models also continues to progress.

CHAPTER TWO

2.1 Literature Review

Radio is that means of communication that depends solely on the use of electromagnetic wave propagated through the space at the speed of light. In years ago, different methods have been improvised faster than carrying messages by foot, horses or vehicles. The series of inventions that culminated in radio system include drums, sm

2.2 The History of Radio

The development of radio included many steps and involved many great people who have succeeded in changing our world to become a better place.

The existence of radio wave was predicted mathematically in 1864, long before it was discovered. This prediction was made by English man James Clark Maxwell and in 1888 a German, Hein-rich Hertz, demonstrated that radio wave existed and that they travel through space. Today, radio frequencies are identified and measured in Hertz's.

While Hertz's discovered the radio wave but never communicated by radio, another man Ernest Rutherford improved on his work (1871 – 1937) and became the first man to send radio signals. This signal were sent to about 1,200 meters (3,900ft) and later English man Oliver Lodge figured out the basic principle of tuner.

Gugliclmo Macron, an Italian working in England, climbed further up the ladder and today he is considered the founder of radio communication. In 1901 he succeeded in sending and receiving message signal by radio relay which was wireless telegraph, sending only dots and dashes. No spoken word was transmitted until when radio broadcasting was made possible by the development of the vacuum tube.

In 1904, the first vacuum tube was made by John Ambrose Fleming (1849 – 1948). In 1906 an American inventor, Lee de Forest (1913 – 1961) added a third part to the English man's (Fleming's) vacuum tube. This new tube was called a triode or audio amplifier. It was much like vacuum tube used today. As time went on more and more of radio transmission were discovered and ways to improve them developed. Today, radio waves have been bounded off the moon with satellite, missile launch and radar communication.

The information transmitted by radio is carried by an electromagnetic wave system called the "Carrier wave". This carrier wave is varied in some fashion (modulation) by the electrical signal from the transducer, which is representing the message to be transmitted.

After modulation, the modulated signal is fed to the transmitting antenna, which then takes the electromagnetic wave into the space. At the receiving end, a very small portion of the transmitted signal is capture by other antenna. This signal is fed to the radio receiver which separates he required message from the carrier. The message is then translated from electronic form to sound, pictures or other forms that can be interpreted.

2.3 Radio Transmission

Communication basically is the exchange or sending of information from one person to another. People from all works of life have communicated for thousands of years. It's necessary for the existence of man and no one can live in isolation. Only a few centuries ago did communication made easy through electronic means and interaction with other equipment like computers made easy.

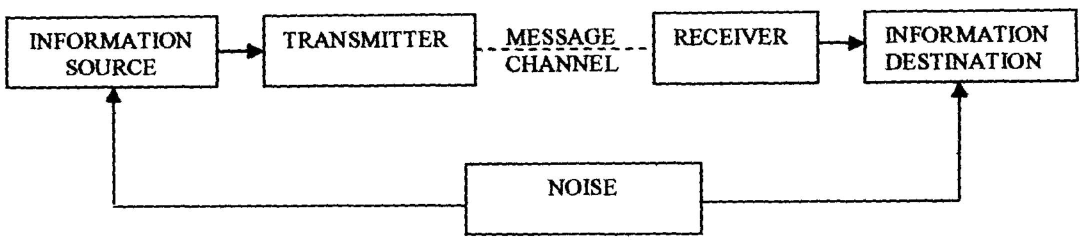


Fig 2.3 A Basic Communication Model

A good communication process must have an information source which is the origin of the information to be communicated. This information to be communicated must be encoded or converted to an electrical signal. This process which is the second stage is known as Transmitter Stage. This encoded information is fed into a message channel which can be electromagnetic wave, wire or some other medium. The message is converted to some intelligent form such as sound or video (picture). At this point the message has been decoded and fed to the destination which could be a person or machine.

Anything that breaks or interrupts communication is called NOISE. It usually enters the communication process through the message channel. A good example of external noise in an electronic communication is lightening and distortion.

The application of the type of system covers a wide range from broadcasting, public address systems to walkie-talkie system or transceiver and remote control. From the channel, the receiver picks up the message, tunes and amplifiers it to produce the information.

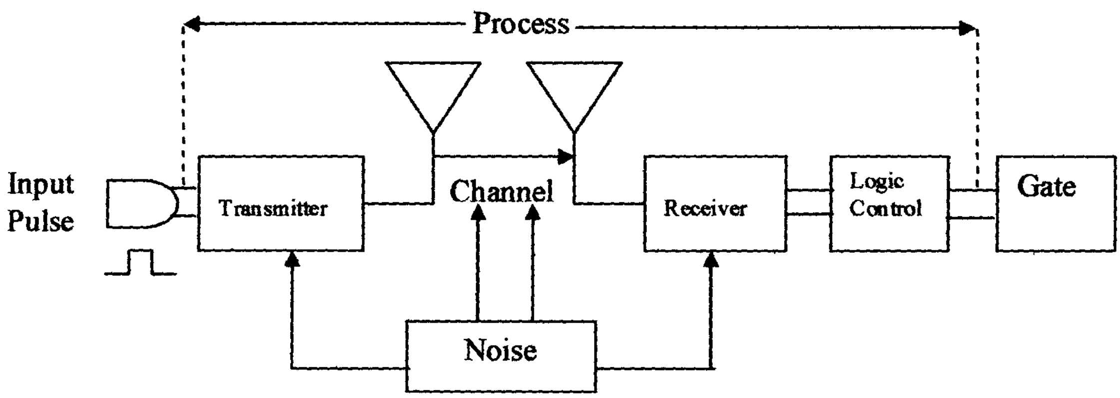


Fig 2.4 Pulse Transmitter

It must be remembered that the use of air space in communication must be rigidly controlled especially by the federal ministry of communications. Radio wave frequencies there must be assigned to satisfy the needs of the people in communication industries, military or other parastatal related to communication. Therefore the need to minimize interference and provide world class service is paramount.

Electro-magnetic waves (Radio wave) are classified into different frequencies. This will improve and ease my write up and make them precisional in later discussion.

FREQUENCY RANGE	BAND
Less than 30 kHz	Very Low Frequency VLF
30 – 300 KHz	Low Frequency LF
300 – 3 MHz	Medium Frequency MF
3 – 30 MHz	High Frequency HF
30 – 300 MHz	Very High Frequency VHF
300 – 3 GHz	Ultra High Frequency UHF
3 – 30 GHz	Super High Frequency SHF
30 – 300 GHz	Extremely High Frequency EHF

2.4 Use of Frequency Bands

At frequencies I the very low frequency (VLF) and low frequency (LF) bands, aerials are very inefficient and high power transmitters must be used. The radiated energy is vertically polarized and will propagate reliably (no fading) for thousands of kilometers using the surface wave for HF (30 – 30 MHz). Services provided in this band are ship-to shore telegraphy, navigation systems and sound broadcasting (hf band).

In medium frequency band, MF, the range of the surface wave is limited to hundreds of kilometers and the main use of this band is for sound broadcasting (AM

647 – 1546 kHz). At high frequency (HF), the main mode of propagation is the sky wave and the surface wave if required service is for distance up to the ship distance. The HF band is used for international point-to-point radio telephony links on a number of sub-bands for sound broadcasting and for marine and aero mobile systems.

For very high frequency (VHF), and higher bands, the surface wave has a very limited range and ionosphere (normally) and does not return to earth. The modes of propagation used are the space wave and at certain frequencies in the S.H.F. band, the communication satellite scatter propagation is also sometime used.

Services provided are sound broadcasting in (VHF) band (88.1 – 96.8 MHz), land, marine and aero mobile systems in VHF and UHF ranges.

Electricity from the supply Authority (PHCN) for the home is 50 Hz or at the power frequency.

CHAPTER THREE

3.1 Component Description and Functions

The circuit is mainly designed by the use of complimentary metallic oxide semi-conductor (CMOS) integrated circuit (IC). The logic is attributed to numerous merits. These include high fan-out, wide voltage range (3-18V), low power consumption, low cost, high output stability etc the logic quite better than the other type transistor transistor logic (TTL), in the sense of power consumption. And even, it is of great importance in term of circuit compatibility. The 4000 series is a set of IC design to met both simple and complex projects. It holds all the major set of logic

3.2 The 4060B (Oscillator)

It is a 14-stage ripple binary counter/divider. The oscillator can operate both in the RC and crystal mode such features makes it of great Importance in term of output frequency stability. The CMOS IC provides up to ten frequencies output at its terminals. This is quite an exceptional feature not seen in other frequency generators (especially 555 timers). It is also attributed to special pin feature such as enabling input (Pin 12). This terminal can be use to control the altogether IC. It is active low terminal. Meaning a low logical level is required at the terminal for the device to be functional. A high logical level at the point disenabled the IC. The pin 11, 10 and 9 are attributed to the oscillation of the device. Specific resistance and capacitance values are connected to the terminals. And this value determines the output frequency of the device. The output frequency can be estimate with the leading frequency formula.

$f_0 = 1/2.3R_0C_0$

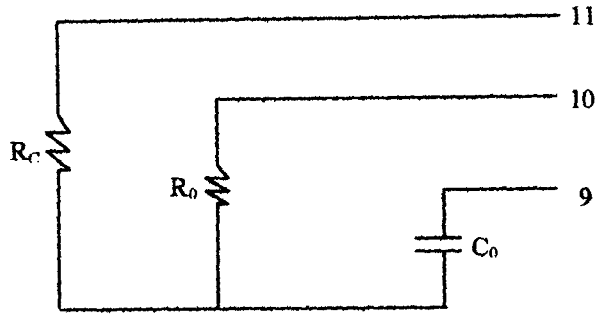


Fig 3.1 frequency Output of 4060B

RC must be $2R_0 < R_C < 10R_0$

The frequency formula is applicable at frequencies lower than 100 kHz

Therefore, the frequency output is

$F = 1/2.3 * 33 * 10^3 * 0.001 * 10^{-6}$

$= 13.2$ kHz

So that the frequency output at pin13 is

$F_0 / 2^{10}$

The 4000B is used in the circuit for automatically resetting the SR latch so that a toggling effect can be achieved.

The F_0 frequency is internally divided fourteen times so as to have multiple frequency output at lower range.

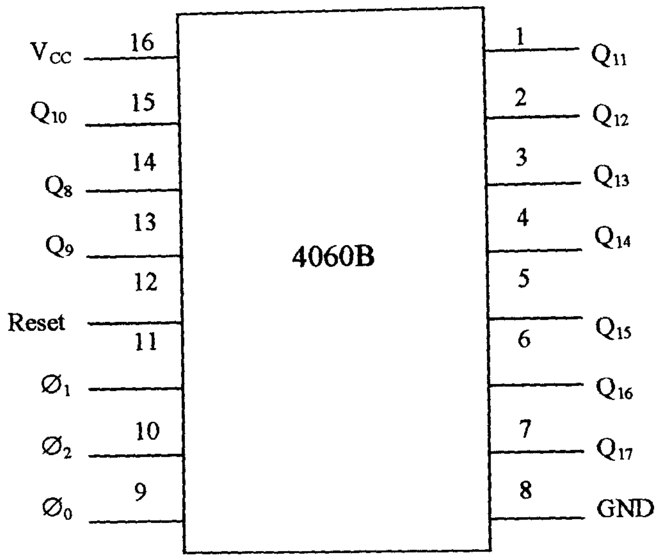


Fig 3.2 Pin Assignment of 4060B

3.3 The 4013b (Latch)

It is a D-type latch. Two are in-built in the integrated circuit (IC). Each of the devices holds a set, reset, D-input, and clock inputs. Moreover, the latch is usually configured in the SR mode by the ground of the clock and D-input terminals.

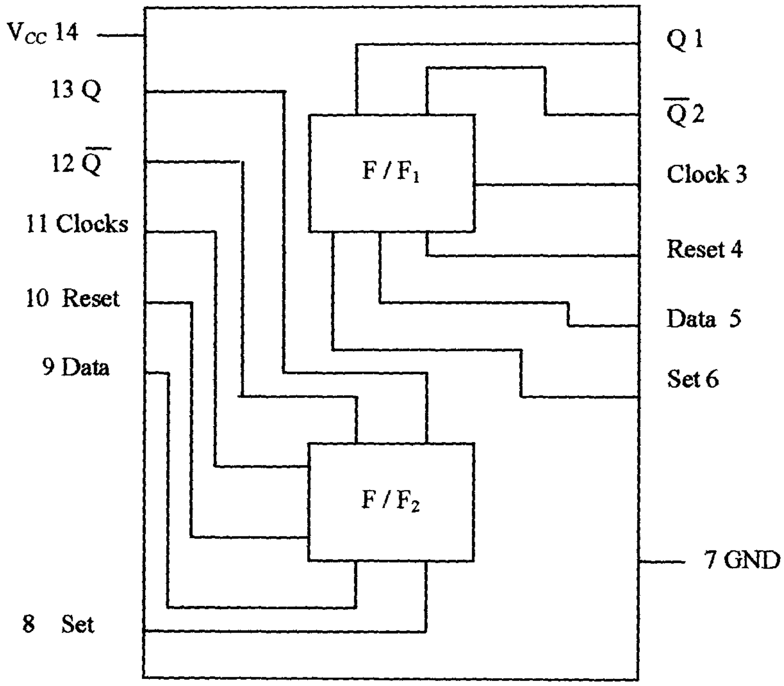


Fig 3.3 Pin Assignment of 4013B

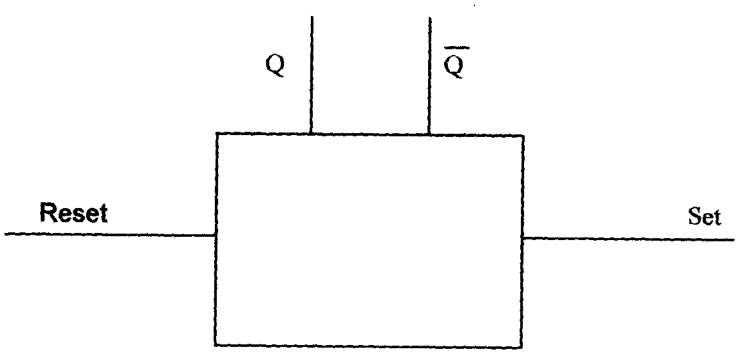


Fig 3.4 SR Latch

Table 3.1 Truth Table of SR Latch

S	R	$\overline{Q}$	Q
0	1	0	1
1	0	1	0

3.4 KA2297 integrated circuit

The IC is designed to receive both FM and AM radio frequencies. It internally incorporates all the major circuits for such receiver design. The FM mode is in use in the leading circuit and limited number of components is required. The pin1 and 2 are connected with the antenna circuit. The signal flows into the IC through this terminal. The signal is fed to pin 15 in which a particular RF is tuned to by the use of specific LC tuned circuit. The RF circuit feeds the received signal to the mixer. A local oscillator frequency (f2) is generated at pin 13 of the IC. And it is mixed with the RF. The results of mixing are four resulting frequencies. The frequencies are f1, f2, f1 + f2 and f2 – f1. The second to the last frequency is least strong. And the difference provides the strongest output. This frequency is the best and also known as the intermediate frequency (IF). This frequency is the most important and it is required for filtration. The output comes out of pin 3 and a 10.7MHz (IF) crystal is connected to the pin. So that the filtrated frequency output is connected to pin 8. Pin 5 is used for automatic voltage control (AVC). And it is connected with a 33μf 16V electrolytic capacitor. Pin 9 is ground and additional IF. Filtration is done through the connection of an intermediate frequency crystal to pin 10.

The intermediate frequency is fed back into the IC for demodulation. The audio signal after modulation is fed out from pin 11.

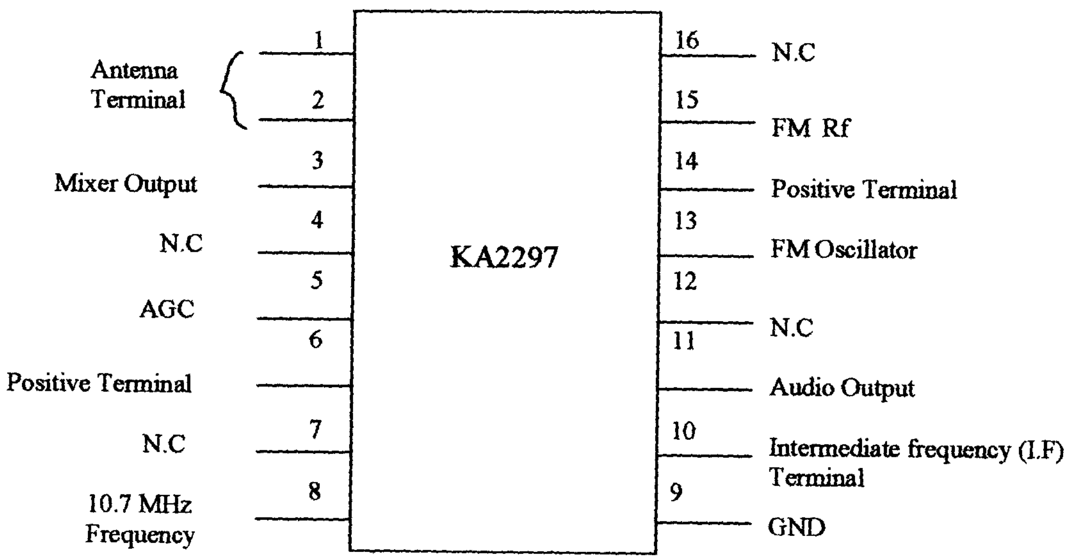


Fig 3.4 Pin Connection of KA2297

3.5 The Transmitter

This circuit generates the carrier wave which link the receiver. The oscillator generates a pulse which injects noise into the carrier wave. The 4060B is the oscillator that generates frequency based on the resistor-capacitor circuit. The FM transmitter is a single transistor oscillator which generates frequency range of 60 to 70 MHz. The 10KΩ and 0.022μf are transistor base biasing circuit and the frequency of operation is based on inductor capacitor in the circuit. Also the 3 – 5 ρf capacitors are use for antenna coupling. Inductor and capacitor are variable so as to alter the frequency range. The transmitter is power by 9V battery and its control switch pressed to send command signal to the receiver.

3.6 The Lm 386 (Audio Amplifier)

The integrated circuit is a 1 watt audio amplifier. It is designed for limited external components. Pin 3 is concerned with the audio input. Both pin 1 and 8 are related to as gain. Pin 2 and pin 4 are ground. Pin 6 is the positive power source and pin 5 is the output.

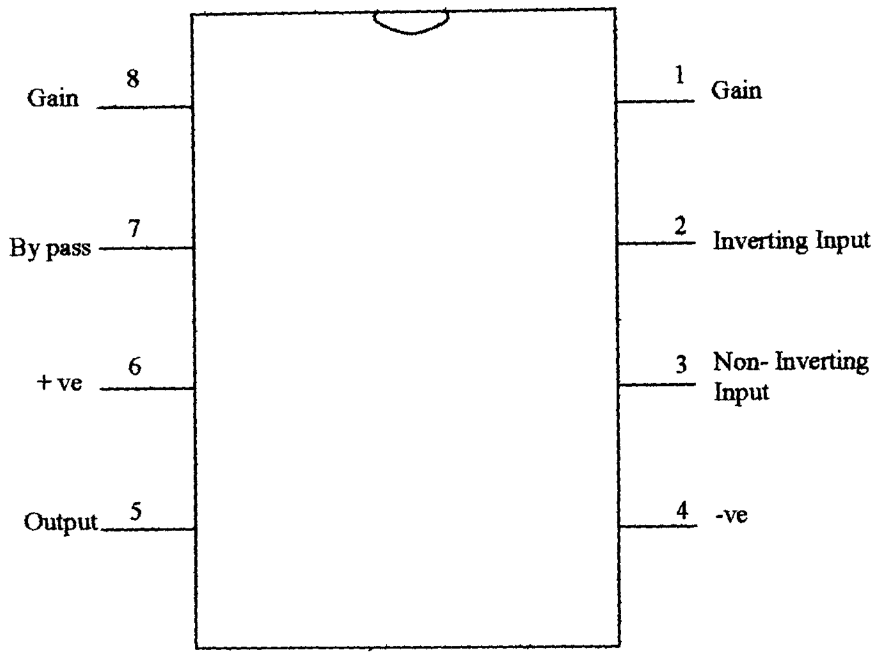
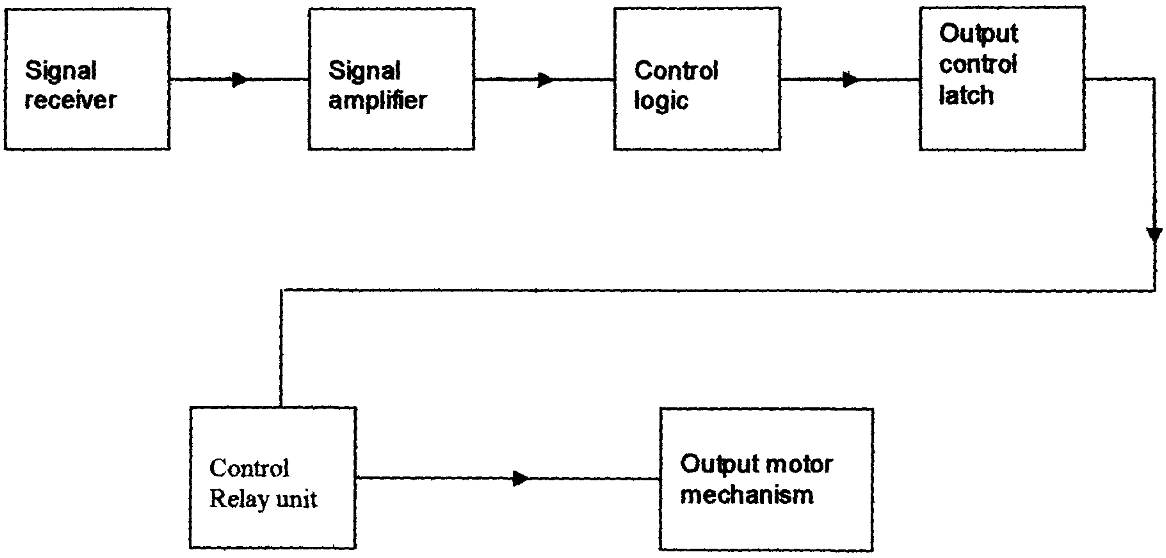


Fig 3.6 Pin assignment of LM 386

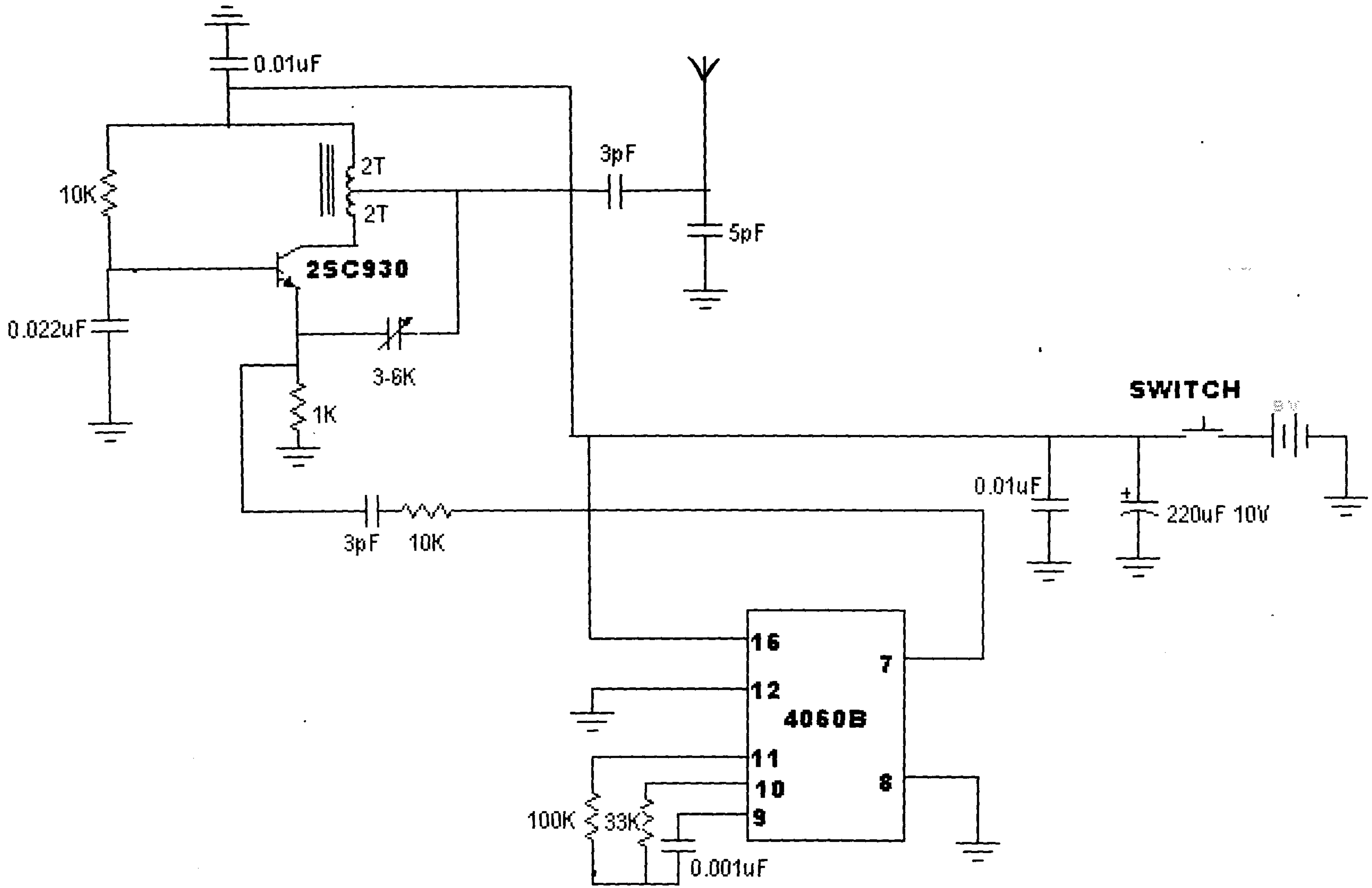
3.7 Circuit Operation

The input section or unit is the fm receiver. The signal is amplified by the audio amplifier and the output comes out of terminal 5. This is connected to terminal 6 which is the SR latch so that when the transmitter is activated the SR latch is set changing Q output from low logical level to high .$\bar{Q}$ changes low and the terminal is connected to pin 12 of the 4060B. The oscillator/timer is enabled and pin 13 feed back a HIGH logical level to reset the SR latch.

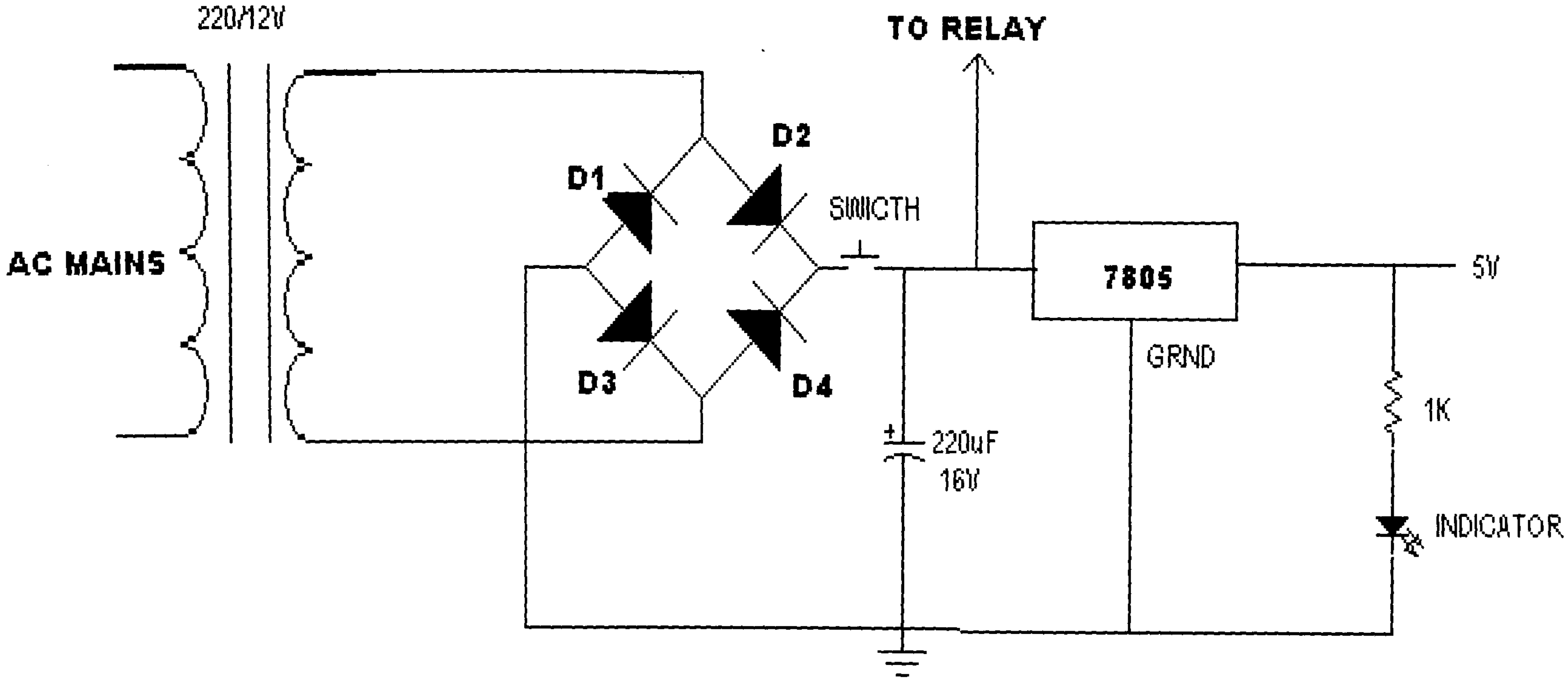
Pin 1 of the SR latch is connected to the clocked output of the toggle latch. The output of the SR latch behaves like a clocking pulse for the toggle latch. So, that the output of the toggle latches toggle the base of the switching transistor Q! and Q2. The output controls the switching of the relays. The relays are connected so that the terminals of the motor can be interchanged. Q1 and Q2 are spark reduction diodes and the 4.7KΩ resistors are base biasing resistor. Q3 (25D400) is designed to supply negative power to the electric motor. It's switching signal is fed from Q output of the SR latch. The time at which Q3 is switched on is determined by the complete opening and closing of the door.



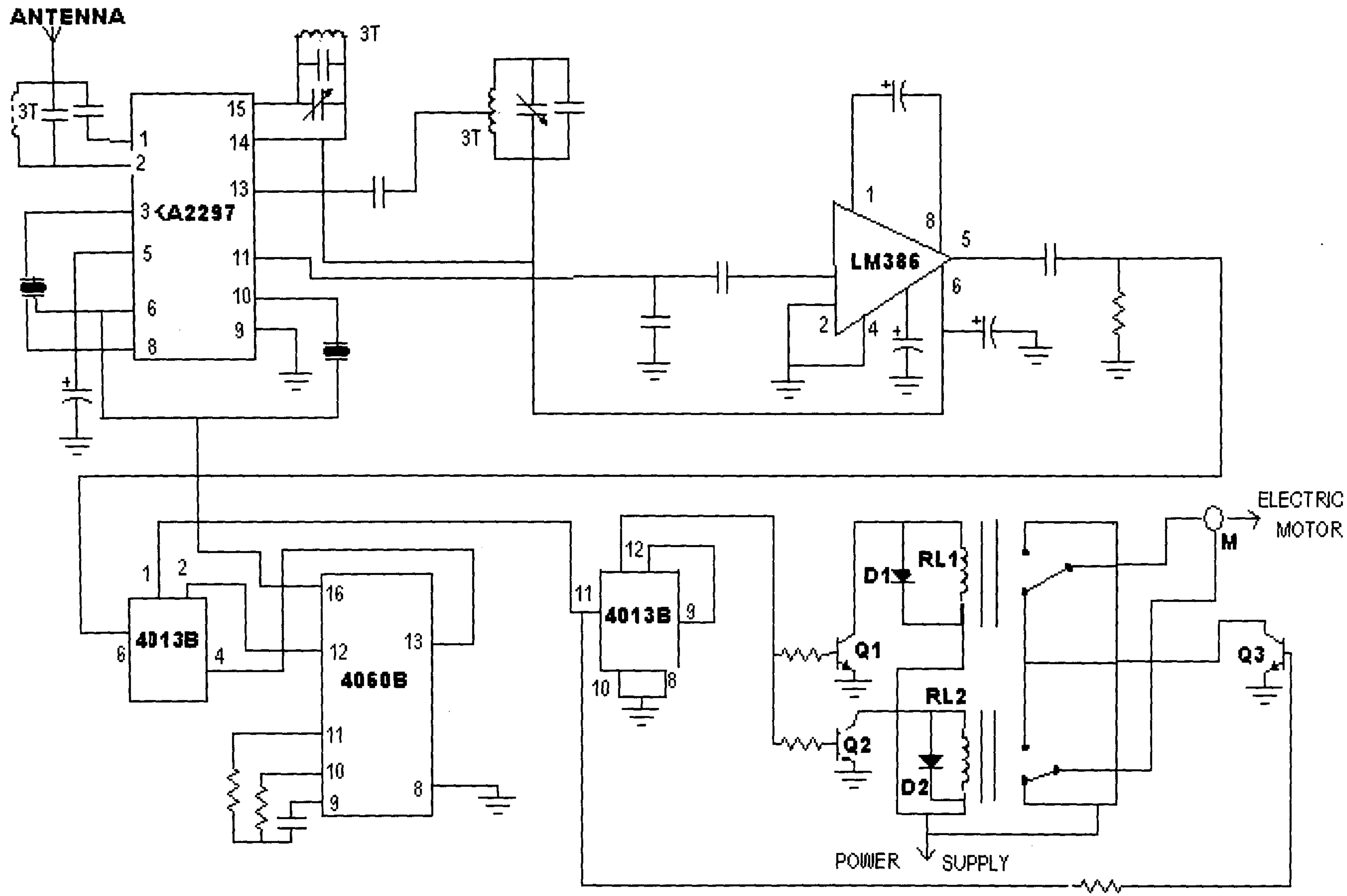
Radio Remote Control Circuit. Block Diagram



RADIO REMOTE CONTROLLED CIRCUIT



POWER SUPPLY CIRCUIT



RADIO RECIEVER CIRCUIT

CHAPTER FOUR

4.1 Construction, Testing and Result

In constructing this project, a larger part was tested and placed on the breadboard except for the power circuit. Each component in module of the design were tested before soldering on to the Vero board.

4.2 Circuit Construction

The power sector was first constructed with the bridge rectification properly put in place and filter with a 25V/2200μf capacitor. The step down transformer used is rated 12V, 500mA. Output was finally obtained after series of checking and filtering to ensure correct connection of all components.

This however, was followed by supplying the output to the receiver section as output logic section through a 9V regulator 7809 to supply constant voltage to the circuitry. The output signal to the receiver was filtered and amplified passing through an amplifier LM386 to the output control which contain IC 4060 oscillator and 4013 (Latch). These components were carefully soldered on to the Vero board due to the fed that IC sockets were not used so heating was taken into serious consideration. The output control latch was connected to the output relay through an n.p.n common emitter transistor. The relays are responsible for switching the motor that opens and closes the gate.

The gate and entire circuit is actually a prototype and therefore the replica of gate used is a C.D ROM drive that can easily close and open when voltage is applied across its motor terminal.

CHAPTER FIVE

5.1 Conclusion

The main aim of the project using radio remote control to open and close a gate over a frequency range of 60-70MHZ has been fulfilled. The difference in the results using 9V battery supply and variable power supply especially in the receiver circuit is minimal.

5.2 Recommendation

The circuit could be much better if printed circuit board (PCB) is used because it make work neater and of standard measure.

Reception is made easier and better if the amplifier stage is increased and effective distance is attained more than 5meters.

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BILL OF MATERIAL QUANTITY FOR THE PROJECT DESIGN.

S/N	Description of component	Quantity	Unit	Rate ₦	Total amount
1	Diode	6	Lot	5	30
2	12v Transformer	1	Lot	100	100
3	Regulator	1	Lot	50	50
4	Resistor	6	Lot	5	30
5	Capacitor	11	Lot	5	35
6	Transistor	4	Lot	15	60
7	Radio receiver I.C	1	Lot	1	200
8	Amplifier	1	Lot	1	100
9	Oscillator (4060)	2	Lot	120	240
10	Latch 4013	1	Lot	120	120
11	Relay	2	Lot	180	160
12	Gang	1	Lot	80	80
13	Crystal oscillator	2	Lot	50	100
14	Led modality	1	Lot	5	5
15	Toggle switch	1	Lot	50	50
16	9V battery	1	Lot	50	50
17	Antenna	2	Lot	50	100
18	Modeling	1	Lot	1,500	1,500
TOTAL					**3,010**