DESIGN AND CONSTRUCTION OF LAND MINE DETECTOR SYSTEM

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DECLARATION

I hereby declare that this project was conducted by me under the supervision of Eng.j.Kolo; electrical/computer Engineering department, Federal university of technology, Minna.

Mr. Zahir Ashraf

Student's signature

16-10-2003

DATE

Eng.J.kolo

Supervisor's signature

DATE

CERIFICATION

This is to certify that this project LANDMINE DETECTOR SYSTEM was designed and constructed by Zahir Ashraf for the partial fulfillment of the award of Bachelor degree in Electrical/computer Engineering.

....

ENGR. J.KOLO DATE

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ZAHIR ASHRAF DATE

Candidate.

DEDICATION

This project is dedicated to my late Father Mohammed Ashraf Chaudhry.

ACKNOWLEDGEMENT

My greatest thanks go to ALLAH (GOD) for his protection and guidance throughout my academic pursuit.

I express my profound gratitude to Engr. J. Kolo who supervised and suggested the topic of this project work, for making his time available to meticulously scrutinize this project work despite his tight academic schedule.

I wish to thank the H.O.D and all members of staff of the Department of Electrical/Computer Engineering.

I thank all my colleagues and friends who either consciously or unconsciously supported or encouraged me.

ABSRACT

The objective of this project-Land mine detector, is to design a detector that specially detects deadly buried land mine ,detection of bombs and also for security purpose in detecting weapons made of metals that can be easily concealed.

It can also be used to trace cable routes of conduit wiring.

The project design and construction have been done in units. The land mine detector has been adequately tested after the design and construction, it was able to perform its function very appropriately and accurately.

In this report, I have put in much effort to draw easy-to-understand circuit's diagrams and also used easy grammar to explain the project. It is hoped that anyone who goes through the report will easily understand the principle, design and construction of land Mine detector.

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GENERAL INTRODUCTION

1.1 INTRODUCTION:

The word 'land mine' is a charge of high explosive in a metal casing. It is a device used by military for disrupting halting enemy movements. Land mine can be exploded electrically, from a distant or exploded by contact with a vehicle, or a time fuse. Land mines have long been used in tunned built under enemy forts and trenches.

There are two main types of land mine

Antitank land mines and antipersonnel land mine

1.1.1 Antitank Mines

17. These mines are designed to incapacitate tanks and other vehicles either by destroying the track or wheels (immobilizing the vehicle) or by penetrating the hull, causing the death of the occupants. Early versions relied upon blast effects to incapacitate the vehicle. Blast mines, which are the most commonly found Antitank mines, tend to be heavy (weighing up to 14 kg) because they use a large amount of explosive to obtain the pressures needed for desired effects. These mines are mechanically fuzzed to trigger upon contact with the vehicle. Other Antitank mines relies on the projection of a metal slug or jet to penetrate the vehicle hull. While some of these mines have mechanized fuzzes (tilt rods), they generally have magnetic sensors and electronic components. Antitank mines, primarily incapacitate their targets by attack from below (the tank must pass over the mine to initiate it). Alternate modes of attack are side attack and top attack. Side attack mines rely upon the firing of a projectile into the side of a tank as it passes a sensor. They will probably not present a significant

demining problem because there is less risk of abandonment due to their cost and short life as they are battery powered. Top attack mines rely upon sophisticated technology and are still in development. They will not be deployed for a number of years and their expense makes their widespread and uncontrolled use very unlikely. It is unlikely that these mines will be a problem within the context of demining. Manually emplaced AT mines may be secondarily-fuzed (or booby trapped) to prevent removal. Those mines fuzed with these anti-handling devices (AHD) will detonate if disturbed, making mine clearance much more difficult to accomplish. Advanced scatterable mines may include integral electronic AHDs.

1.1.2 Anti Personnel Mines

These mines are designed to kill or incapacitate people. There are generally two types of AP mine: those relying strictly on blast effects, and those throwing out lethal fragments. The blast type AP mine relies upon the individual soldier stepping on it to trigger detonation. Blast effects can vary, from incapacitation and trauma, to loss of life, depending on the size of the charge and the circumstances of initiation. Fragmenting AP mines throw out a spray of lethal fragments, steel balls or pellets. Many of these mines have bounding features, providing increased range and lethality. The mines are triggered by various means, ranging from direct contact to pulling or severing a trip line to command detonation.

1.2 Land Mine Detector

LAND Mine detection is an activity which depends almost exclusively on a single basic technology. Mines have traditionally been cased in metal or, at least, had substantial metal content. By far the easiest way to detect them when hidden from view was by using 'land mine detectors' which reacted in the presence of metal. This basic technology has become more sophisticated but has not changed fundamentally. I have improved the sensitivity to react to smaller pieces of metal. However, whilst bringing an apparent benefit, there is a corresponding disadvantage. Many areas in which mines have been laid have been heavily contaminated by metal fragments such as shrapnel and metal rubbish of many types. The more sensitive the detector, the more fragments that are detected. Each response which proves not to be a mine when uncovered is known as a false alarm. Unfortunately the operator cannot always distinguish with certainty between a live mine and a false alarm. Until responses can be positively identified, each must be treated as if it were a live mine which slows down the rate at which mines are cleared.

1.3 STATEMENT OF PURPOSE

There are two main principle reasons for designing this project "land mine detector"

i. For the protection of life.

ii. For the protections of properties.

1.4 PROJECT OBJECTIVE

Land mine detector is design to accomplish several objectives:

It is special design to detect deadly buried land mine that could seriously be dangerous to human life and properties.

It can as well be used in the detection of bomb.

It can be used mostly for security propose to detect knife, gun and any kind of weapons.

It can be used for the detection any kind of metal (both ferrous and non-ferrous metal).

It can also be use in the detection of gold.

1.5 LITERATURE REVIEW

Land mines detectors have been around for much longer than most people realize. Towards the end of the 19th century, many scientists and engineers used their growing knowledge of electrical theory in an attempt to devise a machine, which would pinpoint metal. The use of such a device to find ore-bearing rocks would give a huge advantage to any miner who employed it. The German physicist Heinrich William Dove invented the induction-balance system, which was incorporated into metal detectors a hundred years later. Early machines were crude and used a lot of battery power, and only worked to a very limited degree. The Scottish physicist, Alexander Graham Bell, used such a device to attempt to locate a bullet lodged in the back of American President James Garfield in 1881.

The modern development of the metal detector began in the 1930's. Dr Gerhard Fisher had developed a system of radio direction finding, which was to be used for accurate navigation. The system worked extremely well, but Dr Fisher noticed that there were anomalies in areas where the terrain contained ore-bearing rocks. He reasoned that if a radio beam could be distorted by metal, then it should be possible to design a machine, which would detect metal, using a search coil resonating at a radio frequency. In 1937, he applied for, and was granted, the first patent for a metal detector. His designs were soon put to the test in a practical way, as they were used as mine detectors during the Second World War. They were heavy, ran on vacuum tubes, and needed separate battery packs - but they worked. After the war, there were plenty of surpluses mine detectors on the market; they were bought up by relic hunters who used them for fun and for profit. The hobby of metal detecting had been born.

Many manufacturers of these new devices brought their own ideas to the market. Whites Electronics of California began in the 50's by building a machine called the Oremaster Geiger Counter, and are still at the leading edge of detector innovation today. Another leader in detector technology was Charles Garrett, who pioneered the BFO (Beat Frequency Oscillator) machine, and whose company is still one of the world leaders in design. With the invention and development of the transistor in the 50's and 60's, metal detector manufacturers and designers made smaller lighter machines with improved circuitry, running on small battery packs. The metal detector was reduced to a size that even a child could use - and use them they did. Fabulous finds were made; prehistoric gold ornaments, chests of Roman coins, jeweled daggers - all types of metal artifacts were coming out of the ground. Suddenly, there was a huge requirement for those early electronic magic wands which might make a man rich overnight. Companies sprang up all over the USA and Britain who wished to supply the growing demands.

1.6 PROJECT OUTLINE

This project write-up is in four chapter for easy comprehension .
Chapter one encompasses the general introduction where a brief knowledge of land mine detection system is discussed.

Chapter two, the design operation of this project is described in detail.

Chapter three, the design operation of this project is described in detail. The components and their functions, particularly the active ones, are also reviewed.

Chapter four ,which is the concluding chapter, comprises the construction of the project and testing ,area for improvement and finally the summary for the whole project write-up.

CHAPTER TWO

LAND MINE DETECTOR SYSTEM

1.1 INTRODUCTION

In this chapter, how land mine detector works and the principle behind it ,is discussed in detail

2.2 DESIGN POINTS.

The object of this design was simplicity and the avoidance of special "close tolerance" components. This has been achieved by using a 40KHz quartz crystal to provide highly accurate timing for all the necessary pulses in the system. This approach also removes many sources of jitter and background noise and so allows stable highly sensitive performance.

The use of a power MOSFET to drive the coil also helps to simplify the circuit .It can be driven directly from a standard CMOS gate and has a very low "on" resistance, a high voltage rating and also is able to switch rapidly between on and off .Such devices are almost ideal to work with especially as they are very forgiving and easily withstanding short overloads.

The final aspect of the circuit design is the use of a simple voltage converter to provide a higher voltage than the battery (the boost supply). This allows the pulse amplifier I.C to work with both of its inputs at the battery positive supply level, and also provides a Higher drive voltage to the MOSFET.

2.3 PRINCIPLE OF OPERATION

2.3.1 Pulse Induction - General

The pulse induction (P.I.) method of metal detection relies on the electrical conductivity of buried objects. Thin sectioned material such as foil is not very conductive and so is largely ignored. Solid objects such as coins, rings, nails, are much more conductive and are readily detected, as of course are larger objects.

The biggest advantage of pulse induction is that it is virtually free of "Ground Effect" - so much so that it works perfectly with the search head immersed in fresh or sea water, provided the coil is adequately protected.

The only real disadvantage of this type of detector is that it detects ferrous and non-ferrous metals alike - and cannot discriminate between different types of metal. This is more than compensated by the sensitivity, simplicity, and ease of use that the P.I. system offers, and it is a firm choice with detector enthusiasts, especially for beach combing.

Mainly the current in the search coil, which also determines the battery life, determines the sensitivity of a P.I. detector. This design has been optimized to operate for a sensible length of time from six AA cells, whilst giving a good practical level of sensitivity - it will detect a new 10p coin at 20cm.

The sensitivity has been optimized for less conductive metals such as gold. This has been done by setting the appropriate pulse sampling time - and will be explained in detail later.

2.3.2 Pulse Induction - Principles

The pulse induction method of detection works by subjecting objects to a rapidly changing electromagnetic field. The field is produced by building up a current in a simple multi-turn search coil, and then forcing the current to fall very rapidly by switching off the supply. As the electromagnetic field decays it induces a voltage back into the coil, and also into objects near the coil.

Poor or non-conductive objects are unaffected, but in conductive items a current is induced, producing a small magnetic field which opposes the decay of the original field. This opposing field means that when near metal, the magnetic field around the search coil decays in a different way, and so the voltage induced in the search coil also differs.

2.3.3 Transmitter

The search coil or loop of a Pulse Induction land mine detector is very simple. A single coil of wire is commonly used for both the transmit and receive functions.

The transmitter circuitry consists of a simple electronic switch which briefly connects this coil across the battery in the land mine detector. The resistance of the coil is very low, which allows a current of several amperes to flow in the coil. Even though the current is high, the actual time it flows is very brief. Pulse Induction land mine detectors switch on a pulse of transmit current, then shut off, then switch on another transmit pulse. The duty cycle, the time the transmit current is on with reference to the time it is off, is typically about 4%. This prevents the transmitter and coil from overheating and reduces the drain on the battery.

The pulse repetition rate (transmit frequency) of a typical PI is about 100 pulses per second. Models have been produced from a low of 22 pulses per second to a high of several thousand pulses per second. Lower frequencies usually mean greater transmit power. The transmit current flows for a much longer time per pulse however, there are fewer pulses per second. Higher frequencies usually mean a shorter transmit pulse and less power however, there are more transmit pulses per second.

Lower frequencies tend to achieve greater depth and greater sensitivity to items made from silver however, less sensitive to nickel, and gold alloys. They typically have a very slow target response which requires a very slow coil sweep speed.

Higher frequencies are more sensitive to nickel and gold alloys however, less sensitive to silver. They may not penetrate quite as deep as the lower frequency models regarding silver however, can be used with a faster coil sweep speed. Higher frequency models are generally more productive for treasure hunting because the faster sweep speed allows more area to be searched in a given time, and they are more sensitive to the ultimate beach find, gold jewelry.

As previously mentioned a typical PI search loop contains a single coil of wire which serves as both the transmit and receive coil. The transmitter operates in a manner similar to an automobile ignition system. Each time a pulse of current is switched into the transmit coil it generates a magnetic field. As the current pulse shuts off, the magnetic field around the coil suddenly collapses. When this happens, a voltage spike of a high intensity and opposite polarity appears across the coil. This voltage spike is called a counter electromotive force, or counter emf. In an automobile it is the high voltage that fires the spark plug. The spike is much lower in intensity in a PI metal detector, usually about 100 to 130 volts in peak amplitude. It is very narrow in duration, usually less than 30 millionths of a second. In a PI metal detector it is called the reflected pulse.

2.3.4 Receiver

Resistance is placed across the search coil to control the time it takes the reflected pulse to decay to zero. If no resistance or very high resistance is used, it will cause the reflected pulse to "ring". The result is similar to dropping a rubber ball onto a hard surface; it will bounce several times before returning to rest. If a low resistance is used the decay time will increase and cause the reflected pulse to widen. It is similar to dropping a rubber ball onto a pillow. Since we are interested in having it bounce once critical damping for a rubber ball might be like dropping it onto carpet. A PI coil is said to be critically damped when the reflected pulse decays quickly to zero without ringing. An over or under dampened coil will cause instability and or mask the fast conducting metals such as gold as well as reduce detection depth.

When a metal object nears the loop it will store some of the energy from the reflected pulse and will increase the time it takes for the pulse to decay to zero. The change in the width of the reflected pulse is measured to signal the presents of a metal target.

In order to detect a metal object we need to concern ourselves with the portion of the reflected pulse where it decays to zero. The transmit coil is coupled to the receiver through a resistor and a diode clipping circuit. The diodes limit the amount of transmit coil voltage reaching the receiver to less than one volt so as not to overload it. The signal from the receiver contains both the transmit pulse and the reflected pulse. The receiver has a typical gain of 60 decibels. This means the area where the reflected pulse reaches zero is amplified 1,000 times.

2.3.5 Sampling Circuit

The amplified signal coming from the receiver is connected to a switching circuit which samples the reflected portion of the pulse as it reaches zero. The reflected pulse up to this point references in actuality a series of pulses at the transmit frequency. When a metal object nears the coil, the transmit portion of the signal will remain unchanged while the reflected portion of the pulse will become wider. The metal object stores some of the electrical energy from the transmit pulse and increases the time it takes for the reflected pulse to reach zero. An increase in duration of a few millionths of a second is enough to allow the detection of a metal target. The reflected pulse is sampled with an electronic switch controlled by a series of pulses which are synchronized with the transmitter.

The most sensitive sampling point on the reflected pulse is as near as possible to the point where it reaches zero. This is typically about 20 millionths of a second after the transmitter shuts off and the reflected pulse begins. Unfortunately, this is also the area where a PI can become unstable. For this reason most PI models sample the reflected pulse at a decay of 30 or 40 millionths of a second, well after it decays to zero.

2.3.6 Integrator

In order for an object to be detected the sample signals must be converted to a DC voltage. This task is performed by a circuit called an integrator. It averages the sampled pulses over time to provide a reference voltage. This DC reference voltage increases when metal nears the coil, then decreases as the object moves away. The DC voltage is amplified and controls the audio output circuitry which increases in pitch and/or volume to signal the presents of metal.

The time constant of the integrator determines how quickly the metal detector will respond to a metal object. A long time constant (in the range of seconds) has the advantage of reducing noise and making the metal detector easier to tune. Long time constants require a very slow sweep of the coil because a target might be missed if it passes quickly by the search coil. Short time constants (in the range of tenths of a second) respond more quickly to targets. This allows a quicker sweep of the loop however, it also allows more noise and instability.

2.3.7 Discrimination

By increasing the time period between transmitter shut-off and the sampling point (pulse delay), certain metal items can be rejected. Aluminum foil will be the first to be rejected followed by nickel, pull tabs and gold. Some coins can be rejected at very long sample delays however, iron cannot be rejected.

There have been many attempts to design a PI that can reject iron however these attempts have had limited results. Iron is detectable at very long time delays however, silver and copper have similar characteristics. Such long time delays also have a negative affect on detection depth. Ground mineralization will cause some widening of the reflected pulse as well, changing the point at which a target responds or rejects. If the time delay is adjusted so that a gold ring doesn't respond in an air test, that same ring may respond in mineralized ground. Mineralized ground thus changes everything regarding the time delays and discrimination of PI metal detectors.

2.3.8 Ground Balance

Average ground mineralization will not store any appreciable amount of energy from the search coil and will not usually produce a signal. Such ground will not mask the signal from a buried object. On the contrary, ground mineralization will add slightly to the duration of the reflected pulse increasing the depth of detection. The term "automatic ground balance" is often applied to PI instruments because it will normally not react to mineralization and there are no external adjustments for any specific ground conditions.

Heavy black sand is an exception. A land mine detector will work in black sand however, some false signals may result if the coil is held very close to the ground. Ground responses can be minimized by using a longer time delay between the shut-off and sample point (pulse delay). Advancing the time delay slightly will help to smooth out the noises caused by most mineralization.

2.3.9 Automatic vs. Manual Tuning

Most PI detectors are manually tuned. This means the operator has to adjust a control until a clicking or buzzing sound is heard in the headphones. If the search conditions change, such as when moving from black sand to neutral sand or from dry land to salt water, the tuning must be re-adjusted. Failure to do so can result in reduced detection depth and missed targets. Manual tuning is very difficult with short integration time constants, so most manually tuned models use long time constants and the search coil must be swept slowly.

This is not a problem when a PI is used for scuba diving because the coil cannot be swept quickly underwater. When used at the surf line, where the coil will be in and out of salt water, a manually tuned metal detector can be very frustrating to use. The tuner must be adjusted continually to maintain a threshold. Some operators elect to set it slightly below the threshold however, that can result in a reduction in depth as the ground conditions change.

Automatic tuning, or S.A.T. (Self Adjusting Threshold) offers a significant advantage when searching in and out of salt water or over mineralized ground. S.A.T. helps keep the metal detector operating at maximum sensitivity without requiring constant adjustments by the operator. It improves the stability, reduces noise, and allows higher gain settings to be used. PI metal detectors do not emit strong, negative signals like a VLF. As such they do not "overshoot" on pockets of mineralization. With S.A.T. the coil must be kept in motion while detecting a target. Stopping over a target will cause the S.A.T. to tune it out or cease responding.

2.3.10 Audio Circuits

Land mine detector audio circuits generally fall into two categories: variable pitch and variable volume. This is primarily true for manually tuned models. The "fire siren" sounds can become annoying and many have trouble hearing the higher tones. A variant of this is the mechanical vibrator device primarily used for deep water. It emits a slow clicking sound and vibration that increases to a buzz to signal a find. The mechanical device is easier to hear and feel over the sound of an underwater air supply.

CHAPTER 3

SYSTEM DESIGN AND ANALYSIS

3.1 INTRODUCTION:

In this chapter, the design operation of this project will be described in detail.

The components and their functions, particularly the active ones, are also reviewed.

3.2 POWER SUPPLY

The power supply used is DC 9V battery. A battery is an electrochemical cell which is used to provide a direct source of energy. Battery is chosen because the device is meant to be used on field where there could be no ac supply.

3.3 SEARCHING COIL

The search coil or loop of a Pulse Induction land mine detector is very simple. A single coil of wire is commonly used for both the transmit and receive functions.

The winding of coil and the number of turn must be 27 turns each signal turn being a loop from starting to end. The winding wire is 0.71mm diameter enameled copper and 20m long, leave a free length of 1.5m and wind 27 turns around the pins.

In the figure3.1 is shown a circular one-turn coil carrying a current of "I" amperes. The magnetizing force at the axial point "P" due to a small element "dl" as given by Laplace's law is

$$dH = \frac{Idl}{4\pi\left(r^2 + x^2\right)}$$

The direction of dH is at right angles to the line AP joining point P to the element "dl".

Now, dH can be resolved into two component.

a. The axial component dH` = dhsinθ

b. the vertical component dH" = dhcosθ

Now, the vertical component $dH\cos\theta$ will be cancelled by an equal and opposite vertical component of dH due to element `dl` at point B. The same applies to all other diametrically opposite pairs of dl's taken around the coil. Hence, the resultant magnetizing force at "p" will be equal to the sum of all the axial components.

$$H = \sum dH' = \sum \int dH \sin\theta \, dl$$

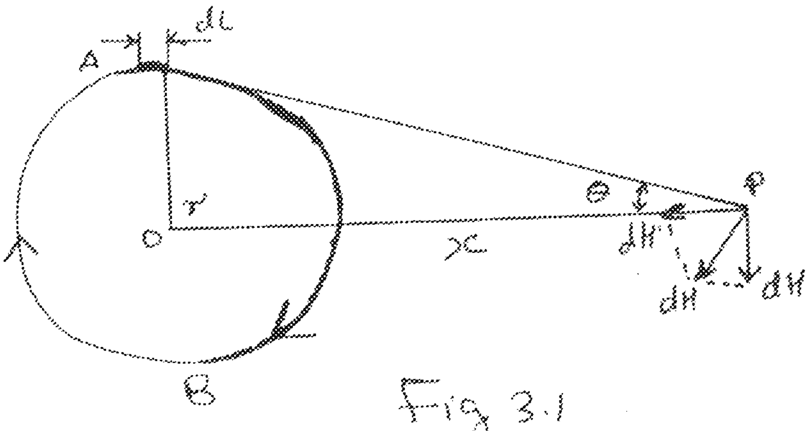


Fig 3.1

$$\sin\theta = \frac{r}{\sqrt{r^2 + x^2}}$$

$$\int \left[H = \sum \frac{Idlr}{4\pi \left(r^2 + x^2\right)} \right] dl$$

$$H = \frac{Ir}{4\pi \left(r^2 + x^2\right)^{\frac{3}{2}}} \int_0^{2\pi r} dl = \frac{Ir2\pi r}{4\pi \left(r^2 + x^2\right)^{\frac{3}{2}}}$$

$$H = \frac{Ir^2}{2\left(r^2 + x^2\right)^{\frac{3}{2}}} = \frac{I}{2r} \frac{r^3}{\left(r^2 + x^2\right)^{\frac{3}{2}}}$$

$$H = I \left[\frac{\left(\sin^3\theta\right)}{2r} \right] \frac{AT}{m}$$

$$H = \frac{NI}{2r} \sin^3\theta \ \frac{AT}{m}$$ for an N-turn coil

In case the value H is required at the centre "0" of the coil, then putting $\theta = 90$ and $\sin\theta = 1$ in the above expression, we get

$$H = \frac{I}{2r}$$ for single turn coil

or

$$H = \frac{NI}{2r}$$ for N-turncoil

The magnetizing force H at the centre of a circular coil can be directly found as follows.

With reference to the coil shown in the figure the magnetizing force dH produced at "O" due to the small element dl (as given by Laplace's laws is

$$dH = Idl \frac{\sin\theta}{4\pi r^2} = \frac{Idl}{4\pi r^2}$$

$$\sin\theta = 90^0 = 1$$

$$\sum_1^n dH = \sum_1^n \frac{Idl}{4\pi r^2} = \frac{I\sum_1^n dl}{4\pi r^2}$$

or

$$H = 2\pi \frac{Ir}{4\pi r^2} = \frac{I}{2r}$$ $$H = \frac{I}{2r}$$ AT/m for 1-turn coil:

$$H = \frac{NI}{2r}$$ AT/m for N-turn coil.

N = 27

Diameter =190mm = 19cm === 0.19m

r = 0.19/2 = 0.095m

I = 80mA =0.8A

H == 27*0.8/2*0.09.5 == 568.42 AT/m

Therefore the magnetizing force H at the centre of a circular coil is 568.42 AT/m

The voltage in the searching coil is produced by the falling magnetic field .Initially TR1 is on and the coil current is building up from the battery. When TR1 turns off the voltage at point B flies to a very high voltage as magnetic field around the coil falls rapidly. After a time field has fallen almost to zero and the voltage across the coil is held at +9V point B will also end up at +9V when the Voltage across the coil is zero.

An exaggerated view of the search coil voltage for one complete operating pulse is shown in Fig.32, Initially TR4 is turned on and the coil voltage is close to 9 volts as the current builds up. When TR4 is turned off, the voltage across the coil rises rapidly as the magnetic field through the coil falls. After a time, the field falls more slowly and the induced voltage falls accordingly, dropping gradually to zero. The solid line shows the observed waveform when the coil is clear of metal, whilst the dotted line shows the waveform when metal is near.

The difference between the two curves is very small - much less than one mill volt - and so a large amount of amplification is needed to produce a useful signal. The demands on the amplifier are harsh. It must be very fast, be able to respond to a very small signal after being overloaded by a huge one, and have a high voltage gain.

The main (earlier) part of the pulse is of no value as it shows no difference between metal and no metal conditions. As the pulse decays, although the actual voltages fall, there is an increase in the difference between the two conditions.

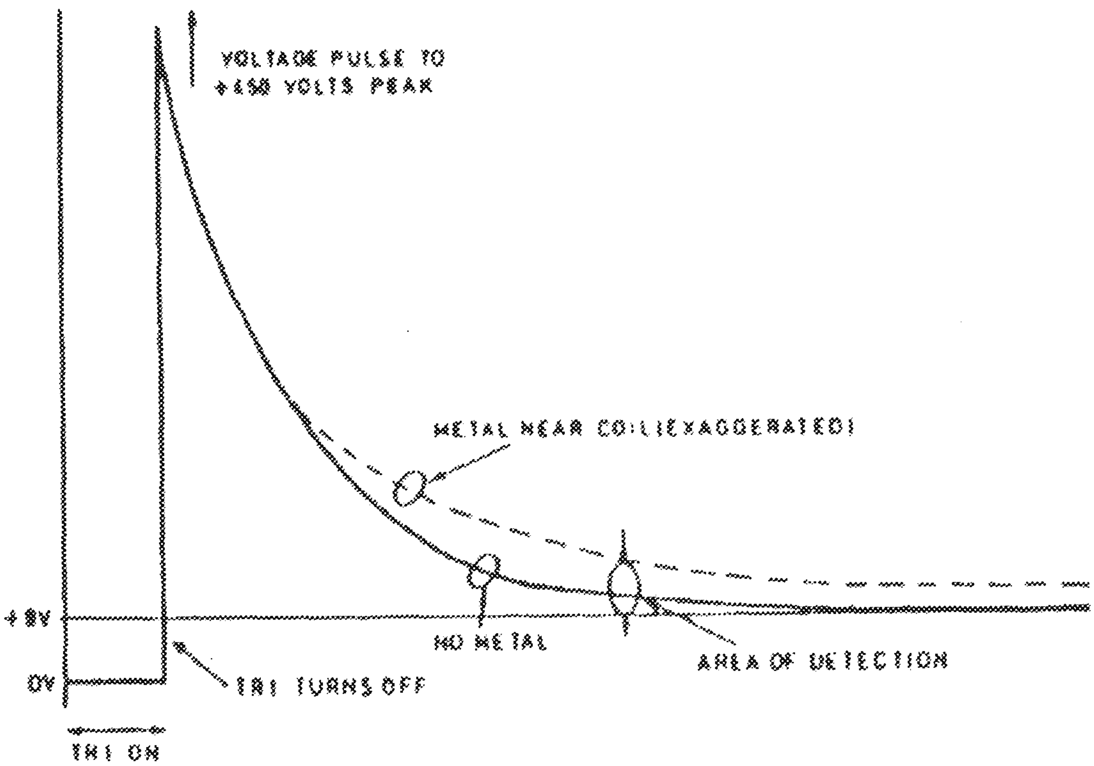


Fig3.2 .search coil voltage waveform, measured at point B on the circuit diagram.

3.4 CIRCUIT OSCILLATOR:

This consists of a crystal oscillator, IC1c which provides an output of 40KHz which is the master clock. Resistor R6 provides dc bias for IC1c and R5, C4, and C5 provide the correct feedback condition for X1 to resonate correctly.

The output from the clock drives transistor TR2 andTR3 via resist R4. These devices are connected as a complementary output stage and produce a 40KHz square wave that is coupled via capacitor C3 to rectifiers D3 and D4 to produce an additional seven volts which is added to the battery positive supply. This boosted supply voltage is smoothed by capacitor C2 and used to power IC1, I.C2 and I.C4 directly and I.C3 via additional decoupling components R11 and C7.

The 40KHZ output from I.C1 also drives the multi stage divider I.C2. This I.C. consists of a series of divide-by-two stages the first of which is driven by an input to pin 10 and all of which can be reset simultaneously by a positive level on Pin11.

Two outputs from the chain of dividers are combined via I.C1b and inverted by I.C1a to produce arrest pulse. The two output puts are after 4 stages and 9 stage of division representing time intervals of 200 microsecond and 6.4 milliseconds. They are combined in such a way that 200 milliseconds where upon the dividers are reset and the cycle repeats. This pulse output appears at PIN12 of I.C2 and is used to drive the MOSFET TR1 VIA R3 directly.

3.5 DETECTION

The pulses produced across the coil L1 have been discussed earlier. Resistor R1 and R2 provide Loading so that the voltage pulse does not "back fire" into TR1,and also that the coil does not act like a tuned circuit and "ring " with its own self capacitance producing an undesirable a.c waveform .Diode D1 and D2 clip part of the coil voltage passed via R2 and so limit the voltage swing which is passed to the amplifier I.C3 to one volt.

The diodes are of different types because D2 has to handle only 50mA during the time that TR1 is turned on, whilst D1 must handle 3A peaks from the coil as TR1 is turned off.

This clipping only affects voltages from the coil above one volt; it leaves the low level area of interest, completely intact.

After clipping, the coil pulses are fed via R10 to IC3. This is an extremely fast OP-AMP I.C which is particularly suited to the amplification of pulses. It has a very high "slew rate" which is measure of the ability to change its output voltage at fast rate and so reproduce pulse accurately. In this circuit it is connected as a standard inverting amplifier with feedback via R13 and C6.The non-inverting input is taken from the positive supply via R9 so that the output is biased correctly with its output at the battery positive supply.

Two controls around I.C3 allow the output voltage to be adjusted. Preset VR2 is the standard "offset null" control and is used to set the output of I.C to "zero" when its input are connected to the same point; potentiometer VR1 provides a means of unbalancing the circuit to allow the output to be set manually. This is used to set up the detector in operation to produce an audio signal to the preferred pitch.

3.6 OP-AMPLIFIER CIRCUIT

IC3 (LM318) is used as an extremely fast OP-AMP I.C which is particularly suited to the amplification of pulses. It has a very high "slew rate" which is measure of the ability to change its output voltage at fast rate and so reproduce pulse accurately. In this circuit it is connected as a standard inverting amplifier with feedback via R13 and C6.The non-inverting input is taken from the positive supply via R9 so that the output is biased correctly with its output at the battery positive supply

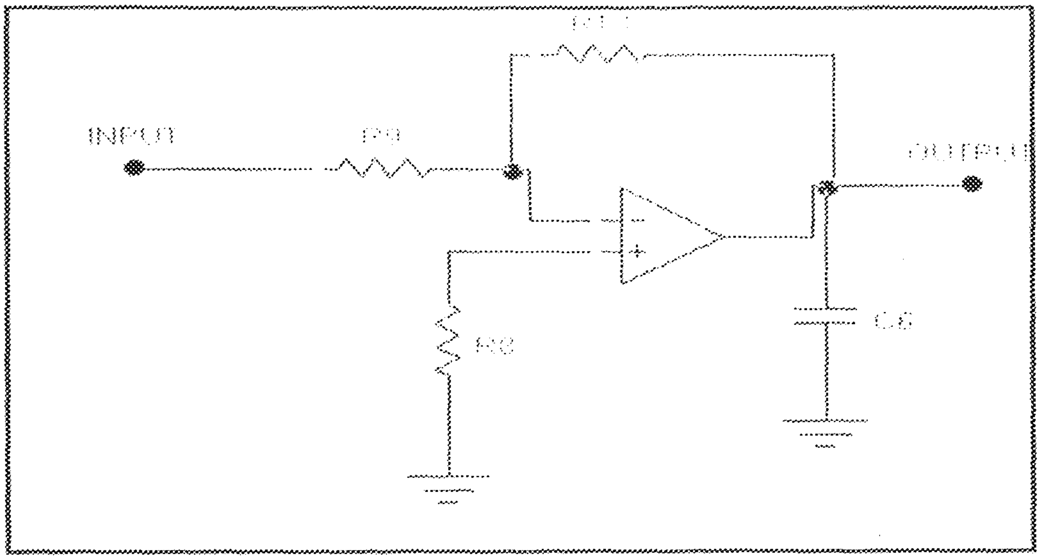


Figure3.3a TEST CIRCUT

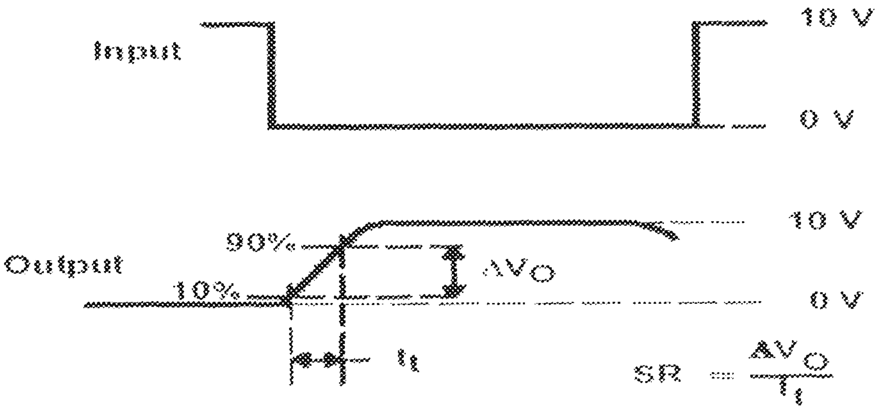


FIGURE 3.3b VOLTAGE WAVEFORMS

3.7 ANALOGUE GATE

The output from I.C3 is a clipped and inverted version of the coil voltage. The next step is to separate the part containing the low level wanted signal from the pre-ceding relatively high pulse. This is achieved by means of analogue gate I.C4. This is a switch which can be opened by applying a voltage to its control pin . This control voltage is derived from I.C2 via I.C1d, D5 and R7 and consists of a pulse which is termed to open the switch just as the output from I.C3 approaches "zero" (zero in this circuit is the positive battery supply).

The pulse is timed at exactly 50microseconds after TR1 turns off. At this point the switch is opened and the output voltage from I.C3 passes via R15, D6, and R18, and is rectified by the base-emitter junction of TR4 so that C9 is charged to the peak level. This is a negative peak of course because I.C3 is an inverting amplifier.

The use of a transistor as a rectifier in this way is necessary because in order to reach the peak value, C9 must change very quickly indeed. The current gain of TR4adds to the base-emitter current so that most of the charge in C9 is provided via R20 so reducing the loading on the output of I.C3.

The constant of C9 and R19 is 100ms .This is long enough to change very little between pluses and short enough to respond rapidly as a piece of metal is swept into and out of range. To reduce the number of components in the circuit, the gating pluses logic is simplified by allowing more pluses to follow the initial one. This is not a problem because the signal voltage decays after the first gating pluses and so subsequent gating pluses pass levels only below the peak already stored thus having no effect.

3.8 AUDIO

The final part of the circuit is the audio oscillator section.

This is a very importance aspect of this project design as this is what will give the tone or clicking sound. The control (searching coil) could sense the presence of landmine but without the sound circuit there will be nothing to give a notice of danger. Special care has been taken to design this circuit as this is the output of the whole design work. Sound of the headphones is another area of importance, consideration was taken to ensure that it sound is like tone or clicking sound.

This is a conventional 555 circuit except that the charge circuits for the capacitor C12is not a resistor but a transistor TR5. TR5 is driven from the peak detector TR4 via a low-pass filter consisting of R21 and C11.

Large pulse cause TR5 to turn on more and so C12 charges more quickly and the output pitch rises. This arrangement is at its most sensitive for the lowest pulse levels and so provides the ideal characteristic for sensitivity to a pair of personal stereo headphones via C14and R25.The two earpieces can be connected in series by connecting to the tip and ring connecting to the tip and ring connections of the phones. This is more efficient then Parallel connection and although the earpieces are then connected in ant phase this does not seem to matter in this type of application.

S/NO	COMPONENT	QUANTITY	SPECIFICATION
1	Resistor (R1)	1	470 2W
2	Resistor (R2)	1	220 2W
3	Resistor (R3,R18)	2	56
4	Resistor (R4)	1	1K5
5	Resistor(R5,R7,R21,R23)	4	10K
6	Resistor(R6)	1	10M
7	Resistor(R8,R12)	2	220K
8	Resistor(9,R10)	2	100
9	Resistor(R11,R20)	2	47
10	Resistor(R13)	1	1M
11	Resistor(R14)	1	150
12	Resistor(R15)	1	27
13	Resistor(R16)	1	1K
14	Resistor(R17,R22)	2	12K
15	Resistor(R19)	1	100K
16	Resistor(24)	1	2K7
17	Resistor(R25)	1	330
18	Potentiometers(VR1)	1	20K Rotary
19	Potentiometers(VR2)	1	220k skeleton preset,vertical
20	Capacitor(C1)	1	1500U radial elect 10V
21	C2,C7,C8	3	68u radial elect 16v
22	C3	1	6u8 radial elect 16V
23	C4	1	1n ceramic plate 50V
24	C5	1	22p ceramic plate 50V
25	C6	1	6p8 ceramic plate 50V
26	C9	1	1u radial elect 10V
27	C10	1	1u5 radial elect 10V
28	C11	1	0u22 radial elect 10V

29	C12	1	33n polyester 100V
30	C13	1	100n ceramic disc 50V
31	C14	1	22u radial elect 10V
32	D1	1	BY407A
33	D2-D4	5	IN4148
34	TR1	1	IRF183CF POWER MOSFET
35	TR2	1	BC183 npn general purpose
36	TR3	1	BC213 pnp general purpose
37	TR4,TR5	2	Bc214 pnp high gain
38	IC1	1	4011B CMOS QUAD NAND gate
39	IC2	1	4040B binary counter
40	IC3	1	LM318 high slew rate op-amp
41	IC4	1	4016B quad bilateral switch
42	IC5	1	TLC555 CMOS 555 timer
43	S1	1	S.p.s.t min toggle switch

3.9 COMPONENTS AND THERE FUNCTION

3.9.1 INTEGRATED CIRCUIT (ICs)

Semi-conductor technology allows manufacture of several components (resistors, transistor, capacitor etc) even circuits on a signal semi conductors chip. This allows micro-electronics to achieve incredible miniaturization of circuits LCS have a lot of advantages of discreet circuit apart from space economy and cheap cost of production, the properties of components simultaneously manufactured on the same chip can be accurately matched and temperature compensated which is a great advantage in instrumentation amplifier and the ease of connecting complex circuit and automatic mass production of devise cannot be over emphasized.

LCS are found as gates, logic circuits, audio amplifier, microprocessors e.t.c.

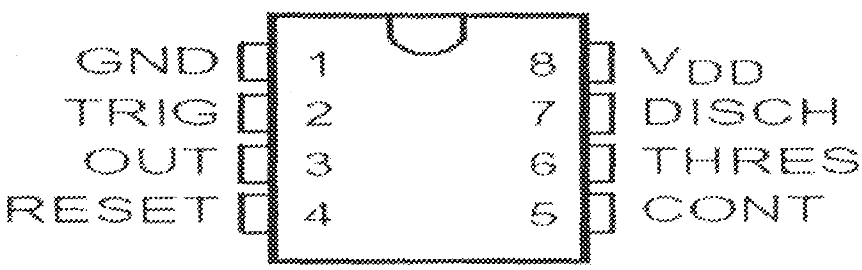


Fig (3.4). PIN DIAGRAM OF 555 TIMERS

GRROUND (GND): This is pin 1 of the 555 timer .should be connected to the negative side of the supply.

TRIGGER (TRIG): This is pin 2 of the 555 timer. It is referred to as the trigger input. A negative going voltage pulse applied to those pin trigger the device.

OUTPUT (OUT): This is pin 3 of the 555 timer. It is capable of sinking or sourcing a load requiring up to 200mA.

RESET: This is pin 4 of the 555 timer.Resetactivated with a voltage level of between 0V and 0.4V.

CONTROL VOLTAGE (CONT): This is pin 5 of the 555timer. Voltage applied to this pin allows device timer variations independently of the external tuning network. It should be by passed to ground using 0.01 micro farad capacitor if unused to maintain immunity from noise.

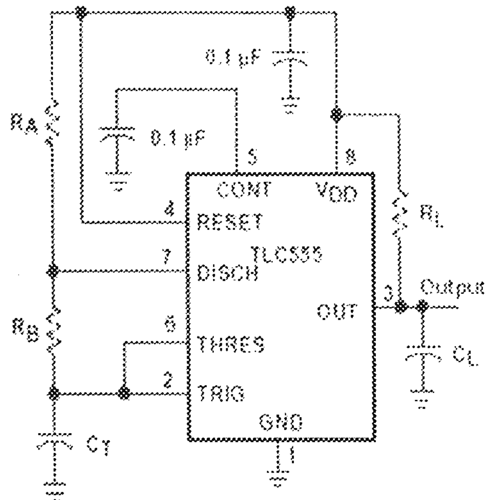
DISCHARAGE (DISCH)): This is pin 7 of the 555timer.Usually the external timer capacitor is connected between discharge ground. And this discharges when the transistor goes on.

VCC: This is pin 8 of the 555timer.It is the power pin and is connected to the positive side of the supply.

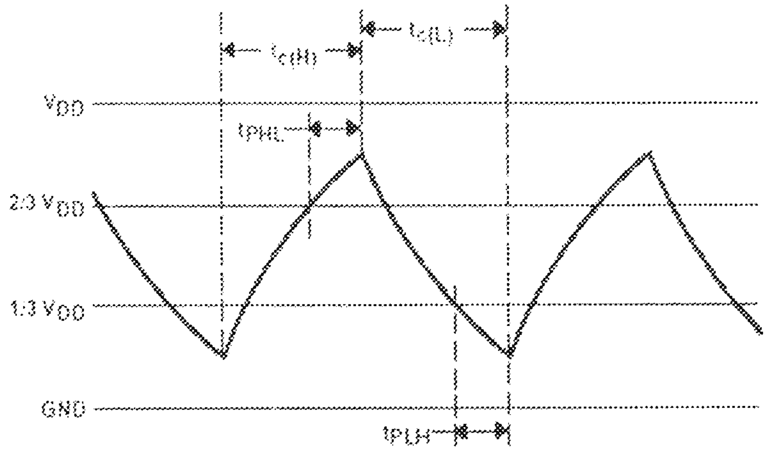
The TLC555 is a monolithic timing circuit and operates at frequencies up to 2 MHz. Because of its high input impedance, this device uses smaller timing capacitors. As a result, more accurate time delays and oscillations are possible. Power consumption is low across the full range of power supply voltage. the TLC555 has a trigger level equal to approximately one-third of the supply voltage and a threshold level equal to approximately two-thirds of the supply voltage. These levels can be altered by use of the control voltage terminal (CONT). When the trigger input (TRIG) falls below the trigger level, the flip-flop is set and the output goes high. If TRIG is above the trigger level and the threshold input (THRES) is above the threshold level, the flip-flop is reset and the output is low. The reset input (RESET) can override all other inputs and can be used to initiate a new timing cycle. If RESET is low, the flip-flop is reset and the output is low.

Whenever the output is low, a low-impedance path is provided between the discharge terminal (DISCH) and GND. All unused inputs should be tied to an appropriate logic level to prevent false triggering. While the CMOS output is capable of sinking over 100 mA and sourcing over 10 mA, the TLC555 exhibits greatly reduced supply-current spikes during output transitions

APPLICATION INFORMATION



Fig(3.5a) ASTABLE OPERATION OF 555



Fig(3.5b) TRIGER THRESHOLD VOLTAGE WAVEFORM

Connecting TRIG to THRES, as shown in fig(3.5a) ,cause timer to as a multivibrator.The capacitor CT charges through R_A and R_B to the threshold voltage level (approximately 0.67 V_{DD}) and then discharges through R_B only to the value of the trigger voltage level (approximately 0.33 V_{DD}). The output is high during the charging cycle ($t_{c(H)}$) and low during the discharge cycle ($t_{c(L)}$). The duty cycle is controlled by the values of R_A, R_B, and C_T as shown in the equations below.

$$t_{c(H)} \approx C_T (R_A + R_B) \ln 2 \quad (\ln 2 = 0.693)$$

$$t_{c(L)} \approx C_T R_B \ln 2$$

$$\text{Period} = t_{c(H)} + t_{c(L)} \approx C_T (R_A + 2R_B) \ln 2$$

$$\text{Output driver duty cycle} = \frac{t_{c(L)}}{t_{c(H)} + t_{c(L)}} \approx 1 - \frac{R_B}{R_A + 2R_B}$$

$$\text{Output waveform duty cycle} = \frac{t_{c(H)}}{t_{c(H)} + t_{c(L)}} \approx \frac{R_B}{R_A + 2R_B}$$

The 0.1-μF capacitor at CONT in Figure 3 decreases the period by about 10%.

The formulas shown above do not allow for any propagation delay times from the TRIG and THRES inputs to DISCH. These delay times add directly to the period and create differences between calculated and actual values that increase with frequency. In addition, the internal on-state resistance r_{on} during discharge adds to R_B to provide another source of timing error in the calculation when R_B is very low or r_{on} is very high.

3.9.2 I.C LM318

LM318 is precision, fast operation amplifiers designed for applications requiring Wide bandwidth and high slew rate. They a factor-of-ten increase in speed over general-Purpose devices without sacrificing dc performance.

These operational amplifiers have internal unity-gain frequency compensation. This Considerably simplifies their application, since no external components are necessary for operation. However unlike most internally compensate amplifiers external frequency compensation may be added for optimum performance. For inverting applications, feed-forward compensation boosts the slew rate to over 150V/us and almost double bandwidth. Overcompensation can be used with the amplifier for greater stability when maximum bandwidth is not needed. Further, a single capacitor may be added to reduce the settling time for 0.1us.

The high speed and fast and fast settling time of these operational amplifiers make them useful in A/D converters, oscillators, active filters, sample-and-hold circuits, and general-purpose amplifiers.

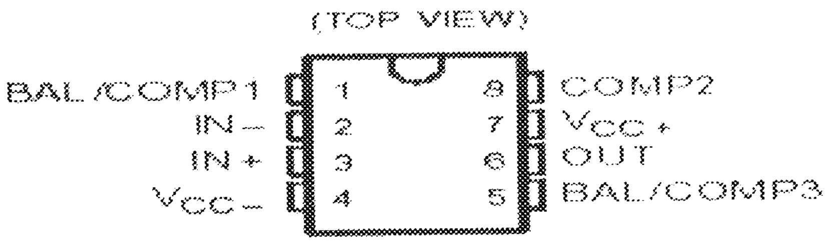


Fig (3.6a) PIN DIAGRAM OF I.C LM318

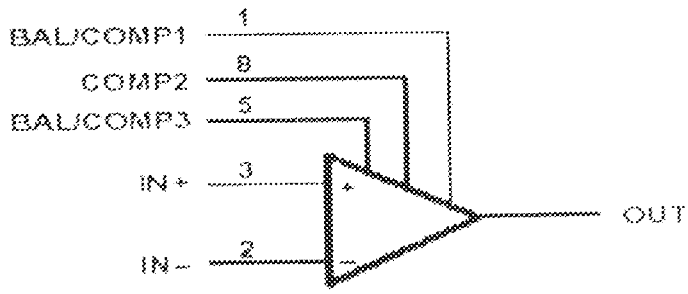


Fig (3.6b) SYMBOL (PIN NUMBERS SHOWN)

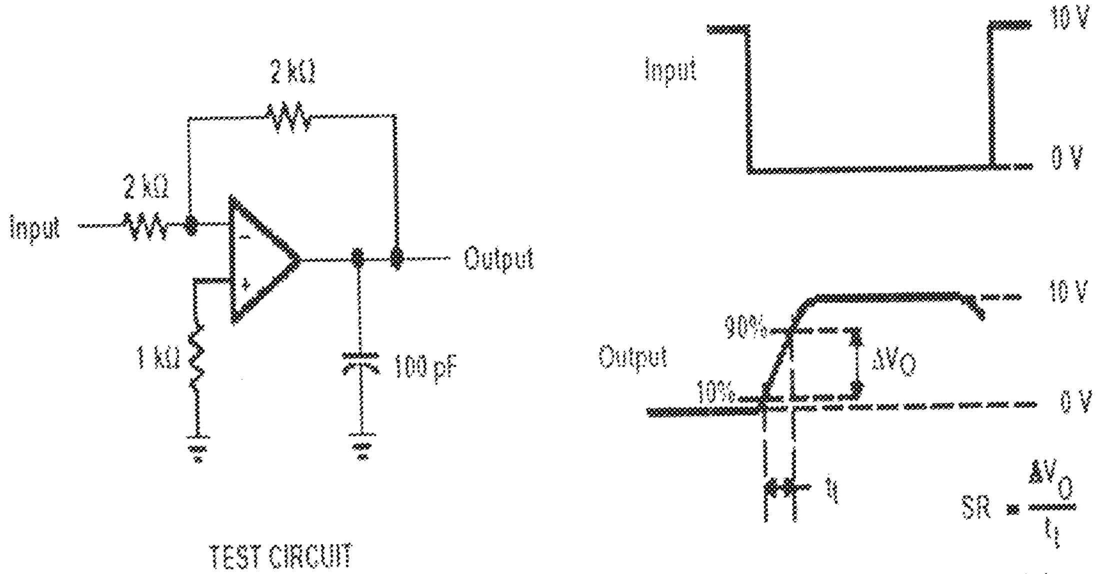


Fig (3.7a)

Fig (3.7b) VOLTAGEWAVEFORM

Fig (3.7). SLEW RATE

3.9.3 CMOS NAND GATES (QUAD. 2 INPUT-CD 4011B)

CD4011B, NAND GATE: Provide the system design with direct implementation of the NAND function and supplement the existing family of CMOS gates. All inputs and outputs are buffered.

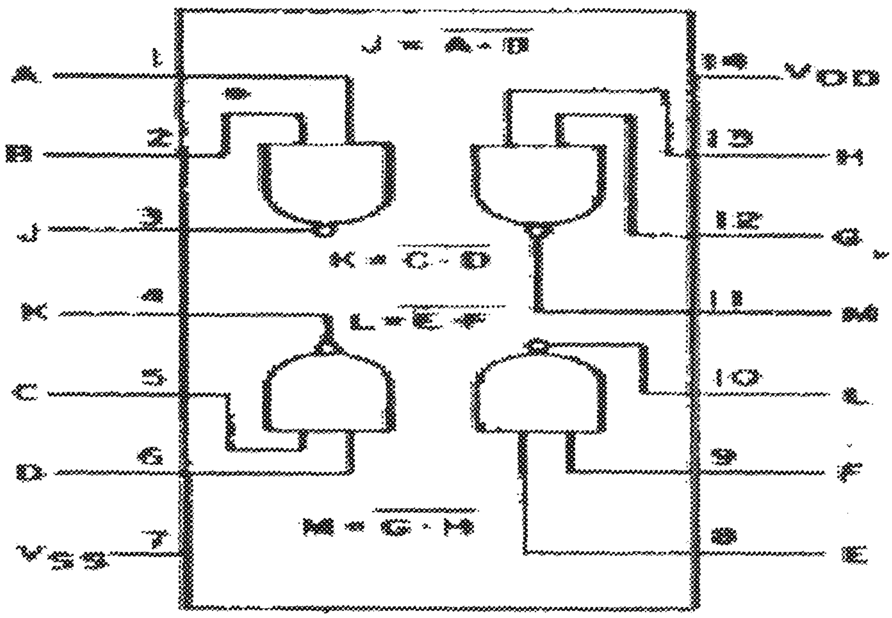


Fig 3.8 CD4011B FUNCTIONAL DIAGRAM

3.9.4 CD4040BC

This is a 12- stage ripple carry binary counter. The counters are advanced one count on the negative transition of each clock pulse. The counters are reset to the zero state by a logical "1" at the reset input independent of clock.

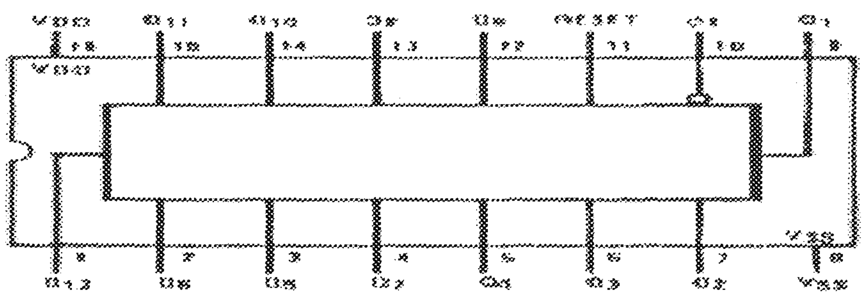


Fig (3.9) FUNCTIONAL DIAGRAM OF CD4040BC

3.9.5 CMOS QUAD.BILATERAL SWITCH (CD 4016B)

CD4016B series types are quad- bilateral switches intended for the transmission or multiplexing of analog or digital signal. Each of the four independent bilateral switches has a signal control signal input which simultaneously biases both the P and n device in a given switch on or off.

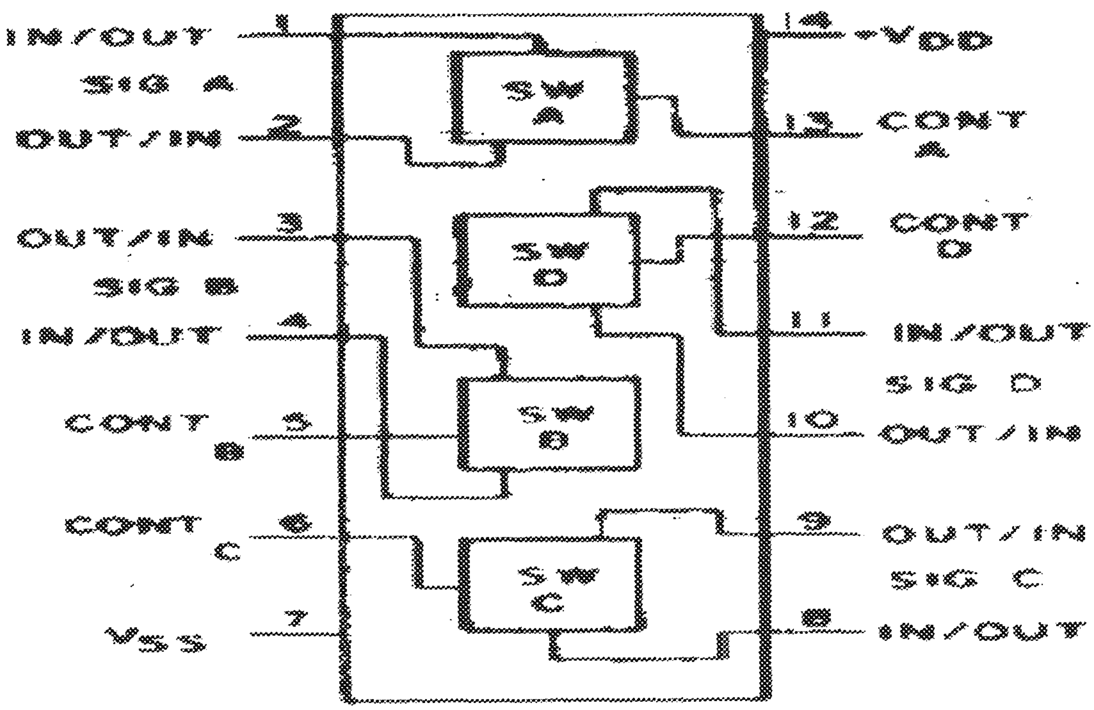


Fig 3.1.1 FUNCTIONAL DIAGRAM OF CD4016B

3.9.6 TRANSISTOR

There are different types of transistor. We have them in different shapes and sizes. They are mainly used for driving current. We also have n-p-n or p-n-p transistor.

The NPN BJT has two n-regions (collector and emitter) separated by a p-region (base). The terminal with the arrowhead is the emitter. The ideal NPN in the parts bin has generic values suitable for most circuits. You can specify a real-world transistor by double-clicking the icon and choosing another model.

The PNP BJT has two p-regions (collector and emitter) separated by an n-region (base). The terminal with the arrowhead represents the emitter. The ideal PNP model has generic values suitable for most circuits. You can specify a real-world transistor by double-clicking the icon and choosing another model.

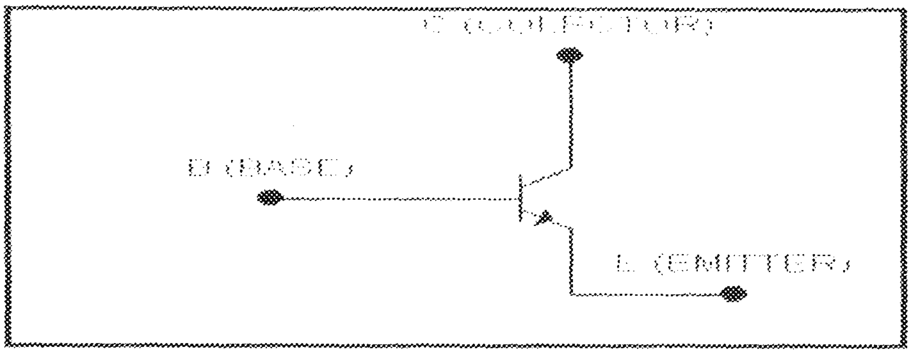


Fig 3.1.2 Circuit symbol of transistor

3.9.7 COMPLEMENTARY SYMMETRY PUSH-PULL CLASS-B AMPLIFER

A standard class-b push-pull amplifier requires two power transistors of the same type with closely-matched parameters. But the chief requirement of a complementary amplifier is a pair of closely-matched but oppositely doped power transistors .The term 'complementary' arise from the fact that one transistor is PNP type and the other is of NPN type.

An elementary complementary class-b push-pull amplifier is diagramed in fig 3.1 .The two transistors are complementary to each other and operate as emitter-follower amplifiers.

The input is direct-coupled with no input signal; neither transistor conducts and therefore, current through RL is zero.

When input signal is positive going transistor A biased into conduction whereas B is driven into cutt-off.When the signal is negative-going. A is turn off while B conducts obviously, this is a push pull amplifier because turning one transistor ON turns the other OFF.

The circuit possesses the essential characteristics of an emitter follower i.e. unity voltage gain, no phase inversion and input impedance much higher than the output impedance.

3.9.8 IRF740CF :

This is an n-channel depletion metal-oxide- semiconductor or MOSFET. Its substrate is connected to its source lead, making it a three-terminal device.

It could be sub-divided as follow:

1. depletion-enhancement MOSFET or De-MOSFET.This MOSFET is so called because it can be operated mode by changing the polarity of VGS.When negative gate –to-source voltage is applied, the N-channel De-MOSFET operates in the depletion mode. However, with positive gate voltage, it operates in the enhancement mode. Since a channel exists between drain and source, Id flows even when VGS = 0.That is why De-MOSFET is Known as normally-ON MOSFET.

2. Enhancement-only MOSFET

As it name indicates, this MOSFET operate only in the enhancement mode and has no depletion mode. It works with large positive gate voltage unlit does not conduct when VGS=0.That is why it is called normally OFF MOSFET.

In a De-MOSFET , d flows even when Vgs = 0.It operates in depletion mode with negative values of Vgs. As Vgs is made more negative, Id decrease till it ceases when Vgs= Vgs (off).It works in enhancement mode when Vgs is positive as shown in figure3.1.4.

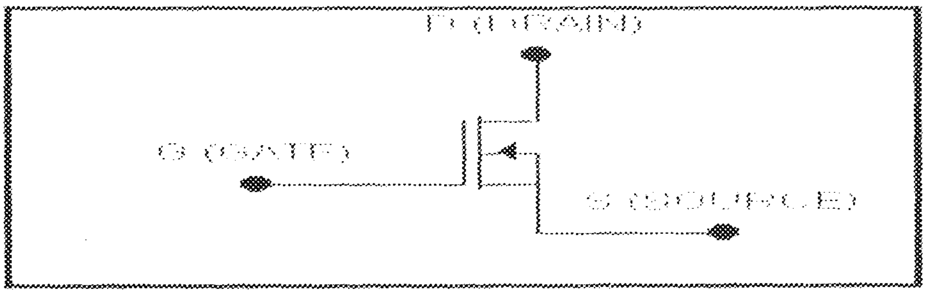


Fig3.1.3 Circuit symbol of MOSFET

Id = Idss

Vds = Vdd – Idss RL

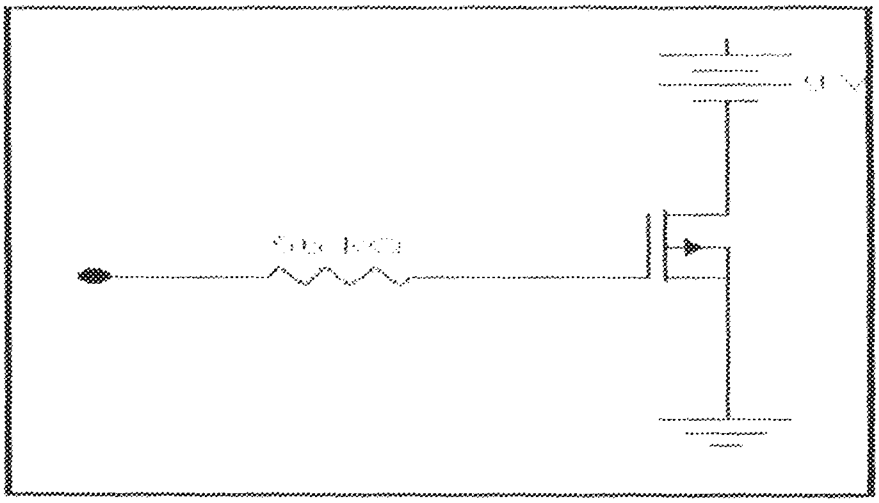


Fig 3.1.4 CIRCUIT DIAGRAM OF IRF740CF

Vgs = 0

Vds = Vdd – Id RL

Vds = 9 – 56 *Id

Id = (9 – Vds)/56

Vg = 0, Id = 0 because Vgs <<Vga with no current Vds = Vdd = 9

3.9.9 CRYSTAL OSCILLATOR

For an exceptionally high degree of frequency stability use of crystal oscillators is essentional.The crystal generally used is a finely-ground wafer of translucent quartz stone held between two metal plates and housed in a package about the size of a postal stamp . This component behaves as a quartz crystal resonator, a circular piece of quartz with electrodes plated on both sides mounted inside an evacuated enclosure. The piezoelectric effect of quartz crystal links the mechanical and electrical properties of the resonator. Electrode voltage causes mechanical movement. Likewise, mechanical displacement generates an electrode voltage.

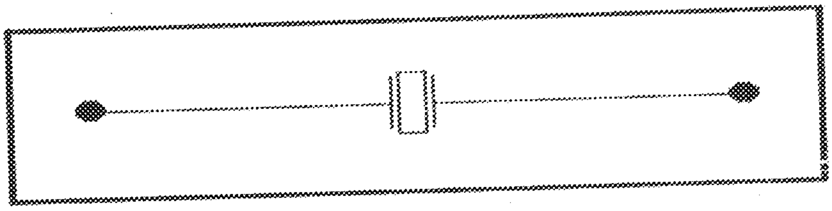


Fig 3.1.5. Crystal oscillators

3.1.1 Potentiometer

A potentiometer is much like a regular resistor, except that you can adjust its setting. In the Value tab of the Circuit/Component Properties dialog box, you set the potentiometers resistance, initial setting (as a percentage) and increment (as a percentage). You also identify the key (A to Z) that you will use to control the setting. To decrease the potentiometers setting, press the identified key. To increase the setting, press and hold SHIFT and press the identified key. For example, say the potentiometer is set to 45%, the increment is 5% and the key is R. You press R, and the setting drops to 40%. You press R again, and it drops to 35%. You press SHIFT and R, and the setting rises to 40%.

CHAPTER FOUR

CONSTRUCTION AND CONCLUSION

4.1 INTRODUCTION

This chapter involves the report on the construction work, measurement and testing of the outputs of the system. The noise level was also considered as the project for the purpose of installation of the system. The area which the system can be further improved upon was also discussed.

4.2 CONSTRUCTION

The construction was undertaken by testing the designed outline stage by stage .In this regard bread board was made use of as all connection's were made on it first and tested before transferring to Vero board and soldered permanently.

The control circuit which comprises of the searching coil, ICS diode, resistor, transistor and potentiometers then the audio circuit. All connection was made as they were specified on the circuit design diagram. At every stage, tests were carried out before the next connection.

The connection were then transferred to Vero board also in stages, soldering of the component to the Vero board was done as each component was transferred from the bread board tightly taking note of the polarity. The Vero board was cut where necessary, to ensure there was no short circuit.

All components are mounted on a single Vero board figure give the component layout and the foil pattern, this is a compact board so must be assembled with care. Before assemble it is wise to check that the board will fit into the guide slots of the case, and that all holes are clear. Begin by fitting the resistors, diodes, and four wire links. Carefully getting all the diodes the right way round with their cathode marking bands as shown.

Next fit sockets for the ICS and the smaller capacitors. Note that all of the electrolytic capacitors must fit the right way round. The are usually marked with a string of "_" signs down the side by the negative lead. Depending on their size it may not be possible to get all of the capacitors flush to the board. This does not matter however, as the leads are generally thick and will supporting them well above the board.

No fit the transistor, being careful to identify the different types and insert them the right way round;TR1 has a metal side which is shown as a thick line on figure .Care was taken with resistors R1and R2 as these are large and must be mounted on end exactly as shown. A length of sleeving over the upper lead is advisable.

The crystal X1 was fitted with care, its leads bent gently over, and its body glued to the board Evo-stick.It can go either way round.

Larger components such as VR2 and C1 were fitted last. Wires to the headphone jack,VR1, and the battery clip and switch were connected directly to the board by stripping a short length of insulation from one end of the leads and passing the bared wire into the board from the component side and soldering it on the reverse.

4.3 SEARCH COIL

The winding of this coil is not difficult but the size and number of turns are critical. There are 27 turns, each single turn being a loop from start to finish. It is easy to misinterpret "one turn" especially the first and last ones.

To make a coil former all that is required is a piece of wood upon which a 190mm critical can be drawn. A veneered clipboard off cut is ideal. Using 16 panel small nails fitted with a 10mm length of sleeving and space them equally around the circle. The winding wire was 0.71mm diameter enameled copper and 20m long , leave a free length of 1.5m and carefully winding 27 turns around the pins.

It is not necessary to neatly layer the winding, as it will finally be bunched into a circular section. Securing the ends with insulating tape and then careful slip short lengths of tape under the windings between the nails and fasten the ends together .Fitting eight pieces of tape like this ,then remove the winding from the board, by removing some of the nails .the result was a neat coil that can now be bound with a spiral of tape to completely enclose it.

The coil is now suitable for the application without further protection. There are numerous possibilities for complete water-proofing, but dipping the coil in varnish and allowing it to dry is probable the simplest way. The final appearance of the coil was tidy as it was carefully made.

4.4 TESTING

Before connecting the coil, some parts of the board were checked for correct operation.

A set of headphone was connected and a 9V supply from six AA cells in a battery holder.

Both controls were set to mid position and switch on. A tone or clicking sound was heard.VR2 was turned carefully until the tone became a steady clicking sound, and then click that VR1 has a similar but finer control over the pitch. Those with a millimeter can chick that the voltage across C2 is approximately 16V and can set the output of IC3 to 9V (the battery supply voltage) using VR2, with VR1 set to mid position.

Connecting the coil to the board (either way round)and position the coil on a cardboard box well away from any wiring and large metal objects.

Once the coil was connected the circuit was set for a steady clicking noise which increases as metal is brought near.

By setting the circuit for very slow clicks maximum sensitivity was obtained. The clicking rate rise at good distances when a 10p coin was brought near.

The coil produced a rather harsh sound high pitch note as a large object brought near.

The current consumption is around 80mA.

4.5 CONCLUSION

The design and construction of a landmine detector system had successfully been carried out as described in the previous four chapters which entails throughout research work and extensive and explicit design work

The aim of the project was achieved as the system was tested and found to be working quite satisfactory

4.6 RECOMMENDATION

There is need for improvement in all area of work; hence I will give hint of recommendation on these areas.

In my research of this design project, I discover that there might be need for the deminer to be extra-careful while detecting land mine.

There is need for computer printed circuit board to avoid breakage of connection while using.

There is need for much more work to be done such as a detector that can scan the ground using computer hardware, since demining is very dangerous activities.

4.7 SUMMARY

The write-up of this project was simplified as possible giving every detail necessary because of the nature of the project (Land mine detector)

REFERENCE.

(1)	B. L. Theraja A. K. Theraja	Electrical Technology
(2)	MPS	Electronics
(3)	ECG	Master Replacement Guide
(4)	David J. comer (1990)	Electronic Design with intergrated circuit Machmillar, England
(5)	Charles K. Adams	Basic Intergrated circuit theory and Projects Theory & projects.

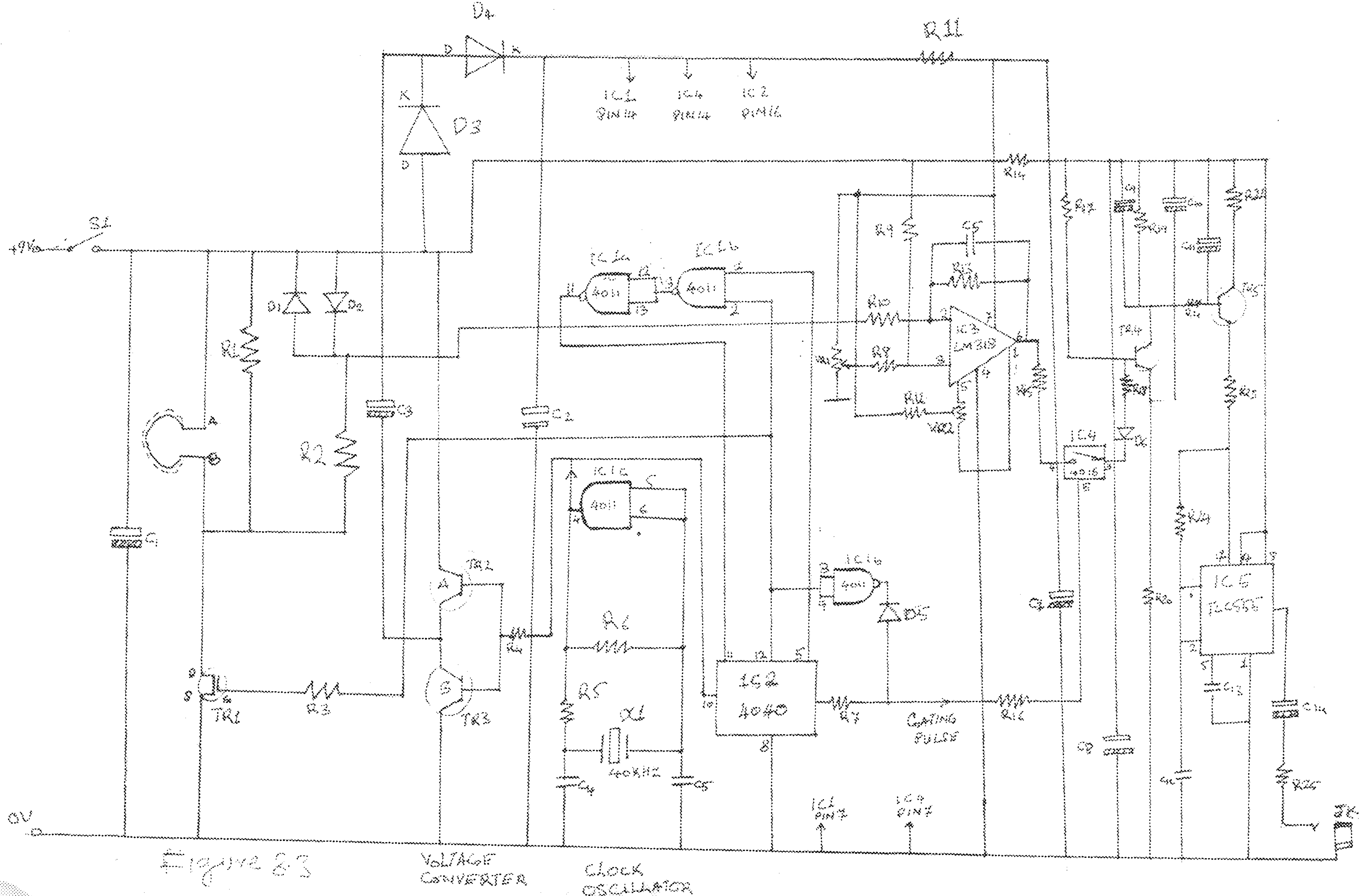

D4
R11
K
D3
IC1 PIN14
IC4 PIN14
IC2 PIN16
R14
S1
+9V
D1
D2
R1
R2
A
B
C3
C2
C1
IC1a
4011
IC1b
IC1c
IC1d
R9
C5
R15
R10
IC3 LM318
R8
VR1
R11
VR2
R13
R17
R19
C9
C10
C11
R22
TR5
TR4
R18
D6
IC4
4016
R23
R20
IC5
ICL555
C13
C14
R25
JK
C7
C8
C6
TR2
TR3
TR1
R3
R4
R6
R5
X1
40KHZ
C4
C5
IC2
4040
R7
GATING PULSE
R16
D5
IC1 PIN7
IC4 PIN7
0V
VOLTAGE CONVERTER
CLOCK OSCILLATOR

Figure 8.3