DESIGN AND CONSTRUCTION OF A DIGITAL DISTANCE RECORDER

BY

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ATTESTATION/DECLARATION

I Alexander H. Tsado hereby declare that this project was carried out by me under the supervision of Mrs. Alenoghena C.O and has not been wholly or partially presented for any degree elsewhere. Information gotten from published and unpublished works of others have been duly acknowledged.

Alexander H. Tsado 5/12/05

Student Signature and Date

Mrs. Alenoghena C.O 5/12/05

Supervisor Signature and Date

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Head of Department Signature and Date

External Supervisor ....

Signature and Date

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With gratitude to God for his grace and mercies for seeing me through this course study successfully as tasking as it was. I wish to express my sincere appreciation to my wonderful and courageous parents Mr. and Mrs. I.Z. Tsado who despite the odds stood by me and gave all the support (moral, financial and spiritual) throughout my years of study, The God of Israel is your exceeding great reward.

My special appreciation goes to my supervisor Mrs. Alenoghena C.O. for her tireless efforts and assistance to the completion of this project.

I'd like to also thank those who supported me morally, financially and otherwise towards the successful completion of this project. Especially my uncles and aunts Mr. and Mrs. M.Y. Tsado, Mr. and Mrs. Micheal Jiya, Mr. and Mrs. John Jiya, Mr. and Mrs. Eli Kolo, Mr. and Mrs. Barnabas Yisa, Mr. and Mrs. Thomas Jiya, Mr. and Mrs. Peter Yisa, Mr. and Mrs. Uriah Jiya.

To my irreplaceable sisters Priscilla, Faith, Hope and Peace I couldn't ask for a better lot to grow up with, you're the best thing that has happened to me.

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DEDICATION

To the Immortal, Invisible and only wise God in whom all things consist and without whom nothing exist for his inspiration, guidance and enabling power to complete this work.

ABSTRACT

This project is the Design and Construction of a Digital Distance Recorder. It was designed to meet the needs of power and telecommunication industries in terms of cable distance measurements and for plot measurements and surveys by town planners with a level of accuracy and less manpower.

The device is wheel incorporated and uses the infra-red transmission – detection technique with holes drilled around the wheel and pulses generated which clocks the BCD counters via the blockage of signal path. The efficiency of the device was found to be about 96% after testing was carried out.

CHAPTER ONE

1.0 GENERAL INTRODUCTION

The design and construction of a Digital Distance Recorder is one of the several efforts of Electrical and Electronics Engineering profession in improving reliability, maintainability and comfort in digital counter system. This project is all about design and construction of a portable wheel incorporated device that could be used to measure distance covered by an individual during a walk and or cable lengths in Power and Telecommunication companies where physical cables are being laid for both long and short distances. Although the device is not a precision metre, but its approximations degree was found good enough for this kind of device.

Generally, a measuring tape is one of the commonly used devices in the measurement of land and/or plot sizes and cable distances. This kind of device makes the measurement of distances cumbersome and inconvenient for just one person to make and many errors are associated with this method. These could be enhanced and higher efficiency achieved with the aid of a wheel incorporated Digital Distance Recorder.

The design on a device capable of measuring distance using the wheel technology. An infra-red transmitter is placed at one side of the wheel and the other side, a detector. The wheel serves as a barrier between the two electronic devices, so that signal only flows through or connects the leading two when holes on the wheel are at the space in between.

The holes are along the circumference of the wheel and are spaced about 1.2cm. That is, the transmitter and detector are wirelessly linked every 1.2cm distance, which gives 1inch on the wheel circumference. Moreover, the blockage of signal path produces a pulse or rather square wave at the amplifier stage. The amplified pulse clocks a BCD counter which records the number of pulses.

1.1 PROJECT OBJECTIVE

The objective of this project is to achieve to a high degree of precision distance required to be covered during cable laying in the power and Telecommunication Industries. It could also be used to measure the distance covered by an individual during a walk. It is simple to handle, easy to move around with and usable without having additional personnel other than yourself. The display is 5-digit so that it could cover a range up to 25,400 metres (25.4km).

1.2 INFRA-RED TRANSMISSION & DETECTION

1.2.1 INFRA-RED TRANSMISSION

The infra-red transmission is done by opto-devices, in this case an infra-red emitter (LED). A LED (generally) is a junction diode made from the semi-conductor material, gallium arsenide phospide. Its action and the type of ray is dependent on the type of semi-conductor doping used[6].

The infra-red type when furnished with appropriate voltage and current (which could be gotten from data sheets), emits infra-red at a given wavelength. Typically the 5mm LED emits infra-red current of about 150mA at a voltage of about 1.7V d.c forward current[6]. The symbol for the infra-red emitter is shown in fig 1.1 blow

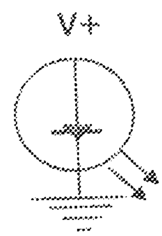


Fig 1.1 Infra-Red Emitting Diode

1.2.2 INFRA-RED DETECTION

This is basically a photodiode (light sensor), which is operated by first reverse-biasing the junction and then illuminating it [2]. A photodiode can turn its current ON and OFF in nanoseconds. Hence, it is one of the fastest photo detectors. It is used where it is required to switch light ON and OFF at a maximum rate. Its applications range from detection of both visible and invisible light emitters to switching, character recognition, encoders, optical communication equipments and logic circuit that require stability and high speed.

It is a two-terminal junction device which has a small amount of reverse saturation current due to thermally-generated electron-hole pairs [3]. In Silicon, it's the range of nanoamperes. The number of these minority carriers depends on the intensity of light incident at the junction. While the diode is in glass package, light can reach the junction and then change the reverse current.

The characteristic level of illumination increases with increase in a given reverse voltage.

The dark current refers to the current that flows when no light is incident. By changing the illumination level, reverse current can be changed [1]. In this way the reverse can be changed by a factor of nearly 20. The photo-diode used is TIL100.

1.3 DIGITAL COUNTERS

A digital counter is an instrument which in its simplest form provides an output that corresponds to the number of pulses applied to the input [8]. In a more advanced way, we can define digital counter as a device which connects Flip-flops used and the way they are clocked determines the number of states called modulus and the categories respectively.

Counters are classified into two major categories according to the way they are clocked. These include SYNCHRONOUS and ASYNCHRONOUS counters. This work employs the synchronous counters due to its working nature.

1.3.1 ASYNCHRONOUS COUNTERS

These are also known as ripple counters, has its first flip-flop clocked by external pulse and then each successive flip-flop is clocked by the output of the preceding flip-flop [7]. Since the term asynchronous refers to events that don't have a fixed time relationship with each other and do not occur at the same time. Therefore, asynchronous counter is one which the flip-flop within the counter does not change at exactly the same time because they don't have a common clock pulse.

1.3.2 SYNCHRONOUS COUNTERS

These refer to counters which have all input connected to all the flip-flops so that they are clocked simultaneously [7]. The ward synchronous refers to events that have a fixed time relationship with each other, and then we say synchronous means that the flip-flops within the counter are all clocked at the same time by a common clock pulse. Furthermore, it is known that counters operate in binary number system since binary is easily implemented with electronic circuitry and also it allows any integer to be represented as a series of binary digits or bits. Where each bit is either 0 or 1 (i.e. at OFF or ON, LOW or HIGH). In the case of a Digital Distance Recorder, it employs the synchronous counter.

1.4 BILL OF QUANTITIES

S/NO.	COMPONENT	QTY	UNIT	RATE (₦)	AMOUNT (₦)
1	4017B Stepper	1	LOT	120.00	120.00
2	4029B IC	5	LOT	120.00	600.00
3	4503B IC	5	LOT	120.00	600.00
4	4511B IC	1	LOT	100.00	120.00
5	LM124 Photo-Cell Amplifier	1	LOT	120.00	100.00
6	4060B Oscillator	1	LOT	50.00	120.00
7	7805 Voltage Regulator	1	LOT	50.00	50.00
8	Infrared Transmitter	1	LOT	50.00	50.00
9	TIL100	1	LOT	50.00	50.00
10	n-p-n Transistors	5	LOT	10.00	50.00
11	9v Battery	1	LOT	80.00	80.00
12	Capacitor 0.01Mf	1	LOT	10.00	10.00
13	100KΩ Resistor	1	LOT	5.00	5.00
14	33KΩ Resistor	3	LOT	5.00	15.00
15	10KΩ Resistor	2	LOT	5.00	10.00
16	2.2KΩ Resistor	5	LOT	5.00	25.00
17	220Ω Resistor	8	LOT	5.00	40.00
18	1MΩ Resistor	1	LOT	5.00	5.00
19	Switches (SPST)	3	LOT	80.00	240.00
20	Reset Button	1	LOT	60.00	60.00
21	Wheel	1	LOT	800.00	800.00
22	Iron Rod	1	LOT	300.00	300.00
23	4069 Inverter	1	LOT	120.00	120.00
24	Vero Board	1	LOT	150.00	150.00
25	Connecting Wire	1	LOT	300.00	300.00
				TOTAL	4, 020.00

CHAPTER TWO

2.0 LITERATURE REVIEW

In ancient times, the body ruled when it came to measuring. The length of a foot, the width of a finger, and the distance of a step were all accepted measurements.

The Inch was the width of a man's thumb; the foot was $11^{1}/_{42}$ inches. Today it is 12 inches, the length of an average man's foot. A yard was originally the length of a man's belt or girdle; today it is 36 inches. A cubit was the distance from elbow to the fingertips; today a cubit is 16 inches [10].

In the early days, distance covered by an individual is measured by assumption method maybe by how long the people have walked or where he is coming from and his destination. With time came the innovation of tape metre which could be used to measure linear distance covered, and most recently the advent of digital counters with display of distance covered which forms my major inspiration on how effective digital counter is, and this eventually prompted my innovation of a Digital Distance Recorder.

Improvement in digital counting technology today is centred on solid state semi-conductors circuits, which are mostly used in modern electronics. Digital Counters may be categorised into two types; these are Moore machine and the Mealy machine. The simpler one is the Moore machine which is also called the clock input or pulse input, whereas Mealy machine has additional inputs that alter the count sequence [8]. Most counters operate in binary number system, since binary is simply implemented with electronic circuitry. Binary allows any integers to be represented as a series of digits or bits. Where each bit is either 0 or 1 and after been worked on by the necessary components like the Integrated Circuit (IC) and various transistors and diodes it displays out the appropriate decimal as its output [12].

Through the years, the need of digital counters has increased tremendously in electrical and electronics engineering as various methods have been explored in the area of measurements, some of which include:

1) Treadmill machine in Gymnasiums.

2) Ultra-Sonic motion detectors in areas where there are not supposed to be any moving objects. Examples of which are: The passive infra-red motion detector and the active infra-red motion detector.

3) Ultra-sonic Range finder.

Virtually every modern electronic equipment which are digitally controlled or has digital numeric display, are made up of digital counters.

Furthermore, some other works related to this project include: The design and construction of a digital step-km counter by Oladunjoye Olawumi Olatayo (November 2004) which measures the distance covered by an individual during a walk. This work basically is not a precision metre. It is a device which uses a tilt (mercury) switch and a monostable multivibrator that provides some degree of freedom from excessive bouncing of the mercury switch and then generates a clean square pulse for the counters to record.

The ultra-sonic range finder [8] requires a transmitting ultra-sonic transducer; a medium, such as air or water; a reflecting surface or object, a receiving ultra-sonic transducer, and a time-of-flight measurement circuit. The speed of sound in air at 20^0C is approximately 343m/sec; which translates to about 1 inches per 74μsec. Doubling the time gives the round-trip speed which is 1 inches per 148μsec. Four aspects of the system limits the maximum measurable distance: the amplitude of the sound wave, the texture of the reflecting surface, the angle of the surface with respect to the incident sound wave and the sensitivity of the transducer [16]

This work uses an oscillator at the infra-red source and CMOS Integrated Stepper.

The oscillator is an electronic circuit that produces varying output signals [5]. A sinusoidal oscillator produces sinusoidal signals, while non-sinusoidal signals are generated by a non-sinusoidal oscillator.

2.1 CMOS

The acronym CMOS stands for Complimentary Metal Oxide Semiconductor. It is one of the most popular logic families in current use; the other is the TTL (Transistor-Transistor Logic). Digital logic is available in Ten (10) popular sub families (CMOS, 40000B, 74C, 74HC, 74HCT, 74AC, 74ACT and TTL; 74LS, 74ALS, 74AS, 74F) all offering the same functions and with a pretty good degree of compatibility between them [7]. The differences have to do with speed, power dissipation, output drive capability and logic levels.

CMOS (4000B) has the following general characteristics;

- SUPPLY: 3 to 15V, small fluctuations are tolerated.
- INPUTS: They have very high impedance (resistance), this is good because it means they will not affect the part of the circuit they are connected.

Unconnected pins can pick noise and change between high and low states in an unpredictable way. This is likely to make the chip behave erratically and it will significantly increase the supply (either 0V or +Vs). This applies even if that part of the clip is not being used in the circuit.

- OUTPUTS: Can sink and source only about 1mA if you wish to maintain the correct output voltage to drive CMOS inputs. If there is no need to drive any inputs the maximum current is about 5mA with a 6V supply, or 10mA with a 9V supply (just enough to light an LED). To switch larger currents, a transistor may be connected.

- GATE PROPAGATION TIME: typically 30ns for a signal to travel through a gate with 9v supply, it takes a longer time at lower supply voltages.
- FREQUENCY: up to 1Mhz, above that the 74 series is a better choice.
- POWER CONSUMPTION: (of the chip itself) is very low, a few μW, it is much greater at high frequencies, a few mw at 1Mhz; for example.
- FAN OUT: one output can drive up to 50 inputs.

The CMOS integrated 4017B stepper is connected to transistors Q1 to Q5 which are used for the multiplexing of switching ON and OFF the five 7-segment displays in accordance with the sequence of the tristate buffers. The 4017B stepper provides the switching order and the 4060B oscillator is the generator.

2.2 BLOCK DIAGRAM

The Digital distance recorder was designed following the block diagram of fig 2.1. A brief description of the blocks that make up the design will be given thus:

INPUT UNIT: This is made up of the infra-red source (photodiode) and a detector TIL100.

CONTROL UNIT: Comprises of the signal amplifier (LM124), a divide by 10 counter, 2-1 multiplexer, 5-digit BCD counter, a forward/backward control input. 5-1 BCD multiplexer and a BCD to 7-segment decoder.

OUTPUT UNIT: It is a 5-digit, 7-segment BCD display.

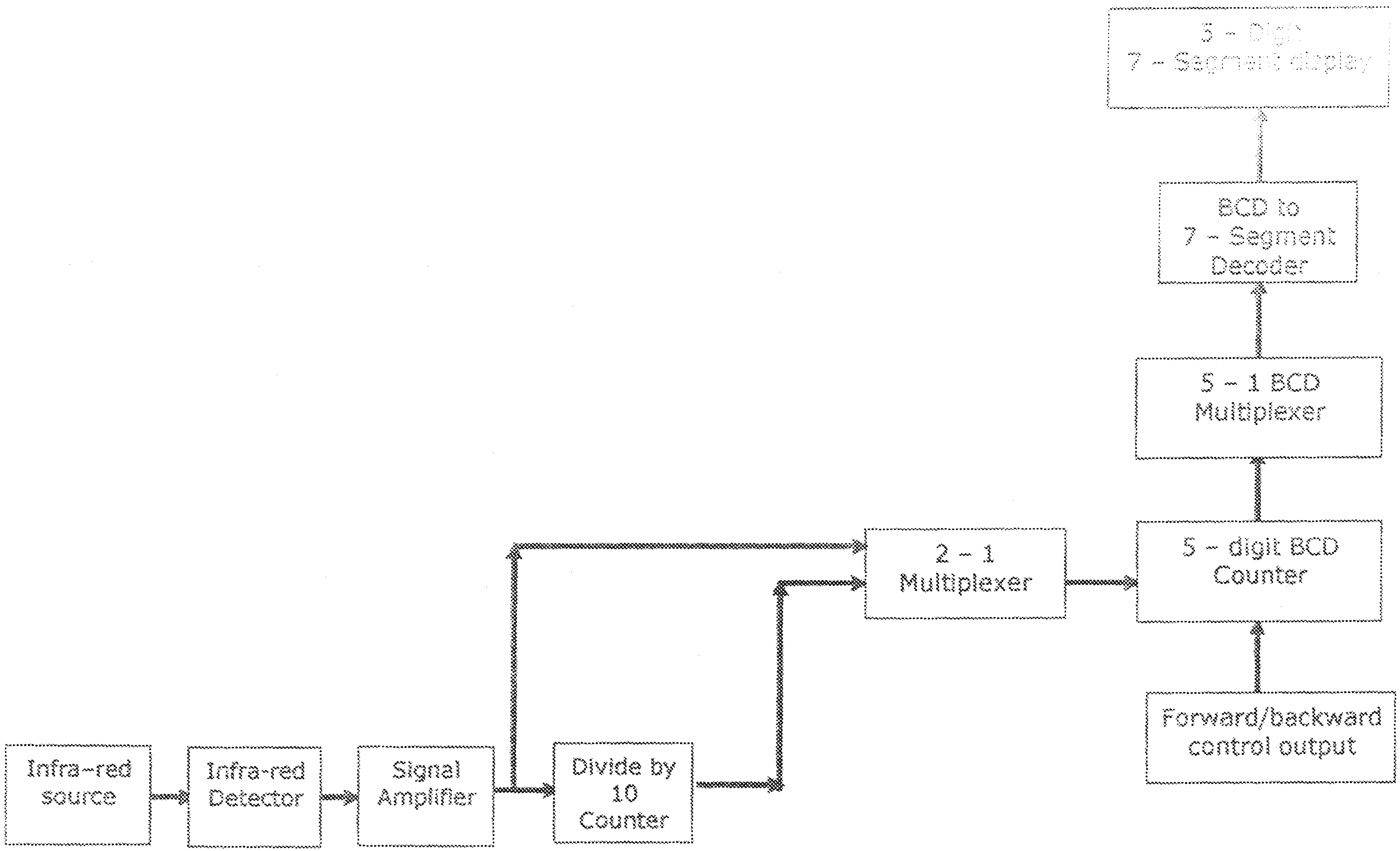


Fig 2.1 BLOCK DIAGRAM OF A DIGITAL DISTANCE RECORDER

CHAPTER THREE

3.0 DESIGN ANALYSIS

The objective of this chapter is to primarily deal with the major sections of this project design: The power supply unit, Infra-red source, Infra-red detector, Signal amplifier, Divide by 10 Counter, 2 – 1 Multiplexer, 5 – digit BCD Counter, 5 – 1 BCD Multiplexer, BCD to 7 Segment decoder and 5 – digit 7 – segment display units. All sub-sections are treated on a modular basis for logical flow and ease of comprehension. Each module under each unit is analysed and some calculations included where applicable and necessary.

3.1 POWER SUPPLY UNIT

The Power Supply Unit consists of a 9V battery power supply, a switch, a 5V voltage regulator (7805). The (7805) 5V voltage regulator regulates the 9V supply to approximately 5V, so that 5V is across the circuit. A single pole single throw (SPST) slider switch is connected in series with the battery to turn OFF and ON the device. Also a 5V voltage regulator is connected in series with the SPST slider switch.

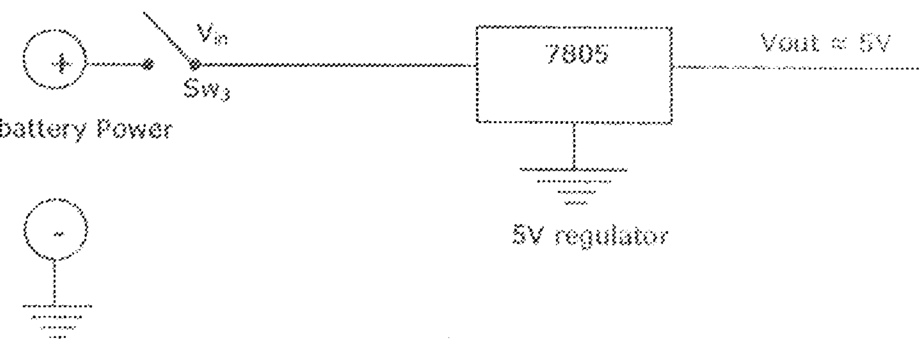


Fig. 3.1 Circuit diagram of the Power Supply Unit.

3.2 INFRA RED SOURCE

It is made up of a 220Ω resistor, an infra-red emitting diode and a 4060B oscillator. The diode is forward biased in series with a 220Ω current limiting diode. The

4060B oscillator is used and fig 3.2a depicts its pin assignments, while fig. 3.2b shows the circuit connection of the infra-red transmitter.

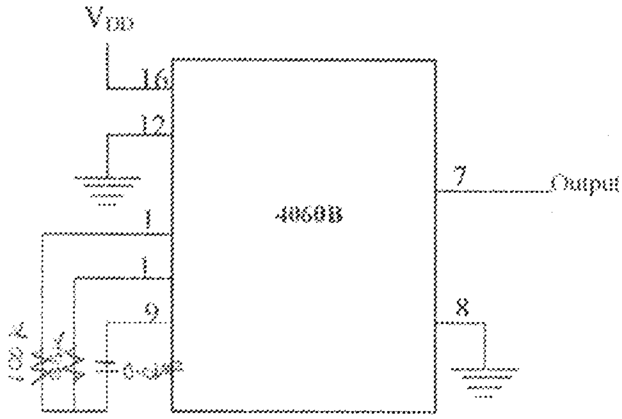


Fig 3.2a Pin assignment for 4060B Oscillator

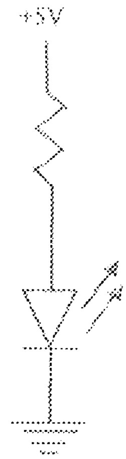


Fig 3.2 b Circuit connection of infrared transmitter

THE MC4060B

The MC4060B is a 14-stage binary ripple counter with an on-chip oscillator buffer. The oscillator configuration allows design of either RC or crystal oscillator circuits. Also included on chip is a reset function which places all outputs into the zero state and disables the oscillator. A negative transition on clock will advance the counter to the next state [9]. Schmitt trigger action on the input line permits very slow input rise and fall times. Applications include time delay circuits, counter controls and frequency dividing circuits.

Features:

- Fully static operation. Diode protection on all inputs.

- Supply voltage range = 3.0V to 18V.

- Capable of driving two low-power TTL loads or one low-power schottky TTL load over the rated temperature range.

- Buffered outputs available from stages 4 through 10 and 12 through 14.

- Common reset line. Pin-for-pin replacement for CD4060B.

V_{DD} DC Supply Voltage -0.5 to +18.0V.

Vin – Vout input or output voltage (DC or Transient) -0.5 to VDD +0.5V

Iin:Iout input output current (DC or transient), per pin ±10mA

P_D Power dissipation, per package 500mW

Tstg Storage Temperature -65 to +150°C

T_L Lead Temperature (8 – Second Soldering) 260°C

The frequency of the oscillator is given by:

$$f = \frac{1}{2.3RxCx}$$

As per manufacturing design. Other design considerations are

1) R_1 = 2Rx to 10Rx

2) RC Oscillator application not recommended at supply voltages below 7.0v for Rx < 50Ke.

$$f_0 = \frac{1}{2.3 \times 33k\Omega \times 0.01\mu F}$$

$$f_0 \approx 1.3 \text{ KHz}$$

3.3 INFRA-RED DETECTOR

This is a heat sensitive (photodiode) TIL100 which changes the signal by the infra-red source into corresponding electric current. It is connected to signal amplifier.

3.4 SIGNAL AMPLIFIER

The LM 124 photocell amplifier is used with a 1mΩ feedback resistance. The weak electric current from the infra-red detector is amplified through the LM 124 amplifier. The circuit diagram is shown in fig. 3.4 below.

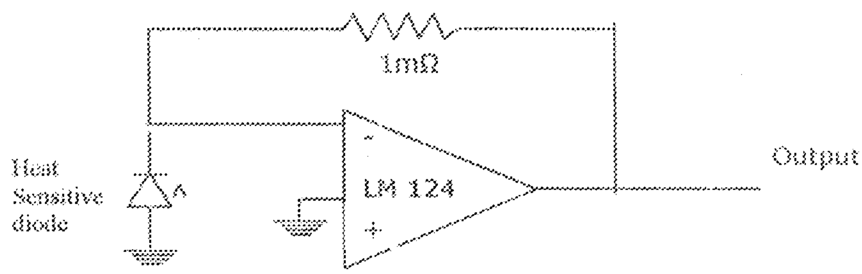


Fig. 3.3 Photo-cell amplifier

3.5 DIVIDE BY 10 COUNTER

It is a 4017B stepper, capable of dividing input clock or pulse by ten (10). i.e. the output will be ten time slower than the input. It is CMOS integrated.

General Description:

- It is a 5 – stage divide by 10 Johnson counter with 10 decoded outputs and a carry out bit.

- Cleaned to zero by a logical "1" on reset line.

- Advanced on the positive edge of the clock signal when clock enable signal is in the logical "0" state.

- The 10 decoded output are normally in the logical "0" state and go to the logical "1" state only at their respective time slot. Each decoded output remains high for one full clock cycle.

- The carry-out signal completes a full cycle for every ten clock input cycles and is used as a ripple carry signal to any succeeding stages.

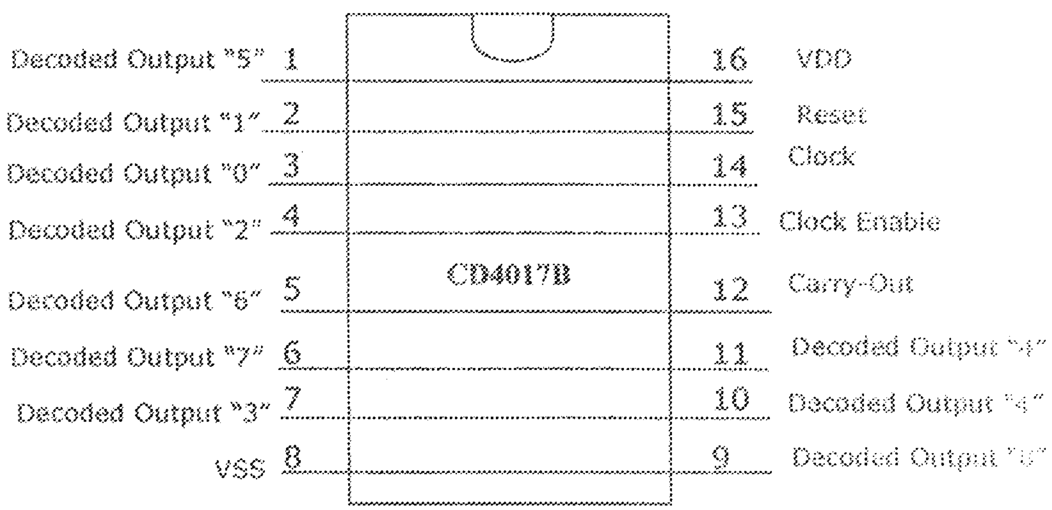


Fig 3.4 shows the pin assignments for the CD4017B stepper.

Features:

- It has a wide supply voltage range: 3.0V to 15V

- High noise Immunity: 0.45 V_{DD} (typical)

- Low power fan out of 2 driving 74L

- TTL compatibility: 1 driving 74LS

- Medium speed operation: 5.0 Mhz (typ) with 10V V_{DD}

- Fully static operation

- Low power 10μW (typ)

The recommended operating conditions include;

- DC supply voltage $+3V_{DC}$ to $+V_{DC}$

- Input voltage (Vin) 0 to V_{DD} V_{DC}

- Operating temperature range (T_A) -40°C to +85°C

Its applications are useful in medical electronics, Alarm systems, Industrial electronics, remote metering, instrumentation e.t.c. The timing diagram of the 4017B stepper is as shown in fig 3.5.

3.6 2-1 MULTIPLEXER

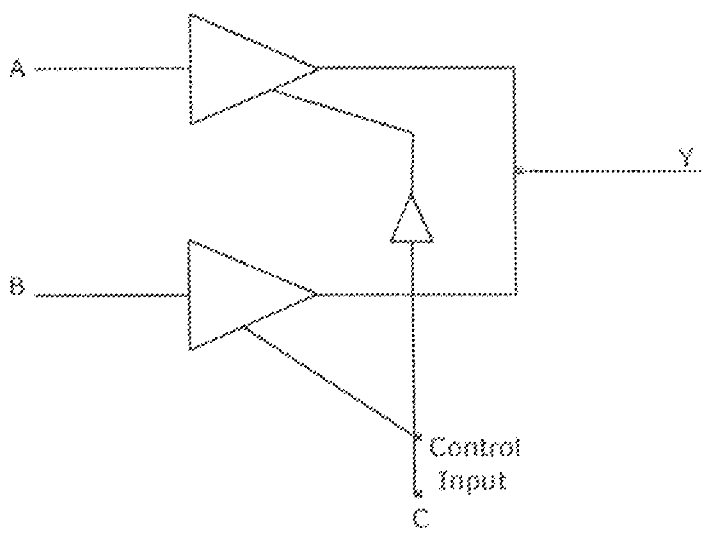


Fig. 3.6

The multiplexer is made of two tristate buffers (for 4503B) and one NOT gate (4069VB inverter). The non-inverting buffers are active low. That is when their control input is low input signal passes to the output is cut-off from the output or simply a high impedance state is reached.

From the diagram in fig 3.6 above when control input C is HIGH, signal A passes to Y and B is cut-off. But when C is low, only B is at Y from the diagram (circuit).

C is connected through a 10Ω resistor to the ground. So point C is low, That is A is enable to the output. But switching ON SW_1 changes C HIGH and the result is that only B is fed to Y.

The 2-1 multiplexer is used to select either the direct or divided pulse. The division is done to allow for more readings but lower accuracy.

The input A is derived from the amplified signal directly from the LM 124 amplifier and the input B is from pin11 of the 4017B stepper which is divided ten times the original pulse. The control input C is supplied by a +5V supply switch and 10kΩ resistor.

3.7 5-DIGIT BCD COUNTER

The CD4029BC is a presetable up/down counter which counts in either binary or decade mode depending on the voltage level applied at binary/decade input. When binary/decade is at logical "1", the counter counts up when the up/down input is at logical "1" and vice versa.

A logical "1" preset enable signal allows information at the "jam" input to preset the counter to any state asynchronously with the clock. The counter is advanced one count at the positive-going edge of the clock if the carry in and preset enable input are at logical "0". Advancement is inhibited when either or both of these two inputs is at logical "1" state and goes to logical "0" state when the counter reaches its maximum count in the "up" mode or the minimum count in the "down" mode provided the carry input is at logical "0" state.

All inputs are protected against static discharge by diode clamps to both VDD and VSS

Features

- Wide supply voltage 3v to 15v.
- High noise immunity 0.45 VDD (typ).
- Low power TTL compatibly: fan out of 2 driving 74L
- Parallel jam input
- Binary or BCD decade up/down counting.

Five counters are involved in the design and all in parallel configuration. In other words "synchronous" state. Moreover, the 4-bit outputs from each counter are fed to corresponding tristate buffer for multiplexing.

The pin connections are shown in fig. 3.7 below also the logic waveforms in the decade and binary modes are shown in fig 3.8 including the switching time waveform and cascading packages.

3.8 THE 5-1 BCD MULTIPLEXER

CD4503B is a hex non inverting buffer with 3-state outputs having high sink and source – current capability. Two disable controls are provided. One of which controls four buffers and the other controls the remaining two buffers. The CD4503B types are applicable in 3-state hex buffer for interfacing IC's with data buses and CMOS to TTL hex buffer.

Features

- 1 TTL Load output drive capability
- 2 Output disable controls.
- 3- state outputs.
- Pin compatible with industry types MM80C97, MC14503 and 340097

- 5-V, 10-V, and 15-V parametric ratings.
- Maximum input current of 1μA at 18V over and 25°C.

  Package -temperature range; 100nA at 18V and 25°C.
- Meets all requirements of JEDEC tentative standard No. 13B, "standard specifications for description of 'B' series CMOS devices."

The recommended supply voltages ranges from +3Vto 18V.

The outputs of the buffers are corresponding connected to the BCD to 7-segment decoder.

3.9 BCD to 7 SEGMENT DECODER

The CD4511B types are BCD-to-7-segment latch decoder drivers constructed with CMOS and n-p-n bipolar transistor output devices on a single monolithic structure. These devices combine the low quiescent power dissipation and high noise immunity features of RCA CMOS with n-p-n bipolar output transistors capable of sourcing up to 25mA. This capability allows the CD5411B types to drive LED's and other displays directly. Lamp Test (LT), Blanking (BL), and Latch Enable or strobe inputs are provided to test the display, shut off or intensify-modulate it and store or strobe a BCD code respectively. Several different signals may be multiplexed and displayed when external multiplexing circuitry is used.

Features:

- High-Output- sourcing capability up to 25mA.
- Input latches for BCD code storage
- Lamp Text and Blanking capability
- 7-segment outputs blanked for BCD input code > 1001
- 100% tested for quiescent current at 20V
- Maximum input current of 1wA at 18V, over full package- temperature range,

100nA at 18V and 25°C.

- 5-V, 10-vand 15-V parametric ratings.

It applications are useful in driving common-cathode LED displays, multiplexing with common-cathode LED displays and driving low-voltage fluorescent displays.

The outputs of the CD4511B are connected to the parallel lines of five 7-segment displays. Transistor Q1 to Q5 are also used for the multiplexing for switching ON and OFF the five 7-segment displays in accordance with the enabling sequence of the tristate buffers. The 4017B stepper provides the switching order and 4060B is the clock generator for the tristate buffers.

The multiplexing is done at a round 1KHz.

The inverters are used to blend the in coming logic with the buffer input setting.

The terminal assignments are show in fig 3.10 below:

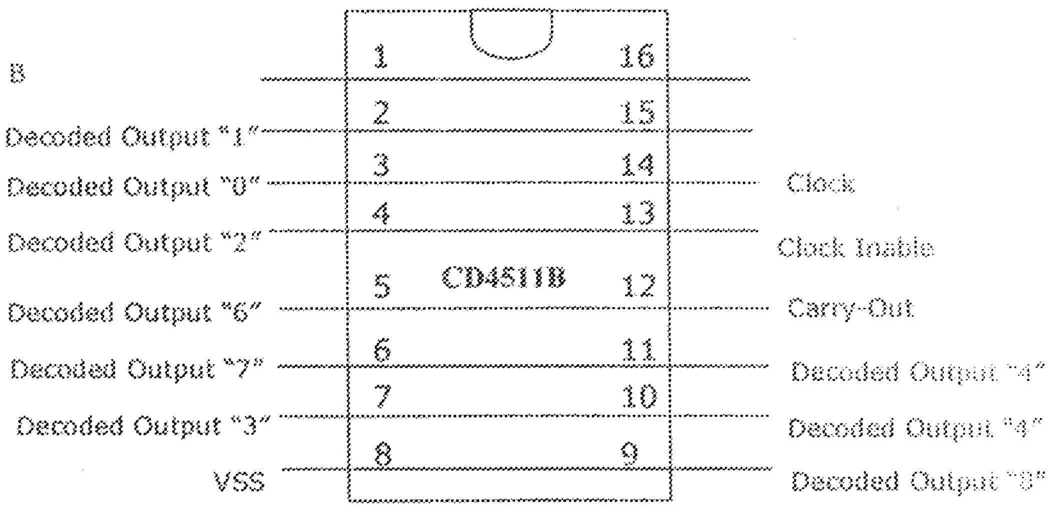


Fig 3.10 Terminal Assignments of CD4511B

3.10 5 - DIGIT 7 - SEGMENT DISPLAY

The display unit for this project is to display the decimal number 0-9. This was achieved with the aid of 5 "common-cathode 7-sement LED mini display".

A seven – segment display consists seven rectangular LEDs which can form the digits 0 to 9.the seven LED segments are labelled "a" to "g" as show in fig. 3.11. Each of these segments is controlled through one of the display LEDs. Also on the unit, is a circular LED used to signify decimal point:

From fig 3.12 each of the outputs of the BCD to 7- segment decoder (4511B) are connected to a segment each of the 7 segment display and parallel connection from the first display to the remaining four is done.

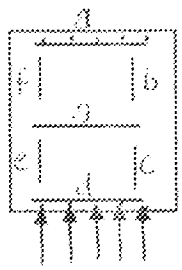


Fig. 3.11 Pin configuration of common cathode seven-segment display.

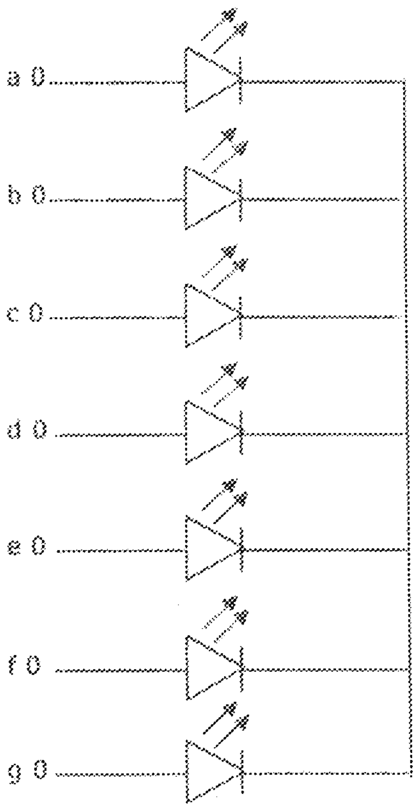
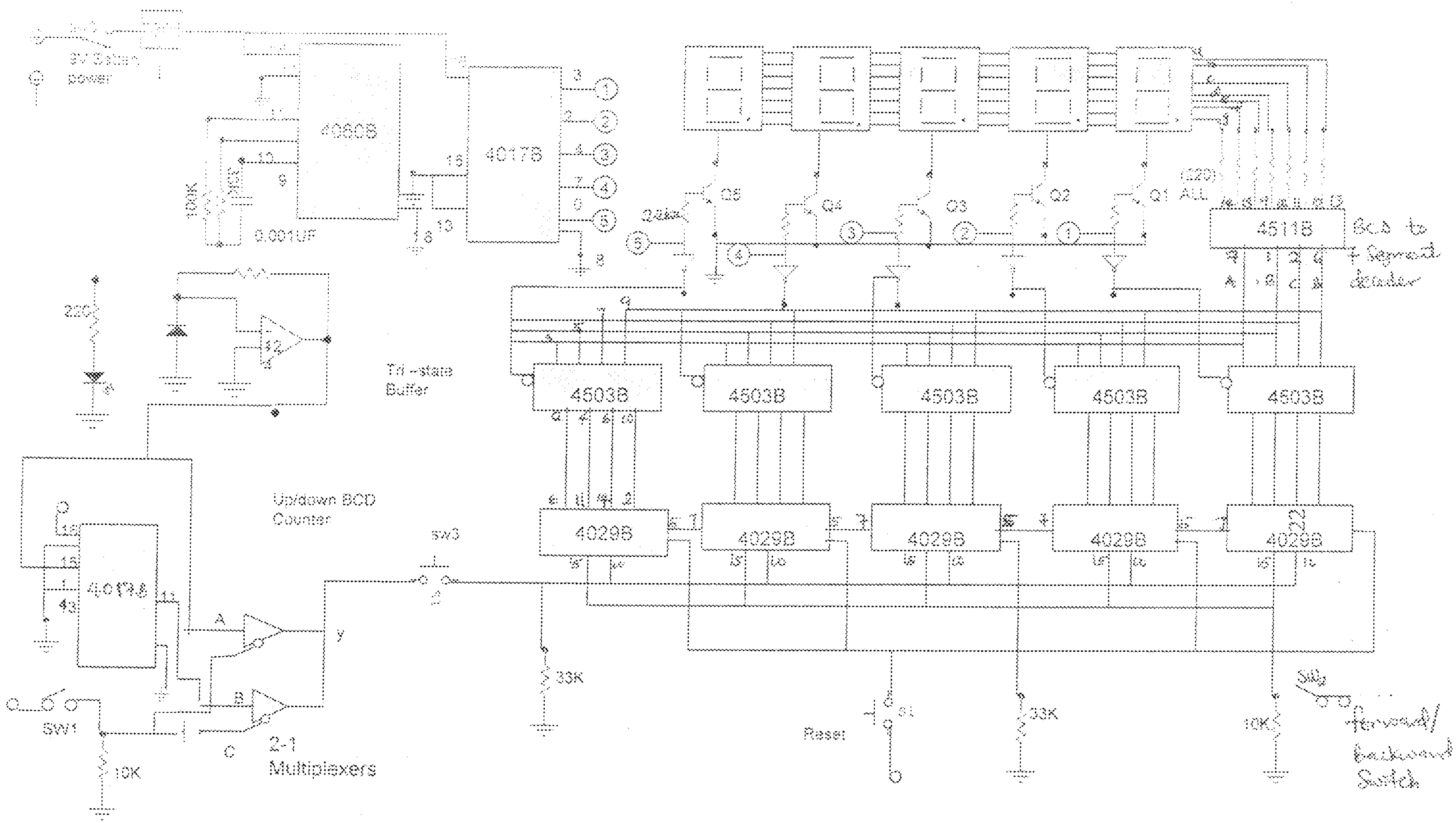


Fig 3.12 Internal arrangements of LEDs in a common cathode display.

3.11 FORWARD / BACKWARD CONTROL INPUT

A +5V supply voltage is connected with a 10kΩ resistor and connected to pin 10 of the CD4029BC, an up/down counter which has the capability of counting in up and down direction. When pin 10 is HIGH the counter is set to the up mode, and when LOW, down mode. The modes used for setting the counters along with the direction of the wheel. When going forward, the mode is set at up and when going backward, down.

Circuit diagram of a digital distance recorder



CHAPTER FOUR

4.0 CONSTRUCTION, TEST AND RESULT

In the construction of a digital Distance Recorder, the design specification of each component was followed strictly. The construction includes a prototype on the temporary location (Breadboard) and later the proper construction of the completed design on the Vero board. Testing was carried out at both stages; results gotten were analysed to ensure that they were within design error.

4.1 HARDWARE CONSTRUCTION, TESTING AND RESULT

The connections of different components were carried out according to design on the Breadboard, testing for each module was carried out. This later transferred to Vero board. The details under given.

4.1.1. POWER UNIT

The Power Unit consists of a 9v battery supply source and a 5v regulator (7805). So that 5v is across the circuit. A Single Pole Single Throw (SPST) slider switch in series with the battery to turn ON and OFF the device.

4.1.2 SIGNAL PROCESSING UNIT

This consists of an infra-red emitting diode, a Heat Sensitive diode (TIL 100 photodiode) and an LM 124 inverting op-amp having a feedback resistance of 1mΩ which amplifies the signal is connected in series with the photodiode.

4.1.3 CONTROL UNIT

This is made up of a 4503B and one NOT gate (4069B inverter). It consists of 2 input lines and a Control Input C, which is connected through a 10kΩ resistor to the ground. The input line A is directly connected to the counters, while the input line B is connected to the divide by 10 counter to scale the output of the counters from 1km to 10km and vice versa.

4.1.4 COUNTER AND BCD/7 SEGMENT UNIT

The leading BCD counter (4029B) has the ability to count in the up and down direction. When pin10 is HIGH, it is set to up mode and when LOW, down mode. Five counters are involved in the design and are all in synchronous states (parallel configuration). The 4-bit outputs from each counter are fed to corresponding Tristate buffer for multiplexing.

Also, the outputs of the buffers are correspondingly connected to the BCD to 7-segment decoder (4511B) whose outputs are in turn connected to the parallel lines of the five 7 segment display.

4.2 SOLDERING

Some of the precautions taken during soldering are outlined below:

- Proper contact was ensured by using enough soldering lead for contact points
- It was ensured that temperature of the soldering iron was not high in order to prevent damage due to overheating.
- Any area of the Vero board on which soldering was to be done was first cleaned up to ensure lasting soldering.
- I ensured connection of all unused input leads to either positive or negative supply voltage.

4.3 CASING

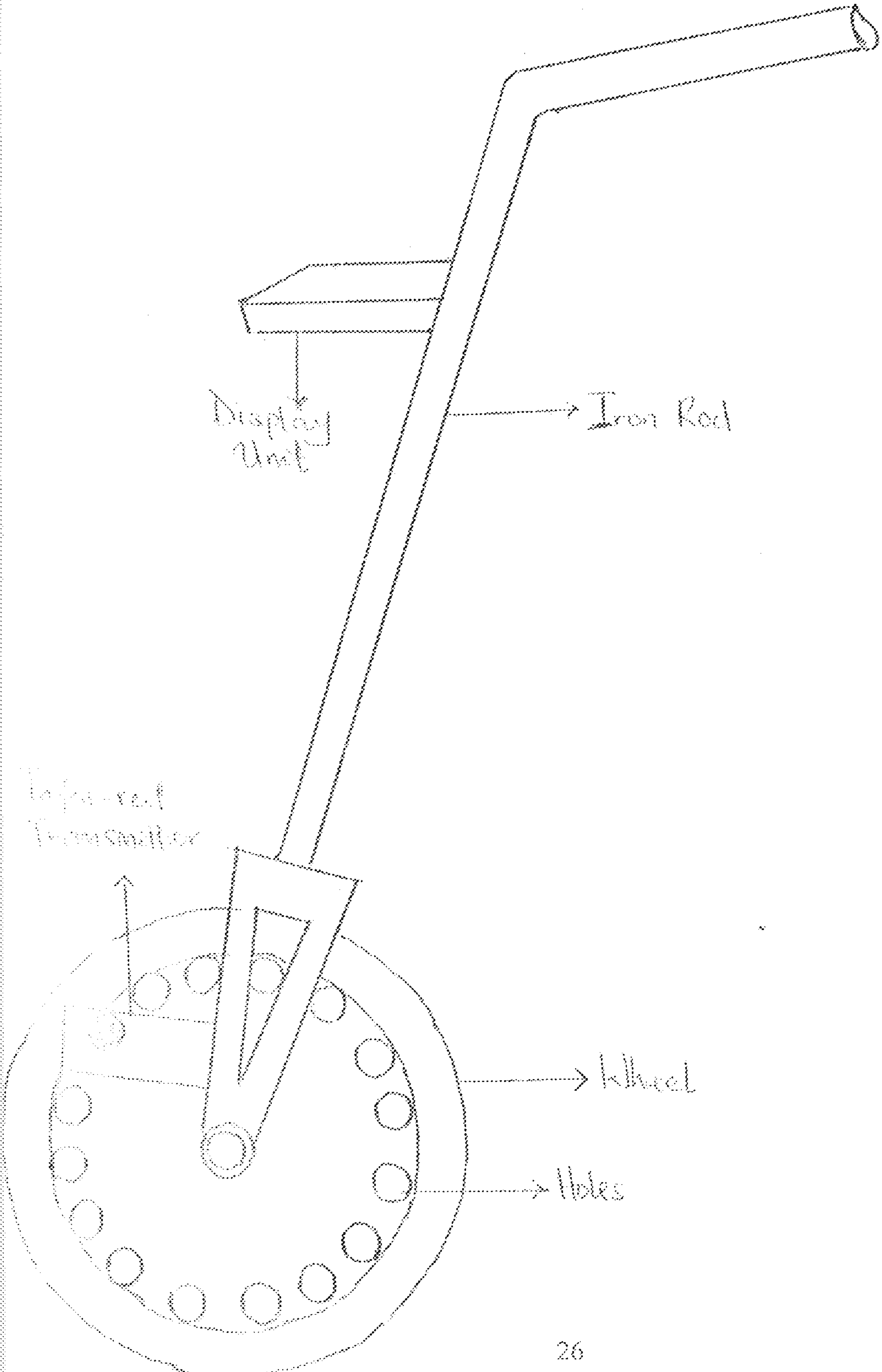
The casing is made of a rubber wheel for movement, an Iron rod neatly painted brown for holding the device and a square shaped steel with wooden cover for the housing of the internal circuitry which is bolted to the Iron rod.

4.4 TEST AND RESULTS

After construction, tests were carried out on the Digital Distance Recorder and the results obtained recorded. For a movement of 6.69 inches the device gave a reading of 7 inches.

$$\text{Percentage error} = \frac{7.00 - 6.69}{6.69} \times 100\% = 4\%\ \text{error}$$

The device is found to be 96% efficient which is within acceptable error limits.


Display Unit
Iron Rod
Infra-red Transmitter
Wheel
Holes

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

The design and construction of a digital distance recorder may seem to many people an easy task. However, that was not the case. The assumed notion that technology advancement, availability of components etc. would ease the execution was not really so as discovered at the commencement of the project. This was due to the difficulties encountered in trying to get components required by specification which delayed the rate of work or job completion. However, I was able to achieve a reasonable degree of economy and efficiency as outlined earlier in the objectives. The Digital distance recorder was constructed, and tested. Test results show an accuracy of 96%.

In view of the financial constraints, availability of components and limited number of projects to work on, it is recommended that the organised private sector and other interested parties take active parts in sponsoring and even initiating projects such as this.

It is seriously recommended that any student who will carry out a further work on this project should venture towards using custom made wheel with exact not approximate values for the wheel and hole spacing to ensure higher accuracy.

REFERENCES

1. Internet; http//www. Red circuit .com/page 9.htm
2. Internet; http//www. eelab. usyd. edu. du/ digital_tutorial
3. Internet; http//www.ibiblio.org/obp/electric circuit/digital
4. Harris Semi conductor, Texas Instruments Data Sheet SCHS072. Pages 3 – 255 to 3 – 259
5. Fairchildsemiconductor TM DS00590. prf www. fairchildsemi.com. Revised January 1999.
6. Smyrna, G.A, Ultrasonic Sensor Application Manual, MuRata Electronics North America Inc.
7. B. L Theraja, A. K. Theraja, A Textbook of Electrical Technology, S. Chand & Company Ltd. (2002). Twenty third revised edition. Pg. 1674, 1700 – 1763.
8. Oladunjoye Olawumi Olatayo, Design and Construction of a Digital Step Km – Counter, Dept. of Electrical/Computer Engineering, F. U. T. Minna, November 2004.
9. Motorola Inc, Motorola Semiconductor Technical Data. Pg. 1-6.
10. Namita Ahuja, Joe Ha, Robert Mitchel, Karl Schrader, Micheal Perry, Ambient light ignoring infrared active motion detector, EE498 Final project proposal, May 1996. pg. 37 - 51
11. Encyclopaedia, "The New Book of Knowledge," 1987, Groher. Canada, Volume 11
12. Denmi, W.H. "Electronic Component and system," Butterworth, London, 1982. pg. 33
13. Millman, J and Grabel, A. "Microelectronics," 1997, Mc-Graw-Hill, 2nd Ed. Newyork pg. 56 – 58

14. Ritchie, G.J, "Transistor Circuit Techniques," hapman and Hall, 3rd Ed. London 1993. pg. 41

15. Lionel, H, "Electronics and Electrical Engineering," MacMillan Press, 2nd Ed. London 1998 pg. 76

16 Holt, C.A. "Electroinic Circuits," John Wiley, Newyork 1998 pg. 61-67

17. Albert, P.M, "Electronic Principles," Mc-Graw-Hill, 3rd Ed. Newyork pg. 86, 99 -103

18. http://www.webopedia.com.

19. http://jidaw.com/digitalnigeria.html.

20. http://iec.org.

21. http://www.seas.upenn.edu.