DESIGN AND CONSTRUCTION

OF A

DIGITAL STEP-KM COUNTER

BY

OLADUNJOYE OLAWUMI OLATAYO
98/7112EE

A PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING (B.ENG) IN ELECTRICAL/ COMPUTER ENGINEERING

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FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE

NOVEMBER, 2004

DECLARATION

I OLADUNJOYE, OLAWUMI OLATAYO, hereby declare that this project presented for the degree of Bachelor of Engineering (B ENG) is an original work and has never been presented either wholly or partially for the award of diploma or degree in any other institution as far as I know.

The information derived from published work of others is acknowledged in the reference section.

.... SIGNATURE

7/12/2004 .... DATE

DEDICATION

To my source of inspiration, my reason and meaning of life, my ever flowing fountain of wisdom, the immortal, invisible, the only wise almighty God

CERTIFICATION

This is to certify that the project "DIGITAL STEP-KM COUNTER" was presented by OLADUNJOYE, OLAWUMI OLATAYO of the Department of Electrical/Computer Engineering, school of Engineering and Engineering Technology Federal University of Technology, Minna and that he has met the required standard acceptable by the above named department.

.... 8/12/04

PROJECT SUPERVISOR DATE

ENGR J .KOLO

.... 8/12/2004

HEAD OF DEPARTMENT DATE

ENGR M.D ABDULLAHI

....

EXTERNAL EXAMINER DATE

ACKNOWLEDGEMENT

I love to acknowledge those who have contributed towards making this project a success and my stay in F U.T Minna a fulfilled one. First to my supervisor, Engr Jonathan Kolo, his constructive criticism and advice contributed immensely to the success of this project, I will also like to acknowledge the contribution of the H.O.D. Engr.M.D Abdullahi and the entire lecturers of the department for their contribution during my stay at the department, am really grateful.

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Oladunjoye, Olatayo

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ABSTRACT

This report presents the design and construction of a Digital step-km counter which measures the distance covered during a walk. The aim is to provide a pocket size device with two-digit digital display for measuring the distance covered by an individual during a walk. It features basically the Power unit, Oscillator unit, Control unit and the Digital display unit. Recommendations for further work are also included in the report.

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 INTRODUCTION

The design and construction of a Digital step-km counter is one of the several efforts of the Electrical and Electronics Engineering profession in improving reliability, maintainability and comfort in the digital counter system. This project is all about design and construction of a pocket size device that could be used to measure distance covered by an individual during a walk. Although the device is not a precision meter, but its approximation's degree was found good enough for this kind of device.

Generally, a treadmill machine is one of the equipments used in Gymnasium. This machine consist of a flat platform which an individual can walk or jog on it and a digital display which displays the distance covered during the walk. Medically, exercise is said to be good for the body. In the light of this, an individual may require to monitor distance covered during a walk outside a Gymnasium. This could be achieved with the aid of a pocket size device called Digital step-km counter.

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. In a more advance way we can define digital counter as device which connect flip-flops together to perform counting operations. The number of 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 the way they are clocked, these includes ASYNCHRONOUS and SYNCHRONOUS counter. In asynchronous counters otherwise 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. 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 common clock pulse. On the other hand, synchronous counters has the clock input connected to all the flip-flops so that they are clocked simultaneously. The word 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 a 0 or 1 {i.e. at OFF or ON, LOW or HIGH} In the case of a Digital step-km counter, it employ both synchronous and asynchronous counter due to the component and it working nature

1.1.2 *DEVICE PURPOSE*

This device measures the distance covered by an individual during a walk. Hardware is located in a small box slipped in pants' pocket and the display is conceived in the following manner: the leftmost display D2 (the most significant digit) shows 0 to 9km and its dot lights after every 50 meters of walking. The rightmost display D1 (the least significant digit) shows hundreds meters and its dot is always on to separate kilometers from meters. The beeper signals each count unit which occur every two steps. A normal step is approximately 78 centimeters, thus the LED signaling 50 meters light after 64 steps or 32 Mercury switch's operations, the display indicates 100 meters after 128 steps and so on.

1.1.3 *CIRCUIT OPERATION*

IC1A and IC1B form a Monostable Multivibrator providing some degree of freedom from excessive bouncing of the Mercury switch. Therefore a clean square pulse enters IC2 that divide by 64. Q2 lights the dot D2 every 32 pulses counted by IC2 IC3 and IC4 divide by 10 each drives the display. P1 resets the counters and P2 enables the displays. IC1C generates an audio frequency square wave that is enabled for a short time at each Monostable count, Q1 drives the piezo sounder and SW2 gives room to disable the beep.

1.2 LITERATURE REVIEW

In the old 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 here comes the innovation of tape meter which could be used to measure the distance covered. But now, with an improvement in the level of technology, a treadmill machine use in Gymnasium could be used to measure the expected distance covered by an individual while walking on it. This is made possible via an in-built digital counting device which will display the distance covered. The treadmill machine mentioned is my major inspiration on how effective digital counter is, and this eventually prompted my innovation of Digital step-km counter.

Improvement in digital counting technology are centered on and around electrical and electronics innovations. Digital counters take many forms which includes, relays used in Old pinball machines and telephone switching systems, geared machine used in tape recorder counter and Odometer (Milometer). But these days' solid state semiconductor circuits are used mostly in modern electronics counter. Digital counters may be categorized into two types, these are Moore machine and Mealy machine. The simpler one is the Moore machine which could also be called the clock input or pulse input, Whereas Mealy machine has additional inputs that alter the count sequence. Most counters operate in binary number system since binary is simply implemented with electronics 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

Over the years the electrical and electronics engineering need of digital counter have increased tremendously and from all indications the world is going digital. Virtually every modern electronics equipments which are digitally controlled or has digital numeric display, all made up of digital counter

1.2.1 *OBJECTIVES:*

- To design and construct a simple low cost device that measures distance covered during a walk.
- To ease up digital counting devices through the aid of a tilt {Mercury} switch.
- To stimulate students' interest in the growing field of digital counter

1.2.2 *ACCURACY AND PRECISION:*

- The device is not a precision meter, but its approximation's degree was found good enough for this kind of device.

CHAPTER TWO

2.0 THEORY AND DESIGN ANALYSIS

This chapter primary deal with the major sections of this project: the Power supply unit, the Oscillator unit, Control unit, Counter and BCD/ 7-segment unit and the Digital display unit. All subsections are treated on a modular basis for logical flow and ease of comprehension. Each module under each section is analysed and some calculations are included. The block diagram of the ''DIGITAL STEP-KM COUNTER'' is shown in figure 2.0 below.

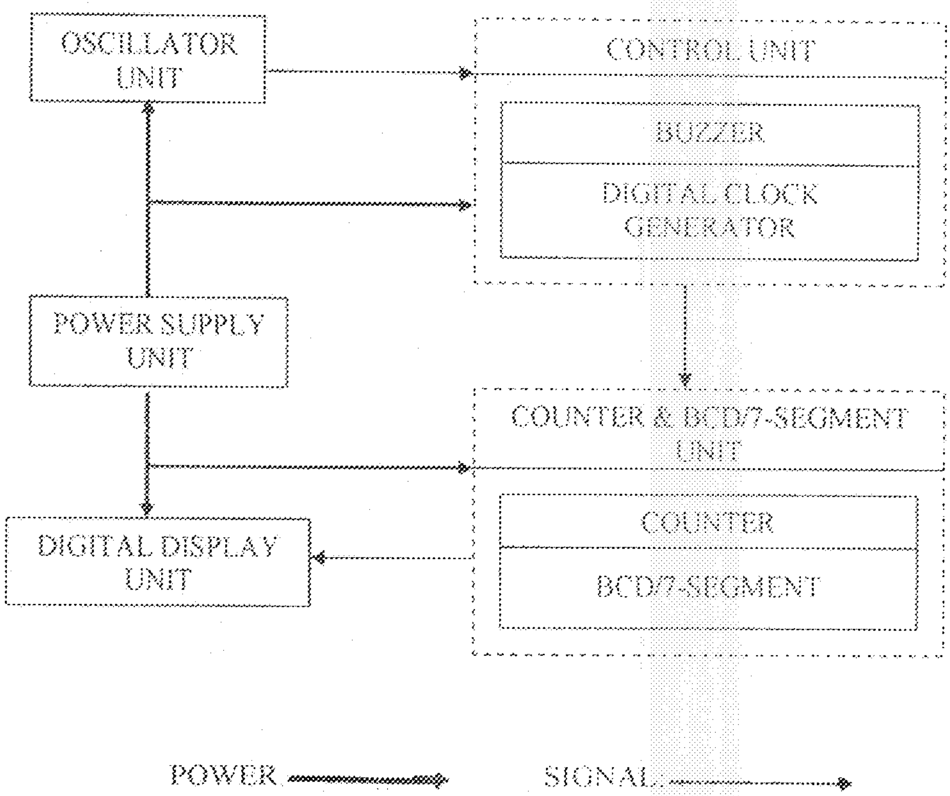
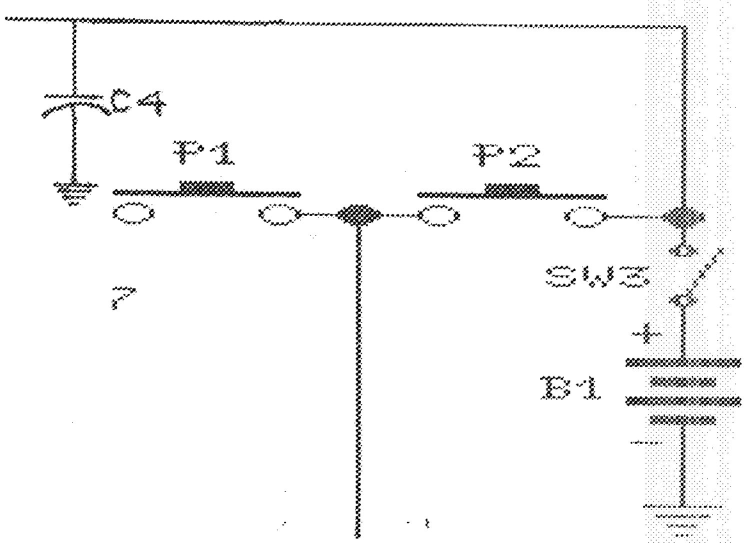


Figure 2.0 Block diagram of the Digital step-km counter

2.1 POWER SUPPLY UNIT

The power supply unit consists of two 2A, 1.5v cells connected in series to give a 3v supply. A single pole single throw (SPST) slider switch is connected in series with the battery to turn OFF and ON the device. Also two "push-to-make" or momentary switch, p1 and p2 are connected in series with the SPST slider switch. Switch p2 is to enable the display in order to ensure low battery consumption. The combination of the two switches (p1 and p2) is to reset the counters. Figure 2.1 below shows the circuit diagram of the Power unit. Capacitor C4 is called a decoupling capacitor. The capacitor absorbs the spikes and keep the Vcc level at each IC constant, thus reducing the likelihood of false triggering and generally, electromagnetic radiation.



P_2 - SPST push button **P_1 –SPST push button**

SW_3 – SPST slider **B1 –3V battery (2A, 1.5v cells in series)**

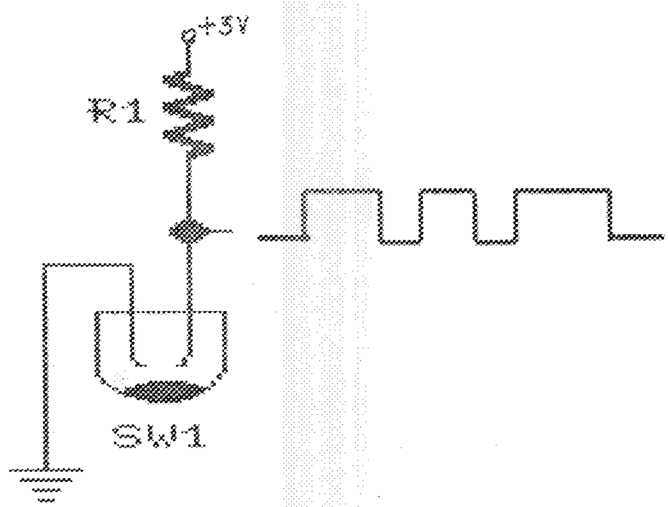
C_4 – Decoupling capacitor (10nF)

Figure 2.1 circuit diagram of the power unit

2.2 THE OSCILLATOR UNIT

An oscillator is an electronic circuit that produces a varying output signal. A sinusoidal oscillator produces sinusoidal signals, while non-sinusoidal signals are generated by a non-sinusoidal oscillator. For example square wave, triangular wave, saw tooth e t. c.

In this project, a tilt switch is used to generate a square wave which will be transmitted by a`` *DIGITAL CLOCK GENERATOR*''. The generation is made possible as a result of the tilt switch to go ''ON'' and ''OFF'' after two steps. Figure 2.2 below shows the circuit diagram of the oscillator



R1=22kΩ

Figure 2.2 circuit diagram of the Oscillator

The mercury switch is a Single Pole Single Throw (SPST), the mercury inside serves as conducting liquid which when tilted; this bridges the conducting element inside. The generated square wave is not uniform due to excessive bouncing of the mercury switch.

2.3 CMOS.

The acronym CMOS stands for Complimentary Metal Oxide Semiconductor. Its 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: 4000B, 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. 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 where they are connected. However, it also means that unconnected inputs can easily pick electrical noise and rapidly 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 0 v or +Vs). This applies even if that part of the chip 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 a 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.

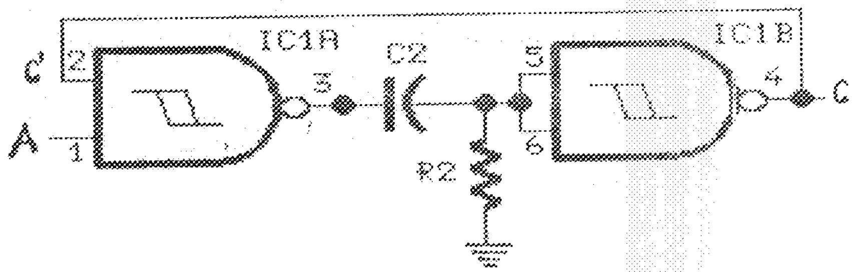
2.4 THE CONTROL UNIT

The control unit of this device is meant to monitor and modify the mechanical action by the mercury switch. This unit could be sub-divided into:

- DIGITAL CLOCK GENERATOR.
- BUZZER UNIT

2.4.1 *DIGITAL CLOCK GENERATOR*

The digital clock generator is used to modify the mechanical action by the mercury switch. It comprises of variation of the flip-flop in which the output of NAND gate IC1A is capacitive coupled to the input of the NAND gate IC1B as shown in figure 2.3 below.



C2=100nF, R2=2M2

Figure 2.3 circuit diagram of the Digital clock generator

The input signal ''A'' is supplied to IC1A,IC1A and IC1B form a MONOSTABLE MULTIVBRATOR providing some degree of freedom from excessive bouncing of the mercury switch. Thereby a clean square pulse ''C'' is generated which enters the 7 stage ripple counter IC (4024). The Monostable flip-flop some time called a ''one shot''

is used to produce a single pulse each time it is triggered. The result is that the circuit sits in one state. If it is forced to the other state by a momentary input pulse, it will return to the original state after a delay time determined by the capacitor (C2) value and the circuit input current. Below is the truth table

A	C'	C
0	0	0
0	1	0
1	0	0
1	1	1

Table 2.0 Truth table of the monostable flip-flop

This action by the Monostable flip-flop is called de-bouncing of a mechanical switch (mercury switch), so that only one is rising and one falling edge occurs for each switch closure. An inverting circuit can also be used to achieve this objective. Fig 2.4 below shows the circuit diagram of the Monostable flip- flop using inverters.

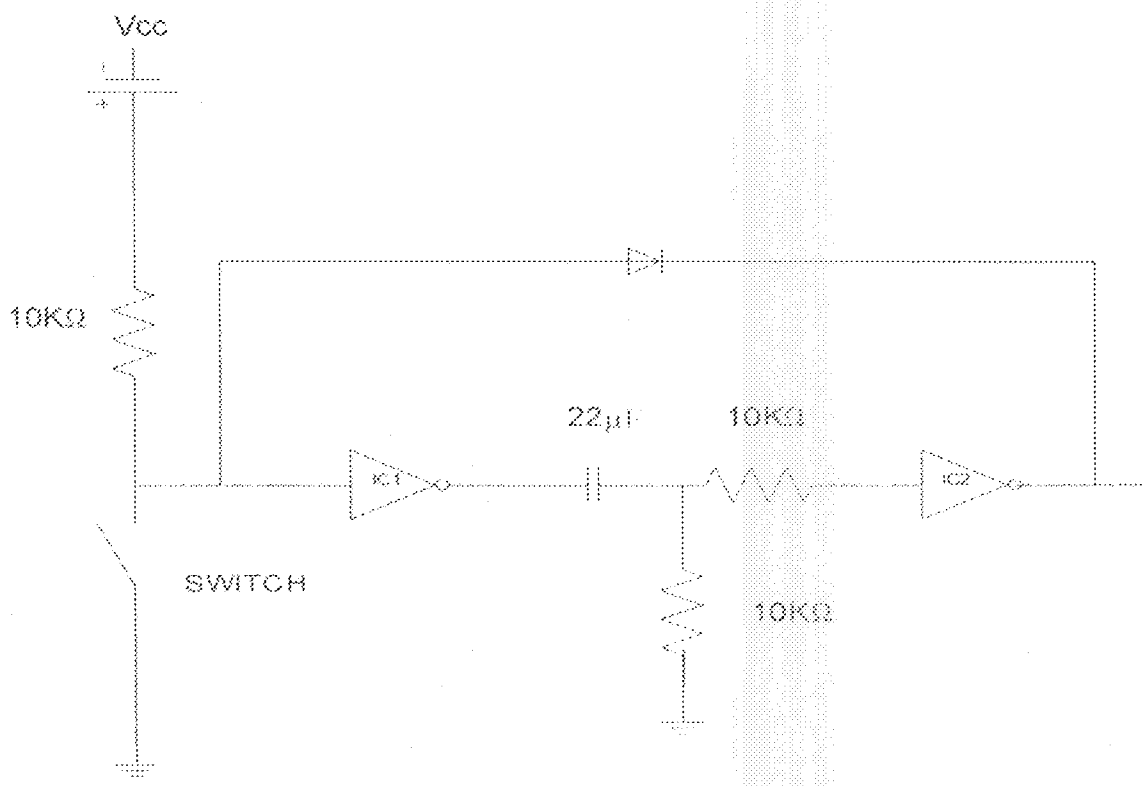
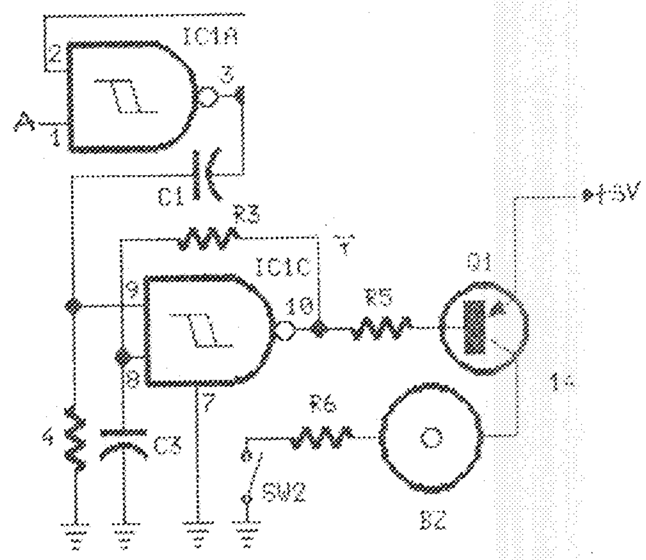


Figure 2.4 circuit diagram of a monostable flip-flop using inverters.

The circuit consists of two logic inverters which are connected by a timing capacitor as shown above. When the switch is closed or input goes negative the capacitor will charge through the resistor generating an initial high level at the input to the second inverter which producers a low output state. The low output state is connected back to the input via a diode which maintains a low input after the switch has opened until voltage falls below ½ Vcc at input of IC_2 at which time the output and input return to a high state. The capacitor then discharge through the grounded 10k Ω resistor and the circuit remains in a stable state until the next input arrives. The 10k Ωresistor in series with the Inverter input IC2 reduces the discharge current through the input protection diode. This resistor may not be needed with a smaller capacitor value.

2.4.2 BUZZER UNIT

This is the monitoring section of the control unit. The circuit diagram is shown in figure 2.5 below.



R3=22K, R4=1MΩ, R5=4K7, R6=47Ω, C1=47nf, C3=10nf, BZ=piezo sounder Q1=BC 327, 45V 800 mA, PNP Transistor, SW2=SPST Slider Switch

Figure 2.5 circuit diagram of the Buzzer unit

Piezo transducers are output transducers, which convert an electrical signal to sound. They require a driver circuit (such as 555 Astable) to provide a signal near their natural or resonant frequency (3 kHz) to produce a sound. They require a small current, usually less than 10mA.The buzzer section of the control unit is to make a sound at each Monostable count. This enables the proper placement of the mercury switch. The action is made possible as result of NAND gates generating an audio frequency (square wave) that is enabled for a short time at each Monostable count. Transistor Q_1 (BC327 45V 800mA PNP) drives the Piezo sounder while the switch (SW) gives room to disable the beep. Trimming the 47Ω resistor will alter or change beeper sound power.

2.5 THE COUNTER AND BCD/7 SEGMENT UNIT.

The counting operation is very important in digital system. There are many type of digital counter, but their basic purpose is to count events represented by changing levels or pulses to generate a particular code sequence. In order to count, the counter must remember the present number so that it can go to the next proper number in sequence. Therefore storage capability is an important characteristic of all counters which is normally implemented with the aid of flip-flops. For this project, both 4024IC and 4026BIC are used for the counting operation.

2.5.1 *COUNTER UNIT*

The counter unit is made up of 7 stage ripple counter or a 7-bit asynchronous counter {4024 IC}, two decade counter with decoded 7-segment display output and display enable{4026B IC}, and NAND gate. The 4024 IC divide the input pulse entering it by 64, while the two 4026B IC drives the corresponding display.

2.5.1.1 4024 IC

This is a 14 pin CMOS integrated circuit (IC). It is a 7 stage ripple counter or a 7-bit asynchronous counter. The pin connection of the IC is shown in fig 2.6 below.

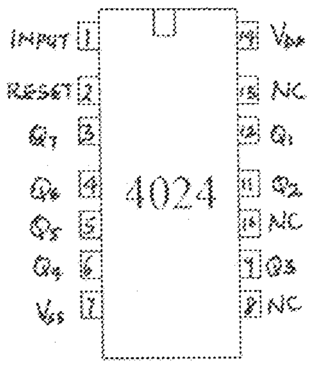
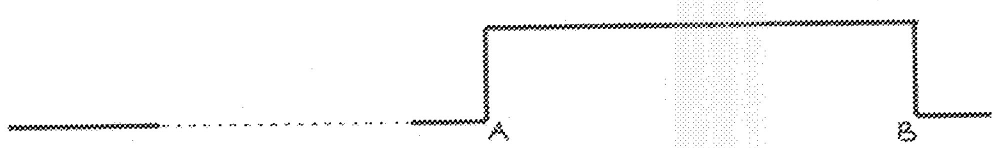


Figure 2.6 pin connection of the 4024 IC

The signal or pulse (square wave) generated by the digital clock generator will be fed into the input pin of the 4024IC. The counting operation is then conceived in the following manner; a normal step is calculated to span approximately 78 centimeters. Thus after 32 mercury switch's operation or 64 steps, 50meters must have been covered (i.e. 78 x 64 = 49.92m). This output will be tapped from pin 4 of the 4024IC, which will light a LED signaling 50 meters. After 128 steps or 64 Mercury switch's operation the LED signaling 100 meters will ON. The counting operation will continue in this format.



A - Coincides with 32 pulses or mercury switch operation counted at the input

B - Coincides with 64 pulses or mercury switch operation counted at the input

Figure 2.7 Signal output at pin 4

Since 64 steps is required for an output from the calculation, therefore Q6 (pin 4) of the 4024IC is where output connection was made. In the light of this, the device used a 6-bit asynchronous ripple counter for its operation.

2.5.1.2 4026B IC

The 4026B is a monolithic integrated circuit fabricated in metal oxide semi-conductor technology available in DIP and SOP packages. The 4026BIC consists of a 5-stage Johnson decade counter and output decoder which converts the Johnson code to a 7 segment decoded output for driving one stage in a numerical display. The IC is suitable for this project because low power dissipation and low package count are of great importance for this device. It is a 16-pin IC which has clock, reset, disable clock, display enabled, not 2 output, carryout, display enable out and 7 decoded output (a-g). Fig 2.7 below shows the pin connection of the IC.

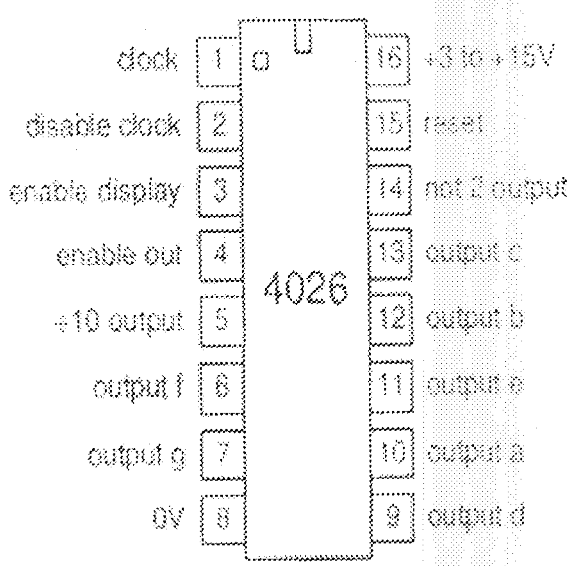


Figure 2.8 pin connection of the 4026B IC

The seven decoded output (a, b, c, d, e, f, g) illuminate the proper segments in a seven segment display device used for representing the decimal numbers 0 to 9. The 7-segment goes high when the "DISPLAY ENABLE IN" is high. When the "DISPLAY ENABLE IN" is low the seven decoded outputs are forced low regardless of the state of the counter. Activation of the display only on request, this will effectively reduce battery consumption. The table 2.1 below shows the pin description of the IC.

PIN NUMBER	SYMBOL	NAME AND FUNCTION
1	CLOCK	Clock input
10, 12, 13, 9, 11, 6, 7	a to g	7-segments decoded outputs
2	DISABLE CLOCK	Clock disable input
15	RESET	Reset input
3	DISPLAY ENABLE IN	Display enable input
5	CARRY OUT	Carry out output
4	DISPLAY ENABLE OUT	Display enable output
14	NOT 2 OUTPUT	Is high unless the count is 2 when it goes low

8	Vss	Negative supply voltage
16	Vdd	Positive supply voltage

Table 2.1 *Pin description of 4026B IC*

The count advances as the clock input becomes high (on the rising-edge). The outputs a-g go high to light the appropriate segments of a 7-segment display as the count advances. The maximum output current is about 1mA with a 4.5V supply and 4mA with a 9V supply. For this project output current is almost 1mA since 3V supply is used. However, this is sufficient to directly drive common-cathode 7-segment LED display. The table 2.2 below shows the segment sequence in detail.

sequence	a	b	c	d	e	f	g
0	1	1	1	1	1	1	0
1	0	1	1	0	0	0	0
2	1	1	0	1	1	0	1
3	1	1	1	1	0	0	1
4	0	1	1	0	0	1	1
5	1	0	1	1	0	1	1
6	1	0	1	1	1	1	1
7	1	1	1	0	0	0	0
8	1	1	1	1	1	1	1
9	1	1	1	1	0	1	1

Table 2.2 *Segment sequence of 4026B IC*

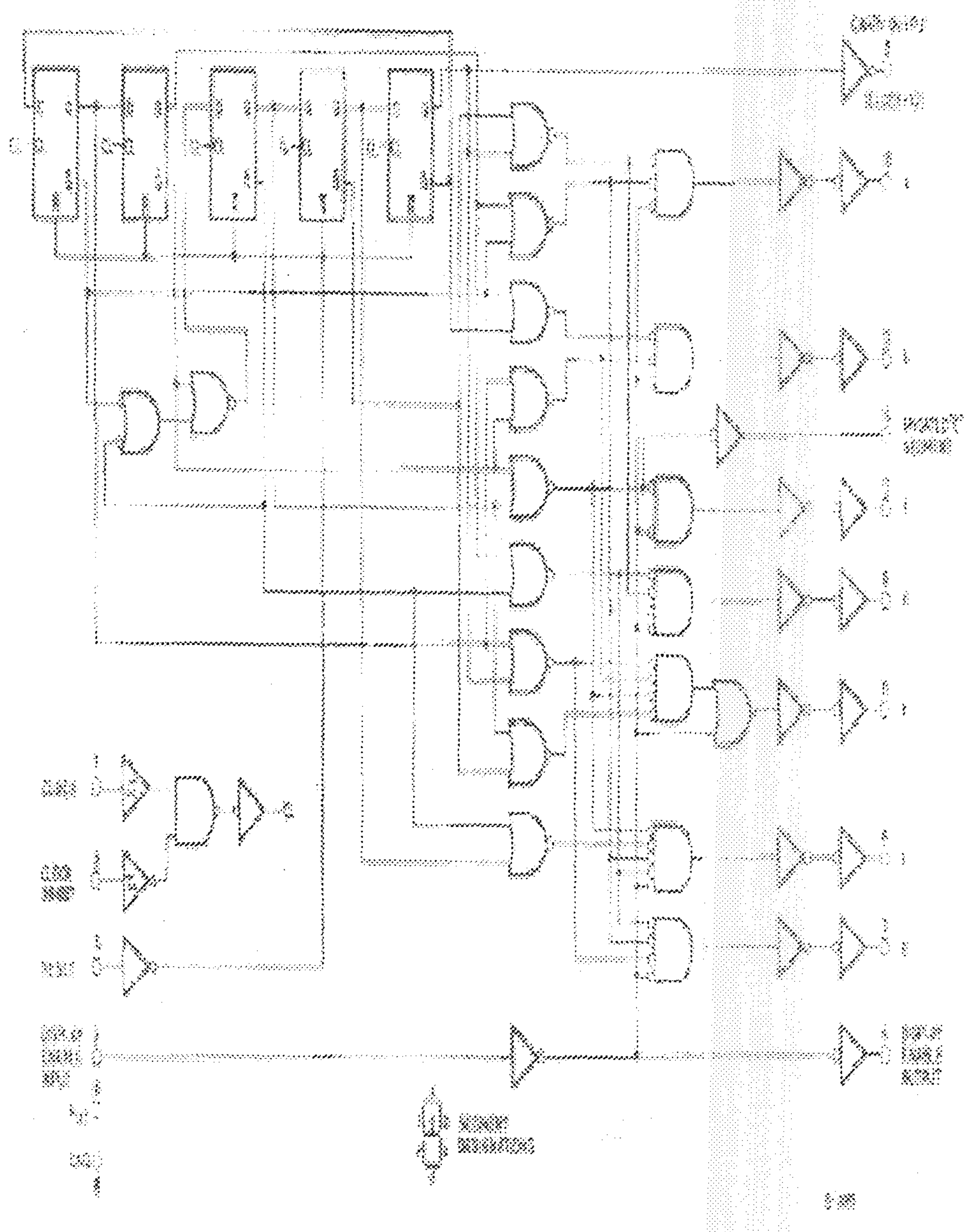


Figure 2.9 logic diagram of a decade counter with decoded 7-segment display output and display enable

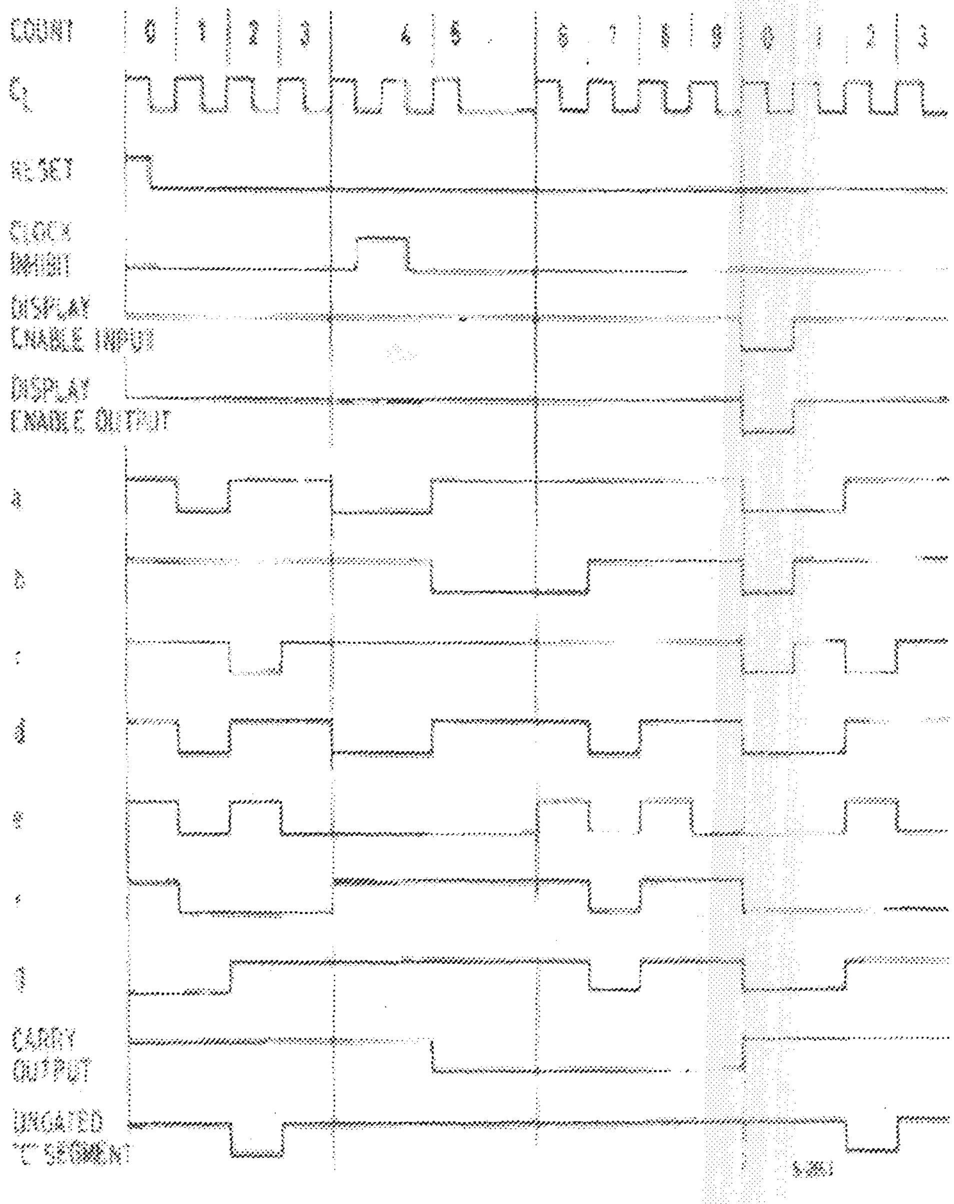


Figure 2.10 timing chart of a decade counter with decoded 7- segment display output and display enable

Conclusively, the combination of 4024IC, NAND gate and 4026BIC is responsible for the counting operation of the COUNTER AND BCD/7 SEGMENT UNIT of the project. The circuit diagram illustrating the combination is shown in figure 2.10 below

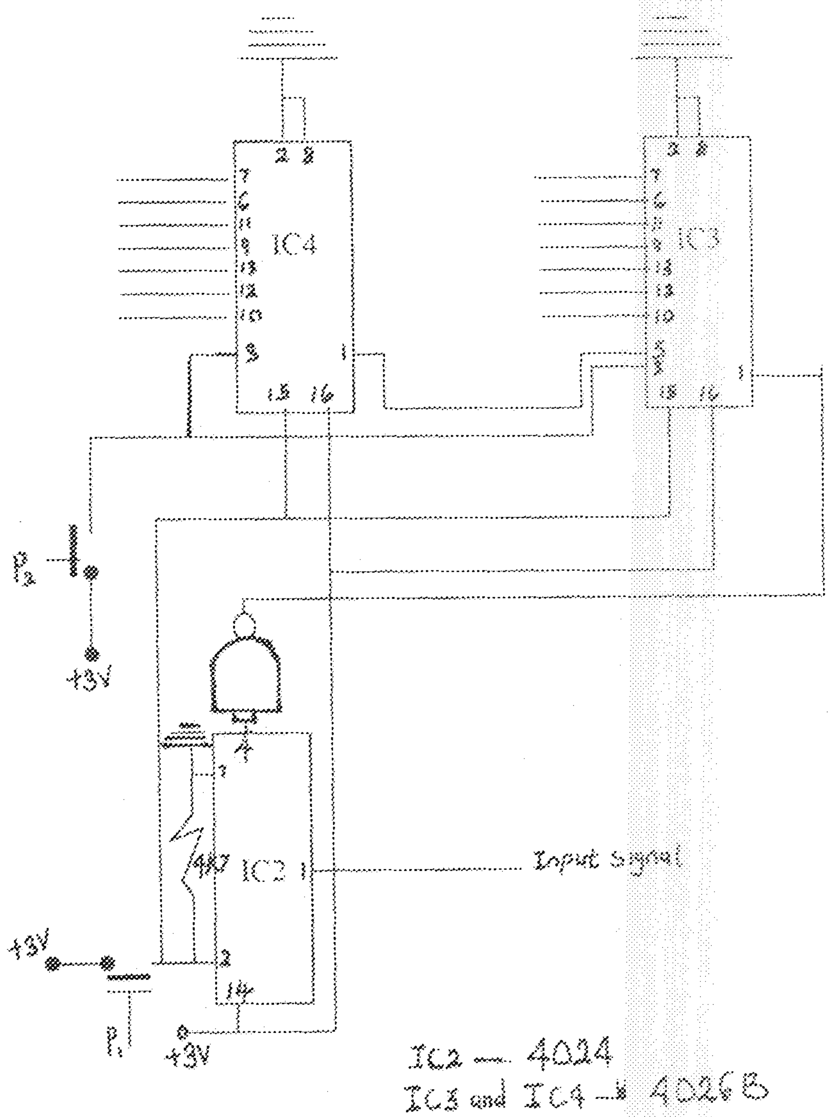


Figure 2.11 *Circuit diagram of the counting unit*

IC3 handles the counting of the least significant digit (LSB), while IC4 handles the counting of the most significant digit (MSB)

2.6 DIGITAL DISPLAY UNIT

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

2.6.1 SEVEN-SEGMENT LED MINI DISPLAY

A seven-segment display consists of seven rectangular LEDs which can form the digits 0 to 9. The seven LED segments are labeled "a" to "g" as shown in Fig 2.12. Each of these segments is controlled through one of the display LEDs. Also on the unit, is a circular LED use to signify decimal point. Seven-segment displays come in two types,

Common-cathode display and Common-anode display.

2.6.1.1 COMMON-CATHODE DISPLAY

In the common-cathode display, the cathode of all the LEDs are joined together and the individual segments are illuminated by HIGH voltages.

2.6.1.2 COMMON-ANODE DISPLAY

In the common-anode display, the anodes of all the LEDs are joined together and the individual segments are illuminated by connecting to a LOW voltage.

In this project, a "common-cathode display is used. Fig 2.12 below shows the pin configuration of a common-cathode seven-segment display.

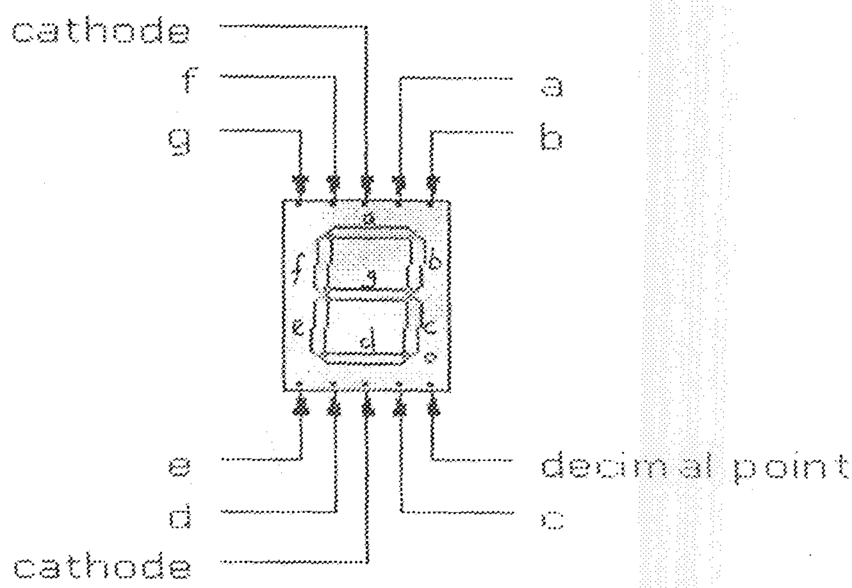


Figure 2.12 pin configuration of a common-cathode seven-segment display.

The internal arrangement of the LEDs in a COMMON CATHODE DISPLAY is shown in figure 2.12 below.

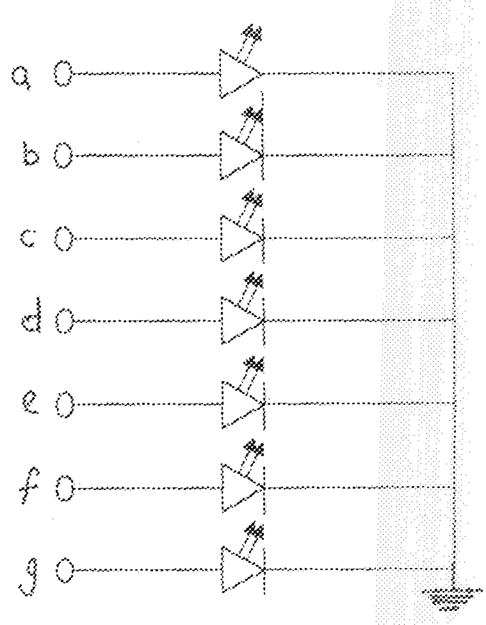


Figure 2.13 internal arrangements of the LEDs in a common cathode display

This seven-segment display LEDs could be driven by any BCD to 7-segment decoders like 4511 IC. But the display is been driven by a 4026B IC. When the 4026B is set up correctly, the outputs follow this truth table shown in table 2.3 below.

sequence	a	b	c	d	e	f	g
0	1	1	1	1	1	1	0
1	0	1	1	0	0	0	0
2	1	1	0	1	1	0	1
3	1	1	1	1	0	0	1
4	0	1	1	0	0	1	1
5	1	0	1	1	0	1	1
6	1	0	1	1	1	1	1
7	1	1	1	0	0	0	0
8	1	1	1	1	1	1	1
9	1	1	1	1	0	1	1

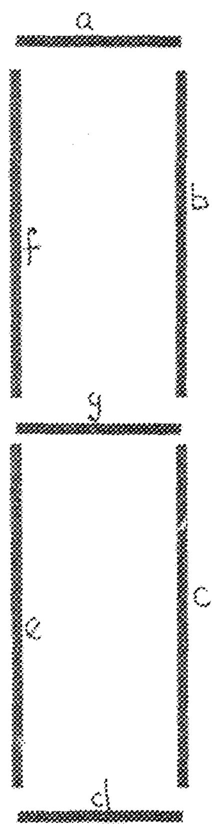
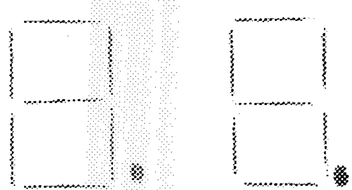
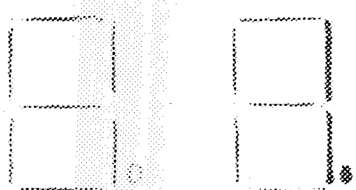
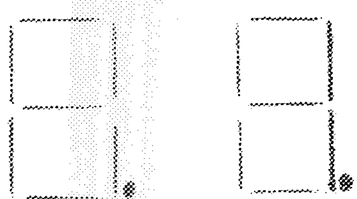


Table 2.3 Outputs from the 4026B counter and display IC

2.7 DISPLAY OPERATION

The digital display unit of this device works as follows: the rightmost display D1 {least significant digit} is to carry out "HUNDREDS READINGS", while the other display is meant to carry out "KILOMETERS READINGS", {i.e. 0 – 9 km}. The dot on the rightmost display is permanently ON while the dot on the other display D2 lights only to indicate a fifty {50} meters covered. In the light of this, the maximum distance this device can measure is 9,950 meters (9.95km) with two digits display. The table 2.4 below gives the detailed explanation on this display operation.

DISTANCE COVERED{METERS}	DIGITAL DISPLAY OUTPUT
50	
100	
150	

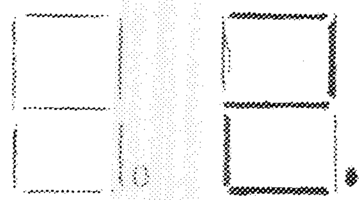
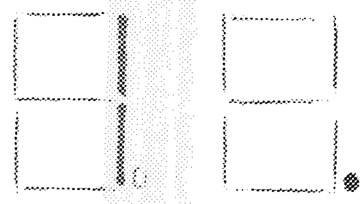
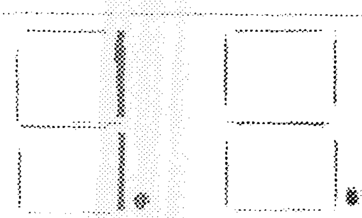
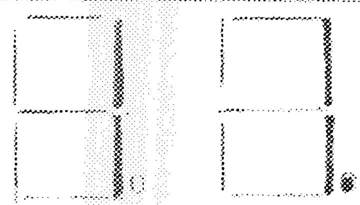
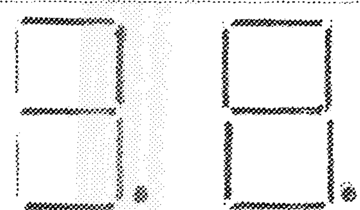
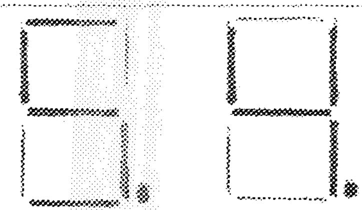
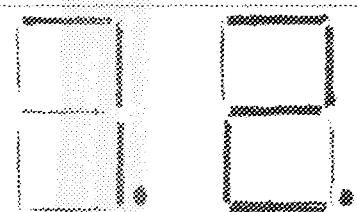
200	
1000	
1050	
1100	
3850	
5450	
7250	

Table 2.4   A table illustrating the display operation.

CHAPTER THREE

3.0 CONSTRUCTION, TEST AND RESULT

In the construction of a digital step-km counter, the design specification of each component was followed strictly except in the case of non-availability of component (mercury or tilt switch).In this case, slight change in design specification was inevitable. The construction includes a prototype on the temporary location (Bread board) and later proper construction of the completed design on the Vero board. Testing was carried out at both stages; results gotten were analyzed to ensure that they were within design error.

3.1 HARDWARE CONSTRUCTION, TESTING AND RESULT.

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

3.1.1 *POWER UNIT*

The power unit consists of two 2A, 1.5V cells connected in series to give a 3V supply. A Single Pole Single Throw (SPST) slider switch in series with the battery to turn ON and OFF the device .Also Included is two "Single Pole Single Throw" (SPST) push button and a decoupling capacitor.

3.1.2 *OSCILLATOR UNIT*

This consists of a 22k resistor connected in series with a mercury or tilt switch. This unit was soldered to the 3V battery supply via the decoupling capacitor.

3.1.3 *CONTROL UNIT*

This consists of three NAND gates, 100nF, 47nF and 10nF capacitors, 47Ω, 1M, 47k and 2.2M resistors, a PNP 45V 800mA transistor, Piezo sounder and a switch. The first NAND gate is connected in series with the mercury switch; also the input is connected to the output of the third NAND gate. The output of the first NAND gate is connected to the inputs of the remaining two NAND gates via their individual coupling capacitors {i.e. 47nF for NAND gate two and 100nF for NAND gate three}.The output of NAND gate three was later connected to the 4024 IC {7 stage ripple counter}, while the output of NAND gate two is connected to the base of a transistor {45V 800mA PNP} via a 4k7 resistor. The transistor which is to drive the piezo sounder is connected to the piezo sounder via its collector, while its emitter is connected to a 3V terminal. The piezo sounder was later grounded via a 47 Ω resistor and a switch connected in series.

3.1.4 *COUNTER AND BCD/7-SEGMENT UNIT*

This section consists of two decade counter with decoded 7- segment display outputs ICs{4026B}, a 7 stage ripple counter IC {4024} and a NAND gate. Each subsection was tested and individual results were gotten before they were finally mounted on Vero board. Since this section is mainly digitally related LED and Digital Multimeter were the testing instruments used. The 7- stage ripple counter was tested on Bread board by connecting LED across the output and it lighted according to 7-bit truth table. The 7-stage ripple counter was therefore soldered on the Vero board. This was followed by the testing of the NAND gate, the NAND gate was tested on Bread board by passing 3 volts at the input. The output was as expected when a LED was connected at its output. Finally the two decade counter were tested by connecting a common-cathode 7-segment LED display at the output while signal was sent to it via the input pin. The expected counting was gotten before the IC was mounted to the Vero board. After every connection had been done and crosschecked for any open or short-circuits, the circuit was tested by connecting the 3V power supply to the device. The mercury switch was tilted for pulse generation. The distance covered was displayed on the 7-segment LED display.

3.2 SOLDERING

Some 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 inputs leads to either positive or negative supply voltage.

3.3 CASING

A wooden casing of convenient size was constructed and used to accommodate the different parts of the project. It was ensured that the casing was robust enough to house the circuit and keep it in good condition. Holes were drilled for heat dissipation. Cuts were also made for fixing the Switches, 7 segments display LEDs, Buzzer and the reset buttons.

CHAPTER FOUR

4.0 CONCLUSION AND RECOMMENDATION

The design and construction of a Digital step-km counter may seem to many people an easy task. However, that was not the case .The assumed notion that technology advancement, availability of components e. t .c. would ease the execution was not really so as discovered at the commencement of the project. The above was due to lack of component required by specification. The retailers of these components were found in most cases to have little or no knowledge of components which could be use as replacements caused some sort of delay and modifications. Nevertheless I was able to make judicious use of what was available to obtain the desired. Thus, with a reasonable degree of economy and efficiency the objectives outlined earlier have been achieved. The Digital step-km counter was constructed and tested.

It will be seriously recommended that any student who will carry out a further work on this project should venture towards using a standard or factory made mercury or tilt switch in order to make the device ready for use. Finally, students are normally limited on projects to work on due to financial constraints and availability of components. It is recommended that the organized private sector and other interested parties take active parts in sponsoring projects like this.

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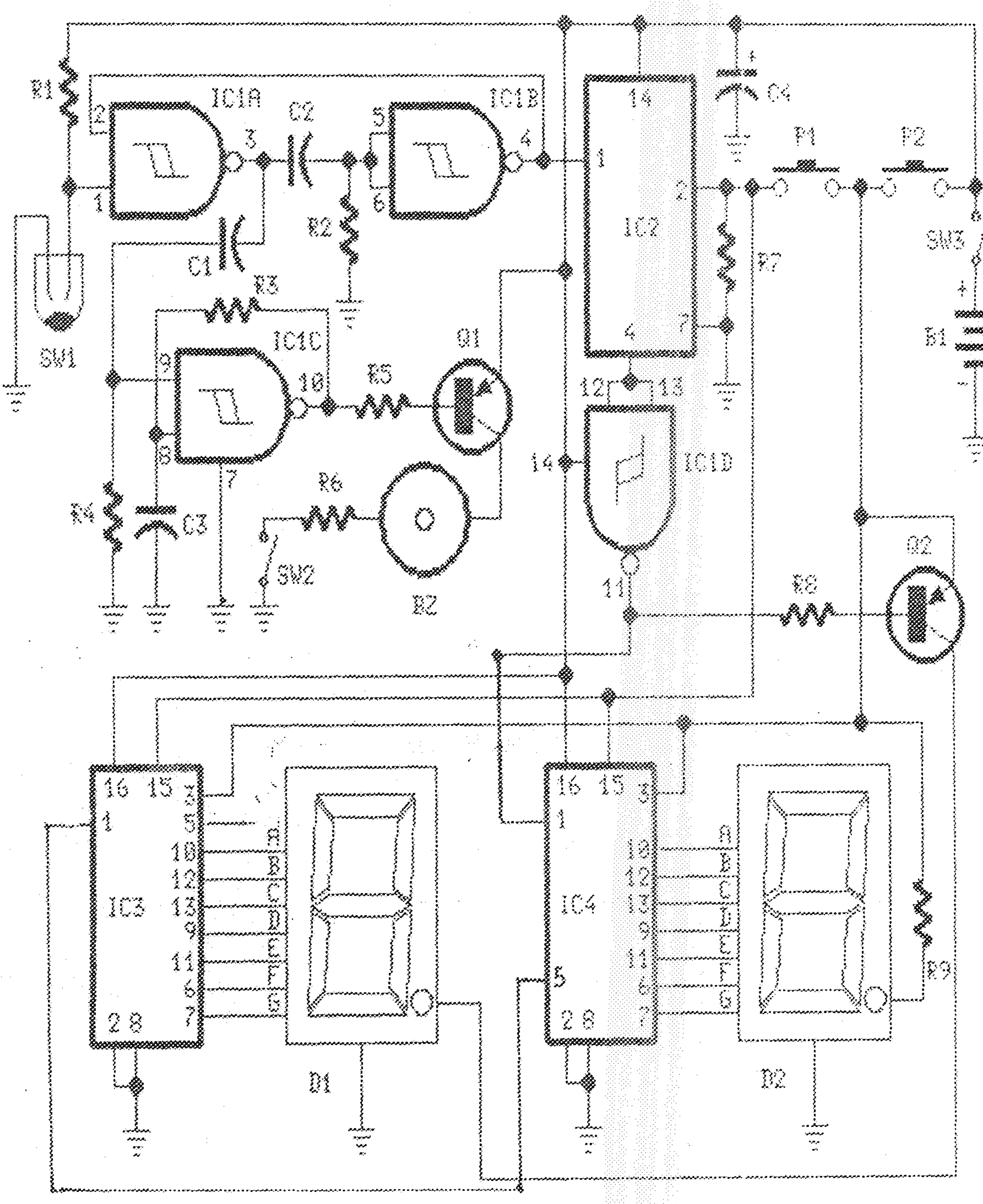
CIRCUIT DIAGRAM OF A DIGITAL STEP-KM COUNTER



APPENDIX

COMPONENTS PARTS:

R1, R3____ 22K 1/4W Resistor — R2____ 2M2 1/4W Resistor

R4____ 1M 1/4W Resistor — R5, R7, R8____ 4K7 1/4W Resistor

R6____ 47R 1/4W Resistor — R9____ 1K 1/4W Resistor

C1____ 47nF 63V Polyester Capacitor

C2____ 100nF 63V Polyester Capacitor

C3____ 10nF 63V Polyester Capacitor

C4____ 10µF 25V Electrolytic Capacitor

D1____ Common-cathode 7-segment LED mini-display (Kilometers)

D2____ Common-cathode 7-segment LED mini-display (Hundreds meters)

IC1____ 4093 Quad 2 input Schmitt NAND Gate IC

IC2____ 4024 7 stage ripple counter IC

IC3, IC4____ 4026 Decade counter with decoded 7-segment display outputs IC

Q1, Q2____ BC327 45V 800mA PNP Transistors

P1____ SPST Pushbutton (Reset)

P2____ SPST Pushbutton (Display)

SW1____ SPST Mercury Switch, called also Tilt Switch

SW2____ SPST Slider Switch (Sound on-off)

SW3____ SPST Slider Switch (Power on-off)

BZ____ Piezo sounder

B1____ 3V Battery (2 AA 1.5V Cells in series)