# MINI PROJECT REPORT

## DIGITAL SPEEDOMETER

**SUBMITTED BY,**

**JOMESH JOSEPH (19)**

**JOSE TOM K (20)**

**VINUPRASAD O M (61)**

**DHANESH PRAKASAN (69)**

**GUIDED BY,**

**SHAMLA B**

**SENIOR LECTURER**

**DEPT. OF ECE**

**GEC THRISSUR**

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# CONTENTS

**ABSTRACT**

The aim of our project is to develop prototype of a product "**Digital Speedometer**". It's used to measure speed up to 999 kmph with a resolution of 1 kmph. It's a hardware project done in the field of Digital Electronics and Instrumentation. It can replace ordinary analog speedometer which has low range and resolution. It's rather inexpensive and can be used in almost all vehicles. It can also be used for measuring speed on industrial machinery and modified version of circuitry can be used as an rpm counter.

This Digital Speedometer is provided for use in an automotive vehicle and includes a transducer for connection to a conventional speedometer cable driver. Transducer is equipped with an IR LED and a photo transistor,that produces pulses in response to the rotational motion of the speedometer cable driver. Pulses are transmitted to a counting circuit which is reset by multivibrator circuits. The number of pulses from the transducer is indicative of speed of the vehicle. It is tabulated by the counting circuits during intervals between reset pulses. The number of counts tabulated during each period is passed to a visual display.

# 1. INTRODUCTION

## 1.1 AIM

The present invention relates to a Digital Speedometer for use with vehicles having internal electrical power supply. In particular, the invention relates to a digital speedometer for automotive vehicles such as auto mobiles, trucks and motor cycles. The Digital Speedometer designed is highly efficient , low cost and can measure speed up to 999 kmph with a resolution of 1kmph.

## 1.2 AREA OF PROJECT

It's dealing with Digital Electronics Circuits and Instrumentation. The main sections of the circuitry are IR section, Comparator, Timer, Counter, Latching section and LED display.

## 1.3 MOTIVATION

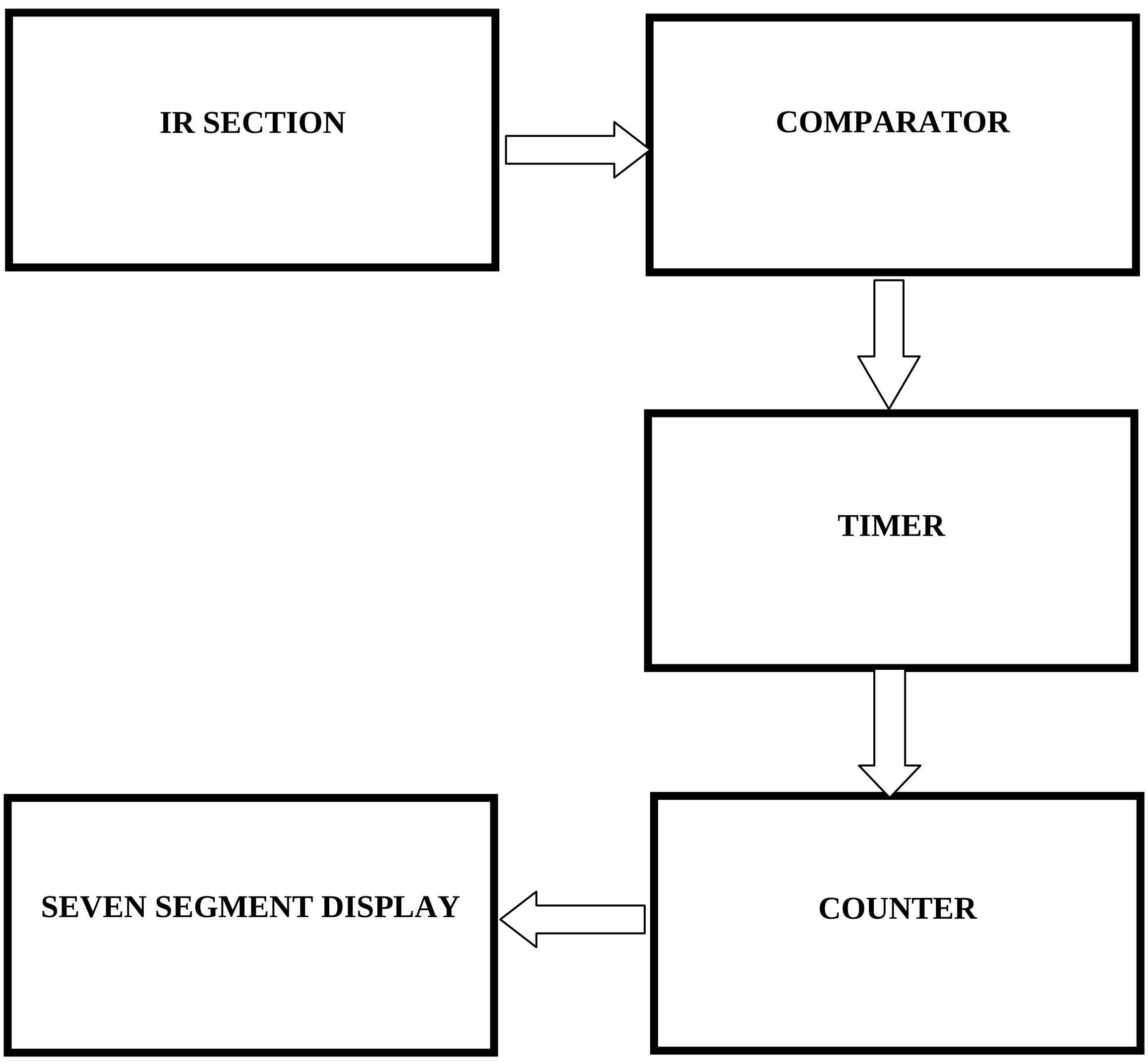
The aim of our experiment is to create an efficient low cost Digital Speedometer. It was inspired by the fact that most of the modern-day vehicles use analog speedometers which have resolution of about 5kmph and the range is also limited.

Historically auto motive vehicles have been provided with mechanical speedometers in which rotation of wheel of the vehicle or of a drive component of the transmission is transmitted as a torsional impulse the torsional force applied to the cable is typically transmitted to needle in the instrument panel which is deflected across a scale to indicate speed at which vehicle is travelling. The Principal dis advantage with such systems has been the requirement for a signal generating system independent of the conventional mechanical speedometer system associated with the auto mobile. It increases the cost of the vehicle.

The Digital Speedometer we have designed can measure up to a speed of 999kmph with a resolution of 1kmph. It's rather inexpensive and can be used in almost all vehicles.

# 2. DETAILED DISCUSSION

## 2.1 BLOCK DIAGRAM



### 2.1.1 INPUT SECTION

Input Section consists of IR LED, photo transistor, a comparator and a mechanical section. An opaque disc is mounted on the spindle attached to the front wheel of the vehicle. This disk has ten equidistant holes on its periphery. On one side of the disc an Infrared LED is fixed and on opposite side of the disc, in line with the IR LED, a phototransistor is mounted. IC LM324 is wired as a comparator.

### 2.1.2 TIMER SECTION

Timer section consists of astable and monostable multivibrator circuits. So we use IC 556 for this purpose. Astable section is used to trigger the monostable multivibrator. IC 7400(AND gate) is used to set the gating period.

### 2.1.3 OUTPUT SECTION

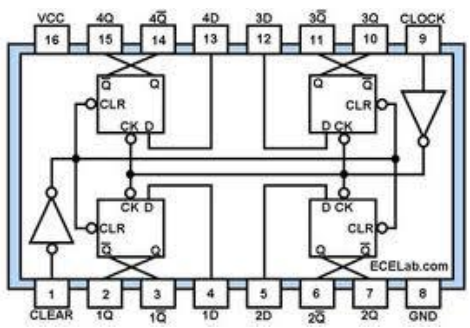
Output section consists of counter and latching sections along with LED display. IC 7490 is used to implement the counter section. The number of pulses counted during the gating period is the speed N in kmph. IC 74175(Quad D flip-flop) is used as the latching circuit. It helps in keeping the LED display constant for a particular period of time so that displayed value could be read. IC 7447 is used as BCD to seven segment decoder. Common anode LEDs are used in the output section to view the speed measured.

## 2.2 COMPONENT DETAILS

### IC 74175

IC 74175 is a quad, edge-triggered D-type flip-flop with individual D inputs and both Q and Q out puts. The common buffered clock (CP) and Master Reset (MR) inputs load and reset (clear) all flip flops simultaneously.

| **TYPE** | **TYPICAL $f_{max}$** | **TYPICAL SUPPLY CURRENT** |
|---|---|---|
| **74175** | **35 MHz** | **30 mA** |
| **74LS175** | **40MHz** | **11mA** |
| **74S175** | **110MHz** | **60mA** |



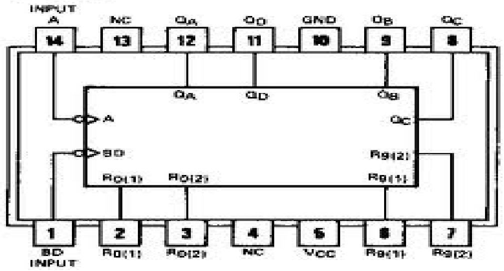
**(Fig.1)**

### IC 7490

IC 7490 is a monolithic counter contain four maser-slave flip flops and additional gating to provide a divide by two counter and a three stage binary counter for which the count cycle length is divided byfive. It has gated zero reset.

| | |
|---|---|
| Supply voltage | 7 V |
| Input voltage | 5.5 V |
| Inter emitter voltage | 5.5 V |

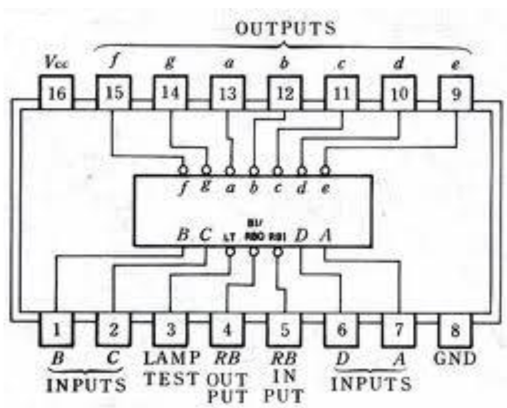
| | |
|---|---|
| Operating temperature | 0 to 70'C |
| Storage temperature | -65 to 150'C |



**(Fig.2)**

## IC 7447

It's a decoder driver IC used to drive a seven segment indicator. There are two types of decoder drivers suitable to two types of seven segmented displays. Logic circuit inside the 7447 convert the 4 bit BCD input to seven bit output which are active low.



**(Fig.3)**

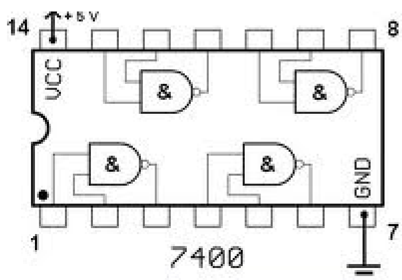
| TYPE | ACTIVE LEVEL | OUTPUT CONFIGURATION | SINK CURRENT | MAX VOLTAGE | TYPICAL POWER DISSIPATION |
|---|---|---|---|---|---|
| SN7447 | LOW | OPEN-COLLECTOR | 40mA | 15 V | 320mW |

## IC 7400

It's output will be 'low' if all the inputs are in 'high' state. IC 7400 is a Quad 2 input NAND gate.
It's logic diagram and functional table are shown below.

FUNCTION TABLE
(each gate)

| INPUTS | | OUTPUT |
|---|---|---|
| A | B | Y |
| H | H | L |
| L | X | H |
| X | L | H |



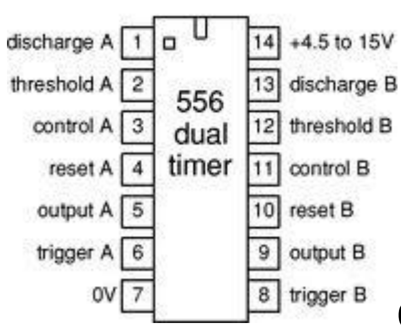


**(Fig.4)**

| PARAMETER | MINIMUM | NORMAL | MAXIMUM |
|---|---|---|---|
| VCC | 4.75 | 5 | 5.25 |
| VIH | 2 | - | - |
| VIL | - | - | 0.8 |
| IOH | - | - | -0.4 |
| IOL | - | - | 16 |
| TA | 0 | - | 70 |

## IC 556

This device provide two independent timing circuits of the NA555, NE555, SA555 or SE555 type each package. These circuits can be operated in the astable or monostable mode with the external resistor capacitor timing control .



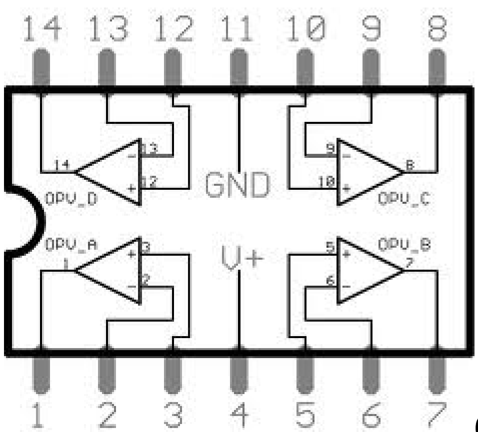

**(Fig.5)**

**FUNCTION TABLE**
**(each timer)**

| RESET | TRIGGER VOLTAGE(1) | THRESHOLD VOLTAGE(1) | OUTPUT | DISCHARGE SWITCH |
|---|---|---|---|---|
| Low | Irrelevant | Irrelevant | Low | On |
| High | <1/3 $V_{DD}$ | Irrelevant | High | Off |
| High | >1/3 $V_{DD}$ | >2/3 $V_{DD}$ | Low | On |
| High | >1/3 $V_{DD}$ | <2/3 $V_{DD}$ | As previously established | |

## IC LM 324

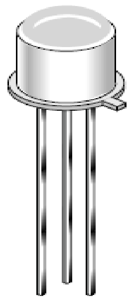
These devices consists of four independent high gain frequency compensated op-amps that are designed specifically to operate from a single supply over a wide range of voltages.

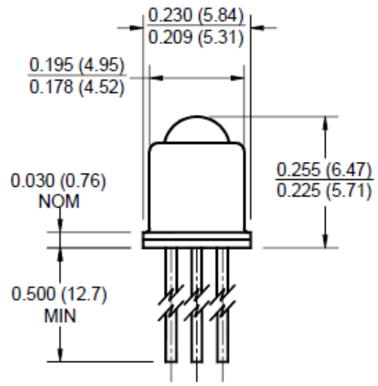


**(Fig.6)**

Applications include transducer amplifiers, dc amplification block and all the conventionasl operational amplifier circuits that can be more easily impemented in single supply voltage systems.

## PHOTO TRANSISTOR






(Fig.7)

**IR LED**

## 2.3 PRINCIPLE AND WORKING

This instrument displays the speed of the vehicle in kmph. An opaque disc is mounted on the spindle attached to the front wheel of the vehicle. This disk has ten equidistant holes on its periphery. On one side of the disc an Infrared LED is fixed and on opposite side of the disc, in line with the IR LED, a phototransistor is mounted. IC LM324 is wired as a comparator.

When a hole appears between the IR LED and phototransistor, the phototransistor conducts. Hence the voltage at collector of phototransistor and inverting input of LM324 go 'low', and thus output of LM324 becomes logic 'high'. So rotation of the speedometer cable results in a pulse at the output of LM324, The frequency of this waveform is proportional to the speed.

Let 'N' be the number of pulses in time 't' seconds and numerically equal to the number of kilometer per hour (kmph).

For vehicle with a wheel circumference of 1.38 meters, and number of pulses equal to

10 per revolution, we get the relationship:

(N pulses)/t = N kmph

= (N×1000)/(3600×1.38) m/s

= (N×1000×10)/(3600×1.38) pulse per second.

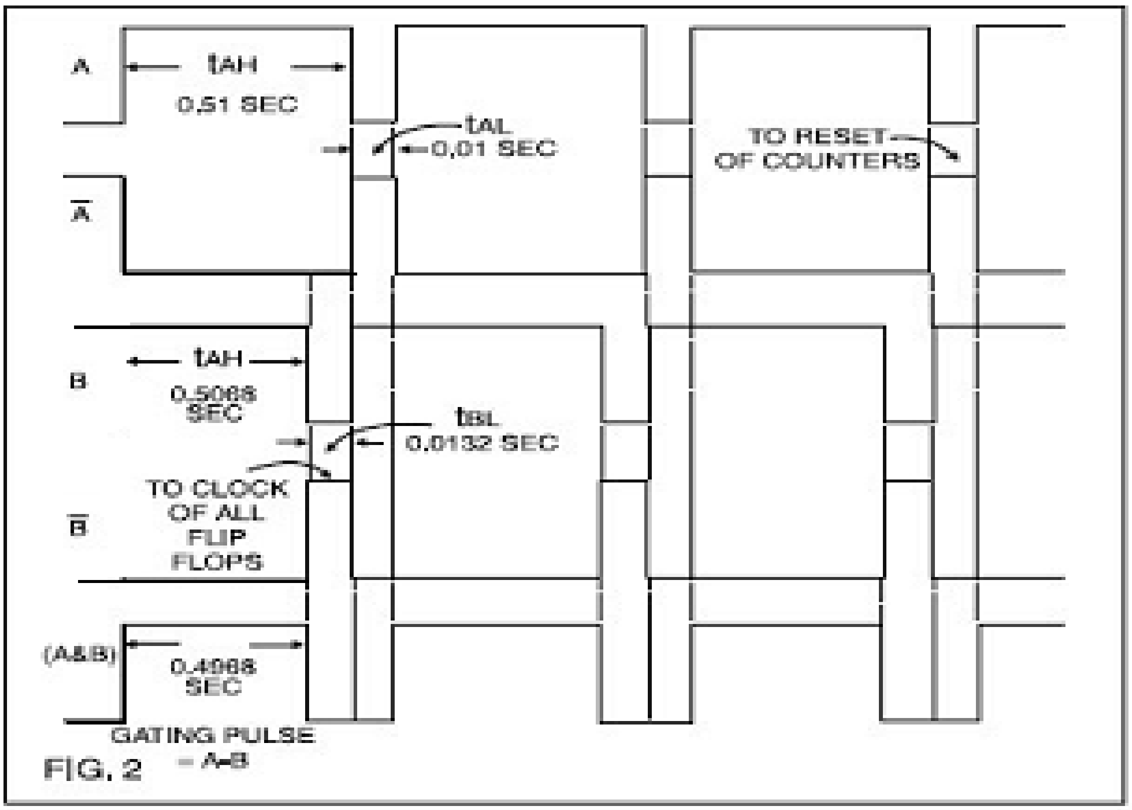
Therefore, time 't'= 0.4968.

As shown in timing diagram, at t=0, output of astable flip-flop IC1(a) goes low and triggers monostable multivibrator IC1(b). Pulse width of monostable multivibrator IC1 (a), ton =0.513 and toff = 0.01 sec. The outputs of IC1 (a) and IC1(b) and the signal from the transducer section are ANDed. The number of pulses counted during the gating period is the speed N is kmph.

At the end of gating period, output 'B' of monostable IC1(b) goes low and $\overline{B}$ goes high. The rising edge of $\overline{B}$ is used to enable the quad 'D' flip-flops 74175.

At this instant, ie at t=0.5068, the number (speed) 'N' will be latched corresponding to the ‘D’ flip-flops and displayed. At t= 0.510, output of astable flip-flop IC1(a) goes low and remains low for 0.01 sec. This waveform is invented and applied to the reset terminals of the all counters (active-high).

Waveforms as shown below,




**(Fig.8)**

Thus the counters are rest and counting begins afresh at t=0.520. up to the time t=0.520 + 0.5068 sec. However the ‘D’ flip-flops are not enabled and the previous speed is displayed. The new speed is displayed at t= 0.520+0.5068 sec. In this way speed will be updated every 0.520 sec. This speedometer can measure up to 999kmph with a resolution of 1kmph.

# 3 DESIGN AND IMPLEMENTATION

## 3.1 DESIGN

Gating Period:

Let 'N' be the number of pulses in time 't' seconds and numerically equal to the number of kilometer per hour (kmph).

For vehicle with a wheel circumference of 1.38 meters, and number of pulses equal to 10 per revolution, we get the relationship:

(N pulses)/t = N kmph

= (N×1000)/(3600×1.38) m/s

= (N×1000×10)/(3600×1.38) pulse per second.

Therefore, time 't'= 0.4968.

Input Comparator Section:

For the comparator, resistance values are determined by the voltage divide rule. Equal voltage (2.5V) are assumed across the + and – terminal. Thus we use 56K at the positive terminal. In order to obtain perfect output we used a 1M potentiometer at the collector of phototransistor.

Astable and Monostable Multivibrator Section:

For astable multivibrator, $t_{on}$ = 0.693.(R1+R2).C = 0.51 Sec

Let R2= 1K and C= 10μF.

Thus we get, R1= 72.9 K. So we use 100 K potentiometer.

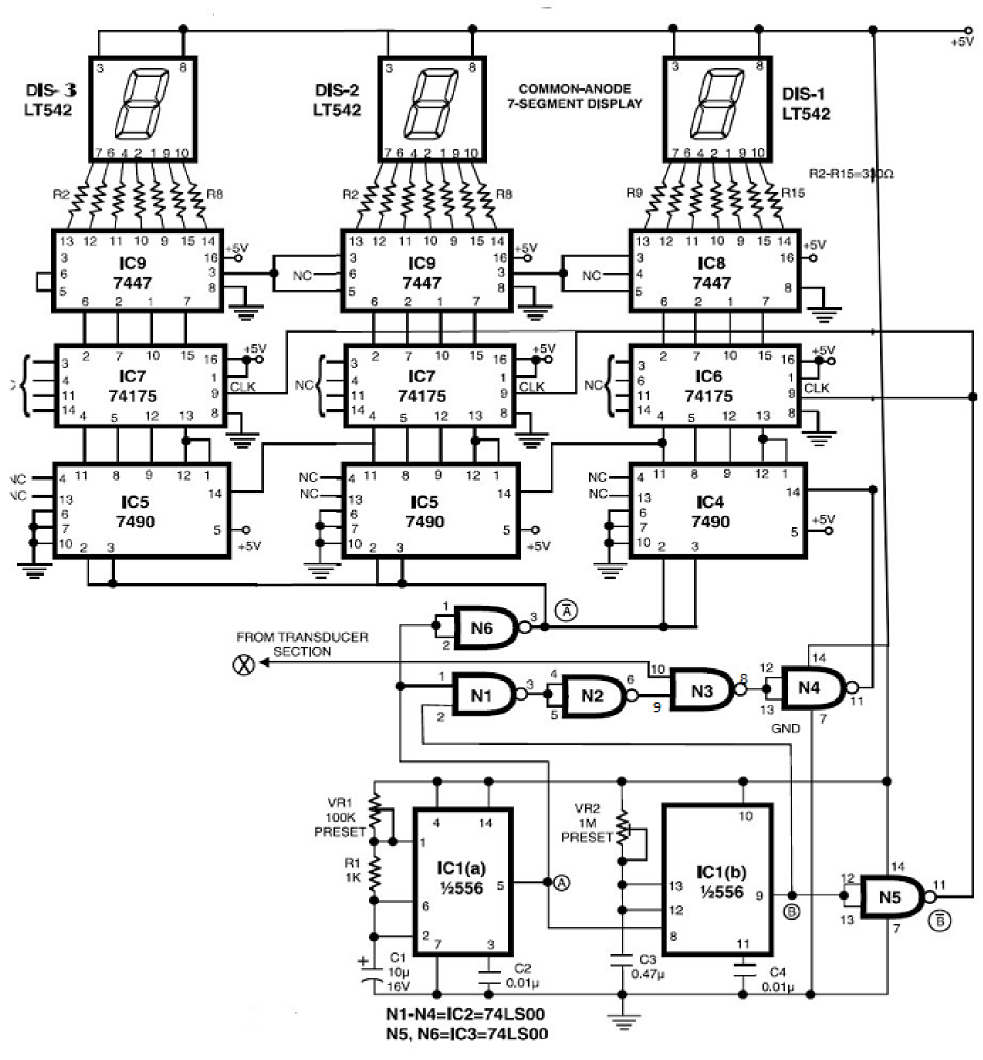
For monostable multivibrator, T= 1.1RC = 0.4968

Let C= 0.47μF.

Thus we get, R=960.9K. So we use 1M potentiometer.

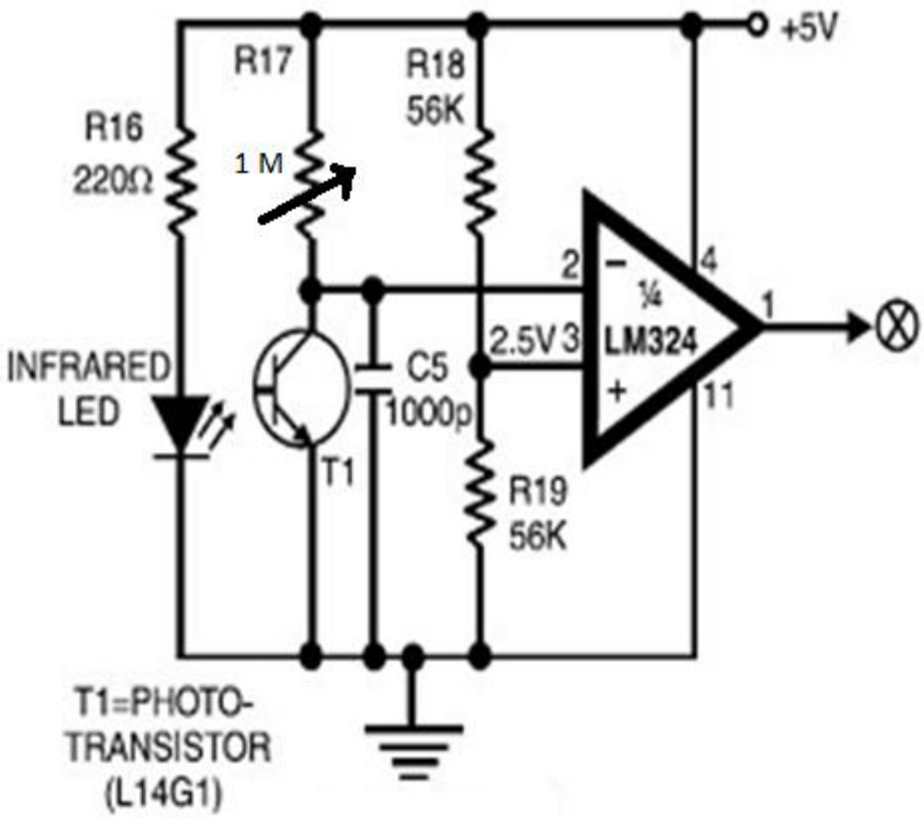
## 3.2 IMPLEMENTATION

### 3.2.1 MAIN CIRCUITRY



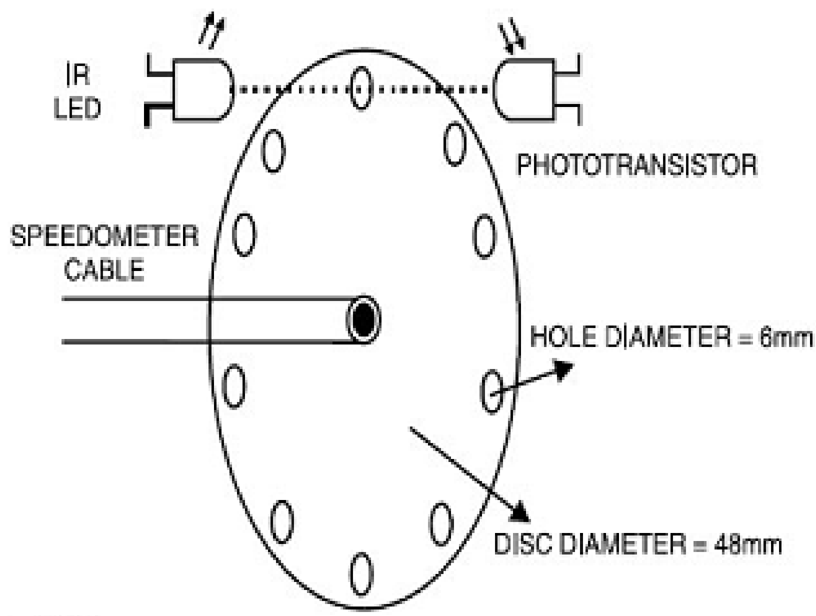

**(Fig.9)**

### 3.2.2 INPUT SECTION



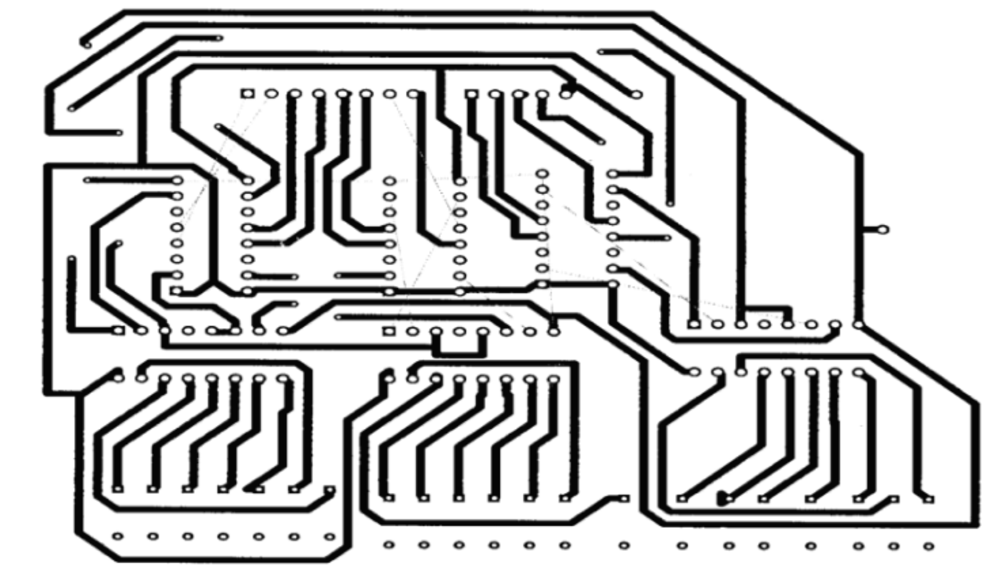

**(Fig.10)**

### 3.2.3 MECHANICAL ARRANGEMENT

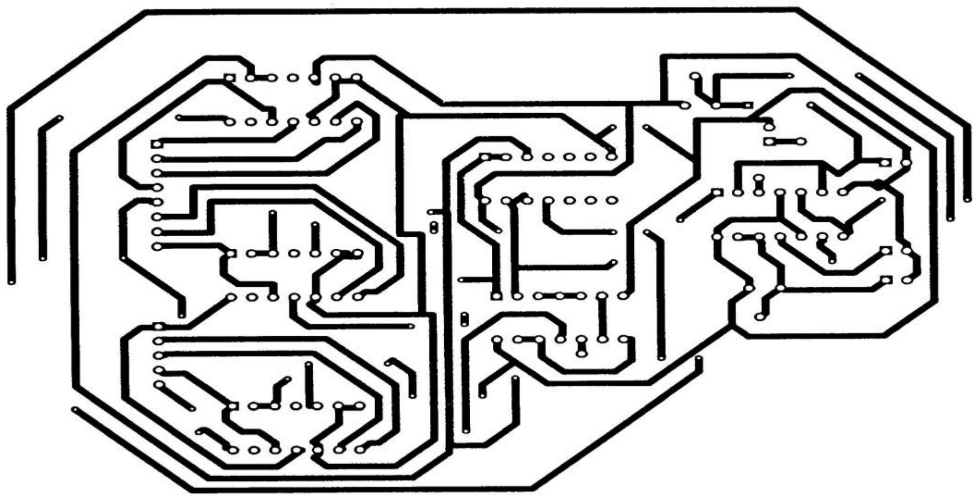



**(Fig.11)**

### 3.2.4 PCB LAYOUT



**(Fig.12)**



**(Fig.13)**

### 3.3 COST OF PRODUCTION

| SL NO. | COMPONENT | SPECIFICATION | QUANTITY | COST (RS) |
|---|---|---|---|---|
| 1. | DECODER IC | 7447 | 3 | 45 |
| 2. | D-FLIP FLOP | 74175 | 3 | 45 |
| 3. | BCD COUNTER | 7490 | 3 | 45 |
| 4. | NAND GATE | 7400 | 2 | 20 |
| 5. | COMPARATOR | LM 324 | 1 | 10 |
| 6. | IR LED | | 1 | 1 |
| 7. | PHOTO TRANSISTOR | | 1 | 50 |
| 8. | 7- SEG. DISPLAY | LT 542 | 3 | 15 |
| 9. | RESISTORS | | 27 | 5 |
| 10. | CAPACITORS | | 4 | 5 |
| 11. | PRESET | 100K, 1M | 2 | 10 |
| 12. | MOTOR | 12V DC | 1 | 100 |
| 13 | LED | | 5 | 5 |
| 14. | MISCELLANEOUS | | | 300 |
| | | END | COST | 656 |

## 4. HURDLES FACED

Fluctuation in display while starting.

Alignment of potentiometer is very difficult

## 5. APPLICATION

It can be used in almost all vehicles.

It can be used for industrial machinery speed measurement.

By modification in the circuitry can also be used as rpm counter and odometer.

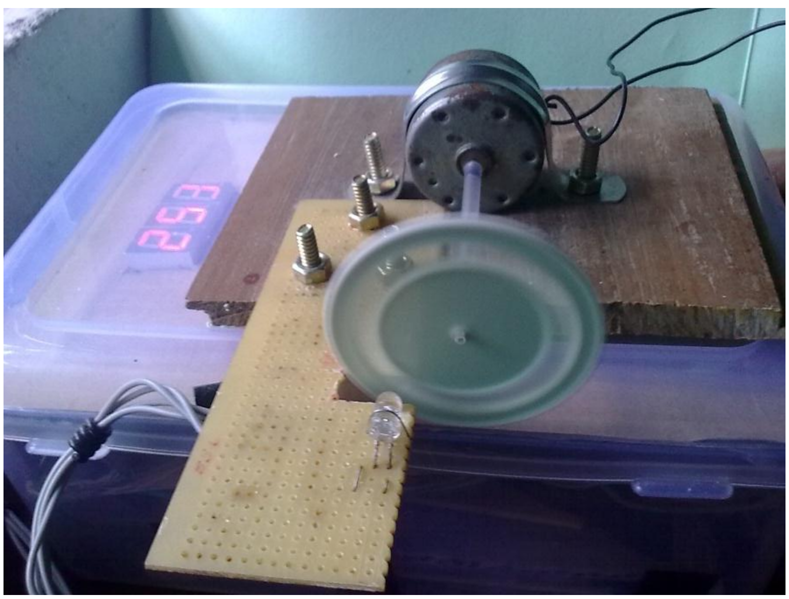
## 6. CONCLUSION

An efficient low cost digital speedometer which can measure speed up to 999kmph with a resolution of 1kmph has been designed.

Resolution can be improved by using additional displays.

Circuit can be modified using microcontroller and LCD display.

**PROJECT VIEW**



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