ABSTRACT

A Tachometer is a device which measures the speed of a rotating object like an electric motor or a crank shaft of a vehicle engine. Speed of an electric motor is determined by the number of revolutions made by the motor in one minute. In other words, speed is measured in RPM (Revolutions per Minute). Here, in this project, we designed a simple Non – Contact or Contactless Digital Tachometer using 8051 Microcontroller,

The basic principle behind the Contactless Digital Tachometer involves a simple embedded system with a sensor, a micro controller and a (16*2) LCD. The sensor used here is Infrared (IR) transmitter – receiver pair, the controller used is the 8051 Microcontroller (AT89S52) loaded with a compiled code and the actuator is a display device, for displaying the speed of the motor.

In this device the speed will be measured in a pre specified time delay of 1 sec and thereby we can plot a graph between speed and time more accurately and since we have set a time delay of 1 sec between two consecutive speed readings of a motor and hence the curve obtained will be a smooth one.

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CHAPTER 1

1.1 INTRODUCTION

1.1.1 What is a Tachometer?

The word tachometer is derived from two Greek words: tachos means "speed" and metron means "to measure". It works on the principle of a tachometer generator, which means when a motor is operated as a generator, it produces the voltage according to the velocity of the shaft. It is also known as revolution-counter, and its operating principle can be electromagnetic, electronic or optical-based. Power, accuracy, RPM range, measurements and display are the specifications of a tachometer. Tachometers can be analog or digital indicating meters; however, this article focuses only on the digital tachometers.

1.1.2 Types of Digital Tachometer

Digital tachometers are classified into four types based on the data acquisition and measurement techniques.

Based on the data acquisition technique, the tachometers are of the following types:

1. Contact type
2. Non-Contact type

Based on the measurement technique, the tachometers are of the following types:

1. Time measurement
2. Frequency measurement

1. Contact Type Digital Tachometer

A tachometer which is in contact with the rotating shaft is known as contact type tachometer. This kind of tachometer is generally fixed to the machine or electric motor. An optical encoder or magnetic sensor can also be attached to this so that it measures its RPM.

Digital Tachometers are capable of measuring low-speeds at 0.5 rpm and high speed at 10,000 rpm and are equipped with a storage pocket for the circumferential measurement. The specifications of this tachometer are LCD 5 digit display, operational temperature range of 0 to + 40oC, temperature storage range of – 20 to + 55o C and rotating speed of about 0.5 to 10,000 rpm.

2. Non-Contact Type Digital Tachometer

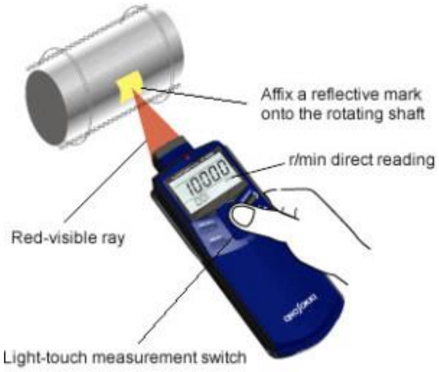


Fig 1. Non-Contact type Digital Tachometer

A tachometer that does not need any physical contact with the rotating shaft is called as noncontact digital tachometer. In this type, a laser or an optical disk is attached to the rotating shaft, and it can be read by an IR beam or laser, which is directed by the tachometer.

This type of tachometer can measure from 1 to 99,999 rpm; the measurement angle is less than 120 degrees, and the tachometer has a five-digit LCD display. These types of tachometers are efficient, durable, accurate, and compact, and also visible from long distance.

1.1.3 Motive of the project

The main idea of doing this project is to determine the speed of a direct current motor and to plot a graph between speed and time. By using this contact-less tachometer we can perform the retardation test and in order to perform this test more efficiently we can use this device. In case of a contact based tachometer there is possibility of human error while taking the simultaneous readings of speed and time.

In this device we have set a time delay of 1 second between two consecutive readings and hence the graph obtained between speed and time will be smooth.

CHAPTER 2

2.1 PRINCIPLE OF CONTACT LESS TACHOMETER

Contact-less digital tachometer by using 8051 microcontroller can be used for measuring the revolutions of a wheel, disc, shaft etc.

This circuit uses various components, such as microcontroller, photo transistors, op-amps, seven segments LED display, and other miscellaneous components. In addition to this, a sensor is placed near the reflective strip – for instance, an aluminium foil that is fixed on to the rotating surface. The LED directed from this device gets reflected as the strip is detected by the photo transistor.

Op-amp LM 324, as a comparator, compares this transistor collector's voltage with the fixed voltage. Therefore, it generates continuous pulses for the rotation of the shaft. These trains of pulses are applied to the microcontroller, which then counts them and converts them into RPM as programmed. Furthermore, they are displayed in a seven-segment display, which is connected in the transistor-driven common anode configuration.

2.2 WORKING PRINCIPLE

The working principle of a contact less tachometer is based on the time interval calculation with the help of microprocessor. To calculate the RPM we are transmitting an infra-red (I.R) light on the surface of the wheel (rotating surface). The color of the wheel has to be dark enough to absorb the infra-red light. A bright line or a small surface with a color which can reflect the infra-red light has to be placed on the wheel. When the infra-red light falls on the dark surface the light is not returned back. In order to receive the light we are using an infra-red photo diode. The current which passes through this photo diode is very low which cannot be directly fetch to the I/O pin of the microprocessor hence an operational amplifier is used to amplify the signal as well as to convert the current into voltage. So that from the non-inverting output terminal of the operational amplifier we can get a sharp high or low pulse.

The output terminal of the operational amplifier is connected to the I/O pin of the microprocessor. The program executing in the microprocessor is responsible for the identification of the first pulse from the sensor. Whenever it gets the first pulse from the sensor it starts the timer and waits until it gets the second pulse whenever it gets the second pulse it stops the counter and calculate the duration between the first and second pulse from the TH0 and Tl0 register.

The time duration is then converted into number of pulse per minute.

After calculating the RPM, the data is transmitted from the microprocessor to the computer system through the serial port.

A program designed in visual basics is responsible for collecting the data from the serial port and display on the screen in a presentable manner.

The graphical user interface, is a type of user interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, instead of text-based user interfaces, typed command labels or text navigation.

The data collected from the system is then stored in a data base for further analysis and use.

2.3 COMPONENTS OF THE CONTACTLESS TACHOMETER

2.3.1. 8051 MICROCONTROLLER

The 8051 is the original member of the 8051 family. Figure shows the block diagram of the 8051 microcontroller. The AT89S52 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM).

The Atmel AT89S52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8Kbytes of Flash, 256 bytes of RAM, 32 I/O lines, three 16-bittimer/counters, five vector two-level interrupt architecture, a full duplex serial port, and on-chip oscillator and clock circuitry.

2.3.2. Pin Description

1. VCC: Supply voltage.
2. GND**:** Ground.

3. Port 0

Port 0 is an 8-bit open-drain bi-directional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs. Port 0 may also be configured to be the multiplexed low- order address/data bus during accesses to external program and data memory. In this mode P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming, and outputs the code bytes during program verification. External pull-ups are required during program verification.

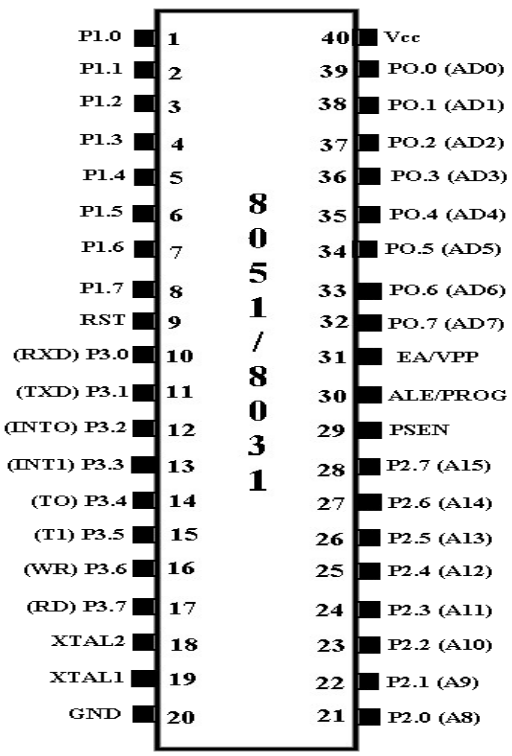


Fig 2 Pin diagram for microcontroller 8051

4.Port 1

Port 1 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 1 also receives the low-order address bytes during Flash programming and verification.

5. Port 2

Port 2 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins they are pulled high by the internal pull-ups and can be used as inputs.

6. Port 3

Port 3 is an 8-bit bi-directional I/O port with internal pull-ups. The Port 3 output buffer scan sink/source four TTL inputs. When 1s are written to Port 3 pins they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups. Port 3 also serves the functions of various special features of the AT89S52 as listed below:

Port Pin	Alternate Functions
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{\text{INT0}}$ (external interrupt 0)
P3.3	$\overline{\text{INT1}}$ (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)
P3.6	$\overline{\text{WR}}$ (external data memory write strobe)
P3.7	$\overline{\text{RD}}$ (external data memory read strobe)

Table 1 Function of port 3

7. RST

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device.

8. ALE/PROG

Address Latch Enable output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming. In normal operation ALE is emitted at a constant rate of 1/6 the oscillator frequency, and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external Data Memory. If desired, ALE operation can be disabled by setting bit 0 of SFR location 8EH. With the bit set, ALE is active only during a MOVX or MOVC instruction. Otherwise, the pin is weakly pulled high. Setting the ALE-disable bit has no effect if the microcontroller is in external execution mode.

9. PSEN

Program Store Enable is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

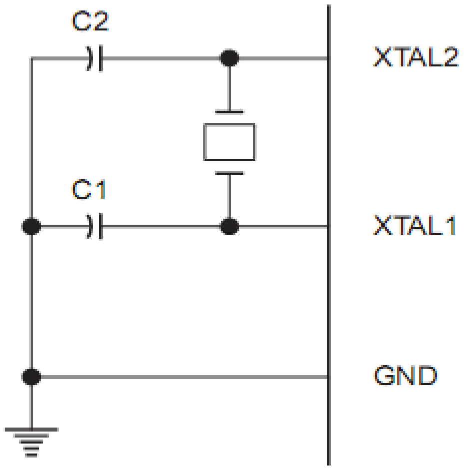


Fig 3 Crystal Oscillator Connections

There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

2.3.3 LCD UNIT

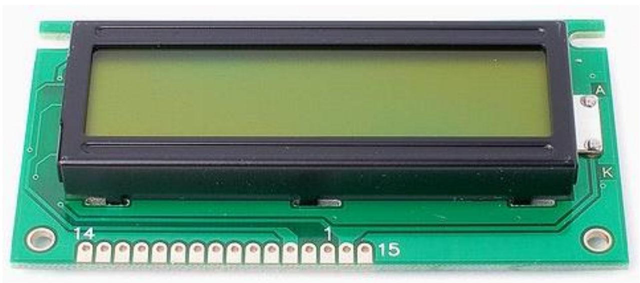


Fig 4. LCD

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals (LCs). LCs do not emit light directly.

LCDs are used in a wide range of applications, including computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they cannot suffer image burn-in. LCDs are, however, susceptible to image persistence.

1. FEATURES

- 5 x 8 dots with cursor
- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED)
- N.V. optional for + 3V power supply

LCDs are more energy efficient and offer safer disposal than CRTs. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. The most flexible ones use an array of small pixels. Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters, the axes of transmission of which are (in most of the cases) perpendicular to each other. With no actual liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

1. LCD COMMAND CODES

- 80 Force cursor to beginning to 1st line
- C0 Force cursor to beginning to 2nd line
- 38 2 lines and 5x7 matrix

- 1C Shift the entire display to the right
- 14 Shift cursor position to right
- 10 Shift cursor position to left
- F Display on, cursor blinking
- E Display on, cursor blinking C Display on, cursor off
- A Display off, cursor on
- 8 Display off, cursor off
- 7 Shift display left
- 5 Shift display right
- 6 Increment cursor (shift cursor to right)
- 4 Decrement cursor (shift cursor to left)
- 2 Return home
- 1 Clear display screen

2.3.4 7805 VOLTAGE REGULATOR

The 78xx (sometimes LM78xx) is a family of self-contained fixed linear voltage regulator integrated circuits. The 78xx family is commonly used in electronic circuits requiring a regulated power supply due to their ease-of-use and low cost. For ICs within the family, the xx is replaced with two digits, indicating the output voltage (for example, the 7805 has a 5 volt output, while the 7812 produces 12 volts). The 78xx line are positive voltage regulators: they produce a voltage that is positive relative to a common ground. There is a related line of 79xx devices which are complementary negative voltage regulators. 78xx and 79xx ICs can be used in combination to provide positive and negative supply voltages in the same circuit.

78xx ICs have three terminals and are commonly found in the TO220 form factor, although smaller surface-mount and larger TO3 packages are available. These devices support an input voltage anywhere from a couple of volts over the intended output voltage, up to a maximum of 35 or 40 volts, and typically provide 1 or 1.5 amperes of current (though smaller or larger packages may have a lower or higher current rating).

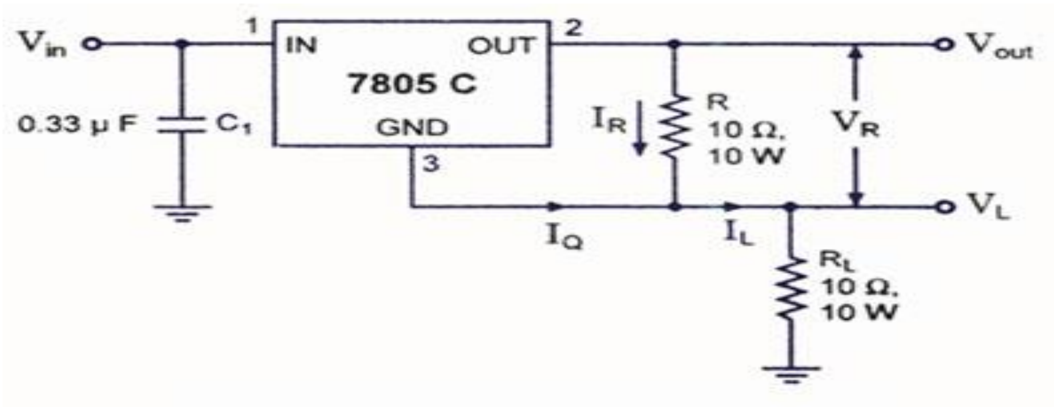


Fig 5 Circuit diagram of voltage regulator

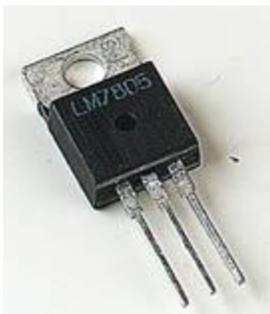
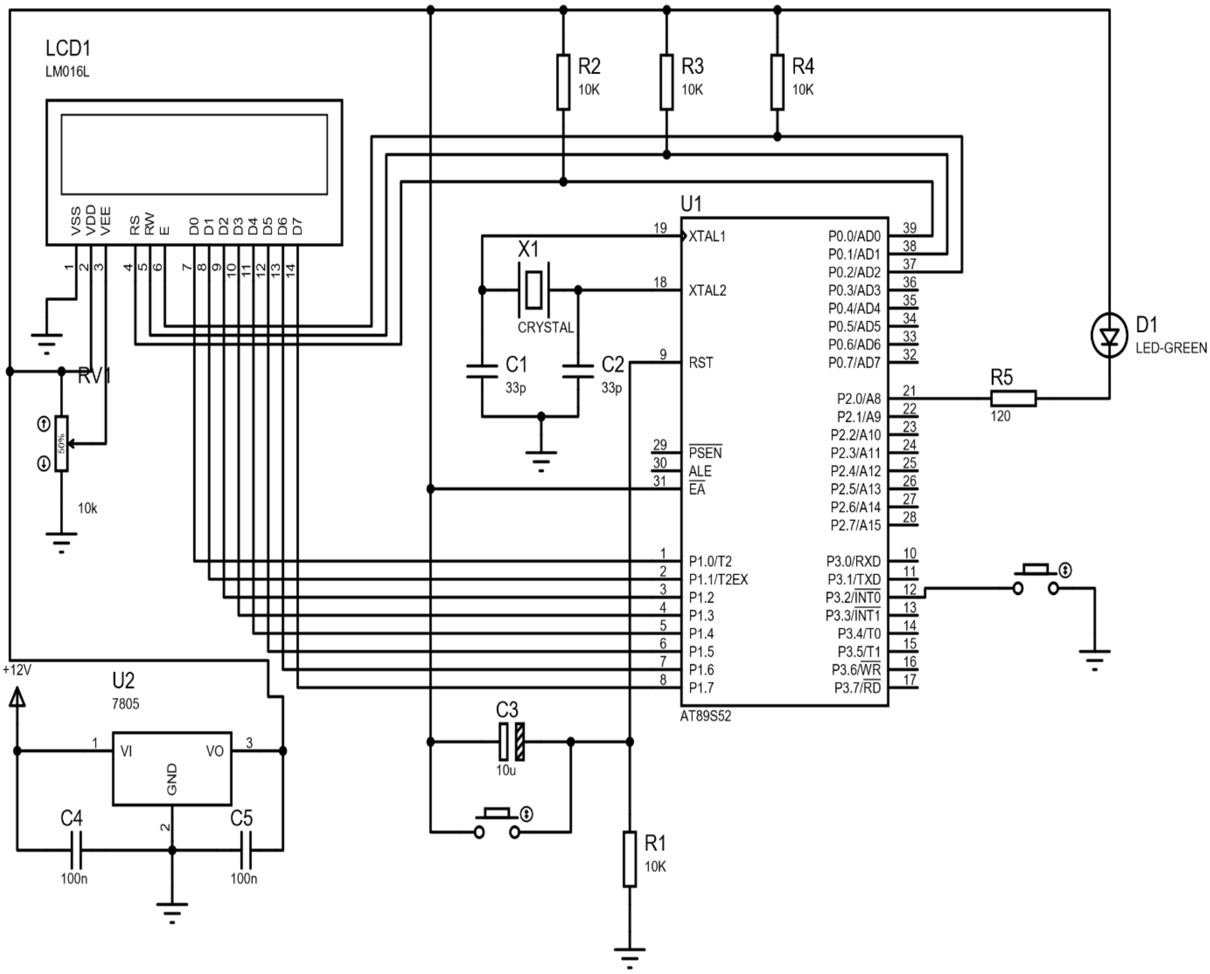
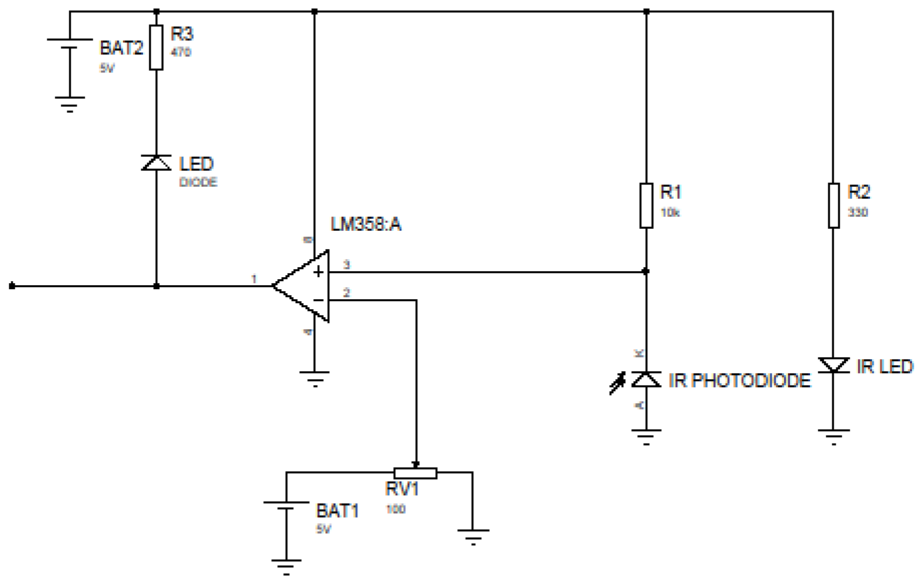


Fig 6 A Three Terminal Voltage Regulator

2.4 Circuit diagram of microcontroller with LCD



2.5 Sensor Circuit Diagram



CHAPTER 3

3.1 SOFTWARES USED

3.1.1 Proteus Software

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it.

The PCB Layout module is automatically given connectivity information in the form of a netlist from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. PCB's of up to 16 copper layers can be produced with design size limited by product configuration.

3.1.2 Embedded System

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.

Examples of properties of typical embedded computers when compared with general-purpose counterparts are low power consumption, small size, rugged operating ranges, and low per-unit cost. This comes at the price of limited processing resources, which make them significantly more difficult to program and to interact with.

Modern embedded systems are often based on microcontrollers (i.e. CPUs with integrated memory or peripheral interfaces), but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more-complex systems. Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, and largely complex systems like hybrid vehicles, MRI, and avionics.

3.1.3 Keil (IDE) MicroVision3

Keil Software development tools are used to create products for practically every industry: consumer electronics, industrial control, networking, office automation, automotive, space exploration. Micro Vision Two is a second generation IDE that simplifies project development and application testing. With Micro Vision Two, we can easily create embedded applications in a mixture of C and assembly.

CHAPTER 4

4.1 SERIAL COMMUNICATION

Computer transfers data in two ways these are

1. Parallel**:** Often 8 or more lines (wire conductors) are used to transfer data to a device that is only few feet away.
2. Serial**:** To transfer to a device located many meters away, the serial method is used. The data is sent one bit at a time.

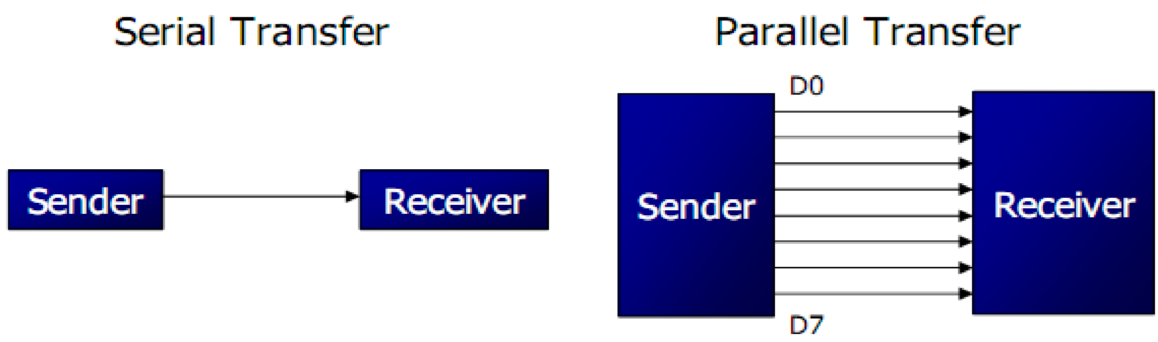


Fig 7 Mode of Communication

At the transmitting end, the byte of data must be converted to serial bits using parallel-in-serial-out shift register. At the receiving end, there is a serial-in-parallel-out shift register to receive the serial data and pack them into byte. When the distance is short, the digital signal can be transferred as it is on a simple wire and requires no modulation. If data is to be transferred on the telephone line, it must be converted from 0s and 1s to audio tones. This conversion is performed by a device called a modem, “Modulator/demodulator”.

Serial data communication uses two methods. First are synchronous method transfers a block of data at a time. Second is an asynchronous method transfer a single byte at a time.

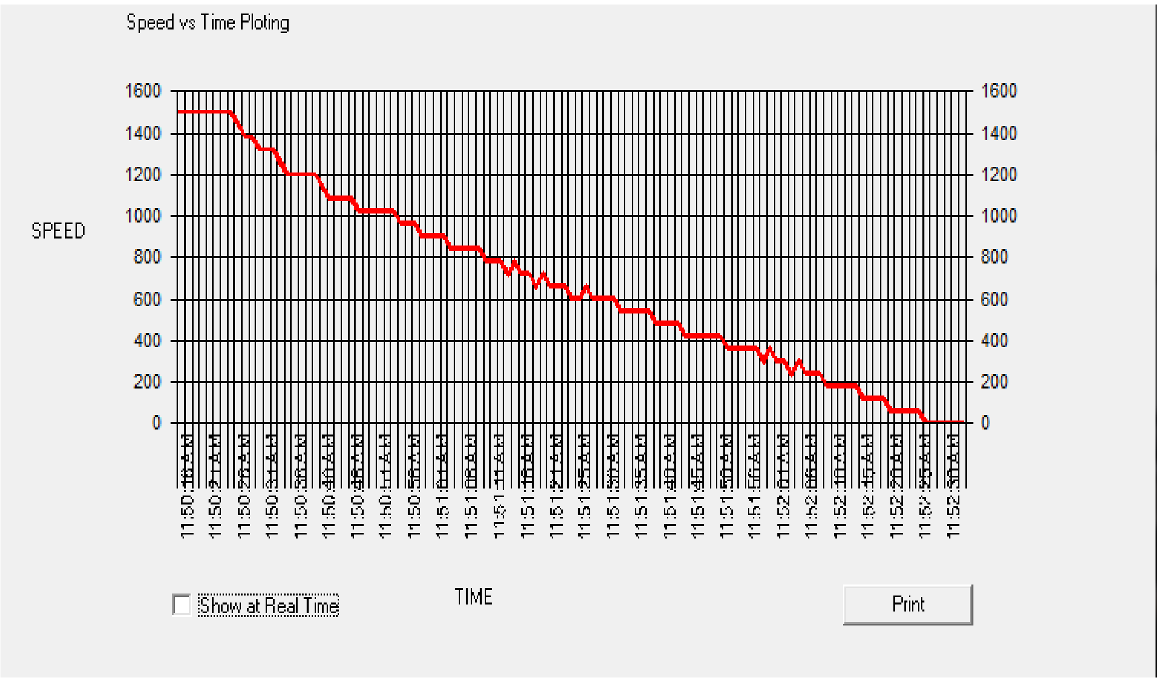
It is possible to write software to use either of these methods, but the programs can be tedious and long. There are special IC chips made by many manufacturers for serial communications namely UART (universal asynchronous Receiver-transmitter) & USART (universal synchronous-asynchronous Receiver-transmitter)

A protocol is a set of rules agreed by both the sender and receiver. Asynchronous serial data communication is widely used for character-oriented transmissions where each character is placed in between start and stop bits, this is called framing and block-oriented data transfers use the synchronous method. The start bit is always one bit, but the stop bit can be one or two bits the start bit is always a 0 (low) and the stop bit(s) is 1 (high).

CHAPTER 5

5.1 TESTING AND RESULTS

Retardation test is performed by bringing the d.c shunt motor to a rated speed and then we cut off the supply and simultaneous readings between sped and time is recorded by the contact less tachometer and a graph is obtained.



5.2 CONCLUSION

In this project we have tried to develop an IR based contact less tachometer which has the following applications.

1. The Contactless Digital Tachometer circuit can be used to calculate speed of rotating wheels, discs and motor shafts.
2. This circuit can be used at places where direct contact with motor shafts or wheels is not possible to be made, as in case of vehicles and also in industrial machines.
3. This circuit can be used at homes to check speed of small battery operated fans and other motor based devices.

APPENDIX

1 CODING

```
#include<reg51.h>

#include<stdio.h>


#define LCDPort P1   // LDCPort (PIN 7 to PIN 14) of LCD is Connected to P1(PIN 1 to PIN 8) of 8051

sbit RS=P0^0; // RS pin of LCD (PIN 4) is Connected         to P0.0 (PIN 39) of 8051

sbit RW=P0^1; // RW pin of LCD (PIN 5) is Connected      to P0.1 (PIN 38) of 8051

sbit EN=P0^2; // EN pin of LCD (PIN 6) is Connected        to P0.2 (PIN 37) of 8051


sbit SENSOR=P3^2;

sbit LED=P2^0;


void delay(int t) // This function will generate t ms delay
 {
    int i;


         while(t>0) // Loop until t become ZERO
          {
           i=1275; // Set the Starting value of i with 1275
                while(i>0) i--; // Decrease the Value of i by -1 , until i become ZERO
           t--; // Decrease the value of t by -1
```

```
            }

 }


void LCDCommand(char c) // This function will execute a Command

 {

   RS=0; // RS=0 means, we are sending Command to LCD

         RW=0; // RW=0 means, we are  using the LCD in Write Mode

         LCDPort=c; // Copy the Value of c (Command) into LCDPort (P1 in Our Case)

         EN=1;      // SET EN pin HIGH  ----------------+

         delay(2);  // Wait for 2 ms                                        +-- Generat a High
To Low Pulse

         EN=0;      // Reset the EN pin Back to LOW ----+

 }


void LCDData(char c) // This function will send a Data to LCD

 {

   RS=1; // RS=1 means, we are sending Data to LCD

         RW=0; // RW=0 means, we are using the LCD in Write Mode

         LCDPort=c; // Copy the Value of c (Data) into LCDPort (P1 in Our Case)

         EN=1;      // SET EN pin HIGH ----------------+

         delay(2);  // Wait for 2 ms                                        +-- Generat a High
To Low Pulse

         EN=0;      // Reset the EN pin Back to LOW ----+

 }

void LCDInit() // This function will Initilized the LCD
```

```
{
   LCDCommand(0x38); // 0x38 - 8 Bit Mode
         LCDCommand(0x06); // 0x06 - Display from Left to Right
         LCDCommand(0x0c); // 0x0c- Display On, Cursor Hide
         LCDCommand(0x01); // 0x01 - Clear LCD
}

/* String: An array of character terminated by NULL ('\o') is Called String
        array index start from 0 (ZERO)
                +---+---+---+--+
                String  | A | E | C        |\o|
                      +---+---+---+--+
                                 ^
                                 0
*/
void LCDPuts(char *s) // This function will Display a String on LCD
{
  int i; // Declare local variable i to use as index of the Character of a String
  for(i=0;s[i]!='\0';i++) // Scan each and every Character of the String One by on
          {
            LCDData(s[i]); // And display the Character on LCD with LCDDatra() function
          }

}
```

```
void main()      // The main() function start here
 {
   char buffer[10]; // Declare an array of Character
   unsigned long int TimerCounter=0;
   int Counter=0;
   int RPM=0;
   LCDInit(); // Initilizing the LCD
   LCDPuts("Contact Less");
   LCDCommand(0xc0); // Set Cursor at the starting of Second Line
   LCDPuts("Techometer");

   delay(100); // Wait for 100 ms
   LCDCommand(0x01); // Clear LCD
   LCDPuts("AEC/EE/2018");
   delay(100); // Wait for 100 ms
   LCDCommand(0xc0);
   LCDPuts("Kunal Nath     ");
   delay(100);

   LCDCommand(0xc0);
   LCDPuts("Dipankar       ");
   delay(100);

   LCDCommand(0xc0);
```

```
LCDPuts("Rajdeep Das     ");
delay(100);


LCDCommand(0xc0);
LCDPuts("Chirantan      ");
delay(100);


LCDCommand(0x01); // Clear LCD
LCDPuts("RPM:");


while(1)
 {


          TimerCounter++;
          if(SENSOR==0)
           {
              Counter++;
                     while(SENSOR==0);


           }
         if(TimerCounter> 65500)
          {


                    TimerCounter=0        ;
```

```
                RPM=Counter * 6; // As we have count for 15 sec, we have to Multiply
by 4 to get RPM
      Counter=0;       // Reset the Counter to 0
                if(RPM>0)
                 {
                  sprintf(buffer,"%4d",RPM);       // Convert The Numeric Data into
String
                  LCDCommand(0x85); // Move the Cursor to 5th Position of First Line
                  LCDPuts(buffer); // Display The RPM on LCD
                 }
         }

        }
}
```

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