

# *Design and Development of a System for Measuring Rack Gear Parameter Using Inductive Sensor*

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**Abstract-** *In today's world for designing any mechanical component a large amount of accuracy is needed. The combinations of ease of measurement along with speed and accuracy have significant positive impact on productivity of an industry. So we are developing a system for measuring rack gear parameter by using inductive proximity sensor and microcontroller the system for measuring these parameters which already exist are measurement by CMM (co-ordinate measuring machine) which have high accuracy, but very expensive and vernier caliper method which is very time consuming thus the system of measuring rack gear parameter using inductive proximity sensor and PIC microcontroller have significant advantages over traditional system. The parameters tooth thickness, pitch are directly shown on LED display when a sensor passes Rack Gear. Theoretical information and overall concept of system are presented.*

**Keywords:** *Rack Gear, Inductive Proximity Sensor, PIC Microcontroller, etc.*

## **1. INTRODUCTION**

Designing of any component accuracy is needed and to avoid failure of the component and increasing quality of the component quality checking system is needed in any mechanical system gears used to transmit the power from one shaft to another shaft to transmit the power gear should be a good quality of the gears can be maintain with the various gear parameters measuring system. The traditional devices that are being used since a long time are time consuming and also required a skilled labor that is very tough. The accuracy can be increased with the help of on machine measuring system. Regarding many advantages of On-machine measurement system, the utilization of the systems has become a subject of many researches. These systems allow controlling the parts directly on the machine tool, and also the process can be integrated directly to the machining process whereas the delays from transportation and measuring process performed on coordinated machine are omitted.

Generally, the accuracy of measurements and authenticity of the results from the measurement is in most cases affected by many

Factors and this is truth also for the measurement by using CMM (Coordinate measuring machine) as well as in On-

machine measurement systems. The factors affecting the accuracy, efficiency and uncertainty of measurement performed via On-machine measurement systems are the object of the research.

To avoid these difficulties we are designing a gauge system for geometric verification of rack gear. Now days devices used for measurement of tooth thickness & pitch distance of rack gear are Vernier caliper, in that constant chord method, base tangent method & two probes method respectively. These methods on the other hand are time consuming and do not provide the required or higher accuracy. These method's also required skilled operator this adds to the disadvantage. There is also the possibility of human error .In large scale manufacturing industries; it is tough to examine each & every rack gear manually. So to avoid this entire disadvantage we have designed gauge system for geometric verification of rack gear. The system includes inductive proximity sensors, 89S52 microcontroller, AC synchronized motor with 60 RPM and 10 kgcm torque, LED display, moving plate, mounting plate, fixed plate, lead screw, rubber coupling and mounters. Rack gear of which parameter is to be measured is mounted on the moving plate in a straight line. To ensure that the rack gear is mounted in a straight line the parallel keys are used. The sensors will be fitted with the help of the mounters at the center of the fixed plate. The size of the rack gear may be varying, so the position of sensor can be adjusted manually with the help of rubber washer. The system includes inductive proximity sensors, microcontroller, AC synchronized motor LED display, lead screw etc.

## **2. METHODOLOGY:**

We have design and development of a system used to measure rack gear parameters using inductive sensor .the system is used to measure the rack gear parameters like tooth thickness , pitch of the gear, no. of teeth. In this gauge system we use inductive proximity sensor which is used for detection of metal with emitter and collector to sense the geometrical parameter like tooth thickness and pitch distance. The system consist of fixed plate, moving plate ,lead screw, sensor, led display and stepper motor, rack gear. In this system we mounted the rack gear on the moving plate .the moving plate operated with lead screw which gets rotary motion from the stepper motor. Stepper

motor used in this system is of 60rpm speed and 10 kgcm torque .the rack gear is pass between emitter collectors of inductive proximity sensor with constant velocity. While passing rack gear between proximity sensor the sensor detects the parameters and which is shown on the led display. The system used for measuring rack gear is only applicable for rack gear any other gear parameters cannot be measured with this system.

### 3. INTRODUCTION TO RACK GEAR

A rack and pinion is a type of linear actuator that comprises a pair of gears which converts rotational motion into linear motion . a circular gear called “the pinion” engages teeth or a linier gear bar called “the rack”. Rotational motion applied to the pinion causes the rack to move relative to the pinion , their by translating the rotational motion of the pinion into linier motion .

For every pair of conjugate involutes profile, there is basic rack . this basic rack is the profile of the conjugate gear of infinite pitch radius (i.e. a toothed straight edge.)

A generating rack is a rack outline used to indicate tooth details and dimensions for the design of a generating tool, such as hob or a gear shaper cutter .

Parameters of Rack Gear

- 1) Tooth thickness
- 2) Pitch
- 3) No of teeth

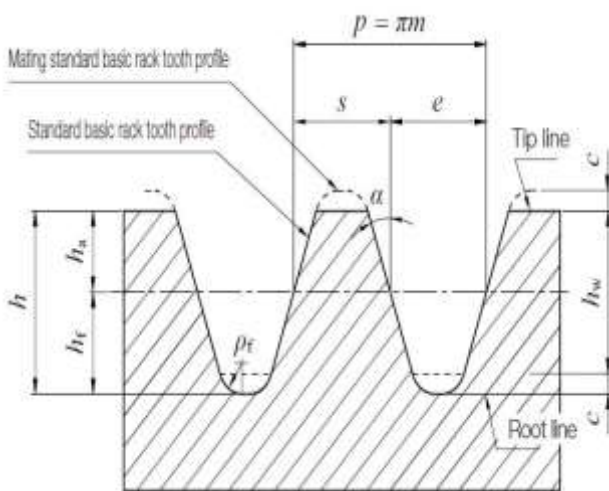


Fig:1 RackGear

### 4. INTRODUCTION TO INDUCTIVE SENSOR:

Inductive sensors are widely used to measure position or speed, especially in harsh environments. However, to many engineers, inductive sensor terminology and techniques can be confusing. Following are the various types and operating principles, as well as their consequent strengths and weaknesses.

Inductive position and speed sensors come in a wide variety of shapes, sizes and designs. All inductive sensors can be said to work on transformer principles and they all use a physical phenomenon based on alternating electrical currents.

#### 4.1 How Inductive Sensor Work:

- Variable inductance sensors typically produce an electrical signal proportional to the displacement of a conductive or magnetically permeable object (normally a steel rod) relative to a coil.
- As with the proximity sensor, the impedance of a coil varies in proportion to the displacement of the target relative to a coil energized with an alternating current.
- Inductive Proximity Sensors detect the presence of metal objects which come within range of their oscillating field and provide target detection. Internally, an oscillator creates a high frequency electromagnetic field (RF) which is radiated from the coil and out from the sensor face. When a metal object enters this field, eddy currents are induced into the object
- As the metal moves closer to the sensor, these eddy currents increase and result in an absorption of energy from the coil which dampens the oscillator amplitude until it finally stops.

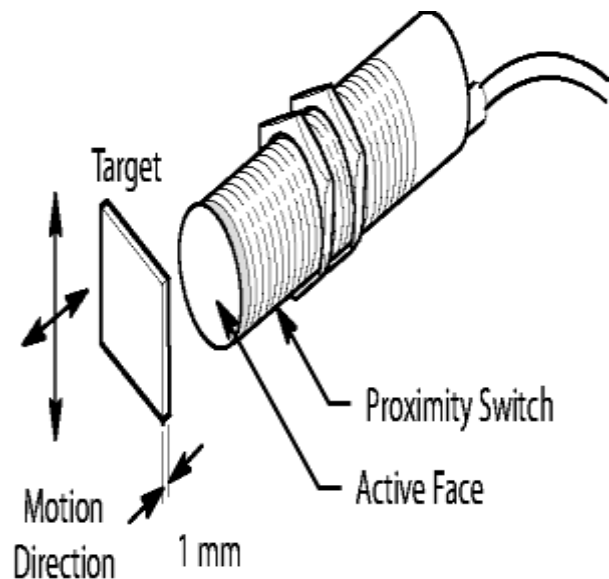


Fig: 2 Inductive Sensors

### 5. ULTRASONIC SENSOR:

Ultrasonic proximity sensors emit and receive sound waves. The carrier signal is a high frequency, inaudible sound wave. They detect the presence of the target object in one of two configurations. Diffuse or Reflective sensors have the transmitter and receiver packaged in the same housing. When a target enters the sensing range of the device, the ultrasonic waves are

reflected back to the sensor.

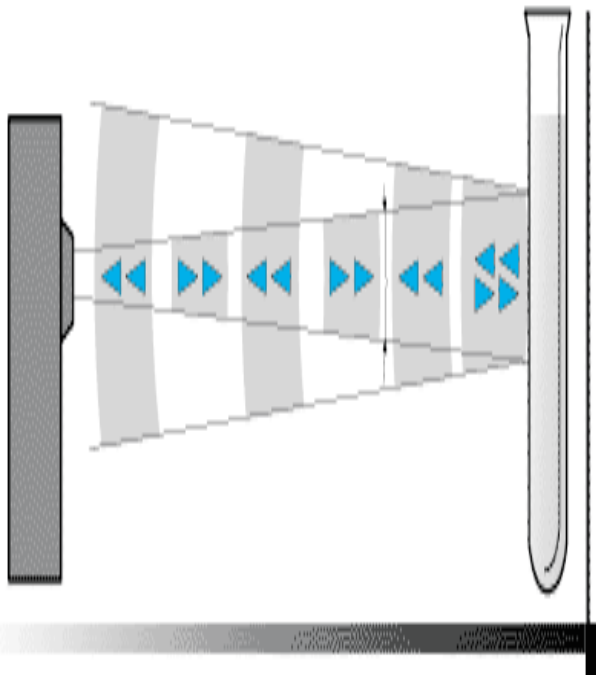


Fig: 3 Ultrasonic Sensor

## 6. ASSEMBLY:

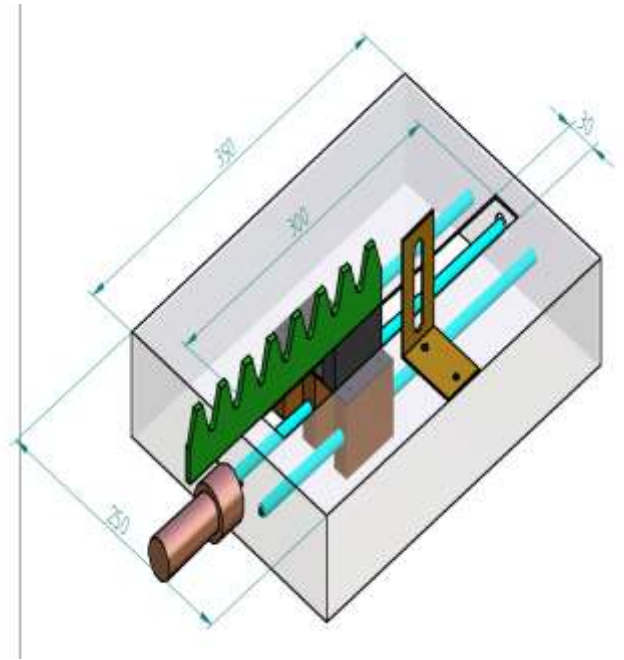
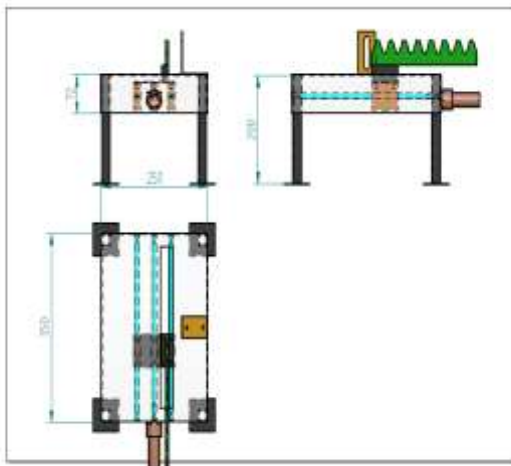
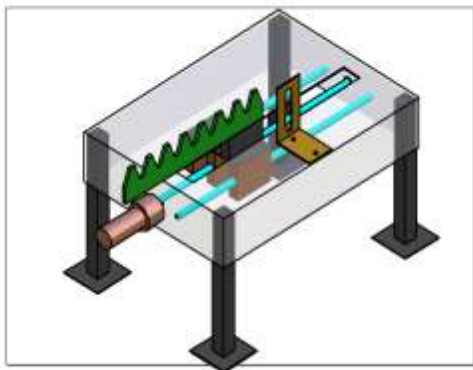


Fig: 4 Assembly Of Design Part

## 7. PARTS OF ASSEMBLY:

**Fixed plate:** Fixed plate houses the other parts of assembly e.g. lead screw, linear guide rod, sensor mounting plate, etc.

**Lead screw:** Lead screw is used to convert the rotary motion supplied by motor into the linear motion of moving plate.

**Moving plate:** Rack gear is mounted on Moving plate so it is passed by sensor.

**A.C. Synchronized Motor:** A.C. synchronous motor of 60RPM and 10 kgcm torque is used to drive lead screw.

Other parts of assembly are as follows:

Lead screw nut, Bearing, Coupling, Allen Bolt Guide Bush, Inductive Sensor Mounting Plate, Linear Guide Rod, Linear Guide Rod Support Plate, Inductive Proximity Sensors, PIC Microcontroller, LED Display, etc

## 8 .PIC MICROCONTROLLER:

**9.1PIC 16F877A:** PIC is a family of microcontroller made by MICROCHIP Technology. The first part of the family where available in 1976. The Hardware capabilities of PIC devices range from 6-pin SMD, 8-pin DIP Chips up to 100-pin SMD chips, with discrete I/O pins, ADC and DAC modules, and communications ports such as UART, I2C, CAN, and even USB.

## 10. LED DISPLAY:

LED (Light Emitting Diode) screen is an electronic display module and has a wide range of applications. A 16 X 2 LED display is very basic module and is very commonly used in various devices and circuits.

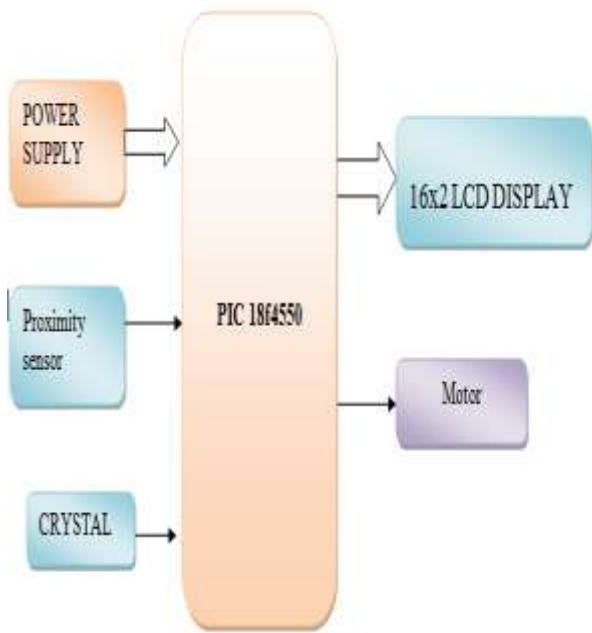


Fig 4.1: Block Diagram

**40-Pin PDIP**

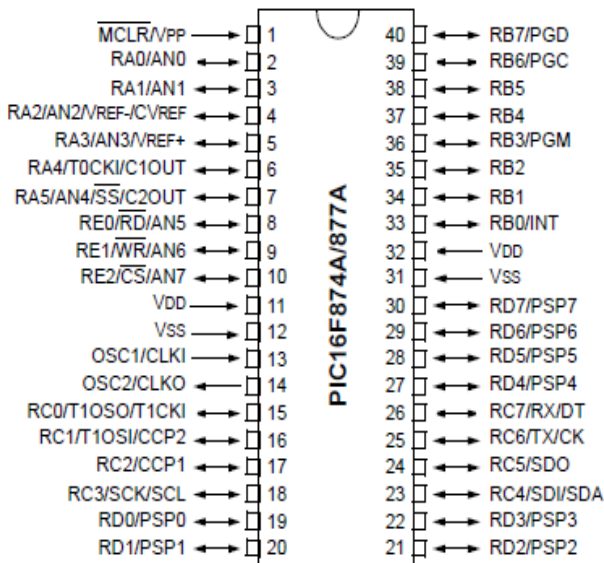


Fig: 6 Pin Diagram of PIC 16F877A

A 16 x 2 LED means it can display 16 characters per line and there are 2 such lines. In this LED each character is displayed in 5 x 7 pixel matrix. The data register stores the data.

To be displayed on the LED. The data is the ASCII value of the character to be displayed on the LED.

Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones, etc.

The 16 x 2 intelligent alphanumeric dot matrix displays is capable of displaying 224 different characters and symbols.

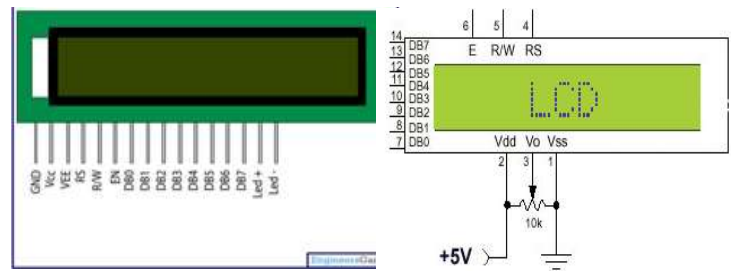


Fig: 6 LED Display

**10. ADVANTAGES**

- Increase the accuracy.
- Easy to operate.
- Reduce the time of measurement.
- Increase speed of measurement.
- Parameters of every Rack tooth can be measure.
- Process is continuous i.e.to measure each parameter it is not necessary to pass the rack every time.

**11. DISADVANTAGES:-**

- We can only measure Rack Gear.
- Sensors used are costly.
- Electricity is necessary.
- Wear and cracks cannot be detected.

**12. FUTURE SCOPE:**

- It can be used in production industry to verify geometrical properties of rack gear.
- Study and verification of rack in lab.
- Use in automation industry.
- Use in small industries and workshops.

**13. CONCLUSIONS:**

We have Manufactured the Gauge system and as per instructions of microcontroller the Inductive sensor senses th3e Rack Gear and it showed the actual value of the pitch and tooth thickness of Rack gear.And in this way we have done with actual reading and we successively completed our project.

**14. ACKNOWLEDGEMENT:**

There are, however, several individuals that have gone well beyond the normal call of duty and now I would like to thanks them. First of all, I would like to thanks Prof. S. R. Kulkarni , who was kind enough to encourage me in the exploration of “Design And Development Of A System For Measuring Rack Gear Parameters Using Inductive Sensor” and in the development of this Project II also wish to express thanks to Prof. S. M. Alage (Head of

Department) and Dr. R. K. Lad (Principal) for the reading availability of college facilities as and when required. Space does not allow me to mention each person by name, I'm deeply grateful to everyone that has been associated with Project.

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