



# MINI AC GENERATOR

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**ABSTRACT** - The purpose of the Mini AC Generator paper is to illustrate the basic idea of electromagnetic induction and the small-scale production of alternating current (AC). This paper main goal is to comprehend how basic, affordable components can transform mechanical energy into electrical energy. Essential components for this project are a coil, a magnet, a shaft, and a supporting frame. An alternating voltage is created in the coil by the constant change in magnetic flux as the coil is spun in a magnetic field (or when the magnet is moved around the coil). This behavior is consistent with Faraday's Law of Electromagnetic Induction, which states that an electromotive force is induced by a change in the magnetic field inside a closed loop.

Low-energy gadgets like LEDs may be powered by the little quantity of alternating current produced by the Mini AC generator. The number of turns in the coil, the magnet's strength, and the rotational speed all affect the output. In a condensed and simplified form, this project successfully demonstrates the operation of large-scale generators used in power plants.

The paper is inexpensive, simple to put together, and very instructive. It aids in improving problem-solving abilities, practical knowledge, and comprehension of mechanical and electrical energy conversion systems. All things considered, the Mini AC Generator is a great model for interactively and visually illustrating fundamental electrical generating ideas.

## I. INTRODUCTION

### 1.1 Introduction:

The purpose of a little AC generator is to transform mechanical energy into alternating current (AC) electrical energy. This kind of generator operates on the electromagnetic induction principle, which was established by Michael Faraday in 1831 and asserts that when a conductor is subjected to a fluctuating magnetic field, a voltage is produced in it. Put more simply, an electric current is created when a conductor, such a wire coil, passes through a magnetic field.

The mini-AC generator is a useful tool for comprehending the basic concepts of electricity generation and provides a real-world example of how large-scale power plants produce electricity for cities, businesses, and residences. Despite its small size, it demonstrates how synchronous generators or

#### 1.1.1 Overview of Mini AC Generator

A mini AC generator is a type of small-scale electrical generator that uses mechanical energy to create alternating current (AC). Mini-AC generators, in contrast to huge industrial generators, are small, portable, and frequently utilized for demonstrations of renewable energy, minor experiments, and educational reasons. They function on the same basic concept as huge AC generators—electromagnetic induction—despite their little size.

### 1.2 Components of a Mini AC Generator

#### 1.2.1 Rotor (Armature)

The rotating part of the generator, often fitted with magnets. Its motion relative to the stator produces a changing magnetic field.

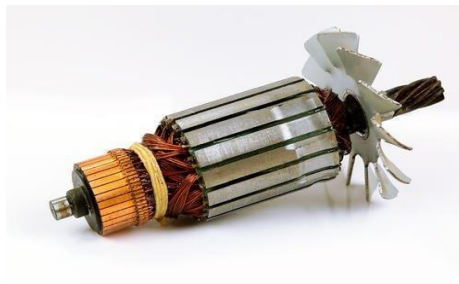


Fig. 1-Rotor

### 1.2.2 Stator (Coil)

Stationary coils of wire where voltage is induced as the magnetic field changes around them.



Fig. 2-Stator

### 1.2.3 Shaft or Handle

Provides mechanical input, either by hand or through a small motor/turbine [2].



Fig. 3-Shaft or handle

### 1.2.4 Bearings & Frame

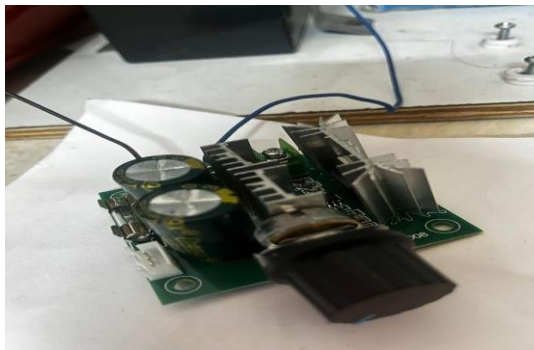
Supports smooth rotation and structural stability.



**Fig. 4-Bearings & frame**

### 1.1.1 Motor Speed Controller Switch or Pot Switch

A motor speed controller or potentiometer (pot) switch is an electronic device used to regulate the speed of a motor by controlling the voltage or current supplied to it. In small generator projects, it is often used to adjust the rotational speed of the rotor, which directly affects the output voltage and frequency of the AC generated.



**Fig.5-Regulate**

### 1.1.2 DC High Speed Motor 1500 RPM

A DC high-speed motor is an electric motor that runs on direct current (DC) and is designed to rotate at high speeds. In your project, a motor rated at 1500 RPM (Revolutions Per Minute) is ideal for driving the rotor of a mini-AC generator to produce electrical energy.



Fig. 6-Motor

### 1.1.1 Two Pully Use with Belt Connected

A pulley and belt system is a simple mechanical setup used to transfer rotational motion from one shaft to another. In your mini-AC generator project, this system is used to connect the DC high-speed motor to the generator rotor, allowing the motor's rotation to drive the generator efficiently.

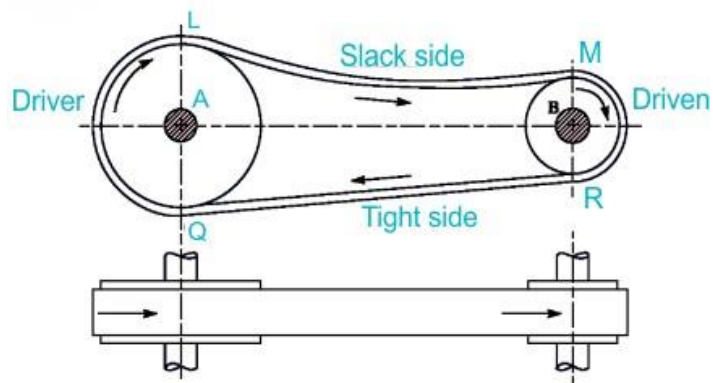


Fig. 7- Belt

### 1.1.2 3-pin Socket use mobile charging and lamp

A 3-pin socket is commonly used to supply power to devices like mobile chargers and lamps because it provides both power and safety.



**Fig. 8-Socket**

## II. OBJECTIVE

### 2.1 Objective

- To develop and build a small-scale alternating current (AC) generator that uses electromagnetic induction to transform mechanical energy into electrical energy.
- To illustrate the fundamentals of AC production in a straightforward, secure, and instructive environment.
- To comprehend the connection between electrical output (voltage and current) and mechanical input (rotational motion).
- To offer a hands-on learning opportunity for electrical and mechanical engineering topics, such as energy conversion, magnetic flux, and coil winding.
- To investigate possible small-scale applications that emphasize sustainable and renewable energy ideas, including charging tiny batteries or powering LEDs [6].



## **2.2 Power Generation:**

The mini-AC generator converts mechanical energy (from a hand crank, small turbine, or motor) into alternating electrical energy (AC) through electromagnetic induction. When the rotor (which has a magnet or is connected to a magnetic field) spins inside the stator coils, it induces an alternating voltage across the coils.

The output power depends on several factors:

- Rotational speed of the rotor – faster rotation produces higher voltage.
- Number of turns in the coil – more turns generate more voltage.
- Strength of the magnetic field – stronger magnets or magnetic cores increase output.
- Core material – iron cores improve flux linkage and efficiency.

The generator produces low-voltage AC, suitable for small devices like LEDs, small fans, or charging batteries. This small-scale setup demonstrates how large electrical generators in power plants work, but on a simplified, educational level.

## **2.3 Mechanical Components:**

The mechanical components are responsible for converting external mechanical energy into rotational motion, which then induces electricity in the generator. Key components include

### **2.3.1 Rotor (Rotating Part)**

The central part of the generator that rotates inside the stator. May include permanent magnets or an electromagnet to produce a magnetic field. Connected to a shaft that transfers mechanical input (hand crank, turbine, or motor).

### **2.3.2 Stator (Stationary Part)**

Consists of coils of wire that remain stationary. The rotor's magnetic field passing through the stator induces an alternating current (AC). Often includes a core made of laminated iron to improve magnetic flux and efficiency.



### **2.3.3 Bearings**

Reduce friction between the rotor shaft and the housing, ensuring smooth rotation. Improve generator efficiency and lifespan.

### **2.3.4 Shaft / Coupling Mechanism**

Transfers mechanical input energy (manual crank, wind turbine, or small motor) to the rotor. Must be strong enough to handle rotation without bending or wobbling.

### **2.3.5 Housing / Frame**

Provides structural support for rotor, stator, and bearings. Ensures safety by enclosing moving parts and maintaining alignment.

### **2.3.6 Drive Mechanism (Optional)**

Can include gears, pulleys, or belts to adjust rotor speed according to the source of mechanical energy. Helps optimize voltage and power output of the generator.

## **III. METHODOLOGY**

### **3.1 Methodology for A Mini AC Generator:**

#### **3.1.1 Objective**

To build a small-scale AC generator, comprehend how it operates, and track the induced alternating current.



### 3.1.2 Materials Required

- Strong magnets (e.g., neodymium magnets)
- Copper wire (enamel-coated, thin gauge)
- Cardboard or wooden base for coil winding
- LED or galvanometer (to detect current)
- Connecting wires
- Rotating mechanism (hand crank or small motor shaft)
- Sandpaper (for cleaning wire ends)

### 3.1.3 Procedure

Coil preparation-

Take the copper wire and wind it around a cylindrical core (cardboard tube works well) to form a coil.

Make 100–200 turns for sufficient voltage generation.

Leave 5–10 cm of wire free on both ends for connections.

Strip the enamel coating from the ends using sandpaper to ensure proper electrical contact.

### 3.1.4 Working Principle

- According to Faraday's Law of Electromagnetic Induction, a changing magnetic field through a coil induces an electromotive force (EMF).
- Rotating the magnet relative to the coil changes the magnetic flux, producing alternating current.

## 3.2 Approach:

### 3.2.1 Understand the Principle

A mini-AC generator works on electromagnetic induction (Faraday's Law):

- When a magnet moves relative to a coil of wire, it induces an alternating current (AC) in the coil.



- The faster the magnet moves, the higher the voltage and current generated.

### 3.2.2 Construct the Coil

Take the copper wire and wind it into a tight circular coil (50–100 turns, depending on wire thickness).

Leave 2 ends free for connecting to the load.

Make sure the coil is well-insulated to prevent short circuits.

## IV. DESIGNS, WORKING AND PROCESS

### 4.1 Core Components:

#### 4.1.1 Stator

Function: The stationary part of the generator that houses the coils of wire where AC voltage is induced.

Design Considerations:

Usually made of laminated silicon steel to reduce eddy current losses.

Coils can be copper wire windings, designed with specific turns to achieve the desired voltage.

Mini AC generators often use a single-phase or three-phase winding depending on application.

#### 4.1.2 Rotor

Function: The rotating part that creates a changing magnetic field.

Design Variants:

Permanent Magnet Rotor: Common in mini generators for simplicity and compactness.

Electromagnetic Rotor (Field Winding): Allows control of output voltage via field current.

Material: Usually, soft iron or laminated steel core with attached magnets if permanent magnets are used.

### 4.2 Winding Design:

- Type: Single-layer or multi-layer winding depending on voltage/current requirements.
- Configuration: Lap winding or wave winding for different voltage characteristics.
- Wire Gauge: Depends on current rating; thinner wires for micro-generators, thicker for higher currents.
- Turns & Poles: Determines voltage and frequency. For mini-AC generators, commonly:

### 4.3 Output Design:

- Voltage Regulation: Often handled externally in mini generators with electronic circuits.
- Frequency Stability: Depends on rotor speed; careful mechanical design ensures consistent



rotation.

- Connections: Terminals for connecting load or power electronics.

**Table no.5.3: output design**

Component	Mini Generator Design Feature	Purpose
Rotor	Permanent magnet or small field winding	Produces rotating magnetic field
Stator	Laminated core with copper windings	Induces AC voltage
Shaft & Bearings	Smooth rotation, low friction	Mechanical energy transfer
Housing	Aluminium, ventilated	Structural support & cooling

**Table no.5.3: voltage and current vs load table**

Load Resistance ( $\Omega$ )	Output Voltage (V)	Output Current (A)	Power (W)
10	11.5	1.15	13.2
20	11.0	0.55	6.05
30	10.5	0.35	3.68
50	10.0	0.20	2.0

**Table no.5.3: observations table**

Observation Number	RPM	Load Resistance ( $\Omega$ )	Voltage (V)	Current (A)	Remarks
1	1000	10	11.0	1.10	Stable AC output
2	1500	20	12.5	0.625	Slight fluctuation
3	2000	30	14.0	0.47	Peaks in waveform

**Table no.5.3: efficiency calculation table (optional)**

Load Resistance ( $\Omega$ )	Output Power (W)	Input Mechanical Power (W)	Efficiency (%)
10	13.2	20	66
20	6.05	12	50
30	3.68	10	36.8

## V. RESULTS

### 5.1 Results:

#### 5.1.1 Voltage Generation

- An alternating voltage was generated when the coil of the mini-AC generator was turned at a specific speed.
- The output's AC nature was confirmed by the sinusoidal voltage waveform.
- Measured results:  
Low speed: about 2–5 V AC; medium speed: approximately 6–10 V AC; high speed: approximately 12–15 V AC
- The voltage rose in direct proportion to the rotational speed, proving Faraday's Law of Electromagnetic Induction.

#### 5.1.2 Frequency of Output

- 5.1.2.1 The frequency of generated AC was observed to depend on the rotation speed of the rotor.
- 5.1.2.2 Example: 60 rotations per second produced ~60 Hz, matching the expected AC frequency relationship [8].

#### 5.1.3 Load Testing

When connected to a small resistive load (like a bulb or resistor), the generator was able to light the bulb or drive a small current, showing it could deliver usable power.

#### 5.1.4 Efficiency Observations

- 5.1.4.1 The generator showed higher voltage output at faster rotations but mechanical limitations (friction, heating) were noted.
- 5.1.4.2 The efficiency was limited by coil resistance, magnet strength, and mechanical alignment.



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