

# Survey on Starter Performance Testbench

<sup>1</sup>Gagana Shetty, <sup>2</sup>Mocica B, <sup>3</sup>Nidhi M, <sup>4</sup>Nischitha P, Raghavendra Y M  
 Department of Electronics & Communication Engineering  
 Gsss Institute of Engineering & Technology for Women  
 (Affiliated to VTU and Approved by Aicte, New Delhi & Govt. Of Karnataka)  
 KRS Road, Metagalli, Mysuru -570 016  
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**Abstract-**Today’s competitive environment has placed a very high demand on automating manufacturing firm for quantitative and qualitative production. Starter performance test bench is one such system in which starter are tested and validated after each process during production. The purpose of the work is to conduct a comprehensive series of validation tests in automotives and aviation. It is possible to achieve maximum types of testing starters. The selection of required test and parameters can be suitably performed as per the requirement without affecting functional efficiency.

## I INTRODUCTION

### 1.1 Overview

Starter is a device used to rotate an internal combustion engine so as to initiate the engine’s operation under its own power. The procedure required to start the modern automobile engine involves a chain of technical events, beginning with the actuation of the starter and the meshing of the starter pinion with the ring gear on the engine flywheel. Modern starting systems require the careful co-ordination of components which must work together to start the engine many times, and which must provide years of trouble- free service.

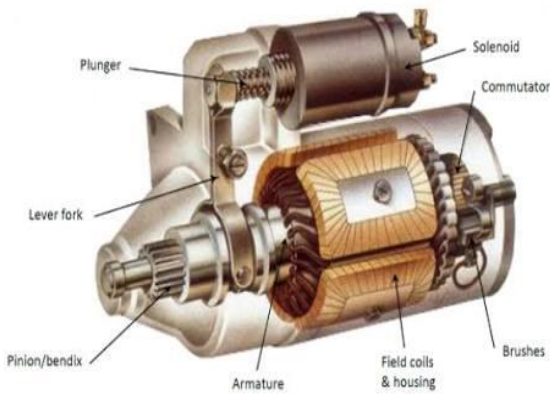


Fig: Starter motor

There are some basic starting components:

- Battery
- Ignition switch
- Battery cables
- Starter motor assembly
- Starter safety switch
- Flywheel assembly

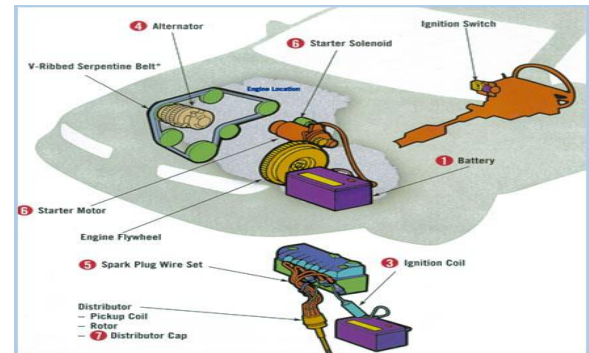


Fig: Basic starting components

The starter circuit has two separate circuits.

- 1) The control circuit
- 2) The starter circuit

Control circuit:

This circuit connects battery power at the ignition switch to the magnetic switch which controls the high current to the starter motor.

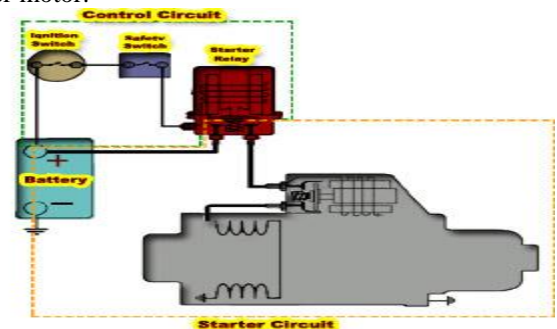


Fig: Control circuit

Starter circuit:

This circuit carries the heavy current from the battery to the starter motor through a magnetic switch in a solenoid.

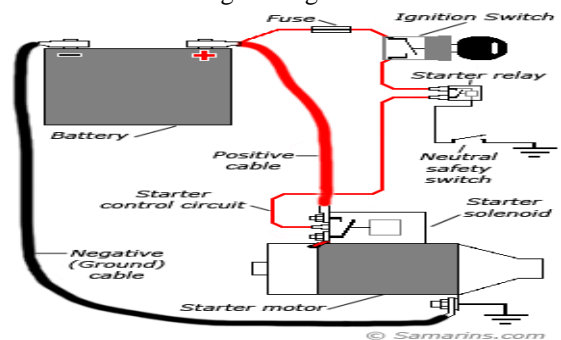


Fig: Starter circuit

**Armature:**

An Armature is the power producing component of an electric machine. The armature can be on either the rotor or the stator of the electric machine. The armature interacts with the magnetic field in the air gap; the field component can comprise either permanent magnet or electromagnets formed by a conducting coil.



Fig: Armature

In the armature, an electromotive force is created by the relative motion of the armature and the field. When the machine is used as a motor, this EMF opposes the armature current, and the armature converts electrical power to mechanical power in the form of torque, and transfers it via the shaft.

**Solenoid:**

Solenoid is the generic term for a coil of wire used as an electromagnet. It also refers to any device that converts electrical energy to mechanical energy using a solenoid. The device creates a magnetic field from electric current and uses the magnetic field to create linear motion. Common applications of solenoids are to power a switch, like the starter in an automobile, or a valve such as in a sprinkler system.

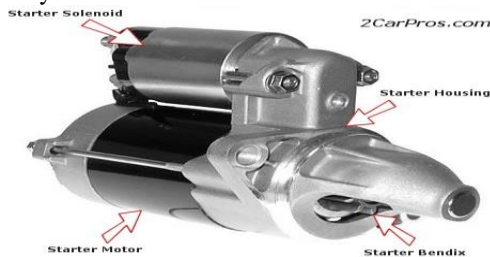


Fig: Solenoid

A Solenoid is a coil of wire in a corkscrew shape wrapped around a piston, often made of iron. As in all electromagnets, a magnetic field is created when an electric current passes through the wire. Electromagnets have an advantage over permanent magnets, in that they can be switched on and off by the application or removal of the electric current, which is what makes them useful as switches and valves and allows them to be entirely automated. In a solenoid, the electromagnetic field causes the piston to either move backward or forward, which is how motion is created by a solenoid coil.

**Epicycloidal Gear Train:**

An epicyclic gear train consists of two gears mounted so that the center of one gear revolves around the center of the other. A carrier connects the centers of the two gears and rotates to carry one gear, called the planet gear, around the

other, called the sun gear. The planet and sun gears mesh so that their pitch circles roll without the slip. A point on the pitch circle of the planet gear traces an epicycloid curve. In this simplified case, the sun gear is fixed and the planetary gear roll around the sun gear.



Fig: EGT

**Fly wheel:**

The fly wheel is attached to the end of the crankshaft. Large diameter, makes it easy for starter to engage and rotate engine through gear reduction.



Fig: Fly wheel

**1.2 Objectives**

The objectives that are to be achieved by this project are as follows:

- To enable maximum types of testing starter
- To eliminate the redundant tasks
- To achieve an user friendly interaction by interfacing HMI
- To obtain a flexible and reliable system using Rexroth L20

**II LITERATURE SURVERY**

Tom Denton has done a paper on starter motor design. This paper describes about the design and function of each parts in starter.

Valerie Johnson has done a paper on working of starter motor. This paper has an complete information about cranking, load and performance of the motor.

Dr. Nebel has done a paper on programmable logic controller. The digital and analog inputs of PLC are explained in detail and also the applications of PLC are given briefly.

Lohr A Main has published a paper on Rexroth PLC functional blocks for field bus drivers. This paper consists of processing in a PLCopen functional block ,general information on data types, functional blocks for parameters access, communicating field bus access to the PLC , profibus interface setting and configuration of PLC Program.

Hans Braun in his book has described the starter motor, starting the internal combustion engine , starter motor design, starter motor variations and technology of electrical starting system, generation of electrical energy in the motor vehicle.

Chandramohan G and Senthil Kumar have described about overview of automobile starting system and their problems in their paper. This paper focuses on causes for various faults and different fault diagnosis methods and also various development in starter motor faults control. The need for electronic control unit based starting system with some of the safety features and online monitoring systems for indicating state of charge of battery is also discussed in the paper.

### III STARTER PERFORMANCE TEST BENCH



#### STARTER PERFORMANCE TEST BENCH MAIN FUNCTIONS

- Imported original servo motor as the load to achieve fixed torque and fixed speed two control modes. The speed control error is less than 5 rpm. The torque control error is less than 1Nm
- Each load point of the control measurement time can ensure within 1-2 seconds. The entire performance curve ensures within 10 seconds to complete
- Achieving speed, voltage, current, torque synchronization acquisition. The total sampling frequency is up to 250KS per second (4 $\mu$ s sampling interval)
- High precision, repeatability measurement error less than 5%;
- Achieving measurement results under the same measurement conditions for comparative analysis. This provides good data analysis platform for engineer on starter design
- The test bench is suitable for online mass testing and laboratory testing of the production line;
- During the entire process of performance testing, the contact pressure drop is monitored to detect reliable operation of the switch at each load point;

- Computer-controlled programmable starting power supply, up to 3000Amp, ripple less than 200mV, simulating 200-4000CCA battery (0-30m $\Omega$ );
- Test data can be queried and for curve analysis and comparison;
- Pneumatic clamping can reliably support high-power starter.

#### PC –BASED STARTER MOTOR TEST

- Starter motors are high speed DC series motors used in automobiles for cranking of engine during starting.
- NO LOAD TEST  
The test motor is run under no-load conditions for a present time to record speed, voltage and current. Here the motor is first disengaged from loading device and then switched on.
- DYNAMIC TEST  
The motor is gradually loaded from no-load up to its full load limit in a continuous ramp till stall condition with recording and plotting of the performance parameters
- TEMPERATURE RISE TEST  
This test is conducted for measuring the temperature rise on the motor body during the cyclic load test. The starter motor is repeatedly loaded to present loads for 10 cycles, the temperature is measured and displayed.
- ARMATURE RUN DOWN TIME TEST  
During the test, the motor will be ON until it reaches the no-load speed. Then the supply to the motor is switched off. The time taken by the motor to come to standstill is recorded.
- ENDURANCE TEST  
This test is similar to temperature rise test except that number of load cycles can be defined. Also, if the current along with the temperature exceeds the specified range, the system will trip.

#### CONCLUSION

Now industries are being replaced by Automation and robotics. All process and work are carried out by machines and robotics process automation. Every industrial sector like manufacturing, process industries, chemical, food & beverages, Oil Gas, Transport, machine tools every where Industrial automation is used. Today's competitive environment has placed a very high demand on automating manufacturing firm for quantitative and qualitative production. Performance testing, a non-functional testing technique performed to determine the system parameters in terms of responsiveness and stability under various workload. Performance testing measures the quality attributes of the system, such as scalability, reliability and resource usage. So every manufactured product need to be tested for efficient use in the future. Since the starter device chiefly responsible for carrying out the processes involved

in starting vehicles up, its efficiency takes a major role for long life time of the motor.

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