



MITIGATING RISKS & ENSURING RELIABILITY

A Deep Dive into Automotive
Electrical Component Testing

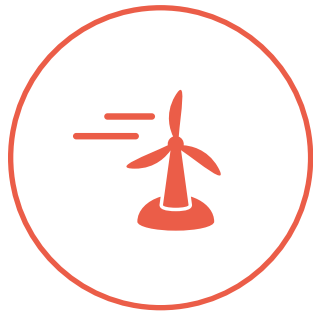
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OVERVIEW OF AUTOMOTIVE ELECTRICAL COMPONENTS



Automotive electrical components are the various electrical and electronic systems that power a vehicle's operations, from the engine and transmission to the lights and infotainment system. These components are strategically positioned throughout the vehicle to ensure efficient and reliable performance.



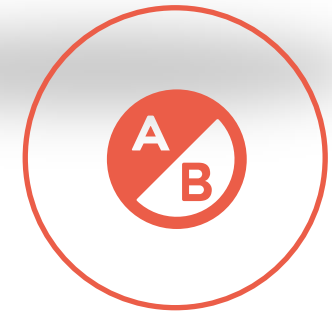
Engine Compartment Components

Covers electrical components like the alternator, battery, ignition system, and engine sensors that power and monitor the engine's performance.



Interior Components

Includes the instrument cluster, lighting controls, infotainment system, and various switches and sensors that manage the vehicle's interior functions.



Chassis Components

Focuses on electrical components in the vehicle's chassis, such as the anti-lock braking system (ABS), power steering, and electronic stability control, which enhance the vehicle's safety and handling.

IMPORTANCE OF RIGOROUS TESTING IN THE AUTOMOTIVE INDUSTRY



VEHICLE SAFETY



Rigorous testing ensures that vehicles meet stringent safety standards, protecting drivers and passengers in the event of a collision or accident.



ENVIRONMENTAL RESISTANCE

Thorough testing assesses the vehicle's ability to operate effectively in diverse environmental conditions, such as extreme temperatures, precipitation, and road conditions.

DURABILITY



Extensive testing evaluates the long-term performance and reliability of automotive components, ensuring they withstand the rigors of everyday use and environmental conditions.



REGULATORY COMPLIANCE

Rigorous testing enables manufacturers to ensure their vehicles and components comply with evolving safety, emissions, and other regulatory requirements, keeping them legally and environmentally compliant.

RIGOROUS TESTING IS ESSENTIAL IN THE AUTOMOTIVE INDUSTRY, ENSURING VEHICLE SAFETY, DURABILITY, ENVIRONMENTAL RESISTANCE, AND REGULATORY COMPLIANCE, ULTIMATELY CONTRIBUTING TO THE OVERALL RELIABILITY AND PERFORMANCE OF VEHICLES.

RELIABILITY & DURABILITY TESTING METHODS



- **VIBRATION TESTING**

Exposing the component to various vibration frequencies and amplitudes to simulate real-world driving conditions and ensure the component can withstand the vibrations without failure.

- **TEMPERATURE CYCLING**

Subjecting the component to extreme temperature changes, from heat to cold, to ensure it can operate reliably in a wide range of environmental conditions.

- **HUMIDITY AND MOISTURE TESTING**

Evaluating the component's resistance to moisture and humidity, which can cause corrosion and other issues, to ensure it can function correctly in various climate conditions.

- **MECHANICAL SHOCK AND TESTING**

Simulating sudden impacts and shocks the component may experience during normal use or in the event of an accident, to ensure its structural integrity and continued operation.

- **SALT SPRAY (CORROSION) TESTING**

Exposing the component to a salt-laden environment to assess its resistance to corrosion and its ability to maintain performance in harsh conditions.

- **ELECTRICAL TRANSIENTS**

Fast risetime, short duration energy pulses that commonly have voltage and current components often transmitted down data or power lines.

BENEFITS OF RELIABILITY TESTING

- **SAFETY**

Meeting the requirements guarantees that the product adheres to necessary safety standards. This reduces the risk of safety recalls, which can damage the reputation of both the OEM and the supplier, ultimately leading to increased customer satisfaction.

- **CUSTOMER SATISFACTION**

Passing the testing plan will lead to customer satisfaction with less warranty issues. This will also help develop brand loyalty.

- **LOWER ENGINEERING COST**

The success of passing a validation test results in lower engineering cost. Product design changes as a result of test related failure increased engineering cost and product launch delays.

CUSTOM TEST STANDS

Custom test stands are designed to provide a flexible and modular platform for rigorously testing automotive electrical components. They offer the ability to precisely simulate real-world operating conditions, enabling comprehensive data acquisition and analysis to ensure the reliability and performance of these critical components.



TEST STAND BUILDING – THE PROCESS

Purpose of Test Stands

- The primary purpose of the test stand is to electrical monitor and exercise the DUT during various test.

Key Components of Test Stands

- The standard components in a testing stand are power supplies, data acquisition, thermocouples. PLC and product specific programs are used to operate the product at different voltages and functional states required by the test plan.

Design Principles for Test Stands

- Key areas to focus on include sample size, voltage requirements, and current specifications. Product functionality should be addressed, as it will determine the types of controls needed for operational modes and voltage minimums and maximums. Additionally, data acquisition requirements will be guided by the number of data points and sample rate necessary to provide a clear and comprehensive picture of the testing process.

KEY PARAMETERS FOR TESTING ELECTRONIC COMPONENTS



- **VOLTAGE**

Verifying the component's ability to operate within the specified voltage range, including any sudden voltage spikes or drops that may occur in the automotive electrical system.

- **CURRENT**

Evaluating the component's capacity to handle the expected current loads, both during normal operation and under fault conditions, to ensure safe and reliable performance.

- **FLOW RATES**

Assessing the component's ability to maintain the required fluid or gas flow rates, such as in cooling systems or fuel delivery, to optimize system performance and prevent failures.

- **TEMPERATURE**

Examining the component's tolerance to a wide range of operating temperatures, from extreme cold to high heat, to ensure it can withstand the environmental conditions encountered in automotive applications.

- **PRESSURE**

Verifying the component's structural integrity and sealing capabilities under varying pressure conditions, such as those experienced in fuel systems, turbochargers, or other pressurized automotive systems.

COMMON TESTING EQUIPMENT



- **MULTIMETERS**

Precision digital multimeters used to measure voltage, current, resistance, and other electrical parameters for component performance evaluation.

- **DATA ACQUISITION SYSTEMS**

Sophisticated data logging and analysis systems that capture and process real-time sensor data to evaluate component performance and reliability.

- **OSCILLOSCOPES**

High-bandwidth oscilloscopes that capture and analyze waveforms to assess signal integrity and timing characteristics of electrical circuits.

- **POWER SUPPLIES**

Programmable, high-precision power supplies that provide regulated DC and AC power for component stress testing under various voltage and current conditions.

SPECIALIZED TESTING EQUIPMENT



- **PLC**

Use to control repetitive task in automation or timing between functions. Low voltage can be used on test stands to switch higher voltage and current devices need for high sample count testing.

- **CHILLERS**

Automated temperature control systems that maintain precise operating temperatures for component testing under extreme environmental conditions.

- **ARBITRARY WAVEFORM GENERATOR**

Used to introduce simple and complex waveforms that automotive components would be subjected to in the application.

- **CAN/LIN**

Serial communication used in automotive to connect devices. Commonly used in engine controllers, headlamps, and transmission controllers.

- **INDUCTIVE LOADS**

Simulate AC motors for EV and Hybrid vehicles to ensure their safety.

SAFETY CONSIDERATIONS FOR HIGH-VOLTAGE SYSTEMS

- **UNDERSTAND SYSTEM VOLTAGE**
Identify the voltage levels of the high-voltage automotive electrical system, typically ranging from 200V to 800V DC.
- **WEAR APPROPRIATE PPE**
Use insulated gloves, face shields, and other protective equipment to prevent electric shocks and burns when working on high-voltage systems.
- **ENSURE PROPER TOOL SELECTION**
Use only insulated and rated tools when working on high-voltage components to minimize the risk of short circuits and electric arcs.
- **IMPLEMENT LOCKOUT/TAGOUT PROCEDURES**
Isolate the high-voltage system from power sources and use locks and tags to prevent accidental energization during maintenance or repair.
- **MAINTAIN A SAFE WORK ENVIRONMENT**
Keep the work area clean, dry, and free of conductive materials to reduce the risk of electrical hazards.

CUSTOM TEST STAND BENEFITS



CUSTOMER BENEFITS

- Consistent testing approach
- Data management and review
Real time failure notification
- Verification of product failures
- Minimizes test related errors
- Product safety and
repeatability
- Leverage test lab technical
expertise

LABORATORY BENEFITS

- Safety built into design
- Automation
- Precision test control
- Software version control.
- Confidence of test results.
- Failure root cause
- Cost saving for customer

QUESTIONS?



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