



Smart Component Tester

Arote Shamkant^a, Kanawade Aditya^b, Paimode Manish^c, Prof. Satpute Adinath^{d*}

Samarth Polytechnic, Belhe, Pune, 412410, India

ABSTRACT :

The Adjustable DC Smart Component Tester is a compact and intelligent electronic testing system designed to simplify the testing and analysis of basic electronic components. Conventional component testing methods often require separate instruments such as multimeters, power supplies, and specialized testing equipment, which can increase testing time and complexity. The proposed system combines an adjustable DC power supply with a smart component testing circuit to provide a convenient and efficient solution for electronic component analysis. The system allows the user to adjust the DC test voltage according to the requirements of the component under test. It can be used to examine components such as resistors, diodes, LEDs, capacitors, transistors, and other low-power electronic devices. The tester measures relevant electrical parameters and provides an indication of the component's operating condition, helping to identify normal, faulty, or damaged components. The proposed system is useful in electronics laboratories, repair workshops, educational institutions, and small-scale electronic servicing applications. Its simple design, adjustable output, and smart testing approach can reduce manual effort and improve the reliability and speed of component testing. The system demonstrates how basic electronic measurement techniques can be integrated into a low-cost and user-friendly testing platform.

Keywords: Adjustable DC Supply, Smart Component Tester, Electronic Components, Component Testing, Fault Detection, DC Voltage, Electronics Testing.

Introduction

Electronic components are the fundamental building blocks of modern electronic systems and are widely used in circuits, control systems, communication equipment, consumer electronics, and industrial applications. The proper functioning of these components is essential for the reliable operation of an electronic circuit. Therefore, testing and identifying faulty components is an important part of electronic circuit development, maintenance, and repair. Traditionally, component testing is carried out using separate instruments such as digital multimeters, regulated power supplies, capacitance meters, and transistor testers. Using multiple instruments can make the testing process time-consuming, complicated, and less convenient, especially for students and technicians working in small repair workshops.

The Adjustable DC Smart Component Tester is proposed as a simple and efficient solution for testing basic electronic components. The system combines an adjustable DC power supply with a component testing and indication section. The adjustable supply allows the test voltage to be varied according to the requirements of the component under test. By applying a suitable voltage and observing the electrical response, the user can determine the operating condition of different components.

The proposed tester can be used for testing components such as resistors, diodes, LEDs, capacitors, transistors, and other low-power electronic devices. It is intended to provide a user-friendly and economical testing platform that reduces the need for multiple separate instruments. The system can be particularly useful in educational laboratories, electronics servicing centers, repair workshops, and small-scale electronic testing applications.

The main objective of this research is to develop a compact, adjustable, and smart component testing system that improves the convenience, speed, and reliability of basic electronic component testing while maintaining a simple and low-cost design.

Leturature Review

The testing of electronic components has been an important area of study in electronics engineering because the reliability of an electronic system depends significantly on the condition of its individual components. Traditional testing methods commonly use digital multimeters, regulated DC power supplies, LCR meters, and semiconductor testers to measure electrical parameters and identify faulty components. These instruments provide accurate measurements, but using separate instruments for different components can increase the complexity and time required for testing.

Several researchers and electronic equipment designers have developed automatic component testers to overcome the limitations of conventional testing methods. Microcontroller-based component testers have become popular because they can automatically identify components and measure

parameters such as resistance, capacitance, diode voltage, transistor characteristics, and continuity. Such systems reduce manual calculations and provide quick test results.

Adjustable DC power supplies are also widely used in electronic laboratories and repair applications. They allow the testing voltage to be varied according to the requirements of different components and circuits. Voltage regulation and current limiting are important features because they protect the component under test from excessive electrical stress. The integration of an adjustable power supply with a component testing circuit can therefore provide a more flexible testing platform.

Recent developments in embedded systems and low-cost sensors have further improved the possibilities for smart electronic testing equipment. Microcontrollers can process measured electrical values and provide visual or digital indications of component conditions. However, many existing component testers are either limited to specific components or require additional instruments for power control and measurement.

Based on the reviewed approaches, there is a need for a compact and economical system that combines adjustable DC power, component testing, measurement, and indication in a single unit. The proposed Adjustable DC Smart Component Tester addresses this requirement by integrating these functions into a user-friendly testing platform suitable for educational laboratories, electronics repair workshops, and basic component analysis.

Behaviour Analysis Module

The Behaviour Analysis Module of the Adjustable DC Smart Component Tester is responsible for observing and analysing the electrical response of the component under test. The module helps determine whether a component is operating normally or showing abnormal behaviour when a controlled DC voltage is applied.

The testing process begins by connecting the component to the appropriate test terminals. The adjustable DC supply provides a controlled voltage to the component, while the measurement section monitors the corresponding electrical response. Depending on the component type, parameters such as voltage, current, resistance, capacitance, or forward voltage can be considered for analysis.

For semiconductor components such as diodes and LEDs, the forward voltage and current response can be observed to determine their operating condition. For resistors, the applied voltage and measured current can be used to verify the resistance value according to Ohm's law. Capacitors can be analysed by observing their charging and discharging behaviour, while transistor testing can be performed by analysing the electrical response at the appropriate terminals.

The measured values are compared with expected or reference characteristics of the component. If the measured response falls within an acceptable range, the component can be considered Normal/Good. If the response significantly differs from the expected behaviour, the component may be identified as Faulty or Suspected. Protection features such as current limiting help prevent excessive current from damaging the component during testing.

The Behaviour Analysis Module therefore provides a systematic method for evaluating component performance. It improves testing convenience, reduces manual observation, and provides a basis for developing a smart and reliable component testing system.

Basic Behaviour Analysis Flow:

Component Under Test → Adjustable DC Supply → Measurement Section → Parameter Analysis → Comparison with Reference Value → Good/Faulty Indication

Proposed Methodology

The proposed **IoT Based Smart Workshop Energy Monitoring and Automation System** is designed to monitor electrical energy consumption and automatically control workshop equipment. The methodology consists of sensing, data processing, IoT communication, behaviour analysis, and automation.

1. Data Sensing

Electrical sensors are connected to the workshop loads to measure parameters such as **voltage, current, power, and energy consumption**. These sensors continuously collect real-time electrical data from machines, lights, fans, and other equipment.

2. Data Processing

A microcontroller such as **ESP32/ESP8266** receives the sensor readings and processes the collected data. The controller calculates important parameters and checks whether the equipment is operating within predefined limits.

3. IoT Communication

The processed data is transmitted through a **Wi-Fi network** to an IoT/cloud platform. This enables real-time monitoring of workshop energy consumption through a mobile or web-based interface.

4. Behaviour Analysis

The system analyzes energy consumption patterns, operating duration, and switching behaviour. It identifies abnormal or unnecessary energy usage by comparing present readings with predefined limits and previous consumption data.

5. Automation and Control

Based on the analyzed data, the system can control electrical loads using **relay modules**. Equipment can be switched ON/OFF automatically according to schedules, operating conditions, or user commands.

6. Monitoring and Alerts

The user can view real-time energy information and receive alerts when abnormal consumption or predefined threshold conditions are detected.

Overall Flow

Electrical Loads → Sensors → ESP32/ESP8266 → Data Processing → IoT Platform → Behaviour Analysis → Automation/Alerts → User

System Architecture

rent Sensing Unit

↓

Control / Processing Unit

↓

Display / Result Indication

5.2 Power Supply Unit

The Power Supply Unit provides the required electrical power to the complete testing system. It converts the available input source into a suitable regulated DC supply for the testing and control circuits.

5.3 Adjustable DC Voltage Regulator

The adjustable voltage regulator provides a variable DC output according to the requirements of the component under test. The output voltage can be adjusted within the designed operating range. This allows different components to be tested under suitable voltage conditions.

5.4 Protection and Current Limiting Circuit

The protection section limits the maximum current supplied to the component. It protects both the component under test and the testing circuit from excessive current and accidental short circuits.

5.5 Component Testing Unit

The Component Testing Unit contains suitable terminals or sockets where the electronic component is connected. Different types of components, such as resistors, diodes, LEDs, capacitors, and transistors, can be tested using appropriate test configurations.

5.6 Voltage and Current Measurement Unit

This unit measures the voltage applied to the component and the current flowing through it. The measured parameters are used to determine the electrical behaviour and condition of the component.

5.7 Control and Processing Unit

The Control/Processing Unit receives the measured electrical parameters and processes them according to predefined testing conditions. A microcontroller can be used in an advanced version of the system to automate measurement, calculation, component identification, and fault detection.

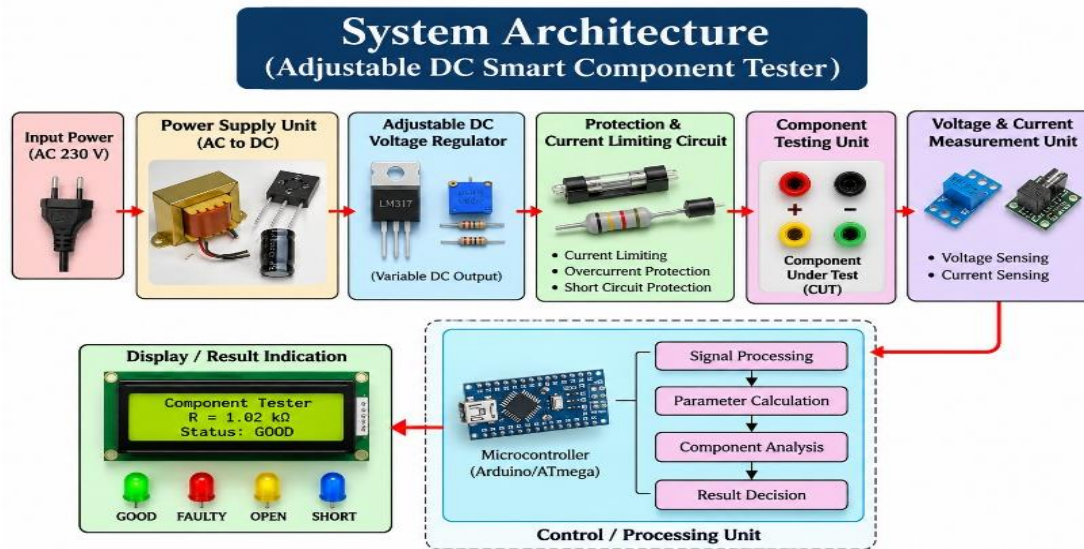
5.8 Display and Indication Unit

The final testing result is displayed or indicated to the user. LEDs, a digital display, or an LCD/OLED display can be used to indicate parameters and component status such as GOOD, FAULTY, OPEN, or SHORT.

5.9 Overall System Operation

The system first generates an adjustable and regulated DC voltage. The selected component is then connected to the testing terminals. A controlled voltage is applied to the component while its voltage and current response are measured. The measured data is processed and compared with the expected characteristics of the component. Finally, the testing result is displayed to the user.

Thus, the proposed architecture integrates power control, measurement, protection, analysis, and indication into a single platform, providing a convenient and economical solution for basic electronic component testing.



Conclusion

The **Adjustable DC Smart Component Tester** provides a simple, economical, and efficient approach for testing basic electronic components. The proposed system combines an adjustable DC power supply, protection and current-limiting circuit, voltage and current measurement, component analysis, and result indication into a single testing platform. This integration reduces the need for multiple separate instruments and simplifies the component testing process.

The system can be used to analyse the electrical behaviour of components such as resistors, diodes, LEDs, capacitors, and transistors under controlled test conditions. By measuring electrical parameters and comparing them with expected characteristics, the system can help identify normal, faulty, open, or short-circuit conditions. The adjustable voltage feature provides flexibility for testing components with different operating requirements, while the protection circuit improves testing safety.

The proposed system is particularly suitable for electronics laboratories, educational institutions, repair workshops, and basic servicing applications. Its compact and low-cost design makes it accessible to students and technicians. In future development, advanced microcontroller-based automation, digital parameter display, automatic component identification, data logging, and improved fault-detection algorithms can be incorporated. Thus, the proposed tester demonstrates the potential of integrating adjustable power and smart measurement techniques to achieve faster, safer, and more convenient electronic component testing.

REFERENCES

1. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, 7th ed., Oxford University Press, 2015.
2. T. L. Floyd, *Electronic Devices*, 9th ed., Pearson Education, 2012.
3. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 11th ed., Pearson Education, 2013.
4. P. Horowitz and W. Hill, *The Art of Electronics*, 3rd ed., Cambridge University Press, 2015.
5. J. Millman and C. C. Halkias, *Integrated Electronics: Analog and Digital Circuits and Systems*, McGraw-Hill Education.
6. Texas Instruments, *LM317 3-Terminal Adjustable Regulator Datasheet*, Texas Instruments.
7. M. H. Rashid, *Electronic Devices and Circuit Applications*, Cengage Learning.
8. R. P. Jain, *Modern Digital Electronics*, 4th ed., McGraw Hill Education, 2010.
9. A. P. Malvino and D. J. Bates, *Electronic Principles*, 8th ed., McGraw-Hill Education, 2015.
10. Arduino, *Arduino Microcontroller Documentation and Technical Reference*, Arduino Documentation.