

Adjustable DC Power Supply with Digital Monitoring & Protection

Hande Gita¹, Shelke Asmita², Dhokare Sanika³, Prof. Satpute Adinath⁴

Student, E&TC, Samarth Polytechnic, Belhe, India¹⁻³

Guide, E&TC, Samarth Polytechnic, Belhe, India⁴

Abstract: An Adjustable DC Power Supply with Digital Monitoring and Protection is designed to provide a stable, variable, and reliable DC output for electronic testing, laboratory experiments, circuit development, and repair applications. The proposed system allows the user to adjust the output voltage according to the requirements of different electronic devices and circuits. A digital monitoring unit continuously measures and displays important electrical parameters such as output voltage and load current, enabling accurate and real-time observation of the power supply operation.

To improve system safety and reliability, protection features such as overcurrent, short-circuit, and overvoltage protection are incorporated. These mechanisms help protect both the connected load and the power supply components from damage during abnormal operating conditions. The system combines voltage regulation, digital measurement, and electrical protection in a single compact unit. Compared with a conventional basic DC power supply, the proposed design provides improved monitoring, operational safety, and ease of use. The developed system can be effectively used in educational laboratories, electronics workshops, prototype development, and electronic equipment servicing.

Keywords: Adjustable DC Power Supply, Voltage Regulation, Digital Monitoring, Overcurrent Protection, Short-Circuit Protection, Overvoltage Protection, Electronic Testing.

INTRODUCTION

A DC power supply is one of the most essential instruments used in electronic laboratories, workshops, testing systems, and research applications. Most electronic circuits require a stable and regulated DC voltage for their proper operation. Conventional power supplies generally provide a fixed or manually adjusted output voltage, but they may have limited monitoring and protection features. Variations in load conditions, excessive current, short circuits, and improper connections can damage electronic components and reduce the reliability of the system.

An adjustable DC power supply provides a variable output voltage according to the requirements of different electronic circuits and devices. By incorporating digital monitoring, the output voltage and load current can be measured and displayed in real time. This allows the user to observe the operating condition of the connected load accurately and make necessary adjustments during testing and experimentation.

The proposed Adjustable DC Power Supply with Digital Monitoring and Protection combines voltage adjustment, digital measurement, and protection mechanisms into a single system. The system is designed to provide regulated DC output while continuously monitoring important electrical parameters. Protection features such as overcurrent, short-circuit, and overvoltage protection help prevent damage to the power supply and connected electronic components under abnormal operating conditions.

The main objective of this work is to develop a compact, reliable, user-friendly, and cost-effective DC power supply suitable for laboratory experiments, electronic circuit development, prototype testing, and repair applications. The integration of digital monitoring and protection improves the safety, accuracy, and practical usability of the proposed system compared with a basic adjustable DC power supply.

LITERATURE REVIEW

Several studies and practical developments have focused on improving DC power supplies in terms of voltage regulation, efficiency, monitoring, and protection. Traditional linear power supplies use transformer, rectifier, filter, and voltage regulator stages to obtain a stable DC output. These systems provide good voltage regulation and low output noise, but they can have higher power losses and heat generation, particularly at higher load currents.

Switch-mode power supplies (SMPS) have been widely studied as an alternative because they provide higher efficiency, reduced size, and better power utilization. However, their switching operation can introduce electrical noise and requires appropriate control and filtering techniques. Adjustable regulator circuits have also been developed to provide variable DC output voltage for different electronic applications.

Recent approaches have integrated microcontrollers and digital sensors into power supply systems to enable real-time monitoring of voltage and current. Digital displays provide users with accurate information about the operating condition of the supply and connected load. Microcontroller-based systems can also implement automatic control and protection functions based on predefined voltage and current limits.

Protection mechanisms are an important part of modern DC power supplies. Previous designs commonly incorporate overcurrent protection, short-circuit protection, overvoltage protection, and thermal protection to reduce the possibility of component failure and improve system reliability. Current-sensing circuits can detect excessive load current and initiate protective action when the specified limit is exceeded.

From the reviewed approaches, it can be observed that combining adjustable voltage regulation, digital monitoring, and multiple protection mechanisms in a single low-cost system can improve the usability and safety of a laboratory power supply. Therefore, the proposed system focuses on integrating these features into a compact and user-friendly adjustable DC power supply suitable for electronic laboratories, workshops, testing, and prototype development.

BEHAVIOUR ANALYSIS MODULE

The Behaviour Analysis Module is responsible for observing and evaluating the operating conditions of the proposed Adjustable DC Power Supply with Digital Monitoring and Protection. The module continuously monitors important parameters such as output voltage, load current, and the status of the connected load. The measured values are compared with predefined safe operating limits to identify abnormal conditions.

During normal operation, the system maintains the selected output voltage and displays the measured voltage and current on the digital monitoring unit. When the load current increases beyond the specified limit, the module identifies an overcurrent condition and activates the protection mechanism. Similarly, if a short circuit or abnormal voltage condition occurs, the system responds by disconnecting or limiting the output to protect the connected circuit and power supply components.

The module can be implemented using a microcontroller, voltage-sensing circuit, and current-sensing circuit. The microcontroller processes the sensor signals and determines the operating condition of the system. Based on the measured parameters, it can provide real-time information to the user and control the protection circuit when required.

The behaviour of the system can therefore be classified into three basic conditions: **Normal Condition, Overload/Overcurrent Condition, and Fault/Short-Circuit Condition**. This analysis enables the power supply to respond appropriately to changing load conditions and improves overall system safety, reliability, and operational stability.

PROPOSED METHODOLOGY

The proposed methodology focuses on the design and development of an **Adjustable DC Power Supply with Digital Monitoring and Protection**. The system is designed to provide a variable and regulated DC output while continuously monitoring voltage and current and protecting the connected load from abnormal operating conditions.

The proposed system consists of several functional stages, including **AC input, voltage conversion, rectification, filtering, voltage regulation, sensing, digital monitoring, and protection**. The AC input is first converted to a suitable voltage level and then rectified to obtain DC voltage. A filtering stage reduces unwanted ripple from the rectified output. The filtered DC voltage is then regulated using an adjustable voltage regulator to obtain the required output voltage. Voltage and current sensing circuits are used to measure the output parameters continuously. The sensed signals are provided to a microcontroller or digital monitoring unit, which processes the measured values and displays the voltage and current on a digital display. This provides real-time information about the operating condition of the power supply. For system protection, predefined voltage and current limits are established. When the output current exceeds the specified safe limit, the controller activates the overcurrent protection mechanism. In the event of a short circuit, the output is limited or disconnected to prevent excessive current flow. Overvoltage protection is also incorporated to prevent the connected electronic components from receiving an unsafe voltage.

The proposed methodology can be summarized as follows:

AC Input → Voltage Conversion → Rectification → Filtering → Adjustable Regulation → Voltage/Current Sensing → Digital Monitoring → Protection → DC Output

The overall system is tested under different load conditions to evaluate output voltage stability, current measurement, protection response, and system performance. The proposed approach aims to achieve a reliable, user-friendly, and cost-effective power supply suitable for electronic laboratories, workshops, circuit testing, and prototype development.

SYSTEM ARCHITECTURE

The system architecture of the proposed **Adjustable DC Power Supply with Digital Monitoring and Protection** consists of interconnected functional blocks that work together to provide regulated and protected DC power. The architecture includes the power conversion section, regulation section, sensing and monitoring section, control section, and protection section.

The **AC Input** supplies electrical power to the system. A **Transformer/Voltage Conversion stage** reduces the input voltage to a suitable level. The reduced AC voltage is then converted into DC using a **Rectifier**. A **Filter Circuit** removes unwanted AC ripple and produces a smoother DC voltage.

The filtered DC voltage is supplied to the **Adjustable Voltage Regulation Unit**, which allows the user to set the required output voltage. The regulated output is supplied to the connected load through the output terminals.

A **Voltage Sensor** and **Current Sensor** continuously measure the output voltage and load current. The sensor signals are processed by the **Microcontroller/Control Unit**. The measured values are displayed on a **Digital Display**, allowing the user to monitor the power supply parameters in real time.

The **Protection Unit** monitors abnormal operating conditions such as overcurrent, short circuit, and overvoltage. When a parameter exceeds its predefined safety limit, the control unit activates the appropriate protection mechanism and limits or disconnects the output. This prevents damage to the power supply and connected electronic equipment.

[1] System Architecture Flow

AC Input → Transformer → Rectifier → Filter → Adjustable Voltage Regulator → DC Output

DC Output → Voltage Sensor + Current Sensor → Microcontroller → Digital Display

Microcontroller → Protection Unit → Output Control

The integrated architecture provides adjustable output voltage, real-time digital monitoring, and automatic protection, making the system suitable for laboratory experiments, electronic testing, circuit development, and repair applications.

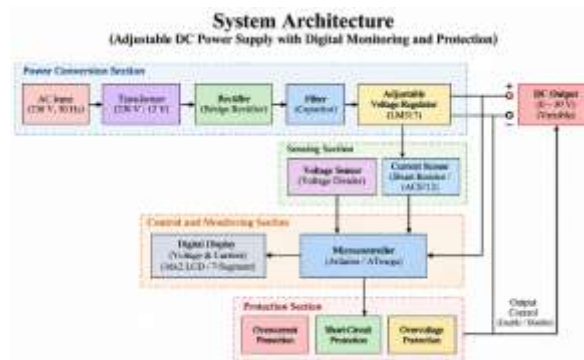


Fig. 1. Block Diagram of Adjustable DC Power Supply with Digital Monitoring and Protection

CONCLUSION

The proposed Adjustable DC Power Supply with Digital Monitoring and Protection provides a reliable and flexible solution for supplying regulated DC power to electronic circuits and devices. The system allows the output voltage to be adjusted according to the load requirements while continuously monitoring voltage and current through a digital monitoring unit.

The integration of voltage and current sensing with a microcontroller enables real-time display and observation of electrical parameters. Protection features such as overcurrent, short-circuit, and overvoltage protection improve the safety and reliability of the system by reducing the risk of damage during abnormal operating conditions.

The proposed system is compact, user-friendly, and suitable for electronic laboratories, workshops, circuit testing, prototype development, and repair applications. Overall, the combination of adjustable voltage regulation, digital monitoring, and automatic protection provides improved functionality and operational safety compared with a conventional basic DC power supply. laboratory experiments, electronic testing, circuit development

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