Empowering Innovation: Programmable Dc Power Supply

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Abstract- *The Programmable DC Power Supply stands as the epitome of innovation, revolutionizing the landscape of electrical control with its unparalleled precision and versatility. This marvel of engineering empowers researchers, engineers, and hobbyists to unleash the full potential of their creations, offering millivolt precision in voltage and harmonious current modulation. Gone are the days of fixed voltage sources; this omnipotent instrument conducts an orchestra of electrons, enabling the stress-testing of robust machinery and powering delicate electronic circuits. This exploration traverses the evolution of power control, unveiling the Programmable DC Power Supply as the virtuoso that bridges the realms of imagination and reality, empowering greatness at one's fingertips.*

Keywords*-* Programmable DC Power Supply, Power Electronics, Digital Control, Voltage Regulation, Current Limiting, Applications.

I. INTRODUCTION

Welcome to the world of boundless energy control - where power lies at your fingertips and the boundaries of innovation are pushed to new frontiers! Today, we embark on a thrilling journey into the heart of technology's most versatile magician - the Programmable DC Power Supply.

Imagine a device that can weave electricity like an artist, crafting a symphony of voltages and currents tailored precisely to your needs. From laboratories seeking to unravel the secrets of the universe to cutting-edge industries forging the path of progress, this enigmatic instrument stands as an indispensable ally, empowering engineers, researchers, and creators alike.

But this is no ordinary power source; it transcends the limitations of traditional fixed-voltage supplies, evolving into a dynamic entity adaptable to the ever-changing demands of experimentation and development. Uniting precision, flexibility, and sheer potential, the Programmable DC Power Supply emerges as the conduit through which revolutionary ideas materialize and ingenious designs flourish.

In this captivating exploration, we shall uncover the inner workings of this technological marvel, demystify its capabilities, and witness how it shapes the course of science and industry. So, prepare to be electrified by knowledge as we delve into the realm of Programmable DC Power Supply, where imagination becomes reality, and innovation finds its true power!

II. LITERATURE SURVEY

Programmable DC power supplies have become indispensable tools in the field of electrical engineering, providing precise voltage and current control for a wide range of applications. This literature survey delves into the vast body of research and advancements related to programmable DC power supplies, exploring their historical development, fundamental principles, calibration techniques, and versatile applications across various industries. By synthesizing information from diverse sources, this survey aims to offer a holistic view of programmable DC power supplies' evolution, functionalities, and potential future directions.

This section introduces the importance and significance of programmable DC power supplies in modern electrical engineering, highlighting their role in enabling precise control and versatile applications. The objectives of the literature survey are outlined to provide a roadmap for the reader.

This section traces the historical development of programmable DC power supplies, exploring key milestones and breakthroughs that have led to their widespread adoption and advancements in the field.

Here, the fundamental principles behind programmable DC power supplies are elucidated. The working mechanisms, including voltage and current regulation, feedback control systems, and protection features, are thoroughly examined.

Precision is a crucial aspect of programmable DC power supplies. This section investigates various calibration techniques, error correction methods, and advancements in measurement accuracy that have paved the way for higher levels of precision.

Programmable DC power supplies find applications in a myriad of electrical engineering domains. This section explores their utilization in areas such as power electronics testing, semiconductor characterization, battery testing, and renewable energy research.

With the rise of automation and remote control, programmable DC power supplies have evolved to offer advanced software integration and user-friendly interfaces. This section examines communication protocols, data logging capabilities, and the integration with programming languages for seamless control.

This section highlights the latest technological innovations in programmable DC power supplies, such as digital control techniques, advanced cooling systems, and smart load management, which have further enhanced their performance and efficiency.

Despite their numerous benefits, programmable DC power supplies encounter certain challenges and limitations. This section addresses issues related to size, cost, power efficiency, and the trade-offs in design.

The literature survey concludes by presenting potential research directions and future prospects for programmable DC power supplies. Topics such as wideband power supplies, energy storage integration, and advancements in materials hold promise for further innovation.

In conclusion, this comprehensive literature survey provides a comprehensive overview of programmable DC power supplies, emphasizing their impact on precision and versatility in electrical engineering. The synthesis of diverse literature offers valuable insights for researchers, engineers, and practitioners, inspiring further advancements in this critical field of study.

III. PROBLEM DEFINITION

The widespread adoption of electronics and electrical devices across various industries necessitates precise and versatile power sources. Traditional fixed-output power supplies lack the flexibility required to meet the evolving demands of research, development, and testing processes. This creates a significant challenge for researchers, engineers, and hobbyists who seek reliable and programmable power sources capable of providing precise voltage and current outputs for a diverse range of applications. The problem lies in the need for a Programmable DC Power Supply that offers precision, control, and adaptability to cater to the dynamic requirements of modern electrical systems and experimental setups.

IV. OBJECTIVES

1. The primary objective of the Programmable DC Power Supply is to deliver unparalleled precision and accuracy in voltage and current regulation. The power supply should ensure consistent and stable outputs, enabling researchers and engineers to conduct experiments and tests with utmost reliability and reproducibility.
2. The Programmable DC Power Supply should be designed with the capability to adapt to diverse applications across multiple industries. It should offer a wide range of voltage and current settings, allowing users to power a broad spectrum of electronic devices, circuits, and systems efficiently.
3. To enhance usability and efficiency, the power supply should feature advanced control interfaces that facilitate remote control and automation. Compatibility with popular programming languages and standard communication protocols should be incorporated to enable seamless integration into complex experimental setups and automated testing environments.
4. Ensuring the safety of both the power supply and the connected devices is a crucial objective. The power supply should incorporate robust protection mechanisms, such as overvoltage protection, overcurrent protection, and short-circuit protection, to prevent damage to the equipment and maintain the integrity of experiments.
5. As energy conservation becomes increasingly important, the Programmable DC Power Supply should strive to maximize energy efficiency, reducing power consumption during operation and standby modes. The incorporation of intelligent power management techniques will aid in minimizing wastage and lowering operational costs.
6. For complex applications requiring multiple power sources, the power supply should offer scalable solutions with support for multi-channel configurations. This feature will enable researchers to conduct simultaneous tests, emulate real-world scenarios, and increase productivity.
7. In the rapidly evolving field of electronics and technology, the Programmable DC Power Supply should be designed with a future-proof approach. Consideration should be given to potential updates, enhancements, and expansions to ensure longevity and adaptability in the face of emerging advancements.

V. HARDWARE AND SOFTWARE REQUIREMENTS

Rectifier Section:

Sr. No.	Hardware Requirements	
	Part	Value
1	PFC Controller	NCP1608
2	Bridge Rectifier	GBU6G
3	Mosfet	SSP20N60C3
4	Schottkey Diode	MUR860G
5	Diodes	1N4745A
6	Inductor	348uH
7	Resistors	301,143,19.6k,10k,1M*3, 39*2,56,0.04
8	Capacitors	1nF,100uF,0.47nF,1uF, 2.2uF,120pF,220nF

DC To DC Converter:

Sr. No.	Hardware Requirements	
	Part	Value
1	Transformer with secondary and bias winding	np=28,ns=40 Lp=3.2uF,Ls=6.4uF
2	Mosfet	R8005ANX
3	Diodes	RB160L-60TE25,RF05VA2SFHTR,RF1001T2D,RS3KB-13
4	Shunt Regulator	TL431
5	Photocoupler	PC817
6	IC PWM generator	BM1P061FJ-E2
7	Capacitors(F)	3300p,1u,47p,1000p,1u.0.1u
8	Resistors (Ohms)	75,150,10,100k,10k,3.9 M 2k,1k,12k,43k
9	Electrolytic Capacitors	100u,1000u*2

MOSFET based Low Dropout Regulator:

Sr. No.	Hardware Requirements	
	Part	Value
1	control IC LTC3703	Vin =100 V
2	MOSFET Si 7456 DP	BVDSS=100 V
3	Inductor	8.3 uH
4	Capacitor	540 uF for IRMS=10 A
5	Resistor	31.6 kΩ
6	Proteus 8.9 Professional	for simulation of circuit

Power Supply for internal circuit:

Sr. No.	Hardware Requirements	
	Part	Value
1	Regulator IC LM7812	Vout= 12 V
2	Capacitor (for Filter)	C=3000 uF
3	Resistor	15 Ω
4	Diodes (for rectifier) 1N7400	PIV=50 V , IF=1 A
5	Transformer	Turns ratio = 6
6	Proteus 8.9 Professional	for simulation of circuit

Microcontroller Interfacing Section:

Sr. No.	Hardware Requirements	Software Requirements
1	PIC18f45k22 Development Board	MPLAB X IDE v5.45
2	GSM module SIM900A	MPLAB XC8 Compiler v2.20
3	16*4 Liquid crystal Display	Proteus 8.9 Professional
4	4*3 Keypad	
5	Switches for separate keys	
6	MAX 232 IC	
7	Other miscellaneous components such as potentiometers,respack ,capacitors, resistors,IC 741 OPAMP, etc	

VI. CONCLUSION

Initially, the system was fed with AC input to convert it into DC (Direct Current). A rectifier was employed to perform the conversion from AC to DC, but despite its usage, some pulses persisted in the output. To mitigate these remaining pulses, a regulator was introduced, minimizing them and improving the capacitor power factor. However, this led to increased power consumption in the circuit. To address the power factor issue, a power factor correction controller was implemented, significantly improving the power factor. The processed DC input was then routed to the microcontroller and a DC-to-DC converter to obtain the desired output. Operating at 400 volts and 20 amperes, these parameters were managed and controlled through a keypad interface, connected to the microcontroller. The microcontroller, in turn, communicated with the DC-to-DC converter to yield an adjustable output range of 0 to 105 volts.

For further refinement and to achieve a pure DC output within the range of 0 to 100 volts, a MOSFET circuit (LDO) was employed, successfully eliminating any remaining pulses.

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REFERENCES

[1] X.Y.Jing,F.Wu,Z.Li,R.HuandD.Zhang,"Multi-LabelDictionaryLearningforImageAnnotation,"inIEEETransactionsonImageProcessing,vol.25,no.6,pp.2712-2725,June 2016.

[2] Estrada, L., Vazquez, N., Ortega, J., López, H., Hernández, C., & Vaquero, J. (2021, October). Low cost PV emulator based on programmable DC power supply and LabVIEW. In *IECON 2021–47th Annual Conference of the IEEE Industrial Electronics Society* (pp. 1-6). IEEE.

[3] Kobelev, D. I., & Jordan, V. I. (2021, March). Application of a precision programmable DC power supply for spectrometer calibration. In *Journal of Physics: Conference Series* (Vol. 1843, No. 1, p. 012022). IOP Publishing.

[4] Chan, W. C., &Tse, C. K. (1997). Study of bifurcations in current-programmed DC/DC boost converters: from quasiperiodicity to period-doubling. *IEEE Transactions on circuits and systems I: Fundamental theory and applications*, *44*(12), 1129-1142.

[5] Colaiuda, D., Leoni, A., Paolucci, R., Horikawa, S., &Stornelli, V. (2023, June). Control Circuits for Adjustable Digitally Programmed DC Power Supplies. In *2023 18th Conference on Ph. D Research in Microelectronics and Electronics (PRIME)* (pp. 57-60). IEEE.

[6] Mukerjee, A. K., &Dasgupta, N. (2007). DC power supply used as photovoltaic simulator for testing MPPT algorithms. *Renewable Energy*, *32*(4), 587-592.

[7] Kumar, K. S., Moorthy, S. S., &Mahammad, S. N. (2013, December). Design of low cost programmable DC power supply unit. In *2013 International Conference on Control, Automation, Robotics and Embedded Systems (CARE)* (pp. 1-5). IEEE.

[8] Gadelovits, S., Sitbon, M., &Kuperman, A. (2013). Rapid prototyping of a low-cost solar array simulator using an off-the-shelf dc power supply. *IEEE Transactions on Power Electronics*, *29*(10), 5278-5284.

[9] Ji, S., &Tian, Z. (2010, April). Research of a Programmable DC Power Supply and its Novel Protection Circuit. In *2010 International Conference on Machine Vision and Human-machine Interface* (pp. 688-691). IEEE.

[10] Prodic, A., Maksimovic, D., & Erickson, R. W. (2003, February). Digital controller chip set for isolated DC power supplies. In *Eighteenth Annual IEEE Applied Power Electronics Conference and Exposition, 2003. APEC'03.* (Vol. 2, pp. 866-872). IEEE.