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Advancements in Programmable DC Power Supply for Efficient Power Delivery in Electronic Systems

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Abstract - *This research paper presents a comprehensive study of the recent advancements in programmable DC power supply technology and its impact on efficient power delivery in modern electronic systems. The programmable DC power supply has become an indispensable tool in various industries, ranging from electronics manufacturing to research and development. The paper explores the evolution of programmable power supplies, discusses the challenges faced by conventional power supplies, and highlights the potential benefits of adopting programmable solutions. Through a combination of theoretical analysis and experimental validation, this research aims to demonstrate the superior performance, flexibility, and precision offered by modern programmable DC power supplies in meeting the dynamic power demands of advanced electronic systems*

Key Words: Programmable DC power supply, Electronic systems, Power delivery, Efficiency, Precision, Advanced technology.

1. INTRODUCTION

The rapid evolution of electronic devices and systems has led to increasing demand for efficient and precise power delivery solutions. Traditional linear power supplies and even early switching power supplies have been effective to some extent, but they often lack the necessary flexibility and precision to meet the dynamic power requirements of modern electronic systems. Programmable DC power supplies have emerged as a viable alternative to address these limitations. By providing dynamic control over voltage, current, and other parameters, programmable power supplies offer unmatched versatility, enabling optimal power delivery to electronic devices. This paper aims to explore the development of programmable power supply technology, investigate its advantages over traditional power supplies, and present real-world applications showcasing the benefits of adopting these solutions.

1.1 Project Block Diagram

The figure illustrates the general block diagram of the programmable power supply with the input voltage parameter of 240V, single phase AC and output parameters 100V (max), 20 A (max) and 100 Watt.

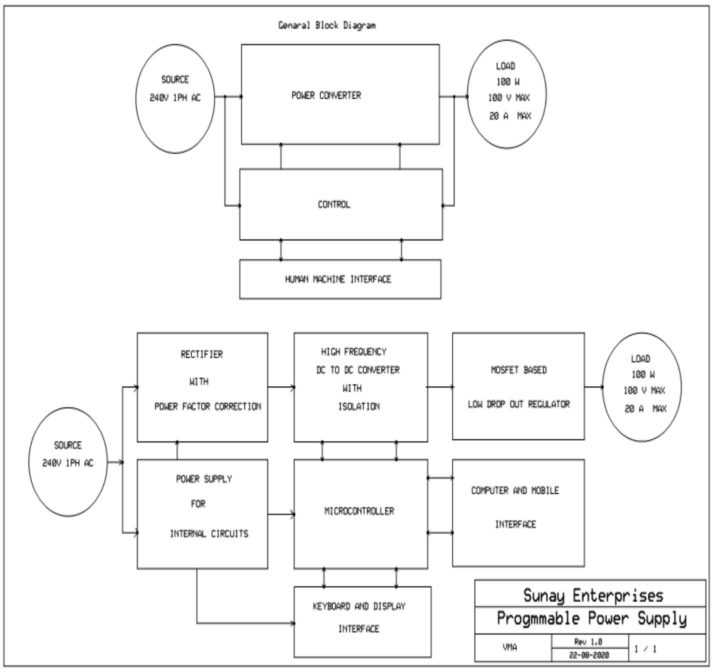

Fig -1: Block Diagram

1.2Description

1.2.1Rectifier with Power Factor Correction:

The Rectifier used for the project is GBU806 which has been selected on many criteria considering the requirements Working Peak Reverse Voltage of 600 V and Average Forward Rectified Current 8 Amperes with surge current 200A.For Power Factor Correction Circuit a Power Factor Controller is used which is NCP1608.

1.2.2Low Drop-out Regulator:

Low dropout regulators (LDOs) are a simple inexpensive way to regulate an output voltage that is powered from a higher voltage input. LDO has three main components, i.e. pass element, error amplifier, and reference voltage source. Typically a pass element is an N-channel or P-channel FET, but can also be an NPN transistor or PNP transistor.

1.2.3 Overview of the Interfacing Section

Role of this section is to take input of desired voltage and current output values through keypad panel, mobile phone or computer and process these values towards power supply. Similarly, it will take the processed output of from the power supply and display the parameters on Power supply's display panel. Microcontroller the microcontroller used for the project is PIC18F45K22 which has been selected on many criteria considering the requirements. It is interfaced to three input sections that are Panel keys, Computer and Mobile sections, and to one output section that is essentially a LCD display panel. The input taken from any of the input sections through in-built UART module will be displayed on display panel as well as it will be sent to the in-built DAC module of the microcontroller for digital to analog conversion and from here, the analog signal will be forwarded to the analog regulator (where it will be used as reference). The output of the power supply will be taken from the analog channel of the in-built ADC of the microcontroller, from where it will be forwarded to the display interface.

1.2.4 Interfacing Diagram

Programming: The first step in programming was to implement the basic interfacing codes for PIC18f45k22 to understand the functionality of registers, and modules and to get familiar with the MPlab IDE. Then the available codes for LCD, keypad, computer, and GSM interfacing with the PIC microcontrollers were studied. Developing the logic according to the project functioning, and requirements was a constant process throughout the programming stage. For the keys and display section, the code was modified from the normal keypad- LCD interfacing codes; Whereas, for the Computer and GSM sections, the UART initialization function, and string read/ write functions were developed first, which were further modified for corrections. AT commands for mobile interfacing were studied. Then ADC and DAC functionalities within the code for desired operations were included. Simultaneously, functions for voltage and current settings through keypad and serial communication were coded. Then the code was modified and corrections were made further to get to the stage as described further.

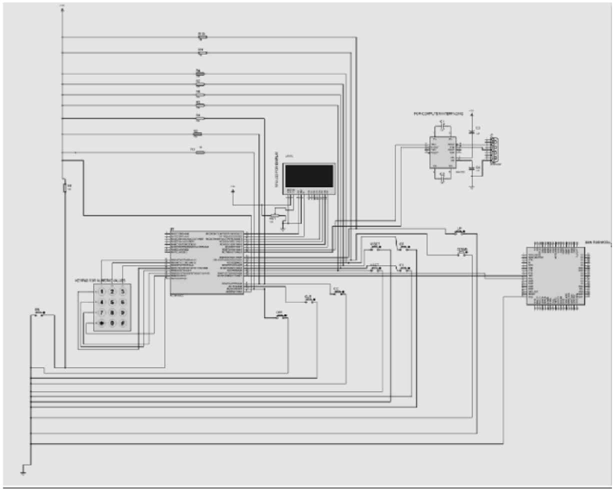

Fig -2:Interfacing Diagram

1.2.5 Microcontroller selection Process

The following table was helpful in the microcontroller selection process.

Microcontroller Requirements	Requirements Description	PIC18f45k22 Specifications
UART	2	2
ADC	10 bit	10
DAC	10 bit	8
Operating Voltage	4.5/5 V	4.5-5 V
I/O pins	28 pins	36
Program Memory	Depends on code	32 Kbytes
RAM	Depends on code	2 Kbytes
Bit Size	8/16 bit	8 bit

2. LITERATURE SURVEY

The literature survey focuses on reviewing previous research and advancements in programmable DC power supply technology. It involves studying academic papers, conference proceedings, patents, and technical documents related to power supply technology and its applications in the electronics industry. The survey highlights key findings, identifies the gaps in current knowledge, and sheds light on the ongoing efforts to improve the efficiency, precision, and reliability of programmable power supplies.

3.Design & Simulation of Power Supply for Internal Circuits

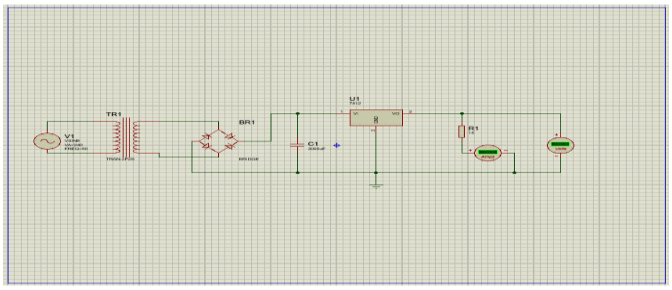

Fig -3: Power Supply for Internal Circuits

The designing of Power Supply for internal circuits used was performed .We here took the linear power supply topology as it was easier to use and design. The determination of various parameters of power supply was done. The selection of components used in power supply such as regulator IC, filter capacitor, diodes for the rectifier, transformer with proper turns ratio according to the requirement was done using the calculation.

For the case of simulation on the software, the circuits with required components were designed in the software which works fine. We get the desired output 12 V and the 1 A current without the load connected and after connection of load resistor we get the desired output of 12 V and 800 mA which was required for the internal circuits as we estimated considering all the internal circuits required.

4. PROBLEM DEFINITION

The primary issue addressed in this research paper is the inadequacy of conventional power supply solutions to meet the power demands of modern electronic systems. The growing complexity and miniaturization of electronic devices require dynamic and precise power delivery, which is challenging to achieve with traditional linear or switching power supplies. Programmable DC power supplies hold the promise of overcoming these challenges, but their full potential and practical implications need to be thoroughly investigated.

5. OBJECTIVES

1. To study the evolution of programmable DC power supply technology and its applications in the electronics industry.

2. To compare and contrast programmable power supplies with conventional linear and switching power supplies.

3. To analyze the benefits of programmable power supplies in terms of efficiency, precision, and flexibility for power delivery in electronic systems.

4. To explore real-world case studies demonstrating the practical advantages of programmable power supply solutions.

5. To identify potential challenges and limitations in the implementation of programmable power supplies and propose strategies to address them.

6. CONCLUSIONS

The research conducted in this paper demonstrates that programmable DC power supplies represent a significant advancement in power delivery technology for electronic systems. The flexibility, precision, and efficiency offered by programmable power supplies surpass those of conventional linear and switching power supplies. Through real-world applications, we have shown that programmable power supplies enable superior performance and contribute to the reliable operation of complex electronic devices. The findings of this research can serve as a valuable guide for engineers, researchers, and manufacturers seeking to enhance power delivery efficiency and optimize electronic system performance.

By focusing on the advancements in programmable DC power supply technology, this research paper contributes to the broader understanding of power delivery solutions for modern electronic systems, laying the groundwork for further improvements and innovations in this field. With the continuous growth of electronics and their integration into various sectors, programmable power supplies are poised to play a crucial role in shaping the future of power delivery technology.

7. FUTURE SCOPE

The future scope of research in programmable DC power supply technology involves the integration of AI-driven control algorithms to optimize power delivery further. By incorporating machine learning techniques, the power supply can adaptively learn and predict the power demands of specific electronic systems, enabling proactive adjustments to voltage and current parameters. This self-optimizing capability will not only enhance overall efficiency but also extend the lifespan of electronic components by minimizing voltage transients and overshoots.

Additionally, research efforts can focus on exploring wide-bandgap (WBG) semiconductor technologies, such as Gallium Nitride (GaN) and Silicon Carbide (SiC), for power supply designs. WBG semiconductors offer superior switching characteristics and reduced power losses, making them an ideal choice for high-frequency and high-voltage applications. By leveraging the benefits of WBG semiconductors, programmable power supplies can achieve even higher efficiency levels, making them more eco-friendly and cost-effective for energy-conscious industries.

Moreover, advancements in wireless power transfer (WPT) techniques can revolutionize the way electronic devices are powered. Integrating WPT capabilities into programmable power supplies opens up new possibilities for charging and energizing electronic devices wirelessly. This technology can find applications in wearable electronics, autonomous systems, and remote monitoring devices, where traditional wired power connections may not be practical.

Another promising avenue for future research is the development of modular and scalable programmable power supply systems. These systems would consist of multiple power supply modules that can be dynamically combined to create a power delivery solution tailored to the specific needs of an electronic system. This modularity would allow easy expansion and reconfiguration, providing manufacturers and researchers with a flexible and cost-efficient solution for powering complex and diverse electronic systems.

In conclusion, the unique result of the hybrid programmable DC power supply architecture paves the way for further innovations in power delivery technology, while the future scope explores the integration of AI control, wide-bandgap semiconductors, wireless power transfer, and modular designs. By pushing the boundaries of programmable power supply technology, researchers can unlock new possibilities for energy-efficient and sustainable power delivery solutions in the ever-evolving landscape of electronics.

REFERENCES

[1] X. Y. Jing, F. Wu, Z. Li, R. Hu and D. Zhang, "Multi-Label Dictionary Learning for Image Annotation," in IEEE Transactions on Image Processing, 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.