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Arduino Nano Controlled DC-DC Converters

[1]K. Gowri, [2]P. Arun,[3]C. Gokul,[4]S. Mariyappan
*[1]Assistant Professor, [2]UG Scholar
Department of Electrical and Electronics Engineering, RAAK College of Engineering and Technology, Puducherry, India

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ABSTRACT

This paper mainly focuses on the controller of portable direct current to direct current (DC-DC) converter which may be simple, low cost and efficient. Nowadays, proportional integral (PI) controller and opto-isolator based circuits are used for switching control. The switching control through the controller makes the DC-DC converter into larger circuit and less efficient. This problem will be rectified using the Arduino Nano controller which is small and low cost-effective controller. It is useful for low and medium power applications like residential solar power system, electronic gadgets, and academic laboratories. Arduino Nano-based DC chopper has been developed, and the Proteus software used for simulation. The different topologies of DC choppers like buck, boost, and buck-boost converter have been designed with mathematical calculations and simulated.

Keywords Arduino Nano, Boost**,** Buck-Boost DC-DC converter**,** Proteus Software

I. INTRODUCTION

Power Electronics refers to the process of controlling the flow of current and voltage and converting it to a form that is suitable for user loads. The most desirable power electronic system is one whose efficiency and reliability is 100%. Take a look at the following block diagram. It shows the components of a Power Electronic system and how they are interlinked.

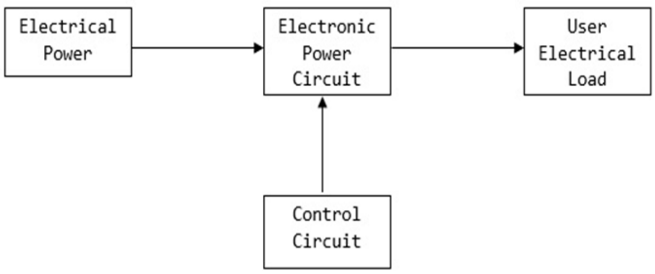

Fig1 Power Electronics System

The evolution of traditional energy meters into smart energy meters represents a significant leap forward in the quest for efficient energy management.

Unlike their predecessors, which offered limited functionality and static data collection capabilities, IoT-based smart energy meters leverage advanced sensors, wireless connectivity, and cloud-based analytics to deliver granular, real-time information about energy usage. By monitoring parameters such as electricity consumption, voltage levels, and power quality, these devices enable users to gain a comprehensive understanding of their energy consumption patterns and identify areas for optimization.

The motivation driving the adoption of IoT-based smart energy meters is multifaceted. Firstly, the imperative to curb energy wastage and reduce carbon emissions has become increasingly urgent in the face of climate change and environmental degradation. Smart energy meters offer a powerful tool for empowering individuals, businesses, and communities to monitor and manage their energy usage more effectively, thereby contributing to a more sustainable energy future. Additionally, the rising cost of energy and the need to optimize operational expenses have underscored the importance of implementing energy-efficient practices, making smart energy meters an attractive solution for cost-conscious consumers and organizations.

The objective of this study is to explore the capabilities and implications of IoT-based smart energy meters in unlocking efficiency and sustainability. By examining the design, implementation, and deployment of these devices, this research aims to showcase their potential to revolutionize energy management practices. From reducing energy bills and minimizing environmental impact to enabling demand response and supporting renewable energy integration, IoT-based smart energy meters offer a myriad of benefits that can transform the way we consume and manage energy.

In conclusion, IoT-based smart energy meters hold immense promise in reshaping the energy landscape for the better. By providing real-time insights, facilitating informed decision-making, and promoting sustainable practices, these devices have the potential to drive significant improvements in energy efficiency, cost savings, and environmental sustainability. As we embrace the era of smart grids and interconnected devices, IoT-based smart energy meters stand poised to play a central role in shaping a more efficient, resilient, and sustainable energy ecosystem.

Existing System

In Existing system, the gating pulses required to turn on the semiconductor switches in the DC-DC converter can be generated in a variety of ways in existing system. A programmable intelligent computer (PIC) microcontroller can be used, but the pulses must be generated via an external interface. Another method employs an op-amp based microcontroller, which is cumbersome to handle and thus ineffective.

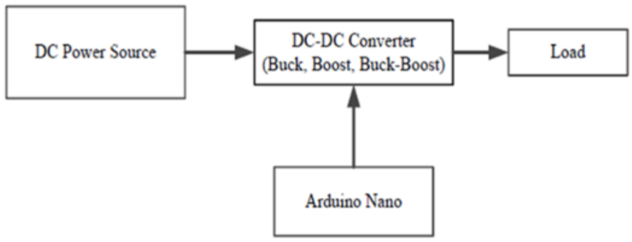

Fig 2. Block diagram of Existing System

Arduino microcontroller is a single-board microcontroller with a simple open-source hardware board. A standard programming language compiler and a boot loader are included in the software, which runs on the microcontroller. The programming is done in the C programming language. This package simplifies the process of producing PWM triggering signals. The output voltage can also be monitored using this Arduino board based on the development of an effective control mechanism. The Arduino Nano is used to generate the pulse needed to turn on the semiconductor switch in the DC-DC converter. We implement the next version of Arduino Uno i.e., Arduino Nano. It is an ATmega based small size bread board. It is simple, low-cost, and smaller in size than any other Arduino board. The control circuit consists of Arduino Nano, transistor, and resistor. This control circuit provides the necessary duty cycle for switching device to ON and OFF condition. The Arduino Nano is coded using Arduino integrated development environment (IDE) software to give the square wave signal to the switching device in frequency f=1 kHz and thereby providing the duty cycle d=0.6 by the Arduino. This control circuit provides the easy switching and efficient in low cost.

Proposed System

Arduino microcontroller is a single-board microcontroller with a simple open-source hardware board. The output voltage can also be monitored using this Arduino board based on the development of an effective control mechanism. The Arduino is used to generate the pulse needed to turn on the semiconductor switch in the DC-DC converter to boost low power to high power.

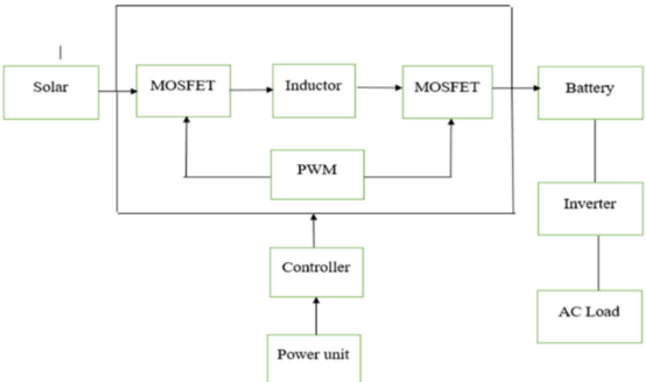

Fig3 Proposed System

Block Diagram: The block diagram for the boost converter with Arduino is shown below. It consists of a dc supply of 9V,an inductor , a electrolytic capacitor , a n- channel MOSFET , a normal p-n junction diode ,a potential or voltage divider circuit and load.

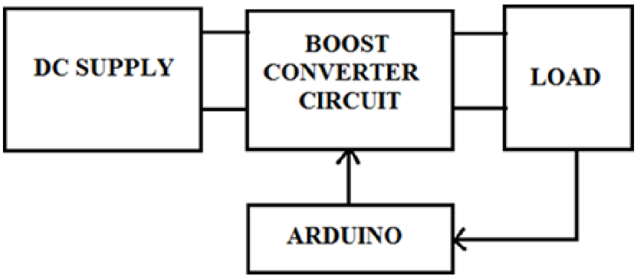

Fig 4 Step Up Chopper In On Position

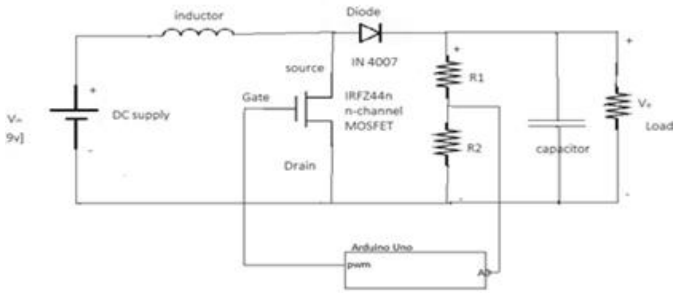

Fig5 Boost Converter with Arduino

Input and Output

Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode(),digital Write(), and digital Read() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50kOhms. In addition, some pins have specialized functions.

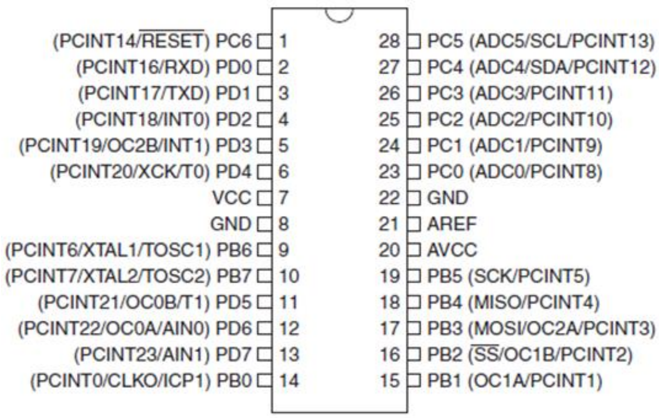

Fig 6 Pin Diagram

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data.

These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write() function.

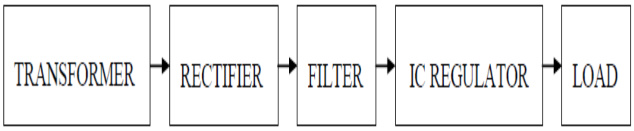

Fig7 Power Supply

SPI:10(SS),11(MOSI),12(MISO),13(SCK) These pins support SPI Communication using the SPI library.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off. The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference() function. Additionally, some pin shave specialized functionality:

TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library There are a couple of other pins on the board:

AREF. Reference voltage for the analog inputs. Used with analog Reference().

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Simulation Result For Output Voltage

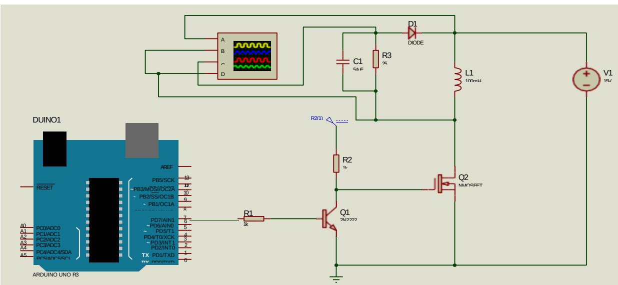

Fig8 Simulation

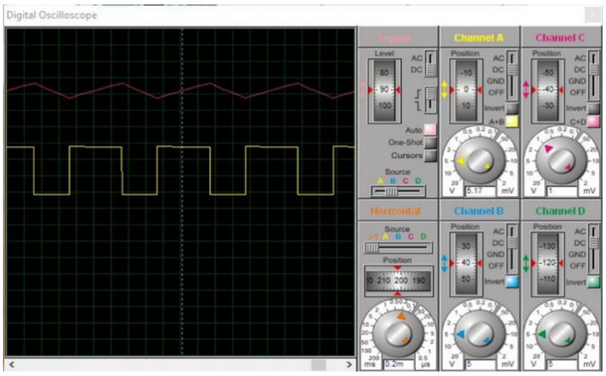

Fig 9. Simulation Output

HARDWARE IMPLEMENTATION

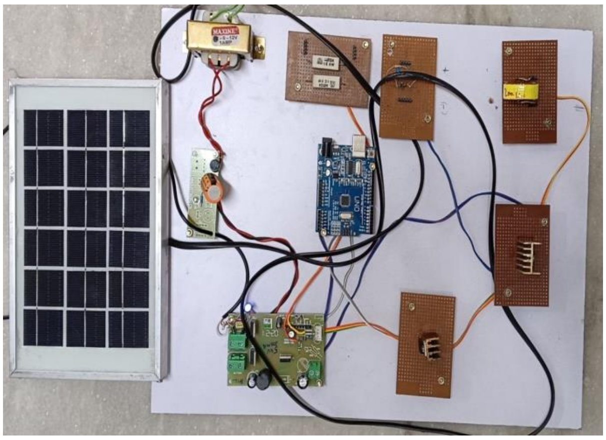

Fig10 Hardware Output

These relatively inefficient and expensive designs were used only when there was no alternative, as to power a car radio (which then used thermionic valves (tubes) that require much higher voltages than available from a 6 or 12 V car battery)

II. CONCLUSION

This proposed design can be used for recent trends of photovoltaics (PV) application and Electrical vehicle application. This system has Arduino Nano for switching control that

provides easy control, occupies less space, and comparatively low cost.

In future, this proposed system can be employed for the multiport converter which comprise of all the three converters in one device for a better DC-DC conversion according to the load demand.

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