

# Dual Multiphase Boost Converter Using Pi Controller with Texas Instruments Microcontroller

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## Abstract

This project focuses on the design and development of a dual multiphase boost converter that can regulate output voltage when the load changes. This system is created to solve common problems found in single-phase boost converters, such as low efficiency, poor voltage regulation, and unstable performance. By using two phases working together, the converter can share current more evenly and improve overall system stability. The converter is controlled by a Proportional Integral or PI controller, which is programmed on a Texas Instruments TMS320F28335 microcontroller. The controller adjusts the duty cycle in real time to keep the output voltage steady. The project starts with simulation in MATLAB Simulink to test how the converter works with and without the controller. Then, the controller code is developed using Code Composer Studio to communicate with the microcontroller. The hardware, including the converter circuit and gate drivers, is designed using Proteus software and built on a printed circuit board or PCB. Testing is done to check if the system performs well when connected to a load. With a fixed input of 5 volts, the converter successfully increased the voltage to around 10.8 volts with stable output. The results show that this converter works well in practice and can be used in systems that need reliable voltage control.

## 1. Introduction

A dual multiphase boost converter is a type of power converter that increases a low direct current or DC voltage to a higher level. It is different from the traditional single-phase boost converter because it uses two or more phases that operate at the same time, and each phase has its own inductor, switch, diode, and capacitor. This design helps to increase efficiency, reduce heat, and lower voltage ripple, which are important for systems that need stable and clean power [1]-[3]. These converters are often used in high power systems, such as electric vehicles, solar energy systems, and industrial machines. They are useful because they can share current between components, which helps prevent overheating and makes the system more reliable [2]-[4]. To make sure the output voltage remains stable when there are changes in the input or load, a control system is needed. In this project, a Proportional Integral or PI controller is used, which compares the actual output voltage to a desired value and adjusts the switching signal to correct any difference [5]-[6]. The converter is controlled using a Texas Instruments TMS320F28335 microcontroller, and the system is tested both in simulation and real hardware. The design process includes simulation in MATLAB Simulink, coding in Code Composer Studio, and building hardware using Proteus software [3]-[5]. This project aims to create a converter that is efficient, stable, and suitable for real-world applications [7]-[9].

## 2. Literature Review

Many researchers have worked on improving dual multiphase boost converters using different control methods, such as solar power systems, particle swarm tuned controllers, and digital current control. These methods show good results in improving voltage stability and system efficiency. However, most of them are complex, need high processing power, or are limited to specific applications like electric vehicles. There is still a need for a simpler and more flexible solution for low power systems. This project fills that gap by using a PI controller with a Texas Instruments microcontroller to build a more practical and efficient dual multiphase boost converter. It aims to give stable output voltage while using less complex control, making it easier to apply in real hardware.

## 3. Methodology

This project uses a dual multiphase boost converter to step up a low DC voltage. Two switching phases are used to improve efficiency and reduce ripple. A PI controller is programmed on the Texas Instruments TMS320F28335 microcontroller to regulate the output voltage. The system reads output voltage using sensors and adjusts the switching through PWM signals.

### 3.1 Block Diagram

The block diagram shows in Fig. 1 illustrates the input voltage goes to the dual boost converter. The output is sent to the load. The microcontroller compares the output to a set value and adjusts the signal sent to the gate driver. This closed-loop control helps keep the output voltage steady.

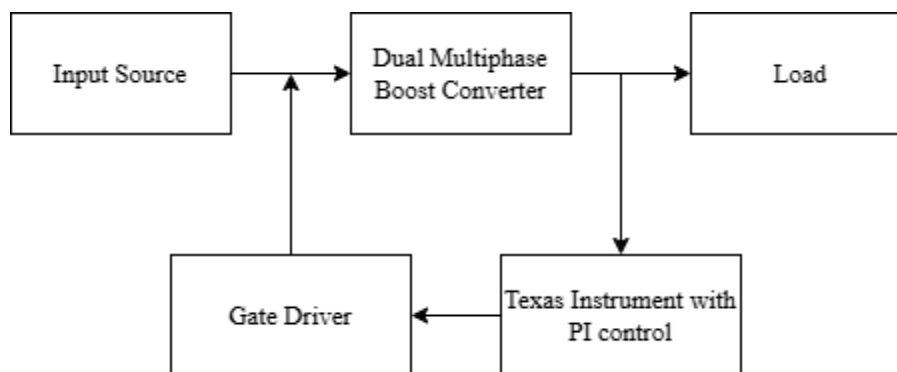


Fig. 1 Overall block diagram

### 3.2 Closed Loop Simulation

The system is first tested using MATLAB Simulink. Two interleaved boost converter phases are modeled. A PI controller adjusts the switching based on the output. Fig. 2 shows the simulation block diagram of the converter which able to increase the voltage and keep it stable under different conditions.

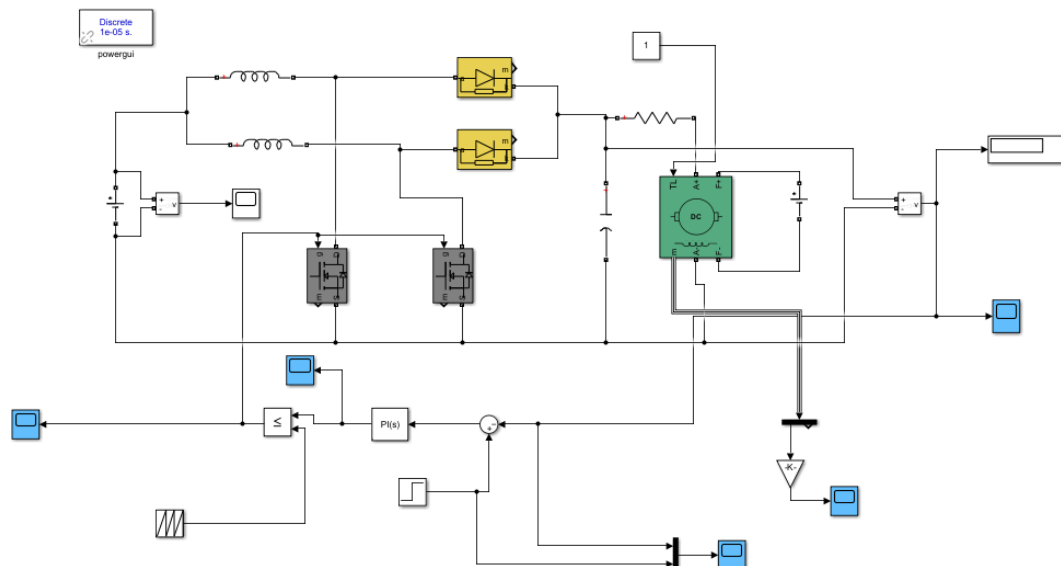


Fig. 2 Closed Loop of Dual Multiphase Boost Converter Simulation

### 3.3 Hardware Development

After simulation, the system is built on hardware as depicted in Fig. 3. The converter, microcontroller, and gate driver are assembled on a PCB. An LED test confirms communication between MATLAB and the microcontroller. The converter is tested with a 5V input and is able to boost the output voltage. Measurements are taken using a multimeter and oscilloscope.

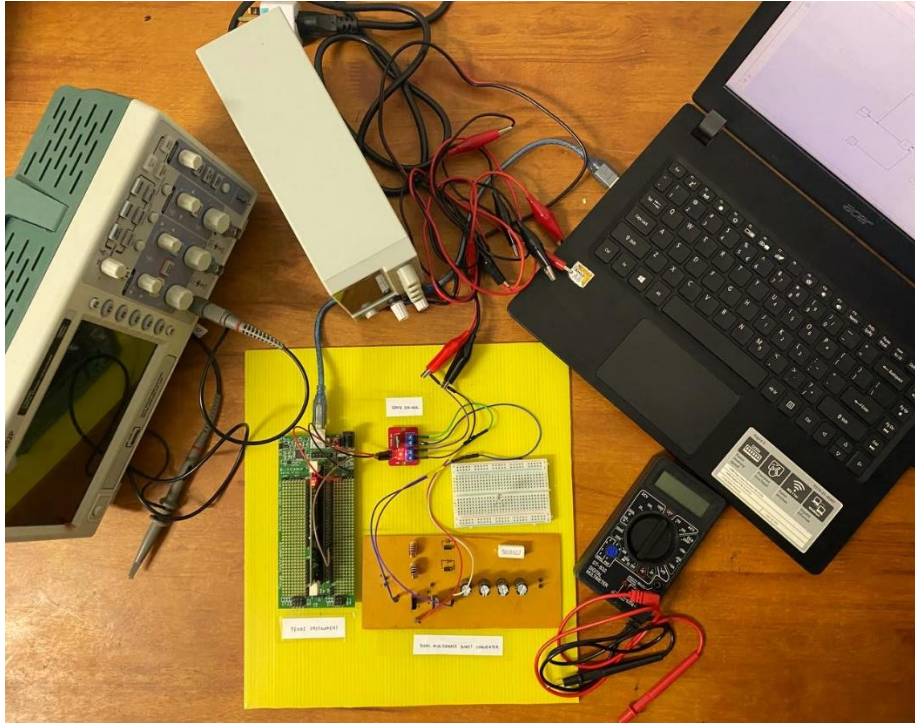


Fig. 3 Hardware Setup

## 4. Result and Discussion

### 4.1. Software Simulation Analysis

The simulation result in Fig. 4 showed that the dual multiphase boost converter successfully increased the input voltage from 5 volts to around 10 volts. The output stabilized smoothly, and the PI controller maintained a steady voltage. This confirmed that the control method worked well under ideal conditions.

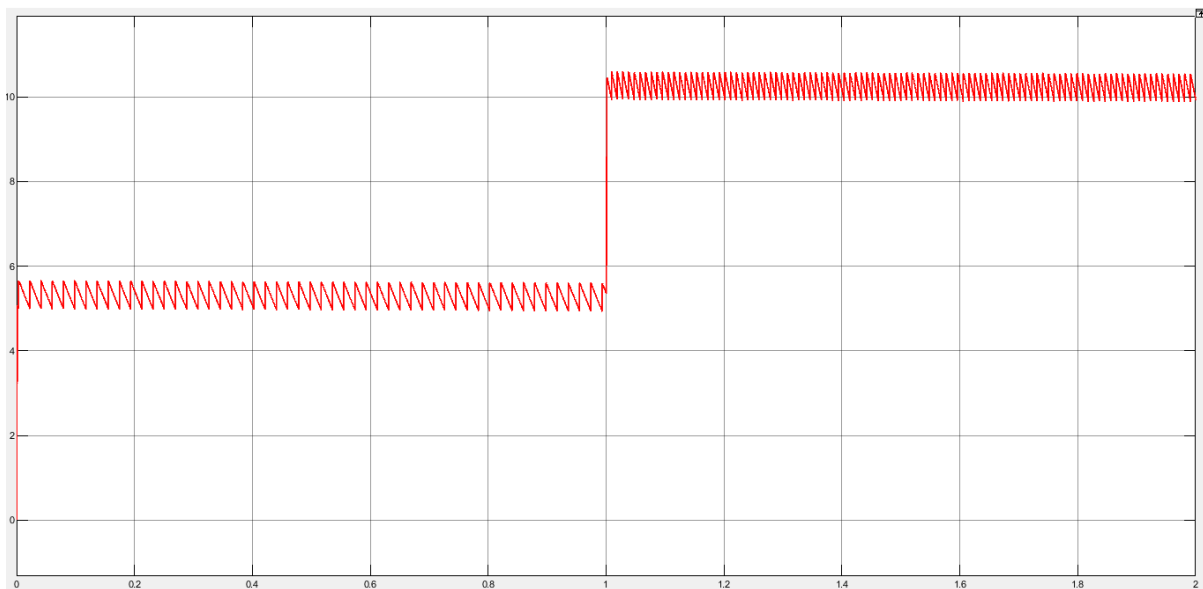
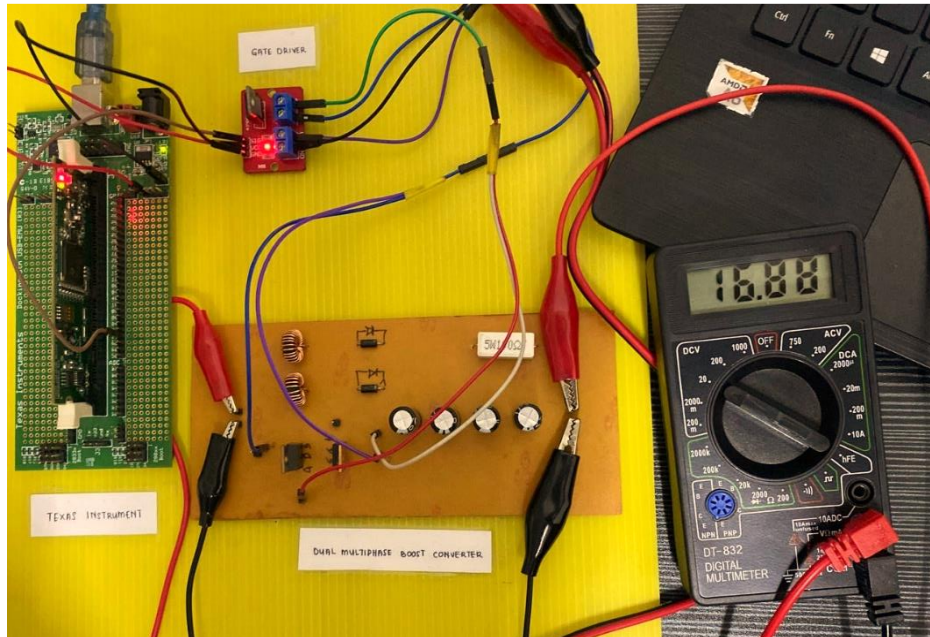


Fig. 4 Voltage output for Closed Loop Simulation

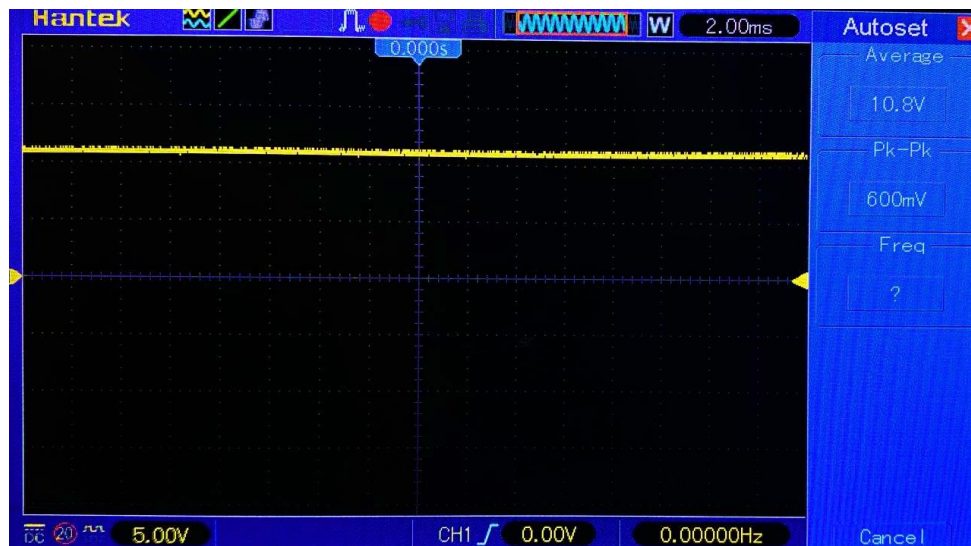
## 4.2. Hardware Testing

In hardware testing, the converter increased the output voltage from 5 volts input to approximately 16.88 volts when measured using a multimeter. The microcontroller generated PWM signals to control the gate driver, which operated the MOSFETs effectively.



**Fig. 5** Output Voltage of Dual Multiphase Boost Converter with 5V Input Supply

When observed using an oscilloscope, the output voltage was around 10.8 volts with a ripple voltage of about 600 millivolts peak to peak. This ripple is typical in high frequency switching circuits and does not affect performance. The output was stable and smooth, indicating that the inductors and capacitors were functioning properly. These results can be obtained in the experimental set up shown in Fig. 5.



**Fig. 6** Boost Converter Output Voltage on Oscilloscope

The microcontroller successfully generated pulse width modulation signals to control the gate driver, which switched the MOSFETs properly. The converter demonstrated reliable performance in stepping up voltage while maintaining consistent output in real hardware as depicted in Fig 6.

## 4.3. Comparison Between Simulation and Hardware Results

The results from simulation and hardware testing were compared in Table 1 to evaluate consistency. In the simulation, a 5-volt input produced a steady 10-volt output. In hardware testing, the same input produced

approximately 10.8 volts on the oscilloscope and 16.88 volts on the multimeter. These differences can be explained by real-world conditions such as switching effects, measurement methods, and hardware tolerances.

**Table 1** Comparison Between Simulation and Hardware Results for Dual Multiphase Boost Converter

	Simulation in MATLAB	Hardware Testing
Voltage Input	5v	5v
Voltage Output	10v	Measurement Tools: Oscilloscope 10.8v Multimeter 16.88v

This comparison shows that the boost converter operates effectively in both simulation and real hardware. The small differences in output are normal and prove the system is functioning as expected.

#### 4. Conclusion

This project focused on designing and building a dual multiphase boost converter using the Texas Instruments TMS320F28335 microcontroller to increase and control output voltage efficiently. Simulations in MATLAB Simulink helped analyze system behavior, and a PI controller was used to maintain stable voltage by adjusting switching times. After simulation, a hardware prototype was built, and the converter successfully stepped up a 5V input to higher levels. The dual phase design reduced stress on components and improved performance. The system was programmed using Code Composer Studio, and the circuit was designed in Proteus. Testing showed the converter performed reliably with a low power application load, confirming smooth operation and effective voltage boosting. This project gave valuable experience in circuit design, control systems, and microcontroller use, proving that a dual multiphase converter is a strong solution for stable voltage applications.

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#### Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

#### Author Contribution

The authors confirm contribution to the paper as follows: **study conception, design, data analysis and manuscript preparation:** Nuratiqah Binti Abd Rahman; **manuscript verification:** Shamsul Aizam Bin Zulkifli. All authors reviewed the results and approved the final version of the manuscript.

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