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DESIGNING OF PID CONTROLLER DC-DC BUCK BOOST CONVERTER MATLAB

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ABSTRACT- The design and simulation of a Buck-Boost Converter using a Proportional-Integral-Derivative (PID) controller in MATLAB/Simulink are shown in this work. In spite of changes in input voltage and load conditions, the system seeks to maintain a steady output voltage. Under various operating settings, the PID controller's ability to maintain voltage regulation is assessed, and the outcomes are contrasted with those of other traditional control techniques.

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I. INTRODUCTION

Buck-Boost Converter Overview: One kind of DC-DC converter that has the ability to step up or step down the input voltage is the Buck-Boost converter. It is frequently employed in situations where the input voltage may fluctuate between higher and lower than the desired output value.

- **PID Control**: PID control is widely used in engineering systems to ensure the stability and accuracy of the system's response. In this paper, PID control is applied to maintain a constant output voltage for the Buck-Boost converter.

SYSTEM DESCRIPTION

Buck-Boost Converter Working Principle: Give a detailed explanation of the converter's operation, describing how the inductor, capacitor, switch, and diode function in various states (on and off).

- **PID Control**: Discuss the PID controller's three components:

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- Proportional (P)
- Integral (I)
- Derivative (D)

- **Controller Tuning**: The PID controller gains are tuned to optimize the response, and this paper explores methods to adjust these parameters for optimal performance.

II. MATHEMATICAL MODELING

- Provide the mathematical model of the Buck-Boost converter, including the equations for inductor current, output voltage, and duty cycle.
- **PID Control Implementation**: Explain how the PID control algorithm is implemented in the system. The controller adjusts the duty cycle based on the error between the desired output voltage and the actual output voltage.

Vout=Vin·D1−DV_{out} = \frac{V_{in} \cdot D}{1 - D}Vout=1−DVin·D

where VinV_{in}Vin is the input voltage, DDD is the duty cycle, and VoutV_{out}Vout is the output voltage.

III. MATLAB / SIMULINK IMPLEMENTATION

Simulink Model: The PID control system and Buck-Boost converter are simulated using a Simulink model. Provide a Simulink model diagram that highlights the key components (e.g., voltage source, switch, inductor, capacitor, PID controller, etc.).

- **MATLAB Code** for the PID controller:

matlab

Copy code

```
% Parameters for PID control
Kp = 1;  % Proportional gain
Ki = 1;  % Integral gain
Kd = 1;   % Derivative gain
```


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```
% Setpoint and initial conditions
setpoint = 12;  % Desired output voltage
initial_vout = 0;  % Initial output voltage
error_prev = 0;   % Previous error
integral = 0;      % Integral term

% Simulate the PID controller loop
for t = 0:0.01:10  % Simulate for 10 seconds with a time step of 0.01
    error = setpoint - initial_vout;
    integral = integral + error * 0.01;
    derivative = (error - error_prev) / 0.01;
    control_signal = Kp * error + Ki * integral + Kd * derivative;

    % Update the output voltage using the control signal
    initial_vout = initial_vout + control_signal * 0.01; % Update output voltage

    % Update previous error for next iteration
    error_prev = error;

    % Record or display results (for plotting, etc.)
end
```

- **Simulink Model**: For the Simulink diagram:
  - Create blocks for the Buck-Boost converter: voltage source, inductors, capacitors, switches (MOSFETs), diodes, etc.
  - Implement a PID controller block that adjusts the duty cycle to regulate the output voltage.

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IV. SIMULATION AND RESULTS

- **Simulation Setup**: Discuss the parameters used in the simulation (input voltage, load resistance, initial conditions, and PID gains).
- **Results**: Show the simulation results for:
  - Step response of the converter with and without the PID controller.
  - Output voltage behavior under varying input voltages.
  - The controller's performance under different load conditions.
- **Performance Metrics**: Include performance metrics such as rise time, settling time, overshoot, and steady-state error.

Example Results

- Graphs of output voltage vs. time for different input voltages.
- Error plot comparing the desired and actual output voltage.

DISCUSSION

- **Performance Evaluation**: Discuss how the PID controller improves the performance of the Buck-Boost converter compared to an open-loop system.
- **Tuning the PID Gains**: Explore how changing the PID gains (Kp, Ki, Kd) affects the system's stability and accuracy.
- **Robustness**: Evaluate the system's robustness against variations in load and input voltage.

V. CONCLUSION

- Summarize the key findings from the simulation results.
- Discuss potential improvements and future work, such as using adaptive control methods or other types of controllers (e.g., fuzzy logic, LQR).

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