STUDY OF POWER ELECTRONIC CONVERTER AND MODELLING OF PID CONTROLLER: AN ANLYTICAL STUDY

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Abstract

The utilization of DC-DC control converters is ceaselessly becoming both in control electronics items and frameworks. In a DC-DC converter application, it is constantly craved to get a directed yield voltage in spite of changes in input voltage, stack current and converter parts. To get controlled yield voltage analysts have utilized different straightforward ordinary to complex automatic control techniques. With the advancement of semiconductor manufacturing technology, effortlessness of configuration, size of gadgets, cost and better change efficiency have turned out to be critical outline criteria. This paper proposes the outline of a straightforward PID controller that can be connected to any DC-DC converter topology. The outlined PID controller is tried with buck and lift converter in MATLAB-Simulink environment. Recreation comes about demonstrate that the controller understands a superior yield voltage following and enhanced converter efficiency alongside the straightforwardness and effortlessness in outline.

1. INTRODUCTION

Power electronics manages an assortment of converters that are utilized at power level as opposed to the flag level. A power electronic framework comprises of at least one power electronic converters. A power electronic converter is comprised of some power semiconductor gadgets controlled by coordinated circuit. The exchanging attributes of power semiconductor gadgets allows a power electronic converter to shape the information power of one frame to yield power of some other shape.

DC-DC converters are a portion of the most straightforward power electronic converter circuits. They are generally utilized as a part of the power supply hardware for most electronic instruments and furthermore in particular high power applications, for example, battery charging, plating and welding. The wide assortment of circuit topologies ranges from the single transistor buck, lift and buck/support converters to complex arrangements containing two or four gadgets and utilizing a few strategies to control the exchanging misfortunes. The standard necessity of a control framework for the converter is to keep up the yield voltage consistent independent of varieties in the DC source voltage V_{in} and the heap current. In any case, stack changes influence the yield voltage transitorily, conceivably causing huge deviations from the enduring state level. Furthermore,in a useful framework circuit misfortunes present a yield voltage reliance on relentless state stack current which must be made up for by the control system.

As of late, with the thriving of compact gadgets and advancement of semiconductor manufacturing technology, change efficiency, power utilization and size of gadgets have turned into the most vital outline criteria of exchanging power converters. It is basic to create exact exchanging power converters, which can lessen more squandered power vitality. For little applications it is imperative to direct the

yield voltage of the converter with high accuracy and execution. Subsequently, a tradeoff among cost, efficiency and yield drifters ought to be considered.

This paper proposes the plan of a straightforward PID controller for power electronics DC-DC converter topologies. Cost, measure, exchanging pace, efficiency and effortlessness are the vital purposes of worry for the plan of proposed PID controller.

2. DC-DC CONVERTER CIRCUITS

The DC-DC converter has a few capacities. These are:

1. Convert a DC input voltage Vs into a DC yield voltage Vo.
2. Regulate the DC yield voltage against load and line variations.
3. Reduce the AC voltage swell on the DC yield voltage beneath the required level.
4. Provide isolation between the info source and the heap (if required).
5. Protect the provided framework and the info source from electromagnetic impedance

Figure1 demonstrates a dc-dc converter as a black box. It changes over a dc input voltage, vg (t) , to a dc yield voltage, vo(t) , with an extent other than the info voltage . This transformation can be accomplished by an assortment of circuits in light of and utilizing exchanging gadgets. The generally utilized exchanging gadgets are diodes, thyristors, power MOS, etc.The converter regularly incorporates one (or a few) transistor(s) keeping in mind the end goal to control the yield voltage, utilizing the control flag (t). It is attractive that the change be made with low misfortunes in the converter. To get low misfortunes, resistors are maintained a strategic distance from in the converters. Capacitors and inductors are utilized rather since in a perfect world they have no misfortunes. The electrical segments can be joined and associated with each other in various ways, called topologies, every one having diverse properties. The buck, lift, and buck-help converters are three fundamental converter topologies.

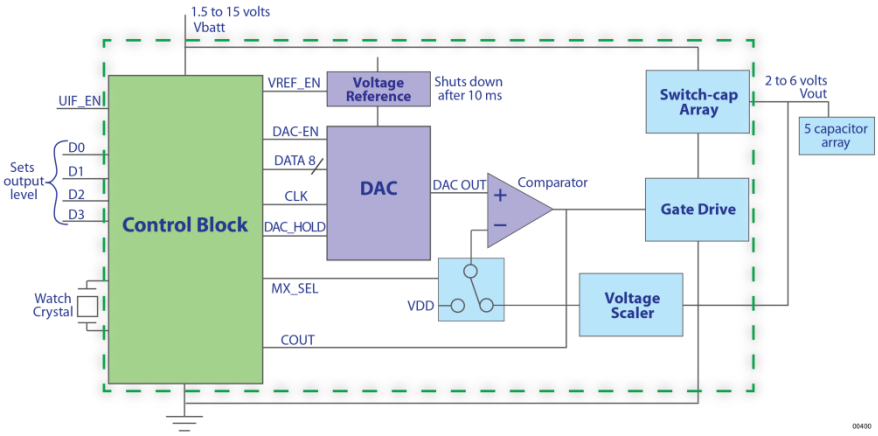

Fig1: Block diagram of a DC-DC converter

By utilizing beat width modulation (PWM) control, direction of yield voltage is accomplished by fluctuating the obligation cycle of the switch. Obligation cycle alludes to proportion of the period where power semiconductor is continued to the cycle time frame. Heartbeat width modulation (PWM) is a powerful procedure for controlling analog circuits. PWM is utilized in a wide assortment of applications, going from estimation and interchanges to power control and transformation. Control of PWM is normally affected by an IC , fundamental for regulating the yield. The transistor switch is the most vital thing of the exchanged

supply and controls the power provided to the heap. It is likewise expressed that Power MOSFET's are more reasonable than BJT at power yield of the request of 50 W. Picking of transistor additionally should consider its quick exchanging circumstances and ready to withstand the voltage spikes delivered by the inductor.

The proposed converter utilizes IGBT as the exchanging gadget. Utilization of IGBTs permits to construct less expensive and better converters. They have three appealing points of interest: higher exchanging frequency, simple and straightforward entryway control and no requirement for snubber circuits. IGBTs are constantly controllable amid turn on and kill. This makes overcurrent limitation significantly less demanding and permits dV/dt control to decrease and dV/dt stresses.

Numerous viewpoints must be considered for the situation where a converter is to be planned. One such angle is keeping the yield voltage in the specified voltage interim. Here are a few cases of changes that can diminish the variety of the yield voltage:

- Change the properties of a portion of the parts in the converter, e.g. increment the capacitance of the capacitor.
- Change the converter topology.
- Change to a more propelled controller.
- Increase the quantity of signs that are measured and utilized by the controller.
- Higher cost.
- Increased weight and volume.
- Lower unwavering quality.
- Lower efficiency.

Accordingly, the change or changes that are most appropriate depend to a huge degree on the converter particular close by. Converters can be enhanced as better segments are produced and more learning winds up noticeably accessible. This rouses inquire about in the zones of segments, converter topologies and controllers for instance. To acquire elite control of a framework, a great model of the framework is required.

3. PID CONTROLLER

Relative Integral-Derivative (PID) controller has been utilized for a very long while in enterprises for process control applications. PID includes three separate parameter, the relative, the fundamental and subsidiaries. By tuning the three constants in PID controller calculation, the controller can give control activity intended to particular process necessity.

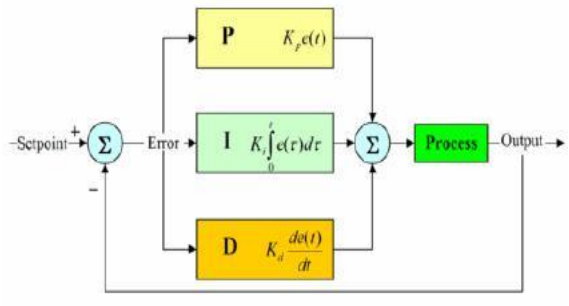

Fig2: Block diagram of a PID Controller

There are different strategies accessible for the tuning of PID controller. In any case, for comfort reason experimentation technique is for the most part utilized.

To begin with the PID controller works in a shut circle framework appeared in Figure2. The variable (e) speaks to the following mistake, the distinction between the coveted info esteem (R) and the genuine yield. This blunder flag (e) will be sent to the PID controller, and the controller figures both the derivative and the necessary of this mistake flag. The flag (u) simply past the controller is currently equivalent to the proportional pick up (Kp) times the size of the blunder in addition to the indispensable pick up (Ki) times the necessary of the mistake in addition to the derivative pick up (Kd) times the derivative of the blunder where, this flag (u) will be sent to the plant, and the new yield will be gotten. This new yield will be sent back to the sensor again to locate the new mistake flag (e). The controller takes this new mistake flag and registers its derivative and it's essential once more. This procedure continues forever, this flag (u) is gotten as takes after.

4. DC-DC BUCK CONVERTER CIRCUIT

The operation of basic buck converter for mathematical modeling and analysis is represented in figure below,

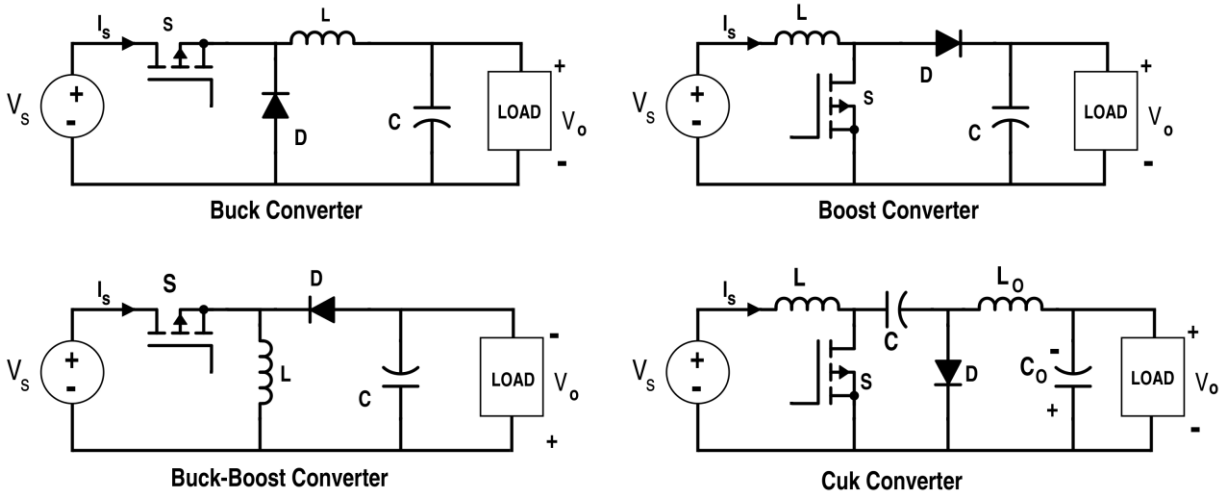

Fig3: Basic Buck Converter circuit (open loop)

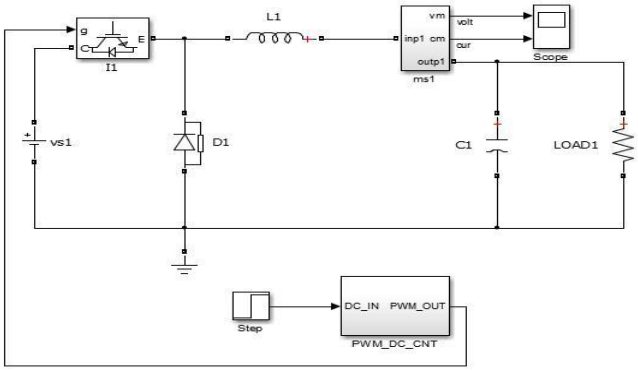

Fig4: Buck Converter circuit with PWM

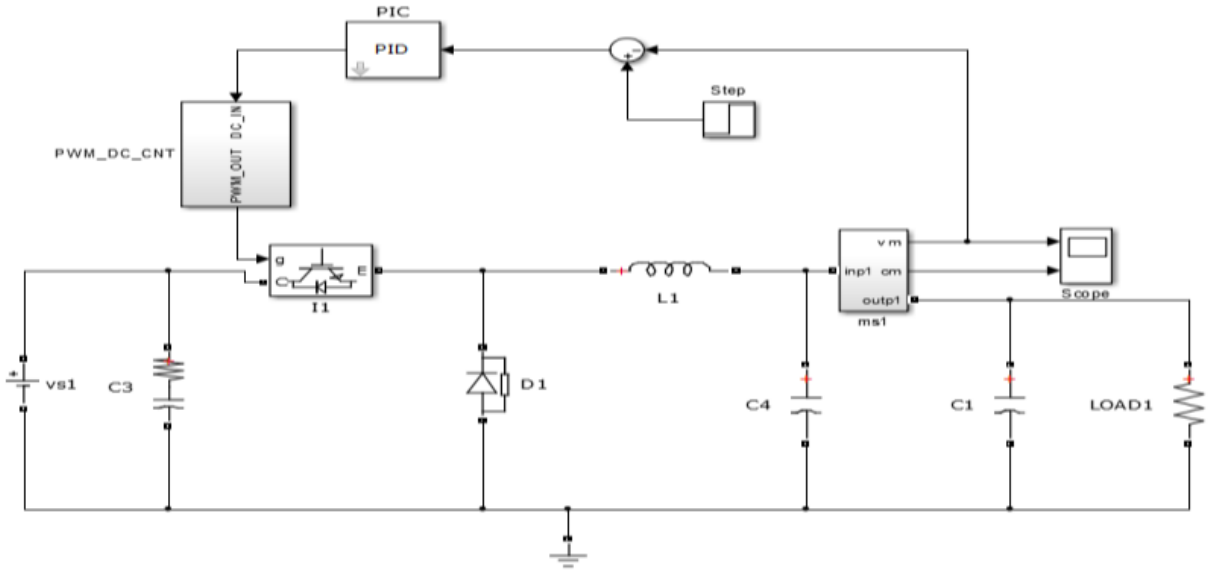

Fig5: Buck Converter circuit with PID controller(closed loop)

5. DC-DC BOOST CONVERTER CIRCUIT

The operation of basic boost converter for mathematical modeling and analysis is represented in the figures 6,7 and 8 below.

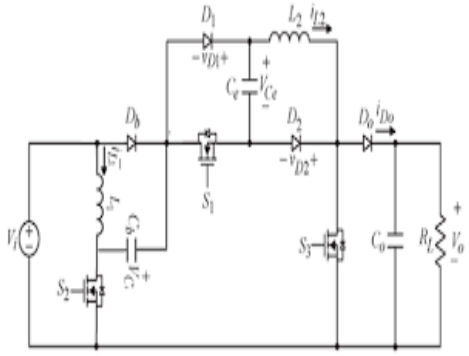

Fig6: Basic Boostloopconverter circuit (open loop)

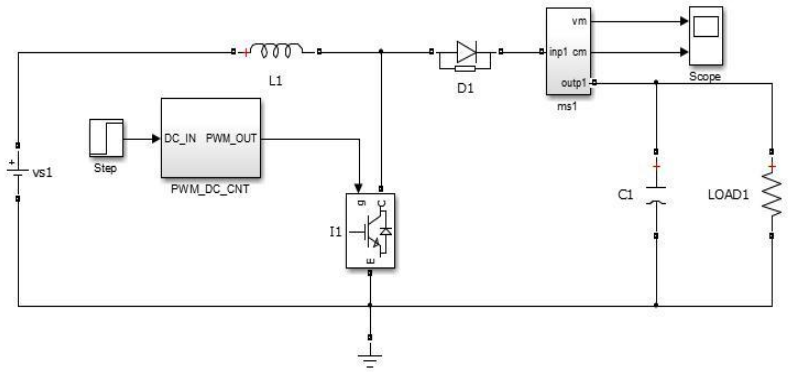

Fig7: Boost converter circuit with PWM

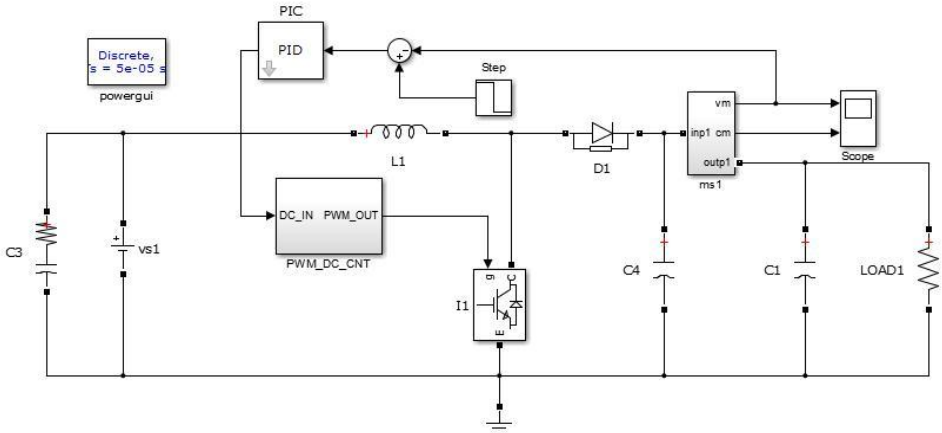

Fig8: Boost converter with PID controller (closed loop)

Two topologies of DC-DC converter to be specific ,buck and lift converters have been outlined and examined. Figures 3, 4, 5 indicate buck converter in open circle and shut circle. The PID controller controls the obligation cycle of PWM flag connected to semiconductor switch IGBT according to the yield necessity. For buck converter the yield DC voltage is not as much as the info DC voltage. A similar PID controller is connected to support converter appeared in figures 6,7,8. The outline and reproduction is completed in MATLAB-Simulink environment.

6. EXPERIMENTAL ANALYSIS RESULTS

The proposed PID controller for buck and lift converter circuit is outlined and recreated utilizing MATLAB Simulink environment. The PID parameters are resolved in light of the basic control designing information that transient exhibitions can be enhanced if the P and I picks up are huge and the D gain is small at the beginning. For both the topologies input voltage is taken as 12V. The operation of the converters can be best checked with step input reference voltage. Reenactment has been done for different changes in stack esteems and info variations. Results demonstrate that the composed PID controller has better yield voltage following capacity, accordingly enhancing yield voltage direction. The plan is exceptionally straightforward with little size and decreased cost

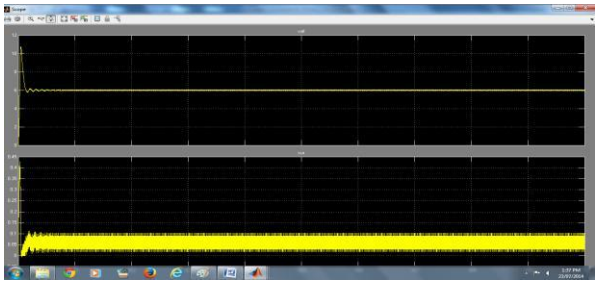

Fig9: Output voltage waveform of basic buck converter

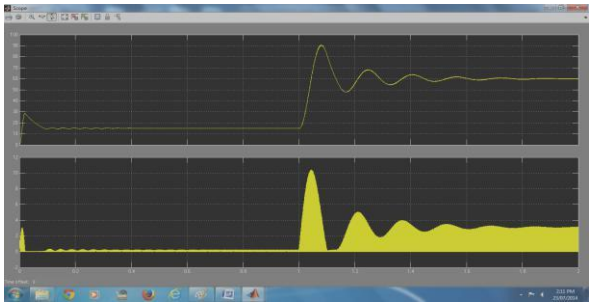

Fig10: Output voltage waveform of buck converter with PWM

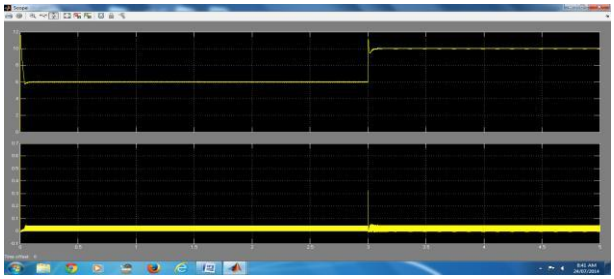

Fig11: Output voltage waveform of buck converter with PID controller

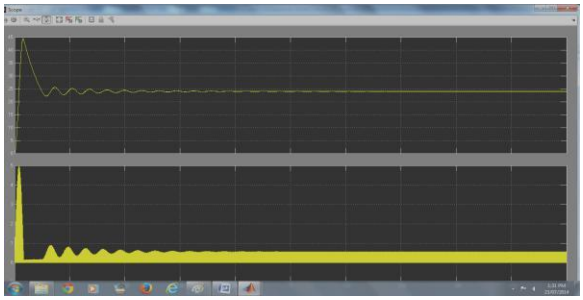

Fig12: Output voltage waveform of basic boost converter

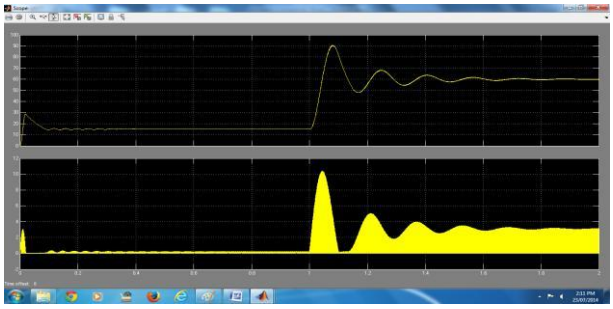

Fig13: Output voltage waveform of boost converter with PWM

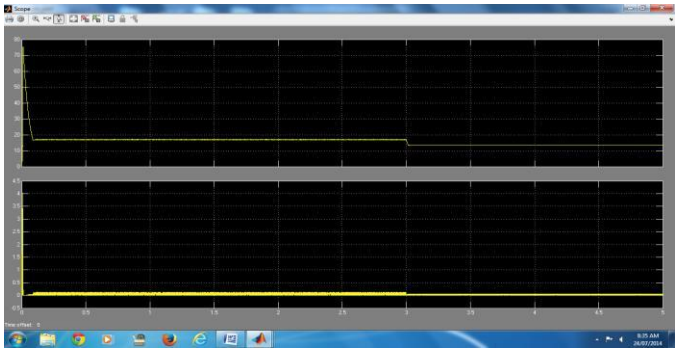

Fig14: Output voltage waveform of boost converter with PID controller

7. CONCLUSION

The composed buck and lift converter works successfully when PID controller is utilized. The controller understands a superior yield voltage following with insignificant overshoot, little relentless state errors, short settling time and enhanced converter efficiency. The outline is straightforward and simple with lessened size and cost.

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