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IMPLEMENTATION OF FUZZY LOGIC CONTROLLER TO IMPROVE DYNAMIC PERFORMANCE OF DC-DC BOOST CONVERTER

S.Sasikala, Dr.V.Jamuna, R.Revathi, G.Shanmugapriya

Abstract— Fuzzy logic is recently era getting increasing emphasis in process control applications. For regulating DC-DC boost converters, the algorithm of a fuzzy controller is designed. An explanation about fuzzy logic controller and its application is also discussed in this paper. Fuzzy controller is evaluated by computer simulations @Mat lab of the closed-loop performance of boost converters in respect of load regulation and line regulation. The divergence between input and output voltages in fuzzy controller is much smaller when compare to other controllers(PI controllers),good performance of transient responses under varying loading conditions and better efficiency are achieved.

Index Terms— DC – DC converter, Fuzzy Logic Controller, PI controller

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1 INTRODUCTION

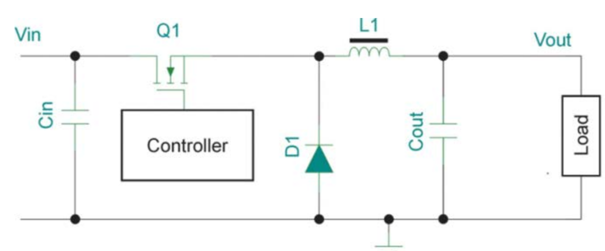
Nowadays, the control systems for many power electronics applications have been increasing widely with demands. The application which we are mainly considered is solar system. In general PV generation systems have two major problem; the conversion efficiency of electric power generation is low and the amount of electric power generated by solar arrays changes continuously with weather condition. The idea to ensure the problem and get desired voltage output can be produced efficiently. Recently FUZZY logic has been applied for tracking the maximum power point of PV systems in because it has the advantages of being robust, design simplicity and minimal requirement for accurate mathematical model. One of the most popular algorithms of MPPT is P&O (Perturb and Observe) technique; however, the convergence problem and oscillation are occurred at certain points during the tracking. To enhance the performance of the P&O algorithm Fuzzy logic converter and Boost converter to the MPPT control. The simulation study in this paper is done in MATLAB Simulink Software.

2. DC CONVERTERS:

recent years with rapidly development of advanced high-speed digital circuits, digital control will slowly replace the currently used analogue controller in high frequency switching converter. Some types of dc-dc converters are buck converter, boost converter, buck-boost converter, cuk Converter.

2.1 Buck Converter

A Buck converter or step-down switch mode power supply can also be called a switch mode regulator which work as a DC-DC converter



In the block diagram the operation of the buck converter can be seen that the output voltage appearing across the load is sensed by the error amplifier and an error voltage is generated which controls the switch.

2.2 Buck-boost:

The buck-boost converter is a type of power controlling device that makes it possiple to adjust the output of the voltage to more or less than the amount of the voltage input received byt the converter. This technology is often utilized in the process of regulating the flow of current form on direct current or dc power source to another adjusting the output manner to help to reduce the potential for over load situations.

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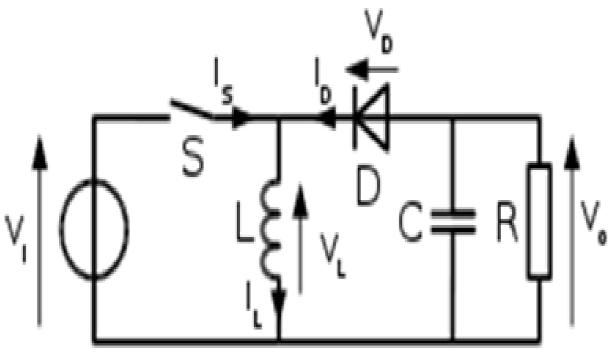
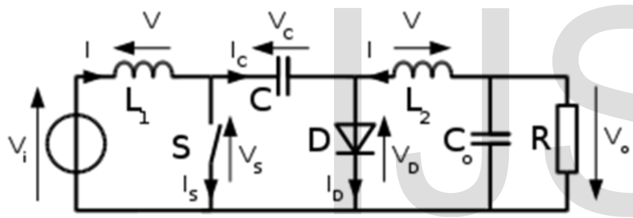


which inhibits the PWM dimming capability of the converter.

2.3 *Cuk converter*:

The Cuk converter is a type of DC-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude.

The non-isolated Cuk converter can only have opposite polarity between input and output. It uses a capacitor as its main energy-storage component, unlike most other types of converter swhich use an inductor.



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2.4 Problems of buck, buck-boost and cuk converter:

Buck:

- output voltage ripple is main drawback of a switching power supply.
- must compensate for voltage drop across diode and N-mosfet.
- Switching nature of design mean inherent voltage ripple exists on the output.

Buck-boost:

- The main disadvantage is that the design of the device usually does not account for any type terminal at the ground point with the switching depending on this aspect design may not have any real impact on the efficiency of the converter.
- Reliability is less.
- If any cell fails the system losses power.

Cuk converter:

- The converter is difficult to stabilize complex compensation circuitry is often needed to make the converter operates properly.
- This compensation due tends to slow down the response of the converter

2.5 To overcome the above problem we going for boost converter.

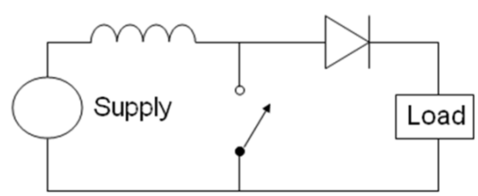
Boost converter:

A boost converter (step-up converter) is a DC-to-DC power converter with an output voltage greater than its input voltage. It is a class of switched-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element, a capacitor, inductor, or the two in combination. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

Power for the boost converter can come from any suitable DC sources, such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a DC to DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it “steps up” the source voltage. Since power must be conserved, the output current is lower than the source current.

2.6 Principle :

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current by creating and destroying a magnetic field. In a boost converter, the output voltage is always higher than the input voltage.



The basic schematic of a boost converter

- A white LED typically requires 3.3 V to emit light, and a boost converter can step up the voltage from a single 1.5 V alkaline cell to power the lamp. Boost converters can also produce higher voltages to operate cold cathode fluorescent tubes (CCFL) in devices such as LCD backlights and some flashlights.

- This circuit topology is used with low power battery applications, and is aimed at the ability of a boost converter to 'steal' the remaining energy in a battery.

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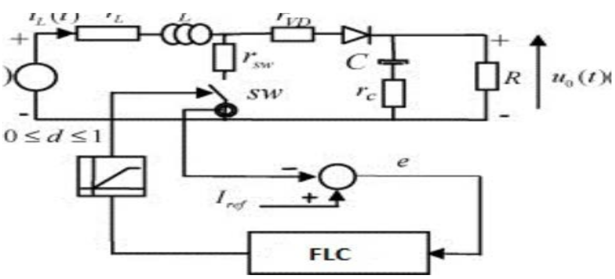
- The main application we are discussing here is in solar (pv) panel.

3 CONVERTER AND ITS COMPONENTS:

3.1 BOOST CONVERTER

In many industrial applications, it is required to convert a fixed-voltage DC source into a variable voltage DC source. A DC –DC converter converts directly from DC to DC and is simply known as a DC converter . A boost converter provides an output voltage greater than the input voltage. The circuit arrangement of a boost converter .Value of the duty cycle is determined by the fuzzy controlled which is equipped with a setoff well defined rules.



3.2 INVERTER:

The main function of an inverter is to convert the DC voltage obtained from the PV generator into an AC current. The lowest DC voltage will occurs with high ambienttemperature, and this effect predominates over the increased of optimal voltage caused by an increment of the irradiance at a constant cell temperature, so the maximum number of series connected models should be determined by this case. Inverter as higher rated voltage of DC link

4 FUZZY LOGIC MAXIMUM POWER TRACKING CONTROLLERS:

The PV fuzzy logic controller consists of three main modules:

- fuzzification process
- inference engine,
- defuzzification process

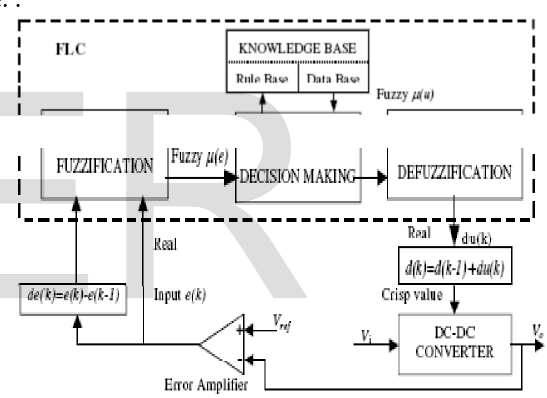
The relationship between these three main components is shown in block diagram, which shows the traditional Fuzzy Logic Controller requires the expert knowledge of the process operation for the FLC parameters setting and the controller can be only as good as the experiseinvolved in the design. FLC with a fixed parameter is inadequate in applications when the operation conditions change in wide range and the available expert knowledge is no trelatable. To make the controller less dependent on the expert knowledge, FLC could be introducing.

4.1 FUZZIFICATION:

The input membership functions take the inputs to the controller (after they have been normalized by some value suitable for the membership functions) and produce a degree of membership for each fuzzy set in the membership function. Membership function values are assigned to the linguistic variables, using seven fuzzy subsets: NB(Negative Big), NM(Negative Medium), NS (Negative Small), PM (Positive Medium) and PB (Positive Big). The triangular shape of the membership function of these arrangement presumes that for any particular input there is only are domain fuzzy subset. The input error (e) & change of error(e) for fuzzy logic controller can be calculated from the maximum power point.

4.2 DEFUZZIFICATION:

Once the degrees of membership of the outputs have been found via the inference engine, the defuzzification process takes these values and translates them into an output dispatch signal. Once fuzzification is over, output fuzzy range is located .since at this stage a non-fuzzy value of control is available a defuzzification is used for defuzzification in the proposed scheme. .



4.3 INFERENCE ENGINE:

Once the degrees of membership for each fuzzy set have been determined for a particular input, they are presented to the inference engine. The inference engine takes these fuzzy set memberships and determines which rules should be evaluated. Inference engine mainly consist of fuzzy rule base and implication sub blocks. The inputs are now fuzzy field are fed to the inference engine and the rule base is then applied. The output fuzzy set are then identified using fuzzy implication method. Here we are using MIN-MAX fuzzy implication method.

5. SIMULTATION AND DISCUSSION:

The evaluation on this dc-dc boost converter, analyzes had been performed. The input voltage was set at 30V and the voltage reference was set at 60 V. The output voltage, output current, inductor current, capacitor voltage, MOSFET voltage, diode voltage, step response etc for the open loop and closed loop circuit had been evaluated for PI controller and the simulation results were taken.

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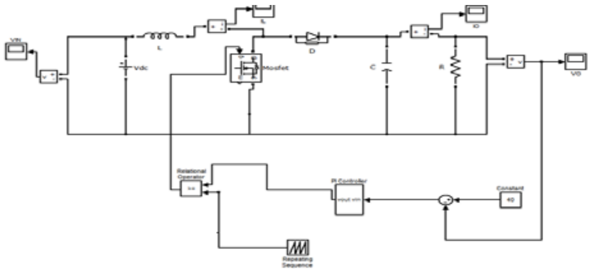
5.1 SIMULATION MODULES:



Transfer Function Of Closed Loop System

The parameters and values for the boost dc-dc converter:

Parameters	Value
Input voltage	30V
Output voltage	60V
Output power	15W
Diode forward voltage	1.575
Duty cycle	1.75
Switching frequency	30
Inductor current ripple	22.5
Capacitor voltage ripple	0.1
Input current	0.50
Output current	0.30

Output waveform for PI controller using closed loop control.

6. CONCLUSION:

Design of PI controller on DC-DC boost converter by using MATLAB @Simlink software has been achieved. In this controller. In PI controller, integral action tends increase the oscillatory or rolling behavior of PV panel. It has maximumovershoot and high settling time. Due to maximum deviation longer response time, longer period of oscillation. To overcome this a simple algorithm based on the prediction of Fuzzy Logic Controller possibly using fuzzy rules parameters are more convenient while compare to other controller. This could solve many types of problems regardless on stability, because we know fuzzy logic is an intelligent controller to their appliances.

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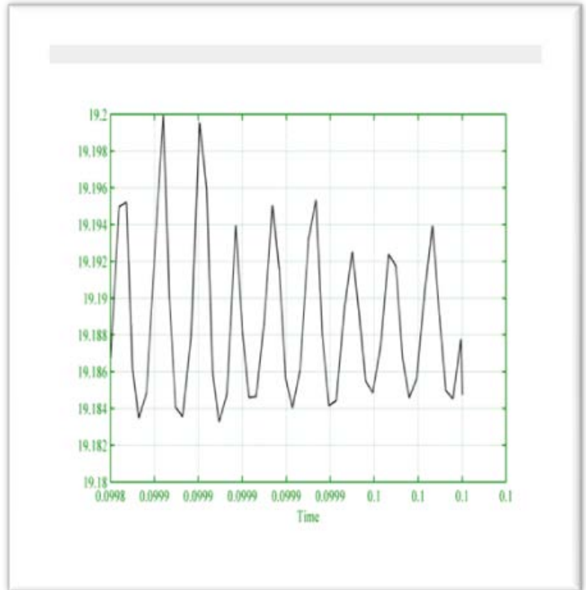

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