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Closed Loop Control Of Two Switch Serial Input Interleaved Forward Converter

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Abstract: This paper deals with closed loop control of two switch Interleaved Forward Converter. When any sudden disturbance occurs at the input of open loop two switch interleaved forward converter, the output is also disturbed for a long time. In order to avoid this, a closed looped control is introduced. By using closed loop control steady state error is reduced. The DC input is converted into high frequency AC using Forward Converter. The AC is rectified using Half-wave rectifier. The output voltage is regulated using closed loop system.

***Keywords*:** Interleaved Forward Converter, DC-DC Converter, Matlab, Microcontroller.

1. INTRODUCTION

Many industrial applications require DC power. A DC to DC converter is an electronic converter which converts a source of direct current from one voltage level to another. DC to DC converters (with isolation) convert one DC voltage level to another, by storing the input energy temporarily and then releasing that energy to the output at a different voltage level. The energy can be stored in magnetic field storage components (inductors, transformers) or electric field storage components (capacitors). This conversion method is more efficient than linear voltage regulation which dissipates unwanted power as heat. The efficiency is increased by the use of power FETs, which operate at high frequency than power bipolar transistors. DC to DC converters are important in portable electronic devices such as cellular phones and computer which are supplied with power from batteries.

Galvanic isolation is the principle of isolating functional sections of electrical system by preventing the moving of charge carrying particles from one section to another, i.e. there is electric current flowing directly from one section to the next. Energy and/or information can still

be exchanged between the sections by other means e.g. capacitance, inductance electromagnetic waves, optical, acoustic or mechanical means. Such a principle is used in these DC to DC converters (with isolation). Two types of converter with galvanic isolation are Flyback converter and Forward converter. Forward converter is a popular switched mode power supply (SMPS) circuit that is used for producing isolated and controlled dc voltage from the unregulated dc input supply. Applications of this forward converters are Power supply for DC motor, Battery charging, Battery operated Electric vehicle, Telecom applications etc.

Analysis and Design of Forward Converter with Energy Regenerative Snubber is given by Smedley (2010). Design of High Efficiency Flyback Converter with Energy Regenerative Snubber is given by Liao (2008). An Efficient Active LC Snubber for Forward Converters is given by Jinno (2009). A Novel Integrated Non-Dissipative Snubber for Flyback Converter is given by Ai (2005). Wide Range Dual Switch Forward-Flyback Converter with Symmetrical RCD Clamp is given by Wei (2005). Transformerless Double-Conversion UPS Using a Regenerative Snubber Circuit is given by Reinert (2009). Spike Suppression Method of Bidirectional High Frequency Inverter using a Regenerative Snubber is given by Ramli (2004). Efficiency Improvement for SR Forward Converters with LC Snubber is given by Jinno (2001). A New Interleaved Series Input Parallel Output (ISIPO) Forward Converter with Inherent Demagnetizing Features is given by Taotao (2008).

The above literature does not deal with modeling of closed loop controlled two switch serial input interleaved forward converter. This paper deals with modeling and simulation of closed loop controlled two switch interleaved forward converter.

The input DC supply for a forward converter is often derived after rectifying (and little filtering) the ac voltage. The forward converter, when compared with the flyback circuit is generally more energy efficient and is used for high power output applications (in the range of 100 watts to 200 watts). Whereas, the flyback converter used for low power application below is 100 watts. The forward converter is simple and retains many features of the buck converter. With a proper choice of the transformer turns ratio, the forward Converter can attain wide step down voltage which is useful for offline applications. Moreover, this forward converter is quite easy to control. This work aims to find a better converter.

2. FORWARD CONVERTER

The block diagram is shown in Fig1. This converter convert unregulated DC power to regulated DC power. It contains high frequency transformer which is also called isolation transformer. This provide isolation between load and main circuit. As the frequency increases, the size of the transformer decreases. Since the flux decreases with the increase in frequency of the transformer.

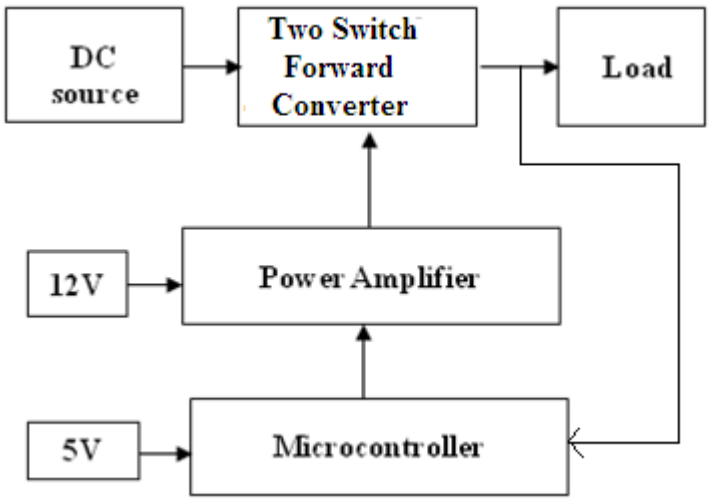

Fig 1 Block Diagram of Forward Converter System

The output is an regulated DC power which is used to run the motor, battery charging, telecommunication, computers, cellular phones, electrical drives and other applications which needs DC power.

3. SIMULATION RESULTS

The simulink model for two switch DC-DC converter is shown in Fig 2.1. The scopes are connected to measure output voltage and output current. A step change in input voltage is applied to the open loop system.

3.1 OPEN LOOP CONTROLLED TWO SWITCH FORWARD CONVERTER

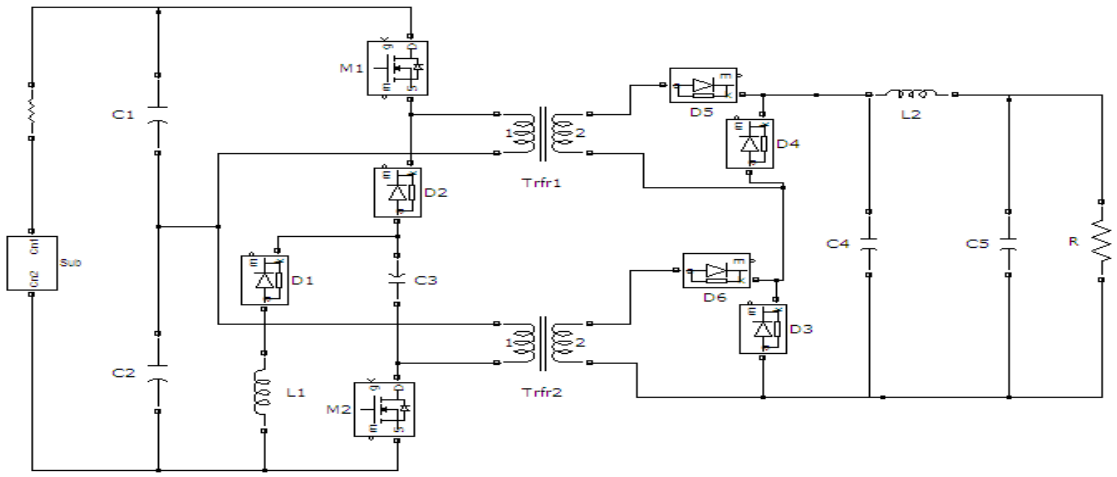

Fig 2.1 Circuit diagram of open loop controlled two switch forward converter

DC input voltage is shown in Fig 2.2 and its 300volts. When a step change is applied, the voltage increases to 318V.

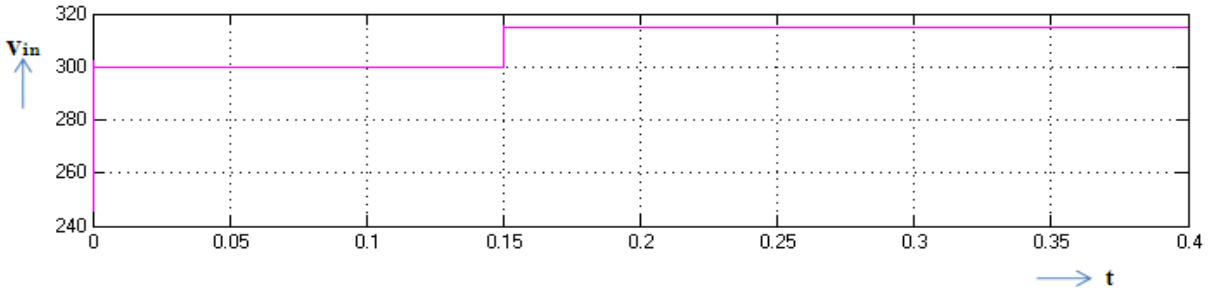

Fig 2.2 Input voltage

The DC output voltage is shown in Fig 2.3. The output voltage increases from 20 to 22V.

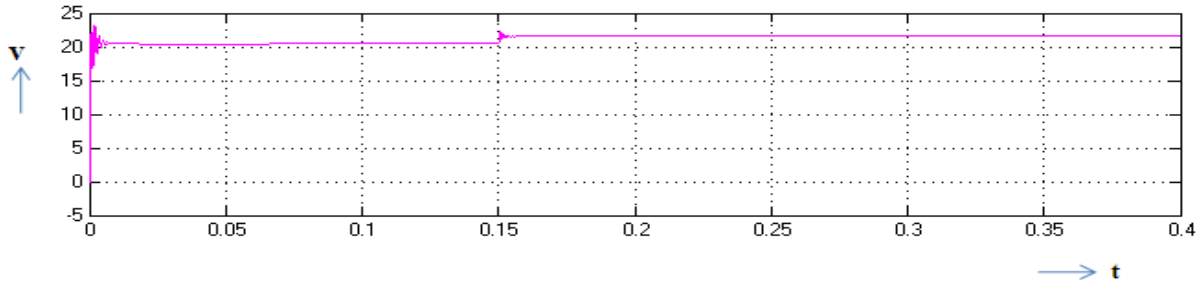

Fig 2.3 Output voltage

The output current and output power are shown in Figs 2.4 and 2.5 respectively.

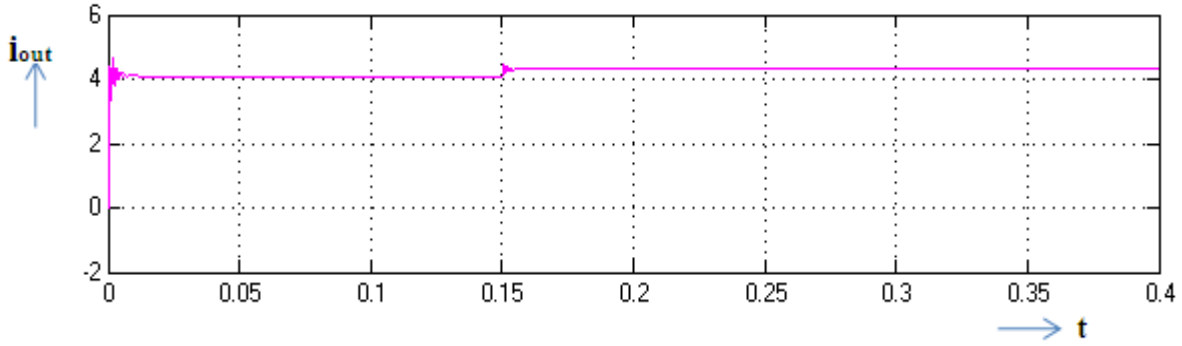

Fig 2.4 Output current

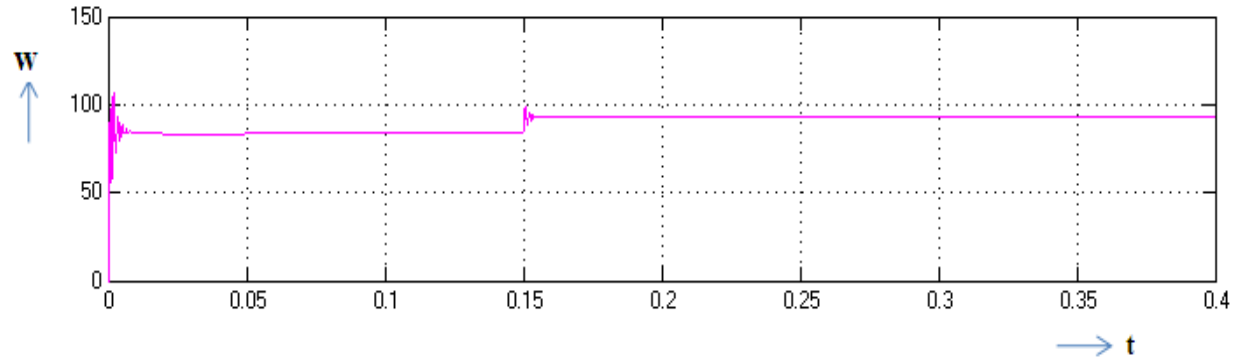

Fig 2.5 Output power

TWO SWITCH FORWARD CONVERTER WITH CLOSED LOOP CONTROL

Two switch serial input interleaved forward converter with closed loop is shown in Fig 3.1. The PI controller is used to reduce error in the output. The output voltage is measured and it is compared with the reference voltage. The error is processed by a PI controller. The output of the PI controller is the input to the comparator. The diodes in the rectifier are replaced by MOSFETs so that the output voltage can be controlled.

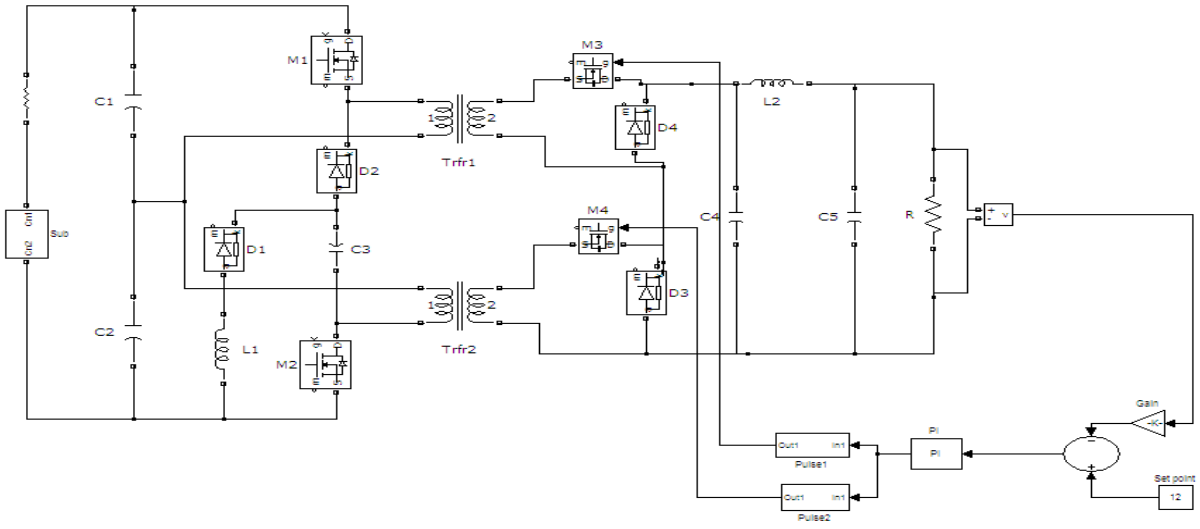

Fig 3.1 Circuit diagram of two switch forward converter with closed loop

DC input voltage is shown in Fig 3.2 and its value is 300volts

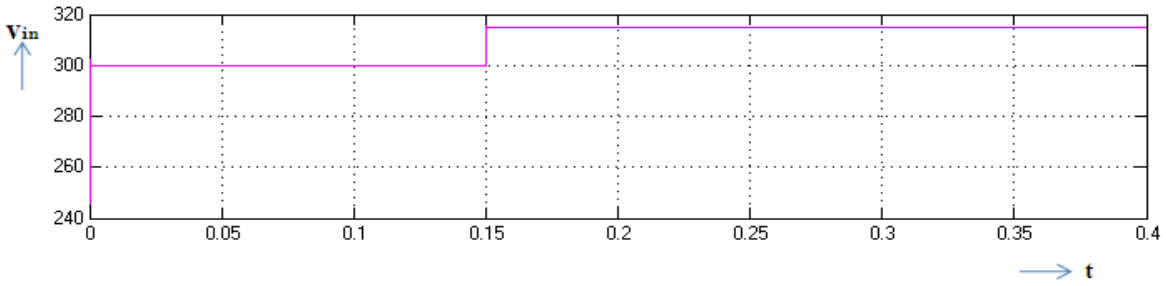

Fig 3.2 Input voltage

DC output voltage is shown in Fig 3.3. It can be seen that the output reduces to the set value.

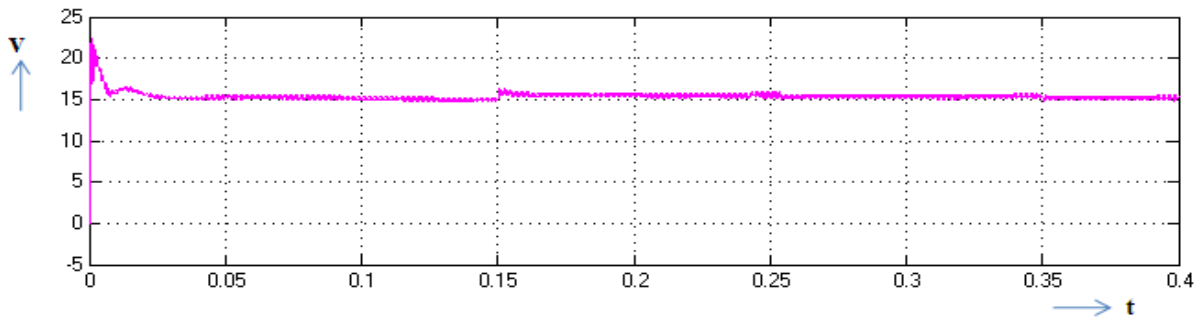

Fig 3.3Output voltage

The output current and output power are shown in Fig 3.4 and 3.5 respectively.

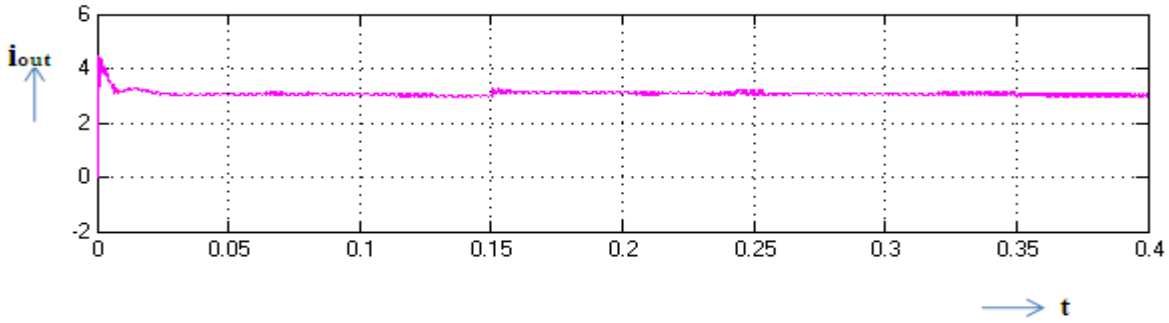

Fig 3.4 Output current

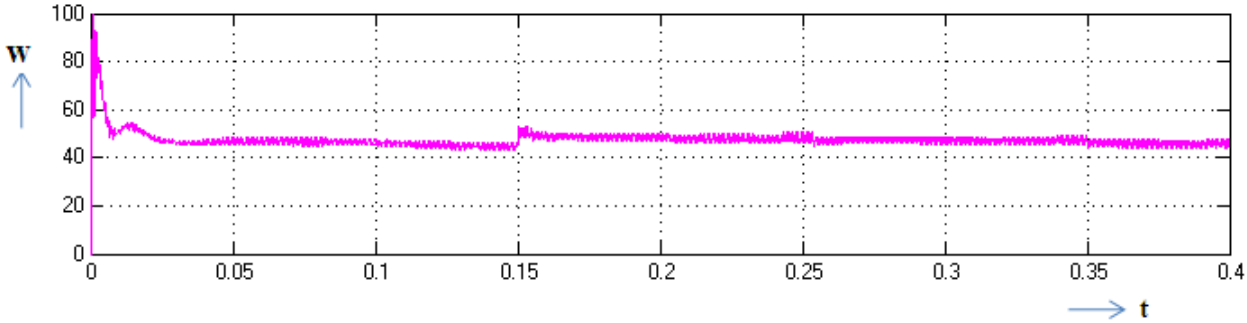

Fig 3.5 Output power

CONCLUSION

Open loop and closed loop controlled two switch serial input interleaved forward converters are modeled and simulated using MATLAB Simulink and the results are plotted. The output of two switch converter system with PI controller is regulated. The steady state error is reduced by using closed loop system.

The scope of this work is the modeling and simulation of closed loop controlled two switch ILFC system. The hardware will be implemented in future.

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