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Zeta Converter based on Model Predictive Controller for Power Factor Correction

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Abstract: This study presented a Zeta converter based on Model Predictive Controller (MPC), this converter consist of high frequency transformer on the primary side and two diodes and two switches for welding application. This proposed converter is operated in DCM discontinuous inductor current mode and dynamic performance using this method result is reduced switch stress and also this converter provides constant output voltage to maintain, easy to control, hence, only one gating signal is used to drive both the switches. Using MPC controller, the proposed converter gives good efficiency, lower Total Harmonic Distortion (THD) and power factor correction at the utility.

Key words: Zeta converter, model predictive controller, total harmonic distortion, DC-DC converter, easy to control, correction

INTRODUCTION

This study describes a Zeta converter of its dynamic performance with mpc controller, normally DC-DC converter are the circuits used to converter sources Direct Current (DC) from one voltage level to another voltage level by tuning the duty cycle of the main switch in the circuit. These converters are largely used in SMPS and Motor drive applications. The operation of switching devices causes the inherently non linear characteristics of the DC/DC converter (Guldemir, 2011). Due to this unwanted characteristics the controller with high degree of dynamic response. The most frequently consider method among the various switching control method is PWM (Pulse Width Modulation). In DC-DC converter it is important to supply a constant output voltage. The input to these converters is often an unregulated DC voltage which is obtained by rectifying the line voltage and it will therefore fluctuate due to variations of the line voltages (Beccuti *et al*., 2009).

The conventional DC-DC converter such as buck, boost, Zeta, Cuk and SEPIC converter has utilized the pulse width modulation for generating gate pulse. The pulse modulation has to enhance the performance of drive system. The voltage may drop below the battery voltage for constant supplying the load with constant voltage (Geyer *et al*., 2008). The converter with separate inductors as a particular case of the more general coupled-inductor case, several topologies are carried out in the literature. It results in the reduction in the cost and complexity of upcoming DC-DC converters. Among them, a Zeta converter provides reduced inrush current and excellent overload current protection (Lazar *et al*., 2006). The conventional Zeta AC-DC converter suffers from a major drawback of high voltage stress across the switch and increases the switching losses. The development of the two-Zeta converter operating in the DCM (Falin, 2010) with high frequency isolation, regulated output voltage, This control strategy for DC-DC converters, non-linear predictive control approach is used to the control input. The nonlinear characteristics of the controlled plant (Niculescu *et al*., 2009) are explicitly taken into account when the control input is calculated good performance and robustness can be achieved. The model predictive control uses an averaged non-linear model to predict the future behaviour of the switched simulink Zeta converter which is the plant to be controlled. The high efficiency renewable PV inverter topology is described by Bavitra *et al*. (2015). In this study (Ponshanmugakumar *et al*., 2014) solar driven air conditioning system integrated with latent heat thermal energy storage is explained.

MATERIALS AND METHODS

Zeta converter: The Zeta converter maintains constant output voltage. This proposed converter topology gives a positive output voltage from an input voltage. Modelling of photovoltaic system with converter topology for grid fed operations (Umadevi *et al*., 2014) explained the converter topology of the photovoltaic systems. It essentially provides an overload and inrush current protections. Therefore, Zeta converters used as a resistive load to input AC mains. Energy efficient voltage conversion range of multiple level shifter design in multi voltage domain (Sinthuja *et al*., 2014) explained the various conversion ranges of the level shifters. Zeta converter is fourth order converters that can step down or step up the input voltage. This converter transfer energy between inductance and capacitance in order to change the voltage between to another the transferred energy is controlled by switching device (MOSFET). Figure 1 shows the circuit diagram of Zeta converter and Fig. 2 shows the block diagram of Zeta converter based MPC controller.

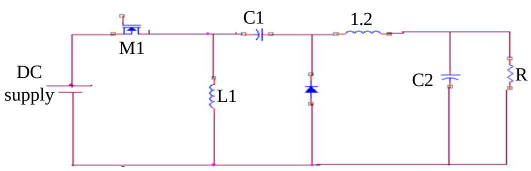

Fig. 1: Zeta converter

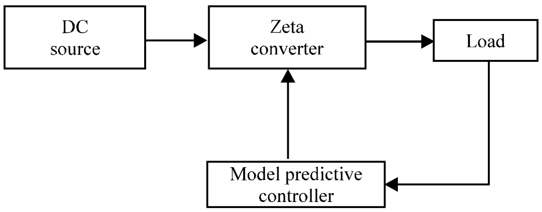

Fig. 2: Block diagram

Model predictive controller: In recent years, it has also been used in power system balancing models. Model Predictive Control (MPC) is a method of advanced Process control used in industries, since, the 1980's. PID and LQR controllers do not have this predictive ability. MPC is nearly universally implemented as a digital control, although, there is research into achieving faster response times with specially designed analog circuitry. The advantage of MPC is the fact that it allows while keeping future timeslots in account the current timeslot to be optimized. This is achieved by optimizing a finite time-horizon but only implementing the current timeslot. MPC has the ability to anticipate future events and can take control actions accordingly.

RESULTS AND DISCUSSION

The proposed Zeta converter based on current mode control method is utilized. Zeta converter exhibits two different modes. In first mode is obtained when the switch is ON (closed) and instantaneously, the diode D is OFF. During this period, the current through the inductor L1 and L2 are drawn from the voltage source Vs. This mode is the charging mode. The second mode of operation starts when the switch is OFF and the diode D is ON position. This stage or mode of operation is known as the discharging mode since all the energy stored in L2 is now transferred to the load R. The input voltage of DC source is shown in Fig. 3. The output voltage of the Zeta converter is shown in Fig. 4. The output current is shown in Fig. 5.

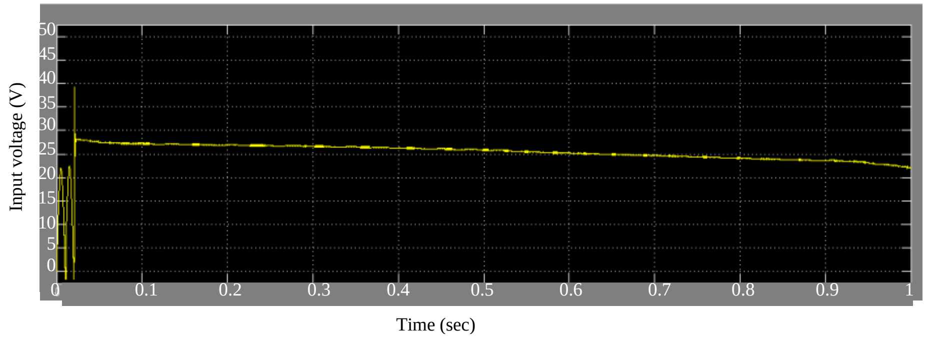

Fig. 3: Input voltage

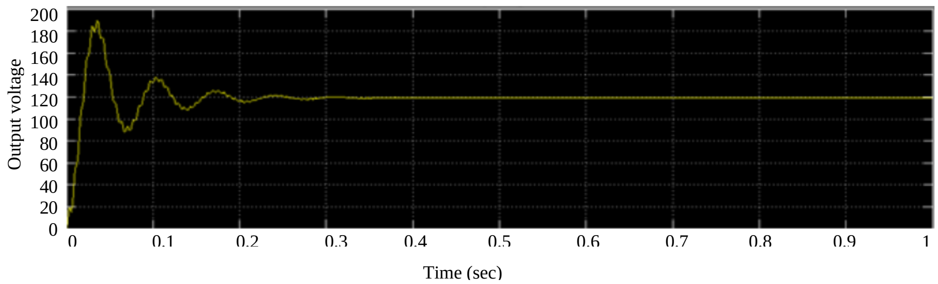

Fig. 4: Output voltage

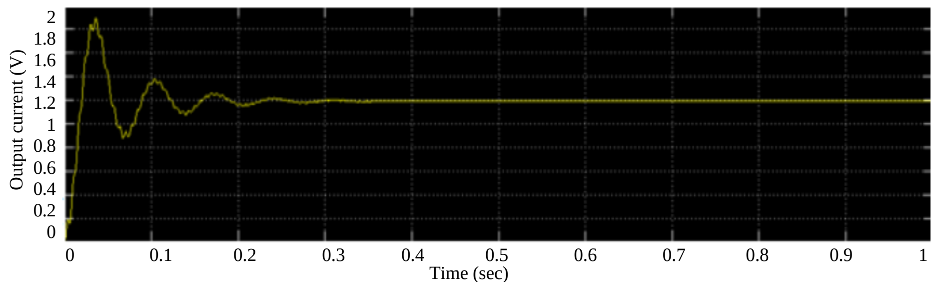

Fig. 5: Output current

CONCLUSION

This study implements a Zeta converter operating in DCM mode using model predictive control. This proposed Zeta converter produces lower ripple output voltage. The circuit output voltage response closed loop system has been analyzed. The model obtained to design a MPC controller that ensures the output voltage regulation with good performances. From the results obtained in the simulation of proposed system, it is clear that both output voltage ripple and peak over shoot during transient condition are reduced even though load variations. Also, it maintains the constant output voltage for various load conditions. Zeta converter circuit parameters have been obtained through MPC control parameters have been obtained with the assist form of the Zeta converter using MATLAB/Simulink Software.

REFERENCES

Bavitra, K., S. Sinthuja, N. Manoharan and S. Rajesh, 2015. The high efficiency renewable PV inverter topology. Indian J. Sci. Technol., Vol. 8, 10.17485/ijst/2015/v8i14/70700

Beccuti, A.G., S. Mariethoz, S. Cliquennois, S. Wang and M. Morari, 2009. Explicit model predictive control of DC-DC switched-mode power supplies with extended Kalman filtering. IEEE. Trans. Ind. Electron., 56: 1864-1874.

Falin, J., 2010. Designing DC-DC converters based on ZETA topology. Analog Appl. J., 1: 16-21.

Geyer, T., G. Papafotiou, R. Frasca and M. Morari, 2008. Constrained optimal control of the step-down DC-DC converter. IEEE. Trans. Power Electron., 23: 2454-2464.

Guldemir, H., 2011. Modeling and sliding mode control of dc-dc buck-boost converter. Proceedings of the 6th International Symposium on Advanced Technological Vol. 4, May 16-18, 2011, Fýrat University, Elazýg, Turkey, pp: 475-480.

Lazar, M., W.P.M.H. Heemels, S. Weiland and A. Bemporad, 2006. Stabilizing model predictive control of hybrid systems. IEEE. Trans. Autom. Control, 51: 1813-1818.

Niculescu, E., D. Mioara-Purcaru, M.C. Niculescu, I. Purcaru and M. Maria, 2009. A simplified steady-state analysis of the PWM Zeta converter. Proceedings of the 13th International Conference on CIRCUITS Mathematics and Computers in Science and Engineering, July 22-24, 2009, WSEAS, Cambridge, UK,, ISBN:978-960-474-096-3, pp: 108-113.

Ponshanmugakumar, A., M. Sivashanmugam and S.S. Jayakumar, 2014. Solar driven air conditioning system integrated with latent heat thermal energy storage. Indian J. Sci. Technol., 7: 1798-1804.

Sinthuja, S., J.H. Kumar and N. Manoharan, 2014. Energy efficient voltage conversion range of multiple level shifter design in multi voltage domain. Indian J. Sci. Technol., 7: 82-86.

Umadevi, K., P. Nalandha and C.C. Kesavan, 2014. Modelling of photovoltaic system with converter topology for grid fed operations. Intl. J. Eng. Technol. IJET., 6: 2392-2400.