RESEARCH PAPER | Engineering | Volume : 6 | Issue : 5 | May 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

A New Control Method for Dynamic Voltage Restorer Using Matrix Converter

KEYWORDS: Dynamic voltage restorer, reduced matrix converter, fuzzy logic, Voltage sag.

Dr.S.Deepa

Associate Professor, Panimalar Institute of Technology, India.

ABSTRACT *Dynamic Voltage Restorer (DVR) is used in power distribution system to protect sensitive loads in voltage disturbances. The performance of DVR is related to the adopted configuration and control strategy used for inverters. In this paper, matrix converter controlled with fuzzy logic method based on synchronous reference frame controller, is used to improve operation of DVR to compensate voltage sag/swell. Also, the multi loop controller using the Posicast and P+Resonant controllers is proposed in order to improve the transient response and eliminate the steady-state error in DVR response, respectively. Simulation results using MATLAB/ Simulink are presented to demonstrate the feasibility and the practicality of the proposed novel Dynamic Voltage Restorer topology.. The simulation results of new DVR presented in this paper, are found quite satisfactory to eliminate voltage sag.*

1. Introduction

Due to the advent of a large numbers of sophisticated electrical and electronic equipments, such as computers, programmable logic, electrical drives etc., power quality problems like voltage sag, voltage swell and harmonic distortion can cause serious problems to industrial and commercial electrical consumers [1,2]. For example, some special facilities are sensitive to voltage disturbances. Therefore, in such cases using compensator for the sensitive loads is necessary. There are some solutions to these problems. Installation of Dynamic Voltage Restorer (DVR) for sensitive loads can be considered as a solution [1–3]. DVR is a custom power device, which is connected to the load through a series transformer. To compensate voltage disturbances, series voltage is injected through the transformer by a voltage-source converter connected to dc power source [1,2]. The first DVR was installed in North Carolina, for the rug manufacturing industry. Another was installed to provide service to a large dairy food processing plant in Australia [4]. A DVR consists of a voltage-source inverter, a series-connected injection transformer, an inverter output filter, and an energy- storage device that is connected to the dc link [1–5].

The voltage-source converter is a power electronic device, which can generate a sinusoidal voltage with any required magnitude, frequency and phase angle. This device employs insulated gate bipolar transistors (IGBT) as switches [5]. This converter injects a dynamically controlled voltage in series with the supply voltage through the three single-phase transformers

to correct the load voltage. The main functions of the injection transformer include voltage boost and electrical isolation [6]. The DC side of the converter is connected to a DC energy-storage device. Energy-storage devices, such as batteries or super-conducting magnetic energy-storage systems (SMES) are required to provide active power to the load when voltage sags occur [6]. In this paper, battery is used as a source of the DC voltage for the reduced matrix converter. The output of the inverter (before the transformer) is filtered by Passive filters in order to reject the switching harmonic components from the injected voltage [5]. Different control strategies were proposed for DVR. Voltage-Space Vector PWM was implemented in [4]. In this paper, a DVR with a new inverter topology is presented to suppress the load harmonics and to compensate the voltage disturbances. This inverter has less voltage harmonics generated on the ac terminal of the inverter compared with conventional technique . The adopted control scheme is fuzzy logic controller based on synchronous reference frame method.

II Proposed control of DVR system with Posicast and P+ resonant controller:

In this project,we use the Posicast and P+ resonant controllers for controlling the transient stability and fast response of DVR. The posicast controller that is the 1+G(s) helps in increasing the settling time of the system. The follwing figure shows the basic logic using which the controllers operate.

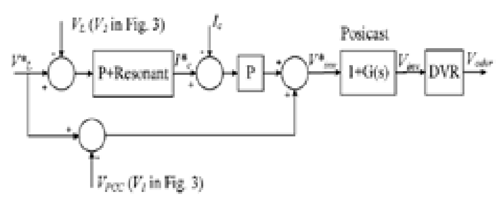

Figure1 Proposed model of DVR

The V_l and V_{pcc} voltages are compared and the error voltage is integrated using an integral controller to reduce the settling time of the system. V_{dvr} voltage is also integrated and then this is compared with the error voltage obtained. This is in three phase as abc which is then converted into a voltage in the d-q axis. This is done because small variations cannot be found in abc plane.

This is then given to the Posicast controller. It has high-frequency gain and hence low sensitivity to noise. This posicast controller has the transfer function

$$1+G(s)=1+\frac{\partial}{1+\partial}\left(e^{-sT_d/2}-1\right) \quad (1)$$

Where ∂ = step response overshoot

Td = period of damped response signal

The damping and the delay time, δ and T_d are derived as

Volume : 6 | Issue : 5 | May 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

$$T_d = \frac{2\pi}{\omega_r} = \frac{\pi}{\sqrt{\left(\frac{1}{L_f C_f} - \frac{R_f^2}{4L_f^2}\right)}} \qquad (2)$$

$$\delta = e^{\frac{\xi\pi}{\sqrt{1-\xi^2}}} \qquad (3)$$

This posicast controller works by pole elimination method and proper regulation of its parameters is necessary. For this reason, it is sensitive to inaccurate information of the system damping resonance frequency. To decrease this sensitivity, the open-loop controller can be converted to a closed loop controller by adding a multiloop feedback path parallel to the existing feed forward path. Inclusion of a feed forward and a feedback path is commonly referred to as two-degrees-of-freedom (2-DOF) control. To eliminate steady-state voltage tracking error (V_L^*-V_L), a computationally less intensive P+ resonant compensator is added to outer voltage loop.

V SIMULATION RESULTS AND DISCUSSION

The proposed three phase DVR circuit is shown in Figure 2

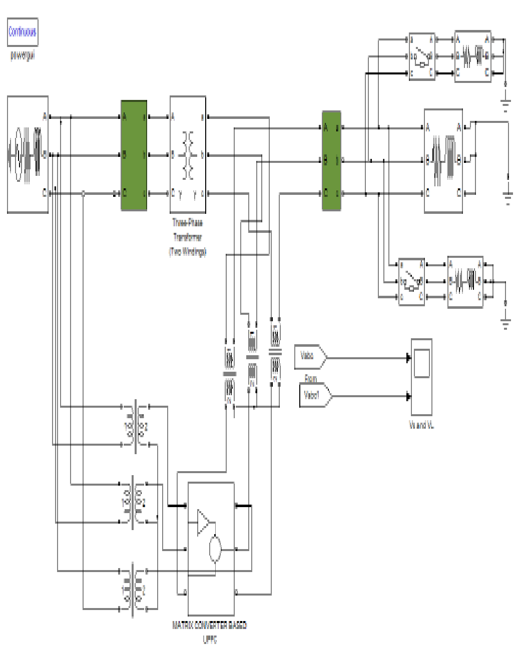

Figure 2 Closed loop controlled three phase DVR

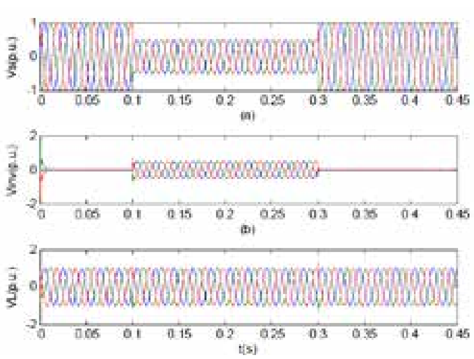

Figure (3) Response of the DVR to a voltage sag using the SVPWM technique

- Supply voltage
- Voltage injected by the DVR
- Voltage at load.

Three phase voltage sag in the system is simulated and a 50% three-phase voltage sag at the utility grid is shown in Figure (3). In Figure 3(a) a 50% voltage sag is initiated at 0.1s and it is kept until 0.3s, with total voltage sag duration of 0.2s. Figures (3) (b) and (c) show the voltage injected by the DVR and the corresponding load voltage with compensation. As a result of the DVR, the load voltage is kept at 1 p.u.

VII Conclusion:

This paper presents the analysis and design of a digitally controlled three-phase SVPWM inverter based dynamic voltage restorer. The simulation results show that the DVR compensates the voltage disturbances such as sag quickly and provides excellent voltage regulation.

References

[1] Mahdianpoor F.M., Hooshmand R.A. and Ataei M. (2011), "A New Approach to Multifunctional Dynamic Voltage Restorer Implementation for Emergency Control in Distribution Systems", IEEE Transactions on Power Delivery, Vol.26, No.2, pp.882–890.

[2] Moradlou M. and Karshenas H.R. (2011), "Design Strategy for Optimum Rating Selection of Interline DVR", IEEE Transactions on Power Delivery, Vol.26, No.1, pp.242-249.

[3] Ramirez D., Martinez S., Platero C.A., Blazquez F. and de Castro R.M. (2011), "Low-voltage ride-through capability for wind generators based on Dynamic Voltage Restorers ",IEEE Transactions on Energy Conversion, Vol.26, No.1, pp.195-203.

[4] Senturk O.S. and Hava A.M. (2012), "A Simple Sag Generator Using SSRs", IEEE Transactions on Industry Applications, Vol.48, No.1, pp.172–180.

[5] Vilathgamuwa D.M., Wijekoon H.M. and Choi S.S. (2012), "A Novel Technique to Compensate Voltage Sags in Multiline Distribution System—The Interline Dynamic Voltage Restorer", IEEE Transactions on Industrial Electronics,Vol.53, No.5, pp.1603-1611.

[6] Pedro Roncero, Jose Enrique and Aurelio Garcia (2009), "A Versatile Control Scheme for a Dynamic Voltage Restorer for power Quality Improvement", IEEE Transactions on power Delivery, Vol.24, No.1, pp.277-284.