Innovative Approach to Multifunctional Dynamic voltage restorer implementation to overcome disturbances in Starting of the Induction Motor

M.Siddartha[1], Salava V Satyanarayana [2] and T.Sirisha[3]

[1]Assistant Professor, EEE, Hyderabad Institute of Technology & Management

[2] Assistant Professor, EEE, Hyderabad Institute of Technology & Management

[3] Assistant Professor, EEE, Hyderabad Institute of Technology & Management

[1]pshve2011@gmail.com, [2]siddartham.eee@hitam.org, [3]pshve2011@gmail.com

Abstract

The dynamic voltage restorer (DVR) is one of the modern device used in distribution systems to protect consumers against unexpected changes in voltage magnitudes. In this paper, extreme control in distribution systems is discussed by using the proposed multifunctional DVR control strategy. Also, the multiloop controller using the Posicast and p+Resonant controllers were proposed in order to improve the transient response and eliminate the steady-state error in DVR response, respectively. The proposed system is applied to some disturbances in load voltage caused by induction motors starting time. Also, the capacity of the proposed DVR has been tested to limit the downstream fault current. The current limitation will restore the point of common coupling (PCC) voltage and protect the DVR itself from fault. Simulation results show the capability of the DVR to control the extreme conditions of the distribution systems.

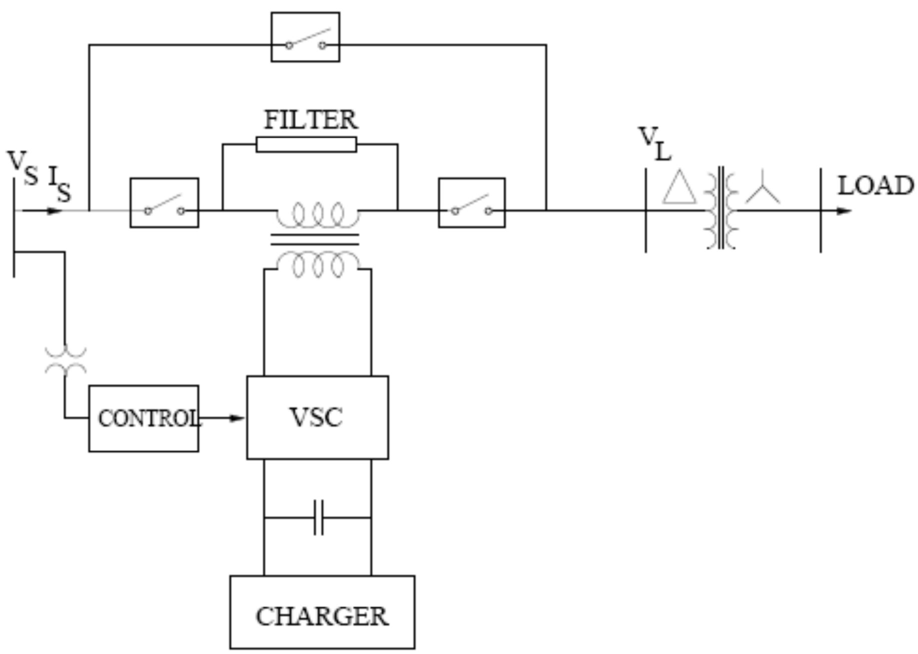
Keywords: Dynamic voltage restorer (DVR), extreme control, load voltage.

INTRODUCTION

Voltage disturbances are the most important power-quality (PQ) problems that encompass almost 80% of the distribution system PQ problems. According to the IEEE 1959–1995 standard, voltage sag is the decrease of 0.1 to 0.9 p.u. in the rms voltage magnitude at system frequency and with the duration of half a cycle to 1 min. Short circuits, starting large motors, sudden changes of load, and energization of transformers are the main causes of voltage disturbances.

PROPOSED SYSTEM

The proposed control strategy in this paper was that when the fault current does not pass through the DVR, an outer feedback loop of the load voltage with an inner feedback loop of the filter capacitor current will be used. A feed forward loop will be used to improve the dynamic response of the load voltage. Moreover, to improve the transient response, the Posicast controller and to eliminate the steady-state error, the P+Resonant controller were used. But when the fault current passes through the DVR, using the flux control algorithm, the series voltage is injected in the opposite direction and, therefore, the DVR acts like series variable impedance.



Typically, DVR is made up of modular design with a module rating of 2 MVA or 5 MVA. They have been installed in substations of voltage rating from 11 kV to 69 kV. A DVR has to supply energy to the load during the voltage fluctuations. If a DVR has to supply real power over longer periods, it is convenient to provide a shunt converter that is connected to the DVR on the DC side. As a matter of fact one could envisage a combination of DSTATCOM and DVR connected on the DC side to compensate for both load and supply voltage variations.

The voltage source converter is typically one or more converters connected in series to provide the expected voltage rating. The DVR can inject a (fundamental frequency) voltage in each phase of required magnitude and phase. The DVR has two operating modes

i. Standby (also termed as short circuit operation (SCO) mode) where the voltage injected has zero magnitude.

ii. Boost (when the DVR injects a required voltage of appropriate magnitude and phase to restore the prefault load bus voltage).

a. Voltage Source Converter (VSC)

This could be a 3 phase - 3 wire VSC or 3 phase - 4 wire VSC. The latter permits the injection of zero-sequence voltages. Either a conventional two level converter (Graetz bridge) or a three level converter is used.

b. Boost or Injection Transformers

Three single phase transformers are connected in series with the distribution feeder to couple the VSC (at the lower voltage level) to the higher distribution voltage level. The three single transformers can be connected with star/open star winding or delta/open star winding. The latter does not permit the injection of the zero sequence voltage. The choice of the injection transformer winding depends on the connections of the step down trans- former that feeds the load.

c. Passive Filters

The passive filters can be situated either on the high voltage side or the converter side of the boost transformers. The advantages of the converter side filters are (a) the components are rated at lower voltage and (b) higher order harmonic currents (due to the VSC) do not flow through the transformer windings.

d. Energy Storage

This is required to provide real power to the load during deep voltage fluctuations. Lead-acid batteries, SMES can be used for energy storage. It is also possible to provide the required power on the DC side of the VSC by an auxiliary bridge converter that is fed from an auxiliary AC supply.

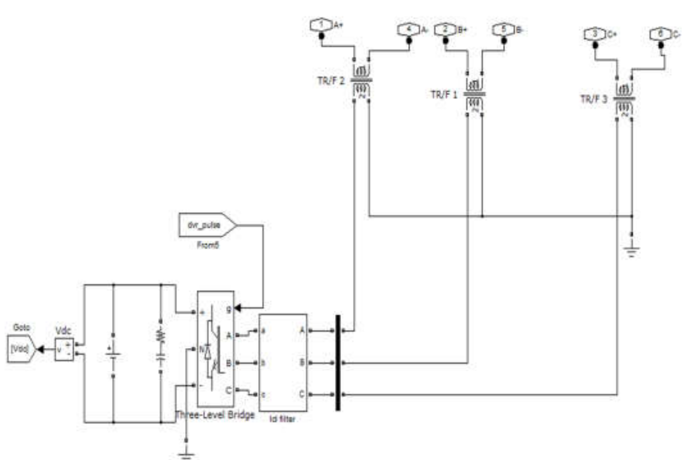


Fig: DVR block diagram in MATLAB

MATLAB/ SIMULATION RESULTS:

The large motor starting current will makes the PCC voltage to drop. The simulation results in the case of using the DVR are shown in below figure. In this simulation, the motor is started at t = 405 milli sec. As can be seen in below figure, at this time, the PCC rms voltage drops to about 0.8 p.u. The motor speed reaches the nominal value in about 1s. MATLAB/simulink model of proposed multifunctional DVR with induction motor in below figure.

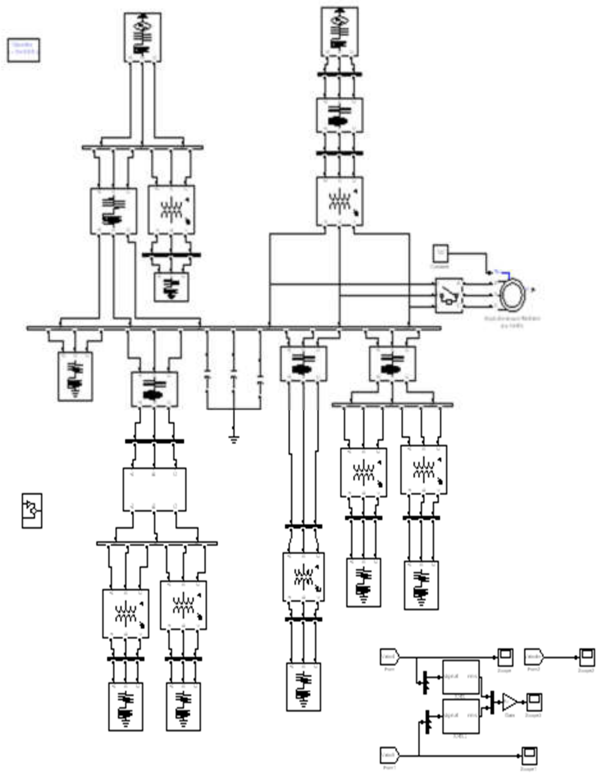
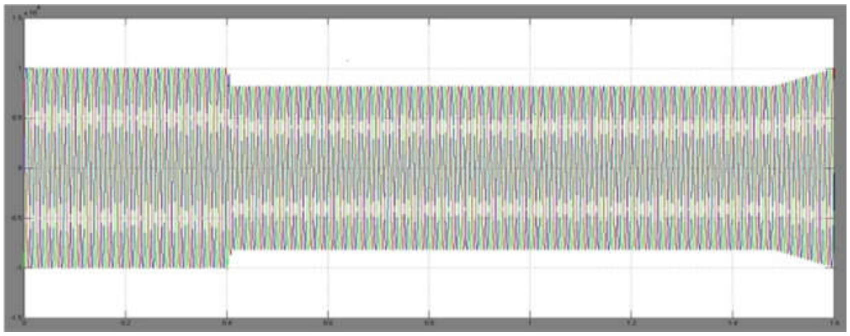
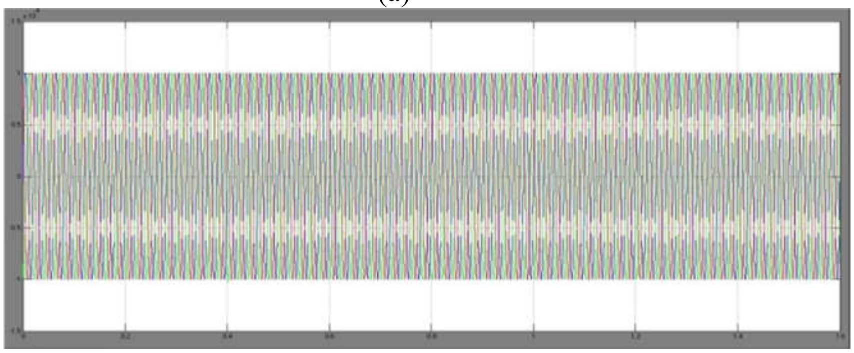


Fig: SIMULINK model of proposed a multifunctional DVR with Induction Motor

During this period, the PCC bus is under voltage disturbance. From t = 1.4sec, as the speed approaches nominal, the voltage also approaches the normal condition. However, during all of these events, the DVR keeps the load bus voltage at the normal condition. The DVR has operated successfully in restoring the load voltage in half a cycle from the instant of the motor starting.



(a)



(b)

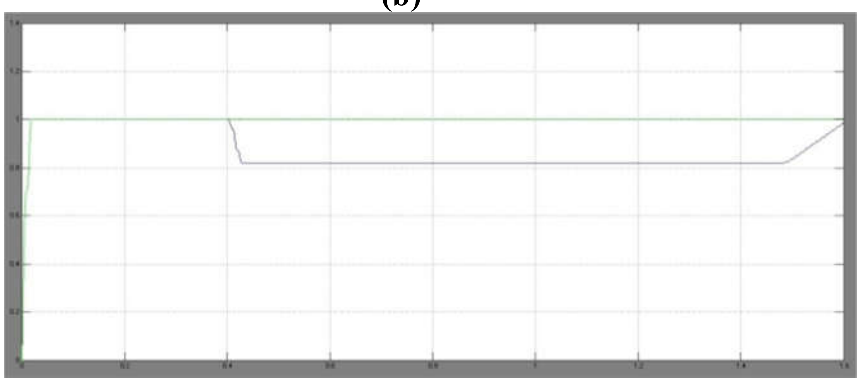


Fig: Starting of an induction motor and the DVR compensation. (a) Three phase PCC voltages. (b) Three-phase load voltages. (c) RMS voltages of PCC and load.

CONCLUSION:

In this paper, a multifunctional DVR is proposed, and a closed-loop control system was used for its control to improve the damping of the DVR output. Also, for further improving the transient response and eliminating the steady-state error, the Posicast and P+Resonant controllers were used. The simulation results verified the effectiveness and efficiency of the proposed DVR in compensating for the voltage disturbances caused by the large induction motor during its starting stage.