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Ensuring Power Quality in Industrial and Medium Voltage Public Grids using DVR

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ABSTRACT

In this paper we are trying to compensate the power quality problems like voltage sag, voltage swell due to balance and unbalanced faults on the transmission lines. Now a days amount of sensitive loads are increasing and hence it is compulsory to reduce the power quality problem in this paper a new control technique is used in the DVR to compensate voltage Sag and voltage swells.

Keywords : Voltage Sag, Voltage Swell, Power Compensation, Power Quality, Power Quality Problems, DVR

I. INTRODUCTION

Now a days electricity is the basic need of human being and the electrical power system is the whole network which generates electricity and the quality of power given to the transmission ,distribution lines and for domestic purposes needs to be very improved and of good quality therefore power quality is the major concern in electrical power system .the power quality disturbances such as sags, swells, harmonic distortions and other interruptions have an impact on the electrical devices and machines and in severe cases cause serious damages. Therefore, any kind of disturbance must be recognized and compensated as soon as possible to guarantee the normal and efficient functioning of the energy system. This project presents the design and modelling of a new facility and a new multifunctional DVR control method for voltage quality correction. The new control method was built into the fixed frame by combining the proportional resonant driver and the sequential decoupling resonant drivers. Motors and voltage distortions are described. The simulation result shows capability of the proposed Dynamic Voltage Restorer to compensate the quality of the power supply under different operating conditions and The proposed method for the new DVR controller is capable of detecting voltage disturbances and controlling the converter to inject the appropriate voltages independently for each phase and compensate for the load voltage.

Three single-phase transformers. The organization of the document is section 2 which contains the main power quality problems, section three explains the DVR, section 4 contains the operation of the DVR, section 5 contains the DVR control techniques, section 6 contains laboratory DVR simulation and last section contains analysis of results and waveforms 2.

II. Main problems with power quality

Energy quality can be defined as the ability of the power supply system to provide its customers with an uninterrupted flow of energy in the form of a sine wave. But in the real case there are many power quality problems, such as voltage drop, voltage rise, transients, harmonics, interruptions, etc. To reduce all these problems, we will design a multifunction DVR.

Voltage Drop - Voltage drop or drop is a short-lived reduction in amplitude, which occurs when the voltage RMS drops between 10 and 90 percent of the rated voltage for half a minute cycle. It is one of the rapid occurred disturbances in distribution systems. It is caused by faults in the power supply system, excitation of the transformer or by the start of large induction motors, among other causes. Voltage swelling - Increase the rated voltage by 10 to 80% per half cycle to one minute. It is not as common as voltage drop. The main causes of voltage swells are the switching of large capacitors or the starting / stopping of heavy loads, among other causes. Interruption is defined as a reduction in voltage or current to less than 10% of the nominal value, not exceeding 60 s in length. Prolonged interruptions occur when the supply voltage or current drops to zero for more than 1 minute. These are the result of faults, equipment faults, control malfunction or incorrect switch intervention. Harmonics: are the waves with frequencies that are the integral multiple of the frequency of the reference wave (to which the power supply system is designed to operate). The transients are defined as a short duration derives from the electricity in the power supply system caused by a sudden change of state.

III. Bottom of Form Multifunctional DVR

Major components of DVR

1. Booster transformer
2. Voltage source converter
3. Harmonic filter
4. Dc links
5. Energy storage unit
6. Controller
7. Detector

Boost transformer- the injected voltage is supplied to the distribution system through an injection transformer. Connect the DVR to the distribution system through the high voltage winding and transform the injected compensation voltage generated by the voltage source converter into the availability voltage after any disturbance has been detected by the controller. Additionally, the injection transformations are accustomed isolate the DVR circuit from the ability system.

Harmonic filter-The most task of the harmonic filter is to stay the harmonic voltage content generated by the VSC at the allowed level. The filter is positioned to dampen the switching harmonics generated by the PWM VSC control.

DC-Link and Energy Storage Unit-The most function of those energy storage units is to supply the required real power during the drop. Two sorts of systems are considered; the primary during which energy is taken from the input power through a bypass converter and also the second during which energy storage devices like flywheels, batteries, superconducting magnetic energy storage (SMES) and super capacitors are used. The energy storage devices have the advantage of rapid response.

The Voltage Source Converter- a VSC is an electronic power supply system consisting of a device and switching devices, which converts the dc voltage of the energy storage unit to a controllable three phase ac voltage. The inverter switches are normally tripped employing a sinusoidal pulse width modulation

(PWM) scheme. In a very multifunctional DVR, the VSC can operate with unbalanced switching functions for 3 phases, and manages each phase independently. Generally VSC isn't only used for voltage sag/swell compensation, but also for other power quality issues, e.g., flicker and harmonics.

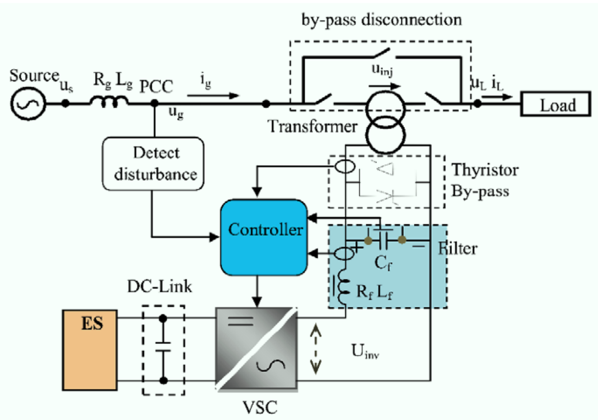


Fig 1. Block diagram of DVR in Power system

IV. Modes of DVR

The DVR has three modes of operation: protection mode, standby mode (during steady state), and injection/boost mode (during sag/swell). In protection mode, the DVR is protected against the overcurrent on the load side because of short-circuit on the load or large inrush current. The DVR may be isolated from the system by using the by-pass switches. In standby mode, no switching of semiconductors occurs and therefore the load current will undergo the transformer primary. In boost (Injection) mode, when the voltage disturbance occurs within the supply is detected, the DVR are injected a compensation voltage through the voltage injection transformer.

V. Control Techniques of DVR

In general, the method control of DVR includes three steps: (1) Detection of voltage sag/swell occurrence within the system; (2) Comparison with the reference value; and (3) Generation of gate pulses to the voltage source inverter (VSI) to come up with the DVR output voltages which compensates / absorbs the voltage sag/swell.

Grid Synchronization Techniques Synchronization to the provision voltages is incredibly important so as to regulate the DVR. It keeps a signal synchronized with a reference signaling in frequency and phase. Synchronization methods are developed and presented in many publications. The foremost often used synchronization method in engineering applications, the phase-locked loop (PLL) has been employed in this paper. It consists of three blocks: the phase detector (PD), loop filter (LF) and voltage-controller oscillator (VCO). The signaling is voltage at PCC bus. The phase detector generates an signal proportional to the phase difference between the signaling and also the signal generates by the voltage-controller oscillator (VCO). It should contain high-frequency components. The loop filter may be a low-pass filters; it's accustomed suppress high frequency components.

The loop filter provides control signal to voltage controlled oscillator which work as an integrator.

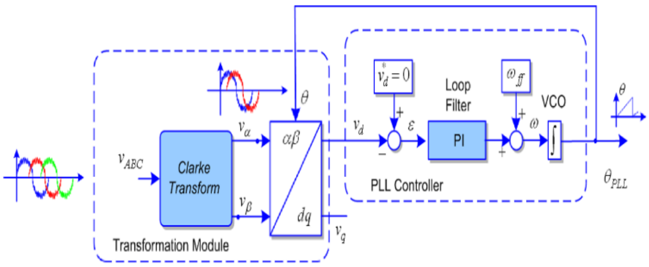


Fig.2 Phase locked loop control

The output of the PI controller is that the inverter output frequency that's integrated to get inverter phase θ. The PI regulator of the LF will set the spatial relation of the dq arrangement to create Vd = 0 within the steady state, which suggests that the PLL are going to be active when the difference between grid phase and inverter phase is reduced to zero. Sag/Swell Detection Techniques.

Voltage sag/swell phenomena are necessary to detect the place to begin, the top point, sag depth and phase shift. There are many alternative methods for detecting voltage sag, swell, like peak value, root mean square (RMS), Fourier transform, wavelet transforms and space vector method. Among variety of methods, space vector control is that the only method which is employed widely in DVR applications. during this method, the three phase voltages Vabc are transformed into a two-dimensional voltage Vdq which successively will be transferred into magnitude and angle. The voltage magnitude and angle shift information is compared with the reference value within the dq frame, which had to be transformed back to the three-phase frame.

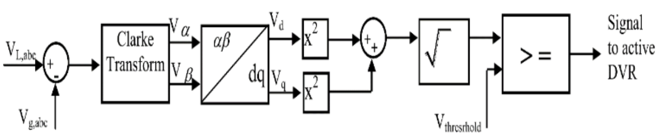


Fig.3 Sag swells detection technique

Control techniques of DVR-

The system is incredibly important in a very DVR, with the necessities of fast response for voltage sags and variations within the supplied load.

Current controller-PR is used as a current controller

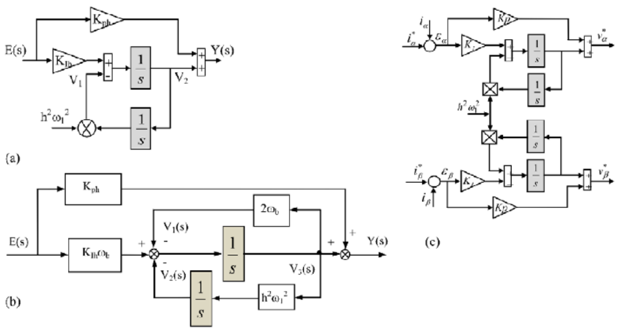


Fig.4. Current controller strategy

Voltage controller-SDR (sequence Decouple resonator) is employed as a voltage controller. it's helpful in extracting the positive and negative component in unbalance condition faults. Finally, we propose the new double loop controller designed in stationary frame by combining a PR controller and a SDR controller Double loop Controller- during this method, the three-phase voltages of the grid are sensed and transformed to two-phase system (αβ) within the stationary organization. Then, the positive sequence and therefore the negative sequence components are extracted. Positive sequence grid voltage vector is compared against the positive sequence load voltage command vector. the method of the negative sequence controller is analogous. The proposed controller performs in stationary frame so its structure is less complicated than the double-loop controller using the PI controllers in rotating frame.

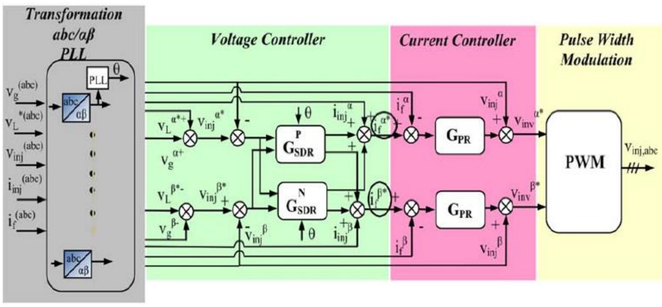
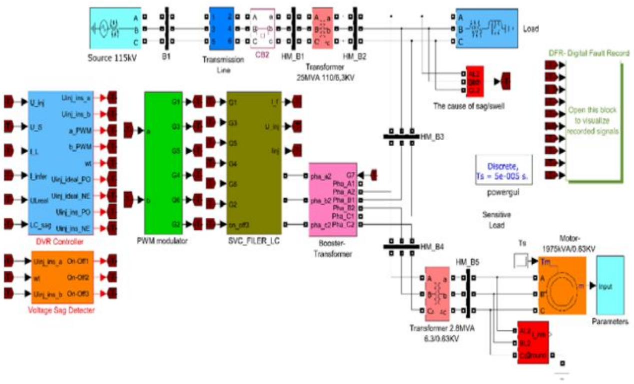


Fig 5. Double loop controller

In the proposed control method, the method variable isn't only injection voltage but also injection current. The output of voltage controller are the reference currents within the stationary frame if α∗ iα∗ f and iβ∗ f if β∗ which are used as an input variables within the current controller to manage the injection voltage. this controller can regulate the injected currents and improve response and proper operation of the voltage controller to revive the load voltage. The proposed new controller is ready to detect the voltage disturbances and control the converter to inject appropriate voltages independently for every phase and compensate to load voltage through three single-phase transformers.

VI. MAT LAB SIMULINK DIAGRAM



VII. RESULTS AND DISCUSSION

The balanced voltage sag at PCC because of three phase contact occurs within the facility, the voltage decreased to 50% from 1.00 s to 1.10 s. grid voltages, the injection voltages of DVR and the load voltages during the sag event.

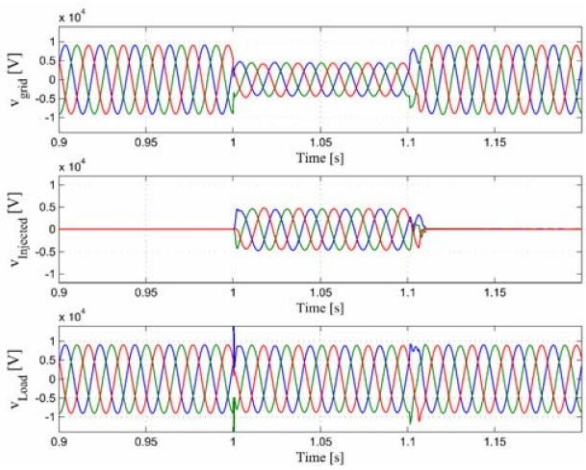


Fig. 6 sag compensation

The Unbalanced Voltage Sag during this case study, from 1.00 s to 1.10 s, a phase to phase short (between phase A and C) occurred within the installation, the voltage at PCC reduced to 35% in phase A, and to twenty-eight in phase C and increased slightly by 10% in phase B respectively to the reference pre-sag voltage and also the phase jump of grid voltage

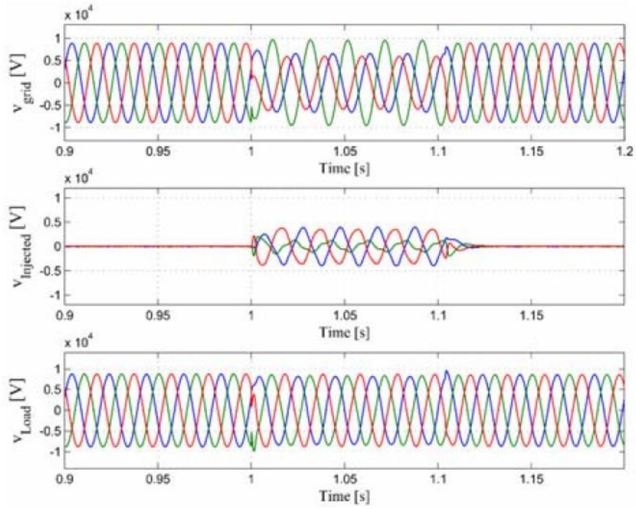


Fig. 7 swell compensation

Observe that the DVR quickly injects the required voltage components; with correct both magnitude and phase to keep up balanced load voltages. It's shown that the DVR can detect and mitigate the voltage sag in numerous phases independently and inject the compensation energy through three single-phase transformers to correct the grid voltage.

VIII. CONCLUSION

For improving the compensation abilities of power quality disturbances like sags, swells, harmonic distortion and other interruptions that have an impression on electrical devices and machines and in severe cases can cause serious damage, a completely unique structure with a complicated controller has been presented during this paper. The proposed DVR has the unique ability to compensate balanced and unbalanced voltage sags and swells and other utility voltage disturbances thanks to a double loop-controller that's able to detect the voltage disturbances and control the converter to inject appropriate voltages independently for every phase and compensate to load voltage through three single-phase transformers. The DVR was described well, with its configuration, its sag/swell detection voltage techniques, grid synchronization techniques and control techniques. The numerical simulation results under several conditions, balanced and unbalanced voltage sags and swells, fluctuations and distortions are presented.

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