Dynamic Voltage Restorer Using PWM AC-AC Converter With Switching Cell Structure.

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Abstract - Now a day, Electricity client demands reliable and qualitative power offer from distribution utilities because of enhanced use of nonlinear loads. There are several varied custom control devices offered, to offset power quality disturbances. Among that dynamic voltage restorer (DVR) is that the simplest and promising versatile ac transmission system (FACTS) device. This paper presents a dynamic voltage restorer (DVR) using a pulse width modulation (PWM) AC-AC converter resolution commutation issues. In the proposed technology, the unit block of the multilevel converter consists of a single-phase PWM ac-ac converter switching cell (SC) structure with coupled inductors. Therefore, the multilevel converter is often short- and open-circuited while not damaging the switching device. This improves the responsibility (reliability) of the DVR system. The simulation outcome is indicated for a three-phase DVR system.

Key Words: Communication Problem, Voltage Control, Switching Cell, DVR, PWM, Simulation, AC-AC Converter.

1. INTRODUCTION

Power quality has become a serious concern to each electrical utility and customer. In several countries, the results of lack of power quality are leading to wastage of many billions of bucks each year. This can be due to the carelessness of most industries in not upgrading their plants that lead to an awfully high value due to loss of product, loss of production time, clean up, and recalibration of the method. The utility of complexity and sensitivity of recent technologies in electrical instrumentality is one of all the main causes of power quality issues like voltage disturbances on the availability network. Power equipment is additionally sensitive to voltage disturbances and ends up in the massive growth of voltage disturbances. It's troublesome to sight the sources resulting in power quality issues. Factors for the causes of most power quality issues area unit on the far side the management of utilities and may ne'er be all eliminated. Voltage sag outlined as a momentaneous decrease within the RMS voltage between zero.1 to0.9 per unit at power frequency, for a length, starting from 0.5 cycles up to one minute. It's clearly delineated as a fast call offer voltage all the way down to 90% to 10% of alleged voltage. It's typically described as faults within the system and differentiated by its amplitude and time length. A dip within the magnitude of the voltage referred to as Voltage sag is that the web RMS voltage throughout voltage sag, which is typically outlined in plutonium of the same old voltage vary. The various factors wherever voltage sag depends on the faulty sort, location of the fault, and also the fault impedance value. The time length of voltage sag principally associated with how briskly the fault is totally slaked by the appropriate shielding device.

For high power-sensitive loads, the DVR shows promise in providing a more cost effective output than the energy storage capabilities of Uninterrupted Power supply (UPS). The higher active power demand related to voltage phase jump compensation has caused a considerable rise within the size and price of the dc-link energy storage system of DVR.

Voltage sag/swell that happens additional of times than the other power quality phenomena is thought because the most imp power quality problems within the power distribution system. Voltage sag is outlined as a sudden reduction of offer voltage down 90% to 10% of traditional. To guard sensitive loads from grid voltage sags, custom power devices (such as SVC, DSTATCOM, dynamic voltage restorer (DVR), and UPQC) area unit being wide used. Among these devices, DVR has emerged because the most cost-efficient and comprehensive solution. The system configuration of a DVR is shown in Fig.1.1.

It consists of a dc-link capacitance serving as associate energy reserve for DVR, series injection electrical device, six switches VSI, and LC filter for removing shift harmonics from injected voltage. The first perform of DVR is to inject a voltage with a definite magnitude and phase in series with the upstream supply voltage specified the load connected downstream invariably sees the pure curving voltage at its terminal. The essential perform of the DVR is to observe any voltage sag/swell that occurred within the cable and injects the balance voltage from the DVR. This can be achieved either by interesting or injecting active or reactive power.

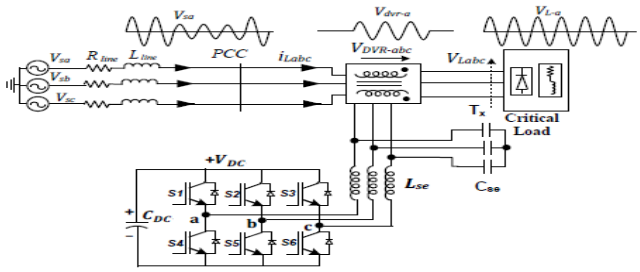


Fig. 1.1 Basic DVR based system configuration

A. **DC energy Storage device:-** It's accustomed offer the power demand for the compensation throughout voltage sag. Lead-acid batteries, Super Conducting Magnetic Energy Storage (SMES), Flywheels, and Super capacitors are often used as storage devices. For DC drives like capacitors, batteries, and SMEs, DC to AC conversion (inverters) is required to deliver power, whereas, for regulator, AC to AC conversion is needed. The utmost compensation ability of DVR notably for voltage sag depends on the active power provided by the energy storage devices.

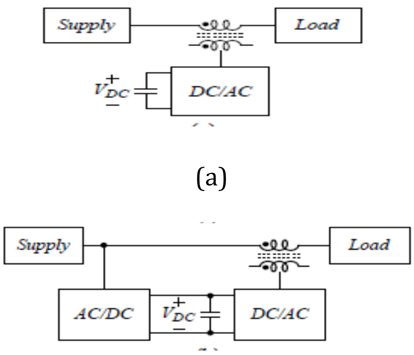
B. **Voltage supply electrical Inverter (VSI):-** The essential perform of VSI is to convert DC voltage provided by the energy device to associate AC voltage. This can be coupled to transformer injection electrical device to the most system. Therefore a VSI with a low voltage rating is enough.

C. **Passive Filter:-** It's accustomed convert the PWM pulse wave into a sinusoidal wave. It consists of inductor electrical device and a capacitor. It are often placed on either the high voltage aspect or the low voltage aspect of the injection electrical device. By putting it inverter aspect higher-order harmonics area unit prevented from passing through the voltage transformer. And it'll scale back stress on the injection electrical device. Once the filter is placed on the high voltage aspect, the higher-order harmonic current will penetrate to the secondary aspect of the transformer, a better rating of the transformer is needed.

D. **Voltage Injection Transformer:-** The essential perform is to extend the voltage provided by the filtered VSI output to the specified level. The high voltage aspect of the injection electrical device (transformer) is connected serial to the distribution line and also the low voltage aspect is connected to the ability circuit of the DVR. During this study, a single-phase injection electrical device is used. For 3 has DVR, 3 single-phase transformers are often connected either in delta/open or star/open configuration.

2. PROPOSED DVR SYSTEM

Many ways of resolution power quality issues, particularity voltage sag and swell, are planned. A standard DVR uses an AC-DC-AC-type convertor with voltage-source electrical converter. During this technique, there are two varieties of system; one exploitation hold on energy system like batteries, capacitors, flywheel, or super magnetic energy storage (SMES) as shown in fig.2.1.(a) and also the alternative having no vital internal energy storage, that is taken energy from the faulted grid offer as shown in fig.2.1.(b).



(a)

(b)

Fig.2.1 Three phase system using DVR (a) DVR with energy storage (b) DVR with no energy storage.

In effect, for DVR applications that need solely voltage regulation, DVRs exploitation direct pulse-width modulation (PWM) AC-AC converters area unit most well-liked in terms of their price and size. Many DVRs supported direct PWM AC-AC converters are introduced in recent literatures. Their simplified schematics area unit shown in Fig.2.2. Not like the traditional DVRs with VSI, the DVRs in Fig.2.2 don't use any large dc-link capacitors and supply quick response at low price. Currently, a brand new approach to direct AC conversion involves the utilization of structure direct PWM AC-AC converters (MPACs) to facilitate scaling to higher voltage and power level.

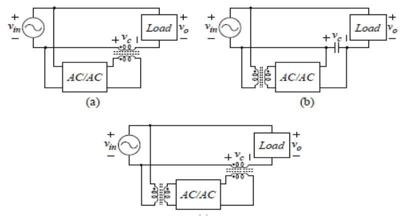


Fig.2.2. Single phase DVR using direct PWM ac-ac converter.

In this, the SC structured AC-AC convertor shown in Fig.2.3 is extended to cascaded MPAC, and a brand new structure DVR topology is planned. Compared with the traditional MPACs, the cascaded MPAC of the planned DVR are often simply extended to higher levels by using a easy PWM technique while not dedicated management. Additionally, as a result of safe commutation is usually warranted by the SC structure.

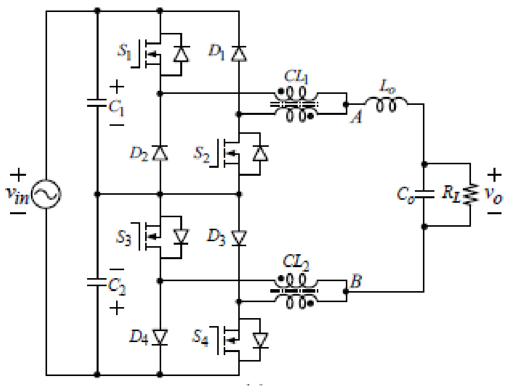


Fig.2.3.Single phase direct PWM ac-ac converter using SC structure.

Fig.2.4. shows the planned DVR system. It's consisted of a SC structured cascaded MPAC, a multi-winding line frequency transformer connected in shunt with a single-phase line, a bypass switch, and output LC filter. The MPAC generates the voltage as compensation for voltage sag. The structure could be a cascaded association of unit, and every unit takes the same structure because the buck-type SC AC-AC convertor shown in Fig.2.3.

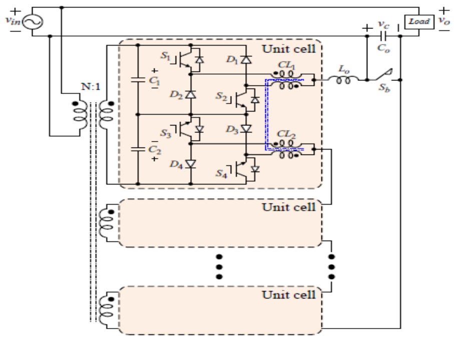


Fig.2.4. Proposed DVR system

3. PROPOSED DCR WITH TWO UNIT CASCADE

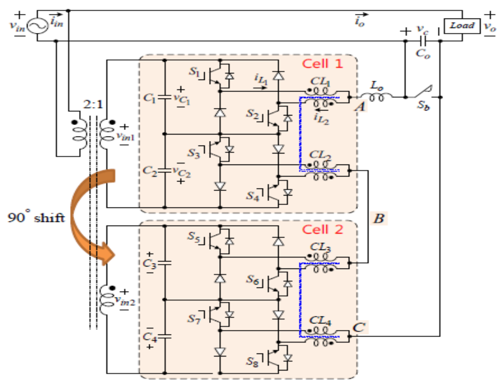
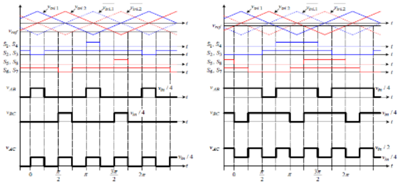


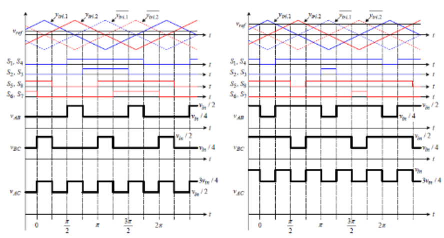
Fig.3.1 Proposed DVR with two unit cell cascaded

Fig.3.1. shows the proposed DVR and two unit cells are cascaded for performance verification. The two isolated input voltages are generated by using a multi-winding low-frequency (60 Hz) transformer. Each unit cell is phase-shifted by 90° (=180°/2) because the *Lo* of the ac-ac converter experiences twice the converter switching frequency. Therefore, four times the converter switching frequency is applied to *Lo* . As the number of cell increases, the size of output filter inductor *L* can be reduced significantly. When N unit cells are cascaded, the gate signal generation of each unit cell is identical, and the gate signals in each unit cell are 180°/N out-of-phase for the interleaving effect. For the purpose of showing the multilevel output,

Fig.3.2shows key waveforms of the multilevel converter as functions of *D* when $V_{in} > 0$ and sag compensation is achieved; a similar analysis can be performed for the case when V_{in} <0.In the analysis, the two isolated input voltages are assumed to be equal to each other and are defined as *vin* / 2 because the transformer divides *vin* into two equal voltages in accordance with the cell number. Furthermore, *vAB* and *vBC* shown in Fig.3.1 denote the voltages of each unit cell between the coupled inductors.



(a)



(b) ()

Fig.3.2 Key waveform of the proposed DVR.

4. MAGNETIC INTEGRATION TECHNIQUES

Magnetic integration of the two discrete coupled inductors in the single-phase SC ac-ac converters. Although the same technique is used in this paper, it is necessary to mention the principle briefly in this Section. Fig.5.1.shows the structure of the integrated coupled inductor connected to each unit cell. On the other hand, as shown in Fig.4.1. The integrated inductor has perfect dc flux cancellation and does not require an air gap, which is the inductance of the *N* turns winding shown in Fig.4.1. Furthermore, the integrated inductor can handle ideally an unlimited amount of current owing to the absence of core saturation caused by the current. As a result, the abovementioned features are well suited to high-power DVR systems.

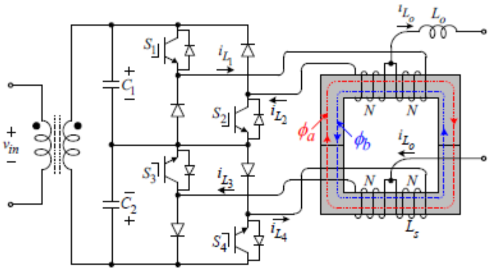


Fig4.1. Configuration of one unit cell and the integrated coupled inductor

5. SIMULATION RESULT

The below Fig.5.1 Shows the simulation result of the proposed DVR. When sudden voltage sag takes place in the source voltage, at that time DVR goes in operated states following the switching of the cell which are connected in a cascaded manner. As the main aim of the DVR is to inject the required amount of voltage to the upstream of the transmission line. As soon as, it injects the required voltage, the proper amount of the voltage is being supplied to the load side. Thus, voltage sag is being compensated with the use of Dynamic Voltage Restorer.

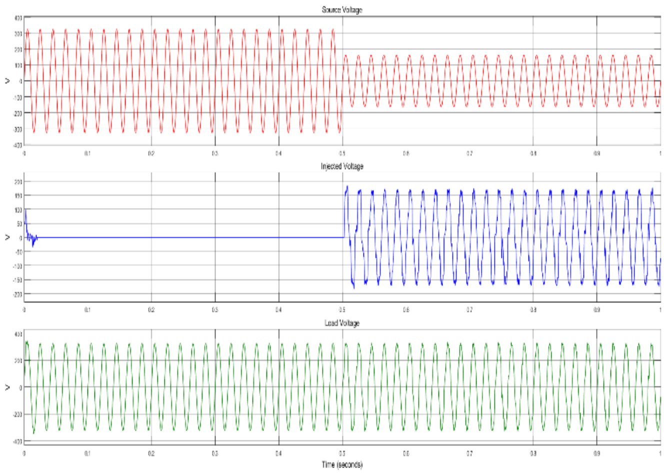


Fig.5.1 Simulation result of Proposed DVR system

6. CONCLUSION

Power quality is one of the major concerns in the era of power system. Power quality problem occurred due to non- standard voltage, current or frequency, that result in a failure of end user equipment. To overcome this problem, Dynamic Voltage Restorer (DVR) is used, which eliminate voltage sag and swell in the distribution line, it is efficient and effective power electronic device. In this project, a new DVR system, employing the proposed cascaded multilevel direct PWM ac-ac converter, was presented. Compared with the conventional DVR topologies using the VSI, the proposed scheme has the advantages of fewer power stages, higher efficiency, and the elimination of bulky dc-link capacitor. In addition, unlike the existing DVR with the direct PWM ac-ac converter, the proposed DVR ensures stable operation because the proposed cascaded multilevel ac-ac converter has the following unique advantages over the conventional ac-ac converters.

1) It is immune to EMI noise because the switching devices are not damaged by the EMI noise's misgating on- or off.
2) It operates properly even with highly distorted input voltage, which is impossible with the conventional approach using soft commutation strategy.

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