Abstract—Loads suffer detrimental effect due to voltage sag which results in economic loss. Dynamic Voltage Restorer (DVR) is of great importance in present power system because of consistent problems related to the power distribution including the voltage sag and voltage swell. Dynamic voltage restorer is a power electronic based device. It protects sensitive loads from the various types of disturbances of the power supply. The basic principle of DVR is to restore the voltage sag to a pre-sag value by injecting a desired value of voltage. Application of this custom power device; a power electronics device makes a remarkable impact.

Keywords—voltage sag; voltage swell; dynamic voltage restorer

I. INTRODUCTION

In this paper, Space Vector Pulse Width Modulation technique is used. The main function of VSC is that it converts the DC voltage which is supplied by the Energy Storage Unit into an AC form of voltage[1]. The DVR power circuit uses step up voltage injection transformer, therefore a VSI with even a low voltage rating would result to be sufficient. In the past, for the improvement of power quality and reliability, various FACTS devices like IPFC: Interline power flow controller, STATCOM: static synchronous series compensator, UPFC: Unified power flow controller, SSSC: Static Synchronous Series compensator, were introduced[10]. These devices were designed for transmission system. Since now a days more importance is being given to the distribution system for power quality improvement, modified devices are being used known as custom power devices. The major custom power devices[8] used are DSTATCOM: Distribution static synchronous compensator, UPQC: Unified power quality conditioner, DVR: Dynamic Voltage Restorer, AF: Active filter.

II. VOLTAGE SAG AND SWELL

The power quality engineers call "sag" as an event that occurs when the line voltage is reduced to less than 80% of the normal voltage for a few cycles [2]. Swell is a brief increase of line voltage[3]. It causes rise in rms voltage in between 1.1 and 1.8 p.u. for a time duration of about 0.5 cycles to 1 minute.

Fig 1. Voltage Sag & Swell.

III. PROPOSED APPROACH

A new approach for DVR control is studied and implemented to get better results as compared to previous techniques used for controlling the DVR. A controller with SVPWM technique is designed to obtain higher amplitude index of modulation as compared to the conventional PWM technique[4].

It is also easier to implement SV-PWM using the digital processors. A total of about 15 percent higher output is obtained if SV-PWM is used instead of the PWM technique[5].

A. SPACE VECTOR PULSE WIDTH MODULATION

There are several of PWM techniques with a view to obtain variable voltage and supply frequency[7]. The most
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popular among these is the sinusoidal PWM and SVPWM. The advantage of using SVPWM is that it has a degree of freedom for placing the Space Vector\[11\] in a switching cycle thereby improving the harmonic performance\[12\]. A three phase Voltage Source Inverter generates eight switching states\[15\] out of which six are active states and two are of zero states\[6\]. These vectors together form a hexagon consisting\[9\][10] of total six sectors each having a span of 60° each.

Fig 2 - Three phase VSI circuit

Fig 3 represents the phase voltage space vectors. The binary numbers indicate the state of switch of inverter legs. 1 denotes the upper switch is ON and 0 denotes that the lower switch of leg is ON.

Fig 3 Phase voltage space vectors

B. MODELING OF THE TEST SYSTEM

The test system is composed by 13 kV, 50Hz generation system which is represented by thevenin's equivalent. The generation system is feeding two parallel transmission lines via a three winding step up transformer Y/Δ/Δ, 13/115/115 kV. These transmission lines are feeding two distribution networks using two step down transformers Δ/Υ, 115/11 kV. One of these feeders has DVR connected in series.

Initially simulating the test system without DVR with asymmetrical fault incorporated in the power system with a fault resistance of 0.4 ohms and a duration of 200ms.

Then the second simulation was carried with the same system but along with the introduction of DVR at the load end so as to compensate the voltage sag that occurred due to the 3 phase fault. In the simulation model, we have used two parallel feeders. Both of the feeders have loads connected parallelly. A feeder has DVR which is in series with line, and the second feeder is without DVR.

Fig 4 – Test power system network

Fig 5- DVR controller design
Fig 6- Simulation model of the proposed approach for the considered test system
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Voltage measurement before using DVR = 1.5 x 10^4 volts.

Voltage measurement after sag = 1 x 10^4 volts.

Therefore, Sag = 0.5 x 10^4 volts.

When the DVR was implemented, the voltage again is compensated back to 1.5 x 10^4 volts.

Fig 7. Output result with 3- fault & without DVR

Fig 8. Output result with 3- fault & DVR

Fig 9. Output waveform at PCC

CONCLUSION

In this paper, a cost effective solution for the voltage sag problem has been discussed. DVR is a fast and effective solution for such problems of voltage sag or voltage dip. The controller used here implements fast forward technique utilizing the error signal. Error is the difference amongst the actual load voltage and the reference voltage. This error signal triggers the switches of inverter using space vector pulse width modulation technique. A simulation study was performed for a system having two parallel feeders one of which consists of fault and DVR implemented in series for compensating the voltage sag. The output plots from the simulated network presents the voltage sag problem without DVR and the compensated voltage after the DVR has been implemented. The effectiveness of DVR was studied with the aid of experiment model and output results.

REFERENCES


