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An Overview on Compensation of Voltage Sag and Swell by using Dynamic Voltage Restorer (DVR)

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ABSTRACT

Power quality has become the most important aspect of electrical engineering in recent years. When the voltage, current, or frequency is abnormal, a power quality issue occurs. Utility distribution networks can be disrupted in a variety of ways. The main issues addressed here are voltage sags/swells. Thanks to fast improvements in power electronics technology, power quality issues can now be minimised. A dynamic voltage restorer, for example, can provide the most mercantile choice for mitigating voltage sag/swell by injecting voltage into the sensitive system. The Dynamic Voltage Restorer is a power electronics-based device that can reduce power quality concerns and restore load voltage to pre-fault levels in the system. The first section of this review paper gives an outline of the related power quality challenges.

Key words: Dynamic Voltage Restorer (DVR), Power Quality, Sinusoidal Pulse Width Modulation (SPWM), Voltage Sags and Swells, Voltage Source Converter (VSC)

INTRODUCTION

In electrical engineering, the Ferranti effect is an increase in voltage occurring at the receiving end of a long transmission line, above the voltage at the sending end. This occurs when the line is energized, but there is a very light load or the load is disconnected. The capacitive line charging current produces a voltage drop across the line inductance that is in-phase with the sending end voltages considering the line resistance as negligible. Therefore both line inductance and capacitance are responsible for this phenomenon.

In general practice we know, that for all electrical systems current flows from the region of higher potential to the region of lower potential, to compensate for the electrical potential difference that exists in the system. In all practical cases the sending end voltage is higher than the receiving end, so current flows from the source or the supply end to the load. But Sir S.Z. Ferranti, in the year 1890, came up with an astonishing theory about medium distance transmission line or long distance transmission lines suggesting that in case of light loading or no load operation of transmission system, the receiving end voltage often increases beyond the sending end voltage, leading to phenomena known as Ferranti effect in power system.

Flexible alternating current transmission system or FACTS is a system which is used for AC transmission of electrical energy and is composed of static equipment and help in boosting control ability and increase power transfer capability of the network. In this project we are going to implement FACTS by thyristor control reactor and this method is used when charging the transmission line or when there is very low load at the receiving end. The main purpose of this project is to get static voltage compensation under Flexible alternating current transmission system in shunt. This helps in lowering

the voltage at the load end that may draw leading current either during charging the transmission line or during low loads.

Power Manager work on the principle of Phase angle controlling method. Power savers work on straightening this unstable electric current to provide a smooth and constant output. The fluctuation in voltage is unpredictable and cannot be controlled. However, the power savers utilize current fluctuation to provide a usable power by acting like a filter and allowing only smooth and constant current to pass through the circuit. Power savers use capacitors for this purpose. When there is a surge of current in the circuit.

In this project model we reduced down the voltage across the load upto a certain limit until current starts increases. As most of the devices can work on 190 vAC, our project gradually decreases the voltage and easures the current, whenever it observes that the current increases, the power electronics circuit will stop decreasing the voltage.

Use of power electronics reduces the mechanical arching and fast reaction time.

OBJECTIVES OF THE WORK

For an economic operation of power system power quality should be maintained properly. Voltage sag/swell has been concerned as major power quality issue. The main objectives of this project are:

1. Detection of voltage sag/swell in the power system network.
2. To mitigate the power quality issue using DVR and its behavioural study.
3. To select the best suitable control technique for DVR.
4. To control the device in order to obtain desired performance.

IMPORTANCE OF POWER QUALITY

PQ expresses the degree of similarity of practical power supply with ideal power supply. 1. If PQ is good then any load connected to the electric network runs efficiently without decreasing its performance. 2. If PQ is poor then any load connected to the network leads either to the failure of the equipment or reduction in its lifetime and performance. In order to prevent the consequences of poor PQ and to improve the utility performance the electric power are analysed to resolve the PQ issues in order to determine the efficient compensation technique.

BLOCK DIAGRAM

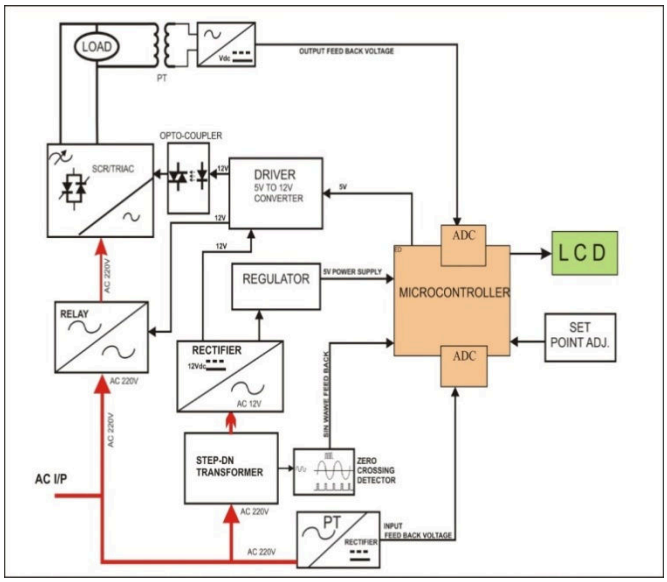

Fig. 1 Block Diagram

Voltage sag/dip

The voltage sag or dip can be stated as decrease in nominal voltage level by 10-90% for short duration for half cycle to one minute as shown in fig.1sometime, voltage sag last for long duration such prolonged low voltage profile referred as ‘under-voltage’. Voltage sag is further divided in three categories: instantaneous, momentary and temporary sags respectively.

Voltage sag are mainly caused due to occurrence of faults in power system, overloading of the electrical network and starting current drawn by heavy electrical loads like motors and refrigerators.
Voltage sag in power system network results in failure of relays and contactor, dim light and fluctuating power.

Voltage Swell

Voltage swell can be stated as voltage rise by 10-80% of normal value for duration of half cycle to one minute. Likewise voltage sag, prolonged high voltage profile is referred as 'over-voltage'. Voltage swell is subdivided as:

i. Instantaneous swell
ii. Momentary swell
iii. Temporary swell

OPERATION

In the above block the main aim is to control and keep balance the voltage across load. Initially controller check the incoming voltage coming from line with the help of ADC (analog to digital converter) present inside the Microcontroller. Our aim is to control a +ve as well as –ve half cycle of incoming AC for that a Firing angle control method is used. For controlling a firing angle of any AC voltage it is necessary to monitor every +ve/-ve half cycles, hence a Sine Wave Cycle Monitor (Zero Crossing Detector) block is used in our project, which informs a controller about start point of every cycle. Once controller knows the voltage across the load and signals from sine wave cycle monitor, controller calculate the firing angle and gives firing pulse to the AC to AC converter in which a static switch formed by a SCR/TRIAC is used. Static switch can operated on high voltage and high frequency as compare to the mechanical switches like relay. The output of AC to AC converter is further give to Reactor which is nothing but a type of single core step-up transformer. (220v to 300v transformer is used in our project), which gives a 220v output at 140vAC input. The output of 220v is further used by a various load. The voltage across load is measured by the controller with the help of Potential Transformer (PT). Potential transformer is used to step down the voltage across the load to be measure and rectified to DC, because microcontroller can read a voltage upto 5vdc only. In our project we are using a Relay for tripping the input voltage in case of very high voltage and low voltage which is beyond control-able limits. The relay used in our project is of 12 volts and controller can give maximum of 5v, hence it is necessary to amplify the 5v to 12v for which a Driver circuit is used.
Microcontroller requires a 5vDC to work, and same will be generated with the help of Power Supply which comprises of a Step down transformer, rectifier, filter and regulator.
Transformer step down the 220vAC to 12vAC, rectifier and filter converts this 12vAC to 12vDC, and regulator converts a 12vDC to a constant of 5vDC.
Capacitor bank is a optional block which can be used in case of beyond limit regulation requires.

PROPOSED MODEL

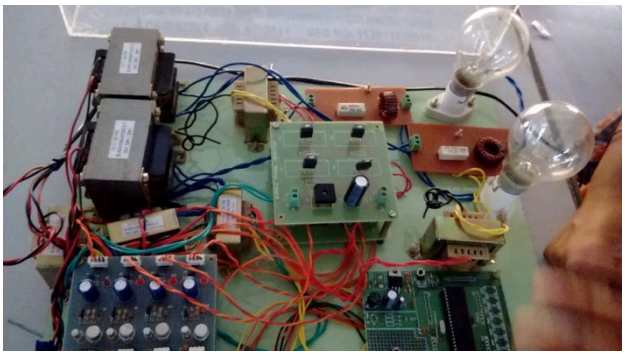

Fig. 2 Working Model

CONCLUSION

This paper has presented a comprehensive study on performance of DVR. The above study shows that the DVR is suitable for compensation of voltage sag and swell by the use of different controlling techniques. From these discussion paper presents DVR may be work in Inferior cost, smaller size, and its quick dynamic response to the disturbance due to power quality issues, Ability to control active power flow, Higher energy capacity and lower costs compared to the

other active devices and also Less maintenance required. This study also gives useful knowledge for the researchers to develop a new design of DVR for voltage disturbances in electrical system. From this study of DVR applications, this work concluded that the trends of DVR through the years are still assumed as a powerful area of research.

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