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RESEARCH ARTICLE

Transient Detection in Industrial Grids and Compensation Using FCL DVR

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ABSTRACT: ***This paper proposes an improved fault current limiting dynamic voltage restorer (FCL-DVR) concept for transient compensation in industrial grids. The proposed work is promising in monitoring the grid voltage and fault criterion and thus protecting the system from fault occurrence in beforehand. In the event of load fluctuations, the DVR controller will deactivate the faulty phase of the DVR and activate its inverter section. The fault condition is detected by constantly sensing the magnitude of phase voltage. The design methodology of the proposed improved FCL-DVR is fully discussed based on simulation obtained from the proteus software. A scaled-down experimental verification is also carried out. Both modelling and experimental results confirm the effectiveness of the improved FCL-DVR for performing both voltage compensation and fault current limiting functions.***

KEYWORDS: ***Dynamic voltage restorer (DVR), fault current limiting (FCL), voltage compensation***

I. INTRODUCTION

In the existing power scenario, both in the power system and utilities side power quality is of prime concern. Industries invest a large effort for the protection of machine since the performance standard has to be maintained throughout their lifetime. With the advancement of technology in machine design, a quality power supply is to be given to obtain an efficient and accurate performance from the machine. The industrial grids not always receive a nominal power supply, transients are irresistible. Fluctuations in the power supply to the loads connected due to these transients may reduce the performance of machine and eventually it leads to failure of

the equipments. Voltage transients are unrestrictable phenomena that occur in a power system transmission line. The transients are sudden abruptive change in the magnitude of voltage, current or both. Though these transients exist for few cycles in the range of milli seconds to seconds they pose a great threat to the efficiency and performance of the system or load connected. The lifetime of the system also get influenced by these transients. Voltage sag and swell are the predominant transients. Though many FACTS compensation devices involve in the protection of system, there are some industrial applications that require precise accuracy in the power quality of supply.

The dynamic voltage restorer is used for transients and fault current limiting. The fault current limiting dynamic voltage restorer (FCL DVR) is used in industrial grids to obtain an efficient performance against voltage transients and short circuit faults. The problems of voltage sag are compensated using FCL-DVR and voltage injection is done by an inverter but the compensation of voltage in cases of voltage swell is not taken into account. The detection of voltage fluctuation and the respective voltage injection to balance it, is expected to be done within few cycles of operation and a balanced voltage supply is to be delivered to the industrial loads. The proposed project is to constantly monitor the line voltage using a PIC microcontroller where it is then compared with a standard reference value. The voltage sag or swell is detected and the command for respective action is given to the inverter circuit to balance the voltage fluctuations.

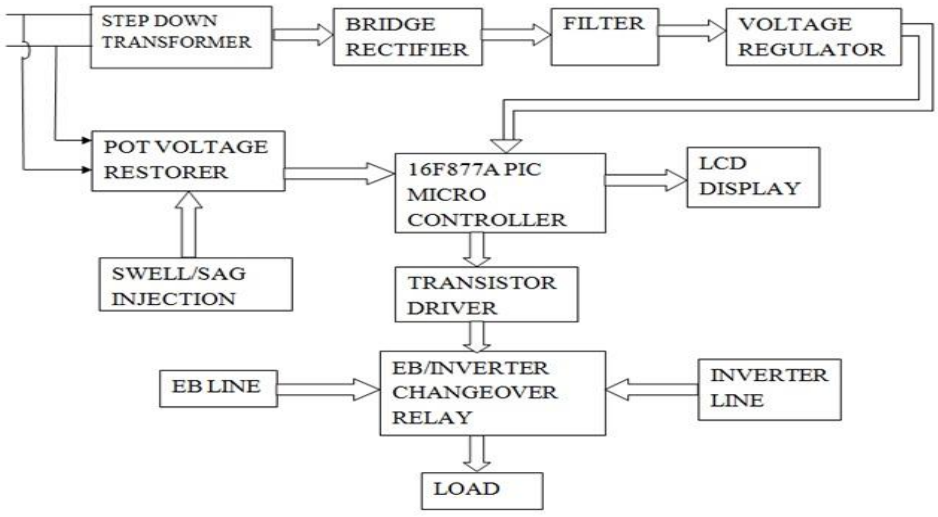
II. TRANSIENTS

A voltage sag is a momentary (i.e. 0.5-60 cycles) decrease in the rms voltage magnitude, usually caused by a remote fault somewhere on the power system. Voltage sags are the most important power quality problem facing many process industry customers. Equipment used in modern industrial plants (process controllers, programmable logic controllers, adjustable speed drives, robotics) is actually becoming more sensitive to voltage sags as the complexity of the equipment increases and the equipment is interconnected in sophisticated processes. Even relays and contactors in motor starters can be sensitive to voltage sags, resulting in shut down of a process when they drop out. Most of the existing methods focus in compensation of voltage sag by injection of additional voltage using a series injection transformer in DVR methodology.

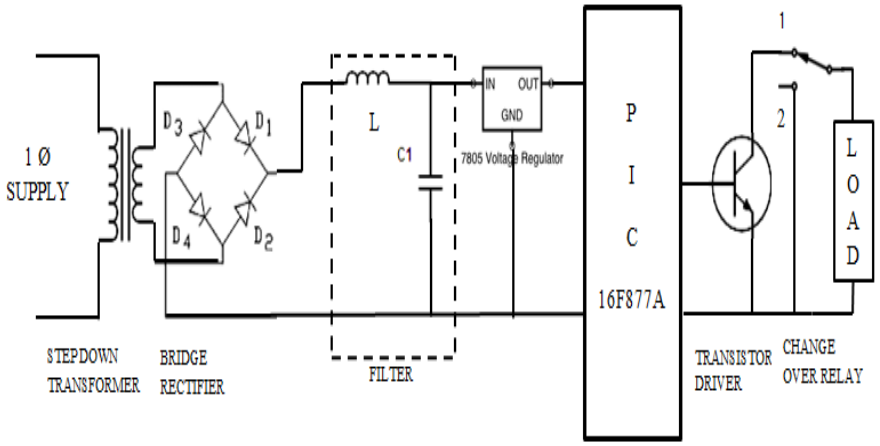
A voltage swell is a momentary (i.e. 0.5-60 cycles) increase in the Rms voltage magnitude, usually caused when a heavy load turns off in a power system

III. PROPOSED METHOD

In the proposed method the transients are detected and displayed in a local Lcd display as a warning. In the existing methods the transients once detected are compensated using series injection of voltage. This method is best opted for transients due to voltage sag yet there is no optimal solution for transients in case of voltage swell. Also in the existing methods the transients are not diminished initially, they exist for few cycles of operation. This is more disadvantageous.



Block diagram of proposed method



Circuit Diagram Of Proposed Method

In the method proposed, series injection is not performed as in existing method instead the faulty phase is disconnected from the healthy part of the system using relay operation and during fault conditions the inverter section are connected to the load and once the transients diminishes after few cycles the main line is connected back. For this operation PIC Microcontroller is used for detection of transient condition with the dc equivalent voltage step down and rectified. As per the proposed work the load is always supplied a constant supply voltage irrespective of the transients occurrence and system is always in a healthy status.

IV. EXPERIMENTAL SETUP

The industrial grid voltage is step down using a transformer and is then converted into a dc voltage by an inverter. Since the electronics devices operates in a low voltage profile the grid voltage is initially step down to a lower value and for a convenient operation the AC voltage is converted into DC voltage. The DC voltage is then made ripple free by using a filter circuit.

The voltage is then fed to a PIC Microcontroller, the measured voltage is compared for the nominal voltage and when it is deviating from the nominal values the respective transient status is displayed in the LCD.

Once a transient condition is detected either a sag or swell, the PIC microcontroller gives the command to the relay circuit through a transistor drive circuit. The relay switches the circuit from EB line to the inverter section which supplies nominal voltage to the load as required. Since transients are momentary change once they diminish the PIC microcontroller reinstates the relay circuit to original position and the load is always fed with a nominal voltage supply. The problems of transients are eliminated from entering into load system from the grid and the system is protected from damage and fault operation.

V. RESULT AND DISCUSSION

Using the proposed method the detection of transients in both the cases are displayed by a local LCD status and compensation is performed at the output terminal by switching the existing connection to an inverter section during the cases of transients and reinstated back to original position when transients dies out and the status displays a healthy normal condition.

INPUT WAVEFORM FOR NOMINAL VOLTAGE AT HEALTHY CONDITION

Considering single phase:

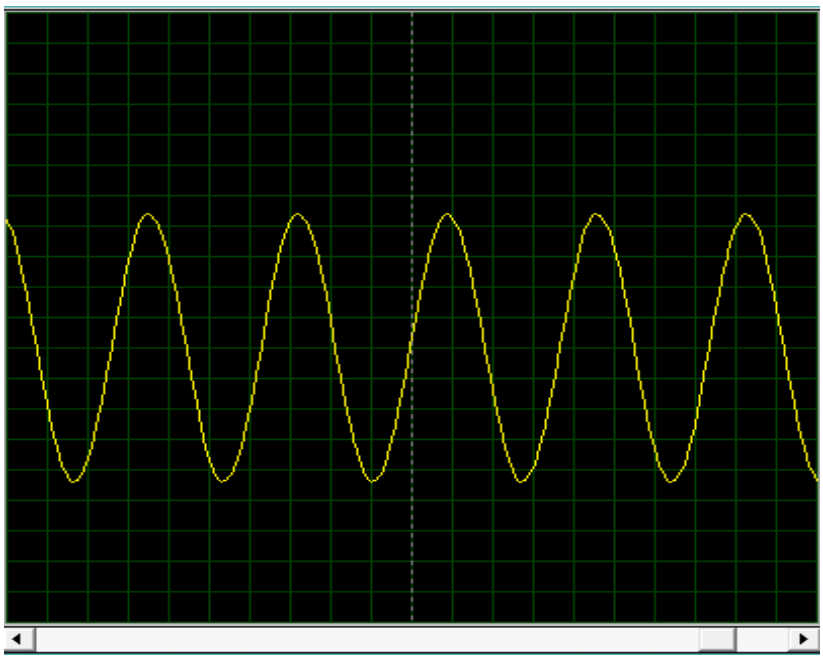
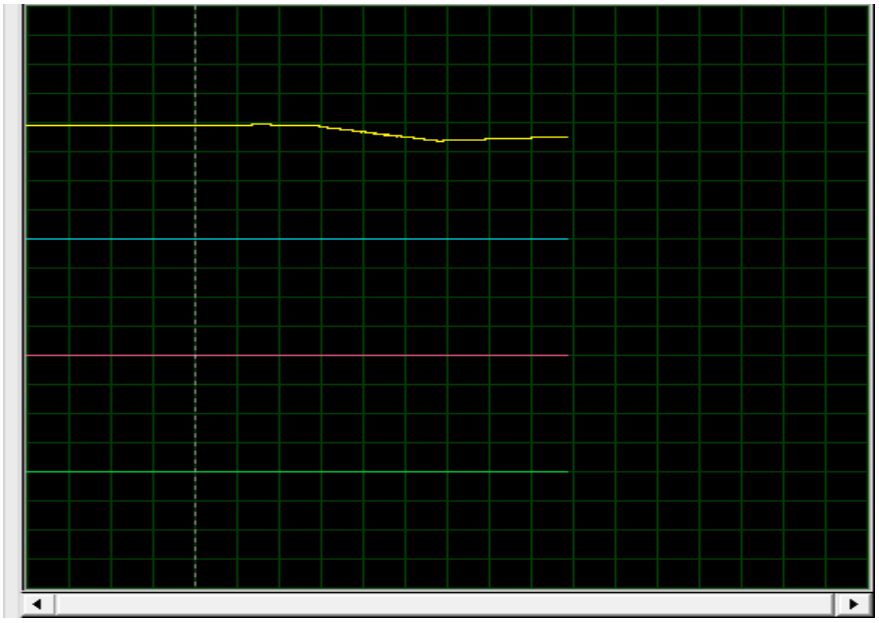


Fig proteus simulation for single phase

Sag injection:



FigProteus Simulation Of Dc Voltage Input To Microcontroller

Swell injection:

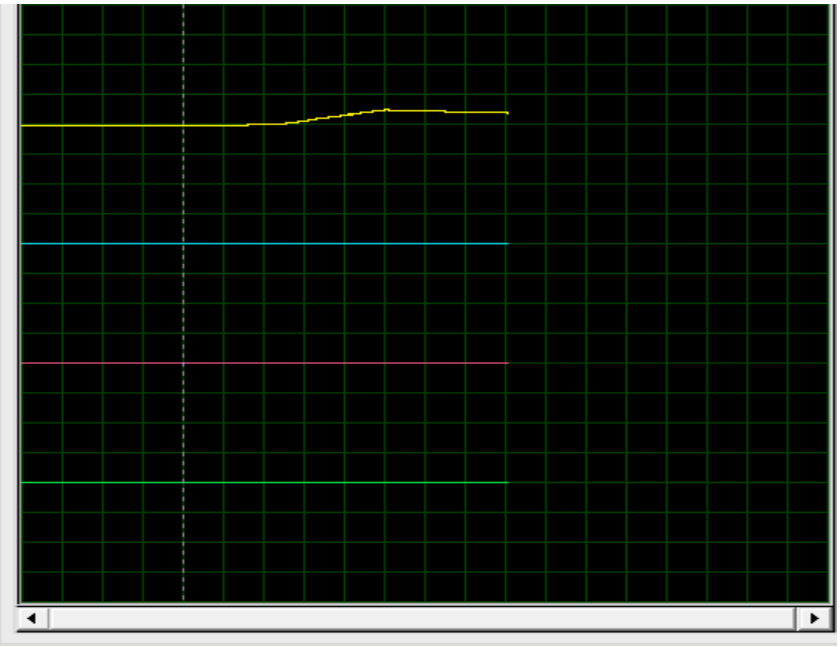


Fig Proteus Simulation Of Dc Voltage Input To Microcontroller

OUTPUT AT THE LOAD AFTER TRANSIENT INJECTION:

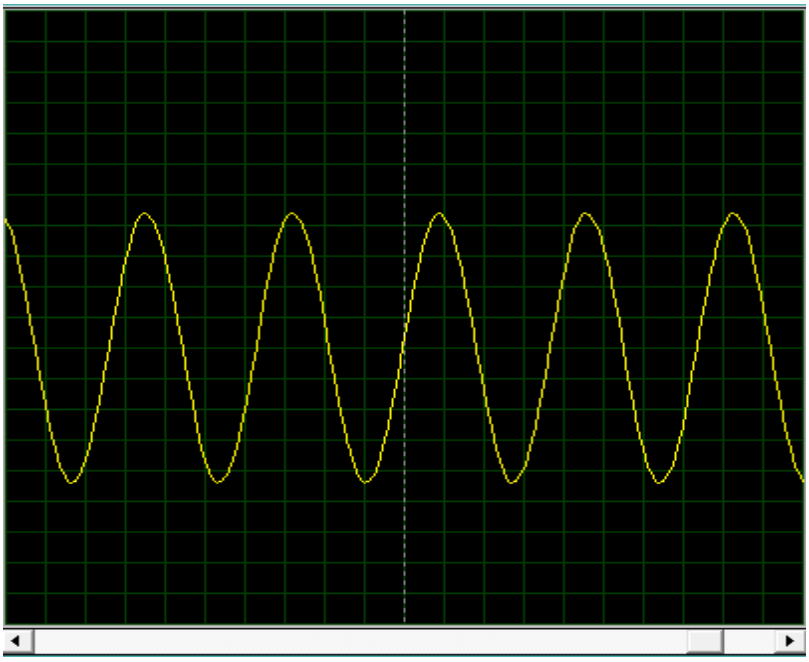


Fig Proteus Simulation Output At The Load

VI. CONCLUSION

An improved method for the problems of voltage sag and swell detection in industrial grids and compensation is presented in this paper and the limitations of existing methods are resolved by considering voltage swell compensation also into account. The proposed method is economical and simple for implementation. The problems of transients and short circuit faults are experimentally studied and simulation analysis is performed for the proposed method. The use of PIC Microcontroller enables us to a have further study of communication of transient conditions and can be utilized for further case studies of machine life time and responses in the future scope.

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