ANALYSIS OF VOLTAGE SWAG AND VOLTAGE SWELL CONCEPT IN POWER QUALITY PROBLEM

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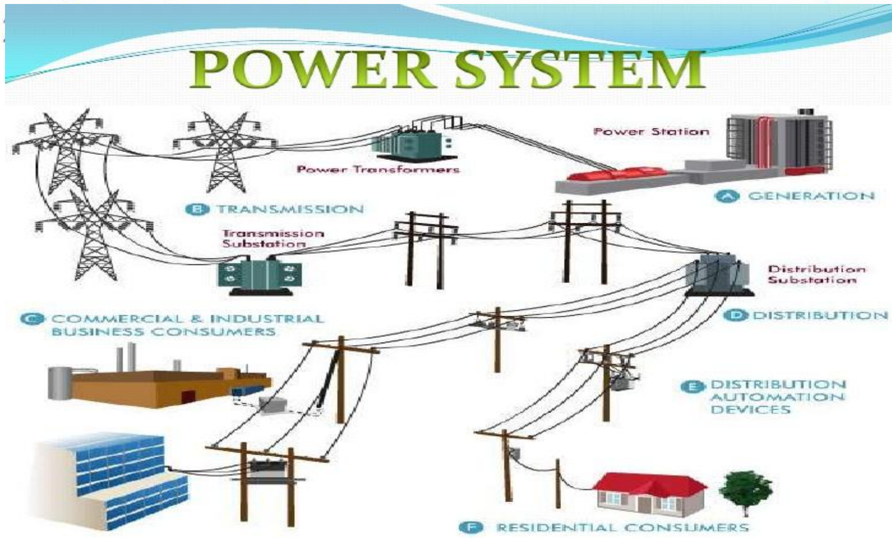
ABSTRACT

This paper summarizes the results from a number of different voltage sag investigations. These investigations involve characterizing the voltage sag performance at a customer facility and evaluating equipment sensitivity to different voltage sag magnitudes and durations. Possible solutions to voltage sag sensitivity problems are also described. Power quality is very important issue recently due to the impact on electricity suppliers, equipment manufacture and customers. Nowadays, there are so many industries using high technology for manufacturing and process unit. This technology requires high quality and high reliability of power supply. The industries like semiconductor, computer, and the equipments of manufacturing unit are very sensitive to the changes of quality in power supply. Power Quality problems encompass a wide range of disturbances such as voltage sags/swells, flicker, harmonics distortion, impulse transient, and interruptions. Voltage sags/swells can occurs more frequently than other Power quality phenomenon. These sags/swells are the most important power quality problems in the power distribution system. The objective and scope of this paper is study of power quality phenomena in distribution systems

I INTRODUCTION

Voltage sags and momentary power interruptions are probably the most important power quality problems affecting industrial and large commercial customers. These events are usually associated with a fault somewhere on the supplying power system. Actual interruptions occur when the fault is on the circuit supplying the customer. Voltage sags are much more common since they can be associated with faults remote from the customer.



II EXAMPLES OF EQUIPMENT SENSITIVITY

Determining equipment sensitivity can be the most difficult task when analyzing voltage sag concerns. The sensitivity of equipment presented here was determined as testing process is disrupted. The chip testers can be 50 kVA and larger in size.

There were 17 voltage sags causing a loss of load in IBM's sensitive tester room during the 12 months April 1, 1991 through March 31, 1992. The testers are located in a facility fed from a 13.2 kV distribution system

2.1 Chiller Control

Process controllers can be very sensitive to voltage sags. An electronic component manufacturer was experiencing problems with large chiller motors tripping off-line during voltage sag conditions. The chillers supply water to an entire chip manufacturing and testing facility. During extreme voltage sags, enough chillers may trip to affect manufacturing, causing large monetary losses. A 120 V, 15 VA process controller which regulates water temperature was thought to be causing individual chillers to trip. This controller was tested using a voltage sag simulator for voltage sags from 0.5-1000 cycles in duration. The controller was found to be very sensitive to voltage sags, tripping at around 80% voltage, regardless of the duration.

2.2 Chip Tester

Electronic chip testers are very sensitive to voltage variations, and because of the complexity involved, often require 30 minutes or more to restart. In addition, the chips involved in the testing process can be damaged, and several days later, internal electronic circuit boards in the testers may fail. A chip tester consists of a collection of electronic loads, printers, computers, monitors, etc. If any one component of the total package goes down, the entire testing

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process is disrupted. The chip testers can be 50 kVA and larger in size. There were 17 voltage sags causing a loss of load in IBM' ssensitive tester room during the 12 months April 1, 1991 through March 31, 1992.

2.3 Program Logic Controller

This is an important category of equipment for industrial processes because the entire process is often under the control of these devices. The sensitivity to voltage sags varies greatly but portions of an overall PLC system have been found to be very sensitive. The remote I/O units, for instance, have been found to trip for voltages as high as 90% for a few cycles. The following figure shows the results of voltage sag ride through testing on two different programmable logic controllers. The figure shows the difference between an old and new version of the same PLC. The newer, Type 1 controller is sensitive at 50-60% of nominal voltage, while the older, Type 2 PLC could ride through zero voltage for 15 cycles. This illustrates how electronic equipment is becoming more sensitive to voltage variations.

2.4 Machine Tools

Machine tools can be very sensitive to voltage variations. Often, robots or complicated machines are used in the cutting, drilling, and metal processing that is required when specialized parts are produced. Any variation in voltage can affect the quality of the part that is being machined. Another reason machine tools are sensitive to voltage variations is for safety reasons. Robots generally need very constant voltage to operate properly and safely. Any voltage fluctuations, especially sags, may cause unsafe operation of the robot or machine. Therefore, these types of machines are often set to trip at voltage levels of only 90%.

III SOLUTIONS TO VOLTAGE SAG PROBLEMS

Several things can be done by both the utility and customer to reduce the number and severity of voltage sags and to reduce the sensitivity of equipment to voltage sags.

3.1 Utility Solution

Utilities derive important benefits from activities that prevent faults. These activities not only result in improved customer satisfaction, but prevent costly damage to power system equipment. Utilities have two basic options to continue to reduce the number and severity of faults on their system:

1. Prevent faults
2. Modify fault clearing practices

Fault prevention activities include tree trimming , adding ine arresters, insulator washing, and adding animal guards. Insulation on any transmission system cannot withstand the most severe lightning strokes, but any line that shows a trend toward lightning-induced faults is usually investigated. Tower footing resistance is an important factor

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in back flashovers from static wire to a phase wire. If the tower footing resistance is high, the surge energy from a lightning stroke will not be absorbed by the ground as quickly. Tower footing resistances should be as low as possible especially in high lightning areas.

IV CUSTOMER SOLUTION

Customer solutions usually involve power conditioning for sensitive loads. Proper application of power conditioning equipment requires an understanding of the capabilities of the device. Also important is a definition of the requirements of sensitive or critical loads. There are several solutions currently available that will provide ride through capability to critical loads

1) Motor-Generator Sets (M-G Sets)
2) Uninterruptible Power Supplies (UPSs)
3) Constant Voltage Transformers (CVTs)
4) Magnetic Synthesizer
5) Super conductor Device

4.1 Motor Generator Set (M-G SETS)

M-G Sets usually utilize flywheels for energy storage. They completely decouple the load from the electric power system. Rotational energy in the flywheel provides voltage regulation and voltage support during under voltage conditions. M-G sets have relatively high efficiency and low initial capital cost.

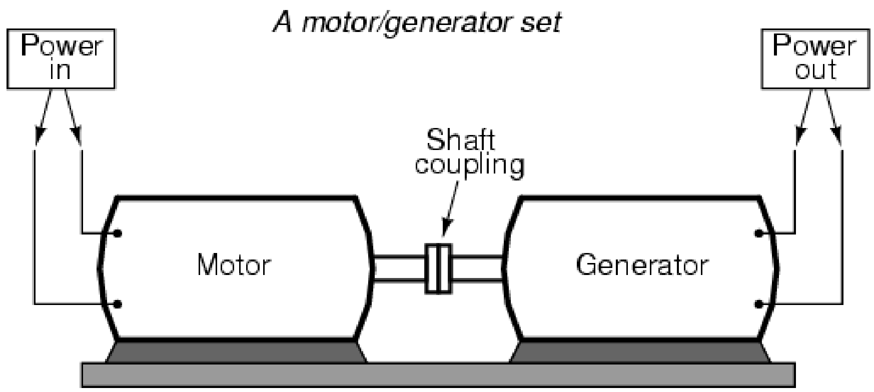

Fig.1 Motor Generator Set

4.2 Uninterruptible Power Supply

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UPSs utilize batteries to store energy that is converted to a usable form during an outage or voltage sag. UPS technology is well established and there are many different UPS configurations to choose from.

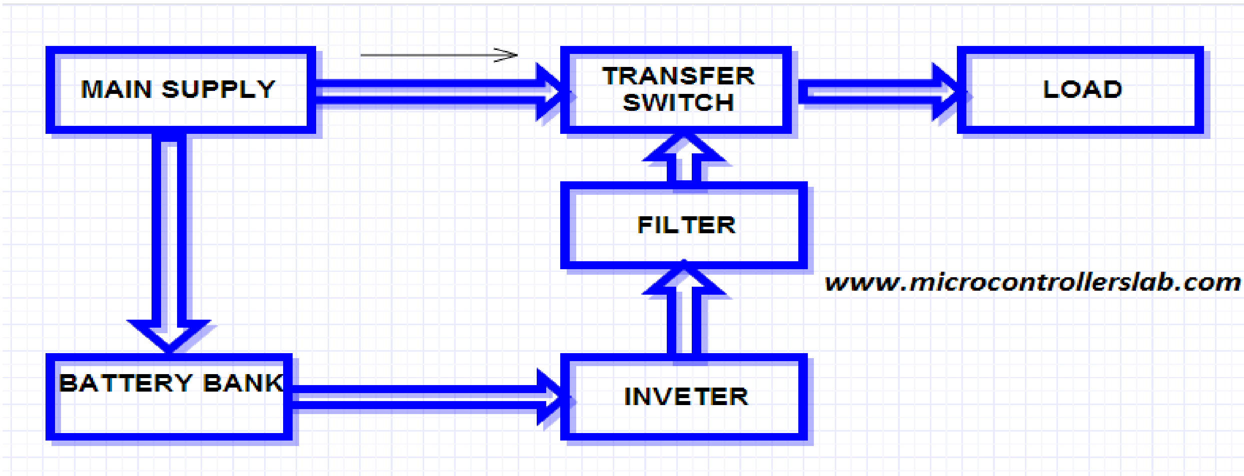

Fig. 2 Block Diagram of UPS

4.3 Constant Voltage Transformer

CVTs can be used to improve voltage sag ride through capability. CVTs are especially attractive for constant, low power loads. Variable loads, especially with high inrush currents, present more of a problem for CVTs because of the tuned circuit on the output. CVTs are basically 1:1 transformers which are excited high on their saturation curves, thereby providing output voltage which is not significantly affected by input voltage variations.

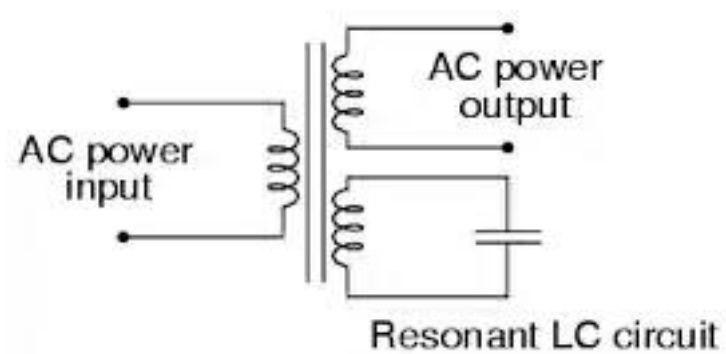

Fig. 3 Constant Voltage Transformer

4.4 Magnetic Synthesizer

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Magnetic Synthesizers are generally used for larger loads. A load of at least several kVA is needed to make these units cost effective. They are often used to protect large computers and other sensitive electronic equipment. The magnetic synthesizer is an electromagnetic device which takes incoming power and regenerates clean, three-phase ac output waveform, regardless of input power quality.

Magnetic synthesizer similar constant voltage transformer which provide improve in voltage from sag. It is used to protect against oscilatric transient and sag

A block diagram of the process is shown in the figure below.

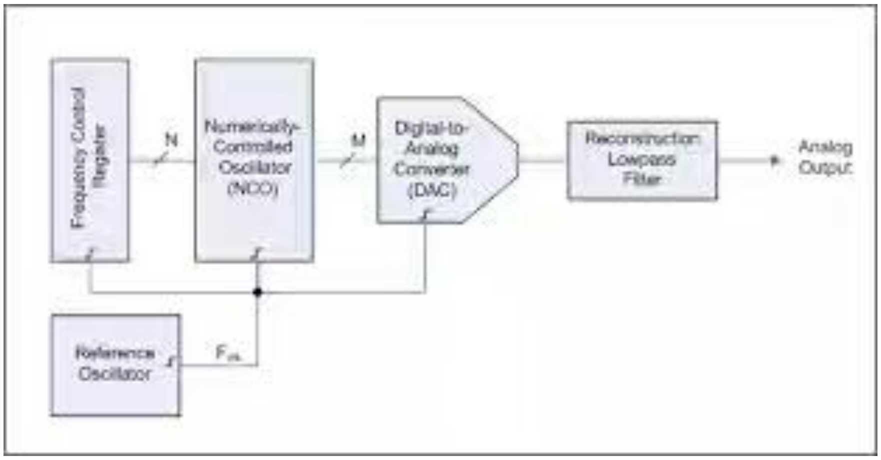

FIG. 4 Block Diagram of Magnetic Synthesizer

4.5 Super Conductor Devicee

SCDs utilize a superconducting magnet to store energy in the same way a UPS uses batteries to store energy. The main advantage of the SCD is the greatly reduced physical space needed for the magnet as compared to batteries. There are also a lot less electrical connections involved with SCDs as compared to UPSs so the reliability should be greater and the maintenance requirements less. Initial SCD designs are currently being tested in several locations with favorable results. The projected future costs of an SCD should be competitive with UPSs

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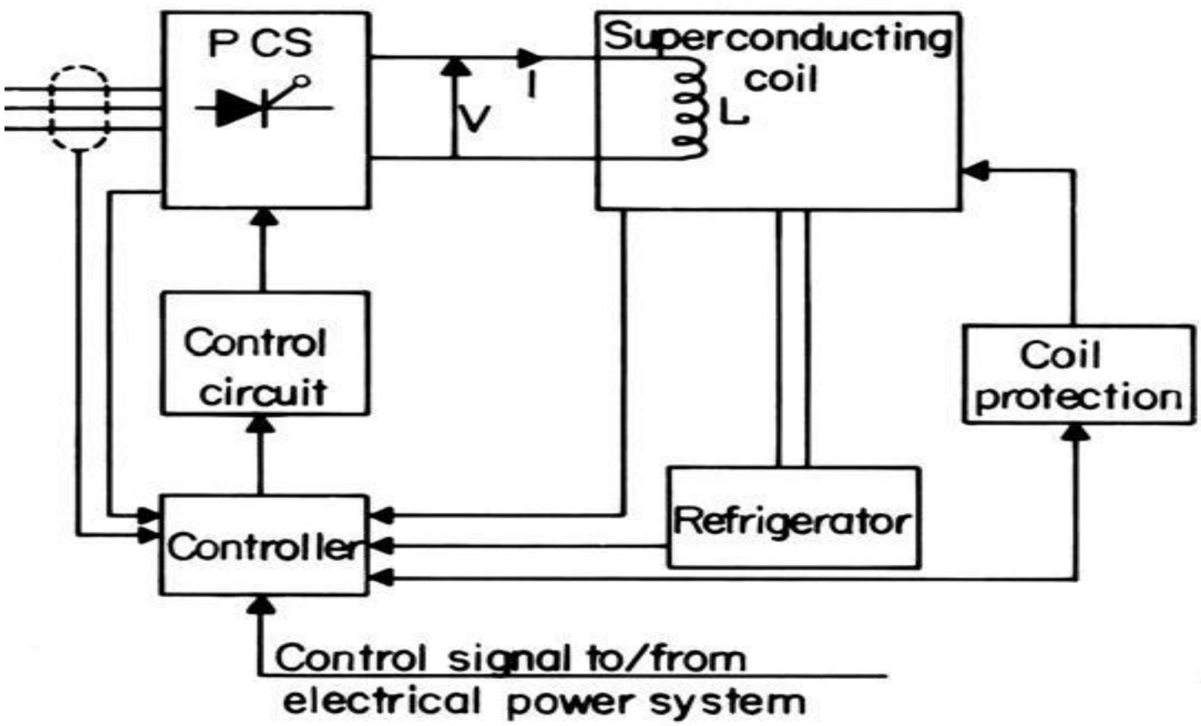

FIG 5 BLOCK DIAGRAM OF SCD

VI CONCLUSION

Voltage sags are one of the most important power quality problems affecting industrial and commercial customers. Industrial processes are particularly sensitive to relatively minor voltage sags. Utilities can improve system fault performance but it is not possible to completely eliminate faults on the system. Therefore, customers will have improve the ride through capability of the sensitive equipment in their facilities.

This can be accomplished with power conditioning or in the equipment itself. Power conditioning to improve voltage sag ride through can be very expensive. Solutions often require protection of virtually the entire process. Very large UPS systems or newer superconducting storage devices must be used in these cases. It will be much more economical in the long term to improve the voltage sag ride through capability of the actual process equipment. Adjustable speed drives are a good example. Some manufacturers now have the capability to resynchronize the ASD output into a spinning motor. This allows use of the motors inertia to ride through most voltage sag events.

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