

Study on Power Quality Problem and its Mitigation Techniques in Electrical Power System

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Abstract– Recent time a large interest has been studios on power quality and reliability; this is two most essential aspects of any power delivery system. Electrical power is collection of all electrical network component put about radiated to supply, transfer and use of electric power, when indicate power quality problem electric equipment get damage or malfunctioning. In this paper various power quality problems and also how to overcome the problem and discuss different schemes to improve it, also the power quality enlargement devices mention.

KeyWords: Power Quality, Voltage Sag, Swell, Harmonics distortion, Facts, Custom power devices, ANN, GA.

1. INTRODUCTION

Power Quality that means different things to different people; Question is that why we are thinking about the power quality problem? PQ is brief term used to describe the electrical system production. The power quality is important due to newer generation load equipment, microprocessor based control and non-linear load an increase in the number of power electronic devices, continues growth of adjustable speed drives and switched mode power supplies, shunt capacitors for a power factor correction result increasing harmonics, electrical disturbance in power system.

According to IEEE standard IEEE1100 defines: “power quality is the concept of powering and grounding sensitive electronic equipment in a manner that is suitable for the operation” [1]. Power quality is usually a distribution system related problem but the transmission system may also have an impact on the quality of power, actually the power quality problems start with the transmission system to transmit power over long distance, there generate power is stepped up by transformer these high voltage bus have own power problem due to corona and losses [2]. According to the paper discuss various power quality issues such as voltage sag, swell, outage, switching, harmonics etc, which causes many problems like equipment failure, electricity bill, and energy west, etc.

Now a day power deliver to End users and utility become more challenging because in a modern society use of sensitive load, non-linear device, motors, computers, lighting etc. thus it's a very important to investigate the problem and its solutions.

Power quality problems most severe problem are voltage sags, swell and harmonic due to voltage distortion affecting the power system.

2. Power Quality issues:

The concept of good and bad power quality depends on the consumers. If the equipment operation satisfactory the user feel that power is good and equipment doesn't operate and malfunctioning and fails there is feeling power is bad. Due to non-linear devices, occurring fault, lighting, outage, the electronics equipment and sensitive devices face lot of problems and equipment get damage or completely shutdown. Power quality problems are voltage sags, voltage swell, interruption, voltage variation, frequency deviation, harmonics distortion, under voltage, over voltage, etc.

(a) Voltage Sag:

The voltage sag is a sudden drop in the RMS voltage for a short period, the duration of the voltage sag is less than 1 minute but more than an 8 ms and the drop of voltage value become 10% to 90% of the nominal voltage. Voltage sag is either unsymmetrical & symmetrical fault. The causes of voltage sag are due to starting a heavy load, LG fault, lighting strike, fault due to short circuit.

(b) Voltage Swell:

A Voltage swell is sudden rise in the RMS voltage for a short duration, the duration of the voltage swell is less than 1 minute and increasing voltage is 10% to 110% of nominal voltage; it is momentary increasing in voltage outside the normal tolerance. Swell are usually associate system fault condition which are causes drop of heavy loads, due to voltage swell shutting down of heavy load, boost capacitor bank, adjustable speed drive which can trip, remodeling in the ground reference on groundless phases.

(c) Interruption:

It can be considered as voltage dip with 100% amplitude for the short duration, the duration is less than 1 minute; the source voltage or current may be near to zero. The causes may be a blown fuse or break opening and effect a shutdown, opening of

automatic re-closer, insulation flash over etc. due to the interruption data storage system gets affected and also malfunctioning of the sensitive loads.

(d) Frequency variation:

The Electric power systems develop to work at a specified value of frequency. The frequency variations are caused if there is any inequality in demand and supply, huge frequency variation are due to generator failures or sudden change in loads. Frequency variation should be within acceptable limit at all devices.

(e) Harmonic distortion:

It is express as the intervention in an ac power signal generated by frequency multiple of the sine wave; the main source of harmonic voltage distortion is use of non-linear device, the most harmonic current drawn non-linear loads are all single and three-phase converters such as rectifier, dc motors, fluorescent lighting, ac motors and transforms, heating furnaces, etc.

(f) Transient:

Voltage disturbance shorter than sag and swell is known as transient and are causes by sudden change in the power system; according to the duration the transient is divided into two parts i.e. switching surge duration of millisecond and impulsive spike duration of microsecond. Due to transient electronic equipment show wrong result, failure of fluorescent lights, motor runs higher temperature.

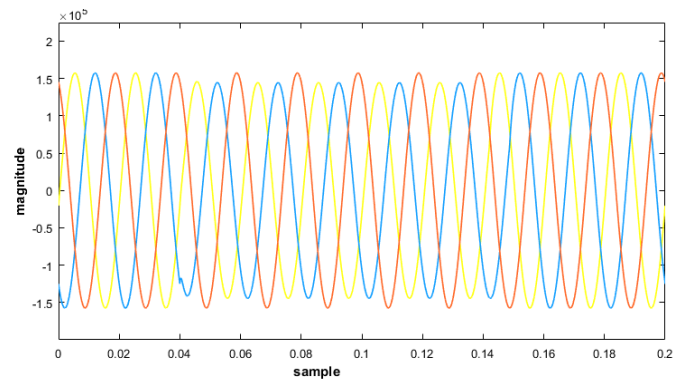


fig. 2 unsymmetrical sag

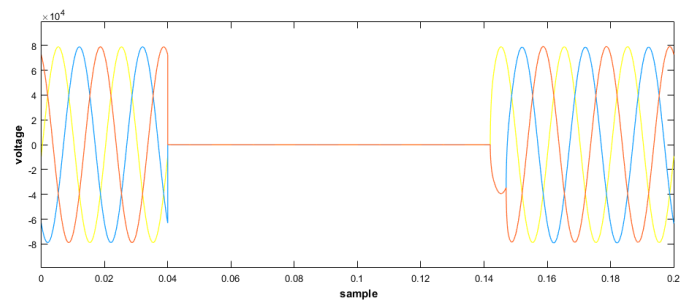


fig. 3 interruption

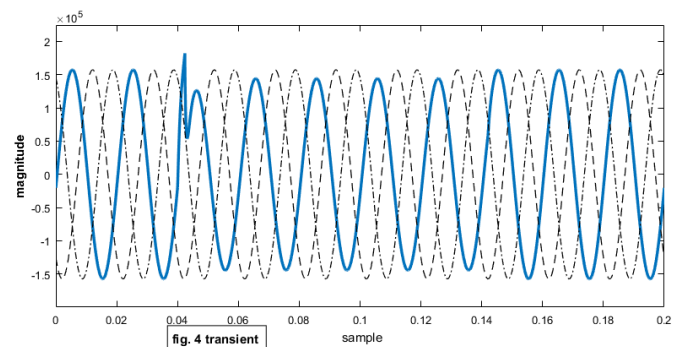


fig. 4 transient

(g) Waveform Distortion:

The power system electric networks do one's best to generate and transmit the sine wave voltage and current. Waveform distortion occurs where a steady states frequency deviates from an ideal sine wave. The causes of waveform distortion are Inter harmonic, dc offset, notching, noise, etc.

(h) Voltage Unbalance:

Voltage unbalance is defined as the condition where the magnitude and phase angles between the voltage signals are not equal. Voltage unbalance causes fault arising in the network, also the large single phase loads. Consequences of voltage unbalance are; increasing power destruction minimizes the life of the equipment, harmonic present in the system.

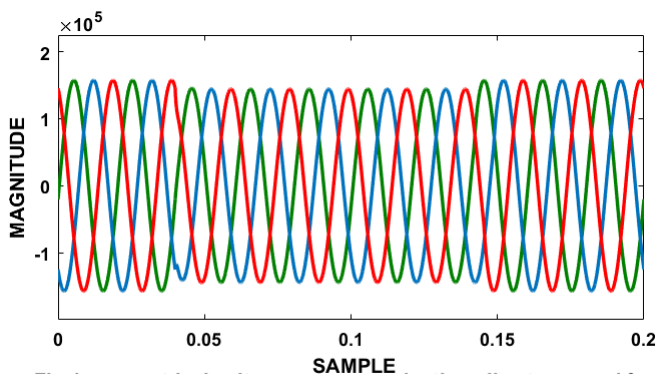


Fig 1. symmetrical voltage sag causes by three line to ground fault

3. Power Quality Mitigation Techniques:

The occurrence of power quality problem can be reduced but cannot be completely eliminated because large number of non-linear loads is increasing; therefore it is necessary to eliminate to employ an improvement technique to minimize the effect of power quality problems. Many types of power improvement devices have been progress to improve the power quality complication, problem should be mitigating in order to keep up the efficiency of the system. The following power devices create to effective power quality are surge protection device, M-G set, uninterruptible power supply, isolation transformer, SVC, UPFC, custom power devices.

i. Surge protection device (SPD):

Automatic control buses, and electrical power system surge protection device is used to address the impulsive transient, eliminates overvoltage. SPD is connected parallel has high impedance.

ii. M-G Sets (Motor Generator Sets):

M-G sets are established at the load side in order to provide power to fault-finding loads during interruption from the power providing company; M-G sets used in all cases expect long duration outage.

iii. UPS (uninterruptible power supply):

UPS can be used in case of voltage sag, swell, interruption, long duration over-voltages and under-voltages, and noise. During voltage sag and outage it provides constant voltage from a battery or super conducting material.

iv. Isolated transformer:

Isolated transformer is used to transfer electric power from source to some electric sensitive load equipment while isolating the power device usually a safety reason. These devices are effective in case of transient.

v. SVC (static var compensator):

These also apply passive element like inductor and capacitors, but the use of solid state switches to regulate the voltage rejection raising the efficiency. Static VAR compensator consist two main parts one is thyristor controlled reactor and another one is thyristor switched capacitor. SVC is connected in parallel with ac line through a transformer in order to reactive power rejection, also regulate high voltage immediately, it reduces the flickers causes by the heavy loads.

vi. UPFC (Unified Power Flow Controller):

UPFC was device made use of the real time control and compensation of ac transmissions system; it provides flexibility to solve many of problems facing the distribution industries. UPFC assist new challenges in power electronics and power system design. The formation of UPFC consist two voltage source inverters one connected to parallel with the transmission line and another one series with the transmission line to regulate the variable (the bus voltage, line impedance and phase angle) affecting power flow in the transmission line.

vii. Noise filter:

Noise filters can be utilized as to detach the undesirable voltage and current signals in the sensitive component. It can be implementing by using the combination of capacitor and inductor, it will create a low impedance path of the high frequency.

viii. Custom power devices:

Custom power devices are used for distribution system like FACTS devices used for the transmission system. These devices are power electronics equipment objective to solve improving power quality problems. These devices are dynamic voltage restorer, D-STATCOM, UPQC.

a. DVR (Dynamic Voltage Restorer):

The power electronic based compensation that protects sensitive load from all type source side disturbances other than outage is known as dynamic voltage restorer. DVR have the ability to generating and absorbing undependable controllable real and reactive power at its ac output. DVR can be applying to make up the load voltage harmonics, used under system frequency variation to provide real power, protect against the voltage sag and swell.

b. D-STATCOM:

Distribution static compensator is power electronic based equipment used to protect the distribution bus from small voltage variation, voltage unbalance, can be controlled by reactive power injection. It is connected parallel with distribution bus generally at a common coupling device.

c. UPQC (Unified Power Quality Conditioner):

The UPQC device is similar with UPFC, it consist two voltage source inverters that connect to general dc energy storage capacitor, one is connect series with ac line and another is parallel with same ac line to reduce the harmonic current by adding the series voltage proportional to the line current (6). Series voltage added to the voltage at PCC such that device can provide a barrier to remove any voltage sag and flickers.

ix. Neural network based mitigation:

Artificial neural network is proposed to newer generation for the power factor, reactive power, active power and fault location for the better utilize the volt-ampere. An important feature of the neural network is its capability to learn and generalize from set-off training.

In the latest neural network based mitigation is used for the power quality analysis and automated fault detection. In the mitigation only input and expected output data are required for the training of neurons. The new mitigation is very useful for the modeling the power network and analysis of power quality problem.

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4. CONCLUSION:

The necessity of electrical power is increasing day to day and same time the quality of power delivered becomes foremost issues in the energy industry. Thus, the quality of power should be maintained efficiently. The different power quality issues voltage sag, swell and presences of harmonic affect the end user appliances.

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