

Power Quality Issues and Its Possible Solutions

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Abstract – Recently Power Quality became a very serious matter in case of electric power utilities. Disturbances which arises in the supply systems are easily identified by Equipment used in power distribution. Moreover, these equipment's are connected together in supply system and in industries for the purpose of manufacturing. As a result, the effect of any power quality issue on the equipment is very large. Such an electrical device can be a generator, motor, transformers, computer, printer, house hold appliances. Power quality is the collections of the all electrical networks as the ability of the system of an equipment to function satisfactorily that type of electrical equipment permits the important manner is the without continuous loss of life of the all electrical equipment. The proposed paper is to overlook the sources and determine the most common power quality problems occurring in the power system and study the methods available for improving these problems.

Key Words: Power Quality, Transients, voltage sag, voltage swell, harmonics distortions, frequency variation, voltage spikes.

1. INTRODUCTION

Power quality can be expressed as the ability to supply a clean, proper and stable power supply to the system which going to be operated. It will be always available as a noise free and pure sinusoidal wave shape even it is always within a voltage and frequency tolerance. It does not contain any power quality issues. It may be defined as the user of electric power utilized electrical energy from the distribution system successfully without any disturbance & interference, interruptions. According to IEEE, POWER QUALITY is described as "The concept of powering and grounding electronic equipment in a manner that is suitable to the operation of that equipment and compatible with the premise wiring system and other connected equipment. Power quality related issues are the very important thing about distribution side as well as an industry side. Normally harmonics are the key issue of power quality problems regarding distribution networks. In the distribution system high power nonlinear loads are connected in such a way to the generation of harmonics in the system. Power quality problems can cause the lot of problems such as equipment failure, increased electricity bills, wasted energy, interference with communications systems and even shut down entire plants. So, this can affect the home computer,

lighting equipment of a photo graphic studio, generator, transformer, large machine used in a production process. Thus, it is very important to investigate these problems and their possible solutions.[1-5]

2. SOURCES OF POWER QUALITY PROBLEM

The primary sources of power quality problems are -

A. Nonlinear Load: With nonlinear load voltage and current do not follow each other linearly. It results in the harmonic distortion which causes overheating of the equipment and are admitted to voltage dips if they are not properly protected.[8]

B. IT and Office Equipment (sensitive loads): The brain of the computer is IC chips and is sensitive to change in the power supply. Any deviation in voltage can cause data to be damaged.

C. Large Motor Starting: During starting, the current in the induction machines is about six times of an ordinary current. It increases the network loading and hence cause voltage sag. Nowadays modern motors use power electronic converter also called 'drive', which control the motors starting current to a desired level.[11]

D. Arc Producing Devices: These are non-linear devices and are main cause of harmonic distortion. Example are electricity discharge lamps, electric arc furnaces and arc welders etc.

E. Load Switching: These are the transient [15] occurs due to switching of massive load of single-phase. Electrical isolation is done in order to preserve the equipment from these disturbances.

F. Inter-connection of Power System: In the recent years the extent of interconnection in the power system is increased and is supposed to have great impact on the quality of power and it is very difficult to isolate them. Harmonics and flicker are some power quality problems which are transferred from one utility to another utility via interconnection.

G. Lightning Strikes and Environmental issues: The Lightning strike produces transient over voltage issues and also it frequently leads to fault in power system. When the

lightning strike hits the overhead transmission lines it causes flash-over to the neighbouring conductors. It consists of transient overvoltage, voltage dips and also fault-clearing interruptions.

3. MAJOR POWER QUALITY PROBLEMS

A. Transient: These are the unexpected and small duration interruption which is occur due to intense variation in balanced situation of current, voltage or both.[13-15]

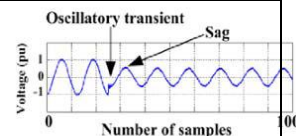
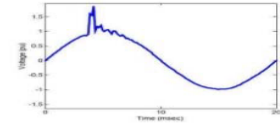
Disturbance Category	Causes	Effects	Waveforms
Oscillatory Transient	Switching of capacitive or inductive loads.	Loss of data, possible damage.	
Impulsive Transient	Utility fault clearing, lightning, switching impulses.	Loss of data, possible damage, and system halts.	

Table -1: Transient Classification

B. Voltage Imbalance: It can be described as the variation in voltage of a three-phase system where both magnitude of voltage and their phase difference are unequal.[11]

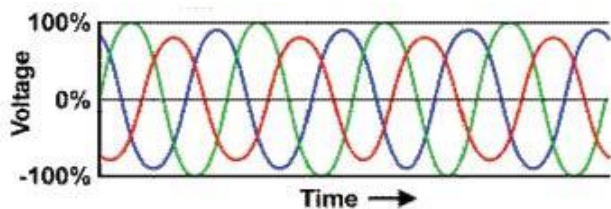
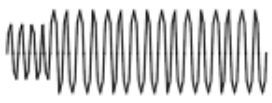

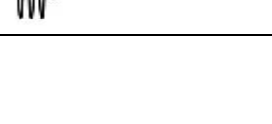


Fig.-1: Voltage Imbalance

C. Short Duration Voltage Variation: It is defined as any variation in supply voltage for very short period which is not more than 1 minute. As mentioned in Table-2.[8-13]

CAUSES-Sudden excitation of large loads, loose wiring connections.

Disturbance Category	Causes	Effects	Waveforms
Over Voltage	System load change, utility faults.	Loss of data, system shutdown, and system halts.	
Under Voltage	System load changes, utility faults.	Equipment damage, reduced life of equipment.	
Sustained Interruption	Utility faults, tripping of breaker, component	System shutdown, loss of data and damages.	


failure.	Disturbance	
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Table-2: Short Duration Voltage Variation Classification

D. Blackout - It can be represented as a condition of zero-voltage which exists for larger than two cycles.

E. Brownouts: It is defined as intended or unintended voltage drop in power system. Intended brownouts are principally used for reduction of load in emergency conditions. This reduction lasts from few minutes or hours. EFFECTS:-Loss of data, systems can experiences glitches and equipment failure.

F. Voltage Fluctuations: IEEE described it as voltage envelope variation, or the random voltage fluctuation, whose magnitude lies in the limits of voltage provided by the standard ANSI C84.1. In general, variation range is about 0.1% to 7% of the system voltage and frequency is under 25 Hz.

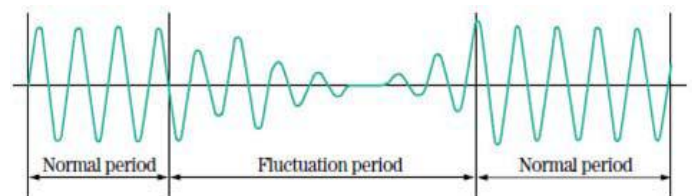


Fig.-2: Voltage Fluctuations

G. Power Frequency Variations: For the adequate working of any network or system the necessary frequency limit is specified, if there is a deviation in its desired limit suppose from 50 Hz to 60 Hz, then it is called as frequency variation of power system.

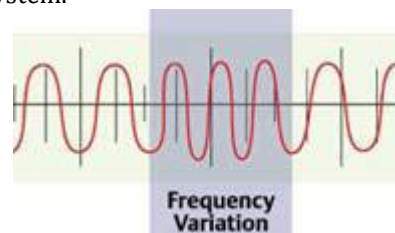
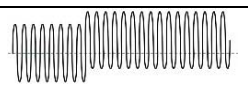



Fig.-3: Power Frequency Variations

H. Wave Form Distortion: If there is any deviation in the voltage and current waveform of power supply from ideal sine wave then it is called wave form distortion.[11-16]

Disturbance Category	Causes	Effects	Waveforms
DC Offset	Power supplies, Faulty rectifier.	Ground fault, current nuisance tripping, transformer heating.	
Harmonics	Due to Non linear loads.	Measurement error, Equipment overheating, loss in machines efficiency, communication interference.	

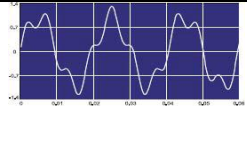
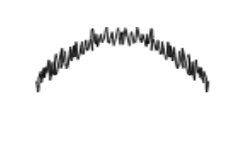
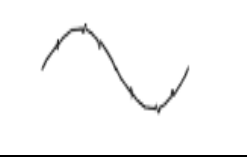
Inter Harmonics	Induction motor, faulty equipment, arcing device.	Heating, Communication interference, light flicker etc.	
Noise	Improper grounding, electromagnetic interferences.	Data loss and data processing errors.	
Notching	Arc welders, light dimmers, variable speed drive etc.	Loss of system data, system halts.	

Table-3: Waveform Distortion Classification

4. POWER QUALITY SOLUTIONS [16-22]

Many types of power enhancement devices have been developed to improve the power quality and also a protect the equipment. The following power devices create a effective power quality. First one is the transient voltage surge suppressors, types of filters such as harmonic filters, noise filters, voltage regulators, isolation transformers, dynamic voltage restorer, ups, off line UPS, line interactive UPS, true on line UPS, Unified power quality conditioner, static Var compensators, thyristor based static switch, motor generator set.

A. Transient Voltage Surge Suppressors (TVSS): TVSS gives the simplest and more expensive through the condition power. These types of units safe for the electronic load. It is very against the most of the transients and also an employed the entire benefit of the protection. It is used as an interface between power source and also the types of the loads. So, that transient voltage is diminished or clamped the by through the TVSS once before this voltage to reach the load. TVSS is having nonlinear resistance component like these types of components also controls the excessive line voltage even it is conducting the any of the excessive impulse energy to ground.

B. Noise Filters: Noise filters can be used as to remove the unwanted voltage signals and current signals in the sensitive equipment. It can be carried out by using the combinations of capacitors and inductors it will be creates a low impedance path to the fundamental frequency and also a high impedance path of the higher frequencies. It is also called as low pass filter used as when noise along with frequency in the range of KHZ.

C. Harmonic Filters: We know that harmonics filters can be used to reduce the unwanted or undesirable harmonics. This has to be split into the two types of groups one is a passive filters another one is an active filters. Passive filters are

defined as the combinations of the resistors, inductors, capacitors it also be carried out low impedance path to the fundamental of frequencies even it is reduced unused harmonic components. A lot of passive filters connected in parallel this to be reduced several harmonic components. Passive filters can be acts as an Ineffective situation when the vary the passive components or system is varied. Then active filter is used to identify the current consume by the load along with it will reduce the harmonics currents generated by the loads. In the past few years it will not be a effective but ii will be becoming cost effective to reduce changing and unknown harmonics

D. Isolation Transformers: Isolation transformer is used to separate the sensitive load from the electrical system. Most of the isolation transformers are keeping the harmonics current by the loads. The main structure is the isolation transformer is grounded shield it will be made up of non-magnetic foil it also located by the between the primary and secondary. If any transient or noise can be coming from the main sources it cannot be passing through the load instead of that first it will through the capacitance between the primary and it can be passing on the ground. It never is passing directly through the reach the load. Isolation transformers avoid the common noise and also an electrical noise effectively filtering. Isolation transformers cannot be compensated voltage fluctuations and any of the power outages problems

E. Voltage regulators: Voltage regulators can used to maintain the output voltage. There are three types of voltage regulators first one is the tap changers, constant voltage transformers, buck boost. Tap changers is used when adjust the input voltage vary automatically taps transferred to the transformer. The main advantages of this high efficiency, having high over load current capability, isolate the noise, the main disadvantages is the noise will be created when the tap changes. Buck boost is creating a high efficiency, withstand the high inrush currents. The main disadvantages is the noise will be created when the tap changes and there is no any waveform correction. Constant voltage transformer is to maintain the nearly constant output voltage during the large input voltage variations. The main disadvantages of this to be a low efficiency, the size will be more.

F. Un interrupted Power Supply (UPS): UPS is to provide the protection if any power disturbance, or any power interruptions. It will be giving power continuously when the power interruption if any power disturbances occurs. Depends upon the various technologies and differ the provide protection such as sag if any continuous noise will occur

G. Dynamic Voltage Restorer (DVR): It will be connecting a series with a load and it is similar to the voltage source. At the load terminals DVR is maintain the output voltage is

constant by using the stored the energy to inject the active and also a reactive power.

H. Static VAr Compensators: Static VAr compensators is used to regulate the high voltage quickly and also a combination of the capacitors and reactance. To prevent the voltage fluctuations the solid-state switches controls this fluctuations insertion of the capacitors and reactors. Static VAr compensators is normally it will regulate the high voltage and also to reduce the flickers caused by large loads.

I. Unified Power Quality Conditioner (UPQC): UPQC is used to reduce the mitigate the voltage and current. It also related to the power quality issues in the power distribution systems. This has to be employed two types of voltage inverters that will be connected to the dc energy storage system. UPQC has to be compensated the current and supply voltage. This current will be drawn from the network supply voltage is delivered to the load.

5. CONCLUSIONS

Power quality is the important and very critical or crucial matter in the modern society. Most of the electrical equipment is failed by the power quality problems. To prevent this problem better way to restoring the technologies, distributed generation, selecting the less sensitive equipment and also using the interface devices. In this paper it is briefly explained, "What is power quality". Poor power quality causes serious effect on the power system like over loading condition, generation of harmonics, voltage fluctuation, waveform distortion, and overheating in system equipment etc. therefore we have to mitigate these power quality issues. This paper gives an idea about appropriate standards for various power quality issues and also provides solution to major power quality problems. While, it is not possible to completely eliminate the causes of power quality but the quality of power supply can be improved and their effect could be reduced. The mitigating techniques includes use of power conditioning equipment such as TVSS, filters, voltage regulators, isolation transformer, use of energy storage systems, and also with use of custom power devices. This paper helps the researchers and electrical power utilities to get an overview of power quality issues so that they come up with latest technology.

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