POWER QUALITY ISSUES, PROBLEMS, STANDARDS IN POWER SYSTEMS

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Abstract

Latest innovative ideas to make the life easier using the technology depends upon the application of power electronics in turn about power quality.According to development of electric power consumption, and increasing nonlinear loads in power systems, production of electric power with a high quality is the main problem of power engineering. Therefore, it is necessary to evaluate the problems of power quality in the power systems in order to improve. Comprehensive knowledge of power quality issues is important in today's electrical power system operating environment, but the ultimate purpose of learning about power quality is to be able to solve power quality problems.The paper describes a review of so far the work carried out on power quality issues which would be helpful for the researchers to do the future work related to power quality

INTRODUCTION

Latest innovative ideas to make the life easier using the technology depends upon the application of power electronics in turn about power quality. With increasing quantities of non-linear loads being added to electrical systems, it has become necessary to establish criteria for limiting problems from system voltage degradation. This paper presents the power quality problems, issues, related international standard, effect of power quality problem in different apparatuses and methods for its correction, which is actually a technology management. This is important for design engineers and researchers in power quality to know the international standards used for power quality.

The paper and the technology on which it is grounded are largely motivated by the power quality issues. The term power quality is rather general concept. Broadly, it may be defined as provision of voltages and system design so that user of electric power can utilized electric energy from the distribution system successfully, without interference on interruption. Power quality is defined in the IEEE 100 Authoritative Dictionary of IEEE Standard Terms 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 Utilities may want to define power quality as reliability [8]. From the Power Quality market or industry perspective, it is any product or service that is supplied to users or utilities to measure, treat, remedy, educate engineers or prevent Power Quality issues, problems and related items [6,8,12,13,15,23,28]. This paper critically discusses about the power quality problems, issues and related standards, assessment of power quality issues and methods for its correction with giving a thorough knowledge of harmonics, power quality indices, parameters effecting electric power etc

Electricity is not anymore a luxury article like few decades ago, but it has become a necessity and a part of our everyday life. Even short interruptions and voltage sags can be harmful when the amount of computers, programmable logics etc. in industry and as well in households have increased rapidly. In modern information society requirements and expectations associated with power quality have become increasingly important. Reasons for that are increased requirements for power quality by network utilities, customers and regulators. Many industrial and commercial customers have equipment that is sensitive to power disturbances. Therefore, it is more important to understand the quality of power being supplied in a power system, faults,

dynamic operations, or nonlinear loads often cause various kinds of power quality disturbances such as voltage sags, voltage swells, switching transients, impulses, notches, flickers, harmonics, etc. One critical aspect of power quality studies is the ability to perform automatic power quality monitoring and data analysis. Usually, utilities install power quality meters or digital fault recorders at certain locations so that various power quality events can be recorded and stored in the form of sampled data for further analysis Power quality is defined in the IEEE 100 Authoritative Dictionary of IEEE Standard Terms 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 Utilities may want to define power quality as reliability. Power Quality may also be defined as "a set of electrical boundaries that allows equipment to function in its intended manner without significant loss of performance or life expectancy

A recent survey of Power Quality (PQ) experts indicates that 50% of all Power Quality problems are related to grounding, ground bonds, and neutral to ground voltages, ground loops, ground current or other ground associated issues. Electrically operated or connected equipment is affected by Power Quality. The commonly used terms those describe the parameters of electrical power that describe or measure power quality are Voltage sags, Voltage variations, Interruptions Swells, Brownouts, Blackouts, Voltage imbalance, Distortion, Harmonics, Harmonic resonance, Interharmonics, Notching, Noise, Impulse, Spikes (Voltage), Ground noise, Common mode noise, Critical load, Crest factor, Electromagnetic compatibility, Dropout, Fault, Flicker, Ground, Raw power, Clean ground, Ground loops, Voltage fluctuations, Transient, Dirty power, Momentary interruption, Over voltage, Under voltage, Nonlinear load, THD, Triplens, Voltage dip, Voltage regulation, Blink, Oscillatory transient etc. The issue of electric power quality is gaining importance because of several reasons:

POWER QUALITY PROBLEMS & ISSUES

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- Piece of equipment misoperates at the same time of day.
- Circuit breakers trip without being overloaded.
- Equipment fails during a thunderstorm
- Automated systems stop for no apparent reason.
- Electronic systems fail or fail to operate on a frequent basis.
- Electronic systems work in one location but not in another location.

Effect Of Power Quality Problems In Equipments& Methods for Its Correction

A Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or a mis-operation of end use equipments .The first sign of a power-quality problem is a distortion in the voltage waveform of the power source from a sine wave, or in the amplitude from an established reference level, or a complete interruption. The disturbance can be caused by harmonics in the current or by events in the main voltage supply system. The disturbance can go for a fraction of a cycle (milliseconds) to great durations (seconds to hours) in the voltage supplied by the source. Power quality problems can basically start at four levels of the system that delivers electric power, first one, includes Power plants and the entire area transmission system. The second one are Transmission lines, major substations where as third one includes distribution substations, primary, and secondary power lines, and distribution transformers and last and fourth one includes service equipment and building wiring. In addition, the problems can be caused by the equipment

supplied with electric power—for example, power-electronic converters.

WORK DONE ON PQ ISSUES

The main Power Quality (PQ) problems were presented with their associated causes and consequences in. The economic impacts associated with PQ were also characterized and some solutions to mitigate the PQ problems were presented. Power Quality is characterized by parameters that express harmonic pollution, reactive power and load unbalance. The best possible solutions to these problems were reviewed and their control systems were elaborated in. The two major power quality disturbances are voltage sag and harmonic distortion. In the event of voltage sag, due to insufficient energy, equipments may malfunction or trip. Harmonics introduced by nonlinear loads can pollute the input supply to the sensitive equipments and cause the connected equipments to malfunction. Power Quality Provider (QPP) proposed has a novel feature of performing dual functions of mitigation of sag and suppression of harmonics quickly, dynamically and simultaneously using a simple unique and novel control scheme based on reference voltage tracking control strategy. Voltage sags are one of the most concerned power quality events in the modern power systems as they often lead to tripping or misoperation of the customer equipment. Paper describes new software developments aimed at automated voltage sag characterization and equipment behavior analysis. Power quality management system presented in has been developed to provide customers with various power quality diagnosis functions so that they can cope well with power quality problems with the right measure in the right place. The Unified power quality conditioner (UPQC) system has the advantages like reduced maintenance and ability tocontrol active and reactive powers. It is found that there is an improvement in the active and reactive powers through the transmission line when UPFC is introduced. The implementation of Unified Power Quality Conditioner connected to 3P4W distribution system by using p-q theory to improve the power quality has been presented in, Where UPQC is installed to compensate the different power quality problems, which may play an important role in future UPQC- based distribution system. Majority of the distributed generations from renewable energy sources are connected to the grid through power electronic interface, which introduce additional harmonics in the distribution systems. Research is being carried out to integrate active filtering that is the combination of series and shunt with specific interface such that a common power quality (PQ) platform could be achieved. For generalized solution, a unified power quality conditioner could be the most comprehensive PQ protecting device for sensitive non-linear loads, which require quality input supply. Also, load current harmonic isolation needs to be ensured for maintaining the quality of the supply current. The paper describes a review for UPQC, for enhancing PQ of sensitive non-linear loads.Power quality measures can be applied both at the user end and also at the utility level. The work in identifies some important measures that can be applied at the utility level without much system upset (or design changes). This paper has presented models of custom power equipment, namely D-STATCOM, DVR, and applied them to mitigate voltage dip which is very prominent as per utilities are concerned.

The paper highlights new areas of interests and future trends in PQ issues and concerns. Factors such as the increase of distributed generation, demand of energy efficiency, and proliferation of power electronics technologies have presented challenges and opportunities for the PQ studies. A distributed Power Quality monitoring system that allows analyzing all steady and non-steady state phenomena related to Power Quality has been presented in. Some on-field measurements performed on two different low voltage sub-networks have been reported for mains Power Quality phenomena. The world today is moving toward smart distribution grids and dispersed generation. One of the most important issues in future grids are the power quality and supply reliability

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load, Crest factor, Electromagnetic compatibility, Dropout, Fault, Flicker, Ground, Raw power, Clean ground, Ground loops, Voltage fluctuations, Transient, Dirty power, Momentary interruption, Over voltage, Under voltage, Nonlinear load, THD, Triplens, Voltage dip, Voltage regulation, Blink, Oscillatory transient etc [4,6,14,18,19]. The issue of electric power quality is gaining importance because of several reasons:
The society is becoming increasingly dependent on the electrical supply. A small power outage has a great economical impact on the industrial consumers. A longer interruption harms practically all operations of a modern society.

• New equipments are more sensitive to power quality variations.

• The advent of new power electronic equipment, such as variable speed drives and switched mode power supplies, has brought new disturbances into the supply system.

FREQUENCY VARIATIONS

Frequency variations that are large enough to cause problems are most often encountered in small isolated networks, due to faulty or maladjusted governors. Other causes are serious overloads on a network, or governor failures, though on an interconnected network, a single governor failure will not cause widespread disturbances of this nature

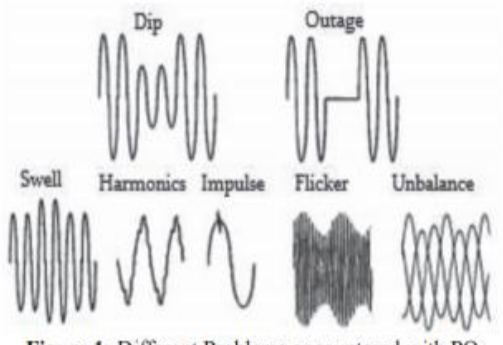

Figure 1: Different Problems encountered with PQ

Causes of Power Quality Problems

In today's fast-paced environments, a huge amount of money is spent on sate of the art computer controlled equipment and systems. These systems are often installed in "unfriendly" electrical environments, which cause owners, industrial companies and investors a great deal of frustration and disappointment and in many cases, result in a great loss of time and money, and that lead us to ask a valuable question "What is the problem?" The answer to this question could have one or more of the following points:

Computer malfunctions
– Interrupted manufacturing sequences
– Catastrophic failures – Erratic equipment behaviour
– High electrical maintenance cost.
IEEE 519 Standard for Curent Harmonics
• General Distribution Systems [120V- 69 kV] Below current distortion limits are for odd harmonics. Even harmonics are limited to 25% of the odd harmonic limits [1,3,5]. For all power generation equipment, distortion limits are those with ISC/IL

The current harmonic distortion limits apply to limits of harmonics that loads should draw from the utility at the PCC. Note that the harmonic limits differ based on the ISC/IL rating, where ISC is the maximum shortcircuit current at the PCC, and I is the maximum demand load current at the PCC.

EFFECT OF POWER QUALITY PROBLEMS IN EQUIPMENTS & METHODS FOR ITS CORRECTION

The first sign of a power-quality problem is a distortion in the voltage waveformof the power source from a sine wave, or in the amplitude from an established reference level, or a complete interruption. The disturbance can be caused by harmonics in the current or by events in the main voltage supply system. The disturbance can go for a fraction of a cycle (milliseconds) to great durations (seconds to hours) in the voltage supplied by the source

The aim for method for correction is to make the power source meet an international standard. Powerquality

problems can basically start at four levels of the system that delivers electric power, first one, includes Power plants and the entire area transmission system. The second one are Transmission lines, major substations where as third one includes distribution substations, primary, and secondary power lines, and distribution transformers and last and fourth one includes service equipment and building wiring. In addition, the problems can be caused by the equipment supplied with electric power—for example, power-electronic converters. Redundancy at all levels of the electric-power system reduces the incidence and duration of line-voltage disturbances [9, 11, 12, 14, 16, 17, 22, 23]

Aircraft Electrical System

Aircraft requires reliable, redundant, and uninterruptible electrical power systems to supply flight critical fly-by-wire loads and mission critical loads. But switched loads and other transient conditions effect the electrical bus power quality. One problem is the presence of rectifiers supplying such loads as electrically powered flight control actuators, other speed controlled motor loads, or avionics loads, see Figure 1. The other problem is a load which changes load level most often. An electrical flight control actuator supplied with dc would cause transient loading on the dc bus, and affect power quality. A fuel transfer pump, electrically driven compressor, or other non-continuous ac load would cause applied-load transients on the ac bus.

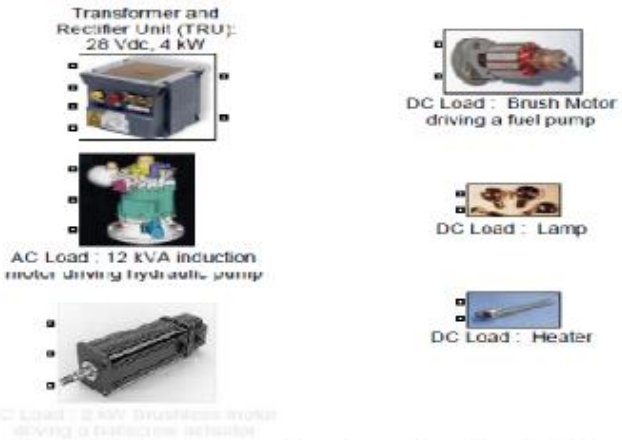

Figure 1 Different type of loads used in Aircraft [37]

Another problem may occur when a source fails and the loads are switched from one bus to another. This type of transient occurs infrequently and would produce an actual power interruption. Many connected devices such as induction motors, could through such a power interruption, even if two buses were not synchronized [31]

CONCLUSION

An extensive review of work done power quality issues has been presented to provide a clear perspective on various aspects of the power quality to the researchers and engineers working in this field. To overcome the negative impact of poor power quality on equipment and businesses, suitable power quality equipment can be invested. Identifying the right solution remains the first step

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