Int. J. of Sustainable Water and Environmental Systems
Volume 3, No. 1 (2011) 45-52

Power Quality Event Recognition and Classification Using a Wavelet-Based Neural Network

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Abstract

In the late 20th century has been observed an enormous increase in electronic equipment. These new generations of electronic equipment became progressively sensitive to power quality disturbances .Therefore, monitoring and detection of power quality disturbances has become a significant issue. The main purpose of this paper is to find, present, test and evaluate a new technique that is being used for power quality monitoring and classification. This is a "Wavelet based Probabilistic Neural-Network (PNN) technique". The wavelet based PNN method was implemented in the Matlab platform and tested with data that have been acquired from the Public Power Corporation (PPC) Power Supply Station in Katsampas at Heraclion, Crete Island, Greece. Those data were acquired via the Series 5500 Dual - Node, a Power Quality Monitoring Device that was installed at the capacitors' 13.8kV busbar of the facility. The results of the algorithm used were evaluated, compared, and some final conclusions came up, regarding their effectiveness and their flexibility.

Keywords: Power Quality, power monitoring and efficiency, power disturbances, PNN, wavelets transform

1. Introduction

The aim of the electric power system is to generate electrical energy and to deliver this energy to the end-user equipment at an acceptable voltage. The constraint that was traditionally mentioned is that the technical aim should be achieved for reasonable costs. The optimal level of investment was to be obtained by means of a trade-off between reliability and costs. A recurring argument with industrial customers concerned the definition of reliability: i) should it include only long interruptions or ii) short interruptions and even voltage dips as well. The term power quality came in use referring to the other characteristics of the supply voltage (i.e. other than long interruptions). But, immediately, the first confusion started as utilities included the disturbances generated by the customers in the term 'power quality'.

Power system can no longer be seen as one entity but as an electricity network with customers. With an ideal network each customer should perceive the electricity supply as an ideal voltage source with zero impedance, which means that whatever the current is, the voltage should be constant. As always, reality is not ideal. Power quality is all about this deviation between reality and ideal.

The term power quality refers to a wide variety of electromagnetic phenomena that characterize the voltage and the current at a given time and at a given location on the power system.

In this paper we use the electromagnetic compatibility approach [5] to describing power quality phenomena and a similar to IEC classification of electromagnetic phenomena [6],[7] that give us the categories and the typical characteristics of these phenomena that shown in Table 1.

2. Electromagnetic Phenomena

Unfortunately due to technical difficulties, regarding the time and duration of the measurement instrument, the only electromagnetic phenomena that were recorded and studied in this paper are sags and swells.

2.1. Sags (dips)

The term sag has been used in the power quality community for many years to describe a specific type of power quality disturbance: a short duration voltage decrease. Clearly, the notion is directly borrowed from the literal definition of the word sag. The IEC definition for this phenomenon is dip. The two terms are considered interchangeable, with sag being preferred in the US power quality community.

Terminology used to describe the magnitude of a voltage sag is often confusing. The recommended usage is "a sag to 20%" which means that the line voltage is reduced down to 20% of the normal value, not reduced by 20%. Using the preposition "of" (as in "a sag of 20%" or implied in "a 20% sag") is deprecated. This preference is consistent with IEC practice, and with most disturbance analyzers that also report remaining voltage. Just as an unspecified voltage designation is accepted to mean line-to-line potential, so an unspecified sag magnitude will refer to the remaining voltage. Where possible, the nominal or base voltage and the remaining voltage should be specified. Voltage sags are usually associated with system faults but can also be caused by switching of heavy loads or starting of large motors. An induction motor will draw six to ten times its full load current during starting. This lagging current causes a voltage drop across the impedance of the system. If the current magnitude is large relative to the system available fault current, the resulting voltage sag can be significant. Sag durations are subdivided into three categories: Instantaneous, Momentary and Temporary.

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DOI: 10.5383/swes.03.01.008