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Phasor Estimation and Modelling Techniques of PMU- A Review

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Abstract

The values of voltage / current signal at various places in a power network are measured by Phasor Measurement Unit(PMU). The PMU's work on the phasor values of the data collected using Phasor estimation technique. This mechanism is essential for analysis and interpretation of collected data in a correct manner. Therefore, a Phasor estimation process has a lot of importance in design of control mechanism and various protection systems to be implemented.

Numbers of PMUs are being installed across the world for different applications such as post fault analysis, state estimation and protection of power system. Since the cost of PMUs is very high, they are placed optimally in the power system such that complete power system is observable. In this study, PMU along with techniques used for phasor measurement has been reviewed. Some of the used phasor estimation techniques viz. zero crossing, DFT and SDFT are described to compute magnitude and phase value of input signal.

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1. Introduction

In a modern day power system, to gain more reliability Wide Area Measurement Systems (WAMS) are being built

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around the world to have continuous monitoring of the system where Synchronphasors are the vital part. Phasor Measurement Units (PMU) are widely used in the day to day operation of contemporary power systems. PMU gives phasor values of voltage and current which are GPS time stamped. Grid monitoring in real-time is essential for ensuring stable operation of the grid. PMU help in making the grid completely observable, i.e., the voltages, currents and power flow at each and every bus are available for complete analysis of the power system. PMU provides monitoring of a large area grid network and thereby blackout conditions can be avoided. Hence, it is considered as key element in the Smart Grid(SG) system. Power system monitoring, analysis, protection and control is done using PMU.

The main objective of this paper is to review the work already attempted by various research personnel and provide a consolidated information for Phasor Measurement Units (PMU), phasor estimation techniques and the technology involved for its applications in accordance with IEEE C37.118 Standard..

2. Literature Survey

Presently, countries around the world are fully dependent on electric power supplies for their routine activities from a power system which is considered as very unreliable till date. The motivation to make the power system Smarter and reliable has attracted many researchers to have further development in this area. PMU is one of the key elements to make the Grid smarter. The data gathered by PMU are time stamped i.e. all data gathered from different PMU's are time synchronized which helps them to be used in checking the status of a large interconnected power system. Therefore, PMU can measure voltage and current at any instant at any location in a power transmission system. Time stamping of the PMU data is done by Global positioning System (GPS) [2,3]. This literature survey is conducted on different available work related to this subject.

Phadke A.G. et. al.[1] in 1983 came up with concept for phase estimation by using Discrete Fourier Transformation(DFT). He mentioned that how the conception of PMU came from Symmetrical Component Distance Relay(SCDR) technology.

S.K. Soonee et. al.[2] member of PGCIL, in 2008 explained the need of Phase angle measurement and synchronphasor technology in Indian electric Power systems for monitoring of a wide area grid. They reiterated that the difference of phase angle between the nodes can be a measure of static stress or instability across the grid. With respect to a predetermined threshold limit, Phase angle can be measured. The awareness of operations in grid system, in Indian context, improved by the approach suggested by the authors.

In 2011, Bindeshwar Singh et. al[3] in his paper explained about the relevance of PMU in the grid. The review work covered the R&D work in the field of application of PMU in power system control, monitoring and protection.

Rohini Pradip Haridas[4]in 2003 explained about the difference in technology of SCADA and PMU. The paper describes about various continuing research, progress and implementation of PMU. The basic difference between SCADA and PMU measurement was well explained.

Phadke A.G et. al. [5](2006) provided the history of PMU and mentioned about their commercial availability as early as in early 1990's. By that time, their use in protection and control was theoretically established. However, their use was limited to digital system disturbance recorders (DSDRs).

Zhenyu Huang et. al., Phadke et.al.[6,7] (2008) had mentioned that after 1996 and 2003 blackouts in US, PMU technology was given high importance and they were recommended for safeguarding and better control in the power system. As a result North American Synchronphasor Project (NASPI) was started. Thus history was created when NASPI could do the wide-area monitoring on real-time basis.

Power System Operation Corporation Limited (POSOCO)[8] in December,2013 outlined the Initiatives of synchronphasors in India. An overview of synchronphasor pilot projects installed till December 2013, were described. The status of each project was discussed. In all, 60 PMUs were installed at pan India level which included three numbers by independent power producers (IPPs). 14 PMU pilot projects were implemented in Northern India.

India Smart Grid Forum(ISGF) is an initiative by Ministry of Power, Government of India for progress and development in Smart Grid technologies with Indian perspective. International Conference and Exhibition on Smart Grids and Smart Cities is organized as a part of India Smart Grid Week (ISGW)[9] every year. The main objective of ISGW is to present India as a significant market for smart grid and smart city technologies, goods and services at

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