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Soft Phasor Measurement Unit

Anisha N P.^{a*}, Prasanna Vadana.D.^a, Suyampulingam A.^a^a*Department of Electrical and Electronics Engineering, Amrita Vishwa Vidyapeetham, Coimbatore-641112, India*

Abstract

Smart grid is a modernized electrical supply network in which information is communicated bi directionally using digital communication technology. Monitoring, analyzing, controlling and communication occurs within the supply chain thus improving efficiency, reducing energy consumption etc. A Phasor Measurement Unit (PMU) or a synchrophasor measures electrical waves on grid. PMUs are used in the transmission side of the grid. These are installed at various places on the grid and are time synchronized using Global Positioning System (GPS). Thus synchronised real time measurements are obtained from multiple measurement points on the grid. PMUs provide power system automation in the grid. A network of PMUs called Wide Area Measurement System (WAMS) can be used for large scale monitoring of grid. Black outs and load shedding can thus be avoided. Creating software for PMU can help reduce the large cost and hardware complexity. PMUs can synchronously measure magnitude of voltage and current, phase angle of voltage and current, frequency, rate of change of frequency and monitors the status of PMU. A PMU is created in MATLAB which can be used as simulation software for PMU. Sine wave representing the signal is fed into the software whose parameters can be measured using appropriate method.

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1. Introduction

Blackouts and load shedding are major problems faced in the current world. These can be avoided by properly monitoring and controlling the existing power grid. Proper monitoring and controlling of power grid can be done using a PMU. The parameters measured using PMUs can be transmitted throughout the network [1]. Smart grid is a modernized power grid that uses digital processing and communication technology to detect and react to local changes in the network thus providing stable and quality power at affordable rates [1]. Thus fault detection is improved and allows self healing using state estimation. The information from the grid must be obtained in a synchronized manner in order to ensure uniform distribution of power over a large area. PMUs are installed

* Corresponding author. Tel.: +91-9656028819.

E-mail address: anishanp1991@gmail.com

throughout the transmission side of the grid and these monitor the state of the electrical network. These networks of PMUs are called WAMS. These PMUs are time synchronized using GPS. PMUs provide phasor parameters of the signal. It monitors the status of the switches, status of the circuit breakers, equipment performance, congestion, outages and demand response events. There are various methods to determine the phasor parameters.

This paper focuses on creating an environment to determine phasor parameter using different estimation algorithms. The user has the freedom to choose the appropriate algorithm applicable for his application. Different phasor parameter estimation techniques are used. These are written as MATLAB M files. Simulink blocks are used to create the PMU in software. Matlab function block is used to obtain phasor parameters. Phasor parameters are obtained using appropriate techniques by adding Matlab m files to the model. User can easily select the best estimation technique to obtain phasor parameters.

This paper discusses about the Phasor Measurement Unit in smart grid. The second section discusses about PMU and its functionalities. Phasor estimation techniques are discussed in third section. Fourth section discusses about the soft PMU and then finally the conclusion

2. Phasor Measurement Unit

Since the invention of PMU in 1988 by Dr. Arun G. Phadke and Dr. James S. Thorp the technique of phasor calculation evolved into the calculation of real time phasor measurements that are synchronized to an absolute time reference provided by GPS [2]. Supervisory Control And Data Acquisition (SCADA) was used in earlier stages. These had a few drawbacks like the measurements were not time synchronized, they provide only magnitude and phase angle measurement of the signal are not obtained [3], observability is not dynamic providing one sample for 2-4 seconds, provides only local monitoring and control. These drawbacks are overcome with the invention of PMU. PMUs provide time synchronized phasor measurements, both magnitude and phase angle measurement. The observability is dynamic with an increased resolution of upto 10 – 60 samples per second. They provide wide area monitoring and control. Monitoring of grid can be done by understanding sequence of events from synchronized data. In the WAMS network the PMUs are installed at various places and are time synchronized with the help of a GPS. A PMU has various functionalities. They provide the real time phasor parameters, magnitude and phase angle, of the voltage and current signals in the grid. Frequency can also be estimated using PMU. They check the status of switches, circuit breakers etc. Performances of various equipments in the grid are also monitored with help of PMU. Congestion during communication of information is avoided [4] and also the black out and load shedding are avoided by continuous monitoring of the grid. Fig. 1. shows a basic block diagram of a PMU [5].

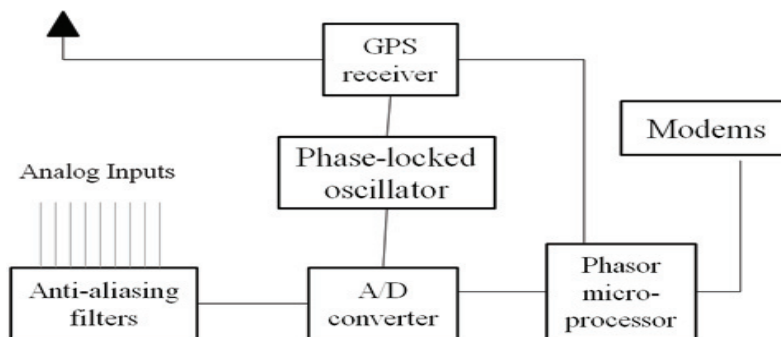


Fig. 1. Block diagram of PMU

Phasor parameters can be estimated in different ways. Few of these are DFT based algorithm, sliding DFT based algorithm, recursive technique etc. A voltage or current signal is considered by considering a sine wave with its harmonics. These are sampled at sampling frequency. The DFT is obtained and appropriate method can be used to estimate the phasor parameters.

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