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PMU'S ADVANCE CONTROL FOR POWER SYSTEM WIDE AREA MONITORING BY USING MATLAB

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ABSTRACT

The power system measurement units on a global basis is moving form lab to the utility. Phase Measurement Unit (PMU) has evolved as a device embedded with the satellite technology that could provide with monitoring, protection, analysis and control. This paper focuses on Wide-area monitoring, control require and protection of specific node information to global locations that are time synchronized. The results are simulated in MATLAB using the model of wide area in SIMULINK.

Keywords: Power system control, power system dynamic stability,power system monitoring, power system protection, predictivecontrol, system protection scheme.

I. INTRODUCTION

A power grid is a complex power distribution infrastructure composed of thousands of miles of transmission lines connecting power generators to power consumers. Keeping such a complex system stable and resilient to failure is not a trivial task. Small fluctuations in one part of the grid can cascade into system wide failures if left unchecked. It is therefore crucial to be aware of things that are happening within the grid so that proper reactionary measures can be taken to insure stability and uninterrupted service. The growing availability of synchronous phasor measurement units (PMUs) and their deployment on power grids is making available a wealth of new real-time data about the state of the grid. PMU data contains large amount of information than is typically measured in existing SCADA systems. PMU measurements are synchronized and time-stamped using a global clock (GPS)[10]. A PMU's measurements, made 20 to 60 times per second, allow derivation of the bus voltage, phase, current and frequency where it is attached[4].

Existing mechanisms for using these data are mainly targeted at collecting them in archival central repositories for use in after-the-fact analysis of system response to normal and abnormal events. Since the nature of the collection mechanisms is centralized they have, limited ability to support the use of these data for real-time applications. For example, if these data has to be employed for the purpose of making control decisions that involve making operational changes at various points throughout the grid, then delay is incurred to first transfer the sampled data to the centralized repository, and then to retransmit the control message to the destination in the grid where it is to be implemented[6].

II. METHODOLOGY

Phasor Measurement Unit

At present, phasor measurement units (PMUs) are the most accurate and advanced synchronized phasor measurement equipment. Figure 1.1 gives a functional block diagram of a typical PMU. The GPS receiver provides the 1 pulse-per-second (pps) signal, and a time tag consisting of the year, day, hour, minute, and second. The l-pps signal is divided by a phase-locked oscillator into the number of pulses per second required for the sampling of the analogue signals. The analogue signals are derived from three-phase voltage and current transformers with appropriate anti-aliasing filtering. The microprocessor calculates the positive sequence voltage and current phasors, and determines the timing message from the GPS, along with the sample number at the beginning of a window [10]

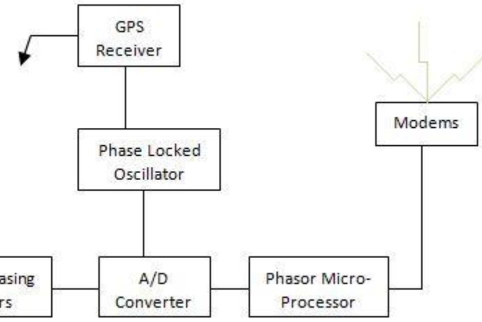

Figure 1.1: Phasor Measurement Diagram Unit Block

If enough PMUs can be installed across a large power transmission network, the real time system operating condition can be directly measured by PMUs. In addition, as the PMUs have a high data reporting rate, the system dynamics can be captured when the system is subjected to disturbances.

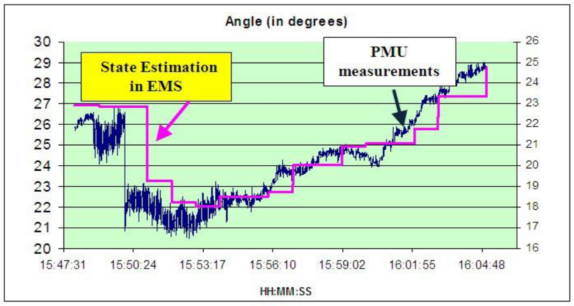

Figure 1.2: State estimation v.s. PMU measurements [10]

Figure 1.2 compares the voltage angle difference between two substations obtained using PMU measurements and traditional state estimation. This comparison demonstrates clearly that a real time monitoring system made up of PMUs will provide much more precise and dynamic system operation information than the traditional state estimation.

Synchrophasor Standard

A WAMPAC system requires a consistent performance from all of the PMUs installed, to meet its application requirements. To ensure a uniform performance among the PMUs from different manufacturers, establishing a standard is an essential step for initializing a WAMPAC system. The IEEE PES Power System Relaying Committee has published the IEEE C37.118-2005 standard to replace the original IEEE 1344 standard for synchrophasor measurements. It addresses the definition of a synchronized phasor, time synchronization, application of time tags, a method for verifying measurement compliance with the standard, and message formats for communication. However, the Standard has not addressed the dynamic performance requirement of a PMU. Also, the Standard does not specify the method with which conformance tests should be conducted[9].

PMU Communication Protocol

The synchrophasor standard C37.118 [8] defines the concept of “frames” for transmitting data from a PMU to a PDC. This standard does not enforce any restriction on the communication media itself.These are designed with particular structure and data type associated with them. Data frame, Configuration frame, and Command frame are binary type and Header frame is of ASCII type. The most frequently transmitted message is the Data frame based on the PMU sample rate, and the typical size ranges in few hundreds of bytes. The variable size is the number of phasors in the Data frame, and analog and digital signals transmitted, depending on the PMU capability. Like for example, if a serial communication is chosen to transmit the PMU data, the capability of data transfer depends on the baud rate of the communication port. The following table represents the typical data transfer capabilities, with the assumption that the PMU supports up to 12 phasor channels[8][9].

Table-1 Estimated number of phasor channels that can be transmitted at various baud rates and PMU reporting rates over serial port

Baud Rate (bps)	Reporting Rate (frames/second)							
	10	**12**	**15**	**20**	**25**	**30**	**50**	**60**
9600	12	12*	10*	6*	4*	2	0	0
19200	12	12	12	12	12	10	4*	2
38400	12	12	12	12	12	12	12	10
56700	12	12	12	12	12	12	12	12
115200	12	12	12	12	12	12	12	12

*Calculated required bandwidth is very close to the actual baud rate, actual number of phasors may be less than the estimate. The above values were calculated for the case - 1 start bit, 1 stop bit, 8 data bits and no parity bit – total 10 bits to transmit for each byte[15].

III. RESULT

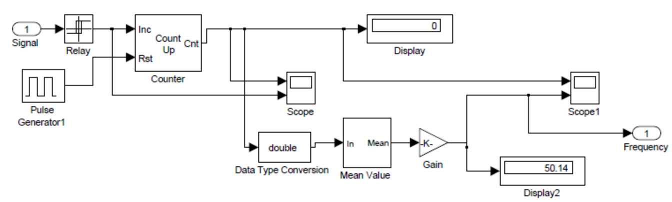

Figure 1.3: Frequency Measurement Unit SIMULINK Model

The above figure showing the frequency measurement unit of current and voltage, it uses a relay to find how many times a signal crosses zero level per second. A pulse reset the counter every second. The output is mean over the time.

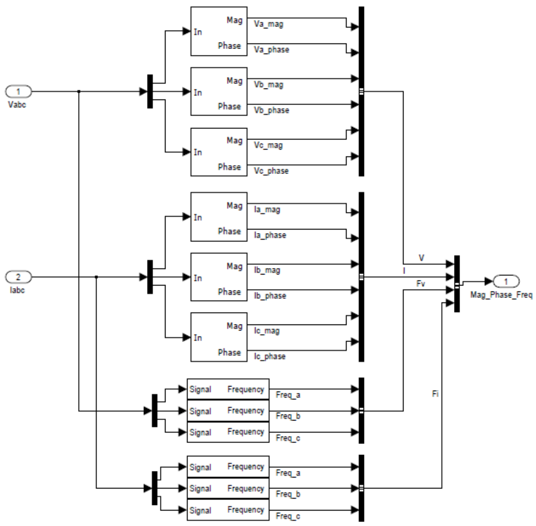

Figure 1.4: Phasor Measurement Unit MATLAB Model

Figure above showing the phasor measurement unit. It directly measure the phase, magnitude and frequency of input current and voltage.

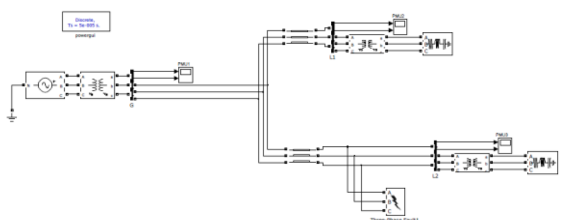

Figure 1.5: Wide Area SIMULINK Model

Figure showing the main model used for simulation comprises one source (left) connected to two different loads via distributed line. PMU is installed at each bus end.

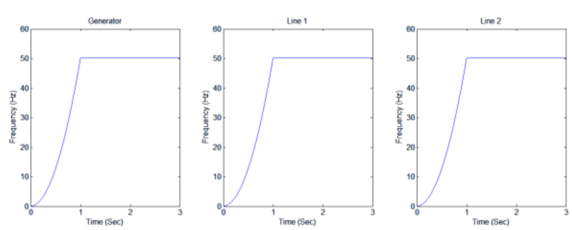

Figure 1.6: Frequency of Voltage

Figure above showing the frequency spectrum of voltage calculated by PMU at each bus end.

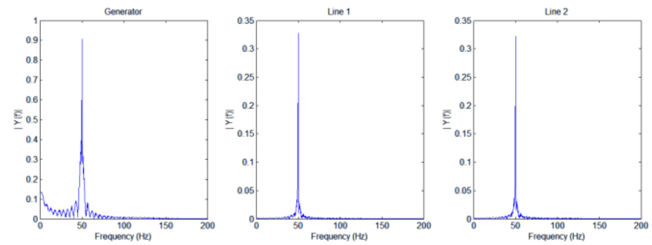

Figure 1.7: Frequency Spectrum of Current

Figure above showing the frequency spectrum of current calculated by PMU at each bus end.

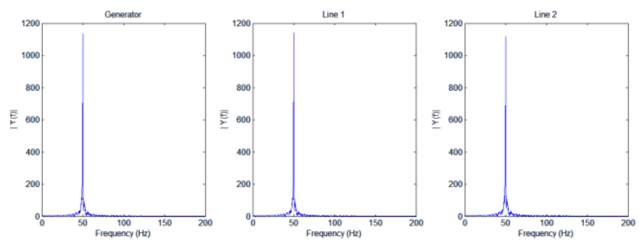

Figure 1.8: Frequency Spectrum of Voltage

Figure above showing the frequency spectrum of voltage calculated by PMU at each bus end.

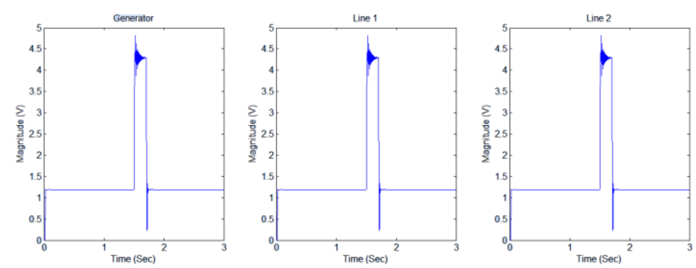

Figure 1.9: Line Current

Figure above showing the frequency spectrum of line current calculated by PMU at each bus end in fault case.

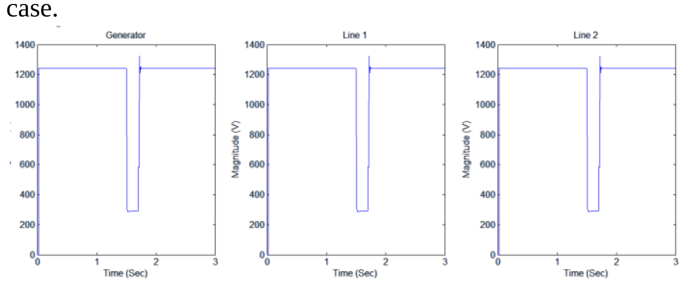

Figure 1.10: Line Voltage

Figure above showing the frequency spectrum of line voltage calculated by PMU at each bus end in fault case.

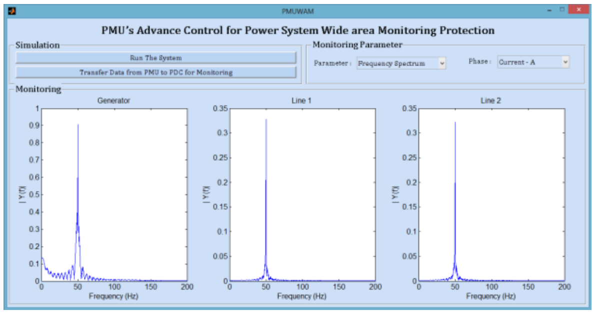

Figure1.11 : Main GUI

Figure above showing the main GUI of simulation paper. In panel simulation the button "Run The System" opens the wide area model and simulate it. PMU measure the data and pass it to PDC for analysis.

By selecting specified quantity and phase from "monitoring parameter" panel we can see the measurements on every bus in monitoring panel.

IV. CONCLUSION & SCOPE OF FURTHER WORK

Conclusion

The paper provides the introduction of the WAMPAC system followed by the brief knowledge about it. The further parts are aligned to present the Synchronized Measurement Techniques that are relevant to the problems of WAMPAC. We studied the effects of monitoring parameters on a global scale and studied the previous works in this segment. We proposed the MATLAB/SIMULINK model of Phasor Measurement Unit to mitigate the problems and application of same in power resources. The references used against these are mentioned at the end of this work.

Scope of further work

The PMU can be optimized for a particular industry needs. The increase in power demand will create a chaos with limited energy resources. Hence the applications of monitoring, control and advanced power distribution will be handful in efficient use of power resources. The PMU could be assist with data concentrators, synchrophasor standards and communication protocols for its premium installation.

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