SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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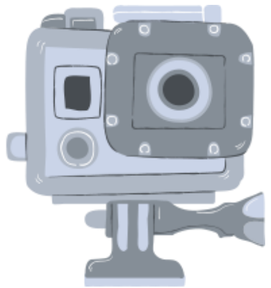
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

UNIT 2

SMART GRID TECHNOLOGIES –
Phase Measurement Unit (PMU)

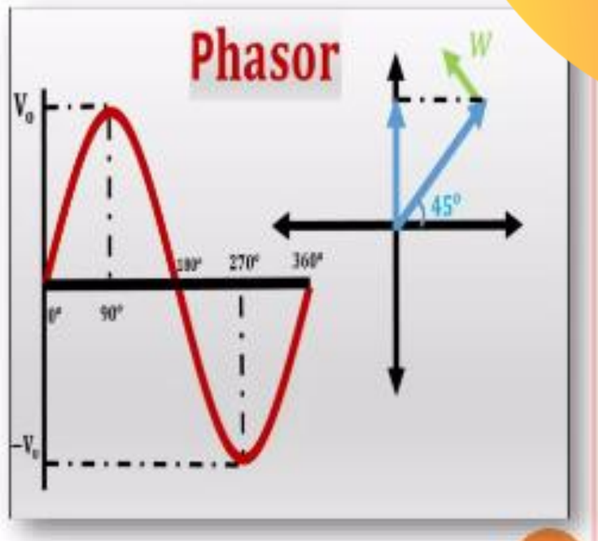
19EEE308 – SMART GRIDS
III year / VI Semester



- **A phasor measurement unit (PMU) is a device used to estimate the magnitude and phase angle of an electrical phasor quantity (such as voltage or current) in the electric grid using a common time source for synchronization.**

WHAT IS PHASOR?

- **Phasor is a quantity with magnitude and phase (with respect to a reference)** that is used to represent a sinusoidal signal.
- Here the **phase or phase angle is the distance between the signal's sinusoidal peak and a specified reference and is expressed using an angular measure.**
- Here, the **reference is a fixed point in time (such as time = 0).**
- The phasor magnitude is related to the **amplitude of the sinusoidal signal.**



Soc : Siemens Global

Phasor Measurement Unit (PMU)

Time synchronization is usually provided by GPS and allows synchronized real-time measurements of multiple remote points on the grid.

PMUs are capable of capturing samples from a waveform in quick succession and reconstructing the phasor quantity, made up of an angle measurement and a magnitude measurement.

The resulting measurement is known as a synchrophasor. These time synchronized measurements are important because if the grid's supply and demand are not perfectly matched, frequency imbalances can cause stress on the grid, which is a potential cause for power outages.

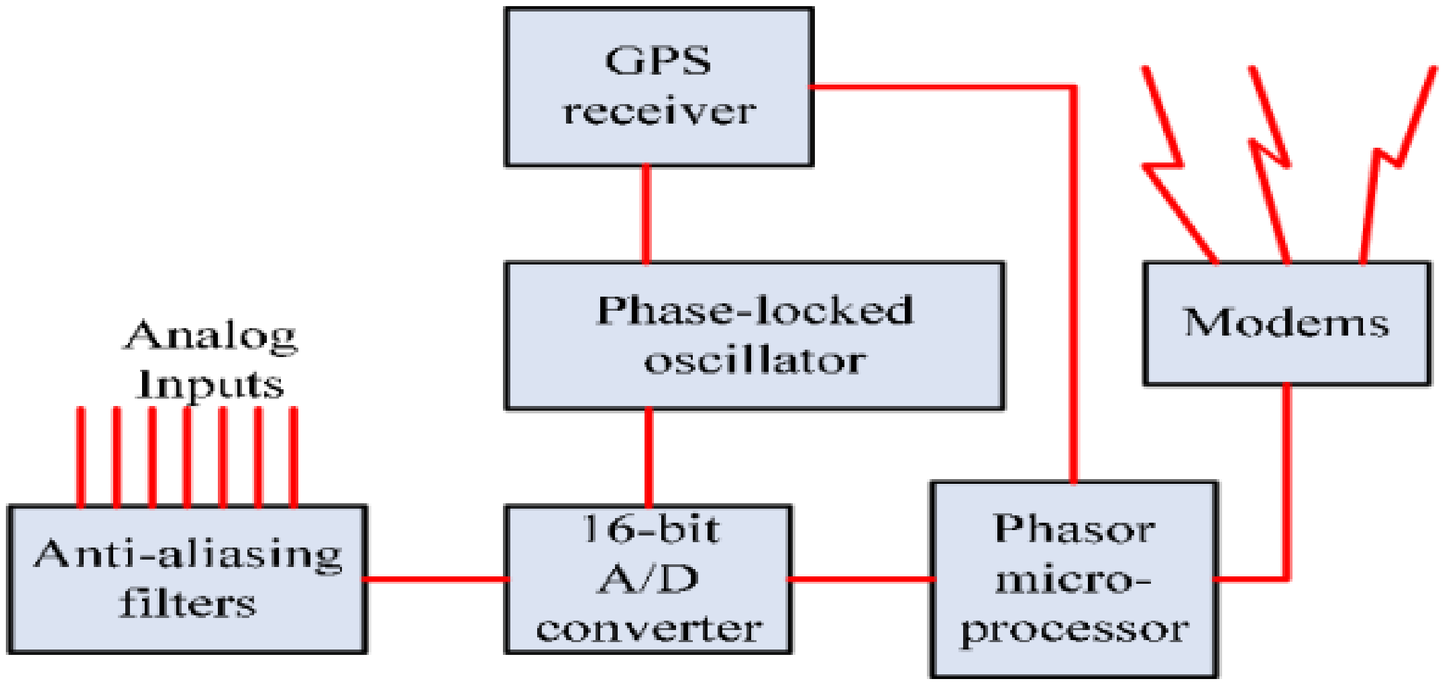
PMUs can also be used to measure the frequency in the power grid.

A typical commercial PMU can report measurements with very high temporal resolution in the order of 30-60 measurements per second. This helps engineers in analyzing dynamic events in the grid which is not possible with traditional SCADA measurements that generate one measurement every 2 or 4 seconds.

Therefore, PMUs equip utilities with enhanced monitoring and control capabilities and are considered to be one of the most important measuring devices in the future of power systems.

A PMU can be a dedicated device, or the PMU function can be incorporated into a protective relay or other device.

Phasor Measurement Unit (PMU) - Blocks



Phasor Measurement Unit (PMU) - Components

1. Analog Inputs 2. GPS receiver 3. Phase locked oscillator 4. A/D converter 5. Anti-aliasing filters 6. Phasor micro-processor 7. Modem

Analog Inputs

Current and potential transformers are employed at substation for measurement of voltage and current.

The analog inputs to the PMU are the voltages and currents obtained from the secondary winding of potential and current transformers.

3.10.2. Anti-aliasing filters

Anti-aliasing filter is an analog low pass filter which is used to filter out those components from the actual signal whose frequencies are greater than or equal to half of nyquist rate to get the sampled waveform.

Nyquist rate is equal to twice the highest frequency component of input analog signal.

If anti aliasing filters are not used, error will be introduced in the estimated phasor

3.10.5 Processor

The microprocessor calculates positive- sequence estimates of all the current and voltage signals using the DFT techniques.

Certain other estimates of interest are frequency and rate of change of frequency measured locally, and these also are included in the output of the PMU.

3.10.3 A/D Converter

Quantization of the input involves in ADC that introduces a small amount of error.

The output of ADC is a sequence of digital values that convert a continuous time and amplitude analog signal to a discrete time and discrete amplitude signal.

It is therefore required to define the rate at which new digital values are sampled from the analog signal.

The rate of new values at which digital values are sampled is called the sampling rate of the converter.

3.10.4 Global Positioning System

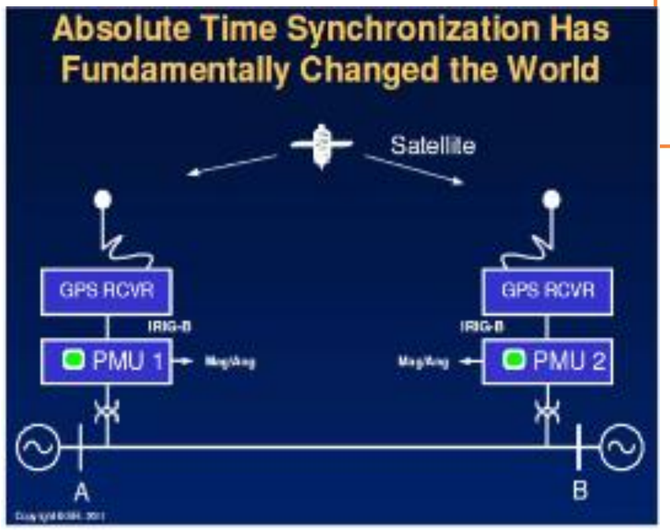
The synchronized time is given by GPS uses the high accuracy clock from satellite technology.

Without GPS providing the synchronized time, it is hard to monitor whole grid at the same time.

The GPS satellites provide a very accurate time synchronization signal, available, via an antenna input, throughout the power system. This means that that voltage and current recordings from different substations can be directly displayed on the same time axis and in the same phasor diagram.

Synchro phasors and PMU Applications

- A synchrophasor is a phasor measurement with respect to an absolute time reference.
- With this measurement we can determine the absolute phase relationship between phase quantities at different locations on the power system.



APPLICATION OF PMU IN POWER SYSTEM

1. Adaptive relaying
2. Instability prediction
3. State estimation
4. Improved control
5. Fault recording
6. Disturbance recording
7. Transmission and generation modeling verification
8. Wide area Protection
9. Fault location

Summary

Activity

KEEP
LEARNING..

Thank u

SEE YOU IN NEXT CLASS