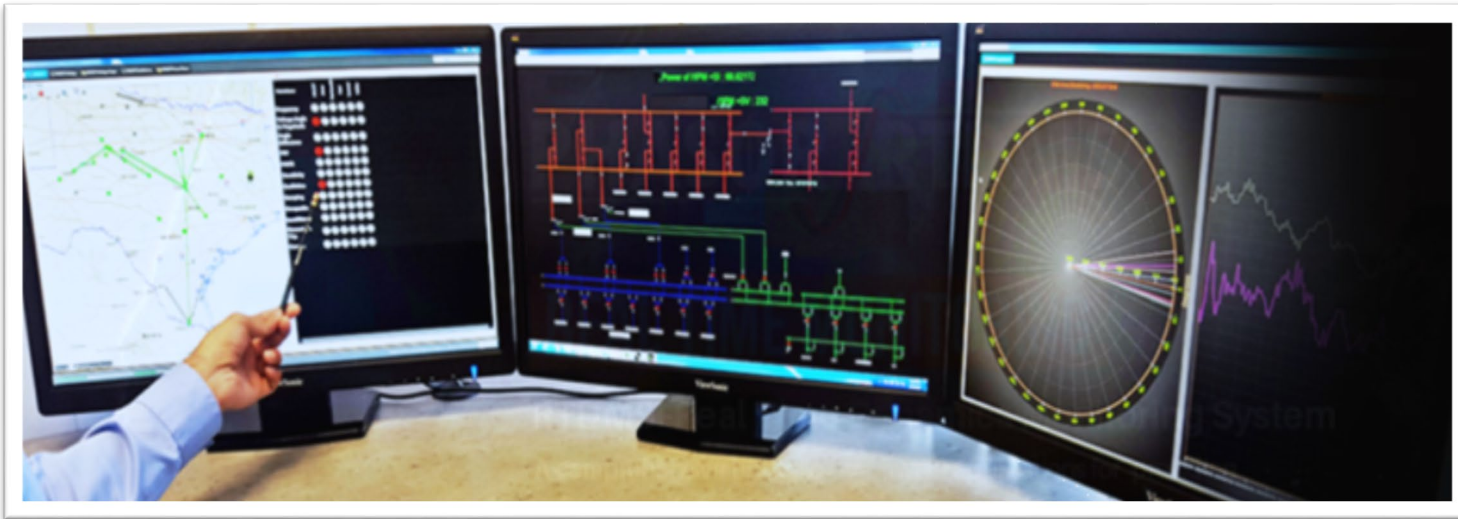

Synchrophasor System Installation Training

Date: June 27 - 28, 2019

Time: 8:30 AM – 4:30 PM

Purpose

Synchrophasor Technology is being widely deployed and used by utilities and ISOs. In order to be effective and reliable, PMUs, PDCs, and other equipment must be properly installed and configured. The operation needs to be tested and validated.

Synchrophasors are the next generation technology being used for:

- Wide Area Situational Awareness
- Oscillation Monitoring
- Event Root Cause Diagnostics and Analytics
- Model Validation
- Improved State Estimation
- Compliance with NERC Guidelines and Standards

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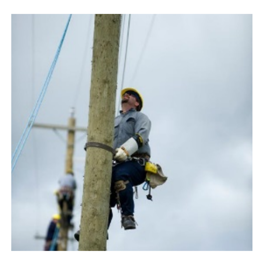
Course Description

Synchrophasor system typically consists of PMU's, PTs, CTs, GPS clock for time synchronized measurements, and PDCs for phasor data concentration. This training will cover the entire process of synchrophasor system installation, network connectivity and validation. It will first acquaint the user with the basic synchrophasor measurement principles. Then it will provide an overview of the system elements and the overall operation. It will cover PMU installation requirements, installation process, calibration and the validation procedure. Communication requirements and options and testing overview will follow. Finally the PDC installation and the configuration with the PMUs will be detailed. Overall system validation and some longer term monitoring recommendations will complete the course.



The Training will equip students to:

1. Understand the basic principles of synchrophasors and the values they represent

2. Understand the elements of and the overall operation of the synchrophasor system

3. Know what is needed to install PMUs, and how to validate the measurements.

4. Know what is needed for communications and PDC operation for bringing phasor data into the control center.

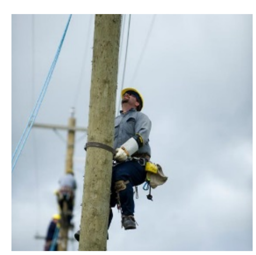
5. Know how to test and validate a PMU installation.

6. Set up long term operation monitoring for system maintenance.

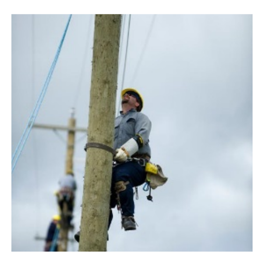
Agenda:

Day 1 – Synchrophasor & equipment basics

- Introduction to Synchrophasor Technology
  - Measurement basics
  - Synchrophasor measurement requirements
  - Impacts of measurement anomalies
  - Standards and guidelines
- Synchrophasor measurement systems
  - The measurement – the PMU
  - Communication system
  - Data gathering – the PDC
  - Applications using synchrophasors
- PMU installation
  - CTs & PTs selection & location
  - Relay vs DFR PMUs
  - Source of errors and Calibration of PMUs
  - Timing input
  - Voltage and current input
  - Data output
- The communication system
  - Requirements for synchrophasors
  - Impacts of different system types
  - Reviews and discussions



Day 2 - Real Time Operations Synchrophasor Cases



- Review previous day
    - PMU and signals
    - Communications
- PDC Installation
    - IT infrastructure
    - PDC operation
    - PDC input configuration
    - Data output
    - Data storage
- Phasor Applications
    - Data requirements
    - Communications
- System validation
    - PMU measurement validation
    - System measurement validation
- Operation monitoring and maintenance
    - Monitoring tools
    - Routine maintenance
    - Trouble maintenance
- Summary
    - Phasor measurement system
    - System components: PMU, PDC, Apps
    - Questions, discussion

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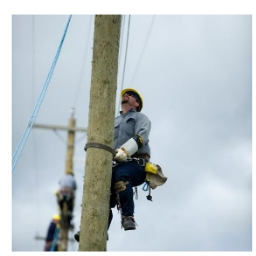
Advanced Courses (available upon request):

1. Oscillations – Oscillations arise from wind/solar resources, or defective control systems at generating stations.
2. Supplemental fault analysis – Often synchrophasors can be useful in analyzing faults and transients, especially when the sampling rates are high and individual A, B and C phases are monitored. Symmetrical components techniques may be used.
3. Unbalanced conditions – In special circumstances, phase imbalances in currents and voltages can cause undesirable effects, equipment damage and outages. Synchrophasors can be useful in understanding unbalance when individual A, B and C phases are monitored. Symmetrical components techniques may be used.
4. Verification of mathematical models for excitation systems – Invalid models can lead to power systems being operated outside their actual capabilities (e.g. In North America as per NERC Mod 26 standard).
5. Verification of mathematical models for governor systems (e.g. In North America as per NERC Mod 27 standard).
6. Verification of system dynamics mathematical models (In North America as per NERC Mod 33 standard).










Training Venue:

211 Commerce Drive

Winnipeg, Manitoba, Canada

Price:

$1,000 CAD - Per Participant

For group pricing and other inquiries, please contact:

elalonde@mhi.ca

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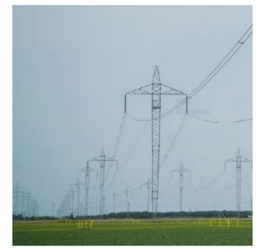


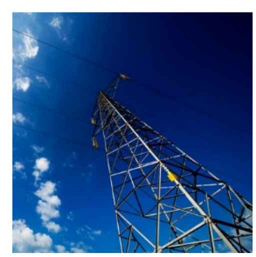
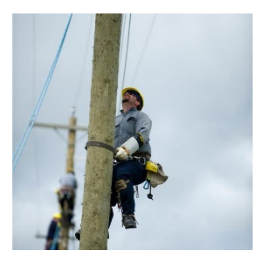


Instructors

Kenneth Martin is a principal engineer with the Electric Power Group (EPG). He has over 40 years experience in the electric utility industry, first at the Bonneville Power Administration (BPA) in communication, precise timing, instrumentation, and testing. He started working with synchrophasor measurement with the original PMUs in 1987 and conducted the first PMU tests.

He developed the phasor measurement system at BPA including building the first phasor data concentrator, and supported similar developments at many utilities. Mr. Martin chaired the development of the IEEE C37.118 Synchrophasor standard series from the 2005 original, through the 2014 amendment.

He was a lead for developing the IEC 61850, TR 90-5, and is the convener for the WG that developed the joint IEC-IEEE 60255-118-1 synchrophasor measurement standard. He also chairs WG P10 that is developing a new synchrophasor communication standard, IEEE P2664.

Mr. Martin is a Fellow of the IEEE and a registered Professional Engineer. He has authored or co-authored more than 60 technical papers and articles.

Krish Narendra, Ph.D, is the COO and technology lead of EPG. Krish joined EPG In September 2017, and brings over 27 years of experience in power system protection, monitoring, control and analysis.

Krish is an internationally recognized expert in power systems protection, monitoring and control. Krish's vision is to leverage his expertise and extend and expand EPG's industry leading portfolio for real time grid monitoring, visualization and analytics to address industry needs for asset health monitoring, digital solutions for power grid automation, and control.

Krish' s skills span power systems disturbance analysis, protection, synchro phasor technology (PMUs), micro grid protection, sub-harmonics in power systems, SSR (sub synchronous resonance), Ferro-resonance, HVDC controls, neural networks, artificial intelligence, fuzzy logic, and the application of IEC 61850 protocols for digital substation protection and control.

His expertise in innovative design; commercialization of protective relays and disturbance monitoring recorders; use of advanced digital signal processing technologies on embedded systems; and in Windows development environments makes him uniquely skilled to lead the convergence of real time grid security, analytics; asset health and automation.

Prior to joining EPG, Krish was the CTO and Board Member of ERLPhase Power Technologies Ltd. of Canada (2007 June – 2017 Aug, with ERLPhase)

Krish has published over 40 papers in various IEEE/IEC journals and conferences, and is an innovator holding several patents. He is a valued IEEE member for over 15 years and an active participant in the IEEE PRSC working groups, a member of the PRTT of NASPI, a member of the CIGRE C4-B5 working group and NERC SMS committee.