# Application of Phasor Measurement Units for Disturbance Recording

**Mark Adamiak**
**GE Multilin**

**Rich Hunt**
**GE Multilin**

## 1. Introduction

This paper looks at the specific application of Phasor Measurement Units (PMUs) for disturbance recording, with a special emphasis on wide area cross-triggering of recording PMUs during events. Disturbance recording, or long-term recording of phasor data, provides valuable information when analyzing wide area disturbance and power swings in the utility system. The newly approved NERC PRC-002 and PRC-018 standards require the installation of disturbance recording equipment at strategic points on the power system. The value of this equipment is only realized when discrete records are captured simultaneously at all points on the power system, to provide a complete snapshot of a specific event. Traditional recorders rely on local triggers to capture the data, however, an individual recorder may not trigger for a specific event, or may trigger in a different time frame than other recorders on the system and not capture valuable data. A practical challenge is adding the disturbance recording function to existing substations and relay systems.

Ongoing projects, such as the Eastern Interconnect Phasor Project, promote the installation of PMUs to provide real time measurement of the state of the power system, by streaming highly accurate synchrophasors at a high sampling rate. The PMUs are generally installed at the same strategic substations that require disturbance recording. In addition, today's digital relays (such as a line distance relay or current differential relay) are capable of synchronous phasor measurements. In addition to streaming data to a centralized database, PMUs may have the ability to record data at the PMU based on local trigger conditions. The record may include synchrophasor data as well as additional analog values and digital status. This recorded data meets the disturbance recording requirements set by NERC. The paper discusses the applicability of synchrophasor data to disturbance recording and the capabilities of PMUs to capture the appropriate data.

This paper also discusses practical aspects of using the IEEE Synchrophasor standard communications in conjunction with IEC61850 communications for wide area cross-triggering of PMUs. Also discussed are communications channels requirements and expected performance of cross-triggers. Other disturbance recording applications exist in the industrial domain, such as motor starting failure events on large motors. Synchronized measurements provide the ability to correlate the failure with other events in the industrial process. This paper will discuss industrial applications of PMUs.

## 2. Phasor Measurement Units and Recording

In the context of this paper, disturbance recording is defined as recording of phasor or RMS values of data over a long period of time. Disturbance recording is intended to show the response of the power system and equipment due to power system faults, such as an out-of-step condition, as opposed to power equipment faults, such as a short circuit. The time interval for these "long term" events can range from 1 second (in the case of a fault and high-speed reclose) to many minutes (in the case of system oscillations). The fast sample rates (30 to 60 phasors per second) of today's synchrophasor-based disturbance recording devices can be used to analyze both power system faults and the more traditional power equipment faults. The term Dynamic Swing Recorder (DSR) is also often used to describe a device that captures disturbance data over a long period of time. A more complete description of these terms is available in [1].

NERC has issued Standard PRC-002-1 entitled: Define Regional Disturbance Monitoring and Reporting Requirements. Section R3 specifically addresses criteria for dynamic disturbance recording, including location of recorders, electrical quantities to record, recording duration, and sampling rate. The NERC standard essentially states that DSRs are to be situated at key locations, are to record voltage, current, frequency, megawatts and megavars for monitored elements and are to record the RMS value of electrical quantities at a rate of at least 6 records per second.[2]

The Regional Reliability Councils (RCCs) of NERC are responsible for refining these standards for a specific operating region. By reviewing the standards as interpreted by some of the RCCs, it is possible to provide a good overview of disturbance monitoring requirements.

> **Location of DSRs**. DSRs are to be located at key substations for the power system. Key substations are generally defined as transmission substations with significant connected generation, large transmission substations (containing 7 or more transmission lines), transmission substations that interconnect to another regional authority or company, at major load centers (such as load centers greater than 2500 MW), or where undervoltage load shedding schemes are implemented.