"Clip-On to Automate" Technologies Revolutionize Substation Automation

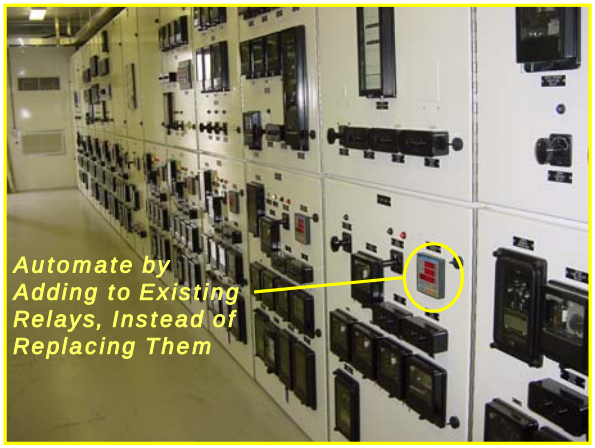
By Edwin R. Hoinowski

Most of the distribution substations in need of automation today are typically older subs constructed 20 or more years ago, with feeders equipped with analog type metering and electromechanical type protective relaying for system protection. Though the existing electromechanical relaying may be old, they still have many years of remaining service in them. They are also regarded by most to be highly reliable, and easily understood by the operators and maintenance people utilizing them. However, they lack the ability to remotely send back measurement and status data information regarding loading, protective relay operation and breaker status. With the ever increasing need for "Smart Grid" performance at these locations, a viable solution must be found to automate these substations in a fast, economical manner.

Traditional Automation Implementation is not a Viable Solution with Today's Economy

The traditional approach to automation, up to now, has been to simply redesign these old feeder panels, tear everything out, and replace the core devices with newer, microprocessor based relaying and other ancillary IED's. There is usually a lot of reluctance to do this due to:

- **High Investment Costs** – estimated costs to automate a single feeder with new equipment, layout and drawings, and installation labor has ranged from $60,000 to close to $100,000 per feeder at several major US utilities. These costs run even higher when old asbestos content panels need to be replaced.
- **Long Implementation Time** – the planning, drawing, bidding, construction and installation process could take up to several years.
- **Disruption of Operation** – down time for replacement panel installation could be months, and usually is not allowed during high demand peak seasons.



The total replacement approach is also being re-evaluated by many Power Utilities as questionable in its ability to provide them the proper measurements they require for a "Smart Grid" with the increasing and changing load distortion present on the power system today. The loading has changed, but the protective relaying measurement techniques have not – most use measurements based on fundamental values only (60Hz) and do not take true RMS measurement values and harmonics into account. Many substations now have measurable harmonic contents in both voltage and phase currents due to increasing non-linear loads. Major creators of these loads are arc furnaces, switching power supplies in computer equipment, variable speed drives, pulse rectifiers, fluorescent lighting ballasts, etc. Their effect on power equipment is thermally related – transformer capacity is decreased, current capacity of wires is decreased, operating time of fuses is decreased, etc. Most protective relays cannot report high neutral currents caused by harmonics. In many cases these relays have reported undervalues of phase currents in the magnitude of 30% or more, with direct proportion to their power readings, providing a false sense of operational security.

Electric utilities have never had a greater need for fast, accurate power data in their substations than in these days of severely limited energy reserves, high energy costs, frequently overloaded power

grids, sporadic blackouts, and ever increasing and changing load distortion. However, the economic times of today require new ways to accomplish automation in older substations in an economical, fast manner that extends the useful life of the existing relays and minimizes any disruption of operation.

The Economic Changes of Today Require a Total New Perspective on Automation

A recent survey of several large utilities in the US provided the following "wish list" of desired features for automating their existing electromechanical relay panels via an "Add-On Automation" type technology, if it was available:

- No major alteration or structural changes to existing panel (drilling, cutting, metal shavings, filings, etc.)
- No rewiring, splicing, rerouting or introduction of additional burden to the relaying CT secondary wiring
- Provide accurate, reliable operational measurements of power, load and demand
- Provide logging and trending data normally provided by obsolete chart recorders
- Provide fault current data to 100 Amps (20X) with pre/post fault waveforms
- Provide Power Quality and Harmonic data
- Digital I/O for breaker status, individual relay trip indication, remote control, etc.
- Easy to read local device display with option for a graphic display for fault information
- Multi-port remote communications to isolate operational data and non-operational data collection by different departments
- Must be considerable less cost than replacement of the electromechanical relay scheme with new microprocessor devices.

New "Clip-On to Automate" Technologies Provide the Needed Solution for Today

At last there is now an alternative solution that can be deployed quickly without disruption and without major investment, while providing the precise information and correct operational data required for today's critical power environment, in an ultra easy, accessible and useable manner.

The SATEC concept of "Clip-On to Automate" calls for adding a single PM174 Power Quality/Fault Analyzer to each feeder with the utmost minimal panel and wiring changes, to give total automation information, while co-working with the existing electromechanical relays, and not interfering with the protection scheme. It extends the useful life of these relays by providing all the information that they cannot. <u>The result is the most cost effective, compact, and fastest means to automate.</u>

Simply "clip-on" to existing 5 Amp CT secondaries up to 400 feet away

The PM174 PQ Analyzer:

- fits into the standard 4-inch round meter hole, replacing the space of any existing analog "needle" meter, or is also available in a Din-Rail transducer version.
- connects to the existing PT's for voltage and simply "clips-on" to existing CT secondaries for currents – not disturbing the CT circuits at all. The clip-on CTs are milliamp driven (not voltage driven) to allow up to 400 feet distance

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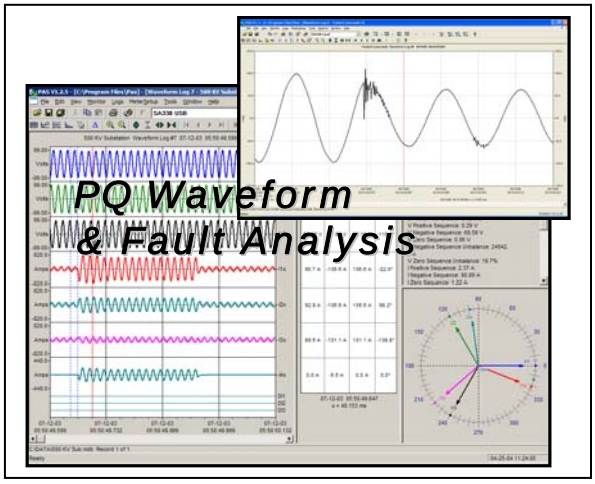
without signal degradation, provide excellent noise immunity, etc.

- provides True RMS, simultaneously sampled, cycle-by-cycle measurements at 128 samples per cycle for 0.2 percent revenue grade accuracy
- provides memory for data logging and trending information traditionally supplied by chart recorders
- measures fault currents to 100 Amps (20X) via clip-on CTs and provides complete fault waveforms at 128 samples-per-cycle, to allow full analysis from long duration trip/reclose recordings to short duration capacitor bank switching disturbances. Also provides phasor diagrams and symmetrical components.
- provides extensive Power Quality information per IEEE-1159 categories. These include a detailed description of the event (sag/swell, transient, etc.), phase, magnitude and duration. They also provide full 3-phase voltage and current waveform information, with pre/post fault, at 128 samples per cycle. Measurements of Flicker per IEC 61000-4-15, ITI (CBEMA) curves, Statistical report writer, and export to PQDIF and COMTRADE format are supported.
- provides full Harmonic information to the 63rd harmonic, and includes Voltage, Current, and Power harmonics, including the direction of each individual harmonic, whether Source or Load generated. It also features intelligent Set-point monitoring to alarm if harmonic levels rise to a point that will cause decreased capacity of equipment, to help prevent transformers, feeder wires, fuses, etc., from being inadvertently overloaded.



100 Amp (20X) Fault Currents, Phasors and Symmetrical Components, as well as Power Quality per IEEE 1159

- provides Smart I/O for status information, logic and control.
  - Up to four digital inputs for monitoring Breaker status, relay trip targets, etc., time stamped to 1 ms.
  - Up to four relay outputs for selective alarm and logical control of capacitors, voltage control, load shedding, etc., via AND/OR set point logic
  - two optional analog outputs are available to output transducer data such as Watts, Vars, etc., to older type SCADA RTU's
  - two optional analog inputs for sensor data such as transformer temperature, pressure, etc
- provides bright 3-phase-at-once LED local display with optional surface or rackmount Intelligent Graphic Touch-screen display for Fault and PQ waveforms, Phasors, etc.
- provides multi-port remote communications to allow standard operational data to be collected by traditional SCADA systems from one port, and higher level "non-operational" type data

Bright LED Display and Optional Intelligent Graphical Touch-screen Display for Waveforms

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from substation feeders to help identify and solve power system problems, that the traditional relays cannot provide, to be polled and collected by different departments. These include Power Quality, Waveform analysis, Harmonics and predictive information. It is ideal for substation automation because of its support of the industry standard DNP3.0 and Modbus RTU protocols over RS232, RS485, Ethernet or modem options.

At last there is now a solution available in the Substation / Feeder Automation market that is considerably less cost than the process of total replacement of the electromechanical relay scheme with new microprocessor devices, is tremendously faster to implement, keeps disruption to an absolute minimum, and provides the precise information and operational data needed for today's critical loads.

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