White Paper

"Bird on Wire" Sensing for Capacitor Bank Control

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QinetiQ
North America

LineWatch™
Powering Grid Awareness

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Introduction

LineWatch™ M, a QinetiQ North America (QNA) product, is a Medium Voltage (MV) sensor that directly monitors both current and voltage on a medium voltage distribution feeder. The sensor (see Figure 1) is referred to as a "bird on wire" device because the sensor is clamped onto a live MV line and has no hard connection to ground. Instead, the capacitive coupling between plates on the outside of the sensor body and ground is used to measure voltage. Accuracy +/-0.5% in voltage and +/-0.5% in current is realized by the QNA's present generation of sensors. These sensors are inductively powered from the line being monitored, operating on line currents carrying currents ≥5A.

Centralized Capacitor Bank Control Use Case

In one use case, the sensors are used as essentially stand-alone monitoring devices. The sensors wirelessly report instantaneous quantities (*i.e.* current, voltage, real and reactive power) along with accumulated quantities (real and reactive energy, volt-hours, amp-hours) at one minute intervals to a nearby Collector. The Collector communicates via either a mesh radio or a cellular backhaul. The Collector implements a DNP3 interface with Secure Authentication over either IPv4 or IPv6 networks using either TCP/IP or UDP as the transport layer protocol. The existing communications facilities allow the sensors to deliver measurements to virtually any SCADA system. That centralized SCADA system (or another third-party application) then uses the feeder measurements provided by the LineWatch™ M sensors to make centralized capacitor bank switching decisions.

Local Capacitor Bank Control Use Case

However, not all utilities implement centralized Volt/VAR optimization. In most cases, capacitor banks are controlled locally on the basis of voltage and current sensors co-located with the capacitor bank. Most often, these sensors are either Line Post sensors or a set of Potential Transformers and Current Transformers. QNA offers a version of a LineWatch™ M system that are direct replacements for either Line Post or PT/CT sensing methodologies, providing real-time outputs that mimic the outputs of either competing sensor type.

The sensors achieve this functionality by employing a different Collector than for the centralized use case. In this use case, each MV sensor talks to a dedicated collector, and this collector generates 60Hz signals proportional to the measured voltage and current. To mimic a Potential Transformer, the collector generates a nominally a 120V 60Hz signal. To mimic Line Post sensor voltage measurements, the collector generates a 0-10Vrms signal. In both cases, the collector generates a 0-10Vrms signal

proportional to the measured current. The sensor is sampled at a higher rate - every 5-20 seconds, depending on configuration. The collector takes instantaneous measurements of current, voltage, and relative phase and uses them to smoothly adjust the amplitude and phase of the generated voltage and current signals.

These sensors have been successfully integrated with capacitor bank controllers from leading manufacturers, and multiple pilot installations are presently in operation.

Cost Advantage

Relative to PT/CT installations, the initial cost of the sensing equipment is lower and the installation effort is greatly reduced. Installation of PTs and CTs, along with the associated structural modifications to utility poles, could take a crew two days of installation time. Furthermore, feeder downtime may be required for CT installation. In contrast, a typical LineWatch™ M sensor installation takes about 15 minutes. The sensors can be installed with a hot stick on a live line, as shown below in Figure 2. One crew is able to install LineWatch™ M sensors at multiple sites in a single day.

Figure 2: Sensors are easily installed with a hot stick on live MV lines.

The accuracy of the LineWatch™ M sensors is higher than the competing Line Post sensors. Typical Line Post sensors are specified at +/-1%, whereas the (~0.5% accuracy), and the QNA sensors have a much smaller phase shift (necessary for accurate power and power factor measurements). The 0.5% accuracy of the QNA current sensors (based on Rogowski coils) with high phase accuracy greatly exceeds the 2% accuracy quoted for most Line Post sensors. The payback for higher sensing accuracy is better quality capacitor bank switching decisions.

Conclusions

QNA's LineWatch™ M product line provides a cost-effective sensing solution for both centralized and local capacitor bank control. In the centralized use case, the sensors are general feeder voltage and current sensors. In local use case, the sensors are drop-in replacements for either PT/CT sensors or Line Post sensors.

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Company Background

QinetiQ North America is an engineering and technology development company. QNA has achieved CMMI Level 3 certification and is certified to Aerospace Quality Management Standard AS9100. QNA maintains a staff of over 200 mechanical, electrical, thermal, chemical, nuclear, aerospace, software and materials engineers working in the areas of robotics, advanced materials, aerospace, homeland security, power systems, and transportation. The main QinetiQ North America campus in Waltham, MA contains 200,000 square feet of offices, laboratories, test facilities, and production areas.

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