Application Note AN2013-07

Changing Metering Direction in SEL-400 Series Relays for SCADA Applications

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INTRODUCTION

Directional relays must be wired with proper current polarity (on the current transformer [CT] and relay terminal) in order to operate properly for faults. The polarity defines the forward direction of the directional protection elements of the relay. In many applications, the metering functions of digital relays are being used to replace separate supervisory control and data acquisition (SCADA) metering equipment. The direction of power flow (both watts and VARs) for this metering is also defined by the polarity of the CT circuit. This can create a problem because certain SCADA applications require the direction of power flow for metering to be opposite of the direction for protection elements. Automation math variables available in SEL-400 series relays can be used to invert the metering values for these applications.

APPLICATION EXAMPLES

One example that illustrates this situation involves an in-line transformer on a transmission line (see Figure 1). The forward direction for the protective relay is towards the remote end of the line. However, the positive (+) direction for power flow required by SCADA for a state estimator is towards the transformer.

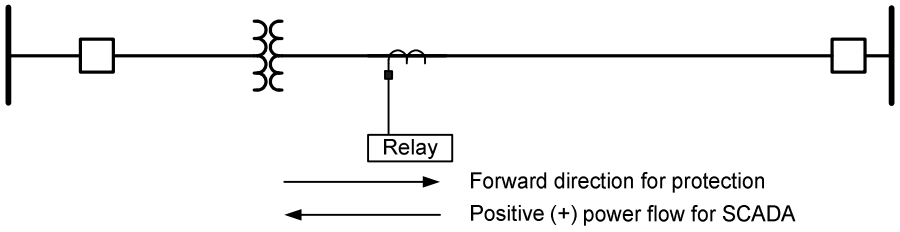

Figure 1 In-Line Transformer Relay Application

A second example involves a shunt reactor (see Figure 2). A relay with a mho element, directional into the reactor, is often applied as part of the reactor protection scheme. The forward direction for this protection element is opposite the direction for negative VAR flow required by SCADA for the state estimator, which is towards the bus.

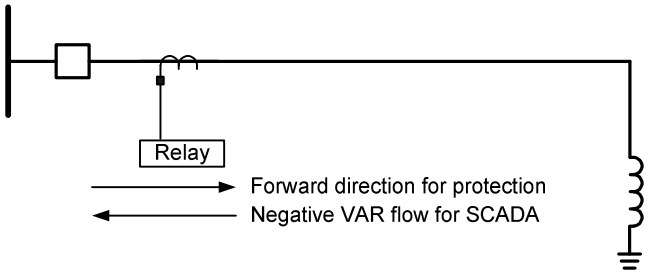

Figure 2 Shunt Reactor Relay Application

In both applications, the polarity of the relay must provide the proper forward direction for the protection elements of the relay. However, directly accessing the metering measurements of the relay results in negative values for power flow in the direction labeled in Figure 1 as positive for SCADA and positive values for VAR flow toward the reactor in Figure 2.

SEL Recommendation and Solution

Automation math variables in SEL-400 series relays can be used to invert the power flow quantities for SCADA applications. The following example shows how this can be done:

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AMV001 := 3P * -1.000000
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In this example, automation math variable AMV001 is assigned a value equal to the inverse of the three-phase power quantity (denoted as 3P). For applications involving VAR flow, 3P in the above equation is replaced by the fundamental reactive three-phase power quantity 3Q_F. AMV001 can then be accessed by SCADA through any number of communications protocols, such as DNP3. In the case of SCADA using DNP3, this value would be programmed into the DNP3 analog input map in place of the original metering quantity to be polled by the SCADA DNP3 master.

SEL Preferred Solution Using Synchrophasor Measurements

Phasor measurement and control units (PMCUs) built into SEL-400 series relays can provide accurate state measurement. SEL Application Note AN2006-10, available at http://www.selinc.com, details the benefits of using the synchrophasor function in SEL products.

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