New Protection Solutions using Existing Pilot Wires

A large number of pilot-wire based protection systems are still in operation throughout the world. Many of the relays used lack the features that modern protection relays bring; stable protection elements, event recording, and flexible backup protection. In an ideal world these protection schemes would all be updated and the copper pilot wires replaced with fibre-optic cables at the same time, however in reality the cost of replacing the pilot cables can mean that protection upgrades get deferred.

An alternative approach is a staged replacement program where initially just the relays are upgraded to devices that have modern feature sets but are capable of operating via the existing pilot wires. At a later stage the pilot cables can then be replaced with fibre cables and the relays adapted to operate via fibre.

Differential Protection Applications

Perhaps the most common traditional application of pilot wire protection has been two-ended line differential protection. In many cases older relays can be directly replaced with a numeric equivalent. The 7SD80 SIPROTEC Compact relay allows direct connection from the device to pilot wires with up to 5kV isolation (Figure 1). If the expected induced voltages exceed this, then external 20kV isolation transformers are available. Relays can be ordered with dual pilot-wire and single/multimode fibre optic interfaces.

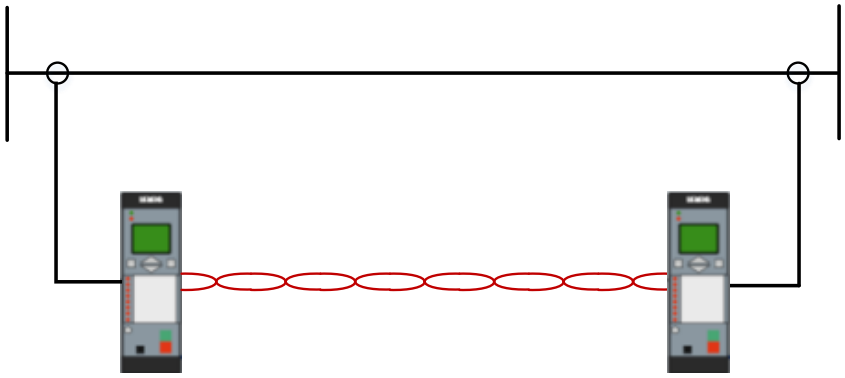

Figure 1. Differential protection of a two-terminal line using 7SD80 relays connected directly to pilot wire

Existing pilot wires can also be re-used in cases where the primary system has been modified to a new configuration. SIPROTEC 5 relays offer the option of protection of a complete transformer/feeder without the need for an HV CB at the site of the transformer (Figure 2).

HV Power Measurements & Protection Ltd
Unit 4, 1 Porters Ave, Eden Terrace, Auckland
P O Box 26-074, Epsom, Auckland 1030, New Zealand
Tel: +64-9- 377 2001
Fax: +64-9- 302 2142
Email: info@hvpower.co.nz

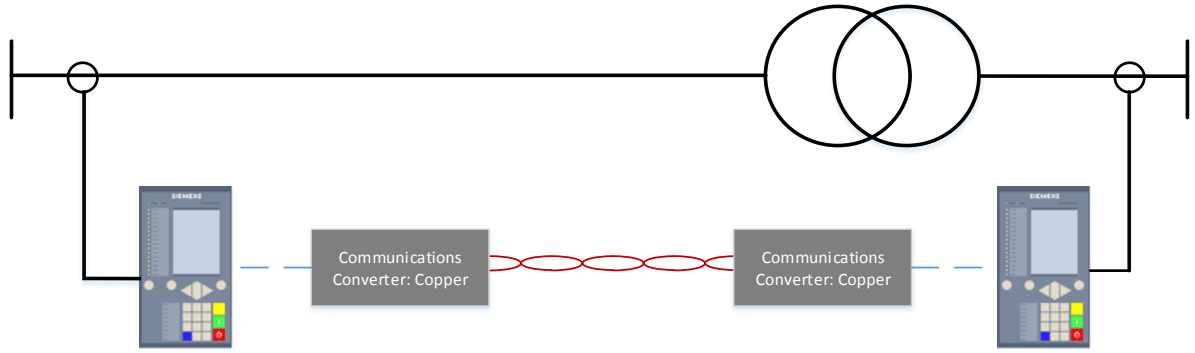

Figure 2. Line differential with transformer-in-zone using SIPROTEC 5 relays with communication converters for pilot wire

It is also possible to adapt two-ended lines to configurations with three or more line-ends (Figure 3). It is also possible to mix pilot wire and fibre or radio links within a single scheme.

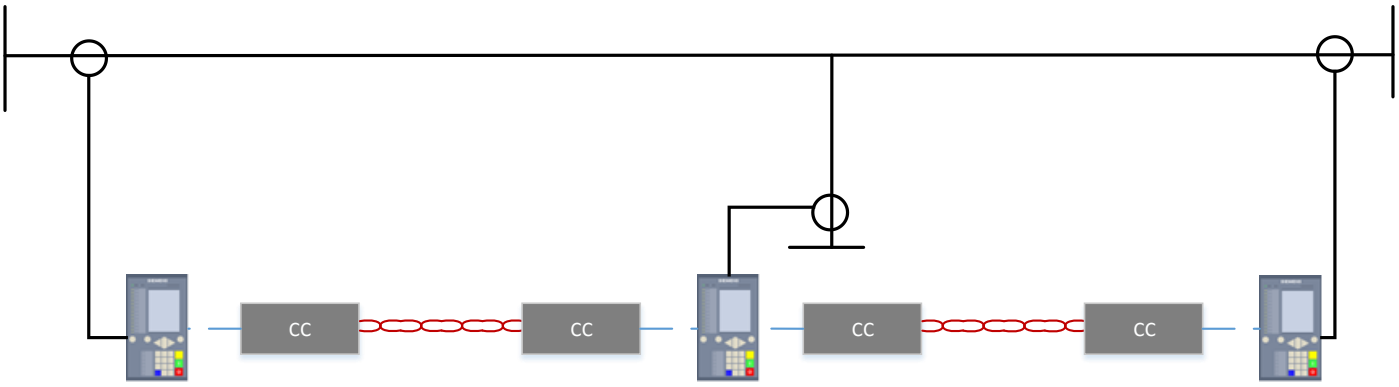

Figure 3. Three-terminal line differential using 2 pilot wires

Binary and Analogue Signal Transfer

An increasing number of applications are becoming apparent where there is a need to transfer binary and analogue signals between sites in a secure and reliable way at protection-grade speeds. Applications include interlocking, automated switching sequences and special protection schemes.

Binary status signals can be transferred via simple I/O unit either from third-party devices or directly from switchgear statuses (Figure 4). The 7SX5673 I/O unit can operate directly via fibre optic cable or can be used with an external Communications Converter to adapt operation to pilot wire. The additional latency that this option introduces is less than 1ms.

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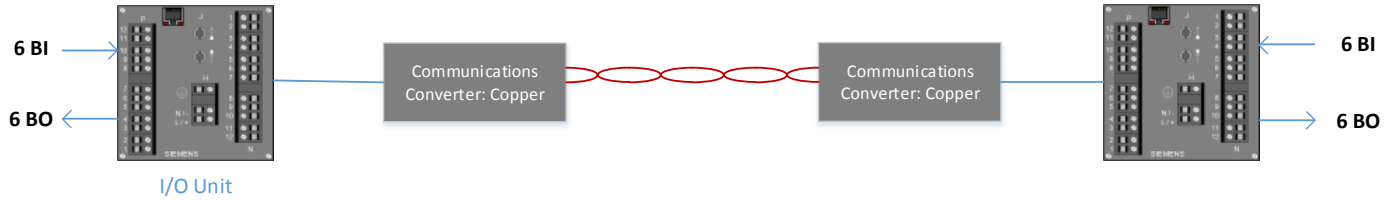

Figure 4. Binary signal transfer using a pair of 7XV5673 I/O units

An alternative is using spare user-defined signals available with protection relays fitted with Protection Data Interfaces (Figure 5).

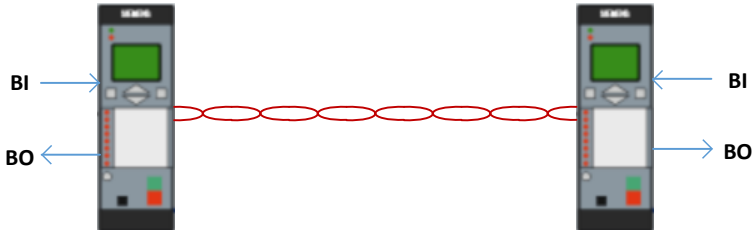

Figure 5. Binary signal transfer using 7SD80 relays directly connected to pilot wire.

SIPROTEC 5 devices also allow the transfer of user-defined analogue scalar values (Figure 6). Possible signal sources are:

- Measurements from CT/VT inputs
- Measured from a mA input card
- Analogue signals from other relays via GOOSE
- Calculated via a CFC chart using a combination of these

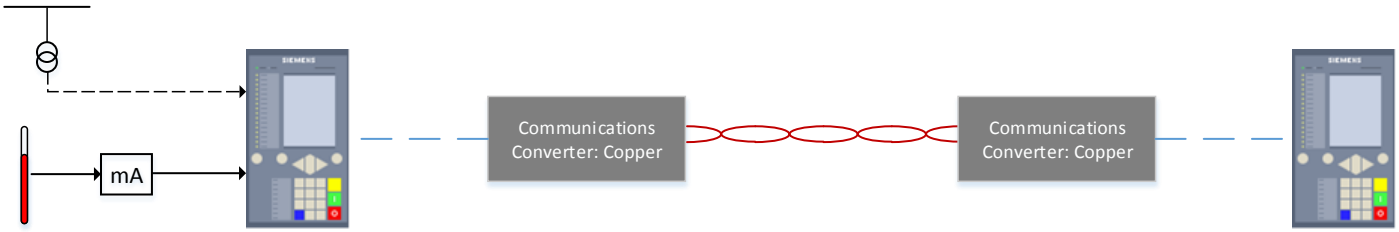

Figure 6. Transfer of user-defined analogue signals between substations.

Some examples of signals that may be useful to share between sites are:

- Remote end voltage
- Tap position
- Total MW load
- Cable or transformer temperature

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Once received at the remote end device the signals can be used as part of interlocking, automation or protection schemes as well as displayed on the relay front panel.

The number of signals that can be transferred via pilot wire depends on the relay model; relays designed for line differential protection reserve some of the data capacity for the differential function. To transfer a single binary status requires one single bit, transfer of an analogue value requires eight 8 bits, the overall bit transfer capacities of selected devices are shown in Table 1.

SIPROTEC 5 Relay Model	User-defined data transfer capacity (bits)		
	Priority 1 (20ms)	Priority 2 (40ms)	Priority 3 (100ms)
Relay without Line Differential (7SJ, 7SA, 7UT)	32	64	256
Relay with Line Differential (7SD,7SL)	8	24	128

Table 1. Data transfer capacity for User-Defined signal with SIPROTEC 5 devices communicating via Pilot Wire.

More Information:

For further information on SIPROTEC devices refer to http://www.hvpower.co.nz/Products/ProtectionRelays.html
Or contact HV Power.

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