REMOTE I/O Boxes
& other Voltage Regulator Relay installation options

Some customers install their REG-D/DA voltage regulators in the transformer control cubical, while others install these devices in the relay room. There are advantages to each, but typically HV Power recommend the later approach.

While meeting the network operational needs with regards to location of control and display, an important driver is minimising costs associated with wiring, and supporting possible future network changes.

"Musical Transformers"– swapping distribution transformers

It's become standard practice for many customers to plan for transformers to be able to be swapped around in emergency situations, and to cater for changes in load growth on their networks. Some REG-D/DA customers have specifically designed their REG-D/DA installations to minimise wiring changes should the need arise for a transformer to be swapped out. For this, all wiring at the transformer is connected to a Voltage Regulator I/O box which connects to the Regulator relay via fibre. With this design, if a transformer needs to be relocated, the fibre is disconnected, but the I/O box and all its connections remain on the transformer. When the transformer is relocated the I/O box is simply connected via fibre to the new regulator at the new location.

For others, the same concept of using a remote I/O box at the transformer, is done to provide a marshalling point for all field-wiring. This provides a savings compared to running multiple sets of field-wiring all the way from the transformer to the regulator situated inside in the switchgear.

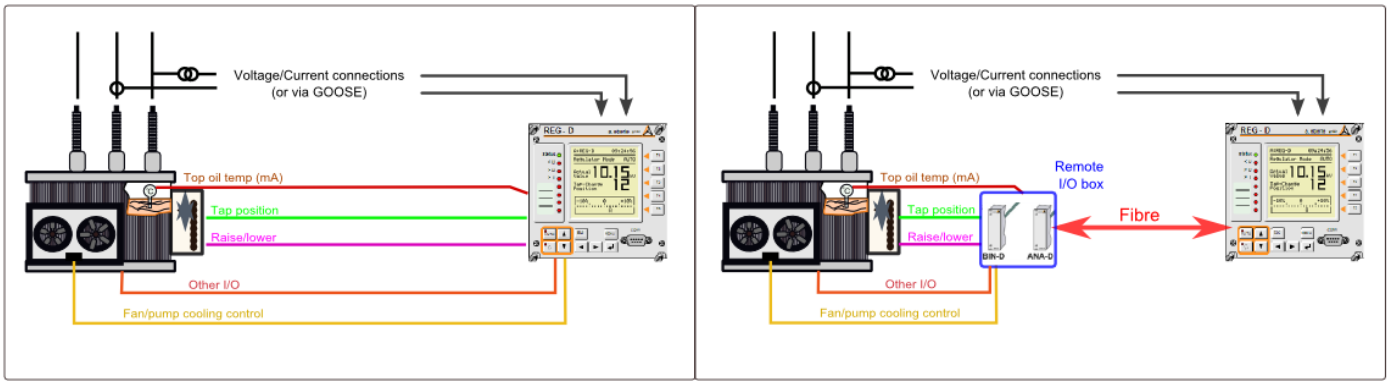

Figure 1. Traditional Voltage Regulator Relay Connection (left) & remote I/O box marshalling at transformer (right)

The Remote I/O box from A-Eberle can be ordered with a variety of enclosure sizes to allow it to be fitted with the desired number of binary input/outputs and analogue input/outputs. Figure 1a shows the concept of all transformer "connections" being marshalled at the I/O box, and a single fibre connection to the Voltage Regulator. The Remote I/O box and REG-D/DA now support the direct interconnection via fibre optic cable, while earlier generations of hardware require the use of external fibre optic converters, or direct twisted pair connection. The supplied software

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tools allow the remote I/O points to be mapped to the regulator, and thus appearing to the regulator as being directly connected.

Use of Goose Messages

GOOSE messaging can be used to communicate the information measured by other IEC 61850 devices to the Voltage Regulator Relay, eliminating the need for the Regulator to also have a direct physical connection to these points. This is one of the many advantages offered by IEC 61850. As confidence in this protocol grows, customers have advanced from the communication of breaker and sectionaliser (binary) status via GOOSE (rather than hardwired I/O), to also using GOOSE for transmission of analogue voltage and current data. This eliminates the need for current and voltage measuring inputs to the regulator altogether.

Meet the standard IEC 61850

One IEC 61850 scheme being developed is where the Transformer Protection Relay measures transformer current and voltages for its own needs, but these measured values are also outputted from the Protection Relay via GOOSE messages. The IEC 61850 equipped Voltage Regulator Relay reads these GOOSE values "off" the station Ethernet, for its own use. This eliminates the need for direct physical connection to VT's and CT's, and the associated cost of this wiring. Note that phase angle information is also required to be communicated via GOOSE so the regulator can determine the amount of circulating current for paralleling purposes.

This advancement in capability demonstrates the future in substation design, where available information is shared between different vendors' IED's on the substation Ethernet network, with the result being simplification in substation design and reduction in cost of physical wiring.

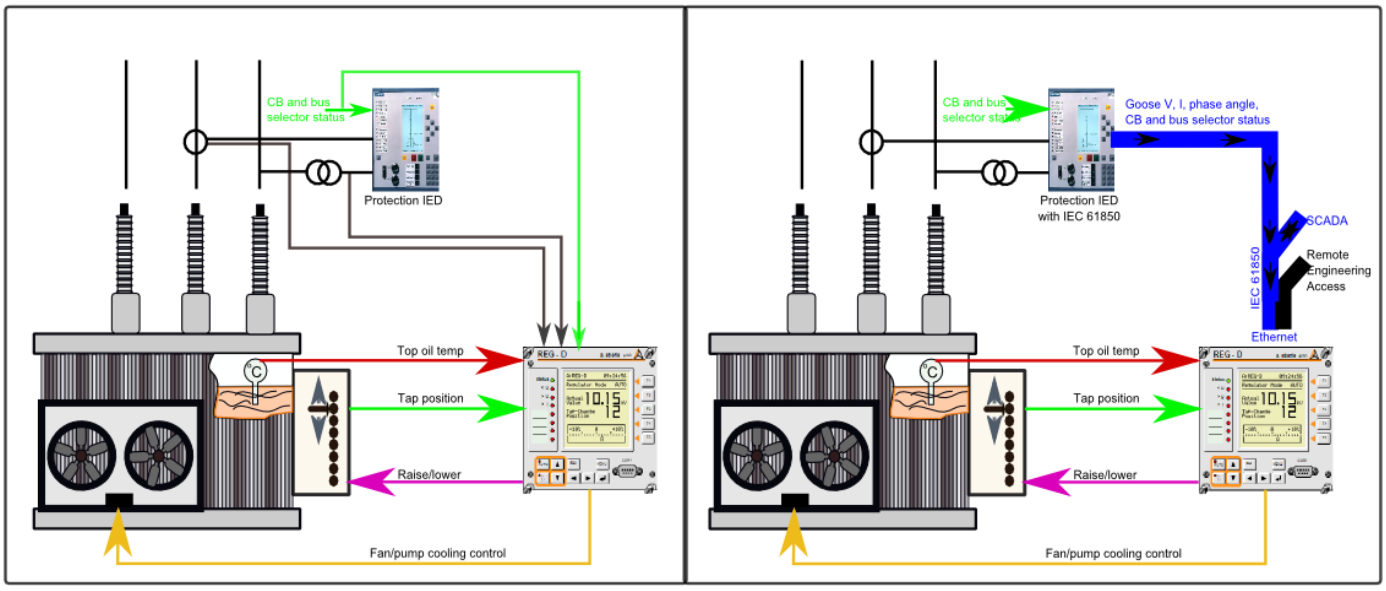

Figure 2. GOOSE messaging (right) replacing hardwire current/voltage inputs (left)

Not shown in detail on these diagrams is that in a paralleling scheme the LV breaker and bus sectionaliser open/closed status information is fed to the Voltage Regulator Relay to allow these devices to determine which transformers are in parallel. This information is normally hardwired to the closest Voltage Regulator, and shared via the E-LAN. However, in IEC 61850 schemes this information can also be GOOSE messaged from the LV feeder relays to the Voltage Regulator Relays – eliminating further hardwired connections.

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E-LAN communications between relays

For parallel control, the Voltage Regulator Relay for each transformer communicates with the others to share information to allow the parallel control algorithms to work. This connection is via A-Eberle "E-LAN", which is physically a RS-485 two wire communication bus. This is normally hardwired between the relays (shielded twisted pair), or via external fibre optic converters. With certain versions of protocol interface, this information can also be routed via an Ethernet network, ideal for sites where IEC 61850 Station Buses already exist. At this stage this functionality is provided by the serial-to-Ethernet conversion capabilities of the "PED" Protocol card, and requires use of serial port normally used for ComServer functions, thus is at the expense of other functionality. However, this Ethernet E-LAN function does provide further wiring simplification and where fibre station bus Ethernet is used, the desirable isolation between devices, which may be more important characteristics for some applications.

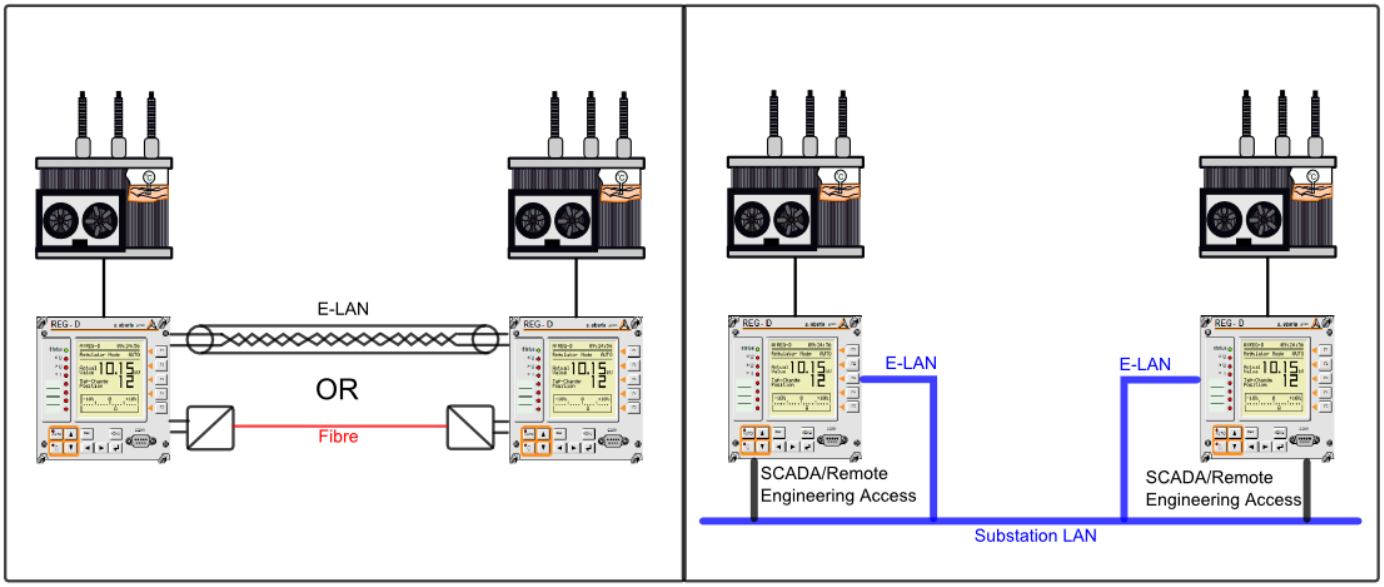

Figure 3. E-LAN communication via traditional E-LAN (left) and Ethernet (right)

Functionality of "firmware/software" driven devices, and Ethernet equipped hardware is consistently evolving, it pays to keep in touch with suppliers to ensure that any standard designs are evaluated for updating to take advantage of new capability.

This publication provides generalised advice on existing and evolving capabilities. Details and drawings do not show all required hardware options and connections.

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