REG-D & REG-DA Voltage Regulating Relays:

E-LAN and the Group List

E-LAN is a communications system that allows A.Eberle Voltage Regulating relays to share all the data required to operate transformers in parallel and also allows engineering access to all supported relays in a substation from a single point.

An E-LAN connection is a basic requirement for the use of the Master-Follower and Circulating-Current [ΔIsinΦ and ΔIsinΦ(S)] parallel programs. It is also conveniently allows the sharing of switchgear statuses between relays for operation of the 'Paragramer' function – reducing I/O wiring.

The E-LAN can be used to connect Voltage Regulators that are not in the same paralleling group, and can also be connected to other supported A.Eberle devices.

The protocol is based on RS-485. Relays can be ordered in copper or copper+fibre E-LAN variants. The copper E-LAN ports can be connected via either 2-wire or 4-wire copper shielded twisted pair with the connection-mode selected via software.

Method	Attributes
2-wire	• Single multi-drop connection to multiple relays • Up to 100 m distance
4-wire	• Point-to-point connection • Up to 1,500 m distance

Table 1. Attributes of 2-wire and 4-wire connection.

Each relay has two E-LAN ports, referred to as E-LAN left (E-LAN L) and E-LAN right (E-LAN R). Data received at one E-LAN port on a device will automatically be retransmitted out its other E-LAN port. This allows the connection of multiple devices in a chain if using 4-wire or fibre connections. However, the 2-wire method is commonly used as this offers the advantage that E-LAN communications between other devices is still possible even if a device is powered down.

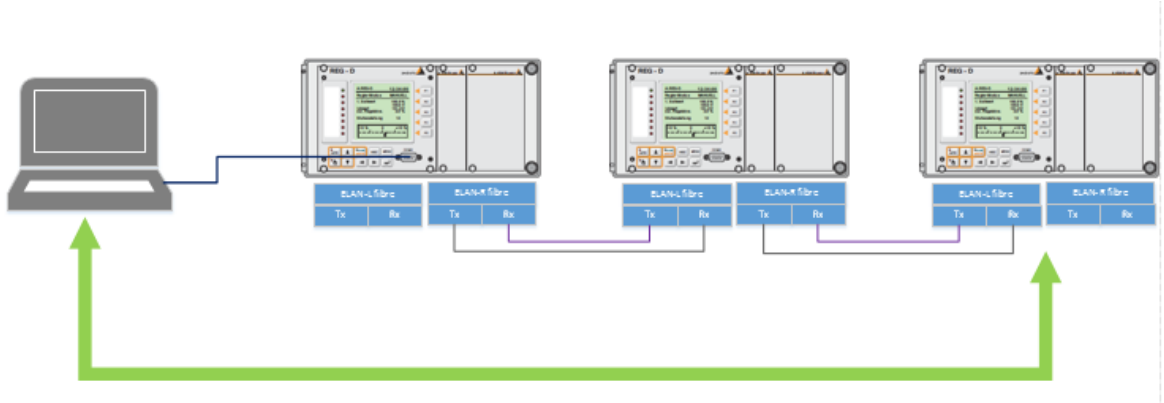

Figure 1. An E-LAN network using multiple point-to-point links. The laptop connected to the front-port of the relay at the left can use the E-LAN to connect WinREG to any of the relays.

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Physical connections and parameters

Each E-LAN port has 4 data terminals. EA+, EA-, E+ & E1. The terminal numbers for the REG-DA relay are shown in Table 2. Terminal numbering on REG-D relays depends on the user-defined options selected at the time of ordering so it is necessary to refer to the terminal diagram provided with the relay.

Function	REG-DA Terminal	
	E-LAN L	E-LAN R
EA+	72	76
EA-	71	75
E+	70	74
E-	69	73

Table 2. Terminal markings for REG-DA.

The 2-wire connection method is the simplest and is recommended in most cases The EA+ terminal of a port should be connected to the EA+ terminal of one port on each of the other relays. The EA- terminals should also be connected in the same way. Normal RS-485 wiring practices should be followed, where connections for intermediately relays are joined at the regulator terminals- avoiding T connections. (Refer **Figure 10** for example).

For the 4-wire method all 4 terminals are used. EA+ from one relay should connect to the EA+ on the next relay. EA-, E+ and E- terminals follow the same pattern. In a chain, where one relay needs to connect to two other relays, then both E-LAN ports should be used, with separate wiring for each connection. (Refer **Figure 12** for example).

Relays with fibre optic E-LAN ports have multi-mode ST connectors for Transmit and Receive lines. The Transmit on one relay should be connected to the Receive on the next relay.

The *Left* and *Right* naming of the E-LAN ports relates to the physical location of the ports on the device – the terminals for the E-LAN L port are closer to the left-hand side than those of the E-LAN R port. There is no relationship between these names and the structure of the E-LAN network or to the physical layout of the transformers or relays on the site. It is possible to connect and E-LAN L port on one device with an E-LAN R port on the next device. The transformer layout within the Paragramer display is defined in the *Group List* – not the E-LAN arrangement.

There can only be one path between two relays in an E-LAN network. Ring structures or parallel paths between relays are not supported, as per standard RS485 convention.

The maximum length of connection between devices depends on the connection method. 2-wire connections can be up to 100 m long. The maximum length of 4-wire connection varies with the data-rate selected as shown in **Table 3**. Fibre connections can typically be up to 1500 m.

Baud rate (kbps)	Maximum distance (km)
15.6 -62.5	1.5
125	1.0
375	0.8

Table 3. Maximum distance of 4-wire E-LAN connections.

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Three setting parameters are available to configure each port (refer **Figure 2**):

- Mode: allows selection between 2-wire and 4-wire methods of connection. For fibre-optic connections 4-wire should be used.
- Baudrate: set the communications data rate in kbps
- Termination: this controls whether internal termination resistors are enabled. This should be set ON for devices at each end of an E-LAN bus to prevent data reflections.

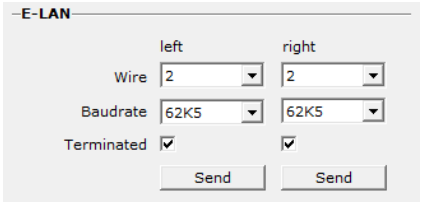

Figure 2. Default 2-wire E-LAN settings shown in WinREG.

Communications settings for unused ports are not important and can be left as default if desired.

Device ID and the Group List:

Each device on an E-LAN network needs to be set with a unique Station ID. This is used as its address on the E-LAN network. To set this using WinREG a separate 'Send' button is used to send this parameter separate from the other parameters (**Figure 3**). The Station ID can also be used as the address that the SCADA protocol card uses to communicate within the relay, so care needs to be taken if making any modifications to ID's in installed schemes.

Figure 3. Sending the Station ID to a relay from WinREG.

The *Group List* is the list of Station IDs on the E-LAN that are to be used within the Parallel Programs or by the Paragramer function. The Group List must be identical for every device in the group – including listing the devices in exactly the same order. The Group List does not need to list every device on the E-LAN, just those Transformers that could be in parallel. Contact HV Power to discuss complex schemes.

The Group List can edited via WinREG (Figure 4) where any ID can be entered. If editing the Group List via the relay front panel (or with WinREG where there is a communication connection to a relay) then only those devices that are currently available (active) on the E-LAN may be selected.

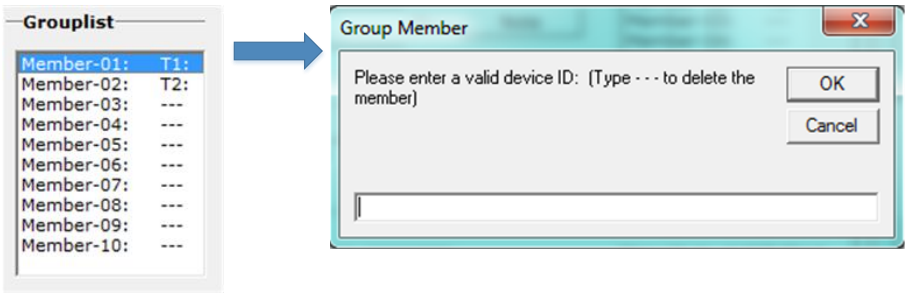

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Figure 4. Editing the group list in WinREG off-line, allows any ID to be entered.

The order of the relays in the *Group List* is important as it affects:

- The order the relays are shown on the display using the Paragramer. The relay at the top of the group list will be at the left hand side in the Paragramer.
- The priority of which relay is assigned as the Master relay in a Master Follower scheme (where Paragramer is used).

Commissioning tools

The status of each E-LAN port on the device can be viewed on the front panel of the device in the E-LAN page, accessible from the Setup 6 menu (**Figure 5**). A solid cross indicates an E-LAN connection is active on this port. If the cross is flashing or is not displayed, it indicates a problem with the connection. Possible causes are:

- Incorrect wiring
- E-LAN settings not matching between connected devices
- A duplicate ID in the Group List
- Identical Station ID's on the E-LAN

LED functions *14:ELAN-L* and *15:ELAN-R* are available for displaying the status of each port.

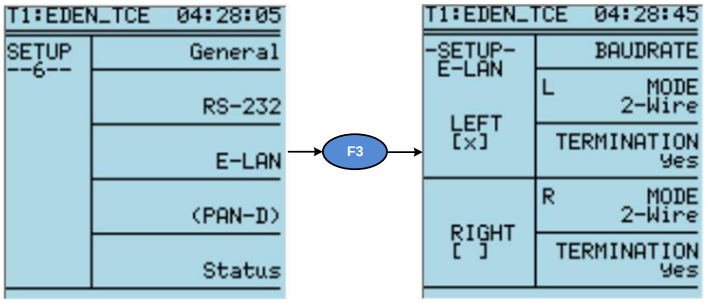

Figure 5. The E-LAN setup and commissioning page is accessed via the Setup 6 menu. Here the [X] shown for the E-LAN LEFT port indicates that it is active.

The Group List can be also be accessed via the relay front panel from the Setup 1 menu (**Figure 6**). The IDs of all devices programmed into the Group List will be displayed. Those devices that are not presently accessible via E-LAN will be shown enclosed in brackets (**Figure 7**). A symbol is also displayed next to each ID – this indicates the parallel-program groupings that are presently active. Devices operating in parallel will share a common symbol.

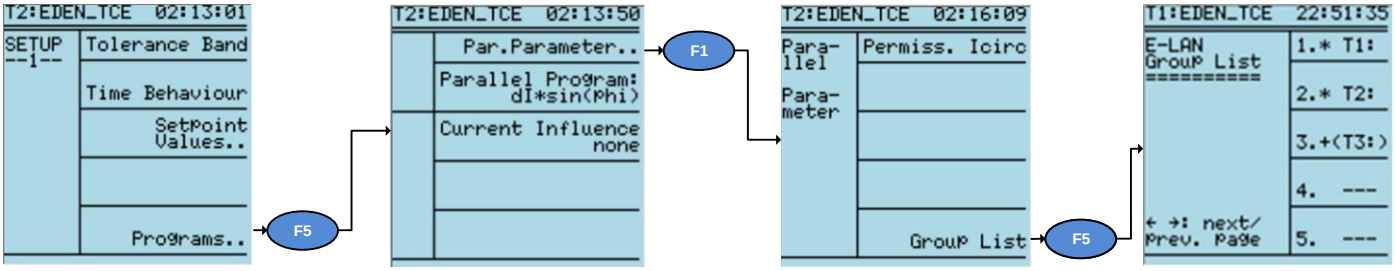

Figure 6. The Group List is located deep within the menu levels.

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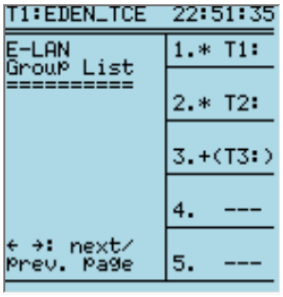

Figure 7. An Example of a Group List of three relays. T1 & T2 share a common symbol (*) so are operating in parallel. The brackets around the T3 ID indicate that it is not accessible via E-LAN.

E-LAN error

An E-LAN error signal will be generated if any device programmed in the Group List is not accessible via E-LAN for more than 30 seconds. The signal can be set as an alarm via LED, binary output or SCADA protocol but can also be used to directly control the behaviour of the regulator. If the parameter *Manual Locked at ELAN Error* is set, an E-LAN error will cause the relay to switch from Automatic to Manual mode. This can be useful when relay are operating in a Parallel Program as sharing of statuses between parallel relays is no longer possible. The exact effect of this parameter varies depending on which Parallel Program is selected.

Accessing a remote relay via E-LAN

From within WinREG it is possible to send and retrieve settings from any device connected to the E-LAN network from the front port of any of the devices in the network (**Figure 8**). The local device (to which you are directly connected) will be marked as (AA:).

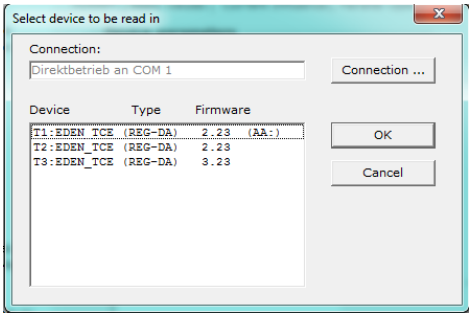

Figure 8. Selection of the device on the E-LAN network to connect to via WinREG. The relay that the computer is directly connected to is indicated by (AA:). Connection to the other devices would be via E-LAN.

Mapping Limit-Signals to Binary Outputs, LEDs or SCADA

Any user-assignable LED can be set to the state of the E-LAN L or E-LAN R connections (**Table 4**). An E-LAN error can also be used to activate an LED or binary output. The LOG mask can be used to record occurrences.

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Signal	Output Relay Function	LED Function
E-LAN L connection available		14:ELAN-L
E-LAN R connection available		15:ELAN-R
E-LAN error	17:ELAN-Err	16:ELAN-Err

Table 4. Output Relay and LED Functions.

The E-LAN status signals and E-LAN error can also be mapped to a SCADA system interface. Refer to the documentation available for the selected SCADA protocol.

Connection Examples

These diagrams show data-connections only. All copper connections should be via shielded twisted pair cables. The usual practices regarding screening and earthing of communications cables within a substation environment should be observed.

2-wire

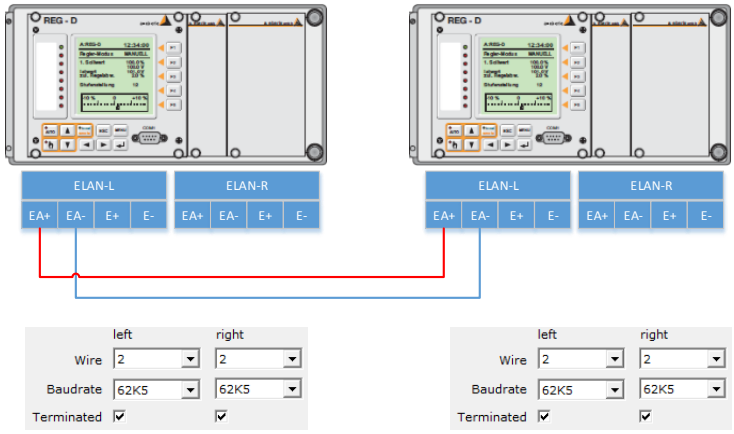

Figure 9. An example of a 2-Wire E-LAN network for two relays. Only the left ports are use in this example. 'Terminated' is set ON for both relays.

2-wire

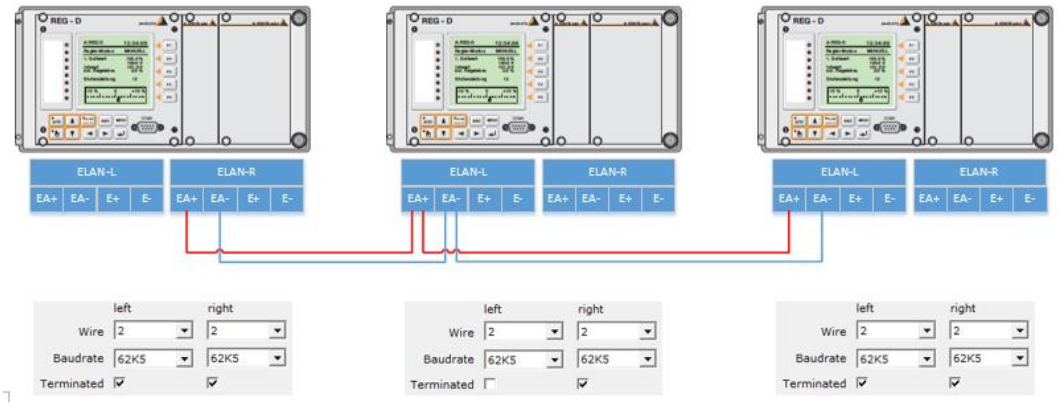

Figure 10. An example of a 2-Wire E-LAN network for three relays. The 'Termination' setting is ON at the two devices at the end of the bus and OFF on the centre device.

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4-wire

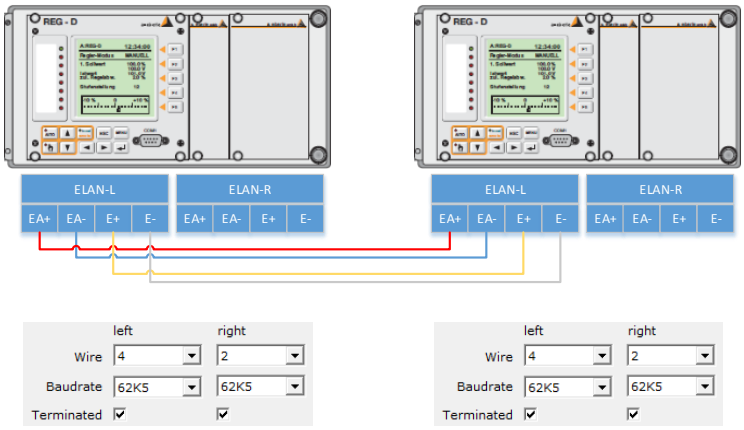

Figure 11. An example of a 4-Wire E-LAN network for two relays.

4-wire

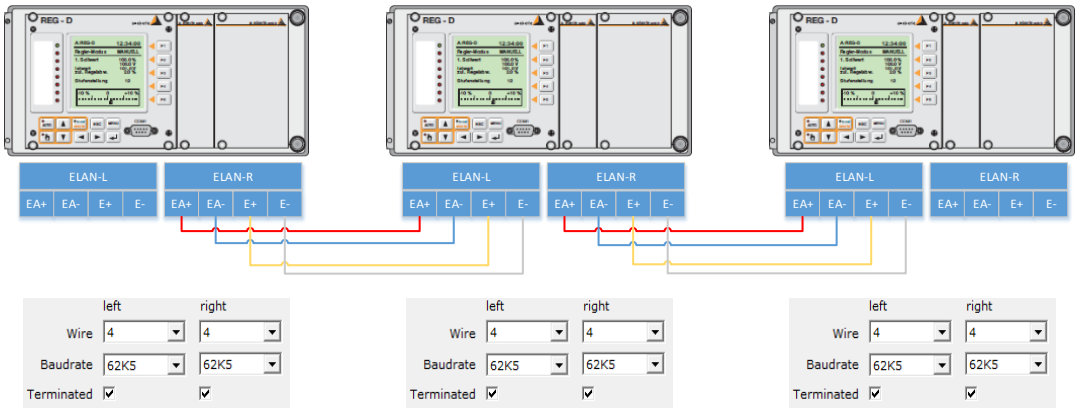

Figure 12. An example of a 4-Wire E-LAN network for three relays. Each link is a point-point connection so both E-LAN ports are used on the centre device.

Fibre

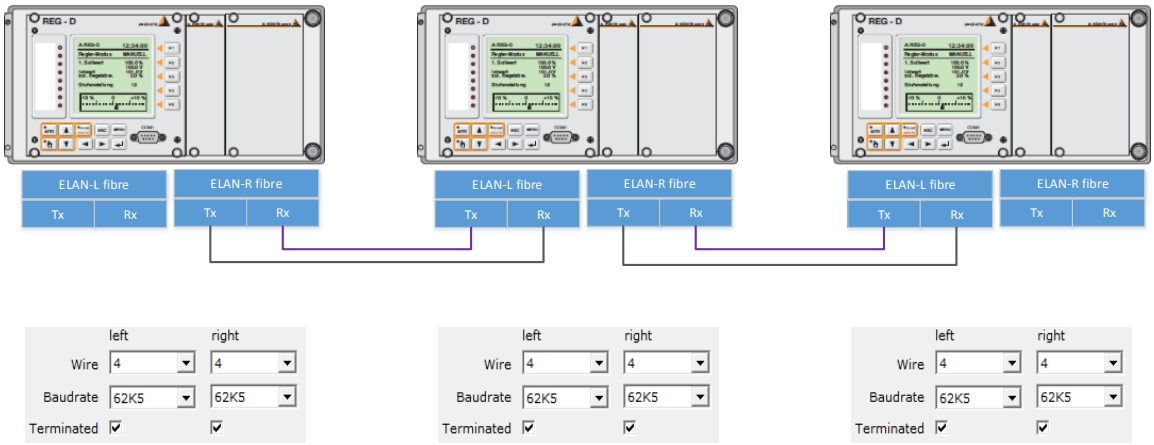

Figure 13. An example of an E-LAN via fibre. The connection parameters are the same as those for the 4-wire connection method.

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More Information:

For further information on transformer control with A.Eberle Voltage Regulating Relays refer to http://www.hvpower.co.nz/TechnicalLibrary/VoltageRegulators.html or contact HV Power.

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