REG-D & REG-DA Voltage Regulating Relays:

Alarm, Inhibit and High-Speed Switching Functions

A range of functions are available in an A.Eberle Voltage Regulator Relay (VRR) that allow controlling regulator behaviour when voltage or current moves outside of set values. These functions allow modification of behaviour of the regulator beyond that normally defined by the active Time Program. They also have associated signals that can be mapped to LEDs, Relay Outputs, the on-board log or to SCADA.

In the most commonly applied settings, the limit functions are set to have the relationship shown in Figure 1. In normal operation, the regulator begins to issues tap commands based on the selected Time Program whenever the measured deviation exceeds the set Bandwidth setting. If the voltage is not corrected within the expected time period, Under-Voltage and Over-Voltage (<U & >U) limits can be used to alarm to an operator. During larger voltage deviations it can be desirable to bypass the normal Time Program and issue tap commands at a faster rate. This is done via the High-Speed Switching (Backwards and Forwards) functions. If the voltage deviation moves beyond the range which it is desirable for the local tap-changer to react to, automatic regulation can be temporarily suspended via the Inhibit-High and Inhibit-Low functions.

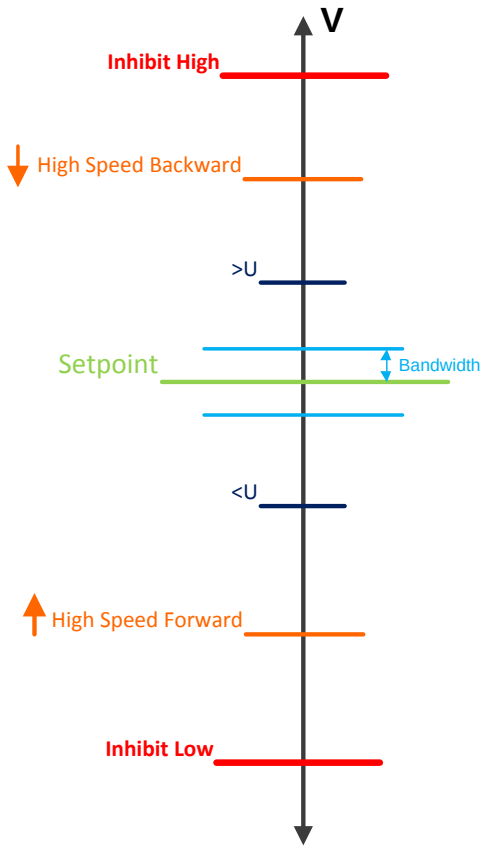

Figure 1. The common application of the Alarm, High-Speed Switching and Inhibit settings in relation to the Setpoint and Bandwidth.

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Current-based limits are also available to either alarm or inhibit operation depending on the level of measured current.

Each of the limit functions has an associated signal that can be mapped to a Relay Output, LED, the on-board log or SCADA protocol to indicate to an operator than an abnormal condition exists.

Limit Functions

Under-Voltage and Over-Voltage (<U and >U)

The Under-Voltage and Over-Voltage limit functions <U and >U are most often used as alarms however they can also affect regulator behaviour in some cases.

If the measured voltage exceeds the *>U* setting for longer than the *>U Time Delay* setting then the >U limit condition becomes active. If the measured voltage falls below the *<U* setting for longer than the *<U Time Delay* setting then the <U limit is activated. The signal associated with each limit condition mapped to an LED, binary output or the SCADA interface.

While a <U alarm is active no further Lower commands will be issued. If a >U condition is active then no further Raise commands will be issued. This behaviour becomes most relevant when multiple Setpoints are used.

Alarm suppression for voltages < 20 V
When the voltage falls below 20 V, the under-voltage limit signal is suppressed. This helps prevent unwanted alarms when a transformer is in a disconnected state.

High-Speed Switching Forwards and Backwards

If High-Speed Forward or High-Speed Backward voltage limits are exceeded for longer than their corresponding delay setting then the normal Time Program will be bypassed and a High-Speed Switching mode will be activated. Tapping commands will then be issued at a fast rate until the voltage deviation returns to within the Bandwidth. In High-Speed Switching Forwards mode Raise commands are issued, in High-Speed Switching Backwards mode Lower commands are issued.

The rate that High-Speed tapping commands are issued is controlled by:

- The value of the setting *Maximum Time Tap-Changer In Operation*.
- An internal limit of 4-5 seconds.
- The status of any binary input assigned to the input function *07:TC.i.Op* (tap-changer in operation). While this is active then no further tap commands will be issued. In all cases the maximum rate that commands will be issued is once every 4-5 seconds.

High-Speed Switching mode status can be seen on the Regulator front display in the Progress Bar. High-Speed Switching Backwards and Forwards are indicated by the '<--<' and '>-->' symbols – Figure 2.

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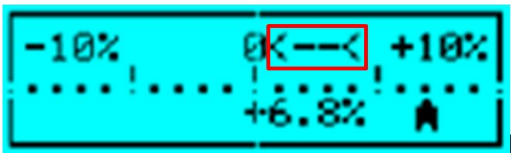

Figure 2. Indication on the Progress-Bar that High-Speed Backwards Switching is occurring.

The High-Speed Switching functions can be prevented by affecting regulation behaviour by selecting setting *Block High Speed Switching*. When selected, the usual Time Program remains active even when the High-Speed Switching limits values are exceeded.

If multiple Setpoints are used then High-Speed Switching can be triggered by changing between Setpoints.

Inhibit-High and Inhibit-Low

The Inhibit-High and Inhibit-Low functions temporarily suspend automatic tapping commands whenever the measured voltage moves beyond the limit setting value for longer than the associated time delay. Once the voltage returns to within these limits then the normal regulation function resumes after a 2-3 second delay. The limit functions can be used to prevent the VRR issuing tapping commands for a voltage deviation that the local tap-changer should not react to.

Fast Inhibit-Low
When the voltage falls below 64 V secondary, the internal 'Fast Inhibit-Low' function becomes active and blocks regulator operation. This inhibit function is not time-delayed. This internal function can be either be disabled, or have a time delay enabled via a Feature code – contact HV Power for details.

Under-Current and Over-Current Limits (<I and >I)

The Under-Current and Over-Current limits inhibit the regulator automatic function when the current falls outside of these limits for longer than the associated time delay.

The blocking behaviour of limits is controlled via the *Block with >I or <I* setting. The options available are:

- >I,<I
- >I
- <I

Over-Current and Under-Current limits share a common time delay setting.

The Over-Current limit could be used for example to block tap changes when transformer current exceeds the tap-changer rating.

Three-Winding Limit

The Three-Winding Limit function applies to cases where two separate VT inputs are connected to a single regulator. This setting is only relevant if the Three Winding feature is enabled, allowing monitoring of the additional VT input.

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Tolerance of limit value functions

A 1 V hysteresis applies to each of the Limit Function voltage threshold settings e.g. if the *>U* setting is 120 V, then the function will pick-up at 120 V and drop-off at 119 V.

The actual time-delay associated with each function can vary depending on input signal processing times.

Mapping Limit-Signals to Binary Outputs, LEDs or SCADA

Any user-assignable binary output or LED can be set to indicate any of the inhibit or alarm states. The output or LED will be activated (non-latching) when the relevant time-delay has been reached. The LOG mask can be used to record occurrences.

Signal	Output Relay Function	LED Function
Under-Voltage	03:<U	45:<U
Over-Voltage	04:>U	46:>U
Over-Voltage OR Under-Voltage	05:>U+<U	
High-Speed-Switching Forwards OR High-Speed-Switching Backwards	12:Quick	10:Quick
Inhibit-Low	72:Inh.Low	72:Inh.Low
Inhibit-High	11:Inh.High	09:Inh.High
Inhibit-High OR Inhibit-Low	13:Inhibit	11:Inhibit
Under-Current	38:<I	35:<I
Over-Current	06:>I	47:>I

Table 1. Output Relay and LED Functions.

Note that the Inhibit-Low signal is also activated by the Under-Current and Over-Current limit functions.

SCADA Functions

The limit signals can also be mapped to a SCADA system interface. Refer to the documentation available for the selected SCADA protocol.

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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