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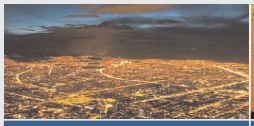
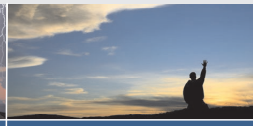
Applications


Grid Dynamics


Power Quality


Voltage Regulation


Earth Fault Detection

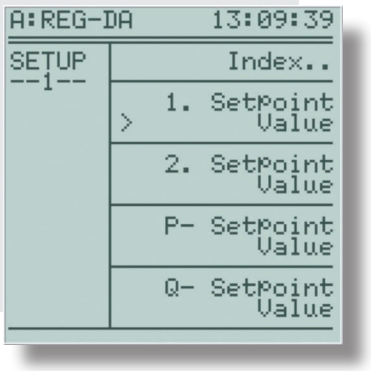
Active and reactive power control by REGSys™

REGSys

Normally a voltage regulator REG-D(A) is responsible for the constant voltage on the secondary side of a transformer. The main task is to find the correct balance between good voltage inside the tolerance band (bandwith) on the one side and less movements of the tap-changer on the other side.

Additionally another firmware feature, PQCtrl, is available on REG-D(A) devices. This has been designed for the regulation of Phase Shifting Transformers, so called Quad Boosters, and other customer-specific-applications. In case of PQCtrl the desired value will be the active- or the reactive power instead of the voltage, which is like explained used for standard voltage regulation.

Main characteristics of the special feature PQCtrl



Setpoints

- It is a software feature which can be activated with regard to the hardware on all REG-D(A) devices independent from the date of delivery. Depending on the existing firmware version it may be necessary to do a firmware update.

- Four desired values (setpoints) will be available: Two voltage values (first and second setpoint), one value for active power (third setpoint) and one value for reactive power (fourth setpoint).

- The general functionality of the regulator REG-D(A) - voltage, active - or reactive power control - can easily be changed by selecting the certain setpoint

- The active and reactive setpoint value can be adjusted in a range from -140 to 140 percent of the nominal power

- The nominal power is calculated with the following formula:

$$P_r = Q_r = \sqrt{3} \times 100V \times KNU \times I_r \times KNI$$

- All limit settings of the REG-D(A) are also available with the PQCtrl feature. The limits <U, >U, inhibit low, inhibit high and high-speed switching depend on the measured voltage. The base for percent limit values is always 100V. The limits >I, <I depend on the measured current.

  If there is via E-LAN the additional monitoring unit PAN-D connected to the REG-D and the regulator operates in P- or Q-mode, the REG-D transmits always 100V to the PAN-D as its setpoint, assumed that the limit base in the monitoring unit PAN-D has been set to "setpoint".

- The key functionalities of the standard voltage regulator REG-D(A) like transducer-, recorder- and statistic mode, logbook, transformer monitoring module and maybe additional the background programs are also available in combination with the feature PQCtrl.

P_r,Q_r: nominal power
KNU: ratio of the voltage transformer
I_r: nominal secondary current of the current input (1/5A)
KNI: ratio of the current transformer

Regulation of phase shifting transformers

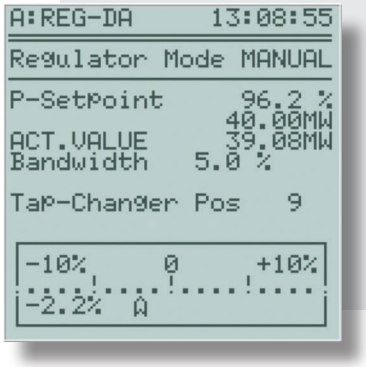
Phase shifting transformers or more simple **Quad boosters** are special constructions of transformers used to control the power flow in three-phase transmission grids. For an alternating current transmission line the power flow through the line is proportional to the sine of the difference in the phase angle of the voltage between the transmitting end and the receiving end of the line. Where parallel circuits with different capacity between two points in a transmission grid (for example, an overhead line and an underground cable) exist, direct manipulation of the phase angle allows control of the division of power flow between the paths, preventing overload. Quad boosters thus provide a means of relieving overloads on heavily loaded circuits and rerouting power via more favorable paths.

In case of a quad booster the tap changer changes not the magnitude of the voltage, it changes the phase angle of the voltage and therefore also the active power flow.

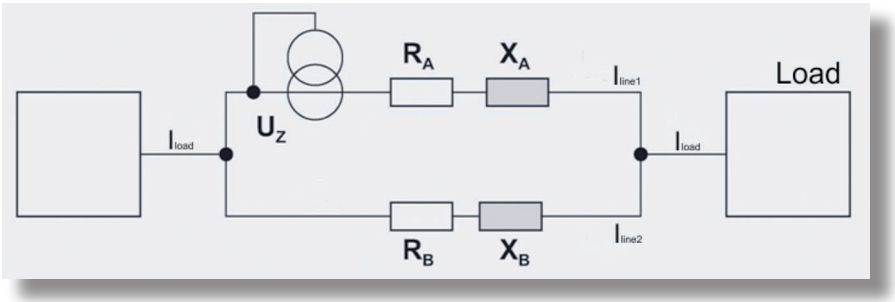
The active power regulation is activated on the REG-D(A) as soon as the setpoint P is selected. In case of P-Control the REG-D(A) regulator screen shows the P-setpoint instead of the voltage setpoint.

On special phase shifting transformers it will be possible to regulate both, the active - and reactive power. Therefore the transformer is equipped with two or even more tap-changers.

In this case one regulator REG-D(A) regulates the active power and a second one controls the reactive power. The coordination between the two regulators can be done depending on the application by an additional programming (background program).



P-setpoint



Phase shifter transformer schematic

Other Applications

Regulation of a generator transformer

Under normal operation conditions the generator controls the voltage of the power plant grid. The generator transformer is also equipped with a tap-changer to regulate the voltage during maintenance periods or in emergency situations. With this tap-changer it is also possible to transform the impedance of the grid during normal operation. This transformation influences the reactive power flow from or to the grid.

REG-D(A) with the feature PQCtrl can handle both situations. In normal operation situations the regulator REG-D(A) controls the reactive power flow. If the generator is switched off, e.g. like mentioned for maintenance periods or in case of an emergency, the power plant consumes the power from the network. In this case the REG-D(A) switches automatically or via external signal from reactive power flow control to voltage regulation an keeps the voltage inside the power plant grid constant. Again background programming can be used to find customer-specific and optimized solutions.

Minimizing of reactive power flow on network feeding points

In some grids it is possible to use only some big transformers or some so called transformer banks for voltage regulation, all other transformers feeding into that grid are operating with Q-regulation to minimize the reactive power flow from or to the transmission grid.

In this special grids the smaller transformers can't influence the voltage at the feeding point much but they can generate a cos (phi) which will be outside of the specification (tolerance), and which will be acceptable for the transmission grid operator. This problem normally occurs during low load periods when the active power of the load is less and therefore the influence of the circulating current is much bigger than normal.

An additional background program takes care that the voltage stays within certain limits during the Q-regulation process. When the grid is separated it is possible to switch back to voltage regulation within seconds. For this application the background program changes also some regulation parameters. So it is possible to use different parameter sets for voltage and for reactive power regulation.

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