Transformer (Temperature) Controls with A.Eberle VRR's; Application & Benefits

Significant cost savings can be realised in the design and implementation of transformer control systems when a one-box approach is employed. A.Eberle's multifunctional REG-D and REG-DA Voltage Regulator Relays (VRR's) can be equipped with (TMM) Transformer Monitoring Module to provide temperature control of cooling fans and pumps. Thus, in addition to their primary role of controlling the tap changer for voltage regulation, the REG-D/DA "TMM" option provides a number of transformer monitoring and control features. Just considering the cooling control capabilities alone, the added cost of TMM certainly stacks up well against the true cost of using conventional electromechanical or stand-alone temperature controls.

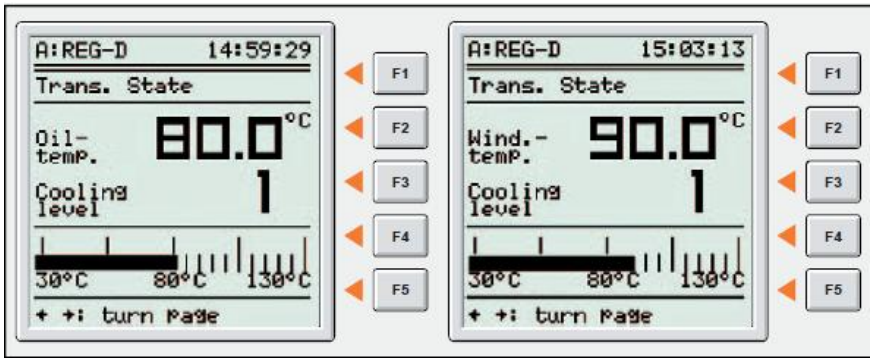

Figure 1. Example of Transformer Temperature Measurement Displays

A typical TMM installation provides:

- Display of top-oil temperature
- Top-oil temperature alarm and trip functions
- Calculation and display of winding hot-spot temperature (Winding Temperature Indicator)
- Hot-spot temperature alarm and trip functions
- Control of multiple fan and pump groups for temperature control of transformer
- Intelligent or "smart" fan control providing preemptive cooling control
- Customised logic added to cooling control such as time-of-use consideration
- Logging of operating time of fans and pumps (hour run timers)
- Transformer "life" consumption calculations
- Estimated I^2t erosion of tap changer contacts logged
- In addition, the above displayed values can be outputted directly to SCADA, as analogue outputs to other devices, or limit alarmed via output contacts

Additional capability includes the ability to:

- Measure oil level of the transformer and the oil level of the tap changer
- Use the REG-D/DA to monitor and report to SCADA the outputs of gas content and moisture content transducers
- Log and strip chart record important parameters

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Benefits:

- One box solution for transformer controls provides:
  - a single SCADA connection point for all transformer related measurements
  - reduction in physical hardware and wiring – reduces installation costs
  - remote monitoring and control capabilities
  - best use of capital investment
  - simplifies setup, commission and maintenance
- Provides measurement and operational capability not available in traditional fan control
  - Customised logic in the REG-D/DA can be provided with H-Code
  - Smart fan controls can activate the cooling long before the transformer can get overheated

Life time information

For regulators with Transformer Monitoring Mode (TMM) enabled, the run time of cooling fans, pumps and tap change motor is logged and available for display. Alarms can be generated when preset thresholds are exceeded.

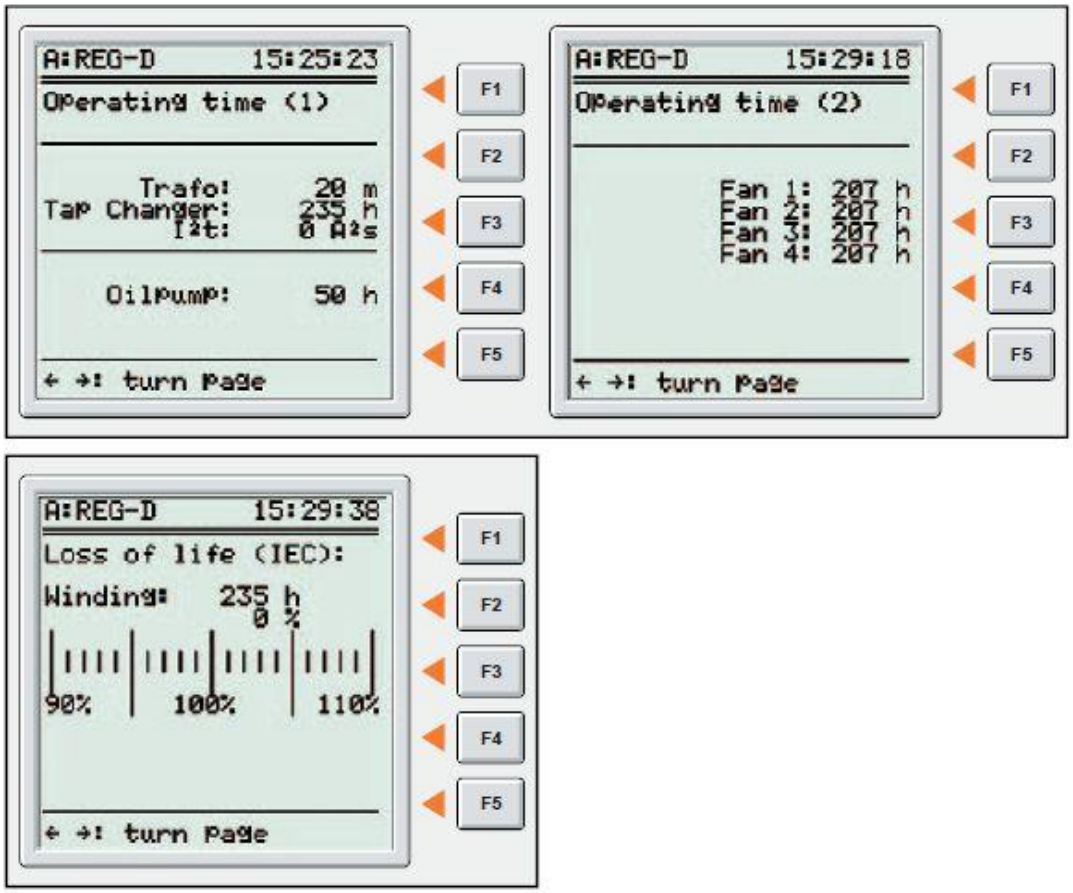

Figure 2. Example of REG-DA life run/consumption information

Transformer winding life is also calculated, based on IEC 354. Essentially for every 6 deg C rise above 80 deg C, a typical transformer's life consumption doubles. TMM measures the transformer temperature, and determines the "consumption" of the transformers estimated life.

Where transformers can be run at higher temperatures, such as in an emergency overload situation, this information is very useful, to log and understand the detrimental effects on transformer life.

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"Smart" fan control

Transformer life is mainly determined by winding insulation, which is predominately affected by transformer (hot-spot) temperature, therefore efficient transformer temperature management is critical.

Standard fan control activates cooling based on the calculated hot spot temperature. Multiple cooling groups can be activated at different temperature settings, for example if the first fan group is not sufficient to limit the temperature, a second fan group is activated as the temperature rises further.

Keep in mind that any rise in hot spot temperature is delayed in time from the load that causes it. This is due to the thermal mass and characteristics of the transformer. Thus standard fan/cooling control actually requires an increase in transformer temperature to occur before it activates, with further added time being required for the cooling to then take effect. Allowing this build-up of temperature and the time taken to cool back down, adds to the erosion of remaining life of the transformer.

Smart fan control offers an advantage over this traditional approach. Smart fan control looks at the hot spot temperature calculation, but excludes the thermal delay. Essentially, it says "given the existing current level, what will be the future transformer temperature?" The operation of cooling is then based on this prediction, rather than waiting for the actual temperature rise to occur. Thus the advantage, transformer cooling is started earlier, limiting temperature rise before the transformer "starts cooking!"

Smart fan control is a standard option in all REG-D/DA voltage regulators equipped with TMM. Just select "smrtctrl" as the "base of regulation". It does not require any additional calculations or other setting changes.

Ordering and Input configuration

TMM function is normally specified at time of ordering the regulator, as the analogue input requirements need to be considered. However, under specific circumstances TMM can be retrofitted to existing devices.

Normal TMM functionality requires measuring transformer load current and transformer oil temperature:

- Most REG-D/DA's are installed with a CT connection to enable the Regulator to monitor circulating current when transformers are paralleled, and to allow the Regulator to display and output to SCADA the transformer loading. This input is also used by TMM
- Transformer temperature is measured by the Regulator using suitable temperature measuring sensors with 4-20 mA output or PT100s to measure the transformer top oil temperature. Configuration and ordering needs to ensure sufficient inputs are available for temperature measurement and tap position measurement

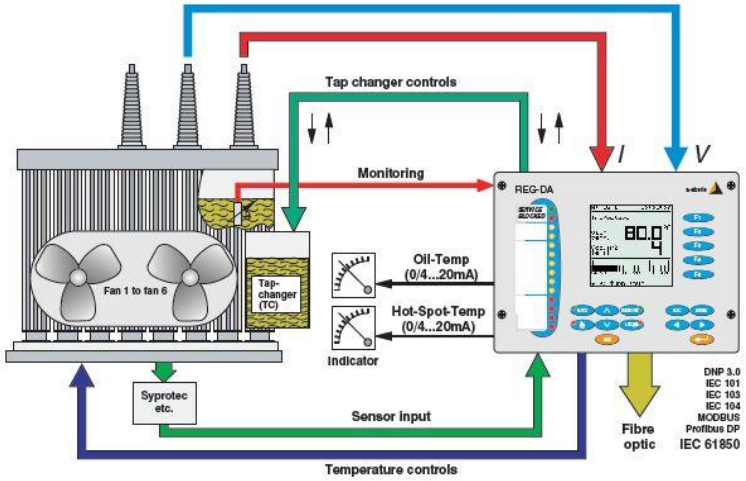

Figure 3. Transformer with TMM

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