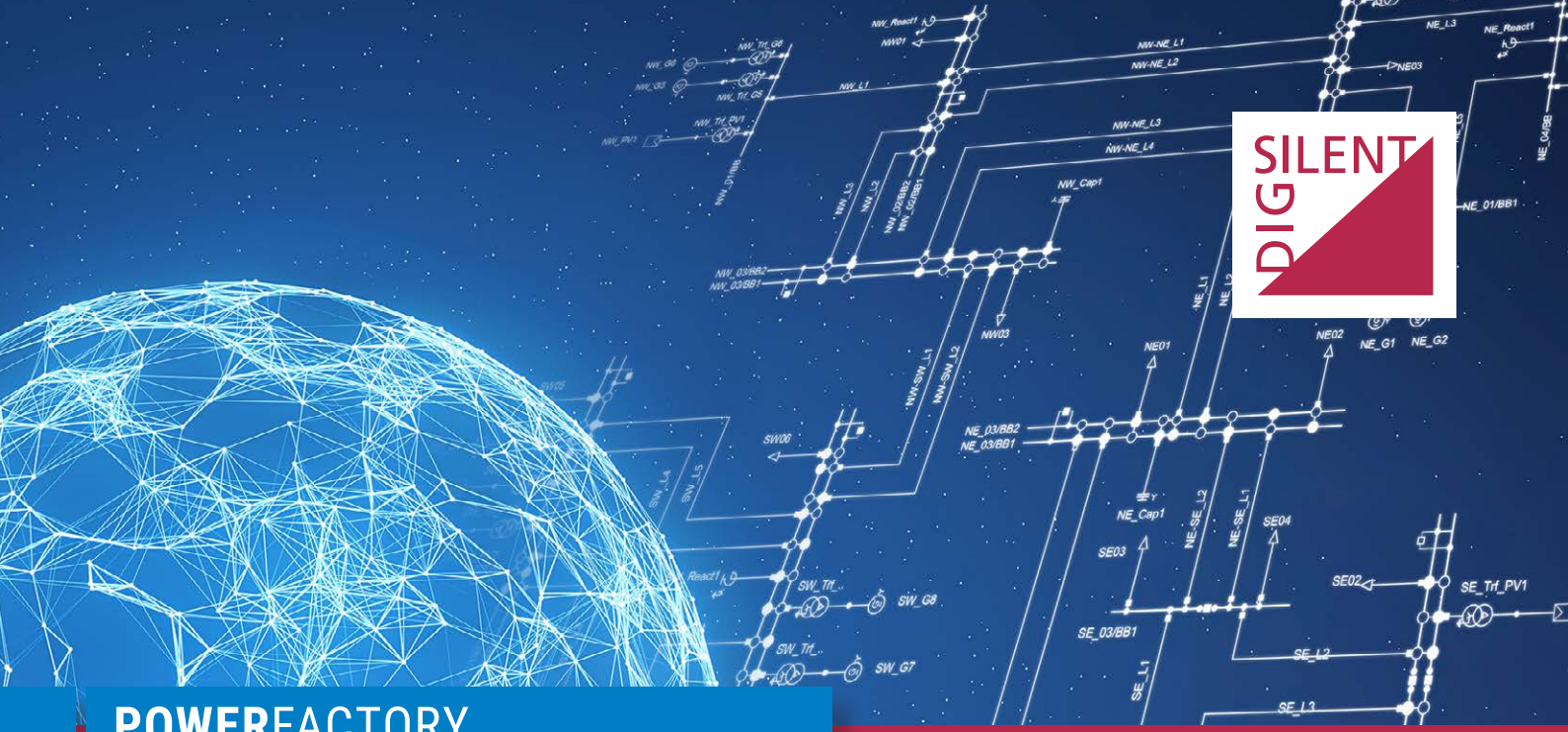

POWERFACTORY

PowerFactory 2021

Technical Reference

Tap-Controller

ElmTapctrl

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

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Contents

1 General Description

The Tap-Controller object is used in Load Flow calculations to model complex ”Master” - ”Slave” tap controlling logic for a group of transformers.

2 Load Flow Analysis

2.1 Load Flow Data

The Load Flow Data page contains the following options:

Automatic Tap Changing (parameter name: $isAutoTap$) When this option is enabled, it activates the automatic tap adjustment of the selected transformers in load flow analysis. When disabled, it is equivalent to being out of service, and all others controls are also inactive.

Setpoint (parameter name : $uset\_mode$) It has two options:

- local: The voltage setpoint and voltage range settings (upper and lower limits) must be entered in the dialogue. See Section 2.2.1.
- bus target voltage: The voltage setpoint and voltage range settings (upper and lower limits) are taken from the controlled busbar (topological search). See Section 2.2.2.

Phase (parameter name: $ilcph$) For unbalanced load flow analysis, the controlled phase needs to be additionally defined.

Controlled Node (parameter name: $iCtrlNode$) This control has the following options:

- *HV*: Tap controls the HV side.
- *MV*: Tap controls the MV side. Only available when there is a three-winding transformer selected.
- *LV*: Tap controls the LV side.

Controlled Node (parameter name: $rembar$) The busbar whose voltage is to be controlled.

Upper/Lower Voltage Limit (parameter name: $usetp\_mx$ and $usetp\_mn$) Upper and lower bound of the voltage. The tap-controller object can only work as a discrete tap changer, that is, the tap control can drive the voltage into a permitted band.

Controller Time Constant (parameter name : $Tctrl$): Time Constant of the controller in seconds.

Max. Tap Deviation (parameter name : $iDeltaTapMax$): Maximal allowed tap deviation between individual transformers taps. Values allowed are 0 or 1. See Section 2.3.

2.2 Topology and Controlling Groups

2.2.1 Local Controlled

The selected busbar (*rembar*) is used as the controlled node and all transformers are automatically in one controlling logic group.

2.2.2 Bus Target Voltage Controlled

For each in-service transformer, a search routine starts from the corresponding internal node (HV, MV, LV) depending on the *Controlled Node* setting, and stops until a busbar is found, which is in the same equipotential area of the transformer terminal. This search routine will stop if any open switch or another transformer is found.

The busbar with the lowest voltage priority (≥ 0) number is used for the controlled busbar and the corresponding target voltage. If no busbar was found (because of an open breaker, for example), the transformer tap-adjustment for the corresponding transformer will be automatically disabled.

All transformers controlling the same busbar are grouped in a controlling logic group.

2.3 Controlling Logic

2.3.1 Max. Tap Deviation = 0

All transformers in a group must have the same tap position (relative tap-position) and are stepped simultaneously. If a flat start load flow is calculated and for all transformers is the *Automatic Tap Changing* option is enabled, the tap-positions are first set to an averagage tap position as follow:

$$Tap_{average} = \frac{\sum_{i=1}^{n} Tap(i)}{n} \tag{1}$$

Where:

- n is the number of in-service transformers of the controlling group.
- $Tap(i)$ is the actual tap position of transformer i.
- $Tap_{average}$ is the average tap position.

$$Tap_{init}(i) = Round(Tap_{average}) \tag{2}$$

Where:

- $Tap_{init}(i)$ is the new initial tap position for transformer i.

The tap positions of the transformers are then adapted in the outer loop of the load flow as follows:

$$\Delta Tap_{total} = \frac{(u_{setp} - u_m) \cdot hctrl}{istep \cdot 0.01 \cdot Tctrl} \cdot n \tag{3}$$

Where:

- u_{setp} is the voltage setpoint in p.u.
- u_m is the voltage at controlled busbar.
- $istep$ is the step direction (1 or -1).
- $Tctrl$ is the controller time constant in seconds.
- $hctrl$ is the global relaxation factor = $krelax \cdot T(min)$.
- $T(min)$ is the fastest controller time constant of all automatic adjusted tap-changer, tap controller and shunts.
- $krelax$: is the min. controller relaxation factor parameter in the load-flow command (/Advanced Options/ page).
- n is the number of in-service transformers of the controlling group.

The new total tap for all transformers of the group is:

$$Tap_{total,new} = Round(Tap_{total,old} + \Delta Tap_{total}) \tag{4}$$

The tap change of one transformer is then:

$$\Delta Tap_{new}(i) = \frac{(Tap_{total,new} - Tap_{total,old})}{n} \tag{5}$$

The tap position of transformer i. is then changed by $\Delta Tap_{new}(i)$.

Note: The tap position is not changed for those transformers in a controlling group, whose *Automatic Tap Changing* option is disabled.

2.3.2 Max. Tap Deviation = 1

Under this logic, the transformers do not necessarily must have the same tap position; however, they can have up to one tap position deviation from each other. This allows a finer tuning of the voltage control, given that the control of the transformers taps is discrete.