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Parallel operation of transformers with system topology

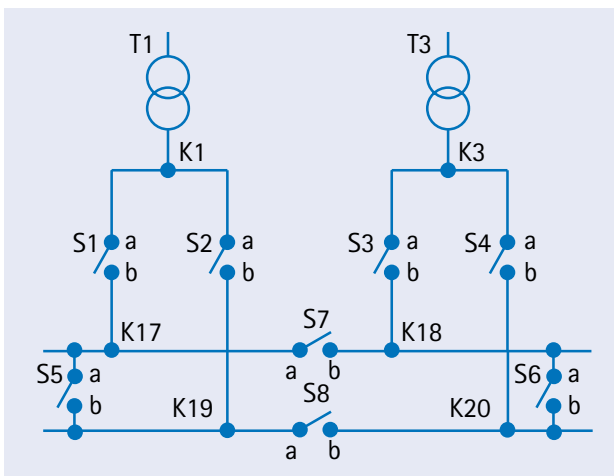
In addition to their principal task, which is to assure constant transformer voltage for a wide range of load conditions, state-of-the-art voltage regulators are also capable of mapping the topology of a switching system with its isolating switches and circuit breakers.

Voltage regulators like TAPCON® 240 are thus capable of taking over the configuration of a switching system and adapting its regulating behaviour to the system's current switched condition.

At the same time, it also allows the parallel operation of transformers to be controlled with great ease. A TAPCON® 240 is capable of controlling up to 16 voltage regulators of the transformers connected in parallel. The exchange of information between the regulators is realized via CAN bus and is possible for distances up to 2 kilometres.

We have used a very simply and straightforward configuration example of a switching system to show you how the software works during parallel operation with system topology.

The example below shows the parallel operation of two transformers, T1 and T3, at a twin bus-bar with bus-tie circuit breaker and bus-tie disconnecter.



Parallel operation of two transformers

Parameters	Connecting nodes	
Designation - Transformer 1		
Designation - Transformer 2		
Designation - Transformer 3		
Circuit breaker 1	Terminal a	1
Circuit breaker 1	Terminal b	17
Circuit breaker 2	Terminal a	1
Circuit breaker 2	Terminal b	19
Circuit breaker 3	Terminal a	3
Circuit breaker 3	Terminal b	18
Circuit breaker 4	Terminal a	3
Circuit breaker 4	Terminal b	20
Circuit breaker 5	Terminal a	17
Circuit breaker 5	Terminal b	19
Circuit breaker 6	Terminal a	18
Circuit breaker 6	Terminal b	20
Circuit breaker 7	Terminal a	17
Circuit breaker 7	Terminal b	18
Circuit breaker 8	Terminal a	19
Circuit breaker 8	Terminal b	20
Circuit breaker 9	Terminal a	0
Circuit breaker 9	Terminal b	0
...
...
Circuit breaker 16	Terminal a	0
Circuit breaker 16	Terminal b	0

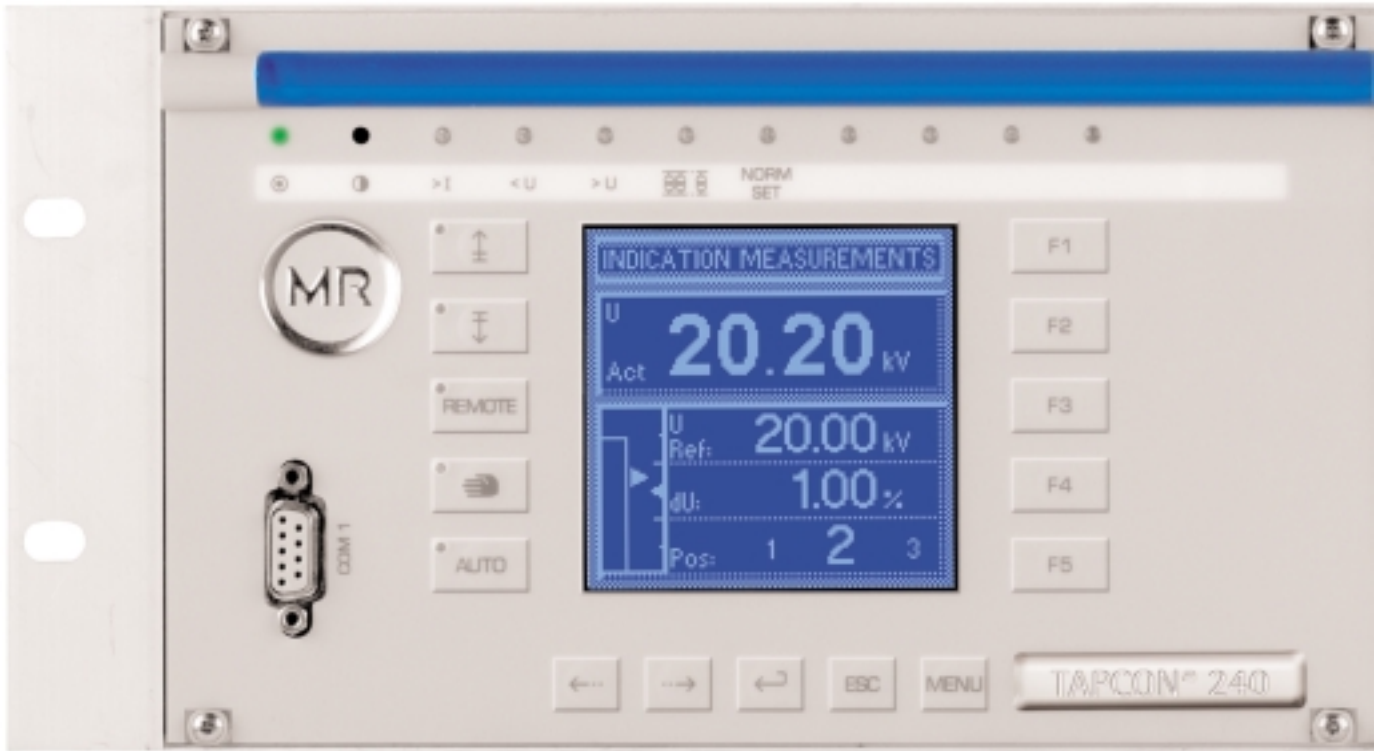
Parameter table of the system topology

Each circuit breaker is represented by a switching symbol. This circuit breaker S permits any switched condition of the system to be visually displayed.

For this purpose, the feed-in points of the 16 transformers possibly connectible are referred to as K1 ... 16. The designation of any additional connecting points will begin with K17.

Each circuit breaker S is equipped with the connection terminals a and b which connects it to the other circuit breakers and/or transformers present in the system.

SYSTEM TOPOLOGY



To make sure the TAPCON® 240 is capable of mapping the switched condition of a system via its binary inputs, the information as to which terminal clamp is connected to which connecting point or feed-in point is laid down in the regulator's parameter file.

The example contained herein refers to the parameter table for the 16 circuit breakers max., in which case any non-existent circuit breakers are simply connected to node Zero and do therefore not register as existent during the subsequent program inquiry.

The software of TAPCON® 240 now uses a method remotely reminiscent of the algorithm of a node tension analysis for detecting the switched condition of a system in order to control the transformers' parallel operation.

To that end, following an inquiry of the circuit breakers by the regulator, the software internally assigns a number to each closed circuit breaker of the system. By comparing the connecting loads via the closed circuit breaker, the software establishes a connection matrix which is then reduced through the comparison of known connections. That way, the regulator can

determine without a doubt which of the transformers are connected in parallel.

The substation topology visualization system realized so far allows the display of up to six transformers on two display pages.

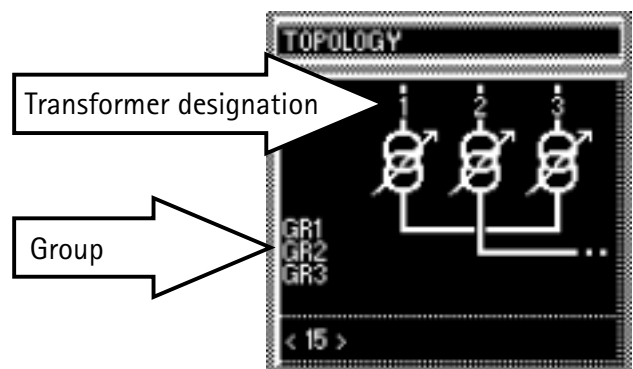
These six transformers in turn can be interconnected into individual groups at the user's discretion.

The transformers represented as symbols are then shown together with their respective switched-in-parallel transformers on the display's topology pages.

The user has a choice of assigning the transformer designations himself, in

the same manner as the designations found in his substation. In case a transformer belongs to a group which is no longer presentable on the same display, the related connecting line will stop as a dotted line at the edge of the screen.

That is how the TAPCON® 240 voltage regulator elegantly solves the tasks of identifying the switched condition of a substation with its connected transformers, executing the activities required for parallel transformer control, and representing the current system topology on its display.



Topology representation on the TAPCON® 240