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Transformers in parallel
Information for installation

Hann. Münden, Apr-19

Installation of transformers in parallel

The following conditions should be fulfilled to permit installation of transformers in parallel:

- The same vector group / The same vector group code numbers
- The same transformation ratio
- The short-circuit voltages of the transformers to be installed in parallel must not diverge by more than 10% from the average of the short-circuit voltages of all transformers involved.

Load distribution in parallel operation

Provided the above conditions are fulfilled, the outputs are divided as follows:

$$S_1 = \frac{S_{r1}}{S_{r1}+S_{r2}} \cdot S_{ges}$$

$$S_2 = \frac{S_{r2}}{S_{r1}+S_{r2}} \cdot S_{ges}$$

S_{r1} : Rated power transformer 1

S_{r2} : Rated power transformer 2

S_1 : Load of transformer 1

S_2 : Load of transformer 2

S_{ges}: $S_1 + S_2$

Differing short-circuit voltages

Transformers installed in parallel absorb a part load in such a way that all transformers have the same short-circuit voltage. The nominal short-circuit voltage relates to the nominal load; at part load, the short-circuit voltage changes at the ration of part load to nominal load.

Example

Transformer 1	Transformer 2	Transformer 3
Sr1 = 400 kVA	Sr2 = 1000 kVA	Sr3 = 500 kVA
uz1 = 4 %	uz2 = 6 %	uz3 = 4.5 %

Total output = 1900 kVA

In general:

$$\frac{S}{Uz} = \frac{Sr1}{Uz1} + \frac{Sr2}{Uz2} + \ldots$$

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The resulting short circuit voltage is described as

$$u_z = \frac{S}{\frac{S_{r1}}{u_{z1}} + \frac{S_{r2}}{u_{z2}} + \frac{S_{r3}}{u_{z3}}} = \frac{1900}{\frac{400}{4} + \frac{1000}{6} + \frac{500}{4,5}} = 5,03$$

Load distribution

$$S_1 = S_{r1} \cdot \frac{u_z}{u_{z1}} = 400 \cdot \frac{5,03}{4} = 503$$

$$S_2 = S_{r2} \cdot \frac{u_z}{u_{z2}} = 1000 \cdot \frac{5,03}{6} = 838,3$$

$$S_3 = S_{r3} \cdot \frac{u_z}{u_{z3}} = 500 \cdot \frac{5,03}{4,5} = 558,89$$

Transformer 1 is therefore overloaded by 26% and transformer 3 by 12%. In order to avoid any overloading, the transformers should only be loaded to the extent that their joint short-circuit voltage uz does not exceed = 4%, this means:

$$S_1 = 400 \cdot \frac{4}{4} = 400$$

$$S_2 = 1000 \cdot \frac{4}{6} = 666,67$$

$$S_3 = 500 \cdot \frac{4}{4,5} = 444,44$$

$$S_{ges} = S_1 + S_2 + S_3 = 1511,11\,kVA$$

Differing vector group code numbers

Transformers with vector-group code number 11 can be operated with code number 5 in parallel provided they are connected as follows:

Conductor		**High voltage**			**Low voltage**		
		$1L_1$	$1L_2$	$1L_3$	$2L_1$	$2L_2$	$2L_3$
Vector-group code number	5	1U	1V	1W	2u	2v	2w
	11	1U	1W	1V	2w	2v	2u
		or					
		1W	1V	1U	2v	2u	2w
		or					
		1V	1U	1W	2u	2w	2v

Transformers with vector-group code number 6 can be installed in parallel with code number 0 provided the beginnings and endings of the low voltage winding are interchanged with one another when connecting the latter transformers.