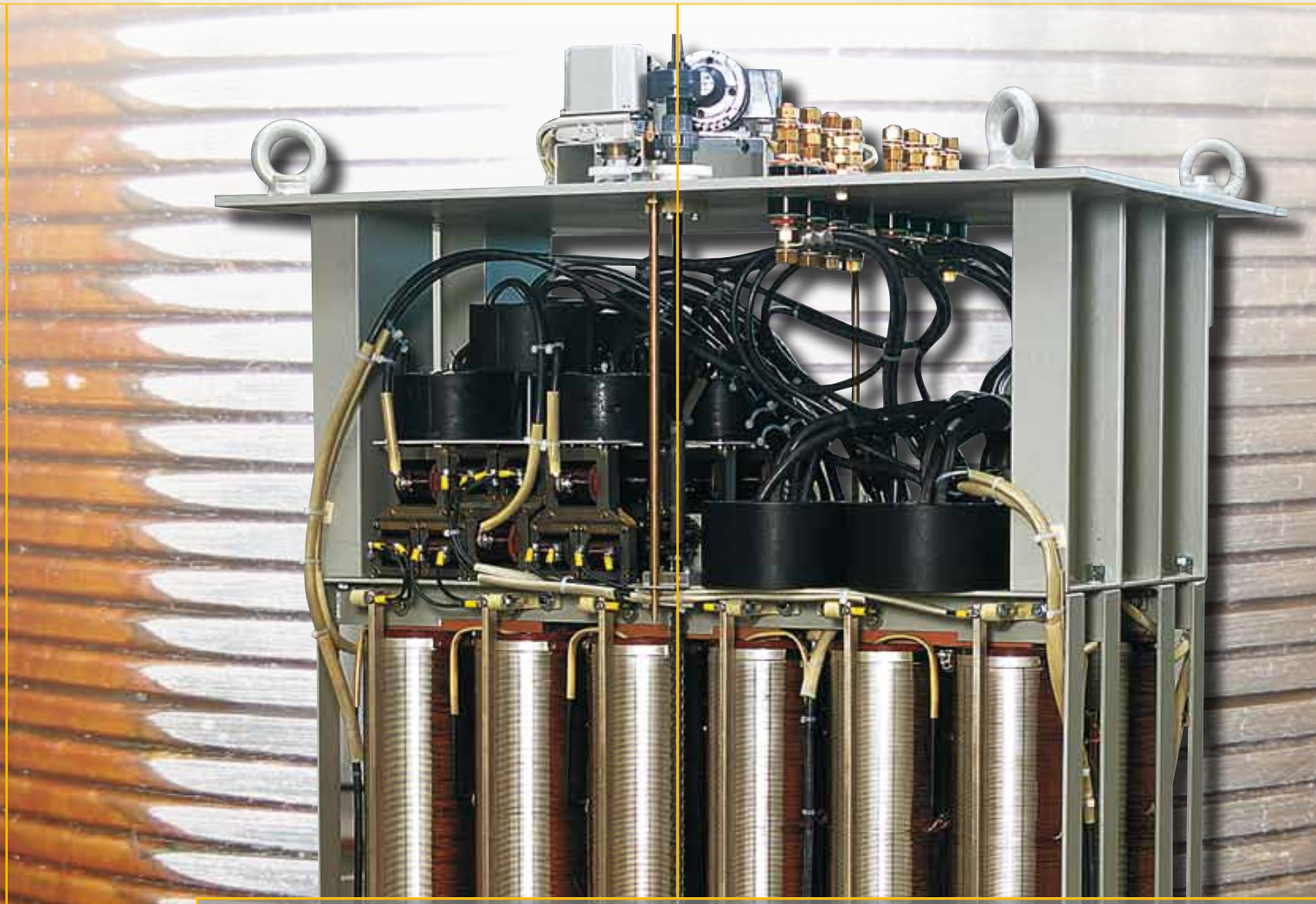
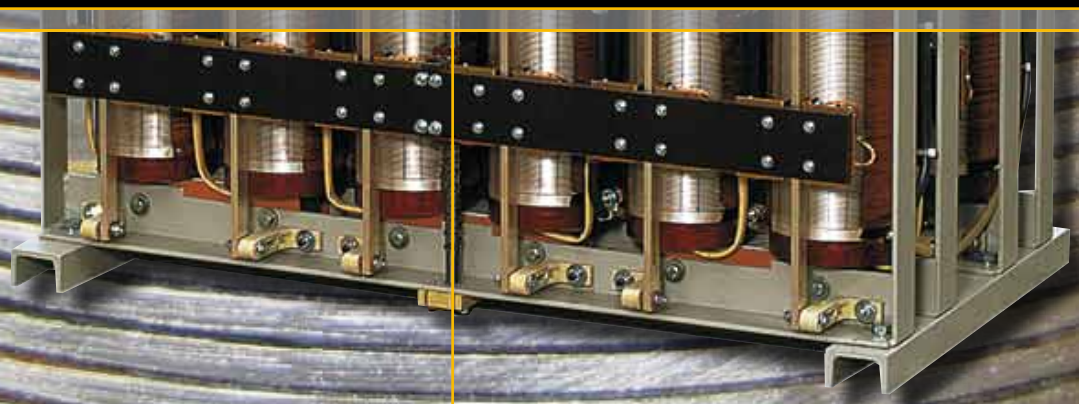
Ruhstrat®

VARIABLE COLUMN TRANSFORMERS



TECHNICAL INFORMATION



GLC CERTIFIED ISO 9001

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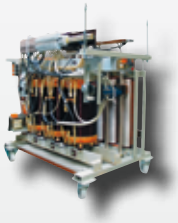

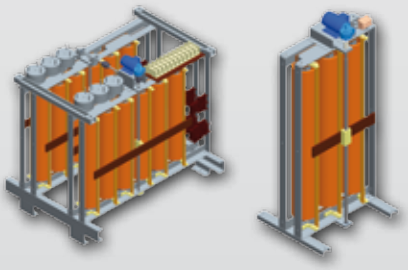

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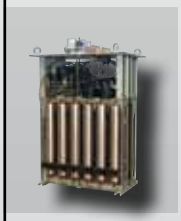
There is no substitute for quality

Ruhstrat has decades of experience in developing and manufacturing electrical winding products. We offer more than innovative technology. Being a reliable partner we assist our customers by developing optimal solutions customized to their needs.

While carrying out the development, the design, the delivery and the creation of solutions is an important part of our business, another important part is the performance of a service comprising all expected tasks, from the maintenance to the support.

Ruhstrat has been specialized in developing and designing transformers, reactors, power supplies and power resistors. Besides the complete standard programme of these business fields Ruhstrat emphasizes the design and manufacturing of plants and systems individually tailored to the requirements of our customers. We manufacture custom-made transformers, reactors, power supplies and power resistors. Ruhstrat components are used wherever products made to specification and small and minimum batch sizes are needed, so for uses which cannot be provided with bulk goods.

Product overview:



Variable Transformers from 20 VA to 2 MVA

- variable toroidal transformers
- variable column transformers

Voltage Stabilizers from 60 VA up to 2 MVA

- magnetic voltage stabilizers
- automatic voltage stabilizers

Power Transformers from 50 VA up to 8 MVA

- dry-type power transformers
- cast-resin transformers

AC/DC Reactors

- as mains reactors, smoothing reactor, three-phase compensation reactor, three-phase filter reactor, motor reactor

Toroidal Core Transformers up to 400 kVA

High-Current Transformers up to 30 kA

Power Resistors up to 5 MW

- load resistors
- test resistors
- tube resistors
- laboratory resistors

TECHNICAL INFORMATION

General

Ruhstrat variable column transformers are developed, manufactured and tested in accordance with relevant EC directives, European standards and VDE regulations, in particular DIN EN 61558-2-14 and VDE 0552. The content of the following descriptions is part of our terms and conditions of sale and delivery.

The nominal powers specified in the tables on pages 11, 13 and 15 apply to operation in maintained mode. The nominal current can be collected over the entire control range. Limit values for overload in intermittent operation (S2) and other operating modes are depicted by the curve in Fig. 1.

Application

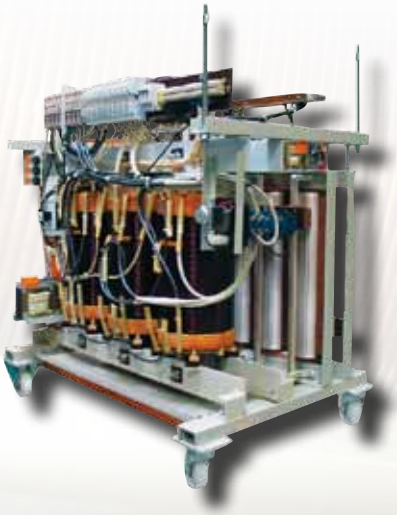
Variable column transformers are used to regulate alternating voltages or currents under load between zero and the nominal value. They are suitable for the power supply to resistive, inductive or capacitive equipment.

For technical testing systems, Ruhstrat offers the entire variable transformer testing technology, including electronic controllers (SIEMENS S7). For labs, test shops or for mobile use – Ruhstrat develops and manufactures customized voltage and current supply systems for stepless regulation from 0 to 10,000 volts and currents up to 30,000 A.

The tables on pages 11, 13 and 15 include only the most common versions. Other control ranges, power outputs, drive types, etc. are available on request.

Power outputs

Variable transformers up to 1,500 kVA and 1,000 volts are available. In combination with a downstream dry-type transformer as a variable transformer aggregate up to 2,000 kVA and 10,000 volts.



Installation

When installing variable column transformers it is important not to block the self-ventilation. Insufficient ventilation can result in excessive heat build-up under normal ambient conditions, which can destroy the variable column transformer as a consequence.

Perpendicular installation of variable column transformers is ideal with respect to the thermal and mechanical properties. The installation location must exhibit sufficient mechanical rigidity and stability.

Connection

For three-phase variable column transformers which are star connected, the neutral point lead-through is insulated. It must never be used to form an artificial neutral point; however, the nominal current can be applied to each strand of such a transformer, if the mains neutral point (earthed neutral conductor) and the transformer neutral point are connected to each other.

Winding connections of variable column transformers with autowindings must never be connected to the protective conductor or earth. However, this does not exclude the necessity for including the transformer and connected consumers in a protective system. If necessary, a transformer with separate windings must be connected for decoupling.

Load

The data specified on the rating plate applies to operation as intended at the nominal voltage and nominal current and a maximum ambient temperature of 40 °C, at an elevation of up to 1,000 m above sea level and relative humidity of up to 85 %. Reduced heat transfer at ambient temperatures above 40 °C and installation at elevations higher than 1,000 m above sea level cause a decrease in the load capacity of variable transformers; the same applies if the ventilation is blocked. See fig. 2.

Heavy-duty operation

Ruhstrat variable column transformers conform to the conditions of VDE 0552 § 5g for heavy-duty operation. According to VDE 552, heavy-duty operation is "operation under extreme electrical conditions, for example

a) no movement of the current collector over extended periods (24 h)

b) frequent switching on and off under load

c) operation with current load in which the ratio of effective value to rectified value is 1.15 (e.g. phase angle control)".

The exact final mode of operation for the required variable transformers is generally not known. Therefore, it must be expected that for technical reasons there will be no regulation over a much longer period than 24 h.

Ruhstrat variable column transformers are designed for these heavy-duty operating conditions.

In variable column transformer for normal operation (VDE 0552, § 5 h) it is assumed that regulation takes place relatively frequently. If this frequent regulation does not occur, then it can be expected that the temperature at the contact point will be above the maximum permissible temperature. In such cases, one can expect defects sooner or later.

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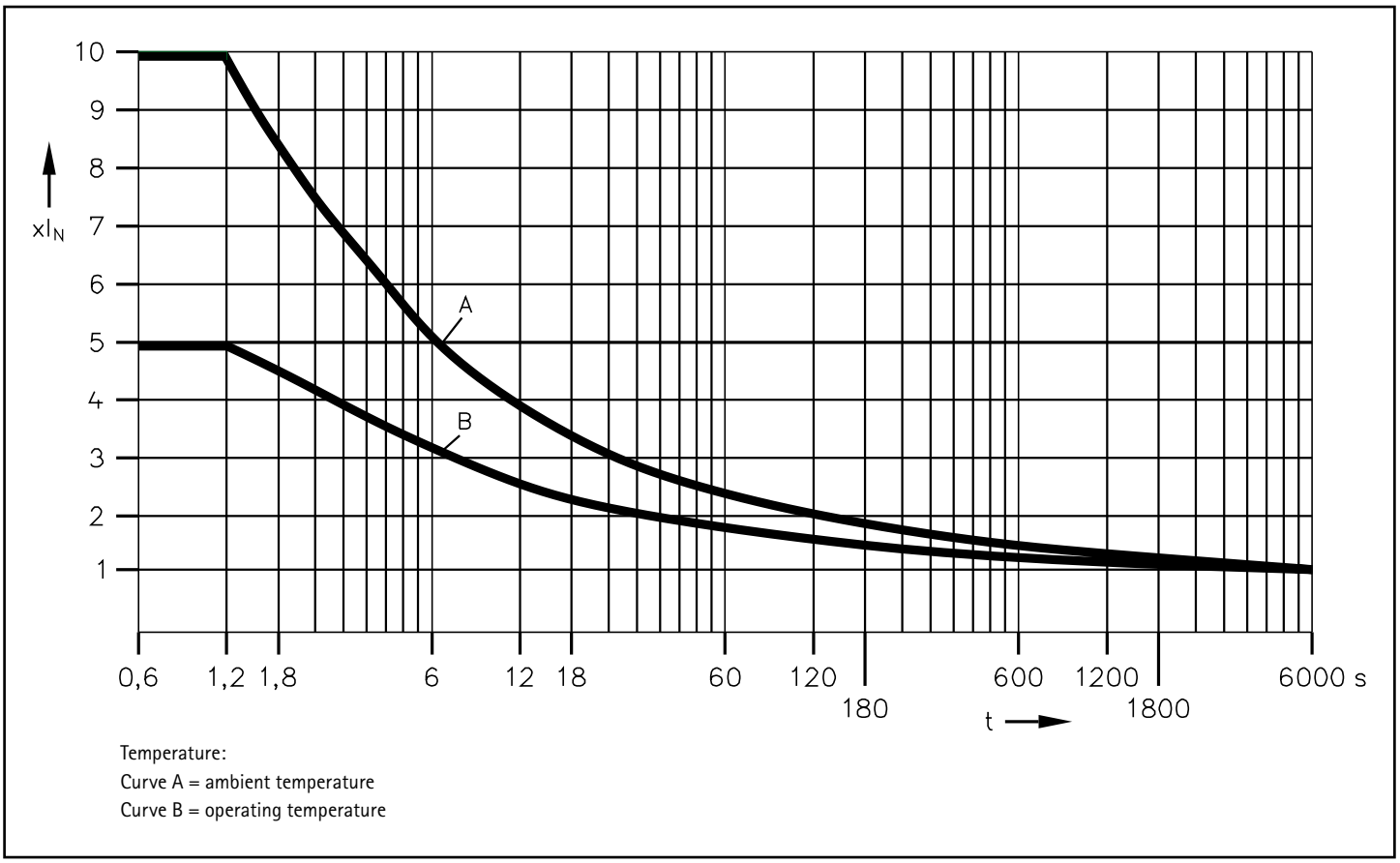

Fig. 1
Limit values for overload in intermittent operation
A – cold state
B – warm state

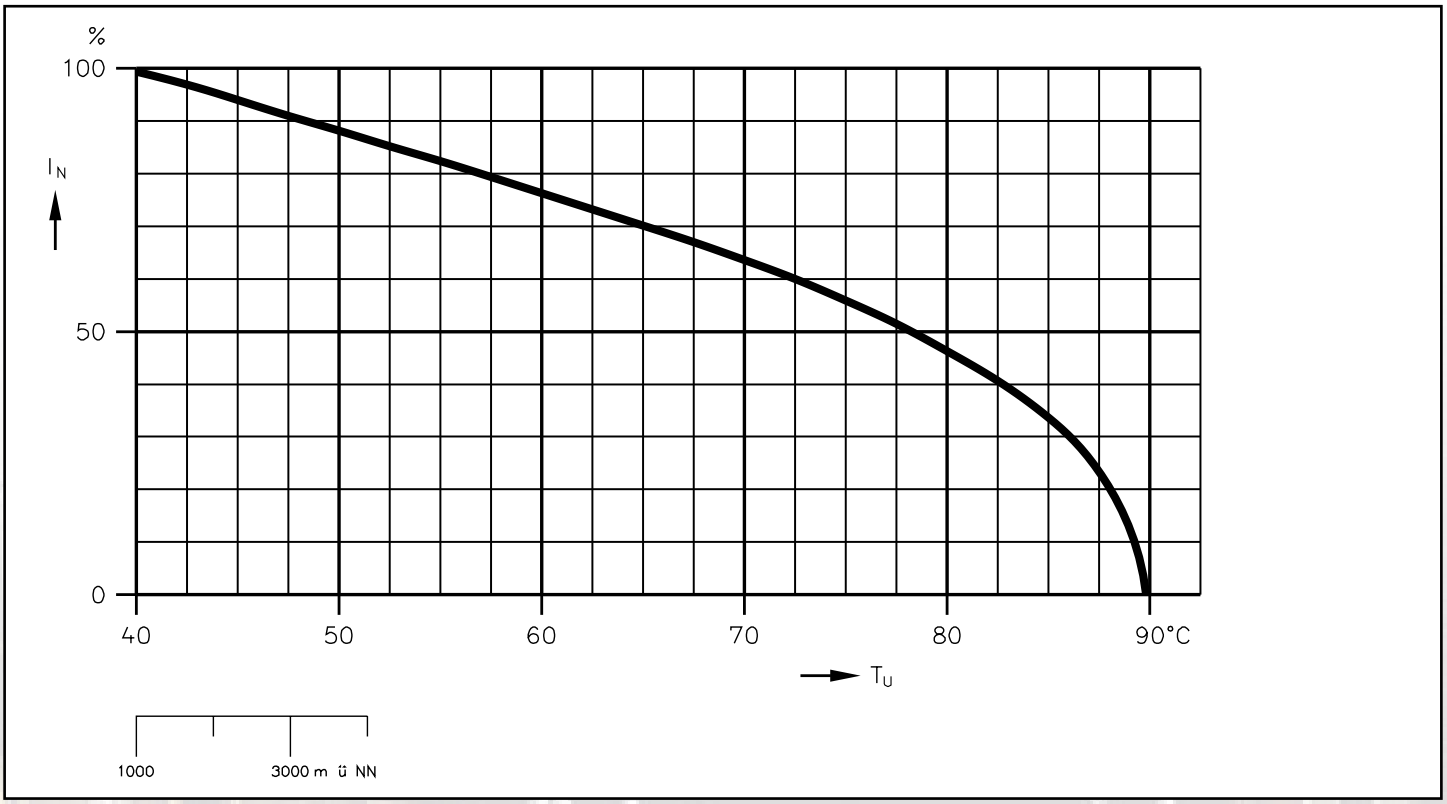

Fig. 2
Reduction curve for ambient temperature and installation elevation

Hard silver plating of the most important contact points
The contacts are optimized by hard silver plating at the decisive contact points (e.g. on the contact track, within the current collector and on the current collector rod).

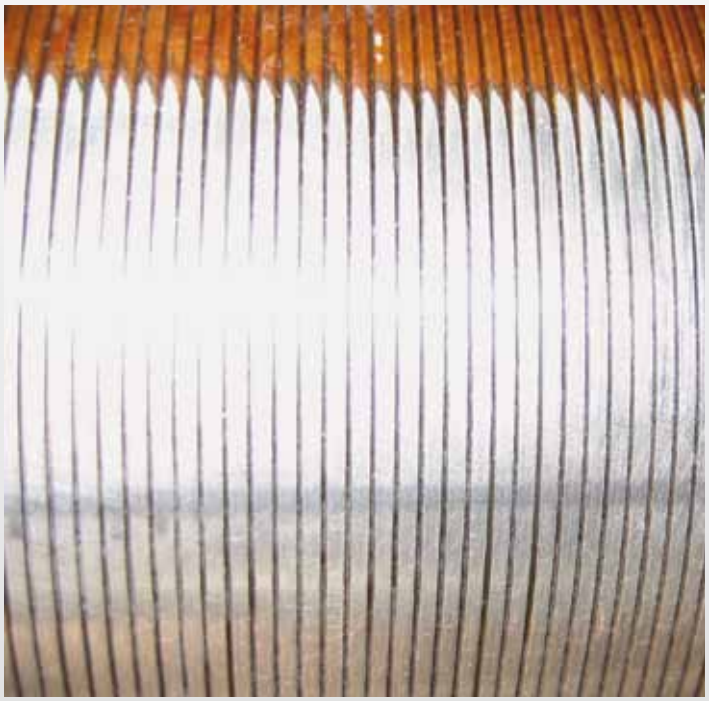

Fig. 3
Hard silver plating on the contact track

Compensation winding
Complete failure of the secondary voltage is possible in extreme control positions in variable column transformers without compensation winding. Therefore, Ruhstrat variable column transformers are designed with compensation winding according to VDE 0552, § 4c 5.

Overload protection
Variable column transformers can be overloaded only temporarily (see fig.) and are not short circuit-proof. Overload devices should be selected based on trigger curves. Input-side overload devices cannot sufficiently protect a variable column transformer due to the changing transmission ratio. If such overload devices are used, the switch-on current impulse must be taken into account. This depends on the mains conditions at the installation location and can be 15 to 30 times the nominal current at the time of switching on, and subsided after ca. 200 ms.

Variable column transformers can be sufficiently protected by an overload device adapted to the output current of the variable transformer and located in the output circuit if it simultaneously shuts off the input side when triggered.

External interferences
When installing variable column transformers in interconnected networks, the wiring must be carefully routed to prevent interference from compensating currents from external circuits. Biasing by single-wave rectifiers or external DC components is not permitted.

3. The protection types
RUHSTRAT variable column transformers are delivered
a) as modular versions
corresponding to IP 00

b) in a housing
for air self-cooling in accordance with IP 20

for oil self-cooling
in accordance with IP 54 for the active element and
in accordance with IP 20 for the drive and connection terminals.

Other protection types on request.

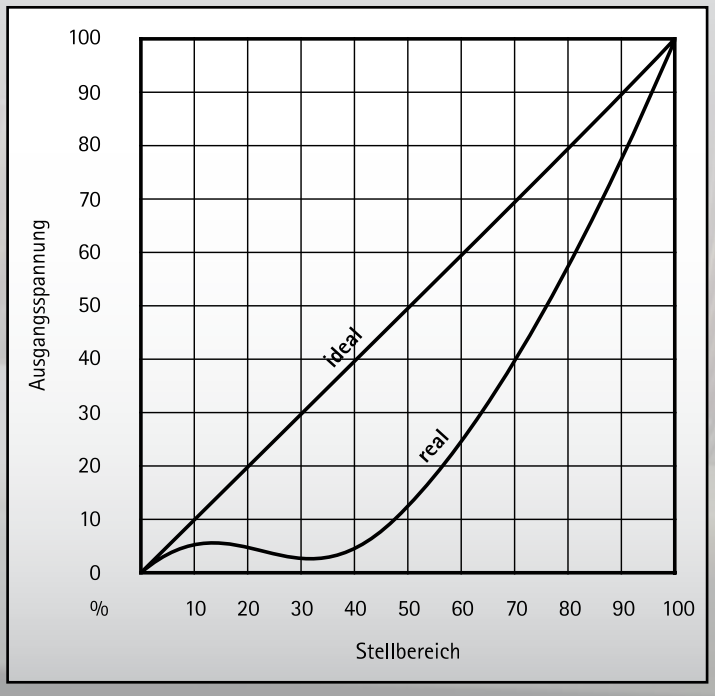

Fig. 4
Voltage drop with variable transformers without compensation winding

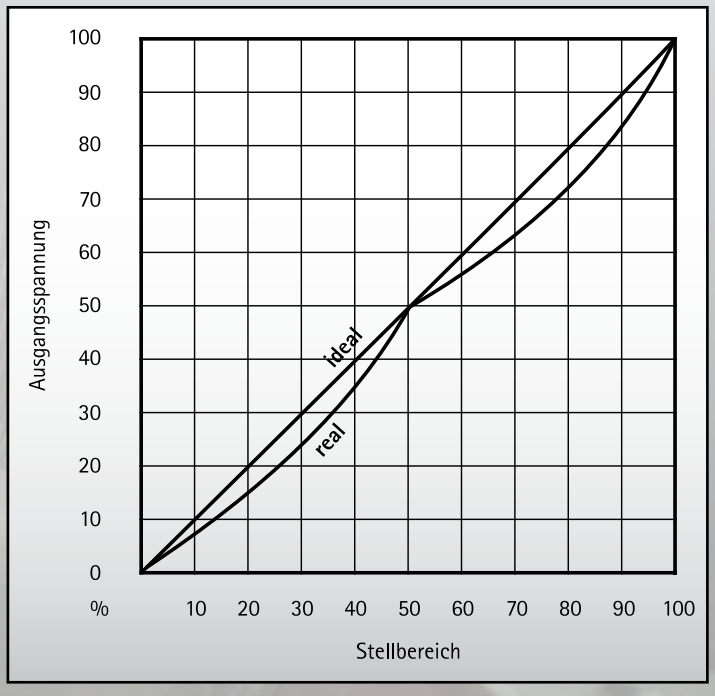

Fig. 5
Voltage drop with variable transformers with compensation winding

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Cooling types

Ruhstrat variable column transformers are available as air self-cooling (AN) and oil self-cooling (ON) models. Oil self-cooling is necessary when variable column transformers are used in areas with high relative humidity or subjected to a corrosive or very dusty atmosphere. Unimpeded, natural air circulation for variable column transformers is sufficient for operation under constant load if the ambient temperature is not higher than 40 °C. Externally cooled variable column transformers are available on request.

Switching types

The variable column transformer allows a large number of switching types. The three most important switching types are described below.

a) **Normal switching (I0)**, the simplest type of switching, is quite common. In this switching type, a load can be supplied with a voltage from 0 – 100 %.

b) **The ± switching.**
The next switching type is referred to as ± or phase reversal switching.
According to the wiring diagram, there is a second current collector on the opposite side. Both current collectors are forced to move in opposite directions.

In the middle position of the current collectors the output voltage is zero. Deviation from the middle position in either direction results in a simple reversal of the phase position. This phase shift of the voltage between the two current collectors can double the control power. This switching type is suitable when only partial control ranges are required for larger control powers.

c) Opposed regulation.
In opposed regulation the variable transformer is similar in structure to the + regulation.
In this switching type, there is no phase reversal. Two currents are created on different potentials. Each current is between a current collector and the end of a winding.

If possible, the device to be controlled (e.g. the primary side of a stationary transformer) should be divided into two decoupled sections, which is quite advantageous for the variable transformer when this switching type is used. The variable transformer then must be designed for only half the current. Half of the current flows into both circuits. When linked to form a network the current that flows corresponds to the total power output. This switching type can also be used for regulated two separate consumers. It is not necessary for both consumers to have the same power output. However, the variable transformer must be designed for the power output of the larger consumer. If both current collectors are provided with separate actuators, both currents can be regulated separately and independent of each other.

Switching groups

Variable column transformers can be manufactured with different switching groups. With autowinding, the switching groups I0, YN0 and D0 are possible. These three different types can be executed in all of the above switching types (normal, ± switching and opposed switching).

For switching group D0, only stationary transformers with an open winding can be connected downstream.

For variable column transformers, separate winding is also possible as a design version. Here, the switching groups Ii0, Yy, Dd, Yd and Dy can be implemented. In these switching groups, ± switching and opposed switching are not possible.

The phase shift between the primary and secondary side is achieved by multiplying the number following the switching group position by 30°.

Windings with zig-zag switching are not possible.

Drive

An even and precise setting is made possible by adjusting the spindle. The spindle is adjusted either by hand, using a handwheel placed directly on the spindle end or a bevel gear, or by means of a flange-mounted gear motor. Normally a three-phase asynchronous machine for fixed variable times is used as the gear motor. Alternate motor running times can also be allowed for. For variable speeds which have to be adapted to alternating operating conditions, a frequency converter is used to control the motor. The limit switches required for the motor drive are provided. Reversing contactors can be installed on request. Normal control voltage is 230 V, 50 Hz. Alternate control voltages can also be allowed for. If necessary, automatic control of the variable transformers provided with a motor drive is possible via additional devices (e.g. stabilization of a pre-defined value, follow-up control).

Fig. 6
Drive

TECHNICAL INFORMATION

Current collector

The contact points are critical for all electrical connections. There are good reasons why the temperature increase at the contact point was selected in VDE 0552 as a criterion for the design of the variable transformers. The temperature of the carbon roll, whose specific resistance must be adapted to the winding voltage and the contact material, is determined by the flowing current. This current increases as soon as the carbon roll bypasses two windings; then a short-circuit current flows between the two windings in addition to the consumer current. Despite this unfavourable situation, the temperature increase at the contact point must never exceed 80 K during heavy-duty operation and with insulation class E. Due to the advanced Ruhstrat contact system, the losses are minimized by the transition resistances and the remaining contact heat is effectively dissipated (Fig. 7). The consumer current is distributed throughout the entire current collector system in a defined manner, thus preventing overloads at contact points. If two carbon rolls are connected in parallel, this is achieved by means of a decoupled conductor rail and a current compensation transformer.

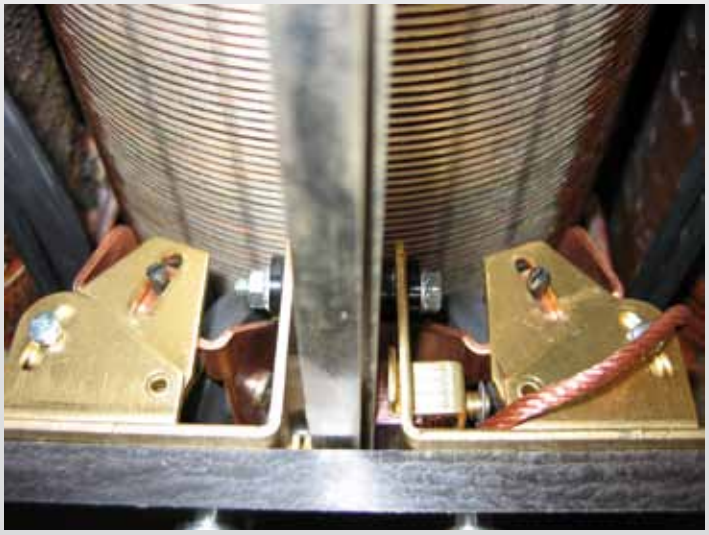

Fig. 7
Current collector system

Maintenance

Regular inspections and preventive maintenance of the Ruhstrat variable column transformers will ensure reliable operation and a long service life. The owner is required by law to conduct risk analyses, to schedule regular inspections and to document the results. Following are the minimum requirements for regular maintenance to be performed on variable column transformers:

- Check all connections, especially of the protective conductor connections for proper contact.
- Check all moving parts for proper functioning, correct position and proper fit.
- Check the limit switch position and its switching function.
- Check the carbon rolls and their moving parts for freedom of movement when moved by hand.
- Check contact pressure and running surface of the carbon rolls by hand test and visual inspection. Damaged or worn carbon rolls must be replaced at once!
- Carbon rolls, carbon roll holders and the contact tracks must never come into contact with lubricants!
- Oxidized contact tracks can be cleaned with acid-free and oil-free polishing compound; however, the contact track must be wiped immediately afterwards with a cloth soaked in alcohol.

Every delivery includes an operating and maintenance manual, in addition to a wiring diagram.

Note:
Depending on the load placed on the devices, inspection intervals may have to be shorter, requiring at least daily, weekly or monthly visual inspections!

Important!
Touching live components can result in loss of life! Before the housing is opened by a trained specialist and before starting maintenance work, first disconnect the power supply!

Safety regulations

We expressly emphasize that all safety regulations must be observed and applied to protect personnel and property when using our variable column transformers.

Component voltages

Configurable component voltages between zero and 50V are not considered extra-low voltage or safety extra low voltage in accordance with VDE 0100 or EN 61558, etc. For utilization of component voltages, the same protective measures apply as for the maximum configurable voltage.

Warning notice

Magnetic data carriers should not be set down in the immediate vicinity of variable column transformers, devices or wires, because the content could be irreparably damaged if used not in accordance with specifications, or in case of short circuits or malfunctions.

CE notices

The products described in this list correspond to the following EC directives when installed and used according to specifications:
1. 2006/95/EC: low voltage directive
2. 2006/42/EC: machine directive
3. 2004/108/EC: electromagnetic compatibility

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Test system for medium voltage vacuum circuit breakers

The test system consists of two three-phase variable column transformers, one three-phase high-current transformer, designed as an exciter unit, and a separate control panel with a PLC controller.

One variable column transformer is used for coarse regulation of the voltage while the second variable column transformer is used for fine regulation of the output current at the high-current transformer. To ensure symmetric current distribution, three motor drives are used for each variable column transformer. The variable speed of the drives can be varied by means of frequency converters.

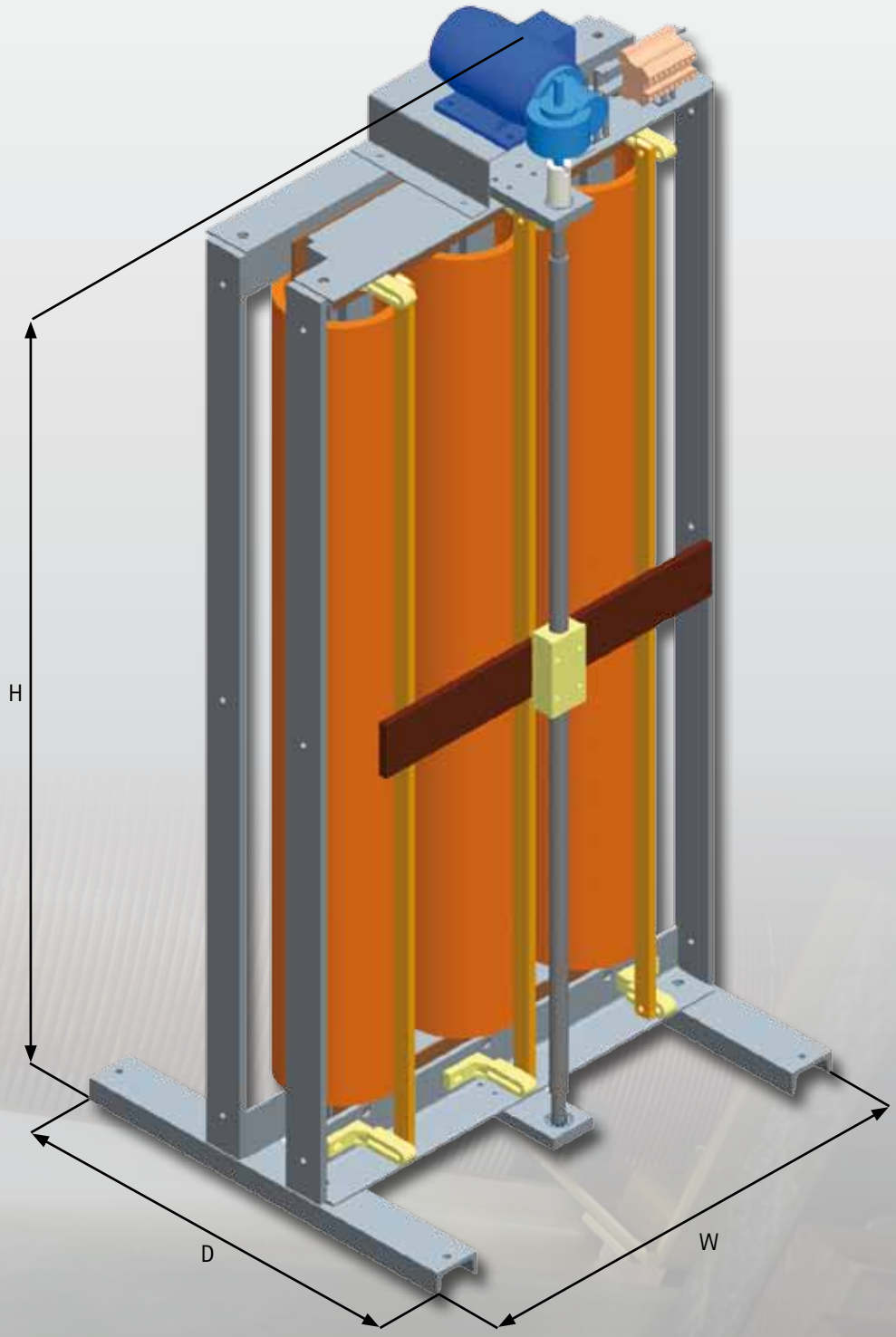
The actual current value is measured by means of current transformers with switchable measuring ranges and sent to the analogue inputs of the PLC. A higher-level process system defines the setpoint value and records the measured values.

TECHNICAL DATA	
Nominal power	300 kVA
Nominal input voltage	400 V (at variable transformer)
Nominal output voltage	0 ... 17.3 V no load (at high-current transformer)
Current collection	10,000 A (at high-current transformer)
Switching group	Dyn5
Cooling system	AN (air self-cooled)
Protection type	Variable transformers IP 00 High-current transformer IP 54 or lead-through conductor rails IP 00, control panel IP 20

Fig. 8
Test system for medium voltage circuit breakers

THREE-PHASE VARIABLE COLUMN TRANSFORMERS

- with separate winding
- constant current throughout the variable range



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LOW VOLTAGE – HIGH QUALITY

THREE-PHASE VARIABLE COLUMN TRANSFORMERS

- with separate winding
- constant current throughout the variable range

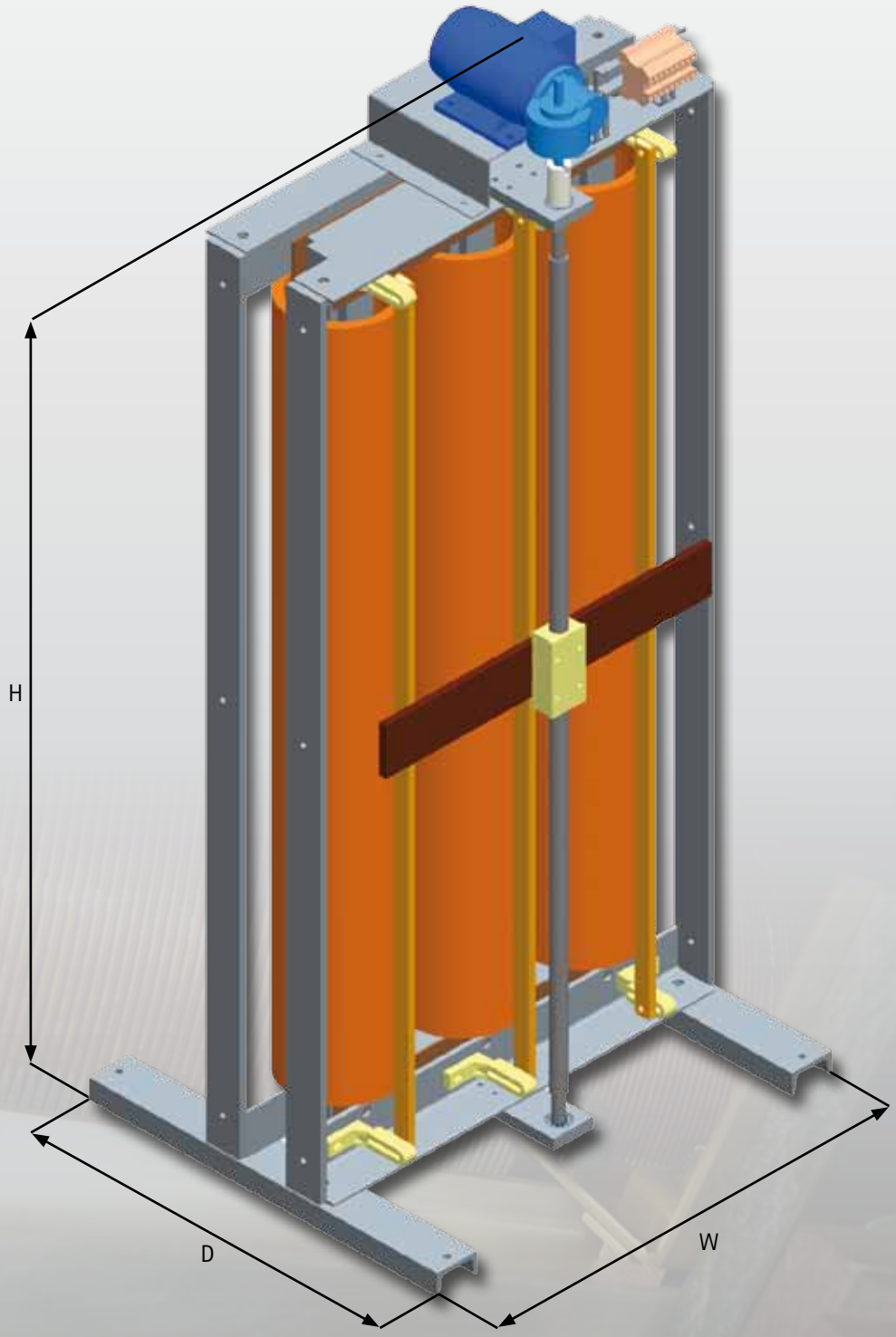
TECHNICAL DATA		
Input voltage:	400 V	
Output voltage:	0...400 V	
Nominal frequency:	50 / 60 Hz	
Vector group:	YNyn0 separate winding	
Phases:	3 ~	
Drive:	Motor, wired to terminals	
Type designation:	TIDMTE	TIDMT
Protection type:	IP00	IP20

No.	Power [kVA]*	Current [A]*	Total columns	Dimensions			Metal weights		Total Weight [kg]
				W [mm]	D [mm]	H [mm]	Ag [g]	Cu [kg]	
1	21.00	30	3	590	520	1,100	43	139	250
2	27.70	40	3	590	520	1,250	54	161	300
3	34.50	50	3	590	520	1,400	65	21	360
4	42.00	60	6	1,330	520	1,100	171	278	500
5	55.00	80	6	1,330	520	1,250	216	322	560
6	69.00	100	6	1,330	520	1,400	262	424	720
7	84.00	120	12	1,330	800	1,100	342	555	960
8	110.00	160	12	1,330	800	1,250	432	644	1,150
9	138.00	200	12	1,330	800	1,400	523	847	1,450

*** Other power outputs / currents on request.**

THREE-PHASE VARIABLE COLUMN TRANSFORMERS

with autowinding and compensation winding



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LOW VOLTAGE – HIGH QUALITY

THREE-PHASE VARIABLE COLUMN TRANSFORMERS

- with autowinding and compensation winding

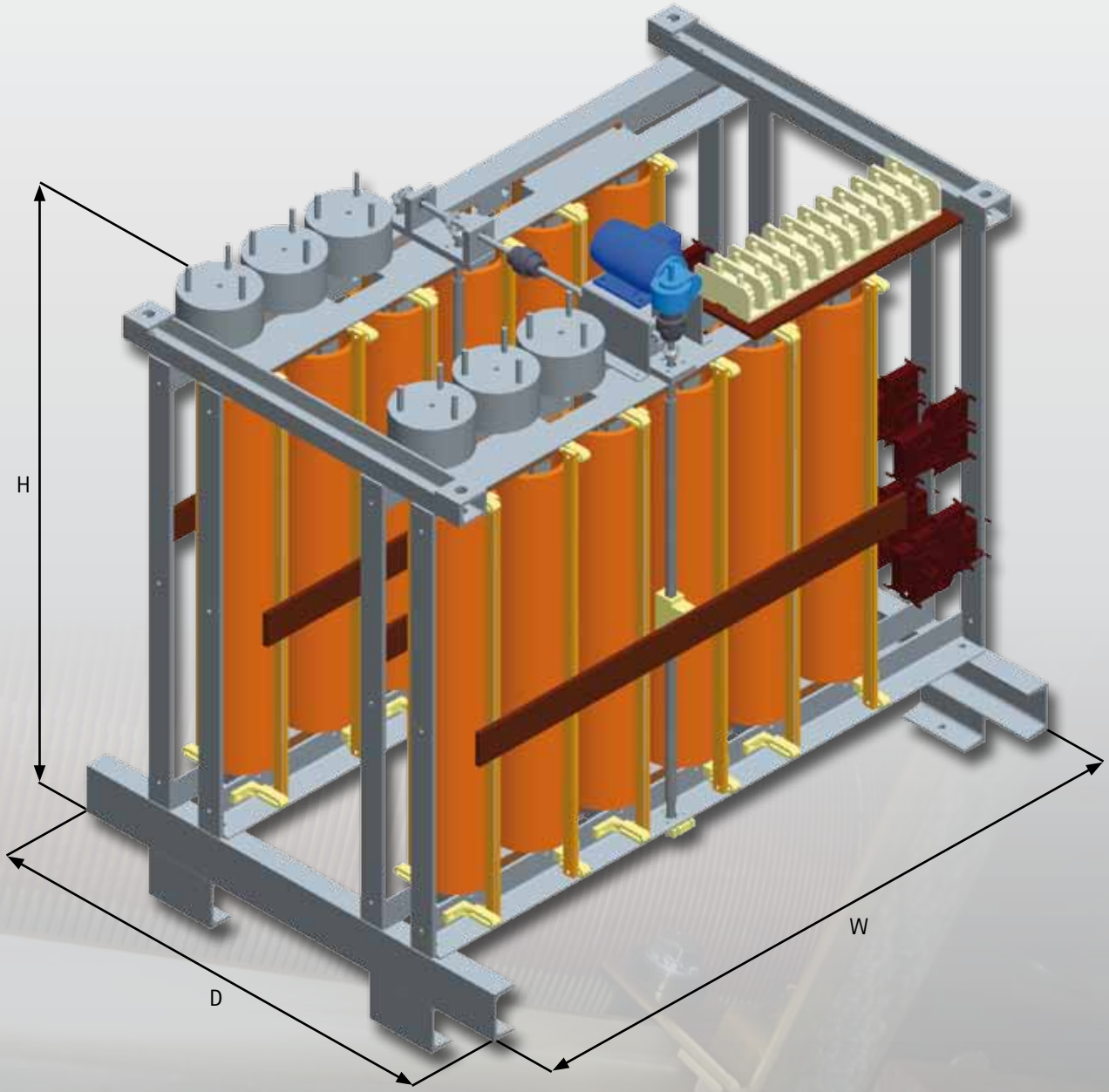
TECHNICAL DATA		
Input voltage:	400 V	
Output voltage:	0...400 V	
Nominal frequency:	50 / 60 Hz	
Vector group:	YN0 autowinding	
Phases:	3 ~	
Drive:	Motor, wired to terminals	
Type designation:	TKDMTE	TKDMT
Protection type:	IP00	IP20

No.	Power [kVA]*	Current [A]*	Total columns	Dimensions			Metal weights		Total Weight [kg]
				W [mm]	D [mm]	H [mm]	Ag [g]	Cu [kg]	
1	10.39	15	3	590	520	1,100	43	16	100
2	17.32	25	3	590	520	1,100	43	48	140
3	27.71	40	3	590	520	1,100	43	84	180
4	34.64	50	3	590	520	1,200	50	101	220
5	41.57	60	3	590	520	1,300	58	126	250
6	55.43	80	6	1,330	520	1,100	86	167	400
7	69.28	100	6	1,330	520	1,200	100	202	480
8	83.14	120	6	1,330	520	1,300	116	253	550
9	110.85	160	12	1,330	800	1,100	172	335	850
10	138.56	200	12	1,330	800	1,200	200	404	950
11	166.28	240	12	1,330	800	1,300	232	505	1,100

*** Other power outputs / currents on request.**

THREE-PHASE VARIABLE COLUMN TRANSFORMERS

- with autowinding
- with ± regulation



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LOW VOLTAGE – HIGH QUALITY

THREE-PHASE VARIABLE COLUMN TRANSFORMERS

- with autowinding
- with ± regulation

TECHNICAL DATA		
Input voltage:	400 V	
Output voltage:	0...400 V	
Nominal frequency:	50 / 60 Hz	
Vector group:	YN0 autowinding	
Switching type:	± / opposed switching	
Phases:	3 ~	
Drive:	Motor, wired to terminals	
Type designation:	TKDMTE	TKDMT
Protection type:	IP00	IP20

No.	± Switching Power [kVA]*	Opposed switching Power [kVA]*	Current [A]*	Total columns	Dimensions			Metal weights		Total Weight [kg]
					W [mm]	D [mm]	H [mm]	Ag [g]	Cu [kg]	
1	10.4	20.8	15	3	590	520	1,100	86	16	110
2	17.3	34.6	25	3	590	520	1,100	86	48	154
3	27.7	55.4	40	3	590	520	1,100	86	84	198
4	34.6	69.3	50	3	590	520	1,200	100	101	242
5	41.6	83.1	60	3	590	520	1,300	116	126	275
6	55.4	110.9	80	6	1,330	520	1,100	172	167	440
7	69.3	138.6	100	6	1,330	520	1,200	200	202	528
8	83.1	166.3	120	6	1,330	520	1,300	232	253	605
9	110.9	221.7	160	12	1,330	800	1,100	344	335	935
10	138.6	277.1	200	12	1,330	800	1,200	400	404	1,045
11	166.3	332.6	240	12	1,330	800	1,300	464	505	1210

*** Other power outputs / currents on request.**

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