Transformer Components

T-Sync® UZ Tap-changers Technical guide

1ZSE 5492-104, REV. 12

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Design principles

On-load tap-changer (OLTC)
The UZ types of on-load tap-changers operates according to the selector switch principle, that is, the tap selector and diverter switch functions are combined in one. The tap-changer is built-up by using single-phase units, each identical, mounted in the openings on the rear of the compartment. Each single-phase unit consists of an epoxy-resin moulding, a selector switch, transition resistors and, in most cases, a change-over selector.

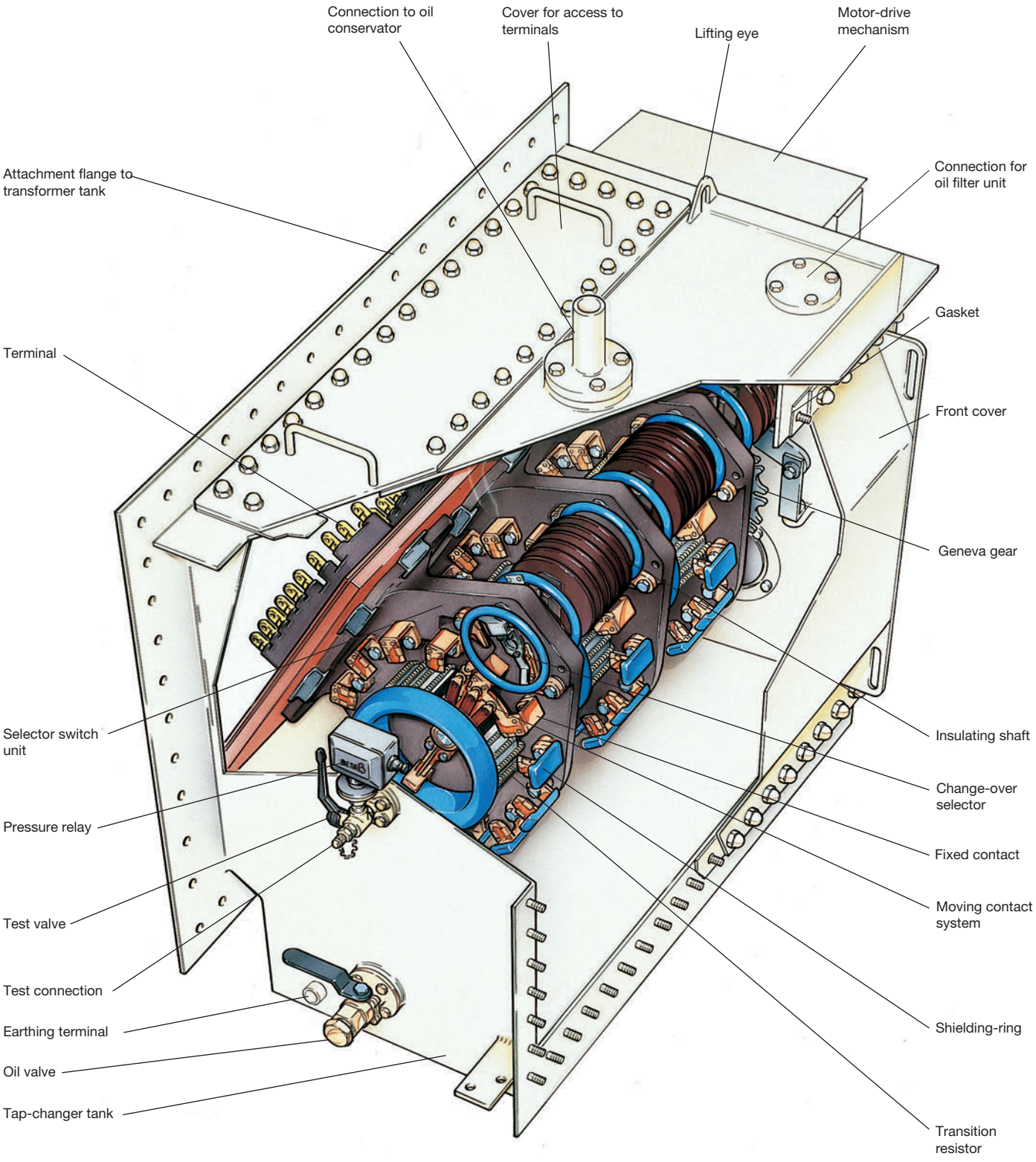
The UZ types of tap-changers are mounted on the outside of the transformer tank. All of the equipment necessary to operate the tap-changer is contained in a single compartment, with the motor-drive mechanism attached to the outside.

Because the UZ types are designed for mounting on the outside of the transformer tank installation procedures are simplified and the overall size of the transformer tank can be reduced.

Standard tanks are designed for the UZ types. The standard tanks have a number of standard flanges to get great flexibility for accessories. Standard accessories are pressure relay and oil valve, and a great number of extra accessories can be ordered. See Figs. 09 and 10.

As a design option, the UZ types can be supplied without the tank. This gives the transformer manufacturer the flexibility to design the tap-changer tank as an integral part of the transformer tank.

The oil should be of class II according to IEC 60296, 2012-02.



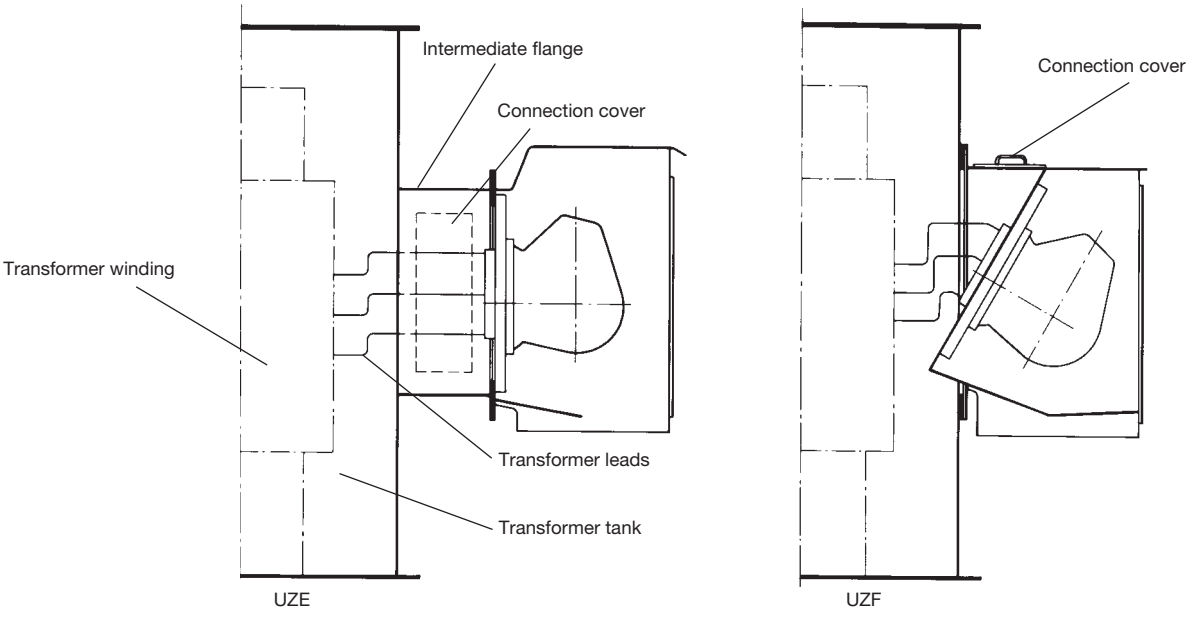
01 Design principle of on-load tap-changer type UZ (UZF shown).

Design differences between the UZE and UZF tap-changers

The basic design difference between the UZE model and the UZF model is the inclining of the active part within the UZF tank to allow easier access to the terminals. Access to the terminals is via a connection cover on the top of the tank.

02 UZFRT 650/600 seen from the connection side.

03 The UZF design makes the connection of the transformer leads to the tap-changer easy.



04 Design differences between the UZE and UZF tap-changers.

Epoxy-resin moulding
The one-piece moulding provides a bushing between the transformer and the tap-changer. The conductors are moulded into position to connect the fixed contacts to the terminals for connection to the transformer windings. Also moulded into the unit are bearings for the selector switch and the change-over selector. See Fig. 05.

The terminals on the moulding are numbered according to the schematic diagrams, see section ”Single phase diagrams” contained in this guide.

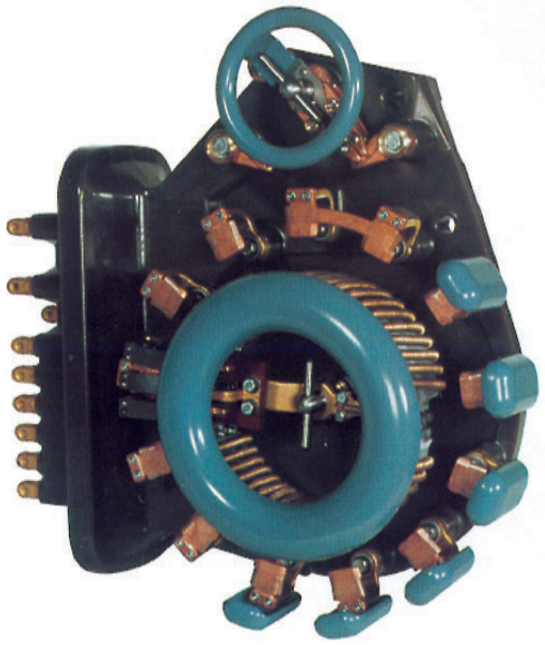
Selector switch
The selector switch consists of fixed contacts and a moving contact system.

The fixed contacts are mounted onto a bracket which is screwed onto the terminals previously moulded into the epoxy-resin moulding. Each fixed contact has on each side two contact paths, one for the main moving contact and one for the moving switching contacts.

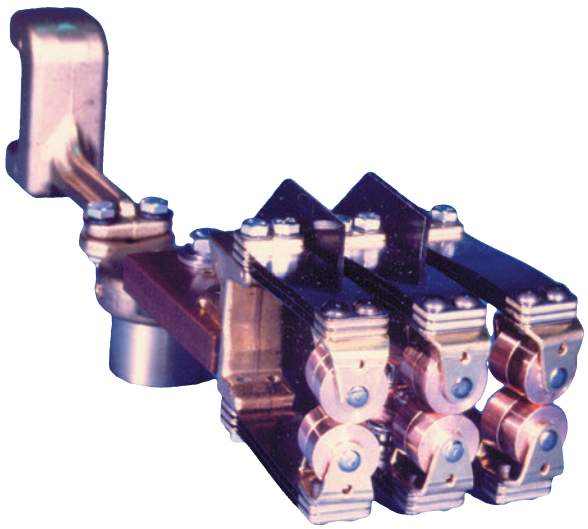
The moving contact system (see Fig. 06) consists of the main contact, the main switching contact and two transition contacts. The system is built as a rigid unit rotated by a common drive-shaft. In the service position the load current is carried by the moving main contact, which consists of two contact fingers, pressed onto the fixed contact by springs. The moving switching contacts and the transition contacts are made as rollers, which move over the knife-like fixed contacts. The making and breaking takes place between the fixed and moving switching contacts.

The switching contacts are made of copper/tungsten, or in the case of tap-changers for lower currents, the contacts are made of copper.

Transition resistors
The resistors are made of spirally wound wire mounted on insulating bobbins. They are connected between the moving main contact and the transition contacts.



05 One phase of an tap-changer type UZ.



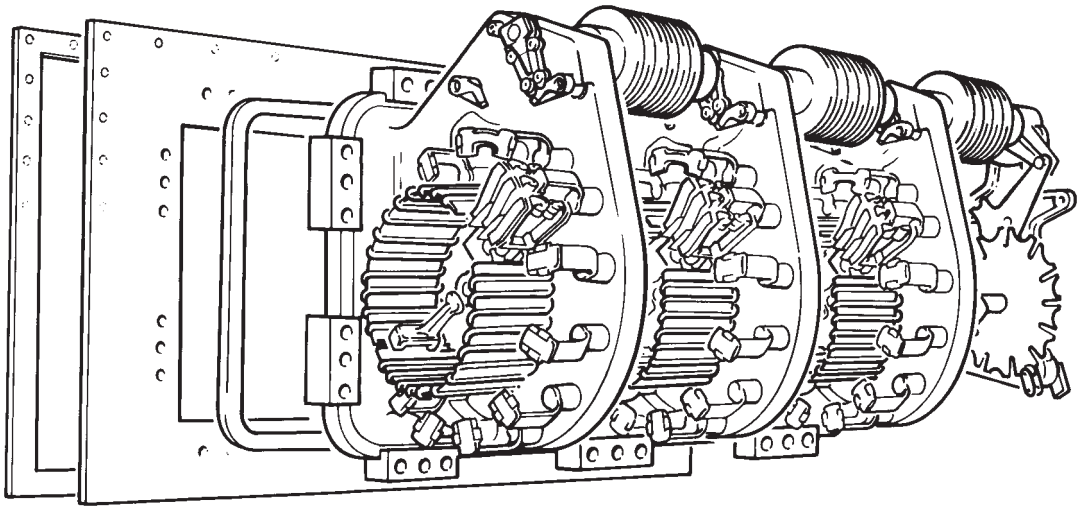
06 Moving contact system.

Change-over selector
The change-over selector is used for reversing the regulating winding or for changing connection in the coarse/fine regulation.

The selector consists of a moving contact and two fixed contacts. The moving contact is fixed to a shaft and is supported by a bearing in the moulding. The current is carried by the four contact fingers of the moving arm, and transferred to the fixed contacts. The change-over selector does not make or break the current during operation.

Geneva gear
The Geneva gear principle is used to change a rotary motion into a stepping motion. Drive is transmitted directly from the motor-drive mechanism to the Geneva gear. The Geneva gear (Fig. 07) operates the selector switch (Fig. 08) and the change-over selector. The Geneva gear is also used to lock the moving contact system when it is in position. The gearing mechanism is maintenance-free.

07 Geneva gear.



08 Selector switch.

Tap-changer tank
A standard tank is designed for each size of UZE and UZF. (For dimensions, see Figs. 30 and 31.) The standard tanks have a number of standard flanges intended for a great variety of accessories. Flanges that are not used are mounted with greyblue covers. Adapter flanges can be bolted on if the sizes of the standard flanges not are suitable.

Standard accessories are pressure relay and oil valve. A great number of extra accessories can be ordered; see Figs. 09 and 10. For accessories available for the tap-changer.

The tap-changer tank can be bolted (standard) or welded to the transformer tank.

A non-standard tank can also be ordered, but to a higher price and with a longer delivery time than the standard tank.

When the tap-changer operates, arcing occurs in the tap-changer. To avoid contamination of the transformer oil, the tap-changer is housed in its own tank separated from the transformer oil. All components that make and break the current during the operation of the tap-changer are located in the tap-changer tank.

The tap-changer tank is separated from the transformer tank by a vacuum-proof barrier, designed to withstand a maximum test pressure of 100 kPa, at a maximum of 60 °C. The barrier and the gasket are oil-tight, which means that they are designed and routinely tested for a permissible air leak at each leak location of 0.0001 cm^3/s, at a pressure difference of 100 kPa and a temperature of 20 °C. This safely guarantees the contaminated tap-changer oil to remain separated from the transformer oil. It should be noted that the barrier has not been designed to allow for a simultaneous over-pressure on one side, and vacuum on the other. All models are supplied with an oil valve, for filling and draining.

Oil conservator
Normally the oil compartment of the tap-changer shall be connected to a conservator, separated from the oil of the transformer. If the transformer oil is to be supervised by gas-in-oil analyses, the conservator for the tap-changer oil should have no connection to the conservator of the transformer on either the oil or the air side.

For use on a sealed tank transformer a special version can be supplied, in which UZE includes the volume needed for oil expansion, an oil level indicator and a breather. UZF needs an own conservator, which can be supplied mounted on the top of the tap-changer tank. See Fig. 32.

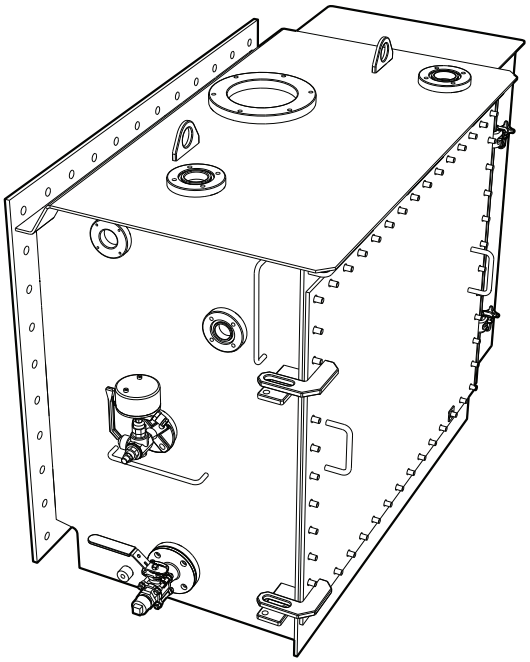
The oil pressure difference between the transformer and the tap-changer should not exceed 25 kPa or 2.8 m oil column. If the pressure difference is between 25 and 70 kPa a reinforced barrier should be ordered. For the version for sealed tank transformers the pressure difference is allowed to be up to 70 kPa (10 Psi) and for that version the reinforced barrier is delivered.

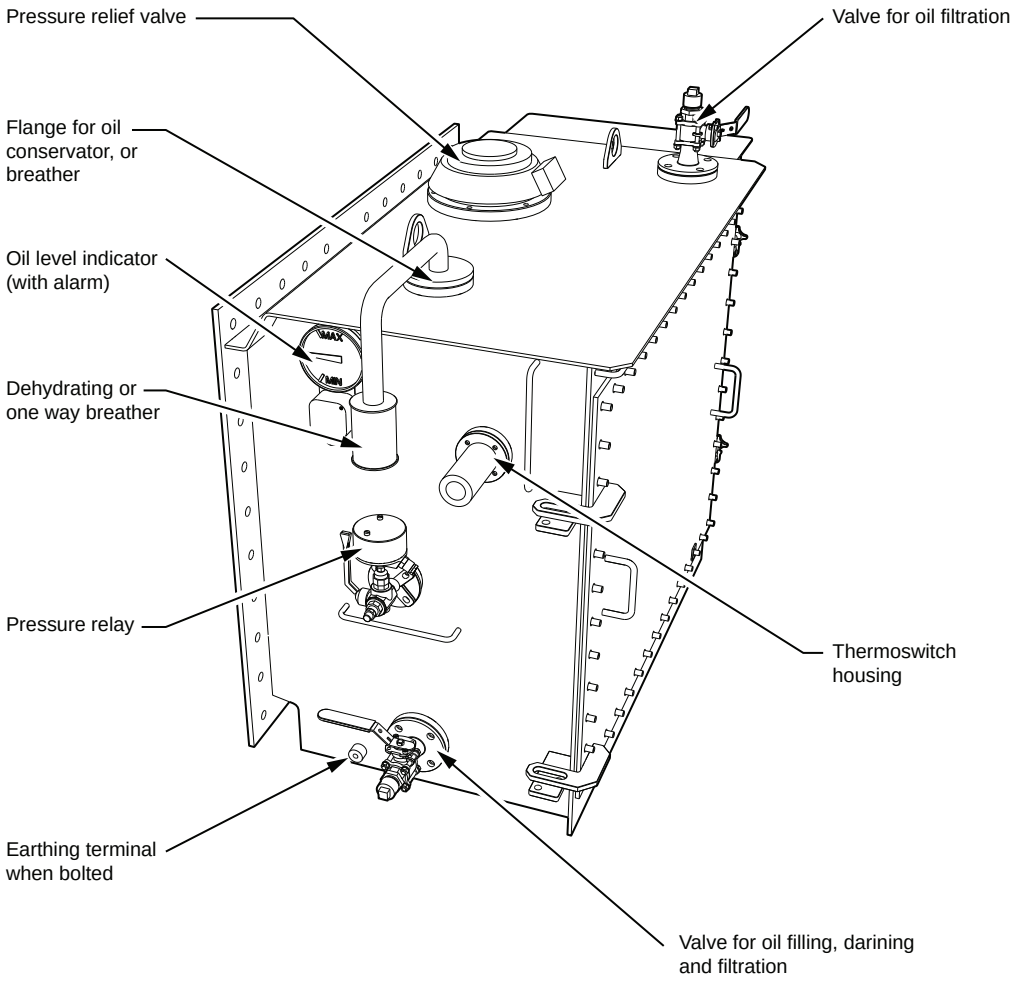
The set point for the pressure relay connected to the UZ tank is normally 50 kPa (7 Psi). Pressure relay with 100 kPa set point is an option. If the tap-changer has a one-way breather its opening pressure must be considered when choosing the pressure relay. For further information, see the Assortment guide 1ZSC000562-AAD.

Special applications, load conditions, environments and insulating liquids
Please contact the supplier for advice in the following cases:
- For non-network applications. (Limitations in number of operations per time might be given.)
- In case of unusual load conditions such as overloads beyond IEC 60076-7, 2005-12, or IEEE C57.91-1995, extreme inductive or capacitive loads or loads beyond the given data in this document.
- In case of requirement of other insulating liquids than mineral oil.

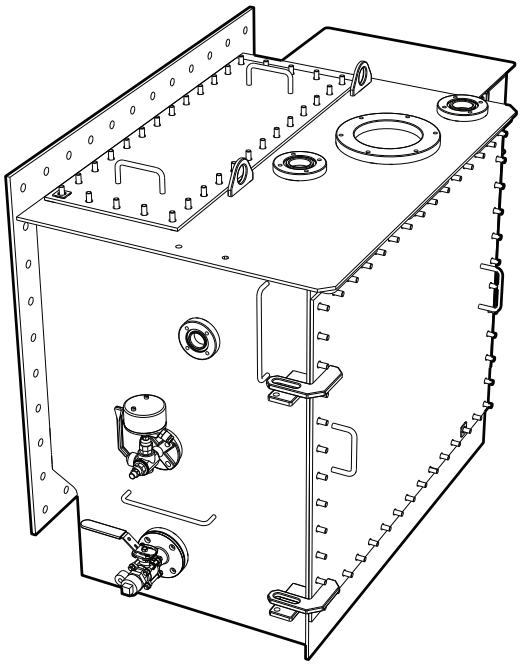
Motor-drive mechanism
The motor-drive mechanism provides the drive to allow the tap-changer to operate. Energy is provided from a motor through a series of gears and out through a drive shaft. Several features are incorporated within the mechanism to promote long service intervals and reliability.

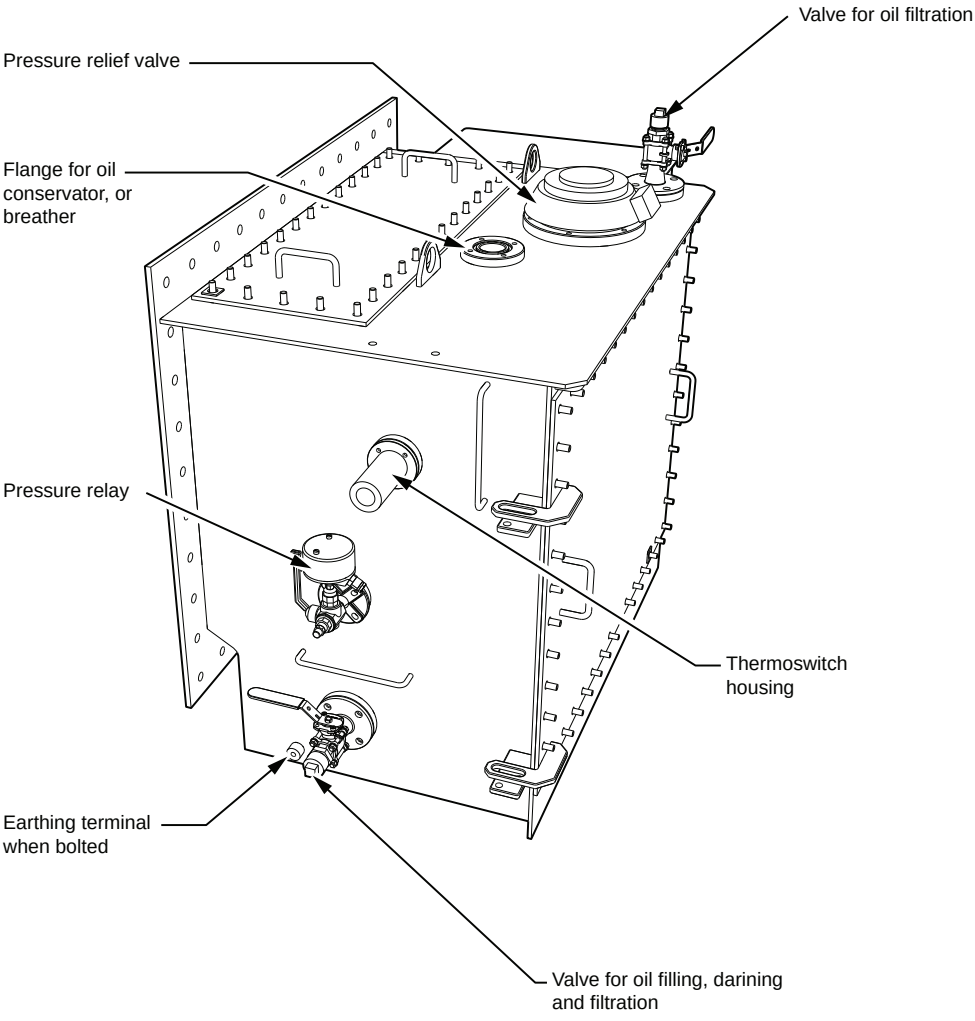
For a detailed operating description, see the section ”Motor-drive mechanism” contained in this guide.





09 On-load tap-changer, type UZE, standard tank and with accessories.





10 On-load tap-changer, type UZF, standard tank and with accessories.

Principles of operation

Switching sequence
The switching sequence is designated the symmetrical flag cycle. This means that the main switching contact of the selector switch breaks before the transition resistors are connected across the regulating step. This ensures maximum reliability when the switch operates with overloads.

At rated load the breaking takes place at the first current zero after contact separation, which means an average arcing time of approximately 6 ms at 50 Hz. The total time for a complete sequence is approximately 50 ms. The tap change operation time of the motor-drive mechanism is approximately 3 s per step.

Selector switch
The switching sequence when switching from position 1 to position 2 is shown in the diagrams of Figs. 11-15. The moving contact H is shown as one contact but consists in fact of two, the main contact and the main switching contact. The main contact opens before and closes after the main switching contact.

Fig. 11: Position 1. The main contact H is carrying the load current. The transition contacts M1 and M2 are open, resting in the spaces between the fixed contacts.

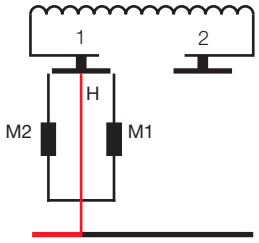


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Fig. 12: The transition contact M2 has made on the fixed contact 1, and the main switching contact H has broken. The transition resistor and the transition contact M2 carry the load current.

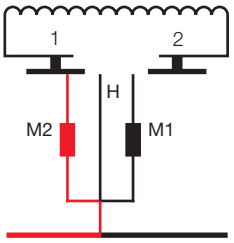

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Fig. 13: The transition contact M1 has made on the fixed contact 2. The load current is divided between the transition contacts M1 and M2. The circulating current is limited by the resistors.

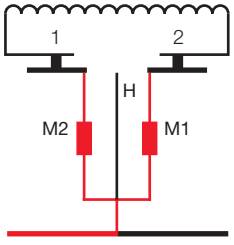

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Fig. 14: The transition contact M2 has broken at the fixed contact 1. The transition resistor and the transition contact M1 carry the load current.

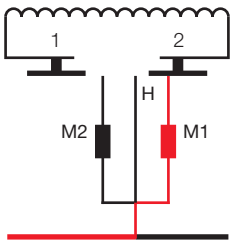

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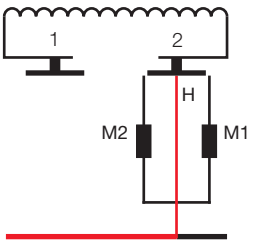
Fig. 15: Position 2. The main switching contact H has made on the fixed contact 2. The transition contact M1 has opened at the fixed contact 2. The main contact H is carrying the load current.

For plus/minus and coarse/fine switching, the change-over selector is used.



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Change-over selector for plus/minus switching
The switching sequence, when the change-over selector R changes over for plus/minus switching, is shown in the diagrams of Figs. 16 and 17. The contact arm of the selector switch has reached the fixed contact 12 after switching from the fixed contact 11. The fixed contact 12 is wide enough to cover the whole distance between two positions of the selector switch. It is connected to the end of the main winding.

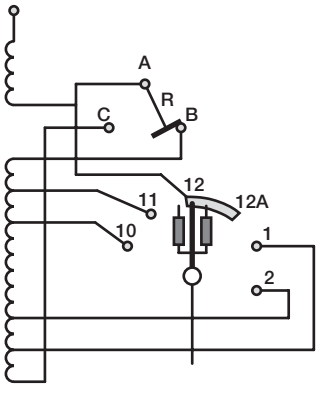
Fig. 16: The contact arm of the selector switch has travelled on to the contact 12, and the change-over selector R is in off-load condition. The load current goes directly from the main winding through the contact 12 and out through the current collector at the centre of the contact arm. The upper end of the regulating winding is still connected to the main winding. This is the service position.

Fig. 17: The contact arm of the selector switch has travelled further on the contact 12 without any breaking or making of the current. At the same time the contact arm of the change-over selector R, has travelled from contact B to contact C, through which the lower end of the regulating winding has been connected to the main winding. This is called a through position, see section "Through positions".

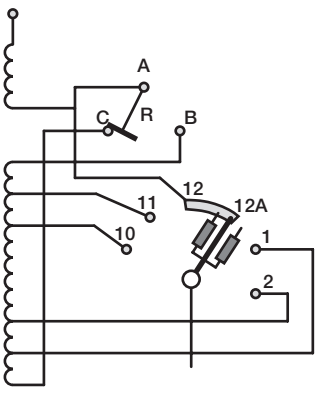
Change-over selector for coarse/fine switching
The mechanical switching is exactly the same as for the plus/minus switching, the electrical switching is different however. The change-over selector connects or disconnects the coarse winding.

Coarse/fine regulation leakage inductance switching
When changing from the end of the fine winding to the end of the coarse winding with resistor type tap-changers, a high leakage inductance can be set up with the two windings in series opposition. This can cause a phase shift between the switched current and recovery voltage of the selector switch and result in extended arcing of the switch and should be limited. The leakage inductance shall be specified in the ordering data sheet. If there are questions regarding leakage inductance switching or the value to be specified, please contact us.

Through positions
The through position is a position the tap-changer has to pass without changing the ratio of the transformer. Figs. 16-17 show how the change-over selector is operated, while the selector moves over the double fixed contact. The extra position has the same number on the scale of the position indicator, together with a letter, e.g. 12A. There might be need for more through positions over the operating range if the number of taps of the winding is less than the number of mechanical positions of the selector. The motor-drive will automatically pass the through positions.



16 Service position.



17 Through position.

Characteristics and technical data

Type designation

U Z . . . XXX/YYY

Type

E	Insert upright
F	Insert inclined

Type of switching

L	Linear
R	Plus/Minus
D	Coarse/Fine

Type of connection

N	Three-phase star point
T	Three-phase fully insulated
E	Single-phase (option)

Impulse withstand voltage

200 kV, 250 kV, 380 kV, 550 kV, 650 kV

Maximum rated through-current

150 A, 300 A, 600 A

Number of positions

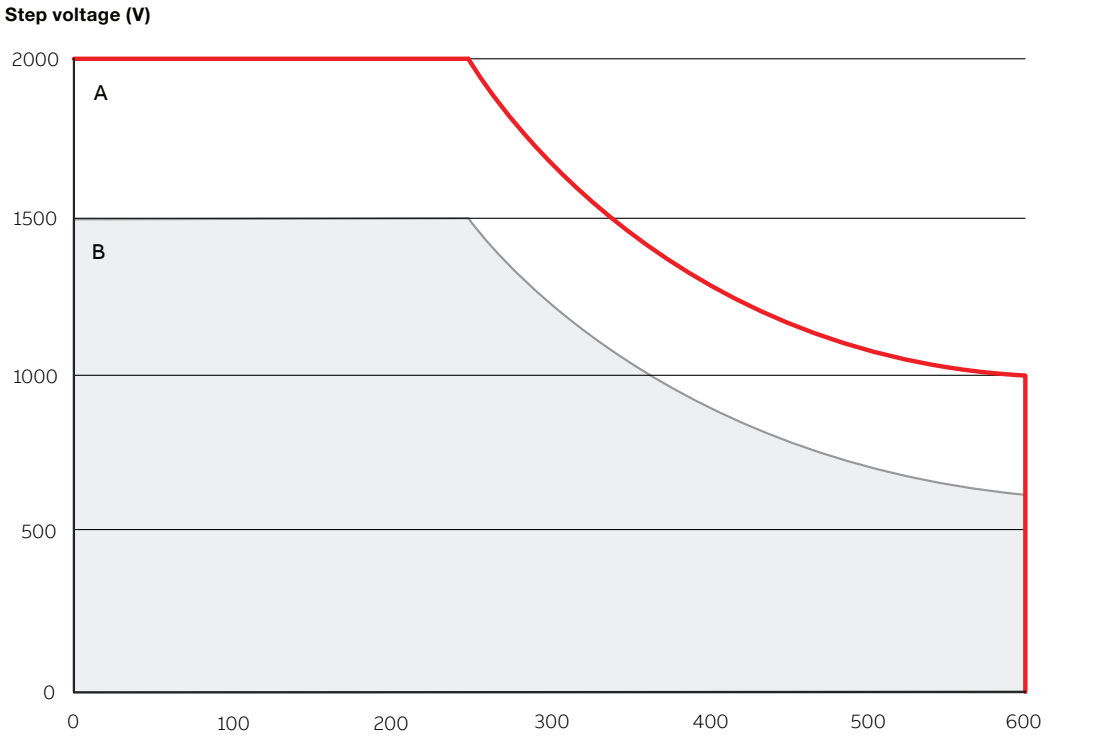
Linear switching:	max 17 positions
Plus/Minus switching:	max 33 positions
Coarse/Fine switching:	max 29 positions

Rated phase step voltage

The maximum allowable step voltage is limited by the electrical strength and the switching capacity of the selector switch. It is therefore a function of the rated through-current as shown in Fig. 18.

Mechanical life

The mechanical life of the tap-changer is based on an endurance test. The test showed that the mechanical wear was negligible, and that the tap-changer was still mechanically sound after one million operations.



Tap-changer with:
A:
max 11 positions, linear
max 23 positions, plus/minus
max 23 positions, coarse/fine

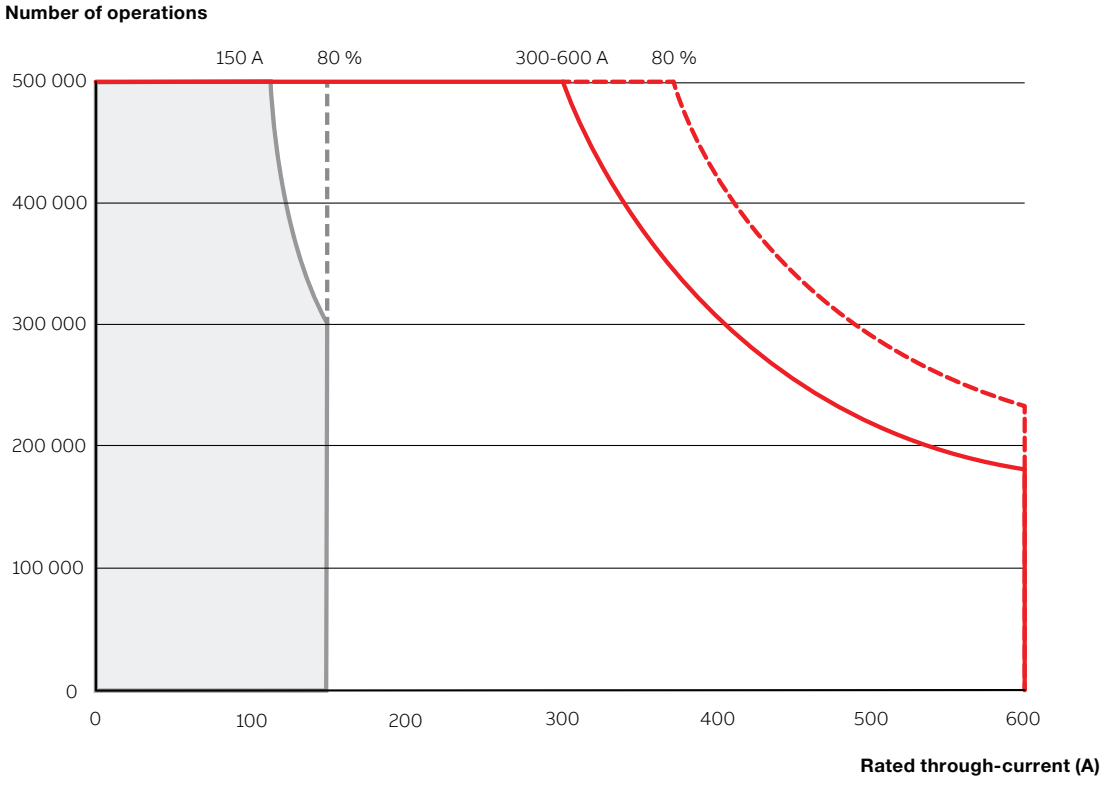
B:
max 13-17 positions, linear
max 25-33 positions, plus/minus
max 25-29 positions, coarse/fine

18 Rated phase step voltage.

Contact life

The predicted contact life of the fixed and moving contacts of the selector switch, is shown as a function of the rated through-current in Fig. 19. As most of the tap-changers are not working at maximum current the whole time, the estimated contact life for a tap-changer with 80 % mean load is also indicated with a dashed line. The values are calculated from the results of the service duty tests.

For step voltages below 500 V, the contact life values can be increased because the through-current is divided between the main contact and the transition resistor. For step voltages equal to or below 40 V at 50 Hz and equal to or below 50 V at 60 Hz the predicted contact life is always 500 000 operations.



19 Predicted contact life at 50 Hz. At 60 Hz the predicted contact life is about 20 % higher, up to the maximum 500.000 operations.

Standards and testing

The UZ types of tap-changers fulfill the requirements according to IEC 60214.

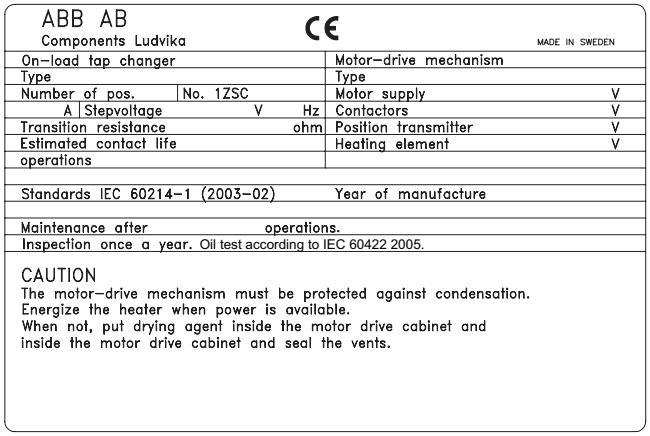
The type tests include:

- Contact temp. rise test
- Switching tests
- Short-circuit current test
- Transition impedance test
- Mechanical tests
- Dielectric test

The routine tests include:

- Check of assembly
- Mechanical test
- Sequence test
- Auxiliary circuits insulation test
- Tightness test
- Final inspection

Rating plate



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On–load tap changer	Motor–drive mechanism
Type	Type
Number of pos. No. 1ZSC	Motor supply V
A Stepvoltage V Hz	Contactors V
Transition resistance ohm	Position transmitter V
Estimated contact life operations	Heating element V
Standards IEC 60214–1 (2003–02)	Year of manufacture
Maintenance after operations.	
Inspection once a year. Oil test according to IEC 60422 2005.	

CAUTION
The motor–drive mechanism must be protected against condensation.
Energize the heater when power is available.
When not, put drying agent inside the motor drive cabinet and
inside the motor drive cabinet and seal the vents.

Insulation levels

Dielectric tests are carried out according to IEC 60214. The test object was immersed in clean transformer oil with a withstand value of at least 40 kV/2.5 mm. In Table 2, withstand levels are indicated as lightning impulse – power frequency withstand voltages.

Table 1. Insulation levels.

	Insulation levels kV		Permissible service voltage between phases for fully insulated design UZE.T and UZF.T [1) 3) 4)]
Type UZE/F	to earth g2 [2)]	between phases fully insulated [1)] b1, d1 [2)]	kV
200/...	200–70	250–95	38
250/...	250–95	250–95	52
380/...	380–150	440–165	80
550/...	550–230	600–230	123
650/...	650–275	650–275	145

1) Class II according to IEC 60214, clause 5.2.8.

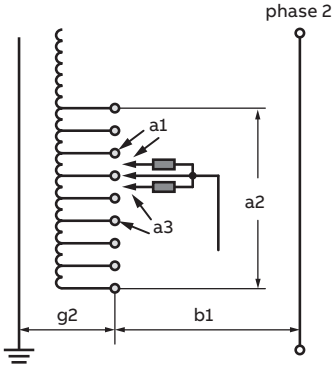
2) Refer to oscillating winding.

3) If the regulating winding is placed in the middle of the delta-connected winding, the permissible system voltage can be higher, provided that voltage between phases and voltage across the regulating winding are not exceeded.

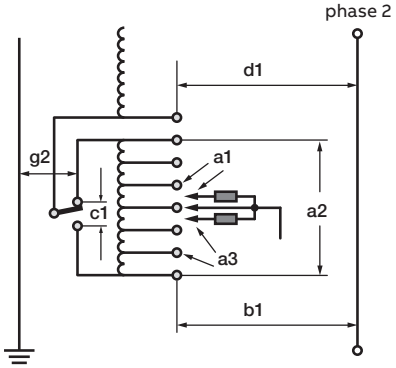
4) Consider the highest appearing voltage between phases on any not connected tap.

Table 2. Insulation levels.

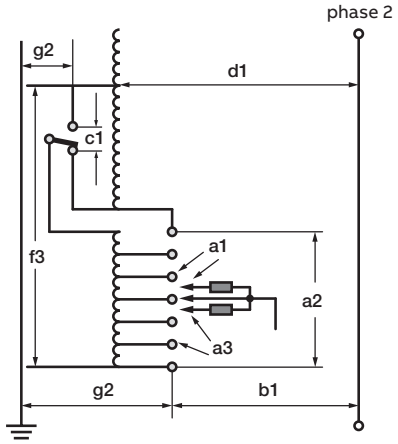
Type of switching	Number of positions	Between electrically adjacent contacts, a1 (Figs. 21-23)	Between the first and the last contacts, a2 (Figs. 21-23)	Between any electrically non-adjacent contacts, a3 (Fig. 23)	Across change-over selector, c1 (Figs. 22-23)	Between ends of regulating windings f3
Linear	7–11	110–30	240–60	220–60		
	13–17	110–30	220–60	200–60		
Plus/minus	11–23	110–30	240–60	220–60	220–60	
	25–33	110–30	220–60	200–60	200–60	
Coarse/fine	13–23	110–30	240–60	220–60	250–60	350–70
	25–29	110–30	220–60	200–60	250–60	350–70



21 Linear switching.



22 Plus/minus switching.



23 Coarse/fine switching.

Short-circuit current strength

The short-circuit current strength is verified with three applications of 3 seconds duration, without moving the contacts between the three applications. Each application has an initial value of 2.5 times the rms value.

Table 3. Short circuit current.

Max rated through-current A rms	Three applications of 3 seconds duration A rms
150	7000
300	7000
600	8000
600 [1)]	12000 [1)]

1) Reinforced performance. Three applications of 2 seconds duration.

Highest phase service voltage across the regulating winding

Table 4 shows the highest permissible phase service voltage for different types of switching and different number of positions.

Table 4.

Type of switching	Number of positions	Insulation across	Highest service voltage kV
Linear	–17	Regulating winding	22
Plus/minus	–29	Regulating winding	22
	31–33	Regulating winding	15 [2)]
Coarse/fine	–29	Fine regulating winding	17.5
	–29	Coarse regulating winding	17.5
	–29	Fine and coarse regulating winding	35 [1)]

1) For 3-phase star point design, BIL 200: 22 kV and BIL 250: 30 kV

2) For service voltages between 15-22 kV, an oil filter unit shall be used.

Rated through-current

The rated through-current of the tap-changer is the current which the tap-changer is capable of transferring from one tapping to the other at the relevant rated step voltage, and which can be carried continuously whilst meeting the technical data in this document.

The rated through-current determines the dimensioning of the transition resistors and the contact life.

The rated through-current is stated on the rating plate, Fig. 20.

The UZ models are designed for maximum rated through-currents of 150 A, 300 A or 600 A.

Occasional overloading

If the rated through-current of the tap-changer is not less than the highest value of tapping current of the tapped winding of the transformer, the tap-changer will not restrict the occasional overloading of the transformer, according to IEC 60354, ANSI/IEEE C57.92 and CAN/CSA-C88-M90.

To meet these requirements, the UZ models have been designed so that the contact temperature rise over the surrounding oil, never exceeds 20 K at a current of 1.2 times the maximum rated through-current of the tap-changer.

The contact life stated on the rating plate, and given in this guide, is given considering that overload currents of maximum 1.5 times the rated through-current occur during a maximum of 3 % of the tap-changer operations.

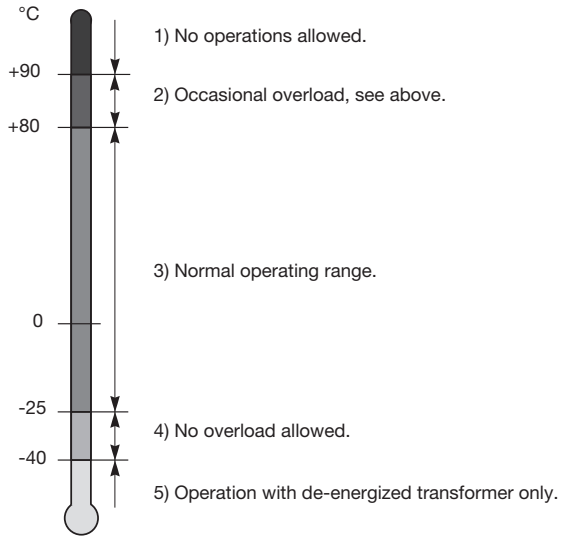
Overloading in excess of the above results in increased contact wear and shorter contact life.

Oil temperature
The temperature of the oil in the tap-changer shall be between -25 and +80 °C for normal operation, as illustrated in Fig. 24. The range can be extended to -40 °C provided that the viscosity is between 2 – 3000 mm^2/s (= cst).

Sound level
During tap-changing the equivalent continuous sound pressure level is about 65 dB (A) measured one metre from the tap-changer.

Tie-in resistors
If the service voltage and the winding capacitances are such that the recovery voltage of the change-over selector exceeds 40 kV, it must be limited to this value or lower, by means of a tie-in resistor. The tie-in resistors are placed in the transformer tank. There is usually a need for tie-in resistors for UZ models, BIL 550 and 650 kV, when delta-connected and placed in the line ends of the windings.

Calculation rules for tie-in resistors are provided in a separate document 5492 0030-39.



24 Tap-changer oil temperature.

Conductors from the windings
The temperature of the conductors connected to the terminals on the back of the tap-changer must not exceed 30 K over the surrounding oil.

Cable lugs
The Cat. No. and required quantity should be ordered separately according to Tables 5 and 6.

Table 5.

Hole diameter (mm)	For cable area (mm^2)	Cat. No.	Mass (kg)
11	50	LL114 003-A	0.10
13	70	-B	0.11
15	95	-C	0.13
17	120	-D	0.14
19	150	-E	0.15
21	185	-F	0.16

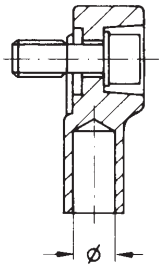


Table 6. Required quantity of cable lugs per tap-changer.

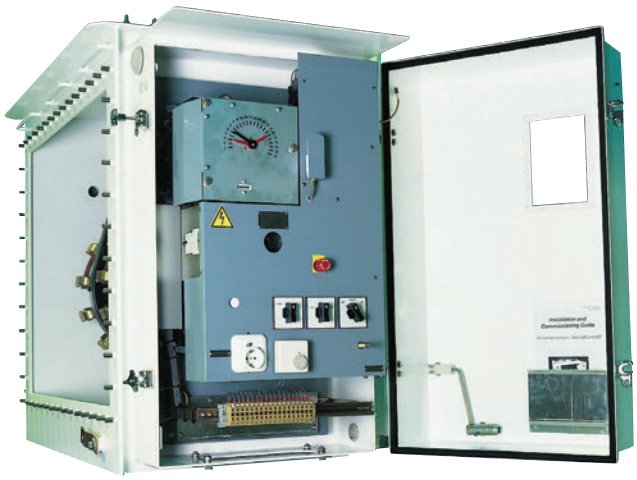
	Linear		Plus/minus		Coarse/fine	
Number of positions	3-phase star point	3-phase fully insulated	3-phase star point	3-phase fully insulated	3-phase star point	3-phase fully insulated
7	22	24	–	–	–	–
9	28	30	–	–	–	–
11	34	36	22	24	–	–
13	40	42	25	27	28	30
15	46	48	28	30	31	33
17	52	54	31	33	34	36
19	–	–	37	39	37	39
21	–	–	37	39	40	42
23	–	–	43	45	43	45
25	–	–	43	45	46	48
27	–	–	46	48	49	51
29	–	–	52	54	52	54
31	–	–	52	54	–	–
33	–	–	58	60	–	–

Motor-drive mechanism

The BUF3 motor-drive mechanism is designed for outdoor operation of UZE and UZF tap-changers.

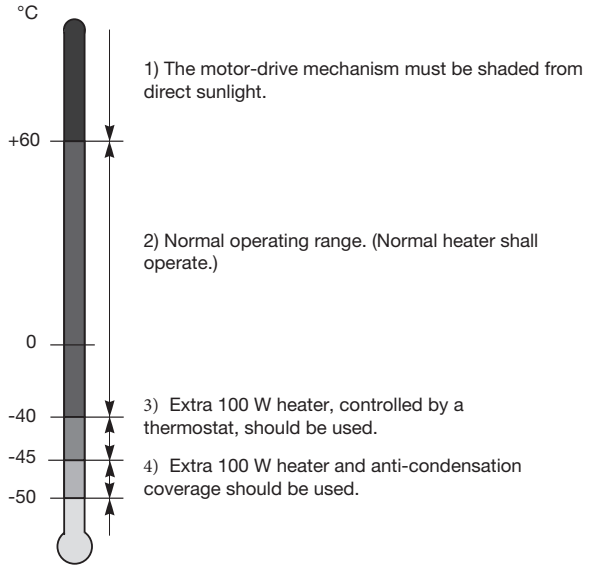
The motor-drive cabinet is manufactured from steel and is welded to the outside of the tap-changer tank. The door, which can be padlocked, forms a cap around the mechanism to allow easy access to all the working parts. Vents, with filters, and a heater are fitted to ensure that the mechanism remains operative in varied climates.

The tightness of the cabinet has been type tested for protection class IP 56 according to IEC 60529.



25 Motor-drive mechanism, type BUF3.

Ambient air temperature
The ambient air temperature requirements for the motor-drive mechanism are shown in Fig. 26. The normal operating range is between -40 and +60 °C.



26 Motor-drive mechanism ambient air temperature.

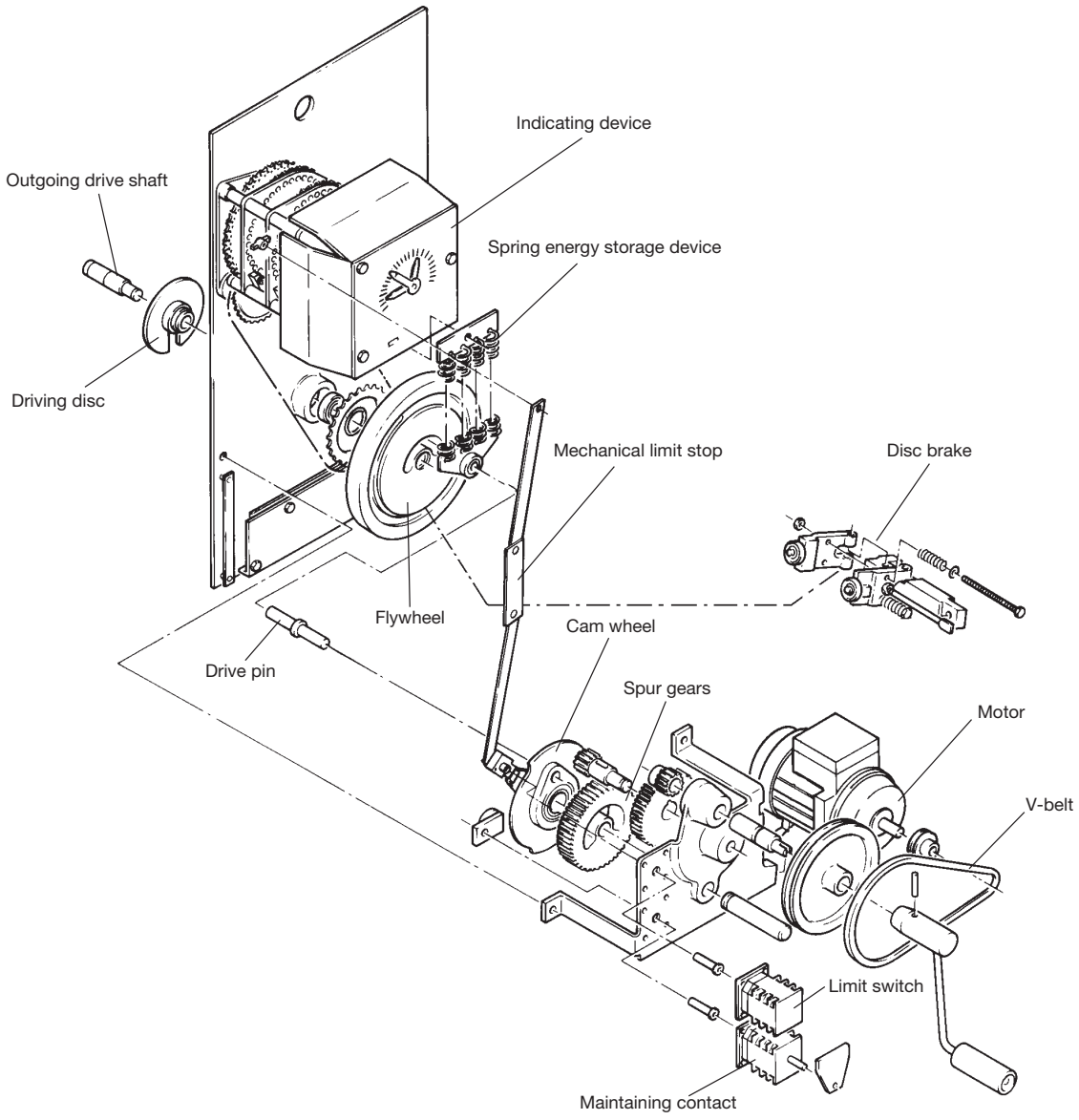
Connection of motor-drive mechanism to tap-changer
Drive is transmitted, via a V-belt, from the motor through a system of spur gears to the drive pin of the cam wheel. The spring energy storage device is charged by this pin.

During the rotation the cam wheel drive pin tensions the springs. When the drive pin reaches its lowest position on the cam wheel the springs are released, and with the assistance of the flywheel, the drive is transmitted to the outgoing drive shaft and the driving disc.

The driving disc operates the Geneva gear within the tap-changer. The flywheel is stopped by a disc brake, which also operates the starting contact.

The outgoing drive shaft, via a chain, drives the Geneva gear of the indicating device. The indicating device consists of the mechanical position indicator, the mechanism for operating the electrical and mechanical limit stop, and the position transmitter.

The maintaining contact is operated by the cam wheel.



27 Motor-drive mechanism.

Operation of motor-drive mechanism
The numbered references under the following sections are to the circuit diagram in Fig. 28 and the contact timing diagram in Fig. 29.

Local control
Control selector switch (S1) in position LOCAL. Raise impulse is given by control switch (S2). Contactor (K2) is thereby energized and will remain so by starting contact (S11:1-2) and its own holding contact. The motor (M1) starts running and soon the maintaining contact (S12:3-4) closes and takes over control of the motor contactor (K2). The brake is released and the starting contact (S11:1-2) opens. The springs are set and will be released when fully charged, and operate the tap-changer. Maintaining contact (S12:3-4) opens and the contactor disconnects the motor. The brake is applied, the starting contact (S11:1-2) closes and the tap change operation is completed. The lowering operation is carried out in a similar manner.

Through positions
The through position is a position the tap-changer has to pass without changing the ratio of the transformer. These positions are passed automatically. The continuation contact (S15) bridges the maintaining contacts (S12:3-4 and S12:1-2) via auxiliary contacts on raise contactor (K2) at through positions. In this way the contactor (K2) raise, or (K3) lower, is kept energized and the motor will automatically make another operation.

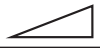
Remote control
Control selector switch (S1) in position REMOTE. The signal for the operation is then received from the control circuits for raise and lower impulses connected to terminals as shown in Fig. 27. Local operation is not possible when switch (S1) is in position REMOTE, and remote operation is not possible in position LOCAL.

Step-by-step-operation
Step-by-step relay (K1) connected so that only one tap change operation is obtained each time the raise/lower switch is operated.

Protection against running-through
A relay (K6) stopping the motor-drive mechanism in case of a failure of the step-by-step control circuit which would cause a running-through of the motor-drive mechanism. The relay energizes the trip coil in the protective motor switch (Q1).

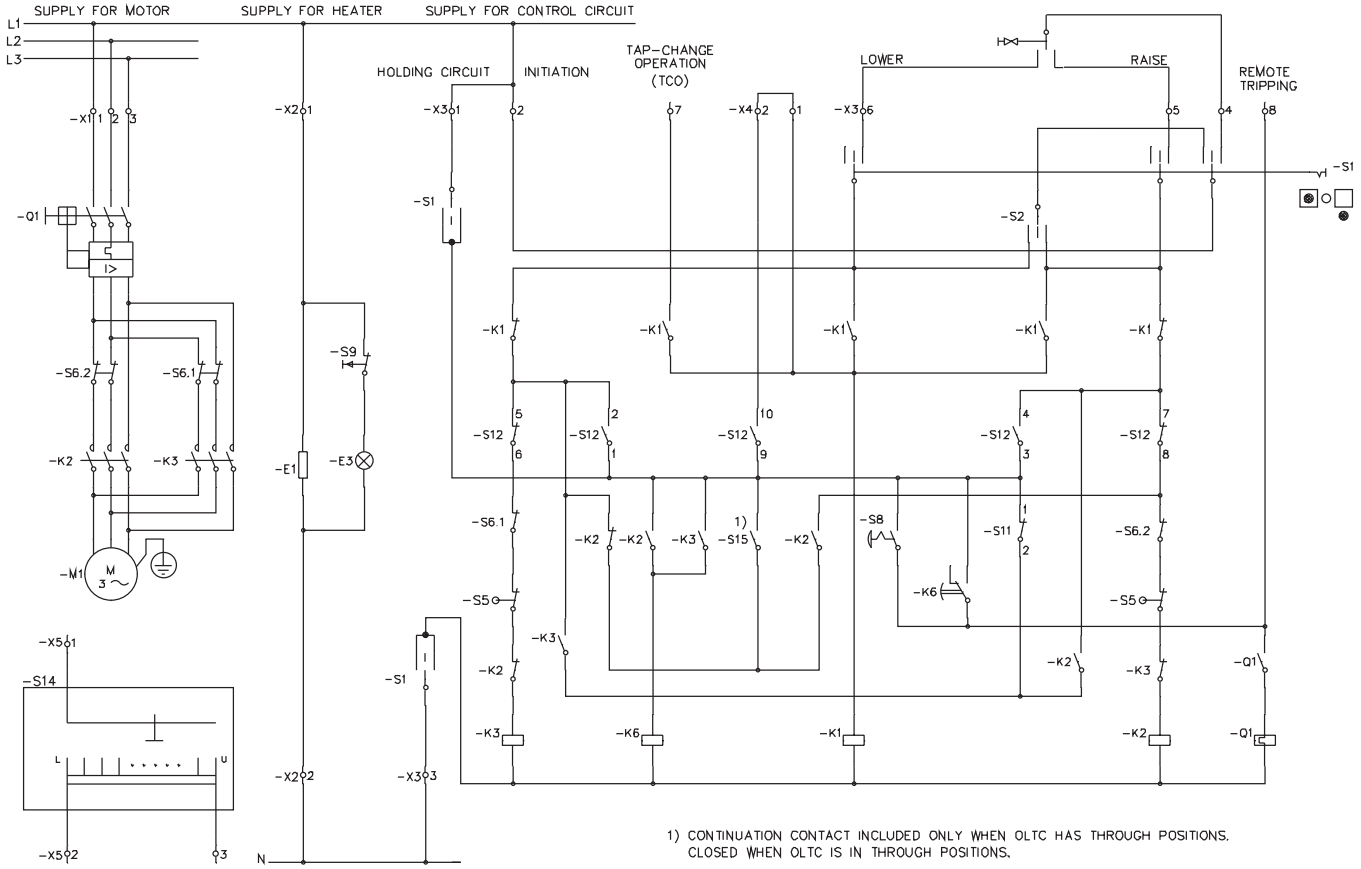
Contact timing
The contact timing diagram, Fig. 29, shows the contact sequences for one change of tap position for raise and lower directions.

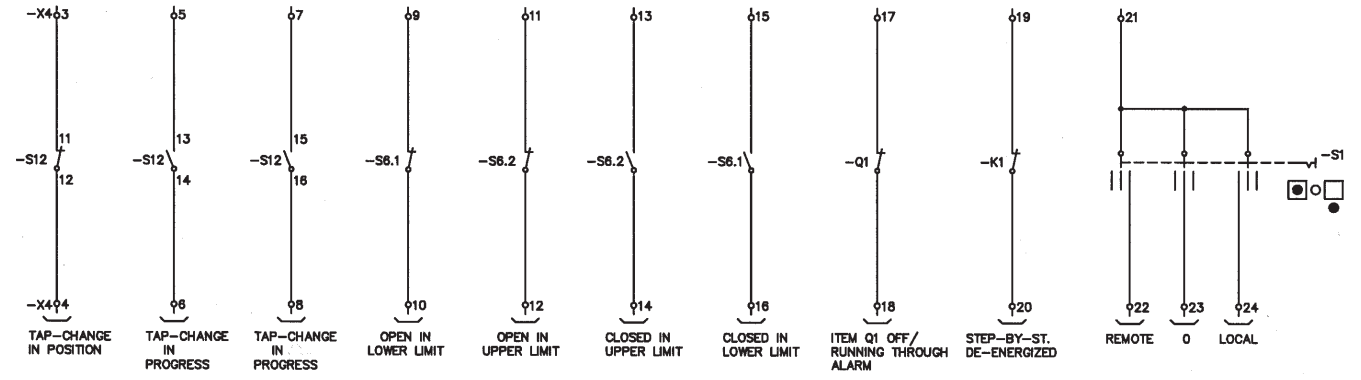
Circuit diagram
The diagram shows the mechanism at the middle position.

	**RAISE operation**
	**LOWER operation**
	**LOCAL control**
	**REMOTE control**
U	**Upper limit-position**
L	**Lower limit-position**
	**Protective earth**
	Crank

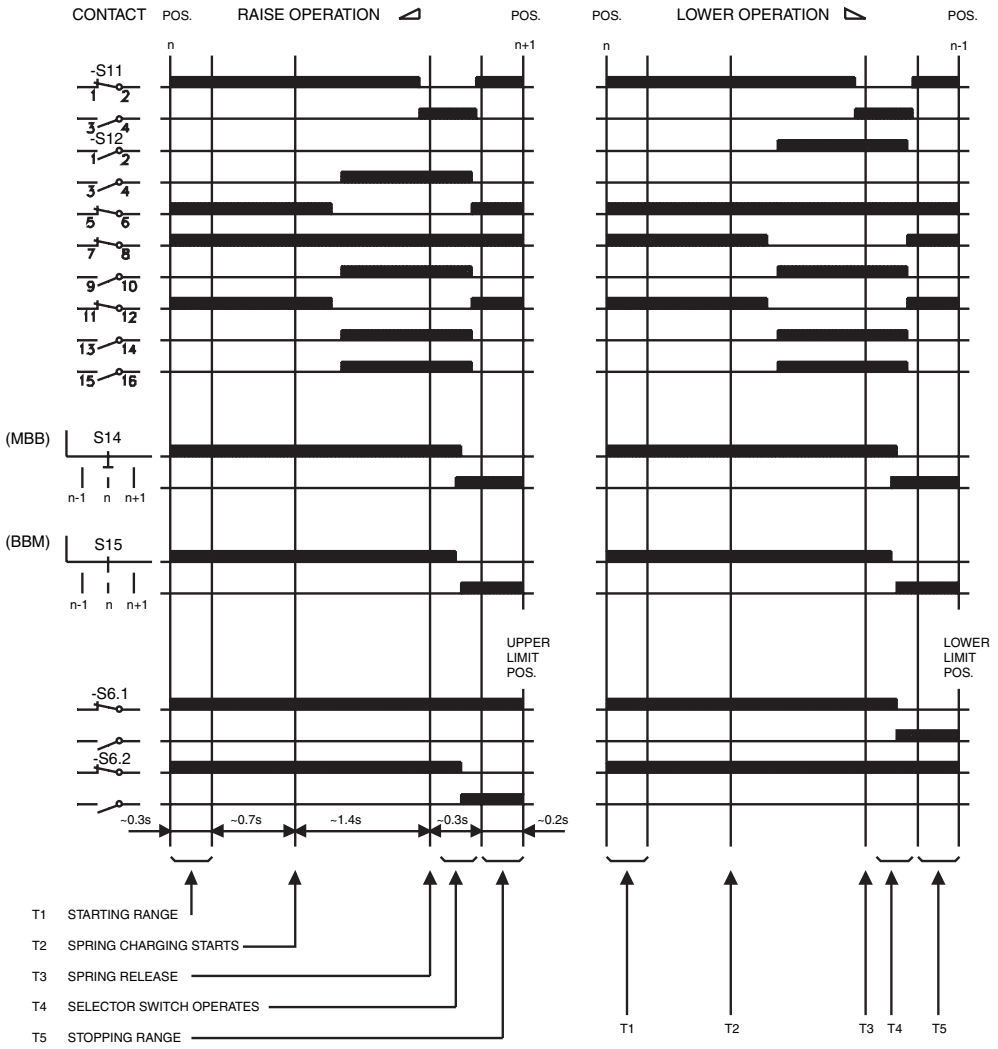
Drive mechanism equipment

E1	Anti-condensation heater
E3	Cabinet light
K1	Contactor, step-by-step operation
K2	Contactor, Raise
K3	Contactor, Lower
K6	Time relay, running-through protection
M1	Motor
Q1	Motor protective switch
S1	Control selector switch
S2	Control switch
S5	Interlocking switch, open when hand crank is fitted
S6	Cam switch (Limit switch)
S8	Push button, Emergency stop
S9	Switch, door operated
S11	Contact block 1-2 Starting contact
S12	Cam switch 1-2, 3-4 Maintaining contact 5-6, 7-8 Interlocking contact 9-10, 11-12 Auxiliary contact 13-14, 15-16 Auxiliary contact
S14	Position transmitter, potentiometer
S15	Continuation contact
X	Terminal board group





28 Circuit diagram (shows position 1).



29 Contact timing diagram.

Standard version of motor-drive mechanism
Control
- Control selector switch, local/remote
- Control switch, raise/lower
- Handcrank for manual operation

Protection
- Protective switch for the motor with thermal overload release and magnetic overcurrent release.
- Limit switches – in both control and motor circuits.
- Mechanical end stops.
- Interlocking contact in the control circuit to prevent electrical operation during manual operation.
- Interlocking contacts in raise and lower control circuits to prevent reverse operation of rotation (with wrong phase sequence).
- Motor contactors are electrically interlocked.
- Protection against running-through in case of a failure of the step-by step control circuit.
- Emergency stop push button.

Indication
- Mechanical position indicator
- Drag hands for max. and min. position indication
- Tap change in progress indicating red flag
- Operation counter
- Position transmitter (potentiometer) for remote position indication, 10 Ω per step.

Wiring
The wiring is of grey polyvinylchloride-insulated, stranded wire. Every wire is marked with figures corresponding to terminal numbers. All external connections are made to terminals of thermosetting resin. Type and data see Table 8.

Short circuit protection (fuses) for motor, control and heater supplies, if required, should be installed in the control cabinet or other separate compartment.

Optional accessories
Anti-condensation coverage
The motor-drive cabinet inside can be supplied with an anti-condensation coverage.

Outlet
Socket outlet according to DIN or ANSI. Prepared for socket outlet, i.e. holes are cut out in the panel and cables are wired to the panel for the outlet.

Extra heater
Extra heater, 100 W, with thermostat and switch for e.g. use in arctic climate.

Hygrostat
For tropical climate the heater can be controlled by a hygrostat.

Extra multi-position switches
- Master switch for parallel control is a break before make multi-position switch.
- Maximum 10 extra contact rows can be accomodated.
- If more than 4 extra contact rows are ordered a special drive system for the switches is required (extra cost).

Table 7.

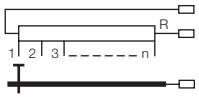
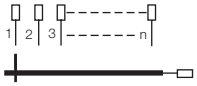
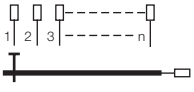
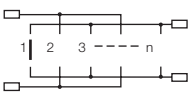
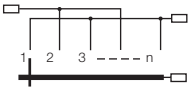
Type	Symbol	Number of contact rows
1 Extra position transmitter		**1**
2 Break before make		**1**
3 Make before break		**1**
4 Step switch for parallel control		**2**
5 Follower switch for parallel control		**2**

Table 8.

Subject	Standard version	Options available at additional cost
Motor voltage Current **1.3/0.8 A** Rated output **0.25 kW** Speed **1390 rev/min**	3-phase, 50 Hz, 220-250 V 3-phase, 50 Hz, 380-420 V 3-phase, 50 Hz, 433 V 3-phase, 50 Hz, 500 V 3-phase, 60 Hz, 208 V 3-phase, 60 Hz, 220-240 V 3-phase, 60 Hz, 380-420 V 3-phase, 50 Hz, 440-480 V	1-phase, 50 Hz, 110 V 1-phase, 50 Hz, 220-240 V 1-phase, 60 Hz, 120 V 1-phase, 60 Hz, 220-240 V 110–127 V DC 220 V DC
Voltage for control circuit	50 Hz, 110 V 50 Hz, 120 V 50 Hz, 220-230 V 50 Hz, 240 V 50 Hz, 250 V 60 Hz, 110-120 V 60 Hz, 127 V 60 Hz, 208 V 60 Hz, 220 V 60 Hz, 230-240 V 60 Hz, 250-260 V	24 V DC 48 V DC 110 V DC 125-127 V DC 220 V DC
Voltage for heater	220-240 V	110-127 V Optional
Mechanical position indicator	Lowest position marked 1	Middle position marked N (Normal position) Optional
Terminal blocks		
Number of terminals supplied	33-Phönix UK 5N I_N: 32 A, U_N: 800 V, AC acc. to IEC Cross sectional area: 0.2–6 mm^2 (NOTE: Max. load current 41 A with 6 mm^2 conductor cross section.)	
Number of terminals that can be accommodated (depending on selected options)	184 - Phönix UK 5N 175 - Weidmüller SAK 4 138 - Phönix URTK/S Ben 48 - General Electric EB-25 102 - Phönix OTTA6	
Cabling	Type H07V2-K, 1.5 mm^2, 750 V 90 °C	Optional
Test voltage on control circuits	2 kV (50 Hz, 1 min)	
Anti-condensation heater (Functions without extra heater down to -40 °C)	50 W	Additional 100 W
Approx. operating time	3 s	
Starting impulse length	< 0.1 s	
Number of turns per operation of the handcrank	20	
Degree of protection of cabinet	IEC 60529, IP 56	
Environmental class ISO DIS 12944-2	C3 C4 Only primer	C5MH

Installation and maintenance

Drying
Drying of the tap-changer is not normally necessary. If the tap-changer is to be subjected to a drying process.

Painting
The tap-changer tank and the motor-drive cabinet can be supplied with various types of painting. The standard painting consists of a rust protective primer both inside and outside, and a finishing coat inside the tap-changer tank and the motor-drive cabinet.

As an option, the tap-changer may also be delivered ready with a finishing coat outside. Special painting will be quoted for on request.

Weights
Table 9 contains the weights of all the models in the UZ range of tap-changers. The motor-drive mechanism and the oil volume is included in the overall weight.

Table 9. Weights.

On-load tap-changer Type designation		Approx. weight in kg		
		Tap-changer without oil	Required oil (excl. conservator)	Total
UZE.N, T	**200/150, 300, 600**	700	500	1225
	250/150, 300, 600	700	500	1200
	380/150, 300, 600	930	950	1880
	550/150, 300, 600	1100	1250	2350
	650/150, 300, 600	1100	1250	2350
UZF.N, T	**200/150, 300, 600**	720	400	1150
	250/150, 300, 600	720	400	1120
	380/150, 300, 600	900	750	1650
	550/150, 300, 600	1100	1050	2150
	650/150, 300, 600	1100	1050	2150

Example of type designation: UZFRT 550/300.

Oil filling
For the correct oil filling procedure, consult the Installation and commissioning guide.

Installation
For installation instructions, consult the Installation and commissioning guide.

Maintenance
The UZ range of tap-changers has been developed over many years to provide a maximum of reliability. The simple and rugged design gives a service life that equals the service life of the transformer. A minimum of maintenance is required for absolutely trouble-free operation. The only parts that require maintenance during the service life are the contacts that may need to be replaced.

Maintenance is easy to carry out since the design provides for quick and easy access and inspection. After the oil has been drained, only the front cover has to be removed to gain access to the entire selector switch mechanism.

An annual inspection should be carried out to read the counting device. These readings are used to determine when overhaul is due. Overhaul shall normally be carried out after 1/5 of the contact life or every 7th year, whichever comes first. If the operating voltage over any of the regulating windings exceeds 15 kV, the interval between overhauls is limited to 3 years. The relevant information is stated on the rating plate.

Please refer to the Maintenance Guide for further information.

Accessories and protection devices
The tap-changer can be equipped with various protection devices. The standard protection device is the pressure relay. An oil flow relay is also available.

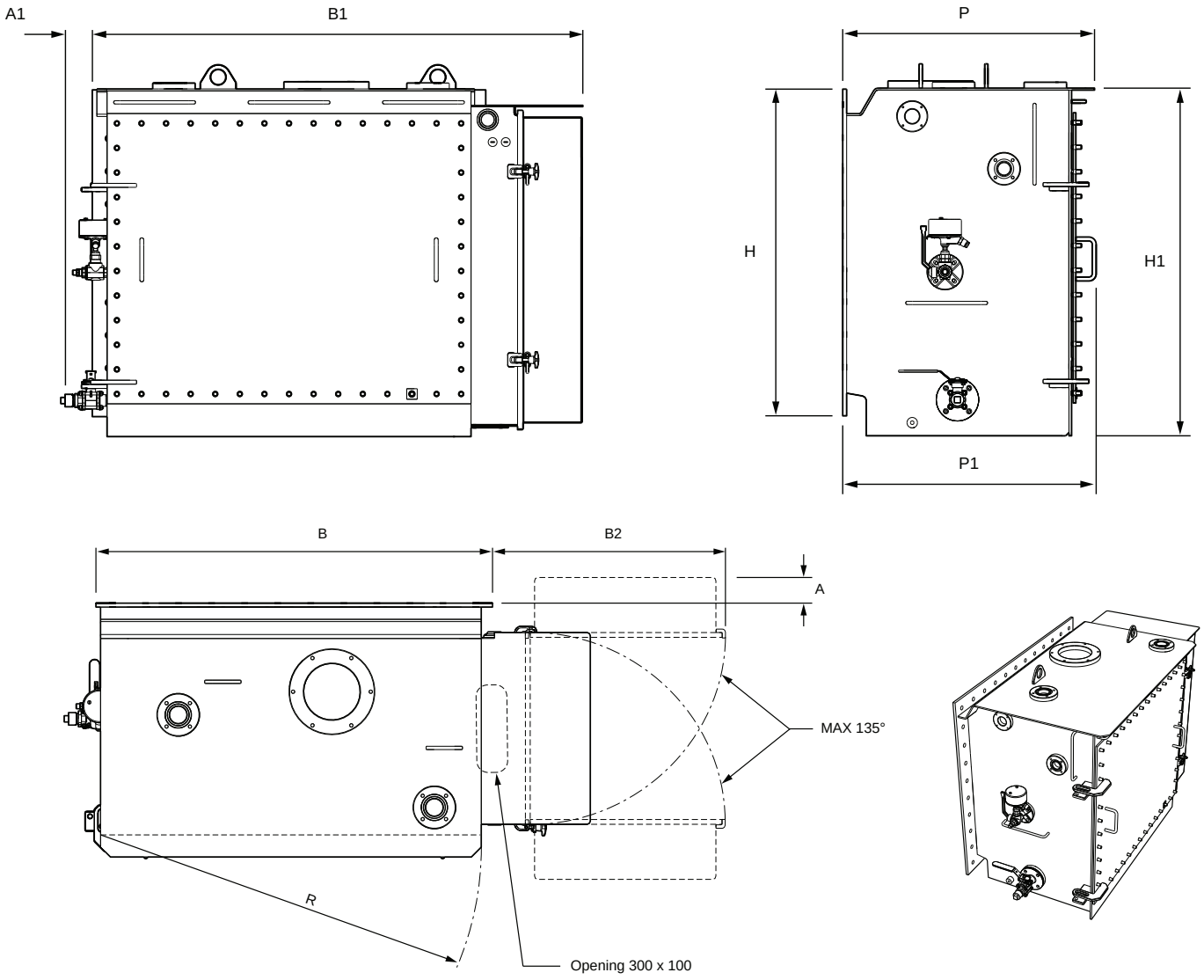
Pressure relief device with alarm signal is also available as well as some other supervisory sensors.

For more information about accessories and protection devices see technical description 1ZSC000562-AAD.

Dimensions

Table 10. Dimensions, on-load tap-changer, type UZE.
Dimensions are subject to modification without notice.

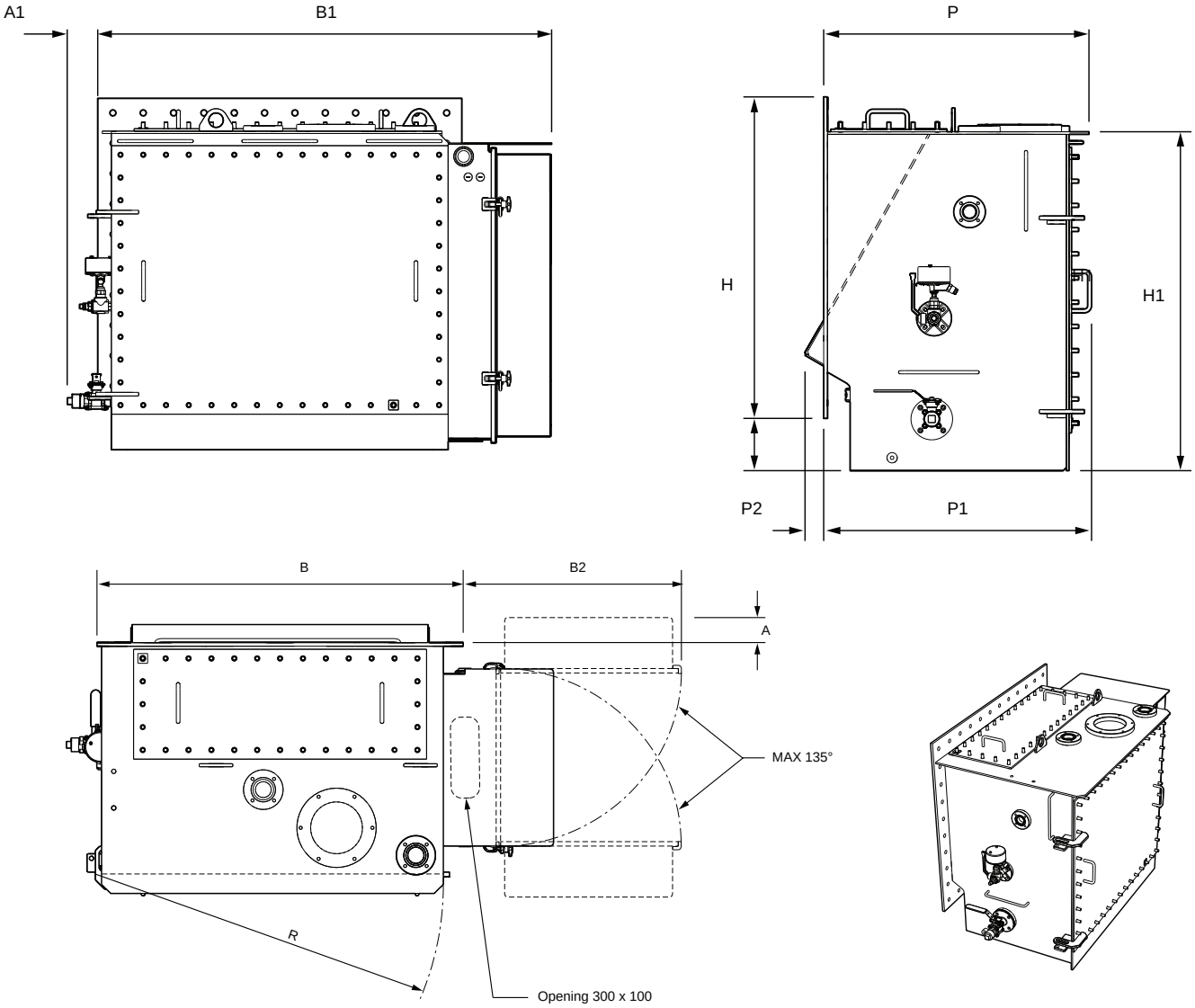
		Dimensions (mm)									
Type UZE	**BIL (kV)**	A	A_1	B	B_1	B_2	H	H_1	P	P_1	R
Three-phase	**200**	110	75	1200	1500	700	1000	1060	770	775	1140
	250	110	75	1200	1500	700	1000	1060	770	775	1140
	380	100	90	1560	1885	730	1100	1255	840	855	1530
	550, 650	90	60	1850	2140	695	1300	1430	810	885	1750



30 Dimensions, on-load tap-changer, type UZE standard tank with standard accessories.

Table 11. Dimensions, on-load tap-changer, type UZF.
Dimensions are subject to modification without notice.

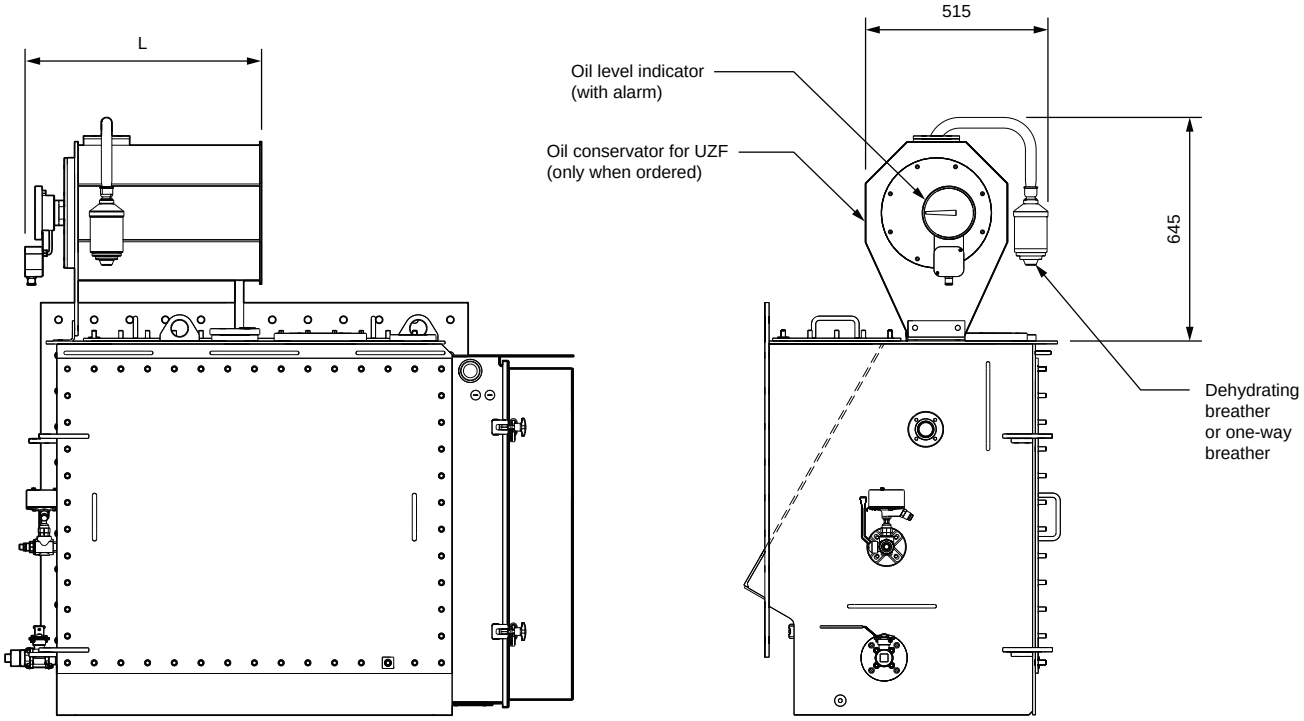
		Dimensions (mm)											
Type UZF	**BIL (kV)**	A	A_1	B	B_1	B_2	H	H_1	H_2	P	P_1	P_2	R
Three-phase	**200**	110	75	1200	1500	700	1000	1050	160	825	835	60	1140
	250	110	75	1200	1500	700	1000	1050	160	825	835	60	1140
	380	140	70	1600	1905	710	1100	1145	155	850	860	120	1530
	550, 650	90	40	1900	2160	665	1300	1295	105	855	925	140	1750



31 Dimensions, on-load tap-changer, type UZF standard tank with standard accessories.

Table 12. Dimensions, oil conservator for on-load tap-changer, type UZF.
Dimensions are subject to modification without notice.

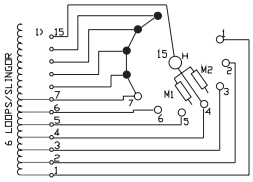
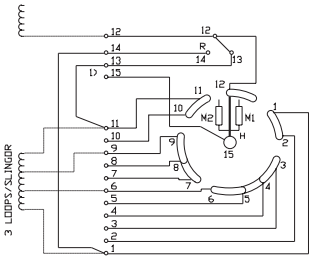
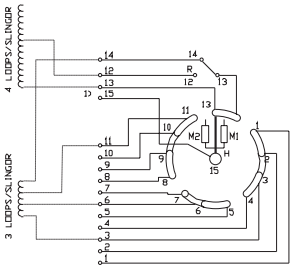
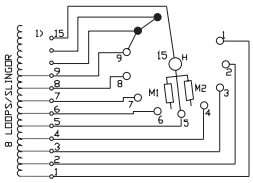
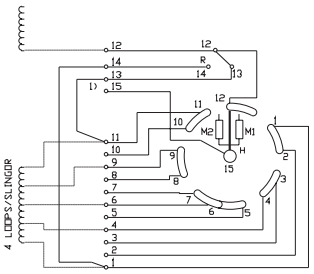
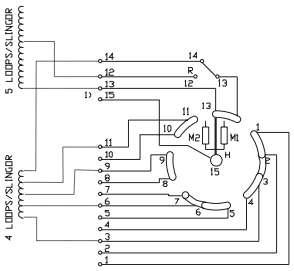
UZF Conservator	**BIL (kV)**	Dimension L (mm)
	200, 250	615
	380	1080
	550, 650	1500

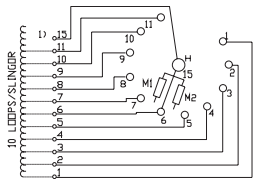
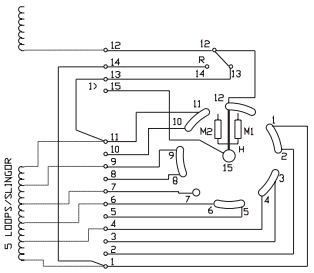
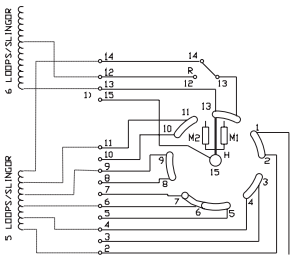
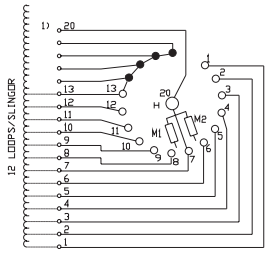
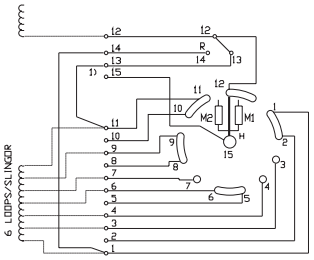
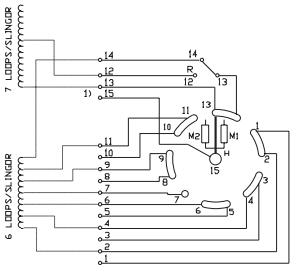
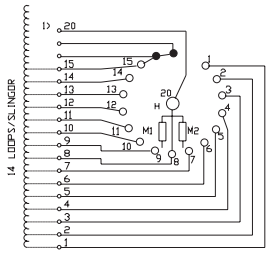
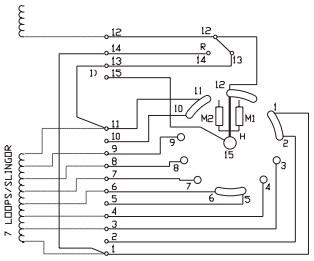
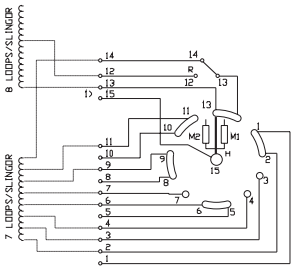
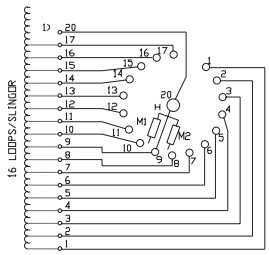
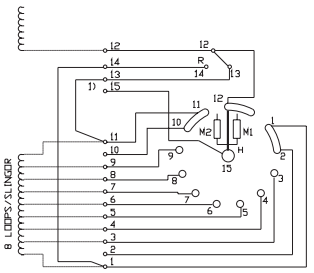
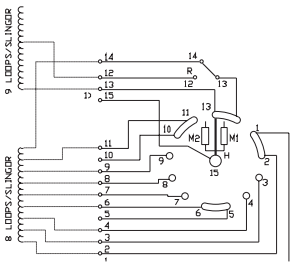


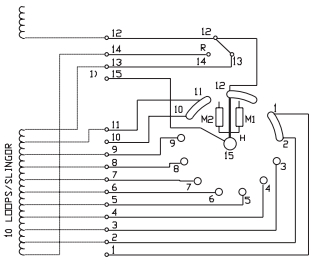
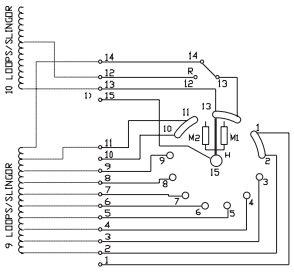
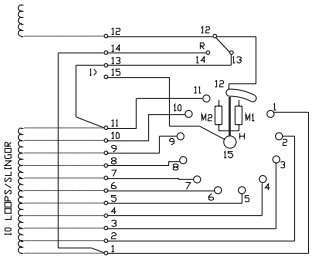
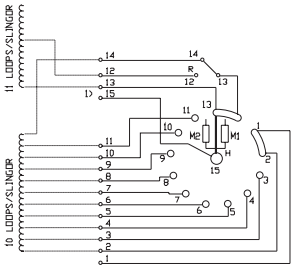
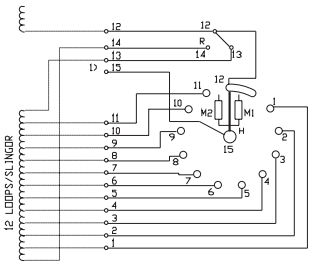
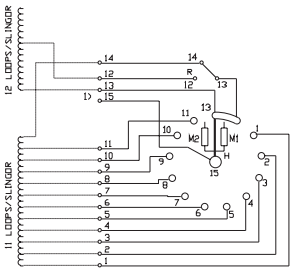
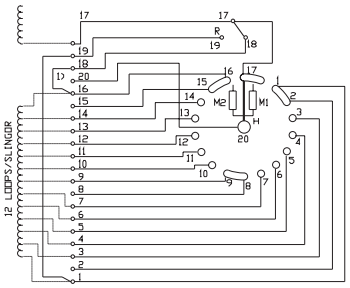
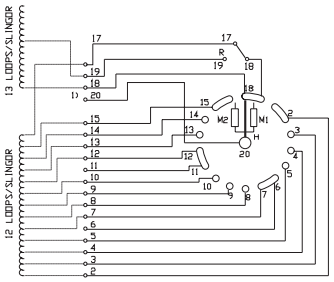
32 Dimensions, oil conservator for tap-changer, type UZF.

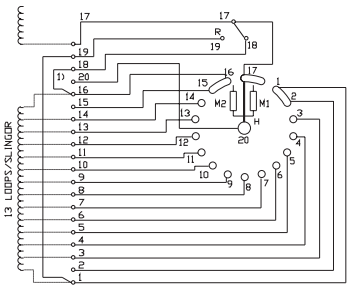
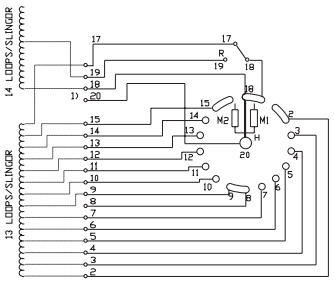
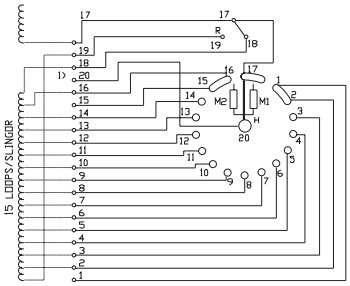
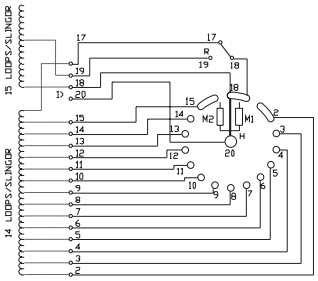
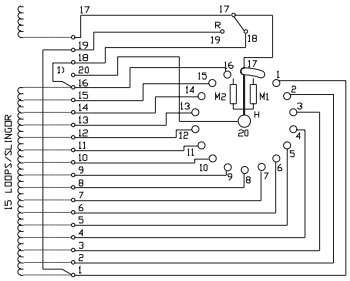
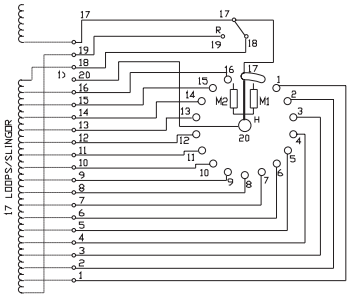
Single phase diagrams

The table shows all the basic connection diagrams for the UZE and UZF series of tap-changers. The basic connection diagrams illustrate the different types of switching and the appropriate connections to the transformer windings. The diagrams illustrate the connections with the maximum number of turns in the transformer winding connected in position 1. The tap-changer can be connected in such a way that position 1 gives a minimum effective number of turns in the transformer winding with the tap-changer in position 1.

Linear	Plus/Minus	Coarse/Fine
Max. regulating steps		
16	**32**	**28**
Max. voltage positions		
17	**33**	**29**
6 steps		
		
Number of loops:		
6	**3**	**3**
Number of tap positions:		
7	**7**	**7**
8 steps		
		
Number of loops:		
8	**4**	**4**
Number of tap positions:		
9	**9**	**9**

Linear	Plus/Minus	Coarse/Fine
10 steps		
		
Number of loops:		
10	**5**	**5**
Number of tap positions:		
11	**11**	**11**
12 steps		
		
Number of loops:		
12	**6**	**6**
Number of tap positions:		
13	**13**	**13**
14 steps		
		
Number of loops:		
14	**7**	**7**
Number of tap positions:		
15	**15**	**15**
16 steps		
		
Number of loops:		
16	**8**	**8**
Number of tap positions:		
17	**17**	**17**

Linear	Plus/Minus	Coarse/Fine
18 steps		
Number of loops:	**10**	**9**
Number of tap positions:	**19**	**19**
20 steps		
Number of loops:	**10**	**10**
Number of tap positions:	**21**	**21**
22 steps		
Number of loops:	**12**	**11**
Number of tap positions:	**23**	**23**
24 steps		
Number of loops:	**12**	**12**
Number of tap positions:	**25**	**25**

Linear	Plus/Minus	Coarse/Fine
26 steps		
Number of loops:		
	13	**13**
Number of tap positions:		
	27	**27**
28 steps		
Number of loops:		
	15	**14**
Number of tap positions:		
	29	**29**
30 steps		
Number of loops:		
	15	
Number of tap positions:		
	31	
32 steps		
Number of loops:		
	17	
Number of tap positions:		
	33	