On-load tap-changers, type UBB
Technical guide
This Technical Guide has been produced to allow transformer manufacturers, and their designers and engineers, access to all the technical information required to assist them in their selection of the appropriate on-load tap-changer and motor-drive mechanism. The guide should be used in conjunction with the Selection Guide and the Design Guides, to allow the optimum selection to be made.

The technical information pertaining to on-load tap-changers and motor-drive mechanisms manufactured by ABB has been divided and is contained in separate documents, with one document for each type.

The information provided in this document is intended to be general and does not cover all possible applications. Any specific application not covered should be referred directly to ABB, or its authorized representative.

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General information

When the on-load tap-changer operates, arcing occurs in the tap-changer. To avoid contamination of the transformer oil, the tap-changer is housed in its own oil compartment separated from the transformer oil. All components that make or break the current during the operation of the tap-changer are located in the tap-changer compartment. The UB range 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 UB type of on-load tap-changer is mounted on the inside of the transformer tank. Both cover-mounting and yoke-mounting may be specified. The tap-changer comes ready for mounting on the inside of the transformer tank, which simplifies installation procedures.

All of the equipment necessary to operate the tap-changer is contained in a cylinder of glass fibre reinforced plastic, the selector switch housing. Driving is from a separate motor-drive mechanism, fitted to the side of the transformer tank, and connected by means of drive shafts and bevel gears.

Fig. 1. On-load tap-changer type UBBRN
Fig. 2. On-load tap-changer type UBBRT
On-load tap-changer

The tap-changer is built-up by using three single-phase units, mutually identical, mounted in the selector switch housing. Each single-phase unit consists of a selector switch and transition contacts.

When plus/minus or coarse/fine switching there is also a change-over selector.

Selector switch

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

The fixed contacts are mounted on bushings which are inserted through the cylinder wall of the selector switch housing. Each fixed contact has two contact paths on each side, one for the moving main contact and one for the moving switching contacts.

The moving contact system for a single-phase 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 insulated drive shaft. In the service position the load current is carried by the moving main contact, which consists of two fingers, pressed on the fixed contact by springs. The moving switching contact and the transition contacts are made as rollers, which move over the knife-like fixed contacts. See Fig. 3. The making and breaking take 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. In service position the current is carried by clean surfaces of copper or silver, which are not subjected to arcing.

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

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

One phase of the change-over selector consists of a moving contact and three fixed contacts. The moving contact is fixed to an insulated cylinder pivoted on the top of the drive shaft, see Fig. 4. The current is carried by the four contact fingers of the moving contact. The contact surfaces consist of silver and copper. 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 via a shaft system and bevel gears from the motor-drive mechanism. A spring energy accumulator actuates the Geneva gear. The Geneva gear operates the selector switch and the change-over selector. The Geneva gear is also used to lock the moving contact system into position. The gearing mechanism is maintenance-free.
Selector switch housing

The tap-changer oil compartment is separated from the transformer oil by a vacuum-proof cylinder, designed to withstand a test pressure of 100 kPa or full vacuum. The cylinder is made of glass fibre reinforced plastic, which on its upper end has attached a metal flange and on the lower end a closed metal bottom. The bottom, the flange, the top-cover and the accessories mounted on the cover are made from casted aluminium. The cylinder and the gasket are designed to be oil-tight, and the tightness is routinely tested with a vacuum/helium-method. This safety guarantees the contaminated tap-changer oil to remain separated from the transformer oil. The top-cover is provided with connecting flanges for pipes to the oil conservator and the pressure relay. The connections are stepless orientable.

Oil conservator

The tap-changer shall be connected to a separate oil conservator, preferably placed at the same height or just below the conservator for the transformer.

Fig 5. On-Load tap-changer system
Motor-drive mechanism

The motor-drive mechanism provides the drive to allow the tap-changer to operate. As the name implies, drive 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.

There are two sizes of motor-drive mechanisms that can be used:

**Type BUL**

BUL is the standard motor-drive mechanism for the on-load tap-changer type UBB, but has limited space for optional accessories.

**Type BUE**

BUE is used when extra space is required for optional accessories in the Motor-Drive Cubicle. For detailed operation description, see separate *Technical Guides for Motor-Drive Mechanisms types BUL or BUE*, respectively.

If there are any doubts about which type to select, please, consult ABB.

Special applications

ABB should be consulted for all special application tap-changers, such as transformers for use with arc-furnaces and converters.

Accessories

For accessories available for both the tap-changer and the motor-drive mechanisms, consult ABB.
Principles of operation

On-load tap-changer

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 milliseconds at 50 Hz. The total time for a complete sequence is approximately 50 milliseconds. The tap change operation time of the motor-drive mechanism is approximately 5 seconds per step.

Selector switch

The switching sequence when switching from position 1 to position 2 is shown in the diagrams of Fig. 8 below. 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. 8a.

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.

Fig. 8b.

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.

Fig. 8c.

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.

Fig. 8d.

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

Fig. 8e.

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.
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 Fig. 9. The contact arm of the selector switch has reached the fixed contact K (10) after switching from the fixed contact 9. It is connected to the end of the main winding. The load current goes directly from the main winding through the contact K and out through the current collector at the selector switch shaft. The upper end of the regulating winding is still connected to the main winding. This is the change-over position.

The contact arm of the change-over selector R has travelled from the contact (+) to the contact (–), through which the lower end of the regulating winding has been connected to the main winding. The load current still goes directly from the main winding through the contact K. After the change-over selector has finished its operation the contact arm of the selector switch starts moving towards contact 1. Both those movements above takes place in the same operation by the motor-drive, so there is no through position.

Change-over selector for coarse/fine switching

Mechanically, coarse/fine switching is carried out 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 diverter or 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 any doubts about this, please consult ABB.
Characteristics and technical data

On-load tap-changer

Type designation

<table>
<thead>
<tr>
<th>Type</th>
<th>Type of switching</th>
<th>Type of connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>U B B... XXX/YYYY</td>
<td>L Linear</td>
<td>N Three-phase star point</td>
</tr>
<tr>
<td></td>
<td>R Plus/minus</td>
<td>T Three-phase fully insulated</td>
</tr>
<tr>
<td></td>
<td>D Coarse/fine</td>
<td></td>
</tr>
</tbody>
</table>

Impulse withstand voltage to earth
200 kV, 350 kV

Maximum rated through-current
150 A, 400 A, 500 A

Maximum number of positions
Linear switching: 14 positions
Plus/minus switching: 27 positions
Coarse/fine switching: 27 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. 10.

Standards and testing
The UB types of on-load tap-changers fulfil the requirements according to IEC 60214-1.

The type tests include:
- Contact temp. rise test
- Switching tests
- Short-circuit current test
- Transition impedance test
- Mechanical tests
- Dielectric tests

The routine tests include:
- Check of assembly
- Mechanical test
- Sequence test
- Auxiliary circuits insulation test
- Vacuum test
- Final inspection

Rating plate
Fig. 11. Example of rating plate

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. It is limited by the step voltage according to the curve in the diagram, Fig. 10.

The rated through-current determines the dimensioning of the transition resistors and the contact life, and is stated on the rating plate, Fig. 11.

Maximum rated through-current
The UB models are designed for maximum rated through-currents of 150 A, 400 A or 500 A.

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. 12. 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 indicated with a dashed line in the figure. The values are calculated from the results of the service duty test. 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.
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 more than 500,000 operations.

Insulation levels
The insulation levels are indicated as 1.2/50 μs impulse withstand voltage – power frequency withstand voltage.

<table>
<thead>
<tr>
<th>Type of switching</th>
<th>Number of positions</th>
<th>a2</th>
<th>c1</th>
<th>b1</th>
<th>d1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Within one phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a2 Between the first and the last contacts (Figs. 13–15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c1 Across change-over selector (Figs. 14 and 15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b1 In selector switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>d1 In change-over selector BIL 200</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BIL 350</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear</td>
<td>10</td>
<td>200–60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>180–60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>170–60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plus/Minus</td>
<td>9, 15–19</td>
<td>200–60</td>
<td></td>
<td>250–60</td>
<td>250–60</td>
</tr>
<tr>
<td></td>
<td>11, 21–23</td>
<td>180–60</td>
<td></td>
<td>250–60</td>
<td>250–60</td>
</tr>
<tr>
<td>Coarse/Fine</td>
<td>15–19</td>
<td>200–60</td>
<td>250–60</td>
<td>250–60</td>
<td>350–140</td>
</tr>
<tr>
<td></td>
<td>21–23</td>
<td>180–60</td>
<td>250–60</td>
<td>250–60</td>
<td>350–140</td>
</tr>
<tr>
<td></td>
<td>25–27</td>
<td>170–60</td>
<td>250–60</td>
<td>250–60</td>
<td>350–140</td>
</tr>
</tbody>
</table>

Fig. 12. Predicted contact life at 50 Hz. At 60 Hz the predicted contact life is about 20% higher, up to the maximum 500,000 operations.

1) Class II according to IEC 60214, clause 5.2.6.

Table 1. Insulation levels.

Fig. 13. Linear switching
Fig. 14. Plus/minus switching
Fig. 15. 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>
<thead>
<tr>
<th>Max. rated through-current A, rms</th>
<th>Three applications of 3 s duration A, rms</th>
</tr>
</thead>
<tbody>
<tr>
<td>150, 400, 500</td>
<td>8000</td>
</tr>
</tbody>
</table>

Highest phase service voltage across the regulating winding

The highest permissible phase service voltage is the product of the maximum number of steps and the allowable step voltage according to Fig. 10.

Tie-in resistors

If the service voltage and the winding capacitances are such that the recovery voltage of the change-over selector exceeds 25 kV, it must be limited to this value or lower, by means of a tie-in resistor. The tie-in resistors are placed under the bottom for star point types and on the connections outside the cylinder for fully insulated types.

Calculation rules for tie-in resistors are provided in a separate document, On-Load Tap-Changer Tie-in Resistors, 5492 0030-39.

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 "Loading guide for oil-immersed transformers", ANSI/IEEE C57.91 "Guide for loading mineral-oil-immersed power transformers" and CAN/CSA-C88-M90.

To meet these requirements, the UB 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 beyond these values, results in increased contact wear and shorter contact life.

Oil temperature

The temperature of the oil surrounding the on-load tap-changer shall be between -25 and +105 °C for normal operation, as illustrated in Fig. 16. The range can be extended to -40 °C provided that the viscosity of the tap-changer oil is between 2-800 mm²/s (= cst).

![Fig. 16. On-load tap-changer oil temperature](fm_00215)

Conductors from the windings

The temperature of the conductors connected to the terminals on the back of the on-load tap-changer must not exceed 30 K over the surrounding oil.
Design, installation and maintenance

On-load tap-changer

Single-phase diagrams

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, with the tap-changer in position 1.

The tap-changer can also 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.

<table>
<thead>
<tr>
<th>Regulating steps</th>
<th>Linear</th>
<th>Plus/minus</th>
<th>Coarse/Fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td><img src="linear_8_steps.png" alt="Diagram" /></td>
<td><img src="plus_minus_8_steps.png" alt="Diagram" /></td>
<td><img src="coarse_fine_8_steps.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regulating steps</th>
<th>Linear</th>
<th>Plus/minus</th>
<th>Coarse/Fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td><img src="linear_9_steps.png" alt="Diagram" /></td>
<td><img src="plus_minus_9_steps.png" alt="Diagram" /></td>
<td><img src="coarse_fine_9_steps.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>10</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Regulating steps</td>
<td>Linear</td>
<td>Plus/minus</td>
<td>Coarse/Fine</td>
</tr>
<tr>
<td>------------------</td>
<td>--------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>10 Regulating steps</strong></td>
<td><img src="image1" alt="Diagram" /></td>
<td><img src="image2" alt="Diagram" /></td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of Loops</td>
<td>10</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tap Positions (Electrical)</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>11 Regulating steps</strong></th>
<th><img src="image4" alt="Diagram" /></th>
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</thead>
<tbody>
<tr>
<td>Number of loops</td>
<td>11</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>12 Regulating steps</strong></th>
<th><img src="image5" alt="Diagram" /></th>
<th><img src="image6" alt="Diagram" /></th>
<th><img src="image7" alt="Diagram" /></th>
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</thead>
<tbody>
<tr>
<td>Number of loops</td>
<td>12</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>13</td>
<td>13</td>
<td>13</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>13 Regulating steps</strong></th>
<th><img src="image8" alt="Diagram" /></th>
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<tbody>
<tr>
<td>Number of loops</td>
<td>13</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>14</td>
</tr>
<tr>
<td>Regulating steps</td>
<td>Linear</td>
</tr>
<tr>
<td>------------------</td>
<td>--------</td>
</tr>
<tr>
<td>14</td>
<td><img src="image1.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>8</td>
</tr>
<tr>
<td>Tap positions</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>8</td>
</tr>
<tr>
<td>Tap positions</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td><img src="image7.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>10</td>
</tr>
<tr>
<td>Tap positions</td>
<td>19</td>
</tr>
<tr>
<td>20</td>
<td><img src="image10.png" alt="Diagram" /></td>
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<tr>
<td>Number of loops</td>
<td>10</td>
</tr>
<tr>
<td>Tap positions</td>
<td>21</td>
</tr>
<tr>
<td>Linear</td>
<td>Plus/minus</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>22 Regulating steps</strong></td>
<td><img src="image1.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>12</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>23</td>
</tr>
<tr>
<td><strong>24 Regulating steps</strong></td>
<td><img src="image3.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>12</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>25</td>
</tr>
<tr>
<td><strong>26 Regulating steps</strong></td>
<td><img src="image5.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Number of loops</td>
<td>14</td>
</tr>
<tr>
<td>Tap positions (electrical)</td>
<td>27</td>
</tr>
</tbody>
</table>

*Basic connection diagrams for the UBB series of on-load tap-changers*
Drying
The tap-changer should be stored indoors and left in its plastic shipping cover until time for assembly. Drying of the tap-changer is not necessary if the plastic cover not have been destroyed before assembly.

The tap-changer can be dried together with the transformer according to one of the following processes: alternating hot-air and vacuum or vapour-phase at a maximum temperature of 135 °C (275 °F) and a maximum pressure difference of 100 kPa between the tap-changer and the transformer.

Painting
The top section against air of the tap-changer is painted on surfaces facing the air.

The painting system consist of 3 layers, 30 µm single component acrylic based primer 60 µm two component epoxy based primer and 60 µm two component polyurethane based finishing coat.

The finishing colour is grey/blue according to Munsell 5.5B 5.5/1.25.

Weights
Table 3 contains the weights of all the models in the UB range of on-load tap-changers. The motor-drive mechanism and the drive shaft system are not included in the overall weight.

<table>
<thead>
<tr>
<th>On-load tap-changer Type designation</th>
<th>Approx. weight in kg</th>
<th>Tap-changer without oil</th>
<th>Required oil</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>UBBLN XXX/YYY</td>
<td>140</td>
<td>100</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>UBBRN XXX/YYY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UBBDN XXX/YYY</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>UBBLT XXX/YYY</td>
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<tr>
<td>UBBDT XXX/YYY</td>
<td></td>
<td></td>
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</tbody>
</table>

Table 3. Weights

Motor-drive mechanism (BUL): 75 kg
Motor-drive mechanism (BUE): 130 kg
Drive shaft system: Approx. 10 kg

Oil filling
For the correct oil filling procedure, consult the appropriate Installation and Commissioning Guide.

Installation
For installation instructions, consult the appropriate Installation and Commissioning Guide.

Maintenance
The UB range of on-load tap-changers has been developed 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, the oil and the motor-drive mechanism.

An annual inspection should be carried out while the transformer is in service. At this inspection the counter is read to determine when overhaul is due.

Overhaul shall normally be carried out after one fifth of estimated contact life or at least every fifth year, whichever comes first. The overhaul must be carried out by personnel well acquainted with the product. At overhaul the oil is drained and the insert is lifted up. The overhaul mainly consist of cleaning, checking of the contacts (replacement if they are worn) and filtering or replacement of the oil. The motor-drive mechanism and shaft system should also be checked and lubricated, and the pressure relay checked.

The appropriate Maintenance Guide should be consulted for further information.

Oil filter unit
The on-load tap-changer can be equipped with an oil filter unit for continuous oil filtration. For further information, see manual 1ZSE 5492-152.

Ordering alternatives
Pipe connection alternatives as shown below.

Standard
Valve R ½”
Pipe for connection to conservator
Cover with air release valve
Pressure relay

Draining
For assembly of pipe and valve on the transformer
Pipe with air release valve for oil-draining
Pipe for connection to conservator
Cover with air release valve
Pressure relay

Oil filtering
Pipe for connection to oil-filter, suction side
Pipe for connection to conservator
Pipe for connection to oil-filter, return pipe
Pressure relay
Pressure relay

General description
Protection for the on-load tap-changer is provided by a pressure relay which is mounted on the tap-changer cover. In the event of an over-pressure in the tap-changer, the relay will trip the transformer main circuit breakers. After a pressure relay trip, the tap-changer must be opened and carefully investigated according to the Repair Guide. Faults, if any are located, should be repaired before the tap-changer is energized.

Design
The pressure relay is mounted on a three-way valve. On the other two outlets of the valve there is a connection flange on one side, and a connection for test equipment on the other, see Fig. 17.

The pressure relay housing is made of copper-free aluminium alloy and is externally coated with an enamel. A stainless steel model can be provided on request. Degree of protection IP66.

Table 4. Technical data – Micro-switch

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Breaking capacity Resistive load</th>
<th>Inductive load ( \frac{L}{R} \leq 40 \text{ ms} )</th>
<th>Withstand voltage between open contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>110 V DC</td>
<td>0.8 A</td>
<td>0.2 A ( \frac{L}{R} \leq 40 \text{ ms} )</td>
<td>2 kV, 50 Hz, 1 min</td>
</tr>
<tr>
<td>125 V DC</td>
<td>0.6 A</td>
<td>0.15 A ( \frac{L}{R} \leq 40 \text{ ms} )</td>
<td></td>
</tr>
<tr>
<td>220 V DC</td>
<td>0.4 A</td>
<td>0.1 A ( \frac{L}{R} \leq 40 \text{ ms} )</td>
<td></td>
</tr>
<tr>
<td>125 V AC</td>
<td>5 A</td>
<td>5 A cos ( \varphi ) \geq 0.4</td>
<td></td>
</tr>
<tr>
<td>250 V AC</td>
<td>2.5 A</td>
<td>2.5 A cos ( \varphi ) \geq 0.4</td>
<td></td>
</tr>
</tbody>
</table>

The pressure relay is designed for one or two switching elements. The function pressure (set point) has been set by the manufacturer. The micro-switch is hermetically sealed and filled with nitrogen with over-pressure, and separated from the connection space with a sealed cap. These measures are done to ensure a safe function.

Operation
When the pressure acting on the face of the piston exceeds the spring load of the piston, the piston will move and activate the switching element.

The function time is less than 15 ms in the temperature range of -40 °C to +80 °C, with a pressure of 20-40 MPa/sec. The function time is the time from the pressure in the on-load tap-changer oil compartment exceeds the adjusted set point of the pressure relay until the pressure relay gives a stable signal for operating the main circuit breakers.

Function pressure
The function pressure (set point) is 100 kPa (14 Psi) if the oil level is less than 7 metres above the level of the pressure relay. Pressure relay with higher function pressure can be delivered on request.

Testing
At commissioning of the transformer and for testing the pressure relay, the instructions in the Installation and Commissioning Guide should be consulted.
Dimensions, on-load tap-changer
All dimensions are in millimetres unless otherwise stated.

Motor-drive mechanism

Design
For detailed design description, see separate Technical Guides for Motor-Drive Mechanisms types BUL or BUE respectively.

Installation
The motor-drive mechanism is fitted to the outside of the transformer tank, and connected to the tap-changer (or tap-changers) by drive shafts and bevel gears.
For correct installation procedure, consult the appropriate Installation and Commissioning Guide.

Maintenance
The motor-drive mechanism should be inspected at regular intervals and at the same time as the tap-changer is inspected.
For the correct inspection and maintenance procedures, consult the appropriate Maintenance Guide.

Fig. 18. Dimensions, Type UBB

Table 5. Dimensions, Type UBB

<table>
<thead>
<tr>
<th>Type designation</th>
<th>Dimension H (mm)</th>
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<tr>
<td>UBBRN XXX/YYYY</td>
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</tbody>
</table>
Dimensions, drive shaft system and motor-drive mechanism

All dimensions are in millimetres unless otherwise stated.

1) Angle deviation max 4°
2) The shaft can be mounted within these angles. (The gearbox stepless turnable)

Fig. 20. Dimensions, drive shaft system and motor-drive mechanism