On-load tap-changer, type UCG with motor-drive mechanisms, type BUE/BUL

Maintenance guide
Recommended practices

ABB recommends careful consideration of the following factors for maintenance work on on-load tap-changers:

Before you start any work, make sure that the personnel doing the job have read and fully understood the maintenance documents provided with the unit.

To avoid damaging the unit, never exceed the operating limits stated in delivery documents and on rating plates.

Do not alter or modify a unit without first consulting ABB.

Follow local and international wiring regulations at all times.

Use only factory authorized replacement parts and procedures.

WARNING, CAUTION and NOTE

WARNING

A WARNING provides information which, if disregarded, could cause injury or death.

CAUTION

A CAUTION provides information which, if disregarded, could cause damage to the equipment.

NOTE: A NOTE provides additional information to assist in carrying out the work described.

Safety precautions

WARNING

The Maintenance guide should be read and understood before any work is started, and the procedures in this document should be followed at all times.

Before any work is carried out on the on-load tap-changer:
Make sure that the transformer is disconnected and that earthing is properly carried out. Obtain a signed certificate from the engineer in charge.

Before carrying out work on the on-load tap-changer, put the LOCAL/REMOTE switch in the motor-drive mechanism to position 0. It is also recommended to shut the door of the motor-drive mechanism and pad lock it when work is carried out on the on-load tap-changer. The key should be kept by the operator. This is done to avoid unexpected start of the motor-drive mechanism.

Before starting any work inside the motor-drive mechanism, the auxiliary power must be switched off.

N.B. The motor, contactors and heating element may be energized from separate sources.

In no case should any person go down into the diverter switch housing. The cleaning of the diverter switch housing should be carried out by using brushes and rags and by flushing with oil.
CAUTION

Approval should be given for inspection as well as for operating the on-load tap-changer.

ABB recommends that only maintenance engineers trained by ABB carry out contact replacement.

During service

WARNING

Small amounts of explosive gases will always come out from the breathing devices (dehydrating breather or one-way breather). Make sure that no open fire, hot surfaces or sparks occurs in the immediate surroundings of the breathing devices.

If a failure in power supply occurs during operation, the operation will be completed when the power returns.

The hand crank must not be inserted during electrical operation.

If the on-load tap-changer is not in its exact position and the hand crank is pulled out, the motor-drive mechanism will start and go to the exact position if the power supply is on.

CAUTION

After a pressure relay trip, follow the instructions in the chapter “Pressure Relay” in the Repair Guide.

During oil handling

WARNING

Unused transformer oil is slightly harmful. Fumes from unused warm oil may irritate the respiratory organs and the eyes. After long and repeated contact with transformer oil skin becomes very dry.

Used on-load tap-changer oil from diverter switch housings and selector switch housings contains harmful substances. Fumes are irritating to the respiratory organs and the eyes and are very easily set on fire. Used transformer oil may well be carcinogenic.

Avoid contact with the oil as much as possible and use oiltight protective gloves when handling the oil.

First aid:
Skin contact: Wash the hands. Use skin cream to counteract drying.  
In the eyes: Rinse the eyes in clean water.  
Swallowing: Drink water or milk. Avoid vomiting. Call a doctor.

Collect used oil in oil drums.

Waste and cleaning up: Should be absorbed by an absorber. Treat it as hazardous to the environment.

Upon fire: The fire should be extinguished by using powder, foam or carbon acid.
WARNING
When oil that has been used in a selector switch compartment is pumped out, conducting tubes and hoses that are earthed should be used to avoid the risk of explosion due to the gases produced by the arcs during service.

The oil in the selector switch compartment may be hot. Be cautious!

There is always a cushion of explosive gases in the top of the diverter switch housing. No open fire, hot surfaces or sparks may be present during opening of the housing or draining from the valve. After the cover is removed let the gas vent away approximately 15 min before any work is started.

Be aware of the risk for slipperiness caused by oil spillage for instance when working on the transformer cover.

CAUTION
Take care to avoid ingestion of moist air when oil is drained. If the ambient air is moist, let incoming air pass through a dehydrating breather with slow air flow to obtain proper dehydration.

Do not fill oil into the on-load tap-changer if the transformer tank is under vacuum and the on-load tap-changer is not.

Do not fill oil into the transformer tank if the on-load tap-changer is under vacuum and the transformer tank is not.

Leave a gas cushion on top of the oil in the diverter switch housing.

After oil filling

CAUTION
Do not energize the transformer earlier than three hours after oil filling in atmospheric pressure. This waiting period is needed to allow airbubbles to disappear.

Mounting of gaskets

CAUTION
Sealing surfaces and gaskets must be clean and undamaged. Diametrically opposed bolts in sealing joints must be tightened alternately several times, beginning with a low tightening torque and finally with the recommended tightening torque as described in section 1.3 Tightening torque, in this guide.
3.18 Oil filling
   3.18.1 Filling methods and restrictions
   3.18.2 Before filling
   3.18.3 Filling at atmospheric pressure
   3.18.4 Oil level
   3.18.5 Restoring the gas cushion
   3.18.6 Waiting period
3.19 Check of contact timing
3.20 Putting into operation
4. Contact replacement
   4.1 Dismantling the boards
   4.2 Dismantling the moving main contacts
   4.3 Dismantling the moving transition contacts
   4.4 Mounting the moving transition contacts
   4.5 Mounting the moving main contacts
   4.6 Replacing the fixed main contacts
   4.7 Replacing the fixed transition contacts
   4.8 Mounting the boards with transition resistors and fixed contacts
5. Specification of materials
   5.1 General
   5.2 Diverter switch housing
   5.3 Diverter switch
   5.4 Tap selectors
   5.5 Conductors
   5.6 Gearing mechanism
   5.7 Drive shaft systems
   5.8 Motor-drive mechanism
1. Introduction

1.1 General

The UC range of on-load tap-changers manufactured by ABB has been developed over many years to provide maximum reliability. The simple and rugged design gives a service life equal to the service life of the transformer. Minimum maintenance is required for trouble-free operation. The only parts requiring maintenance are contacts that might need replacement during the service life, the insulating oil and the motor-drive mechanism.

The design allows excellent access to all parts, making inspection and maintenance quick and simple.

The on-load tap-changer, type UCG, is housed in the transformer tank. The motor-drive mechanism is attached to the transformer tank and connected to the on-load tap-changer by means of drive-shafts and a bevel gear, see Fig. 1.

![Diagram of On-load tap-changer and motor-drive mechanism.](image)

**Fig. 1. On-load tap-changer and motor-drive mechanism.**
Fig. 2 shows the general arrangement of an on-load tap-changer type UC. The main components are the spring-operated diverter switch and the tap selector with sliding contacts. For maintenance the diverter switch is lifted. The contacts are then immediately accessible and can be inspected for wear. The drive-shafts should not be dismantled when lifting the diverter switch.

Maintenance is normally not required on the parts operating in the oil of the transformer tank. However, when the on-load tap-changer has made one million operations a check of the tap selector is recommended.

The diverter switch has its own housing separate from the transformer oil. This is to prevent contamination of the transformer oil since the diverter switch oil deteriorates due to the switching operations. The oil needs to be checked and filtered at regular intervals to maintain adequate dielectric strength as well as to prevent mechanical wear.

It is necessary to inspect the contacts and clean the insulation parts of the diverter switch as well as to clean the housing inside at regular intervals.

The main components of the diverter switch are:

- Fixed main contacts
- Moving main contacts
- Fixed transition contacts
- Moving transition contacts
- Transition resistors
- Spring-driven polygon link system

Besides the maintenance of the diverter switch and cleaning of the oil, the motor-drive mechanism should be checked and lubricated.

The pressure relay, the device that protects the transformer from damages due to excessive pressure in the diverter switch housing, should also be checked.

NOTE: One on-load tap-changer of UCG type may consist of one, two or three units driven by a common motor-drive mechanism. The instructions in this guide deals with one unit. If there is two or three units, all work described should be carried on all units unless otherwise is stated. If more than one diverter switch is lifted out at the same time, make sure the right diverter switch is lowered into the right housing (compare with the serial numbers, see Fig. 2).

### 1.2 Maintenance schedule

Maintenance of the on-load tap-changer consists of three major steps:

- Inspection
- Overhaul
- Contact replacement

#### 1.2.1 Inspection

On the rating plate, “inspection once a year” is recommended. This principally concerns the motor-drive mechanism and refers to a visual inspection inside the motor-drive cabinet to check that nothing is loose and the heater is functioning.

In the motor-drive mechanism a counter registers every tap-changer operation. During inspection the counter is read. If possible, motor and counter are tested by operating one step and then back.

If the on-load tap-changer has its own oil conservator, the breather and the oil level indicator are checked according to the instructions from the transformer manufacturer.

The inspection is carried out while the transformer is in service.

If the on-load tap-changer is equipped with an oil filter unit from ABB, it should be inspected once a year according to the **Oil filter unit for on-load tap-changers, manual**.
1. Introduction

Fig. 2. General arrangement of on-load tap-changer, type UC.

1) Only at impulse withstand voltage to earth of 650 kV and 1050 kV
2) Not on UCG of the short type
1. Introduction

1.2.2 Overhaul

The contact life and the frequency of operations or the time in service determine the time interval between overhauls.

The number of operations run by the on-load tap-changer is recorded by a counter, housed in the motor-drive mechanism cabinet. The registered number of operations should be noted at every inspection and overhaul.

The on-load tap-changer should normally be overhauled regularly at intervals of 1/5 of the estimated contact life. The relevant information is stated on the rating plate. Hereby, the contact wear can be followed and necessary preparations can be made for replacing the contacts.

If the tap-change operations occur infrequently and a very long time elapses until the number of operations amounts to 1/5 of the contact life, the interval between overhauls should be limited to the time stated on the rating plate (normally 7 years).

1.2.3 Contact replacement

On the rating plate of the on-load tap-changer the estimated contact life of the breaking contacts in the diverter switch at rated load is stated.

The contacts will withstand a very large number of switching operations. For normal power transformers the number of operations of the diverter switch is approximately 20 per day, which means that replacement of the contacts is not normally necessary during the life of the transformer. (In case of on-load tap-changers on furnace transformers, the frequency of operations may be considerably higher).

**CAUTION**

The number of operations must in no case exceed 500 000, due to weakening spring tension of the contacts.

1.3 Tightening torque

The following tightening torques are recommended:

<table>
<thead>
<tr>
<th>Screw Joint</th>
<th>Torque (Nm)</th>
<th>±10 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6, metallic</td>
<td>10</td>
<td>±10 %</td>
</tr>
<tr>
<td>M8, metallic</td>
<td>24.5</td>
<td>±10 %</td>
</tr>
<tr>
<td>M10, metallic</td>
<td>49</td>
<td>±10 %</td>
</tr>
<tr>
<td>M12, metallic</td>
<td>84</td>
<td>±10 %</td>
</tr>
<tr>
<td>M10, non-metallic</td>
<td>9</td>
<td>±10 %</td>
</tr>
<tr>
<td>M12, non-metallic</td>
<td>13</td>
<td>±10 %</td>
</tr>
<tr>
<td>M16, non-metallic</td>
<td>22</td>
<td>±10 %</td>
</tr>
</tbody>
</table>

if not otherwise is stated in this guide.
2. Inspection

The inspection mainly consists of a visual check of the motor-drive mechanism and the conservator once a year while the transformer is in service.

In the motor-drive mechanism the following points are to be checked:

- Motor and counter
- Heater
- The counter’s value

On the conservator the following are to be checked:

- Oil level
- Breather

2.1 Required tools and material

The following equipment is required for the inspection:

- Set of screw drivers
- Pen and note pad

2.2 Procedure

**WARNING**

This work **must** be carried out from ground level since the transformer is energized!

The breathers and the tube from the conservator contains explosive gases. No open fire, hot surfaces or sparks may be present when loosening the breather.

**CAUTION**

Approval should be given for inspection as well as for operating the on-load tap-changer.

1. Check the breathers according to the instructions for the transformer.
2. Check the oil level in the conservator for the on-load tap-changer. The oil level should be according to the transformer documentation. Figs. 3 and 4.
3. Open the cabinet door of the motor-drive mechanism and turn the selector-switch to the LOCAL position. Then turn the control switch to the RAISE (LOWER) position.
4. Check that the motor works properly, the position indicator increases (decreases) one step and the counter advances one step for each operation. Record the counter’s value. The counter shows the number of operations run by the on-load tap-changer (the overhaul-schedule can be determined with the help of this information).
5. Turn the control switch to the LOWER (RAISE) position for 1-2 seconds. Check that the motor also works properly in that direction, the position indicator decreases (increases) one step and the counter advances one step more. Reset the draghands.
6. Check the emergency stop.
   Give a RAISE or LOWER impulse and after about one second press the emergency stop. The operation should be interrupted. Reset the emergency stop by turning the knob clockwise and by switching on the protective motor switch. The started operation should now be completed. Operate back to service position.
7. Check the earth fault protector (option).
   If the motor-drive mechanism is equipped with an outlet, the earth fault protector should be tested by pressing the test knob on the outlet on BUE and by pressing the test knob on the separate earth fault protector on BUL.
8. Disconnect the incoming auxiliary power.
2. Inspection

---

**WARNING**

Before starting any work inside the motor-drive mechanism the auxiliary power must be switched off.

N. B. The motor, contactors and heating element may be energized from separate sources.

9. Open the control panel
10. Check by feeling with a finger on the protection plate that the heater has been functioning.
11. Close the control panel and reconnect the incoming auxiliary power.
12. Complete the inspection by turning the switch to the REMOTE position and closing the cabinet door.
2. Inspection

Layout of motor-drive mechanism, type BUE

1. Locking device prepared for padlock
2. Emergency stop
3. (Option) Switch for extra heater
4. Air vent
5. LOCAL/REMOTE switch
6. RAISE/LOWER switch
7. Outgoing shaft
8. Lamp (40 W socket E27)
9. Lifting eye
10. Counter
11. Tap-change in progress indicator
12. Position indicator with draghands for max. and min. position
13. Shaft for handcrank
14. Heater 50 W + optional 100 W (behind the panel)
15. (Option) Outlet with earth fault protector
16. Terminal blocks (behind the panel)
17. Protective motor switch
18. (Option) Thermostat or hygrostat for extra heater 100 W
19. Door-operated switch for lamp
20. Handcrank
21. Descriptions and circuit diagram
2. Inspection

Layout of motor-drive mechanism, type BUL

1. Position indicator with draghands for max. and min. position
2. Tap-change in progress indicator (Red = in progress, White = in position)
3. Counter
4. Outgoing shaft with multihole coupling half
5. Shaft for handcrank
6. Lifting eye
7. Locking device prepared for padlock
8. (Option) Multi position switches
9. (Option) Measuring amplifier
10. (Option) Switch for extra heater
11. (Option) Outlet
12. (Option) Earth fault protector (when outlet is installed)
13. Emergency stop
14. RAISE/LOWER switch
15. LOCAL/REMOTE switch
16. Protective motor switch
17. Air vent
18. Door operated switch for lamp
19. Terminal blocks
20. Hand lamp
21. Heater 50 W + optional 100 W
22. (Option) Thermostat or hygrostat for extra heater 100 W
23. Descriptions and circuit diagram
24. Handcrank
3. Overhaul

WARNING
Before any work is carried out on the on-load tap-changer:
Make sure that the transformer is disconnected and that earthing is properly carried
out. Obtain a signed certificate from the engineer in charge.

3.1 Required tools and materials
Necessary for the overhaul is the following equipment:
- Normal hand tools (keywidth up to 19 mm)
- Normal set of combination spanners
- Pipe wrench
- Thickness gauges (0.40; 0.50; 1.20 mm)
- Small hammer
- Sliding caliper
- Spring balance (10 N)
- Watch (with hand for seconds)
- Oil can
- Ohmmeter (1-30 Ohm)
- Air pump with pressure gauge (0-200 kPa) and connection to R 1/8" male thread
- Telphcr (at least 150 kg lifting force)
- Empty and clean barrels for transformer oil (calculate with max. 225 l for each diverter
  switch housing)
- Oil draining and filtering equipment with connections
- Test equipment according to IEC 156
- Two buckets (approximately 10 l)
- Rags (non-fuzzying)
- 50 l of new transformer oil (class II according to IEC 296)
- Grease (GULF-718 EP synthetic grease, Mobilgrease 28, Shell-Aero Shell grease 22 or
  similar
- Oil (for plain ball and roller bearings)
- Degreasing agent
- Protective gloves, oil proof
- Dimension drawing for the on-load tap-changer
- Pen and note pad
- Set of spare contacts (see Spare parts list for UC)
- Brass shims according to Fig. 9 (12 pcs)
- New O-ring for the cover (435x8)

When restoring the gas cushion. (section 3.18.5):
- Small oil pump with connection to the oil valve
- Empty and clean barrel for transformer oil (~ 15 l)
- Box wrench, 6 mm

When measuring contact timing, add this equipment:
- See section 3.19
When replacing contacts (chapter 4), add this equipment:

- Universal pliers
- Pipe wrench
- 4 mm mandrel
- 5 mm brass mandrel, 320 mm long
- Steel ruler
- Round file
- Torque wrench (10 Nm)
- Piece of wood, 50 mm thick, 400 mm long

3.2 Procedure

The overhaul procedure includes the following points:

- Oil testing and oil draining
- Lifting and cleaning the diverter switch
- Cleaning the diverter switch housing and the oil filter (if any)
- Oil filtration
- Checking the breathers
- Checking the contact positions
- Checking the contact wear
- Checking the transition resistors
- Checking before lowering the diverter switch
- Lowering the diverter switch
- Checking the pressure relay
- Lubrication
- Checking the motor-drive mechanism
- Oil filling
- Check of contact timing
- Putting into operation

3.3 Preparations

NOTE: If the on-load tap-changer is oil filled under atmospheric pressure, a waiting period of three hours is needed before energizing. To save out of service time of the transformer, carry out all work on the on-load tap-changer and the oil filling before the maintenance of the motor-drive mechanism is started.

3.3.1 On-load tap-changer position

Note the position of the on-load tap-changer to enable restart of the transformer in the right tap position.

3.3.2 Disconnection and earthing of the transformer

WARNING

Before starting any work in the on-load tap-changer the protective motor switch and the LOCAL/REMOTE switch must be set at 0.

Before any work is carried out on the on-load tap-changer:
make sure that the transformer is disconnected and that earthing is properly carried out. Obtain a signed certificate from the engineer in charge.
3. Overhaul

3.3.3 Oil volumes and lifting heights

The necessary number of empty drums for collecting and filtering of the oil in the diverter switch housing should be kept ready. The drums must be carefully cleaned and free from water. New oil needed should be of class II according to IEC 60296.

<table>
<thead>
<tr>
<th>UCG..</th>
<th>380/...</th>
<th>Approx. 170 litres (lifting height 1.4 m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCG..</td>
<td>650/...</td>
<td>Approx. 170 litres (lifting height 1.4 m)</td>
</tr>
<tr>
<td>UCG..</td>
<td>1050/...</td>
<td>Approx. 205 litres (lifting height 1.7 m)</td>
</tr>
</tbody>
</table>

NOTE: The volume of the oil conservator is not included.

Alternatively, the oil may be replaced by new oil and the used oil filtered at some later occasion. A certain quantity of new oil, at least 50 litres, should be kept ready to replace waste oil and for cleaning.

CAUTION

Do not energize the transformer until oil has been filled as per section 3.18 "Oil filling" in this guide.

3.3.4 Recommended set of spare parts

It is recommended to have a set of contacts for the diverter switch available during the overhaul, see Spare parts list for ordering.

3.4 Oil testing and oil draining

The diverter switch housing is equipped with an oil valve placed on the top section. For connection dimensions, see the dimension drawing for the on-load tap-changer.

WARNING

The oil in the diverter switch housing may be hot. Be cautious!

Take an oil-sample from the oil valve and carry out the dielectric strength test according to IEC 60156 (between spherical calottes, distance 2.5 mm). This test is carried out for deciding whether the oil can be filtered or must be exchanged.

The dielectric strength of the oil should not be allowed to be less than 120 kV/cm for an on-load tap-changer in service.

NOTE: When taking the oil-sample, first drain some oil into a bucket to clean the valve.

If the oil conservator of the on-load tap-changer is common with the oil conservator of the transformer tank, close the valve in the pipe connection to the oil conservator and open the oil valve. After a while, open the air release valve. See Fig. 22.
NOTE: If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, oil draining and filtering is not needed, provided that the dielectric strength is at least 160kV/cm (IEC 60156).

NOTE: There is a hole in the upper part of the draining tube to prevent air from being trapped inside the tube when oil filling. The air sucked in through this hole when draining might disturb the function of some types of pumps. In such case, drain the oil using a hose instead.

**CAUTION**

Never block the hole in the draining tube!

Use the filtering equipment or the pump to drain oil from the on-load tap-changer into carefully cleaned oil drums. Connect the pump to the oil valve and drain the oil from the diverter switch housing and the conservator. Draining can be effected quickly if filtering equipment is used and at the same time the whole oil quantity will be filtered once. Remove the cover of the diverter switch housing while draining.

**WARNING**

There is always a cushion of explosive gases in the top of the diverter switch housing. No open fire, hot surfaces or sparks may be present during opening of the housing or draining from the valve. After the cover is removed let the gas vent away approximately 15 min before any work is started.

When oil that has been used in a diverter switch housing is pumped out, conducting tubes and hoses that are earthed should be used to avoid the risk of explosion due to the gases produced by the arcs during service.

Drain the remaining oil in the bottom of the housing by using a hose.

---

**Fig. 5. Diverter switch, general arrangement.**
3.5 Lifting and cleaning the diverter switch

The weight of the diverter switch is approximately 90 kg.
Lift the diverter switch partly so you can flush it with oil. After careful flushing, lift the diverter switch from the housing and wipe it with rags. Lift according to Fig. 7.

NOTE: If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, the flushing and wiping of the diverter switch is not necessary.

CAUTION
When lifting the diverter switch, use a manually operated telpher to avoid damages on the diverter switch. Make sure that the end of the tie-rod or its coupling is kept clear of the inner edge of the flange.

3.5.1 Lifting rig

The diverter switch (mass approximately 90 kg) can be lifted out of the housing by means of a telpher. As a holder for the telpher, it is recommended to use a rig similar to the one shown in Fig. 6. Install the supports on the flange of the top-section after the cover is removed, see Fig. 7.

WARNING
Make sure the rig is properly fixed to the cover flange before the diverter switch is lifted.

Fig. 6. Lifting rig.
3.6 Cleaning

3.6.1 Cleaning the diverter switch housing

Clean the inner walls of the housing by means of a nylon brush, then flush with oil. Drain the oil. Wipe the bottom and inner walls with rags.

**NOTE:** If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, the cleaning of the diverter switch is not necessary.

**WARNING**

In no case should any person go down into the diverter switch housing. The cleaning of the diverter switch housing should be carried out by using brushes and rags and by flushing with oil.

Drain the housing completely by using a hose before oil filling is carried out.
3.6.2 Cleaning the oil filter in the conservator pipe (if any)

The diverter switch housing and the oil conservator are connected by a pipe. The diverter switch oil is contaminated due to the arcing that occurs when the contacts operate. In case of a common conservator with the transformer the impure oil in the diverter switch housing must be prevented from entering the oil conservator. An oil filter is therefore mounted in the pipe.

The filter, which is mounted in a flange pipe on the top of the diverter switch housing, is screwed from the inside. It can easily be screwed out for inspection and cleaning. The oil filter does not need to be replaced nor cleaned in any other way than by washing with oil.

![Fig. 8. Oil filter details.](image)

3.7 Oil filtration

The drained oil should be filtered until it is cleaned and has regained the high dielectric strength required. The break-down value for purified oil should be at least 160 kV/cm according to IEC 60156.

To check the result of the filtering, take test sample after the oil has been filled into the on-load tap-changer.

**NOTE:** If the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB and it is maintained and operated according to our instructions, no further oil filtration is necessary. Only take an sample and measure the dielectric strength of the oil, see section "Oil testing and oil draining" in this guide.
3. Overhaul

3.8 Checking of the breathing device

Check the breathing device according to the instructions from the transformer manufacturer.

**WARNING**
The breathers and the tube from the conservator contains explosive gases. No open fire, hot surfaces or sparks may be present when loosening the breather.

3.9 Checking the contact positions

Those parts of the fixed contacts and the moving contacts which are exposed to arcing during an operation are tipped by copper-tungsten.

In a tap position, the moving main switching contacts and the fixed main switching contacts should have a clearance of min. 0.5 mm as shown in Fig. 9.

For checking the clearance on both sides of the diverter switch it has to be operated. Operate it by turning the coupling with a pipe wrench, see Fig. 5. Note the position of the diverter switch before operation.

**WARNING**
Take care to avoid finger injuries when operating the diverter switch. Oil splash occurs during operation, especially in the moving direction.

If the clearance is too small you may adjust the clearance by installing a shim of brass between the board and the current bar. The shims are included in the spare parts set. The shim dimensions are also shown in Fig. 9. Operate the diverter switch to the opposite side when mounting the shims.

Operate the diverter switch back to the first side and check the clearance again. If still too small, put in a shim more and test again.

**CAUTION**
Never mount more than three shims on each other.

Make sure all washers and screws are put back and tighten. Proceed with the other side of the diverter switch. When finished, operate the diverter switch back to the position it had before the first operation.

Fig. 9 shows the current carriers through the fixed main contact and the copper part of the moving contact.

Fig. 10 shows the copper-tungsten tips of the transition contact touching each other in a tap position.

Make sure that all flexible connections, operating springs, contact springs and all plug-in contacts are in good condition. Make sure that no bolts have worked loose.
Fig. 9. Fixed and moving contacts clearance.

Fig. 10. Transition contacts.
3. Overhaul

3.10 Checking the contact wear

The contact system consists of fixed and moving contacts.
Check the degree of contact burning on the breaking contacts.
For a new contact with tips of copper-tungsten (Fig. 11), the thickness at (A) and (B) is 5.5 mm in the upper end of the contact. In the lower end, the thickness is 3 mm.
Estimate the degree of contact burning and record this to enable comparison with the condition at the next overhaul. Do not file or smooth the burned and pitted contact surfaces.
A contact with a tip of copper-tungsten (Fig. 11) should be replaced when the thickness at (A) and (B) in the upper end of the contact is approximately 0.5 mm. (The thickness in the upper and the lower end of the tip will be approximately the same when close to the limit for replacement).
Also replace contacts which are assumed to wear out before the next overhaul.
The dimensions above are valid for both main contacts and transition contacts. For contact replacement, see chapter 4 "Contact replacement".

Fig. 11. Tolerance limits for contact erosion.

3.11 Checking the transition resistors

Measurement is carried out on the side with open contacts. Connect one cable from the ohmmeter to a fixed main contact and the other cable to a fixed transition contact. Measure the resistance.
Measure the resistance of each resistor branch across the open switch.
Operate the diverter switch to the other side as described in section 3.9 and measure the resistance with open contacts.
Check that the resistors are undamaged and compare with the value on the rating plate. The values must not differ by more than 10 %.
Check that nothing has worked loose. Operate the diverter switch back to its previous position.
3.12 Checking before closing

Before installing the diverter switch, make sure that no foreign objects, tools, wires, rags etc. are left in the diverter switch housing.

3.13 Installation of the diverter switch

**CAUTION**

Check the serial numbers to make sure that the diverter switch is mounted in the correct housing, see Fig. 2.

Make sure that the diverter switch housing is clean and dry and that no foreign objects (tools etc.) are left in the housing.

Lower the diverter switch into its housing carefully so that neither the diverter switch nor the housing are damaged.

The UCG diverter switch is provided with a guiding slot that fits against the oil draining tube in the diverter switch housing, see Figs. 12 and 13.

Rotate the diverter switch so the half-circle shaped guiding slot is aligned with the oil draining tube, see Figs. 12 and 13.

When the diverter switch is lowered, check visually that its plug-in contacts are aligned with the contacts in the cylinder wall.

In order to ensure that the diverter switch pin has engaged the coupling disc, carry out at least three tap change operations in one direction. A distinct sound is heard when the diverter switch operates which indicates that the driving pin of the diverter switch has been connected.

If no sound is heard, the diverter switch might need to be pushed down while operating the motor-drive.

Carry out another three operations in the same direction while pushing the diverter switch down.

The top part of the diverter switch lifting device should be below the level of the machined surface for the cover when lowered to its final position. Only the springs of the lifting device should be above this level.

If a check of contact timing should be carried out, proceed with that according to section 3.19 before mounting the cover.

Insert a new O-ring for the cover in the upper flange. Mount the on-load tap-changer cover. Turn the cover so the guiding pin in the housing is facing the guiding hole in the cover. (The cover has to be pressed down in order to overcome the spring force of the springs which hold the diverter switch pressed in place.) Insert screws and washers and tighten them.
Fig. 12. Diverter switch.

Fig. 13. UCG Diverter switch housing, view from above.
3. Overhaul

3.14 Checking the pressure relay

3.14.1 Functional check of the pressure relay

1. Set the valve handle to the test position as shown on the information plate.
2. Connect the air pump and the pressure gauge to the test tap on the pressure relay. (Thread R 1/8").
3. Raise the pressure until the pressure relay trips the circuit breakers of the transformer.
4. Read the pressure on the manometer and check against the pressure stated on the information plate. Max. permitted deviation is ±10 %. If the deviation is greater, the pressure relay should be replaced.
5. Check that the signal disappears when the pressure is released.
6. After finishing the check, turn back the valve handle to service position.

3.14.2 Replacing the pressure relay

If replacement of the pressure relay is necessary, it is carried out according to the instruction in 1ZSE 5492-129, Repair guide for On-load tap-changers types UC.
3. Overhaul

3.15 Lubrication of the on-load tap-changer and the drive shaft system

The bevel gears are greased at delivery and the same type of grease is used for the couplings of the outer shaft system.

For access to the couplings, loosen the hose-clips and push the protective tubes together.
For access to the bevel gears, dismount the covers.

**WARNING**
The bevel gear contains moving gears. Be cautious!
Rotating shafts. Be cautious!

Check and lubricate with grease if necessary. Recommended types of grease are GULF-718 EP Synthetic Grease, Mobilgrease 28, Shell-Aero Shell Grease 22 or similar.
Remount covers (make sure the gaskets are properly in place).

3.16 Checking of motor-drive mechanisms types BUE and BUL

The motor-drive mechanism should be checked and lubricated at the same time as the on-load tap-changer.

The overhaul includes the following points:

**Before disconnecting the power supply:**
- Motor protection function
- Earth fault protector (option)
- Counter function

**After disconnecting the power supply:**
- Heater function
- Toothed belt
- Cable connections
- Disc brake function
- Position transmitter and other position switches
- Lubrication

Reconnect the power supply and make operation tests according to section 3.17.
Fig. 15. Motor-drive mechanism, type BUE.
3. Overhaul

Fig. 16. Motor-drive mechanism, type BUL.
3.16.1 Motor protection

The function of the protective motor switch is checked. For three-phase AC motors, one of
the phase fuses is removed and the function time of the protective motor switch is checked
by a RAISE or LOWER operation. The protective motor switch shall release within 60 sec-
onds at a current setting equal to the rated current of the motor at actual voltage.

WARNING
The motor power voltage is dangerous.

If the protective motor switch do not trip within 60 seconds, switch off the power and adjust
the current setting. Repeat the test when the motor is cold.

Protective motor switches for DC motors and for single-phase AC motors are not tested.

3.16.2 Earth fault protector (option)

If the motor-drive mechanism is equipped with an outlet, the earth fault protector should be
tested by pressing the test knob on the outlet. (On BUL, the earth fault protector is sepa-
rated from the outlet and knob is on the relay).

3.16.3 Counter

Check that the counter is functioning at RAISE and LOWER operations.
Check that the position indicator increases (decreases) one step and the counter advances
one step for each operation. Record the counters value. The counter shows the number of
operations run by the on-load tap-changer.

3.16.4 Heater

WARNING
Before starting any work inside the motor-drive mechanism, the auxiliary power must
be switched off.

N.B. The motor, contactors and heating element may be energized from separate
sources.

Check by feeling with a finger that the heating element has been functioning.

3.16.5 Toothed belt

Check that the toothed belt is sufficiently tight. If tightening is required, adjust the motor
support. The tightness of the belt can be checked by a spring balance attached to the belt
halfway between the pulleys. At a 10 N load the belt should yield about 5 mm on BUE and
at a 6 N load the belt should yield about 2 mm on BUL.

3.16.6 Motor cable connections

Check that all cable connections within reach are secure.

3.16.7 Disc brake, BUE

Wipe the brake disc free from grease.
The kinetic energy in the motor and the toothed wheels should be absorbed by the brake,
and the motor-drive mechanism should stop as shown in Fig. 17, with a tolerance of ± 25°
as measured on the brake disc (± 125° measured on the hand crank), see Fig. 17.
This can be adjusted by tightening both of the spring bolts on the brake. Using the hand crank, operate the motor-drive mechanism until the brake is fully open. At this point the length of the springs must not be less than 35 mm. If the brake still does not function with that spring length, oil or grease has entered the brake linings, which will then need cleaning. Clean as follows:

Using a pair of tongs, remove the roll pins that hold the supporting shafts on the brake blocks, see Fig. 15. Then remove the shaft and the brake blocks. Clean the brake linings on the two brake blocks with degreasing agent.

When refitting the brake, check that the brake disc is completely free from grease. Adjust the spring force of the brake until the motor-drive mechanism stops within the tolerances given above.

**CAUTION**

If the motor-drive still not stops when the brake is adjusted to a spring length of 35 mm when the brake is fully open, please contact ABB for advice.

**3.16.8 Brake for the maintaining contact, BUE**

Check that the brake for the maintaining contact prevents the arm system on the maintaining contact shaft from swinging beyond its normal position when the roller on the driving arm moves free from the cam disc, see Fig. 15. At the end of the operation, contacts for operation in the opposite direction shall not move when the arm system swings back towards its normal position.

Unpermitted swinging should be prevented by raising the braking force, i.e. tightening the spring bolt.

An adjusted increasing spring force on the brake makes the maintaining contact arm swing back with a different speed, and the brake for the maintaining contact must be adjusted.
3.16.9 Disc brake, BUL

Run the motor-drive mechanism and check that the centre of the notch in the cam disc stops within ±2 mm from the centre of the roller on the brake arm, see Fig. 18. If it does not stop within the tolerances, adjust the breaking force with the adjusting screw in the lower end of the brake arm. Loosen the contra nut. Tightening the screw (clockwise) makes the stop earlier and loosening the screw (anticlockwise) makes the stop later. Tighten the contra nut after the adjustment.

**CAUTION**

If the motor-drive still not stops when the brake is adjusted to min. 15 mm according to Fig. 18 please contact ABB for advice.

---

![Fig. 18. Brake adjustment, type BUL.](image)

---

3.16.10 Position transmitter and other position switches, BUE

Clean the contact plates and arms (Fig. 18) from dust and dirt with a dry cloth.

Check and adjust the resilience of the moving contacts in the multi-position switches. The moving contact shall, in all positions, have a clearance between the nut and the contact arm of 0.4–1.2 mm. Adjustment is made with the nuts on the contact (Fig. 19).

![Fig. 19. Contact arm play.](image)
3. Overhaul

3.16.11 Position transmitter and other position switches, BUL

Check the contact function in all positions at both RAISE and LOWER operations. No adjustment of the contacts should be made. For replacement of a position switch see 1ZSE 5492-129, Repair guide, On-load tap-changers, types UC.

If there is a lot of dust, it can be removed from the circuit cards and the transparent covers with a vacuum cleaner, without disassembling the multi-position switch.

![Diagram of position transmitter](image)

Fig. 20. Position transmitter, checking.

3.16.12 Lubrication, BUE

See Fig. 21.

The bearing points of the brake blocks and the links should be sparingly lubricated with oil. (Use oil for plain ball and roller bearings.) The spur gears, the geneva wheel with the limit stop, the cam discs and the cam bar are sparingly lubricated with the same type of grease as for the shaft system when necessary. Other bearing points do not need lubrication.

**NOTE:** Protect the brake disc and the brake linings against lubricants. Wipe off excess lubricant.

Reconnect the power supplies.

3.16.13 Lubrication, BUL

Lubrication is not needed at normal working conditions. All ball bearings have rubber seals and are permanently greased. All cam discs and some gears are made of selflubricating material. If needed, the bevel gears for the hand crank, the geneva wheels and the bevel gears for the position indicator might be sparingly lubricated with the same grease as the shaft system. (GULF-718EP Synthetic Grease, Mobilgrease 28, Shell-Aero Shell Grease 22 or similar). See Fig. 16.

Reconnect the power supplies.
NOTE: The small bevel gear for the position indicator shaft shall be greased.

Fig. 21. Lubrication points, BUE.
3.17 Operation test

Operate the motor-drive mechanism, first by manual operation and then electrically between the limit positions. Check the limit stops by operating the on-load tap-changer to one of the end positions. When trying to operate it electrically beyond the end position, the motor should not start. Check the mechanical end stop by trying to hand crank it beyond the end position. After a couple of turns on the hand crank it should be mechanically stopped. Handcrank back to the end position (where the indicator flag is positioned in the middle for BUE, and when the indicator flag shows white colour for BUL). Operate the on-load tap-changer electrically to the other end position and carry out the same test procedure as above.

Check the emergency stop by giving a RAISE or LOWER impulse and after about one second press the emergency stop. The operation should be interrupted. Reset the emergency stop by turning the knob clockwise and switch on the protective motor switch. The started operation should now be completed.

Check the running-through protection with the step-by-step function disengaged. This is done by first removing the connection between terminals X4:1 and X4:2 and then keep the RAISE/LOWER switch engaged. The motor-drive mechanism should stop before the fourth operation is completed. This checking must be done at least five steps from the end position. After the test reset the time relay by putting the LOCAL/REMOTE switch to 0 and then back. Reset the protective motor switch to ON. Remount the connection between X4:1 and X4:2.

Check the step-by-step relay by keeping the RAISE/LOWER switch engaged in RAISE. The on-load tap-changer shall make only one step. Repeat the check in LOWER.

Check the function of the position transmitter and other multi position switches in all positions.

3.18 Oil filling

If check of contact timing is to be carried out, see section 3.19, fill the diverter switch housing with oil up to the level of the fixed main breaking contacts by easiest possible method before checking. Oil fill completely according to the instructions below after check of contact timing.

3.18.1 Filling methods and restrictions

Oil filling can be carried out at atmospheric pressure or under vacuum. The wall between the diverter switch housing and the transformer tank is designed to withstand vacuum on one side and atmospheric pressure on the other side. It is not allowed to have vacuum on one side and the pressure of an oil column on the other side.

After maintenance oil is normally filled at atmospheric pressure. This procedure is described in section 3.18.3. If filling is to be carried out under vacuum, see 1ZSE 5492-116 Installation and commissioning guide for UCG and UCL.

After oil filling, a gas cushion should remain on the top of the oil in the diverter switch housing.

The connection to the oil conservator is designed to automatically give a gas cushion when filling at atmospheric pressure.

NOTE: If new oil, especially degassed oil, is filled into the diverter switch housing and the number of operations is low, the gas cushion may be dissolved in the oil. The oil level in the oil conservator should then be checked after a month in service and if the oil level is lower than after the oil filling, (corrected for temperature differencies), the gas cushion should be restored according to section 3.18.5 "Restoring the gas cushion" in this guide.
3.18.2 Before filling

NOTE: Oil filling may be carried out in different ways depending on what is convenient as long as the rules above are fulfilled and the on-load tap-changer is filled with oil to the correct level with a gas cushion on the top. The method below is recommended and if it is followed in detail no pressure limits are exceeded and oil levels and gas cushion will be correct. If the on-load tap-changer consists of more than one unit, fill one at a time.

3.18.3 Filling at atmospheric pressure

See Fig. 22.

1. Close the air release valve
2. Open the conservator valve, if any.
3. Dismantle the breathing device on the conservator for the on-load tap-changer.
4. Pump oil into the diverter switch housing via the oil valve (connection dimensions, see the dimension drawing for the on-load tap-changer). Continue until the conservator is filled to the correct level at the actual temperature. See section 3.18.4. If there is more than one unit connected to the same conservator, fill all of them until the oil level indicator starts to move and fill up to the right level when filling the last unit.
5. Shut the oil valve and disconnect the pump.
6. Remount the breathing device. Make sure the connection to the breathing device is properly sealed.

3.18.4 Oil level

For correct oil level in the oil conservator, see the transformer documentation.

3.18.5 Restoring the gas cushion

Check the oil level in the oil conservator one month after oil filling. If the oil level is lower now than when the oil filling was finished (correct for temperature differencies!) and no leakages are observed, the gas cushion has been solved in the oil and has to be restored.

The procedure below is used for on-load tap-changers without oil filter unit for continuous oil filtration. In case the on-load tap-changer is equipped with an oil filter unit for continuous oil filtration from ABB, and it is installed according to our recommendations, follow the instructions in Oil filter unit for on-load tap-changers, manual for restoring the gas cushion.

In case the on-load tap-changer consists of more than one unit, do the restoring in one unit at a time.

WARNING

The oil in the diverter switch housing may be hot. Be cautious!

Before any work is carried out on the on-load tap-changer:
Make sure that the transformer is disconnected and that earthing is properly carried out. Obtain a signed certificate from the engineer in charge.

CAUTION

To operate the on-load tap-changer with a too small or no gas cushion means a risk for a trip of the pressure relay.
3. Overhaul

3.18.5.1 Procedure

1. Close the valve in the tube to the conservator.
2. Connect the oil pump to the oil valve. (For connection dimensions, see the dimension drawing for the on-load tap-changer), see Fig. 22.
3. Open the oil valve and the air release valve.
4. Start the oil pump and drain approximately 15 litres of oil into a clean and dry container.
5. Close the air release valve.
6. Close the oil valve and disconnect the pump.
7. Connect the output side of the pump to the oil valve.
8. Open the oil valve.
9. **Open the valve in the tube to the conservator!**
10. Pump the earlier drained 15 litres of oil back into the diverter switch housing.
11. Close the oil valve and disconnect the pump.
12. The level in the oil conservator and the gas cushion are now restored.

If the on-load tap-changer consists of more than one unit, proceed with the other one until the last one has been restored.

**CAUTION**

Avoid to do the restoring in damp weather since moisture will get into the diverter switch housing. If the restoring has to be done in such weather, the incoming air has to be dehydrated and the drained oil protected from water.

---

**Fig. 22. Air release valve (position may be on another vertical flange).**
3.18.6 Waiting period

**CAUTION**

Do not energize the transformer earlier than three hours after oil filling in atmospheric pressure. This waiting period is needed to allow airbubbles to disappear.

3.19 Check of contact timing

Checking the contact timing is a good check of the condition of the on-load tap-changer, but it is not necessary to check contact timing at every overhaul. It is recommended to be carried out after every 500 000 operations.

The test requires:

- Two indicator lamps (glow discharge lamps for the minimum possible magnetisation of the transformer)
- Necessary leads
- Two stiff insulated leads or bars

**WARNING**

Never force DC current through the transformer windings.

The insulated leads (or bars) are used for connection to the moving contact arms of the tap selector via the plug-in contacts of the diverter switch (They can be made of an insulating tube with a lead inside.)

Connect the lamps as shown in Fig. 23.

The diverter switch contacts are designated as shown in Fig. 24.

Determine if x or v contacts are closed, see Fig. 24. In the contact-timing diagram for the on-load tap-changer you can find out the corresponding position. See Figs. 25 and 26.

The diverter switch housing shall be filled with transformer oil up to the fixed main contacts to secure the correct function of the dash pots during operation of the diverter switch, see section 3.18.

At repeated operations in the same direction the selector arms V and H operate every second time. When the direction of operation is reversed, the contact arms will be at rest during the first operation. The operation is then performed by means of the diverter switch only.

**NOTE:** When testing, the operation must be carried out in the same direction as the previous operation.

The test is to be made on all three-phases and is to be carried out as follows:

Find the exact position of the on-load tap-changer by adjusting the disc brake as shown in Figs. 17 and 18.

1. Note the number of whole turns and parts of turns on the hand crank, during a slow manual operation.
2. Note when each tap-selector arm breaks and makes (the corresponding lamp goes out or lights).
3. Note when the diverter switch flicks over (a distinct sound is heard).
3. Overhaul

Fig. 23. Indicator lamp connection during contact timing test.

Fig. 24. The diverter switch outlet marking.
After this, compare the operations with the contact-timing diagram applicable to the on-load tap-changer in Figs. 25 and 26. One operation corresponds to 25 turns of the hand crank on the motor-drive mechanism, type BUE and 15 turns for BUL.

Remove the equipment for contact-time measuring. Mount the cover of the diverter switch housing according to section 3.13. Complete the oil filling according to section 3.18.

**CAUTION**

If the result is beyond the limits given here, please contact ABB.

**NOTE:** The diverter switch must have switched over before the 20th turn is finished with the hand crank.

---

**Fig. 25. Example of contact-timing diagram, BUE.**
NOTE: The diverter switch must have switched over before the 12:th turn is finished with the hand crank.

Fig. 26. Example of contact timing diagram, BUL.

3.20 Putting into operation

Operate the on-load tap-changer to the position noted in section 3.3.1. Put the LOCAL/REMOTE switch to REMOTE. Reset the drag hands. Make sure that no tools or foreign objects are left in the motor-drive mechanism cabinet. Close the door. Make sure that nothing is left on the transformer cover.

Sign the revision protocol and give it to the engineer in charge and inform that the on-load tap-changer is ready for energizing.
4. Contact replacement

CAUTION

ABB recommends that only authorized personnel from ABB carry out contact replacement.

Replace worn-out main switching contacts and transition contacts as required. (It is not necessary to replace both main switching contacts and transition contacts if, for instance, only the main switching contacts are worn out).

CAUTION

Fixed contacts and its corresponding moving contacts should always be replaced at the same time.

Also replace contacts which are assumed to wear out before the next overhaul. Replacement of contacts is described in the following sections.
Fig. 27. Diverter switch, contact design.

1) Mounted vertically on some types
4. Contact replacement

4.1 Dismantling the boards

Dismantle the boards from the frame by removing the six screws and the locking washers from each board (Fig. 28).

Punch the guide pins with a 4 mm mandrel. Note that the guide pins are placed high on one board and low on the other board in order to make the boards non-reversible.

When mounting, use new locking washers and guide pins.

Lift away the boards in the lifting eye, see Fig. 7 with fixed contacts and transition resistors from the contact-mechanism (Fig. 29). The boards, which are made of insulating material, shall be wiped with rags.

Fig. 28. Contact replacement, dismantling the boards.
4. Contact replacement

4.2 Dismantling the moving main contacts

Dismantle the moving main contacts according to Figs. 30 and 31. Take away split pins, washers and springs in both ends of shafts 1–3. There is one shaft for each pair of contacts.

NOTE: Notice that the outer end of the outer phase have washers with a larger diameter, see Fig. 30.

Do the same for the contacts on the opposite side.

Pull out shaft 1. Take care of the silver washers. Do the same with shaft 3. Punch out the middle shaft 2 by means of a 5 mm mandrel of brass. Shaft 2 must then be passed through the holes for shafts 1 or 3 and remain there until new contacts are mounted.

Repeat the procedure for the contacts on the opposite side.
4. Contact replacement

Fig. 30. Contact replacement, taking away split pins.

Fig. 31. Contact replacement, pulling out shaft.
4.3 Dismantling the moving transition contacts

Dismantling of the moving transition contacts should be carried out according to Figs. 32 and 33.

The transition contacts are held by a common shaft 4 going through all the contacts. The shaft 4 is locked with two split pins (Fig. 33). Remove the split pins and punch out the shaft with a 5 mm mandrel of brass and take care of the springs, washers and contacts when the mandrel is pulled out.

The springs in Fig. 33, view A – A, are loosened in the following way:

Punch out the locking pin in one end of the pin with a 2 mm mandrel. Thereafter the spring holder can be loosened and the contacts with springs can be removed. Take care of the pin.

Repeat the above procedure on the other side of the diverter switch.

Fig. 32. Contact replacement, moving transition contacts.
4.4 Mounting the moving transition contacts

Mount the moving transition contacts according to Fig. 33.

A replacement contact consists of a contact with mounted spring.

Punch the shaft through the first bearing hole and put a contact, spring, insulating washer and another contact on the shaft as it is continuously punched in. Then proceed with the next phase. Finally lock it with new split pins. Mount the springs by means of the pin and new locking pins.

Proceed with the other side of the diverter switch. Put a ruler on the linings of the transition contacts. No lining should lie more than 1 mm from the ruler.

If any lining does, adjust these contacts closer to the board by filing off material on the surface of the contact that lies against the stop shaft.

When all transition contacts on both sides are mounted, make sure that the contacts move easily in the bearings and that the springs are functioning.

Fig. 33. Transition contact construction.
4.5 Mounting the moving main contacts

Fig. 34 shows how to mount the moving main contacts. Washers and springs shall be placed as shown in Fig. 34. The contacts are equipped with copper-tungsten tips. Washers and springs shall be placed as shown in Fig. 34.

**CAUTION**

The outer end of the outmost phases should have the washers with larger diameter, (Ø=25 mm) see Fig. 34.

Fig. 34, view A – A shows the replacement contact which consist of two contacts with a mounted spring, mounted on the current bridge.

Begin with the middle phase. Put the contact and the silver washers on the shaft and punch the shaft in to the bearing hole with the 5 mm mandrel. Put the next silver washer and contact in position and punch in the shaft. Mount washers, springs and split pins according to Fig. 34.

Proceed with the outer phases. Put the outermost silver washer and contact on the shaft and punch the shaft into the bearing hole. Put the next silver washer and contact into position and punch in the shaft. Mount washers, springs and split pins as shown in Fig. 34. Check with Fig. 34 that all containing details are correctly assembled.

Put a ruler on the linings of the moving main contacts. No lining should lie more than 1 mm from the ruler.

If any lining does, adjust these contacts closer to the board by filing off material on the surface of the contact that lies against the stop shaft.

Carry out the same procedure on the other side of the diverter switch.

---

![Fig. 34. Moving main contacts with tips of copper-tungsten, washers and springs.](image-url)
4.6 Replacing the fixed main contacts

Unscrew the fixed main contacts, see Fig. 27. Mount new contacts. Use new conical spring washers and locking nuts.

Put the washers as shown in Fig 27. Press the contacts against their bracket when tightening the screws. Tightening torque approximately 10 Nm, (not critical).

**NOTE:** The conical end of the nut should be turned upwards.

4.7 Replacing the fixed transition contacts

Unscrew the screw and nut holding the connection for the transition resistors.

Unscrew the fixed transition contact. Mount new contacts.

Put the washers as shown in Fig. 27. Use new locking washers. Tighten the screws, tightening torque approximately 10 Nm.

Mount the connection for the transition resistors as shown in Fig. 27. Tightening torque approximately 10 Nm. Use new conical spring washers and locking nuts.

**NOTE:** The conical end of the nut should be turned upwards.

4.8 Mounting the boards with transition resistors and fixed contacts

To assemble the mechanism and the boards with transition resistors and fixed contacts, do as follows:

When the boards are lowered, put one side of the mechanism on an approximately 50 mm high piece of wood to make the fixed and moving contacts free from each other (Fig. 35).

The boards should be fixed with new guide pins (4 x 30 mm, spring-type straight pin slotted). Guide by inserting a 6 mm mandrel into an adjacent screw hole. Put in and tighten all screws. Secure the screws with new locking washers (Fig. 28). The plain washers should be closest to the board.

Check that the linings of the fixed main contacts are aligned with the linings of the moving main contacts. If not, loosen the nuts slightly and adjust the fixed main contacts. Tighten the nuts. Check (and adjust, if necessary) the alignment of the transition contacts as described for the main contacts. Tighten the screws and lock the locking washers.

Proceed with the other side of the diverter switch by first operating it to the other side as described in section 3.9.

**WARNING**

Take care to avoid finger injuries when operating the diverter switch.

Check (and adjust, if necessary) the diverter switch according to section 3.9. Operate it and check that the contact movement is correct. Remount the diverter switch into the housing according to section 3.13.
Fig. 35. Contact replacement, mounting the boards.
5. Specification of materials

5.1 General

On disposal of this product, it is recommended that local environmental regulations in each country are met. For environmental reasons, materials used are specified.

5.2 Diverter switch housing

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>15 kg</td>
</tr>
<tr>
<td>Aluminium</td>
<td>75 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>5 kg</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>35 kg</td>
</tr>
<tr>
<td>Transformer oil</td>
<td>150–200 kg</td>
</tr>
</tbody>
</table>

5.3 Diverter switch

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>25 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>10 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>25 g</td>
</tr>
<tr>
<td>Tungsten</td>
<td>0–1 kg</td>
</tr>
<tr>
<td>Polyester resin</td>
<td>20 kg</td>
</tr>
<tr>
<td>Presspan</td>
<td>1 kg</td>
</tr>
<tr>
<td>Resistor wire (mainly copper and nickel alloys with small amounts of aluminium and manganese)</td>
<td>5-50 kg</td>
</tr>
</tbody>
</table>

5.4 Tap selectors

<table>
<thead>
<tr>
<th>Tap selector I:</th>
<th>Approx. amount</th>
<th>Tap selector C:</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>50 kg</td>
<td>Steel</td>
<td>5 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>25 kg</td>
<td>Aluminium</td>
<td>15 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>0–100 kg</td>
<td>Copper and alloys</td>
<td>20 kg</td>
</tr>
<tr>
<td>Phenol resin laminate</td>
<td>20 kg</td>
<td>Silver</td>
<td>70 kg</td>
</tr>
<tr>
<td>Polyester resin</td>
<td>1 kg</td>
<td>Polyester resin</td>
<td>5 kg</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>15 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tap selector III:</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>10 kg</td>
</tr>
<tr>
<td>Aluminium</td>
<td>40 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>50 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>10 kg</td>
</tr>
<tr>
<td>Polyester resin</td>
<td>10 kg</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>20 kg</td>
</tr>
</tbody>
</table>
5. Specification of materials

### 5.5 Conductors

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>5–10 kg</td>
</tr>
<tr>
<td>Cellulose</td>
<td></td>
</tr>
</tbody>
</table>

### 5.6 Gearing mechanism

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>15 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>5 kg</td>
</tr>
</tbody>
</table>

### 5.7 Drive shaft systems

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>8 kg</td>
</tr>
<tr>
<td>Aluminium</td>
<td>2 kg</td>
</tr>
<tr>
<td>Brass</td>
<td>2 kg</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>2 kg</td>
</tr>
</tbody>
</table>

### 5.8 Motor-drive mechanism

<table>
<thead>
<tr>
<th>Material</th>
<th>Approx. amount</th>
<th>Approx. amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>100–120 kg</td>
<td>55 kg</td>
</tr>
<tr>
<td>Copper and alloys</td>
<td>5–10 kg</td>
<td>5 kg</td>
</tr>
<tr>
<td>Aluminium and alloys</td>
<td>–</td>
<td>10 kg</td>
</tr>
<tr>
<td>Silver</td>
<td>10 kg</td>
<td>10 kg</td>
</tr>
<tr>
<td>Plastics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chlorsulphonated polyethylene</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>polyamide with MoS₂</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>phenol resin laminate</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>polyester</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>PVC</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>carbonate plastic</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Rubbers:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nitrile rubber</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>fluorine rubber</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**CAUTION**

Materials listed in the table above without any specification of amount are included because they may cause pollution problems during de-commissioning, even in the small quantities used.
Contact us

ABB AB
Components
SE-771 80 Ludvika, Sweden
Phone: +46 240 78 20 00
Fax: +46 240 121 57
E-Mail: sales@se.abb.com

www.abb.com/electricalcomponents