three-phase HV/LV transformers
mineral oil-immersed distribution models

Minera

Instruction for installation, operation and maintenance

Schneider Electric

TABLE OF CONTENTS

1. INTRODUCTION

The apparatus described in this instruction has been designed, manufactured and tested with the utmost care and attention. With correct installation, commissioning, operation and maintenance the user will receive a lifetime of trouble free service.

We have attempted to include all aspects which will be of value to the user, but if problems arise outside the scope of this publication, please do not hesitate to contact **PT. Schneider Electric Indonesia - TRANSFORMER** giving details of the problem together with information contained on the transformer rating plate.

2. CONSTRUCTION

The transformers are of the hermetically sealed type with complete filling, known as integral filling. In this type there is no gas space. The pressure in the tank due to liquid expansion is compensated by the expansion of the cooling fins.

3. DELIVERY AND PRELIMINARY CHECKING

Each transformer is inspected before dispatched from the factory. The distribution transformers are dispatched with oil filled and accessories fitted.

On receipt of equipment, ensure that it corresponds with your order by checking machine characteristics indicated on the rating plate (capacity, voltages, etc.). Also check that the tank lead seal, fixed to one of the cover screws (usually at a tank corner) is intact, because its breakage causes the transformer guarantee to lapse. Should the unit have been damaged or if accessories ordered are found to be missing:

- enter a reservation on the final haulage contractor's delivery note and confirm by recorded delivery letter within 3 days.
- write a report and send it immediately to your supplier (**PT. Schneider Electric Indonesia - TRANSFORMER** or a dealer as the case may be).

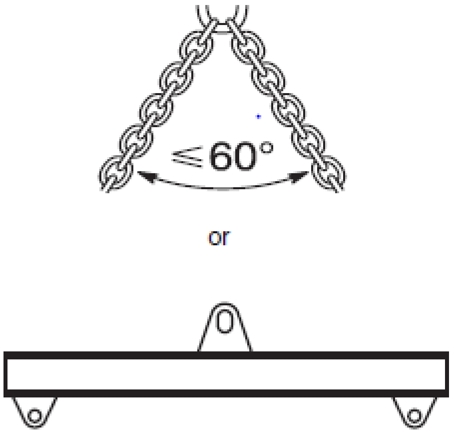
4. HANDLING

Transformers are usually stabilized during transit by heavy timber bearers fixed to the vehicle bed. It is therefore essential to remove these bearers before lifting the transformer unit off the vehicle.

Transformer units incorporate specific handling devices.

- **Lifting by means of slings or a lifting beam**

The unit must be handled using the 2 lifting rings located on the transformer cover.



- **Hauling**

The transformer must only be hauled from its chassis. 30 mm diameter holes have been drilled in the ends of chassis members for this purpose, except in the case of low capacity units or those built to a special specification. Hauling must only been undertaken in two directions: along and perpendicular to the chassis centre line (see figure handling using a forklift truck).

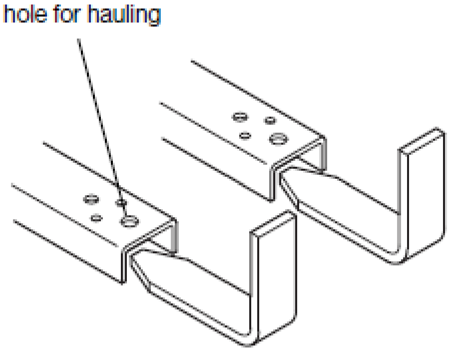
- **Handling using a forklift truck**

Forks must only lift the chassis from within the inverted channel sections, with idler rollers removed.

In case lifting eyes are provided on top edge of the tank, then they must be used instead of the ones on the top cover. For jacking, jacking pads specially provided for that purpose should be used.

Never place jacks under valve and radiators. It is necessary to avoid jolts and vibrations, which could occur through handling or during transport over rough roads.

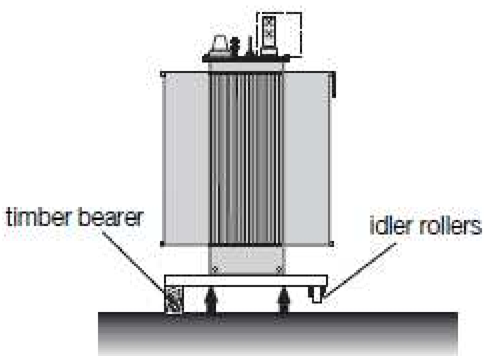
Do not exert pressure on the built-up radiators or on the insulators in the terminal chambers if provided.



- **Positioning of idler rollers**

- either by lifting with slings or a lifting beam.
- or by lifting with a forklift truck.

In this case, position the forks of the truck within the inverted channel sections. Place heavy timber bearers, which are slightly higher than the idler rollers, crosswise beneath the ends of the chassis members and lower the unit onto these timbers. Position jacks and remove timber bearers one by one. At the same time, fix each idler roller in the required position (idlers swivel in 2 directions) using the locking screw. Then, remove the jacks and allow the unit to rest on its idler rollers. **Ground clearance due to the idler rollers is essential for transformer cooling.**



5. EXAMINATION UPON ARRIVAL

Examine carefully the way in which the transformers have been secured on the trailer or container and check the conditions of the crates or packing cases.

Immediately after a transformer is received, it should be unpacked and thoroughly examined externally for possible damage, which may have occurred during transportation. The complete unit should be signed in accordance with the result of the examination or as "not examined ", and any damage found should be reported to the carriers and to **PT. Schneider Electric Indonesia - TRANSFORMER** within three days.

Check the bill of material against the material received.

Check carefully whether the liquid level is correct, or at least can be seen on the gauge if provided.

Check the condition of the tank and any attachments. Also check fittings and valves for leakage of liquid.

6. STORAGE

It is desirable that the transformers are completely erected and commissioned with the minimum delay on arrival at site.

If this cannot be done, store the transformers in a dry place protected from the weather, preferably indoor. This precaution will contribute to keeping the paint in good condition.

Transformers must not be placed too close to one another in order to avoid damage to the radiators and other projecting attachments.

Access ways between the transformer rows will allow inspection to be carried out on the liquid level and paint when they are in storage. After more than twelve months in storage, the dielectric strength of the liquid must be tested. It should not be less than 30 kV / 2.5 mm.

7. INSTALLATION

Ensure that machine characteristics shown on the rating plate correspond with installation conditions: primary voltage(s), tapping links.

This plate may be moved and attached to any side of the tank so that it is visible

once the machine is in position. In general, installation must comply with the requirements of IEC Standard 71-1, 2 and 3 in relation to insulation co-ordination.

E.g.: case of overhead-underground connection to be protected by lightning

arresters installed at both ends of the HV cable.

- unit to be installed at a maximum altitude of 1000 m, unless otherwise specified with order, because air rarefaction adversely affects cooling of the windings.

- unless otherwise specified with order, transformers of standard design are sized in accordance with IEC Standard 76 for the following ambient temperatures:
    - maximum : 40°C
    - average daily : 30°C
    - average annual : 20°C
    - minimum : – 25°C

When the transformer is live, the ambient temperature inside the plant room must comply with the above values, unless the transformer has been specially designed on the basis of a particular specification.

Determining the height and cross-sectional areas of ventilation wall openings

In the general case involving natural cooling (AN), the purpose of the plant room ventilation system is to disperse the heat, resulting from the total heat losses generated by the operating transformer, by natural convection. An efficient ventilation system comprises a fresh air inlet wall opening of cross sectional area S positioned low down in the room, and air outlet opening of cross sectional area S' positioned high up on the opposite wall of the room at a height H above the air inlet opening.

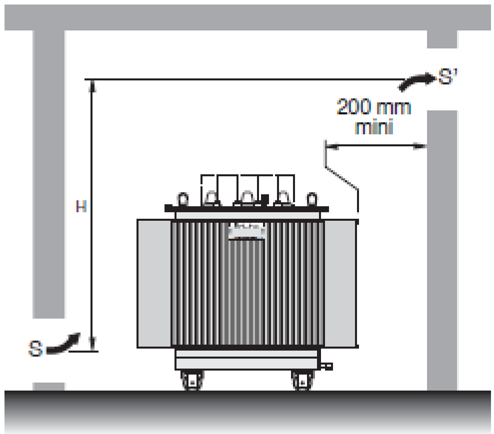
It should be noted that restricted air circulation around the unit causes a reduction in available power. For this reason, the transformer must be positioned at a minimum distance of 200 mm from any solid wall.

Design calculation:

- P = sum of losses under no load and losses due to load on transformer, expressed in kW at 75°C, plus losses generated by any other unit in the same room.
- S = cross-sectional area of fresh air inlet wall opening (deduct possible area obstructed by grill), expressed in m2.
- S'= cross-sectional area of air outlet wall opening (deduct possible area obstructed by grill), expressed in m2.
- H = difference in height between inlet and outlet wall opening centre lines, expressed in m.

$$S = \frac{0,18P}{\sqrt{H}} \text{ and } S' = 1,10 \times S$$

This formula is valid for an average annual ambient temperature of 20°C and at a maximum altitude of 1000 meters.



Forced ventilation of plantroom

A ventilation system of this type is required for a cramped or poorly ventilated plantroom, or for a room in which the ambient temperature is much higher than the temperature outside, in view of the ambient temperatures used for designing the transformer. Should the transformer be frequently overloaded, a forced ventilation system can help to disperse the heat generated by the unit, although it will not reduce the adverse effects of such overloading on the equipment's life.

An air extract fan discharging outside the plantroom may be fitted to the outlet wall opening, located at high level, in order to increase natural convection in the room; this fan can be thermostat-controlled.

Recommended discharge rate (m3/s) at 20°C = 0.10 P

P = total heat losses to be dispersed, expressed in kW, for all equipment installed

Our naturally cooled transformers depend solely on the surrounding air to dissipate the heat, which they give off.

For this reason, great care must be taken to ensure good ventilation of the room where they are installed, so that the warm air is quickly evacuated and replaced by cool air entering from outside. If the room has little ventilation, air exchanges take place slowly and the inside temperature may become too high.

The temperature of transformer is always greater by a few degrees than the surrounding air, being the sum of surrounding air temperature and the temperature increase of the transformer, which depends on the load.

For good ventilation, a cool air intake should be located at a level with the lower part of the transformer and an opening for evacuation of the warm air at the top of the transformer room.

The intake and outlet opening should be located diagonally across the room.

As a guide, losses of 1 kW require a cool air intake of 3 m^3 / min at 20°C.

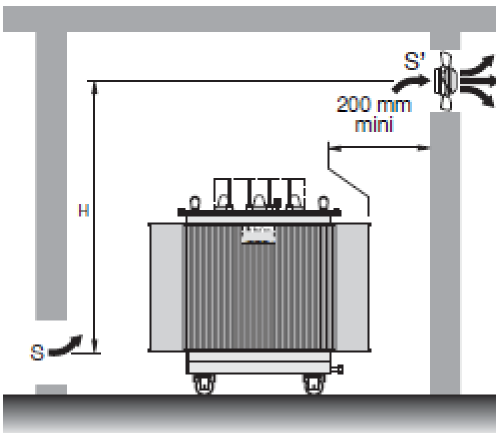
For a difference of 3 m in level between the air intake and outlet, the outlet opening must have a cross-sectional area of about 0.4 m^2 for losses of 5 kW, or 0.2 m^2 for 2.5 kW.

Note that the area of the cool air intake may be less than that of the warm air outlet by about 10 %. Not withstanding this, the opening is to be made as wide as possible.

In order to the air can circulate freely around the transformer, a distance of not less than 50 cm should be applied between the transformers and the wall or partition.

The same precautions must be taken if there will be several transformers in the same room. The transformers must be arranged so that supervision and maintenance may be carried out while they are operating. Particularly, the filling or draining plugs and the couplings must be easily accessible.

Gauges, buchholz and pressure controllers must be visible if provided.



Setting the voltage commutator

Adjustments to tapping point or voltage commutators must be undertaken with the transformer **off-load and de-energized.**

Commutator setting is carried out in the following way:

- unscrew fully the red locking knob,
- simultaneously pull and turn the commutator rotating head until the pointer indicates the right setting,
- push the rotating head back ensuring that the pointer is engaged in the notch for the setting required,
- rescrew fully the red locking knob

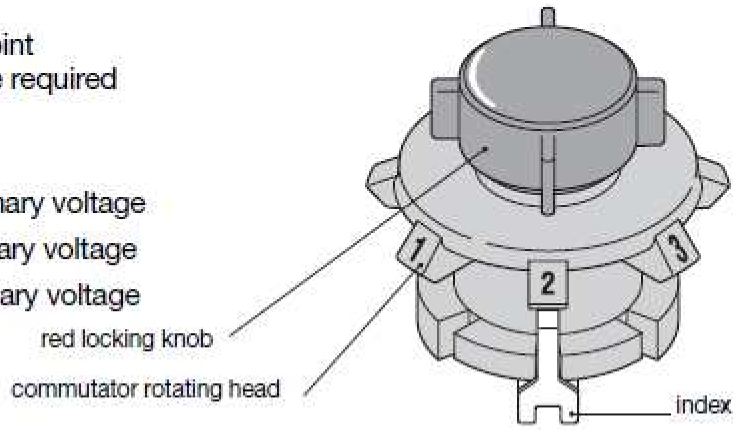
▶Tapping links

Set the tapping point commutator to the required position:

Pos. 1: upper primary voltage

Pos. 2: rated primary voltage

Pos. 3: lower primary voltage

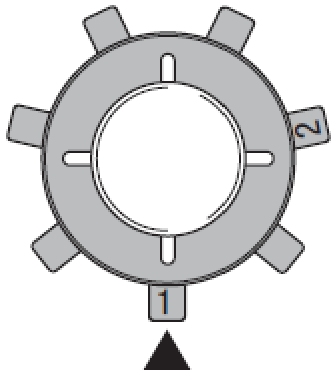


▶Double primary voltage

For units using 2 primary voltages, select position as required.

Pos. 1: HV1

Pos. 2: HV2



Statutory restrictions for oil-immersed transformers

Each country issues its own regulations covering the installation of oil-immersed transformers on its territory.

These regulations invariably respond to concerns for the protection of people, property and the environment. Available protection systems depend on the technology adopted for the transformer concerned.

When the unit is in service, the volume of the dielectric fluid used to cool its coils (usually mineral oil complying with IEC Standard 296) varies continually, due to temperature variations in the windings.

These volume changes must be "absorbed" by a suitable expansion system which has given rise to two distinct technologies:

Hermetically sealed type transformer

The unit's tank, containing the active part, is hermetically sealed: variations in volume are absorbed by expansion of the cooling fins positioned around the tank, the dielectric fluid is not exposed to the surrounding air.

Maintenance of this type of unit is thus greatly reduced.

Protection accessory: the protection relay

Fitted directly to the transformer cover, this relay ensures protection against internal faults, prolonged overvoltages and fire risks associated with the use of inflammable dielectric fluids.

The accessory continuously monitors:

- dielectric fluid level,
- tank internal pressure,
- dielectric fluid temperature at two different thresholds.

To operate properly, the protection relay must be fully filled with fluid (level higher than the float visible in the transparent section of the unit). If this is not the case, check the instructions which appear inside each casing.

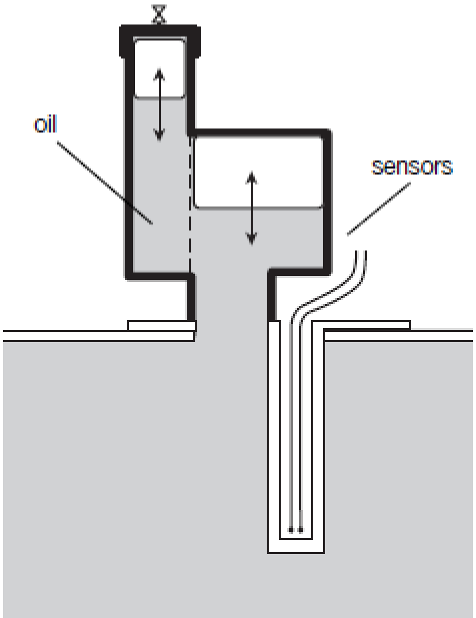
To ensure optimum protection, the following action and adjustments are recommended

Finding	Recommended adjustment	Fault detected	Action to be taken
Gas emitted or drop in level	Large float at the top	➩ Serious fault	➩ De-energize unit
Pressure switch	*	➩ Serious fault	➩ De-energize unit
Thermostat threshold 1	90°C	➩ Overvoltages	➩ Activate alarm
Thermostat threshold 2	100°C	➩ Overvoltages	➩ De-energize unit

*. For Hermetically sealed transformer : 0.275 bar / 4 PSI

*. For N2 type transformer : 0.482 bar / 7 PSI

*. For conservator type : 0.275 bar / 4 PSI



Faults detected on live transformer unit

- Dielectric fluid level is detected as low

  The protection relay is empty and the large float is at the bottom.

  May be due to:

  - air entering; there must be a dielectric fluid leak and thus oily stains should be visible on the ground.

    Accurately localise the fault, carry out repair, then recheck the level with the body of fluid at a temperature of 20°C, before switching the unit live again.

  - internal gas emission: gas should be sampled using a syringe and then analysed.

    Whilst awaiting results, under no circumstances should the transformer be switched live again because a risk of total destruction exists.

    Should gas analysis reveal an inflammable gas, contact **PT. Schneider Electric Indonesia – TRANSFORMER**

    After-Sales Service, or your SCHNEIDER correspondent.

- Overheating is detected

  This may be due to:

  - improper cooling of the transformer (insufficient air flow around unit or plantroom ventilation),
  - continuous overvoltage.

- Excess pressure is detected

  This may be due to:

  - overheating: see above,
  - internal gas emission: see above,
  - topping up of dielectric fluid with the body of fluid below 20°C; drain the overflow with the transformer de-energised and the dielectric fluid at 20°C.

Breather type transformer with expansion tank

The transformer tank is connected by pipework to an expansion tank, mounted above the unit, which ensures that the dielectric fluid level remains sufficiently high in the transformer tank: variations in dielectric fluid volume are absorbed by the expansion tank which remains at atmospheric pressure.

This type of unit therefore requires maintenance which is both regular and suited to the climatic conditions in the vicinity of the transformer.

Protection accessory : the Buchholz relay

Fitted to the pipework linking the expansion tank to the transformer tank, this accessory ensures protection against internal faults only, by monitoring dielectric fluid levels and fluctuations.

To ensure proper operation, the Buchholz relay must be completely bled of air.

Faults detected on live transformer unit

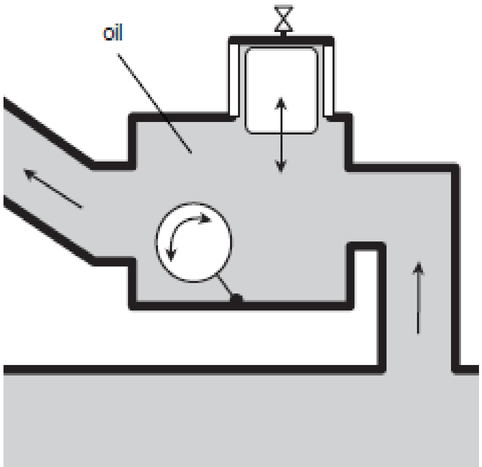
- Dielectric fluid level is detected as low.

  The Buchholz relay is partially empty, the top level float is at the bottom. Reasons for this low fluid level are the same as those given for the protection relay but in the present case, the relay will activate automatically the alarm.

- Major discharge of oil towards the expansion tank is detected

A violent emission of gas, resulting in serious electrical faults within the transformer tank, leads to a large discharge of oil to the expansion tank, which causes the Buchholz relay bottom float to pivot; the transformer unit must be de-energised immediately and permanently.

Contact **PT. Schneider Electric Indonesia - TRANSFORMER** After-Sales Service, or your SCHNEIDER correspondent.



Dielectric fluid retention system

In an environmental protection context, the retention system used must be capable of containing the total quantity of dielectric fluid, unless otherwise specified by local regulations.

It may comprise:

- a raised door threshold if the plantroom floor is oil tight,
- a low oil tight wall around the transformer,
- a steel trough positioned beneath the transformer.

In the last two cases, ensure that the system does not adversely affect transformer cooling by preventing air circulation around the tank cooling fins.

8. COMMISSIONING

Check:

- The characteristics of the transformer correspond with those of the installation.
- The tap changer is securely in correct position.

CAUTION - TAP CHANGER IS TO BE OPERATED OFF LOAD. BEFORE OPERATING ENSURE TRANSFORMER IS DE-ENERGIZED.

- The transformer has been grounded. Earth terminals are specially provided at the base and on the cover of the transformer.
- The level of the transformer tank dielectric liquid is correct.
- The insulation of the winding, measured with a 500 V mega-ohm-meter is at least.

  100 MΩ between low-voltage winding and earth.

  250 MΩ between high-voltage winding and earth.

  250 MΩ between high-voltage winding and low-voltage winding.

9. TRANSFORMER PROTECTION

As the transformer is the junction point between HV and LV, it is subjected to all the fluctuations of the networks to which it is connected.

Efficient protection should prevent the transformer from any incident.

9.1. Setting of protective devices

Most of the protective device, ordered with the transformer are installed and pre-adjusted in factory.

The choice of the protective device that is not directly installed on the transformer must take into account the effect of switching transient voltages and currents caused by energising the transformer.

9.2. Inrush current

Energising a transformer gives rise to high over current. This inrush current is between 3 - 5 times the rated current of the transformer.

This current reduces accordingly to an exponential law whose time constant depends on the winding resistance and the secondary load.

10. Maintenance

10.1. Routine maintenance

- Clean bushings and shorting bars.
- Check insulating liquid level. If level is too low, check for leakage.

- Check paintwork.
- Check dielectric strength of liquid every two years. The result should not be less than 30 kV / 2.5 mm (for sampling oil instructions, please see appendix I).

10.2. Elimination of leakage

Leakage may accidentally occur, especially at the following points:

- HV or LV bushings
- Transformer instrumentation
- Tank sealing gaskets
- Pipework device
- Valves
- Radiator and on tank

In all circumstances, when leaks occur, the fault must first of all be located by suitably cleaning all liquid-covered parts.

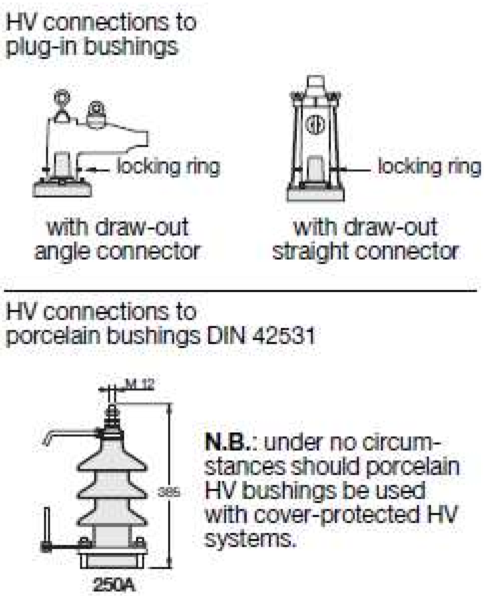
10.2.1. HV bushings

The leakage can be the result of a cracked insulator, a defective seal between the cap and the insulator or between the insulator and the cover/wall of the transformer.

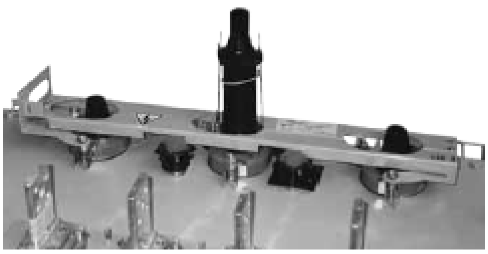
If tightening the fixing arrangements or hexagonal nut on the cap does not give a satisfactory result, dismantle the bushing as follows, and replace defective item. In case of a transformer with sidewall bushings, lower the liquid level to one centimetre below the bushings.

Remove the nuts from the connecting stud, the cap, the porcelain bushing holder ring, the insulator, and the gasket.

- Replace the defective seal.
- Then reassemble the parts in the reverse order, taking care to guide the cable connecting stud and to clean the surface of the cover where the liquid seal will be placed, retighten the porcelain bushing holder ring but not too excessively, and also the first nut on the connecting stud, to make sure that the bushing is sealed at the top.
- Bushing type in the HV connections



- Potection of HV bushings
  - Draw-out connectors (straight or angle) may be kept plugged into the plug-in bushings using a padlockable locking device (padlock / lock not supplied); Release of this locking system may be made conditional on prior isolation of the transformer from the HV supply.



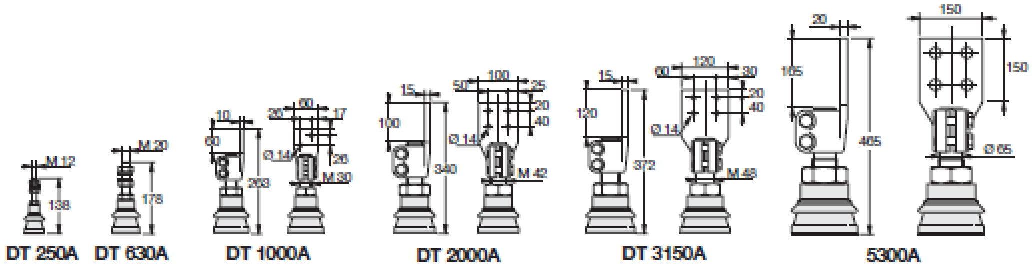
  - Porcelain bushings may be fitted with a sealable protective cover, whose design will depend on the HV voltages, the configuration and number of cables.

10.2.2 LV bushings

If tightening does not stop the leakage, the bushing must be dismantled as follows:

- Remove the top nut, the upper washers with the gaskets, upper insulator and the gasket.
- Clean the sealing surface of the gaskets to be replaced.
- Reassemble the bushing in reverse order.
- Bushing type in the LV connections

LV connections to porcelain bushings (mandatory for 100 and 160 kVA units) DIN 42530



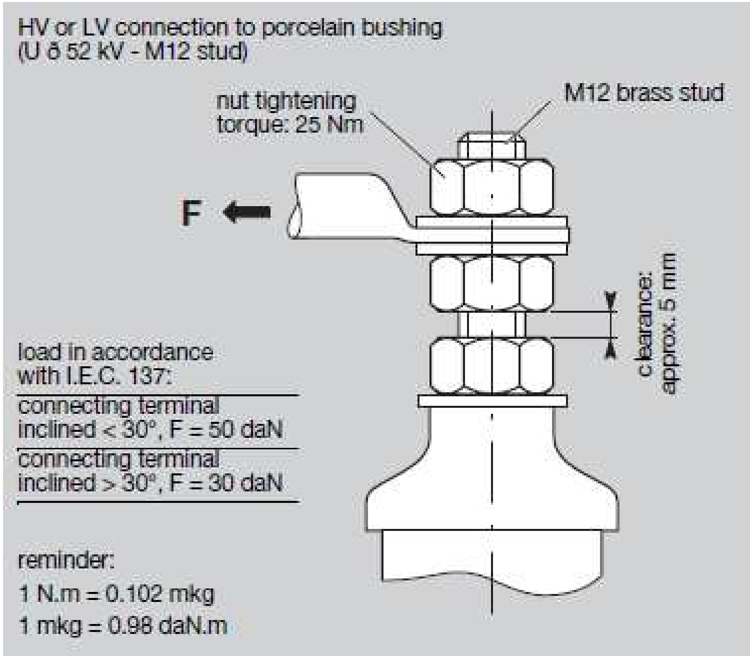
- Protection of LV bushings

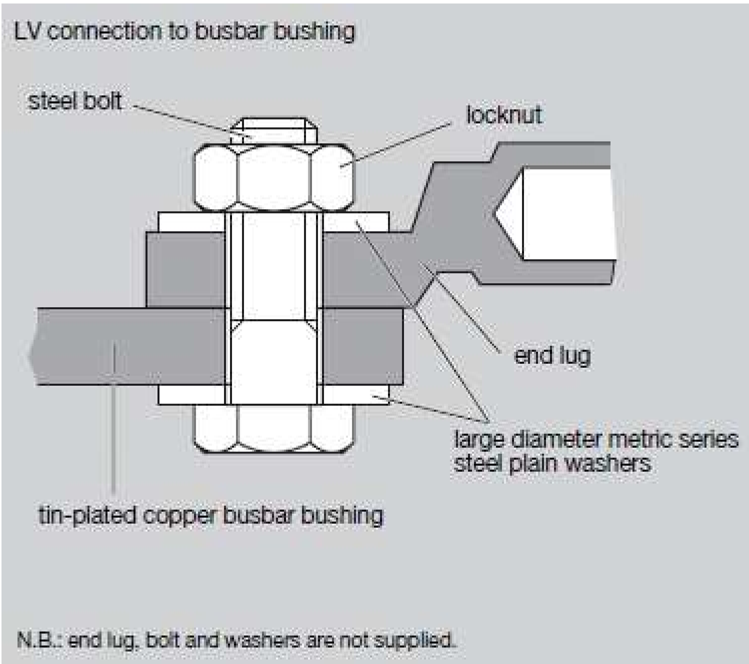
  Busbar or porcelain bushings may be protected by sealable cover

10.2.3. Assembly and Maximum tightening torque

Bushings must not be subjected to stresses resulting from cable or busbar connections; such loads can cause leaks at various joints.

Furthermore, the following connection details and tightening torque values shall be complied with:





Tightening torque values

• Bushing studs	: M8	: 15 Nm
	: M10	: 24 Nm
• Tank cover bolts	: M8	: 18 Nm

		: M10	: 24 Nm
•	Oil filling plug	: M22	: 120 Nm
•	Drain plug	: ¾ "	: 150 Nm
•	Bolted cable lugs	: M12	: 35 Nm
		: M20	: 70 Nm

PERIODIC MAINTENANCE

NO	CHECK ITEM	METHOD	ACCEPTANCE CRITERIA	ACTION IF REQUIRED	FREQUENCY
1	Cleanness of Transformer	Visual check	No dust and oil slippage	Cleaning	Every 2 years
2	Oil Level	Visual check	Indicated Maximum	Topping up	Every 2 years
3	Oil Dielectric Strength	Breakdown Voltage Test	> 30kV / 2.5 mm	Purification	Every 2 years
4	Leakage of Gasket	Visual check and re-tightening according to standard torque	No Leak	Change Gasket	Every 2 years

11. APU SERVICE SUPPORT - UMV

PT. Schneider Electric Indonesia - TRANSFORMER

Jl. Selayar Blok A9 – 10 MM2100 Industrial Park - Cibitung
Bekasi 17520, Indonesia

Contact Person : Rudy Dhaniyanto
Phone : + 62 21 2926 5800
Direct : + 62 21 2926 5880
Fax : + 62 21 460 4179
Email : rudy.dhaniyanto@schneider-electric.com

General note

It is important for all seal and gasket replacement operations to be carried out in a dry place.

The topping-up liquid which will be required after replacement of the seal must be clean and dry and of the same quality as the liquid in the transformer. The tank should be filled up through the filling valve on the cover of the main tank.

APPENDIX I. Insulating Liquid

A. Typical characteristics

Property	Mineral Oil
Viscosity, 40 °C, cs	16.5
Specific gravity	max 0.895
Pour point, °C	- 45
Flash point, °C open cup	min 140
Volume resistivity ohm. Cm 25 °C	1×10^{14}
Loss tangent, 25 °C 50 Hz	0.0005
Permitivity, 25 °C 50 Hz	2.2

B. Sampling

The sample container shall be made of amber glass and shall be cleaned and dried. The glass bottle is preferable to a metal container as it can be examined to see if it is clean. It also allows visual inspection of the oil before testing, particularly free water and solid impurities.

However, any samples to be tested for colour, power factor or sludge-forming characteristics must be kept in the dark, as light produces changes in these properties. This is not necessary for any other test.

Sampling oil from the transformer

When taking samples of oil from the transformer use the sampling valve.

Care should be taken to procure a sample, which fairly represents the oil at the bottom of the tank.

A sufficient amount of oil should therefore be drawn off before the sample is taken, to ensure that the sample will not be the oil that was stored in the sampling pipe.

It is of utmost importance that the sample of insulating oil represents the actual condition of the oil in the transformer. Every precaution should be taken to keep the sample and container free from foreign impurities or moisture.

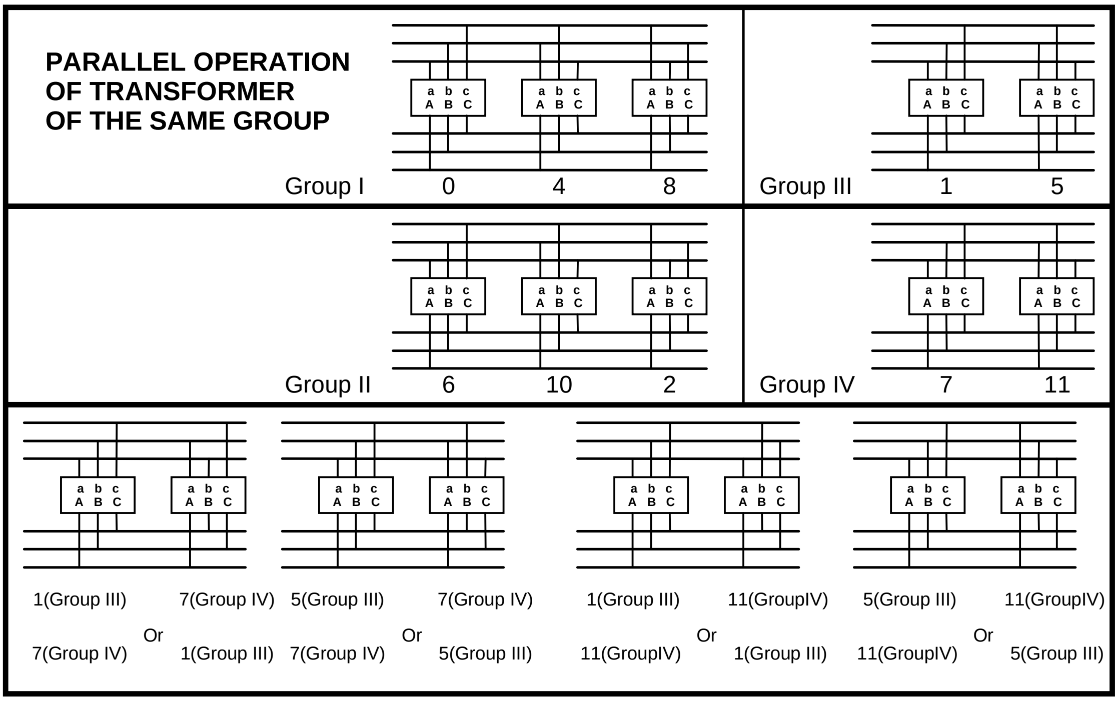
If the transformer is installed outdoors, care should be taken to prevent contamination of the sample by rain, dust, etc.

APPENDIX II. Parallel Operation

Connection can be classified in four groups:

- Group I contains hour numbers 0, 4 and 8
- Group II contains hour numbers 6,10 and 2
- Group III contains hour numbers 1 and 5
- Group IV contains hour numbers 7 and 11

Parallel operation of two transformers having different clock directions must follow the configurations in the diagram below :



Furthermore the following requirements must be fulfilled:

- The impedance voltage of the various transformers must be the same (tolerance ±10 %).
- The difference between the voltages obtained at the secondary on the various transformers and corresponding phases or between these phases and the neutral must not be higher than 0.4 %.

Make the most of your energy™

PT. Schneider Indonesia
Jl. Selayar Blok A9 - 10
MM2100 Industrial Park
Bekasi, 17520 INDONESIA
Ph. +62(0)21 2926 5800 (Hunting)
www.schneider-electric.com

+62 (0)21 2926 5801 (General)
+62 (0)21 460 4179 (Distribution)
+62 (0)21 460 6159 (Switchgear)