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Installation, Operation and Maintenance Manual

General operating principles

The transformers supplied are dry type Cast Resin three phase distribution transformers having a Delta connected primary winding and a Star connected secondary winding.

Overloads are permitted in accordance with IEC 354

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1. General.....	3
2. Packing.....	3
3. Transport.....	3
4. Storage.....	4
5. Installation	4
6. Connection to the supply network.....	5
7. Voltage Tappings	6
8. Putting into service	6
9. Parallel operation	7
10. Maintenance.....	8
11. Spare parts.....	9
12. Protection against excessive temperatures.....	9
13. Damage, disassembling and repairs	9
14. Overloads.....	10
15. Additional Information - temperature protection system.....	11

1. General

Cast Resin dry type transformers, manufactured by Pauwels, are made to conform to international standards IEC 726, HD538 S1, HD464 S1, DIN 42 523 as appropriate for the destination country. Cast Resin dry type transformers have high voltage windings, which are encapsulated by means of an epoxy based resin cast under vacuum. Low voltage windings may be of Prepreg construction or of vacuum impregnated construction or even fully of cast resin encapsulated construction depending on the particular application and client specification. The casting or impregnation process is done under vacuum to ensure that the windings are fully covered with resin without any air bubble inclusions. This results in a strong coil structure with very high resistance against short-circuits and impulse voltages. Cast Resin transformers are protected against the penetration of humidity and against deposits of dust.

2. Packing

Dry type transformers with encapsulated windings are not harmed by natural humidity and packing is not necessary for short inland transport. During bad weather and during long distance transport by lorry, we advise the use of a plastic sheet envelope around the transformer. For transport overseas we pack in wooden cases, crates or in containers.

3. Transport

To lift the transformer, all four lifting lugs must be loaded uniformly with equal length straps of suitable length in order to avoid distortion to the top core clamping structure and system of core and coil supports. The Cast Resin transformer must be rigidly fixed during transport by locking the rollers and by using strapping wires, which must be fixed to the towing lugs on the transformer.

When unpacking from crates the steps are as follows:

- A. Remove Cover
- B. Remove Side Walls
- C. Fit Rollers

4. Storage

Cast Resin transformers must be stored in a dry, well-ventilated room and covered with a plastic sheet. After a long storage period at extreme low temperatures or after a lengthy period de-energised in very humid surroundings, the transformers must be dried before putting back into service. Drying can be achieved by warm air heaters or by industrial dehumidifiers if, for instance, the humidity is due to concrete setting in the vicinity.

5. Installation

After packing materials and any other blocking means used during transport are removed, the transformer should be cleaned and dusted-off, taking special care of the air cooling ducts between the windings and between the low voltage coils and the magnetic core.

Once in final position ensure that the transformer is secured by blocking the rollers.

In selecting the installation location, consideration must be given to the efficient cooling of the transformer. The following conditions are important:

- a) Keep the ambient temperature in the transformer room as low as possible.
- b) Avoid stagnation of hot air above the transformer, which could impede the convective cooling process.
- c) Try to obtain a diagonal airflow through the transformer bay or housing. The fresh air should enter by lower part and the hot air should exit from the upper part of the bay.

Accessories removed for transport purposes, such as cable boxes, connectors, coupling bars and cubicles for auxiliaries should be unpacked and fixed in their respective places according to the relevant drawings.

In order to limit the noise level of the transformer it is advisable to install it as far as possible from the walls of the bay as reflections can add to the noise from the transformer. Sometimes it is advisable to fit anti-noise and vibration pads under the rollers in order to avoid transmission of vibrations to the building structure.

The values of the noise levels mentioned in our brochures are for transformers without any protection of housing (protection degree IP00)

Cast Resin transformers are only for indoor installation in IP00 condition.

Outdoor installation is only allowed when installed inside a protective housing and where no condensation or dripping water can occur.

6. Connection to the supply network

Proper care must be taken when Cast Resin transformers are connected to the supply network.

- All electrical connectors must have an ample cross-section, be of suitable strength and with clean contact surfaces using compatible materials.
- The conductors from the transformers to the supply can be provided with cable lugs, concentric connectors or with busbars.
- As standard, brass screwed studs are fitted on the HV terminals of the transformers; the low voltage terminals are flat conductor bars rising (normally) from the low voltage coils. The low voltage terminals may be of copper or of aluminium, depending on the transformer design. Where copper busbars will be connected to aluminium transformer terminals we recommend the fitting of CUPAL bimetallic plates which ensure that the joint is aluminium to aluminium on one side and copper to copper on the other. For currents of 1,250/1,600 Amps and above we recommend that a flexible link is used between the transformer terminals and the busbar system in order to compensate for thermal expansion of the copper busbar system and LV coil risers.
- Sharp bends in the high voltage conductors are to be avoided.
- For connection of the HV terminals the minimum clearances specified in section "Putting into service" must be observed.

ATTENTION

Before the putting in service of the transformer, all electrical connections must be checked (incl. the tapping link connections). A poor electrical connection causes unnecessary heating, resulting in possible damage to the transformer insulation.

Bolt Torque Tensioning moments (NM)				
Bolt	M10	M12	M16	M20
HV	25	40	100	200
LV	50	90	200	-

7. Voltage Tappings

Cast Resin transformers with are normally provided with an off circuit tapping adjustment on the high voltage windings. As standard, five positions are normally provided ($\pm 5\%$ in 2.5% steps). In all cases these adjustments are made phase by phase by changing the link positions. The tapping links are fitted on the front side of the coils in the middle of the high voltage winding. Voltage adjustment is obtained by connecting between the appropriate terminals with the bolted links. For the five-position execution, there are six connection points or five position settings for the links. The voltage adjustment is executed such that the highest voltage is also the highest position of the link on the coil when the HV-connection is at the upper side. So connection between terminals 5 and 6 in the uppermost position gives tap position 1. At this position 105% of the winding turns are in the circuit. This way a higher than normal by 5% incoming voltage can be compensated. Alternatively the low voltage output voltage can be dropped by about 5% for a normal incoming voltage level. Conversely, connecting between terminals 3 and 8, tap position 5 takes 5% of the HV winding turns out of the circuit compensating for a low incoming voltage or increasing the low voltage output voltage.

WARNING

We draw your special attention to the fact that the transformers must be de-energised and off-circuit before they may be touched or even approached!

8. Putting into service

Before the transformer is put into service the following checks must be carried out:

- Checking of the complete system and of all circuits.
- Connection and control of the earthing conductors.
- Checking of the transformer for cleanliness and foreign objects. If necessary, clean it with vacuum cleaner.
- Connect and test the thermal protection system. Please refer to separate instructions on the particular thermal protection system fitted.
- If the transformer is provided with a forced air cooling fans, the operation of the fan circuits must be checked. Do not forget to check the direction of rotation of the fan.
- Megger test to verify that HV to LV and HV or LV to earth resistance's are correct.
- Check that phase and voltage tappings concur with the data on the name and diagram plate.

- All conductors of the auxiliary circuits and also the fixing points of the accessories must be made with respect to minimum High Voltage clearances (windings, connectors and terminals). The minimum distances to be applicable are as follows:

Impulse voltage peak value	Minimum distance according to IEC 71-3
(kV)	(mm)
20	60
40	60
60	90
75	120
95	160
125	220

WARNING

The Cast Resin transformers may not be touched or even approached when in service. It is therefore forbidden for anyone to work in the proximity of a non-protected transformer when live.

HV Pressure testing

Please note that we recommend against leaving the transformer in-circuit during HV cable pressure testing.

9. Parallel operation

In case of parallel operation the following conditions must be fulfilled: The transformers must have the same vector group. Four groups are standardised:

Group I: Ddo, YynO, DznO
Group II: Dd6, Yyn6, Dzn6
Group III: Dyn5, Yd5, Yzn5
Group IV: Dyn11, Yd11, Yzn11

They must have the same impedance voltage, however a tolerance of $\pm 10\%$ is permitted.

They must have the same rated voltage and be connected at the same tapping position.

- These three conditions are indicated on the name and diagram plate, or can be calculated from it. If these conditions are fulfilled, the following procedure must be carried out:
- Connect the corresponding high voltage terminals.
- Connect the corresponding low voltage terminals.
- Ground the units through a common earth point where the transformers are installed in close proximity to each other.
- Connect the transformers to the supply at the high voltage side. The low voltage main switches should be open.
- Check for any difference in voltage between the corresponding low voltage phases. The voltmeter should show no readings. If however there is a difference in voltage, the source should be traced. This difference could be caused by a non-symmetrical connection or by a faulty tap position.
- Only when it is certain that no difference in voltage exists between corresponding low voltage terminals, can the low voltage circuits be energised by means of the low voltage main switches.

Notes

When looking for the source of voltage difference between the corresponding low voltage terminals the low voltage neutrals must be connected together.

When running permanently in parallel, the rating ratio of the transformers in service must be taken into account. We advise against the application of rating ratios above 3/1.

10. Maintenance

In general, Cast Resin type transformers do not need any maintenance unless the accumulation of dust is a problem. When necessary, it is advisable to clean the transformer. It is essential that dust or other deposits, which may impede cooling airflow, do not obstruct the cooling ducts.

11. Spare parts

Our Cast Resin type transformers are assembled following a modular system. Disassembly is recommended only in our factories. A defect on a temperature protection system may be repaired at site with spares available from our stores.

12. Protection against excessive temperatures

There are two types of sensors that can be provided on our Cast Resin type transformers. They are installed in the hottest point of the low voltage winding. The first type is the PTC sensor or thermistor. This device has a very high resistance until a pre-set temperature is reached whereupon control switching can be activated.

The standard system used is two sensors per low voltage winding. One for alarm and one for trip. This is used to give two temperature detection level systems. One of each pair per coil is coupled in series and connected to a tripping relay. Once the pre-set temperature level for the lower temperature sensor (alarm) is reached an alarm system is activated. If the temperature continues to rise to the next level (trip) the transformer is normally disconnected by means of a signal to a tripping coil provided on the high voltage circuit breaker. If two sensors per phase are fitted the temperatures will be set with a difference of 10 degrees centigrade between the two levels.

The second type of sensor available is the linear resistance PT 100 type. This has a linear resistance characteristic as a function of the temperature rise of the windings. When a PT 100 sensor system is used, only one sensor per low voltage phase is generally fitted. The temperature switching levels are normally pre-programmed into a temperature protection unit that can also manage fan control where forced cooling is fitted.

Further information on the thermal protection system is given separately depending on the particular system fitted. See L203 or D404 instructions as appropriate.

13. Damage, disassembling and repairs

If damage occurs to the coils, they can be replaced with spares supplied from our works against a particular quotation with reference to the transformer serial number. If the magnetic core of the transformer becomes damaged, we recommend sending the transformer back to the factory for repair or replacement.

14. Overloads

Our Cast Resin transformers are designed to be loaded indefinitely with their nominal rating, taking into account the temperature limits stated in the specifications. Overloads in excess of those permissible will shorten the lifetime of the transformer insulation materials. The transformer may be overloaded temporarily in defined conditions. The time duration and the value of the overloads depend on the ambient temperature and on the previous loading of the transformer prior to the overload condition. For a time constant of half an hour of the low voltage windings the admissible overloads in percent and for an annual average temperature of 20 degrees centigrade are as follows:

Overload time (hours) Previous load in % of the nominal rating	12	8	4	2	1
	Overload in %I _N				
25	6	8	15	25	32
50	6	8	15	22	30
75	5	7	13	22	27

I_N: a rated current

This table conforms to IEC 905 "loading guide for dry type transformers". An average temperature rise of 100 degrees centigrade for windings with insulating materials class F has been taken into account. The absolute maximum temperature that the hottest spot of the windings may reach is 190 degrees centigrade. This temperature must never be exceeded.

15. Additional Information - temperature protection system

Information follows separately on the particular temperature protection system used. This will either be the L203 PTC system or the D404 PT100 system.

Auxiliary control transformer for fan power supplies

Please note that where fans are fitted to the transformer to increase the rating by force cooling for UK and where the supply for these fans is derived from the LV side of the transformer we also add a control transformer to step down from 250V AC to 230V AC. This control transformer is normally located between the lower core clamps at one end of the Cast Resin transformer.

This control transformer which is normally rated 1250VA also has internal protection fuses fitted.

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