Trihal Dry Type Transformer

Instructions for installation, use and maintenance

Cast resin distribution transformer up to 36kV and 10 MVA

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Contents

Important Safety Instructions

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this manual or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

1.0 Introduction

Schneider Electric applies its own advanced and patented technology whilst introducing vacuum cast static mixed material equipment to manufacture low noise cast resin dry type transformers with low losses. These transformers are fully compliant with standards with

- IEC 60076-11:2018 and IEC 60076-12:2008 and has been C4, E4 and F1 certified.
- AS 60076-11:2006

The Trihal product has the following advantages such as; being power efficient, being compact, being lightweight, producing less noise, being dampproof, being pollution resistant, being able to withstand overloading for a short duration (as specified in the standards).

2.0 Warning

- For transformers without an enclosure, place a barrier around it to isolate it before installing and commissioning it
- After commissioning the transformer, do not touch the body of transformer.
- Site Testing, installation and maintenance of transformer must be done by qualified professionals

- Please make sure to follow the advice presented in the storage section.

3.0 Normal Service Conditions

- Altitude
  - no higher than 1000m
- ambient temperature
  - maximum +40ºC (unless the transformer has been uniquely designed)
  - maximum daily average +30ºC
  - maximum yearly average +20ºC
  - minimum -25ºC (outdoor)
  - minimum -5ºC (indoor)
- Wave-shape of supply voltage
  - approximately sinusoidal
- Symmetry of polyphase supply voltages
  - approximately symmetrical

Note: In the event the ambient temperature is greater than +40ºC or the altitude is higher than 1000m, the appropriate actions should be taken as specified in the related regulation.

- IP code: IP00, IP21, IP23, IP31, IP44.
- The cooling methods include both natural air ventilation (AN) and forced ventilation (AF). Please see the section below regarding the ventilation design.

4.0 Ventilation Design

Natural Substation Ventilation

In the general case of natural cooling (AN), the ventilation of the substation or the enclosure occurs through natural convection. The purpose of this ventilation is to dissipate the heat generated by the transformer's total losses in operation. However, it should be noted that restricted air circulation reduces the transformer's available power.

Basic Method:

The required ventilation opening surface areas S and S' can be estimated using the following formulas:

$$S = \frac{1.8 \times 10^{-4} P}{\sqrt{H}} \quad \text{and} \quad S' = 1.10 \times S$$

where:

S = Lower (air entry) ventilation opening area (m²) (grid surface deducted)

S' = Upper (air exit) ventilation opening area (m²) (grid surface deducted)

P = Total dissipated power [W]

P is the sum of the power dissipated by:

- the transformer (dissipation at 00 load and due to load)
- the LV switchgear
- the MV switchgear

H = Height between ventilation opening mid-points [m]

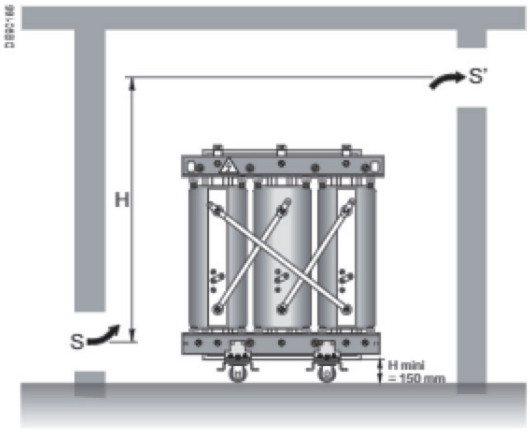


Figure 4.1: Visual aid for calculations

Note:

This formula is valid for a yearly average temperature of 20°C and a maximum altitude of 1000m.

Example:

Transformer dissipation = 7 970 W
LV switchgear dissipation = 750 W
MV switch gear dissipation = 300 W
The height between ventilation opening mid-points is 1.5m.

Calculation:

Dissipated Power P = 7970 + 750 + 300 = 9020W

$$S = \frac{1.8 \times 10^{-4} P}{\sqrt{1.5}} = 1.32m^2 \quad \text{and} \quad S' = 1.10 \times 1.32 = 1.46m^2$$

Figure 4.2: Basic calculation method

For a more complete calculation method please see the figure in Appendix 18.1.

Forced Ventilation

Forced ventilation is required;

- If the environment is small or badly ventilated.
- If the environment has an annual average temperature greater than 20°C.
- If frequent overloading of the transformer occurs.

So as not to disturb the natural convection in the premises, an extractor fan discharging air outside will be installed in the outlet hole located in the top part of the unit, it can be thermostatically controlled.

Th recommended flowrate (m³/hour) at 20°C = 0.10 P, where

P = total losses to be removed, in kW, emitted by all the installed equipment, at full load.

5.0 Delivery

When transporting the body of transformer, it should be enclosed with a plastic cover.

- The transformer can be transported by train, ship, truck and plane. The compartment transporting the transformer should be kept clean and uncontaminated.
- Fix the transformers (without an enclosure) on the carriage by using the holes on the rollers, yokes and lugs. It should not be tied to the winding, insulation, underlay or down lead, else these parts will be damaged.
- Load and secure the transformer firmly as specified by the relevant transport regulations so that it does not get damaged. Figure 5 shows the correct way to do this, and figure 6 shows the incorrect way.
- For transformers without enclosures, any attached accessories, equipment or documents will be included and delivered with transformer.
- Do not stack these transformers.
- It should be placed on timbers which have a height greater than 100mm.

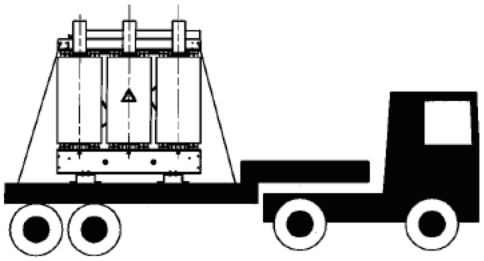


Figure 5.1: Correct positioning

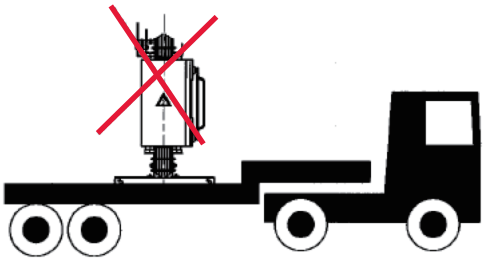


Figure 5.2: Incorrect positioning

6.0 Handling

Suitable equipment must be used for lifting such as cranes, lift trucks and forklift trucks.

- Lifting with slings (figure 6.1). For a transformer without an enclosure, lifting is carried out using the 4 lifting lugs. For a transformer with an enclosure, lifting is done using 2 lifting lugs. The slings should not form an angle greater than 60º as seen in the diagram.
- Lifting with a forklift truck (figure 6.1). The lifting capacity of the forklift truck should first be checked. If possible, the forks should be inserted inside the base channels after removing the rollers.
- Towing the transformer, both with or without an enclosure, must be performed from under the base. 27 mm diameter holes have been provided for this purpose on all sides under the base. Towing can only be carried out in two directions: parallel to the base axis and perpendicular to the base axis.
- Fitting the rollers
    1. When lifting with slings (figure 6.1) or lifting with a forklift truck (figures 6.1 and 6.2), position the lifting forks under the base channels.
    2. Place timbers taller than the rollers under the channels and lower the transformer onto them.
    3. Position the jacks and remove the timbers.
    4. Attach the rollers in the desired position (bi-directional rollers).
    5. Lower and remove the jacks and allow the transformer to rest on its rollers.
- Lift the transformer carefully, following any related lifting regulations.
- There is a lifting sign on the enclosure, so, when lifting, hitch the four angles of enclosure as seen in figure 6.4. If there is no enclosure, use the steel wire on the wood (not provided) that is used to support the transformer, else lift the transformer from the enclosure. Make sure to lift with all the lifting lugs, noting that the slings should not form an inclination greater than 60º (see figure 6.5).

Note: Strictly lift the dry type transformer with four lifting lugs.

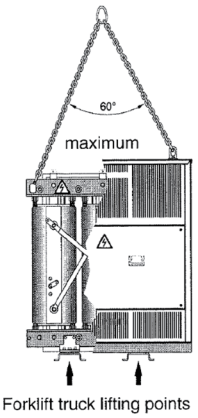


Figure 6.1: Lifting with slings or forklift truck

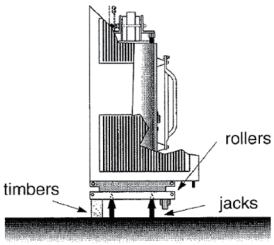


Figure 6.2: Fitting the rollers

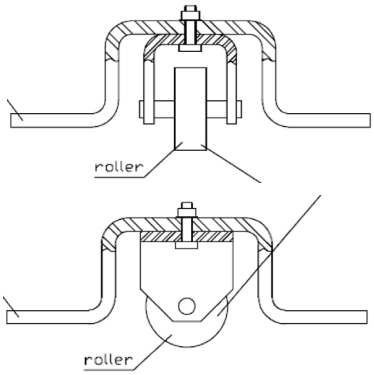


Figure 6.3: Detail of bi-directional rollers

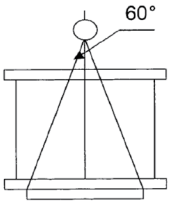


Figure 6.4: Depicts angle at 60º

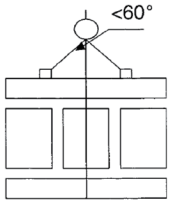


Figure 6.5: Depicts angle at less than 60º

7.0 Receipt and check

- Check the equipment and confirm it corresponds with the order.
- Check the attached documents, accessories and components against the order.
- Check the characteristics indicated on the rating plate such as type, rated power and rated voltage.
- Ensure the transformer has not been damaged during transportation, i.e. damaged components, ruptured connections or damaged insulation. Please also remove any materials used for transportation while checking for damage.
- If the transformer is damaged or accessories are found to be missing, please follow the storage instructions below to avoid further damages or losses.

Note: The customer should check as soon as they receive the transformer. If you have any concerns, please contact the Schneider Electric Services team for more information.

8.0 Storage

- If the equipment is not needed immediately, place it into storage and leave it unopened to prevent losing any parts. After performing a receipt and check (as above), make sure to store the equipment in the way outlined below
- When storing the equipment long-term, use a space that meets the below criteria.
- Place the cast resin dry type transformer into storage and protect it from exposure to water and dust. (For example, keep it away from masonry or sanding work). Use compressed air to clean the body of transformer, wipe foreign bodies off the transformer, such as oil, and cover it with plastic. Please note that the storage room should also be kept clean, dry and not contain any chemical products and/or vermin. Regarding the SEI thermo-sealed packing used to prevent damage, the guarantee against humidity is for a maximum of 24 months. Beyond this period, the customer will need to take additional precautions to keep the transformer in a humidity free environment.
- The equipment must NOT be stacked on top of each other.
- In general, dry type transformers should be stored indoors. However, it can be stored outdoors for a short period of time if it is unopened, protected from water, mounted on timbers which have a height greater than 100mm, and if no stacking of the equipment takes place.
- The product should not be stored outdoors for more than 2 months and the ambient temperature should not be lower than -10°C. However, for a short time, the Trihal cast resin dry type transformer can be stored in temperatures down to -25°C.

9.0 Installation

Before installing this product, please read this instruction manual, the rating plate, and review the drawings carefully. Please note the weight of the product and understand the method of installation needed beforehand to prepare the relevant equipment and tools.

- Installation location. The location of the installation must be dry and clean. Ensure that the infrastructure can meet the load requirements and is earthquake-proof. The location should have sufficient ventilation to ensure that the total heat losses of the installed transformers can be adequately dissipated.

Note: The cast resin transformer should not be installed in flood hazard zones.

- Generally, the clearance between the transformer and the wall (or other barriers) should be 500mm. The clearance between neighbouring transformers should be 500mm.
- The minimum safe clearance between live parts of the transformer and earth should be in accordance with IEC60076-3 (Insulation levels, dielectric tests and external clearances in air).

Minimum safe clearance between the surface of HV winding and earth

Voltage (kV)	≤1	6	10	15	20	35
Minimum clearance (mm)	40	60	90	120	160	250

Minimum clearance to wall

Voltage (kV)	6	10	15	20	35	
Minimum clearance (mm)	90	120	160	220	320	

- Generally, if the relevant checks and commissioning tests have been conducted, the transformer can be placed directly in the distribution room and can run after being installed. In certain situations, special measures need to be taken during installation. For example, to earthquake-proof the equipment, the foundation where the transformer is to be installed should be embedded with bolts as specified in the drawing of the transformer. If the transformer is equipped with rollers (usually 4 rollers) during installation, the wheels can be removed, and the transformer can be bolted down.
- The transformer wheels can pivot up to 90°.
- The insulation is F class with a temperature limit of 155°C. The product is available with natural cooling (AN) or with forced ventilation (AF). For the AF system, the temperature control unit should be installed at the same time as the transformer. The main functions of the equipped temperature control unit are:
  - To display the temperature of each phase and the maximum temperature.
  - To set the temperature threshold values (based on the user's request) to determine when the fan should be turned on. The fan will run in two cases, the first case is in the event the maximum temperature of any of the windings of the three phases exceeds the set value for the fan. The second case is if the fan is started manually.
  - To notify the user when overheating occurs. When the maximum temperature of any winding of the three phases exceeds the set value, the temperature control unit will sound an alarm and light up the "over temperature" LED on the panel
  - To notify the user when a trip occurs. When the maximum temperature of any winding of the three phases reaches trip temperature, the temperature control unit will sound an alarm and light up the "cut power" LED on the panel, while simultaneously switching off the power supply to protect the transformer.

For further details on the functions and operations of the TCU, refer to Appendix 18.2 and install and use the controller in accordance with this manual.

Note: When setting up the threshold values, note that the trip temperature ≥ alarm temperature ≥ start up fan temperature ≥ stop fan temperature.

- The maximum alarm temperature to be used is 130°C and the maximum trip temperature to be used is 150°C. If the user sets up the wrong threshold values, they will be responsible for any damages that occur.

10.0 Test before commissioning

The following tests should be completed before the transformer is commissioned:

- Measure the DC resistance of each of the taps of the windings.
- Measure the voltage ratio of each tap and have a connection symbol (or vector group representation) as according to IEC standards.
- Check the earthing continuity of the transformer.
- Measure the insulating resistance of the winding (generally, temperature: 20-30°C, humidity ≤90%):

HV-LV earth ≥ 300MΩ meter: 2500V Megger

LV-earth ≥ 100MΩ meter: 2500V Megger

The insulating resistance of the transformer will be lower in humid conditions. Generally, if the relative insulating resistance is no less than 2MΩ per kV (at approximately 25°C), it will be suitable for commissioning. Please wait one minute before taking a reading, (to get an accurate measurement), and ensure the transformer is dry before commissioning it.

- Measure the insulating resistance of the core (generally, temperature: 20-30°C, humidity ≤90%):

Core - clamp and earth ≥ 2MΩ meter:500V Megger

Inlet screw - core, earth ≥ 2MΩ meter:500V Megger

Similarly, under humid conditions, the resistance of the core may decrease if its value is ≥0.5 MΩ. The transformer must be dry before commissioning.- When applying the AC voltage, the test voltage is 80% of the test voltage conducted at the factory.

Note: According to IEC60076-11, the following routine tests are finished in our factory.

1. Measurement of winding resistance
2. Measurement of voltage ratio and check of phase displacement
3. Measurement of short-circuit impedance and load loss
4. Measurement of no-load loss and current
5. Applied voltage test (AV)
6. Induced voltage withstand test (IVW)
7. Partial discharge measurement

11.0 Commissioning Checklist

- Check that fixed components and connectors are tight. After connecting the active components of the transformer, check that the minimum clearance between the HV/LV cable, (the LV copper row and the surface of the HV winding) is no less than 120mm.
  - The tightening torque of HV connectors on the HV terminal and the tapping link bars (brass fixing with flat washers and contacts) are shown below:

Bolts	M10	M12	M16	M20
Tightening torque	15~20	25~30	35~40	45~50

Maximum force on the HV terminals: 500N

  - Tightening torque of LV connectors on the LV bars (steel fixings):

Bolts	M10	M12	M16	M20
Tightening torque	18~22	32~39	80~96	157~195

1m·kg=9.8da N·m 1 N·m=0.102m·kg

- Check that the components that were sent individually are correctly installed. Also ensure that any foreign material, such as dust, is removed to adhere to the appropriate regulations.
- Auxiliary wiring from the transformer should be attached on rigid supports and have sufficient clearance from live parts. The minimum clearance is determined by the insulation voltage indicated on the rating plate (see following table).

Voltage (kV)	6	10	15	20
Minimum clearance (mm)	270	450	450	450

Note: Under no circumstances should attachments be added onto the core (and winding) of the transformer.

- Check that the fan, temperature control device and other auxiliary devices are running correctly. For the three-phase power supply fan, check the direction of rotation and ensure that the wind blows from the bottom of the winding. If this is not the case, the fan is in reverse and the phase order of the supply must be changed as according to the temperature control unit's instruction manual.
- Check that the temperature control device, temperature display device, and all other related devices are correctly connected, and operate according to the instruction manual.
  - When the temperature of any winding in the transformer reaches 100°C, the temperature control unit will automatically start the fan to cool the winding.
  - When the temperature of the winding decreases to 80°C, the temperature control unit will automatically stop the fan.
  - When the temperature of the winding reaches 130°C, the temperature control unit will trigger the alarm contactors, outputting an alarm signal.
  - When the temperature of the winding reaches and/or exceeds 150°C, the temperature control unit will trip the over temperature contactors which are connected in parallel to the switch-brake button of the breaker (or switch) on the HV cabinet to protect the transformer. In the event of parallel operation, verify the identity of the HV and LV voltages and the compatibility of characteristics and especially of the vector groups and the impedance voltage. Make sure that identical tappings are selected for transformers to be connected in parallel.
- Eliminate the risk of metal granule (chipping), conductive granule, sundries and water spilling on the live components.
- Make sure there is a distance of at least 120mm between the surface of resin or link-pole and the following components
  - all feedback cables
  - earthing line
  - protection circuit
  - any other components
- Limit the switch current of LV capacitor with the appropriate equipment.
- Ensure good ventilation: cold air should enter from below and the hot air should flow out from the top.
- Make sure the supply voltage is less than or equal to the rating voltage.
- Keep a minimum distance of 150mm between the transformers with an enclosure and earth to ensure good ventilation.
- Check the position of the tapping links (three phase), and the tightening torque for the HV tapping link and HV bars (2m·kg).
- Connect the protection circuit to monitor system and check for effective earthing.
- Firmly secure the HV cables and LV cables to avoid movement.
- Clean the transformer periodically, especially if it is installed in harsh conditions (environments that contain oil and conductive granule).

12.0 Commissioning and Offload Tap Changing

Before commissioning, set the tap to the correct position according to the rating plate and signal plate.

- In the case of off load tap changing, connect the tap of the tap connector according to the grid voltage, the rating plate and the signal plate

Example: For a transformer 10000±2 x 2.5%V, the rating voltages are as follows:

1-2	2-3	2-5	3-4	4-5
10500V	10250V	10000V	9750V	9500V

If the local grid voltage is

- 10kV, the tapping links should be connected to 2-5, as shown in Figure 12.1.
- 10.5kV (high), with the power turned off, the upward links of the tap should be connected, as shown in Figure 12.2.
- 9.5kV (low), with the power turned off, the downward links of the tap should be connected, as shown in Figure 12.3.

After commissioning the temperature control and temperature display as per the instructions, allow the transformer to run before operating the temperature control and display devices.

- When the transformer is energized but not loaded there will be an inrush current. The maximum value of the in rush current can be 8-10 times that of the rated current. The current value of the protection setting should be more than the peak value of in rush current.
- After the transformer has been commissioned, increase the load steadily and check for abnormal noise. Never increase the load outright.
- The transformer will overload according to the overload capacity curve of IEC60076-12 “Guide for Dry Type Power Transformer Load”.
- If the transformer stops running, it can generally run again immediately without any adjustments. However, if the transformer is in an especially humid environment, dry the transformer and make any necessary changes before commissioning it again.

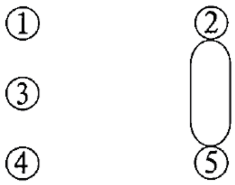


Figure 12.1: Tap setting example 1

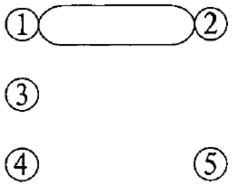


Figure 12.2: Tap setting example 2

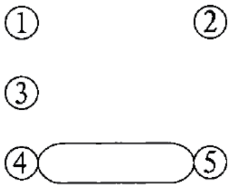


Figure 12.3: Tap setting example 3

13.0 Maintenance

Check and maintain the transformer periodically to ensure it functions correctly. Refer to the recommended maintenance chart below.

Cast Resin Transformers

Preventive maintenance activities	Minimal Frequency(1) / Performance Level									
	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Visual inspection										
Inspection of connections (heating, discharges, etc.)	●	●	●	●	●	●	●	●	●	●
Inspection of magnetic circuit appearance	●	●	●	●	●	●	●	●	●	●
Inspection of degradation of surface coating and transformer components	●	●	●	●	●	●	●	●	●	●
Checking of environmental issues (pollution / fires)	●	●	●	●	●	●	●	●	●	●
Checking of winding	●	●	●	●	●	●	●	●	●	●
Cleaning										
Dedusting	●	●	●	●	●	●	●	●	●	●
Cleaning of transformer compartment	●	●	●	●	●	●	●	●	●	●
Cleaning of bushing (and winding for CRT)	●	●	●	●	●	●	●	●	●	●
Verifications / repairs										
Checking of transformer's protection systems	●	●	●	●	●	●	●	●	●	●
Checking of accessories (temperature probe, …)	●	●	●	●	●	●	●	●	●	●
Tests										
Noise test	●	●	●	●	●	●	●	●	●	●
LV electrical testing	●	●	●	●	●	●	●	●	●	●
MV electrical testing (coupling, insulation resistance, …)	●	●	●	●	●	●	●	●	●	●
Upgrading / Regulation compliance										
IP housing for electrical safety	●	●	●	●	●	●	●	●	●	●
Installation of spike protector device (SPD)	●	●	●	●	●	●	●	●	●	●
Installation of temperature control relay	●	●	●	●	●	●	●	●	●	●
Schneider Electric Proprietary Diagnosis services offers										
Diagnosis to detect drifts from the initial state and significant trends, to anticipate on the corrective action (future failures) required to ensure equipment safety and continuity of service, and plan the action for the most convenient time for customer operations. More info in chapter 4 of this guide										
Spare Parts										
Secure: Parts commonly used in corrective maintenance interventions										
Auxiliary equipments (temperature probe, …)			Light maintenance							
Air dryer (Silicagel)						Exclusive maintenance				
Prevent: Parts whose condition are checked in preventive maintenance interventions										
Desiccant breather			Light maintenance							
Accessories (spike protector, cablebox, …)				Advanced maintenance						
MV connections						Exclusive maintenance				
DGPT2 (ProDiag Transfo Relay recommendation)						Exclusive maintenance				
Life extension: Parts to extend the life of the equipment										
Gasket				Advanced maintenance						
Oil filtration. Followed of a oil diagnostic (gas, water, particles, acidity, corrosivity)						Exclusive maintenance				
Oil retrofilling. Followed of a oil diagnostic (PCB, acidity, corrosivity) or need of a dielectric with a high fire point						Exclusive maintenance				

(1) Recommended under optimal operating conditions. However this recommended frequency should be increased according to a) the level of criticality (low, major, critical) and b) the severity of environment conditions (ie corrosive, naval, offshore) following the prescriptions of manufacturer's services (see table p. 15)

- Light maintenance, conducted by ED equipment manufacturer or customer competent technician
- Advanced maintenance, preferably conducted by ED equipment manufacturer or manufacturer certified partner
- Exclusive maintenance conducted by ED equipment manufacturer only

- Generally, in the case of dry and clean environments, check it once a year. If the environment is contaminated by factors such as dust or chemical smog, check it once every 3-6 months.
- If there is a lot of dust present, it must be removed (without damaging the insulation) to ensure proper air circulation. Make sure to clean the transformer's insulators, underlay and related components. Moreover, blow out the dust present in ventilation pipes with dry compressed air (2-5 atmosphere pressure).
- Check the looseness of tight firmware and the connectors, the presence of rust and erosion on conductive accessories, and finally for any creeping and carbonation on the surface of insulation. If necessary, take the appropriate action to deal with the above issues.

14.0 Trouble shooting guide

Table 1

Symptoms	Devices or subassembly in question	Probable cause	Remedies or actions
Low insulation resistance Approximate values to be measured: HV/earth: 250MΩ LV/earth: 50MΩ HV/LV: 250MΩ	HV or LV windings	Windings or conduits are wet	Dry with a cloth
		Abnormally dusty	Clean the transformer with nitrogen or dry air or vacuum cleaning. Clean all accessible parts
		Contaminated by greasy vapours and dust	Use a cold mechanical grease removing liquid, without chlorinated or aromatic solvent

Table 2

Symptoms	Devices or subassembly in question	Probable cause	Remedies or actions
Tripping when energising (only one transformer)	PTC sensor	Sensor disconnected or incorrectly connected	Check connection and continuity of PTC sensor
	TCU	Incorrect supply voltage	Use correct supply voltage
	HV fuse	Incorrect rating	Change the fuse rating
	Primary CT	CT's saturated by inrush current	Review the CT definitions
	Primary protection relay	Incorrect setting - Over current relay - Timing	Review the settings according to the transformer characteristics
	Windings	Arcing to earth or between turns	Check visually and carry out diagnosis
Tripping when energizing (in the instance of parallel operation)	Off-circuit tapping links bars	The tapping links bars are not in the correct position	Check that devices are compatible with parallel operation - Tapping links bars position - Vector group - Impedance voltage
	HV cables	Cables inverted or incorrect winding connection group	Check the connection group and the matching of phases

Table 3

Symptoms	Devices or subassembly in question	Probable cause	Remedies or actions
Abnormal secondary voltage:			
No output	Primary voltage	No primary voltage	Review installation
	Windings	Discontinuity in the windings	Check continuity, measure DC resistance
	Tapping links bars	Bars missing or incorrectly tightened	Check the tightening of the bars
Too low or high	Network	Too low or high network voltage	Adjust the tapping link as according to the network voltages
Unstable	Tapping links bars	Bars incorrectly positioned	Change the position of tapping links bars
	Network	Unstable network voltage	Review the installation
	Fuse	Fuse blown	Change the three fuses
	Windings	HV or LV break	Check continuity, measure DC resistance
	LV installation	Unstable load	Review LV installation
		Connection not in conformity	Check connections

Table4

Symptoms	Devices or subassembly in question	Probable cause	Remedies or actions
Trip during operation	PTC sensor	Sensor disconnect	Check continuity and connection of sensors
			Change faulty sensors
		Abnormal temperature increase	Check loads and voltage
			Check cooling conditions
	HV fuse blown	Short circuit on the LV system	Remove the cause of short circuit
			Check transformer condition
			Replace 3 fuses and re-energize
	Windings	Arcing to earth or between turns	Do not re-energize, carry out full diagnosis

Table 5

Symptoms	Devices or subassembly in question	Probable cause	Remedies or actions
Abnormal noise	Metal enclosure	Vibration	Check all fixings and tighten the panels
	Busbars	Vibration	Check all fixings and tighten the panels
	Magnetic Core	Dislodging of the core following a blow during transport or handling	Check the mechanical state of transformer
			Measure noise level
			Check the spacing and the centering of the HV coils
	Rating plate	Vibration	Check the fixing
	Off-circuit tapping links bars	Incorrectly positioned	Position the bars on the tapping point corresponding to the network voltage
	Network	Network voltage is too high	Position the bars
		High harmonic (in case of rectifier supply)	Check with the sales dept. if the transformer was originally designed for this use
HV coils off centre and the stabilising pad is loosened	HV coils	Handling or transport damage	Check the mechanical state of transformer
		Incorrect transport conditions	Make allowances for special transportation/delivery conditions for special design conditions.
			Re-centre the coils, reposition and tighten the conduits

After sales service

To get more information or to inquire about replacement parts, it is essential to quote the main characteristics on the rating plate and especially the transformers serial number.

15.0 Repair and End of Life Guidelines of Transformers

Transformer Repair Operations

Any repair activity that would require opening of the transformer, should be done under Schneider Electric supervision

Contact Schneider Electric Services

End of Life / Dismantling Operations

Should be done by qualified professionals experienced in transformer manufacturing to ensure the safety of personnel during disassembly, especially for all active parts of the transformer and the magnetic core. This is because they contain heavy parts which require special handling when lifting and strapping the equipment.

For more information, please contact the Schneider Electric Services team.

16.0 Standard Accessories

Standard accessories are those which will be provided with the Schneider Electric transformer.

16.1 Temperature Controller Unit (TCU) -BWDK

The output of relay signals

- The signal of fan on and off (100ºC on and 80ºC off)
- The signal of fault of the sensor
- The signal of high temperature alarm (130ºC)
- The signal of trip (150ºC)

Note: The above temperatures are the default setting value for F class transformer. It can be changed according to the actual demand.

The option output of electronic signals (digital signals and analogue signals)

- RS485/232
- 4~20mA
- 1~5V

Note: These electronic signals are used for remote monitoring.

For more information, please read the TCU manual carefully (in Appendix 18.2).

Figure 16.1.1: Sensor (PT100&PTC150)

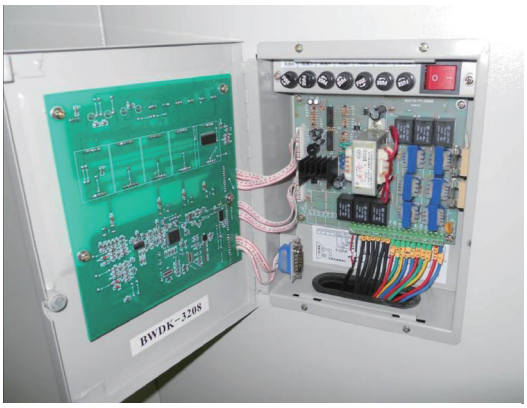


Figure 16.1.2: Electronic Converter

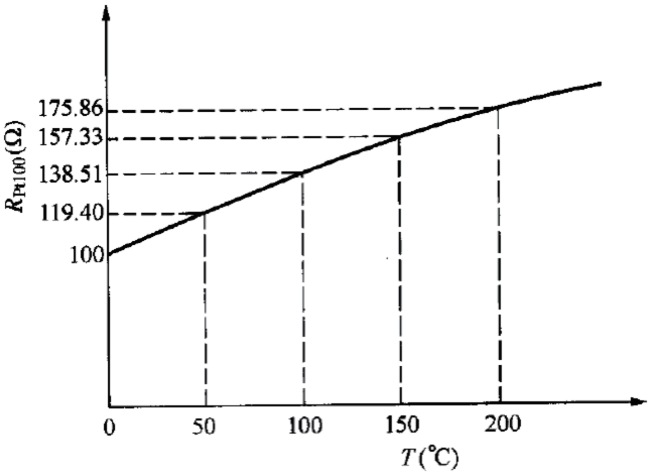


Figure 16.1.3: PT100 R and T curve

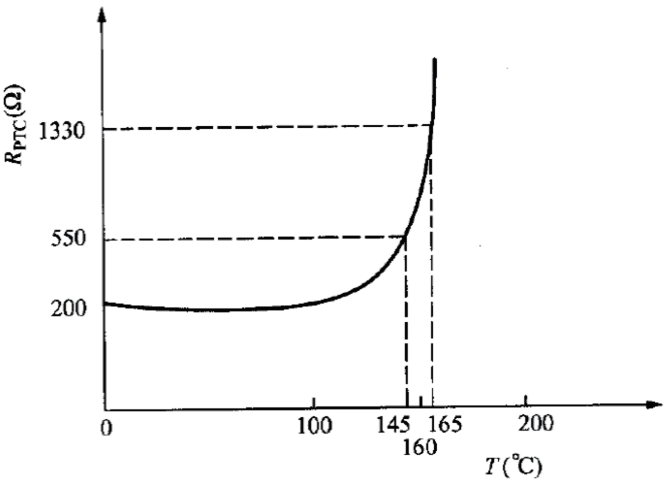


Figure 16.1.4: PTC150 R and T curve (transition T 150ºC)

16.2 Enclosure Door Lock

Normally the transformer enclosure is equipped with door, and the door can be locked based on the below structure.

When the transformer is delivered, the keys of the transformer enclosure door are in the control box.

Please press the lock of the control box to open it and take out the keys. Please take note of where the keys are stored afterwards.

When you want to open the door, please follow the following steps:

1. Use the key to unlock it.
2. Press the lock to open the handle, and then rotate the handle to open the right door.
3. Rotate the handle in figure 16.2.5 to open the left door.

Figure 16.2.1: Control Box

Figure 16.2.2: Keys

Figure 16.2.3: External structure

Figure 16.2.4: Internal structure 1

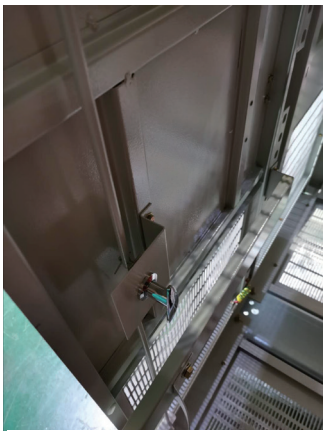


Figure 16.2.5: Internal structure 2

16.3 Marshalling Box

A marshalling box is supplied for the external wiring of the transformer protection devices.

Refer to the schematic drawings for more detailed information regarding the terminal layouts. The devices are further detailed in the transformer accessories section.

Please note that a circuit breaker protected device is supplied to protect all the auxiliaries such as the heater, lights or temperature-controlled unit.

Figure 16.3.1: Marshalling Box

17.0 Optional Accessories

17.1 Limit Switch on the Door

Optional accessories are those which might be provided with Schneider Electric equipment based on the customer's preference.

Normally the transformer enclosure door is equipped with limit switch, one is on the HV side door, and one is on the LV side door The limit switch is used to show the status of the enclosure door.

Normally the limit switch has one NC and one NO contact, the connection is shown in figure 17.1.2.

These contacts can interlock with the MV switchgear.

Normally, the NC contact is used to show that the enclosure door is closed, which means that the MV switchgear can be switched on.

Normally, the NO contact is used to output a shut down signal. If any door is opened, the contact will close and the MV switchgear will be shut down to protect the operators.

Figure 17.1.1: Limit switch

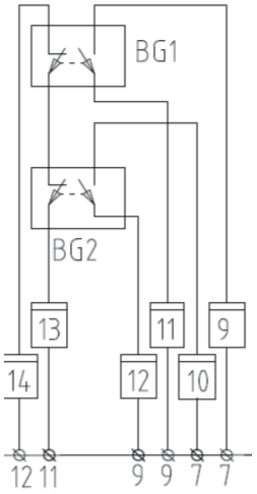


Figure 17.1.2: Circuit diagram

18.0 Appendix

18.1 Complete Method for Sizing Ventilation

$$S = \frac{(P - 2.4 \times \sum(K_i \times S_i) \times T)}{417 \times G \times \sqrt{H} \times T^{1.5}} \quad \text{and} \quad S' = 1.10 \times S$$

where:

S = Lower (air entry) ventilation opening area (m²) (grid surface deducted)

S' = Upper (air exit) ventilation opening area (m²) (grid surface deducted)

P = Total dissipated power [W]

P is the sum of the power dissipated by:
- the transformer (dissipation at 00 load and due to load)
- the LV switchgear
- the MV switchgear

S_i = Area of enclosure surface i [m²]

K_i = Transmission coefficient of surface i (W/m²K)
- K = 7 for steel sheets
- K = 3 for 10 cm and 2.5 for 20 cm of concrete
- K = 0 for the ground (no heat transmission through the ground)

T = Class of enclosure (transformer temperature rise) [K]

G = Grid coefficient
- G = 0.28 to 0.77 for chevron blade louvres (0.38 for90° simple chevrons)
- G < 0.2 for more complex types such as overlapped C beams
- G around 0.6 for punched sheet with rectangular holes

H = Height between ventilation opening mid-points [m]

Note:
This gives smaller ventilation opening areas than the previous method because it takes dissipation through the walls, roof and doors into account.

Example:
Transformer dissipation = 7 970 W
LV switchgear dissipation = 750 W
MV switch gear dissipation = 300 W

The substation area is made up of:
- 14.6 m2 of concrete walls (10 cm thick)
- 7.0 m2 of concrete roof (10 cm thick)
- 6.2 m2 of metallic doors

The enclosure class is 10 K
The ventilation grid is of the chevron louvre type (G = 0.4).
The height between ventilation opening mid-points is 1.5m.

Calculation:
P = 7970 + 750 + 300 = 9020W
∑(Ki x Si) = 14.6 x 3 + 7.0 * 3 + 6.2 x 7 = 108.2 W/K

$$S = \frac{(9020 - 2.4 \times 108.2 \times 10)}{417 \times 0.4 \times \sqrt{1.5} \times 10^{1.5}} = 0.99\text{m}^2 \quad \text{and} \quad S' = 1.10 \times 0.99 = 1.09\text{m}^2$$

Figure 18.1.1: More complete calculation

18.2 BWDK Manual

Disclaimer: Please note that it is not a Schneider Electric product, and we cannot confirm the validity or accuracy of the manual. For further information please refer to the manufacturer's website.

Please read this manual carefully before any operations

WARNING

This instrument is used for controlling power transformer and with a high voltage. The serious injury or even death might happen without strictly following the operations specified by the manual.

Only qualified technicians are allowed to operate the instrument and read this manual carefully before any operations.

1. The input power: 220VAC(±10%), 50Hz(±4%)
2. Make sure all the electrical connections are save and secured
3. Once on power, never contact the naked parts
4. The following terminals with dangerous voltages are 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10
5. The Fan output terminals 3, 4, 5, 8, 9 and 10 (refer to Fig.2) can never be shortcut with common terminals 6 and 7.
6. Disconnect the instrument before high voltage testing the transformer

NOTICE

1. Read the manual carefully before operations
2. The instrument can only be used for the specified purpose by our company. Any parts replacement without the company's permission could lead to the system failure;
3. There should be no SO2 and H2S or other corrosive gases in the working environment to ensure the relay contacts work well;
4. To make sure that the system installation is complete before switch on.
5. The sensors should never be tested with lighter(about 800ºC).
6. Don't apply to the relay's contacts higher voltages or currents than their ratings
7. Put this manual in the place of easy access.

The instrument is a high precision device and it should be handled with care. If there are any problems happened, contact with our company (the service telephone number is on the back cover of this manual) and we will send our service personnel. Thank you for cooperation and using our products. To better our future work, any kindly suggestions and comments are most appreciated.

1. Introduction

The instrument is a new generation of microcomputer controller for the new air-cool dry transformer. The core of it is a microprocessor combined with the most up to date digital storage technology, which makes its performance greatly improved. Compared with the traditional design of temperature controller, our new product is a more compact one with much less components, which greatly enhanced its stabilities. The temperature can be easily set by the keys on the control panel and the parameters will never be lost even after power failure. The instrument has the “black box” function which can record the temperature of the three coils of motor at the moment of power failure. This instrument has had special design both in hardware and software for anti-interference. It also has the good features of operation, installation and maintenance.

- The product meets the standard JB/T7631-2005 which applies to resistance temperature meter
- The product has been manufactured under the IS09002 standard
- The product won the national new key product award in 1997

2. Models & Functions

The Models & their functions of BWDK series Microcomputer controller are given in the table below:

Models	Functions
BWDK-3205	Display the three coils’ temperature circularly, with outputs of Fault, Over Temp. and Power-cut, but without Fan Control Function
BWDK-3205B/C	In addition to the same functions as BWDK-3205, these models have outputs of three 4-20mA analog currents or 1-5V analog voltages to transmit the three analog values of temperatures.
BWDK-3205D/E	In addition to the same functions as BWDK-3205, these models have comm. interfaces RS-232 or RS-485 and they also have three digital outputs to transmit the temperatures and sensors’ states.
BWDK-3207	Display the three coils’ temperature circularly, with outputs of Fault, Over Temp. and Power-cut. It has the fan control functions for 1-6 fans and alarm function for any one of the three power lines failure.
BWDK-3208B/C	In addition to the same functions as BWDK-3207, these models have outputs of three 4-20mA analog currents or 1-5V analog voltages to transmit the three analog values of temperatures
BWDK-3208D/E	In addition to the same functions as BWDK-3207, these models have comm. interfaces RS-232 or RS-485 and they also have three digital outputs to transmit the temperatures and sensors’ states.
BWDK-4207	In addition to the same functions as BWDK-3207, this model has Temp. Display for iron core (Phase D)
BWDK-4208B/C	In addition to the same functions as BWDK-4207, these models have outputs of three 4-20mA analog currents or 1-5V analog voltages to transmit the three analog values of temperatures.
BWDK-4208D/E	In addition to the same functions as BWDK-4207, these models have comm. interfaces RS-232 or RS-485 and they also have three digital outputs to transmit the temperatures and sensors’ states.

3. Specifications

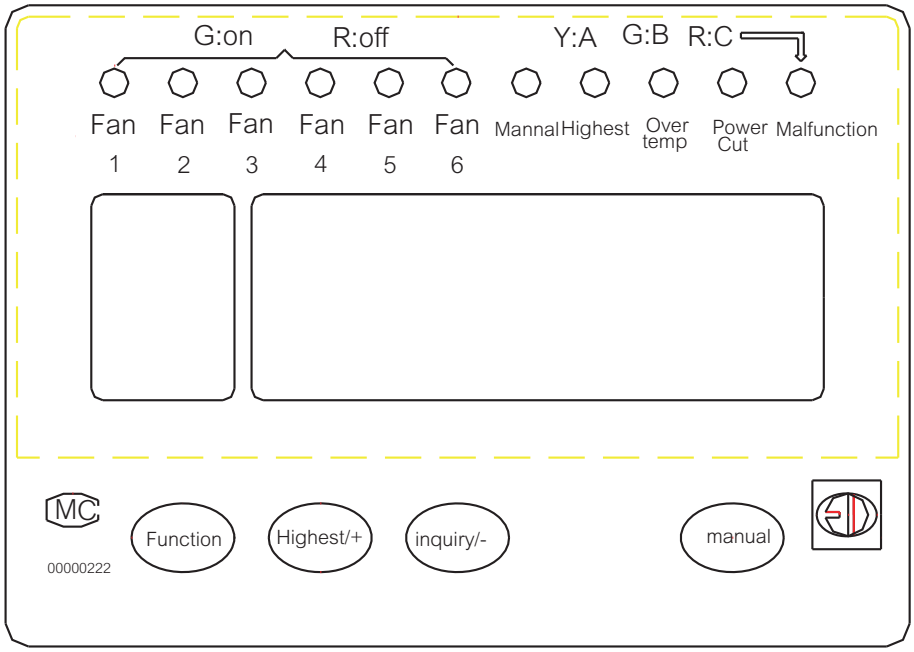
1.	Temp. range:	0ºC-200ºC
2.	Measuring Precision	0.5%FS ±one bit.
3.	Steps	0.1ºC
4.	Power	AC176V- AC242V (50 Hz)
5.	Energy Consumption	5 VA
6.	Contacts Capacity	10A/220VAC
7.	Sensors	3 Pt100 resistors & 3 PTC resistors(optional)
8.	Relay Capacity	10A/250VAC
9.	Weight	Less than 3Kg
10.	Dimension	260×200×80mm

4. Function Descriptions

1. Three coils circular temp. display and the shifting display of the highest temp.(The additional temp. display for models 4207 and 4208)
2. According to the preset temp. to control fan's switch so that to ensure dry transformer works well in normal temp. When any one of the three coil's temp. is over preset value, or under the operator's intervention, the cooling fan will work and the "fan" LED on the panel will be on.
    - 2.1. The transformer can be connected with 0-6 fans. When fans are on, the "fan" LED on the panel will become "Green"; and when fans are malfunctioned the "fan" LED on the panel will become "Red" and the alarming buzz will be on. If the number of connected fans is less than 6, the LEDs for the unconnected fans will not be on
3. Over temp. Alarm function. When one coil's temp. is exceeded, it will output an alarm signal and the Over Temp. LED on the control panel will be on. At the same time, rear panel output terminals (16, 16) will send a signal to the remote control unit to activate alarming signals.
4. Auto-Power-Cut function. When the highest coil temp. has increased the preset limit for 6 seconds, it will send an alarm signal, the Cut Power LED on the panel will be on. At the same time, rear panel output terminals (17, 17) will send signals to cut off the power in order to protect the transformer.
    - 4.1. If the PTC sensor has been used, the Auto-Power-Cut output terminals will not activate unless both kinds of sensors, the PT100 and PTC, have detected the coils' temperature meets the preset limit, thus increasing the reliability of Power-Cut function.
5. The fault LED and alarm beep will be on if any one of the three sensors has malfunctioned. Fault signals will be sent out from the rear panel terminals (15, 15).
    - 5.1. The colours of LEDs represent the related faults: Yellow=Line A, Green=Line B and Red=Line C. When all sensors work fine, no LED will be on.
    - 5.2. The display of different codes has been used to present the working states of sensors. H means the sensor has been disconnected and L means short cut.
    - 5.3. If one or two sensors don't work, the fan will be only controlled by the working one. If all of the three sensors go wrong, the fans will be on immediately.

6. The fan on & off temp., over temp. alarm, power cut temp., timer of fan on & off, the communication address and the connected fans can all be set by panel keys. The preset data will never be lost even after power is cut off.
7. The fan can be on & off through human intervention. This function can also be used to test the fans.
8. There is a timer to control the fan on and off, which can be set through panel keys. The range of timer is from 0 to 255 hours (if 0 is set, this function is cancelled). When the preset time is up, the fans will be on for one minute and then stop. The default value of the timer is 24 hours.
9. The instrument is equipped with a “black box” which keeps the temp. of power off in memory for future inquiry. The recorded data will not be changed if the power off temp. is below 80ºC.

5. Operation Descriptions (figure1. the front panel diagram)



1. The initial power on: When the instrument is turned on, it is in the state of circular display of the three coils A, B, C’s temperatures. (an additional display of D temperature of iron core for model 4207 and 4208)
2. The shift between circular temperature displays and highest temperature displays: There is a panel key “highest/+”. The “highest” LED will be on by pressing the key and it will display the highest temperature among the three coils. Press the key again, it will return to the original state of circular temp. display. Another press of the key will again display the highest temperature, and so on.
3. Manual control Fan: There is a panel key “fan” to switch on/off the fans manually. In the state of circular display, push this key will turn on the fans and at the same time the related LEDs will be on. Push the key again will cancel the previous operation and the system will return to the original state of circular display.

4. Inquiry Coil Temper when power cut off : There is a panel key “demand/-”. To press it continuously in the state of circular temp. display will in turn display the temperatures of coil A, B, and C at the last power cut off (Note: The recorded data will not be changed if the power off temp. is below 80ºC).

5. The inquiry of control parameters

   5.1. Press “function”, the display of first bit is “1”, the rest of bits to the right are fan-off temperature. The default value is 80 ºC.

   5.2. Press “function” again, the display of first bit is “2”, the rest of bits to the right are fan-on temperature. The default value is 100 ºC.

   5.3. Press “function” again, the display of first bit is “3”, the rest of bits to the right are over temp alarm temperature. alarm temp. The default value is 130 ºC.

   5.4. Press “function” again, the display of first bit is “4”, the rest of bits to the right are power-cut temperature. The default value is 150 ºC.

   5.5. Press “function” again, the display of first bit is “5”, the rest of bits to the right are the Iron over temperature alarm. The default value is 140 ºC.

   5.6. Press “function” again, the display is H=024, H means the fan on timer. When the preset time is up, the fans will be on for one minute and then stop. The default value of the timer is 24 hours.

   5.7. Press “function” again, the display is P=001, P is the communication address. The default value is 001.

   5.8. Press “function” again, the display is F=006, F is the number of fans in the system. The default value is 006.

   5.9. Press “function” again and the system will return to the state of circular temperature display.

6. The modification of control parameters

   6.1. Press “function”, the display 1=080 which means the default fan-off temperature is 80 ºC.
   Press “fan” three times, the first digit of LED will flash. Use “+” or “-“ key can set the fan-off temperature from 0-185 ºC.

   6.2. Press “function” again, the display 2.=100 which means the default fan-on temperature is 100 ºC. Use “+” or “-“ key can set the fan-on temperature from 5-190 ºC.

   6.3. Press “function” again, the display 3.=130 which means the default over temp alarm temperature is 130 ºC. Use “+” or “-“ key can set the alarm temperature from 10-195 ºC.

   6.4. Press “function” again, the display 4.=150 which means the default power-cut temperature is 150 ºC. Use “+” or “-“ key can set the power-cut temperature from 15-200ºC.(Note: If the PTC sensor has been used power-cut temperature must be set above 130ºC, then rear panel output terminals can send signals to cut off the power.)

   6.5. Press “function” again, the display H.=024 which means the fans will be on every 24 hours. Use “+” or “-“ key can set the value from 0-255 (0 will cancel the timer function).

   6.6. Press “function” again, the display P.=001 which means the communication code. Use “+” or “-“ key can set the value from 0-255.

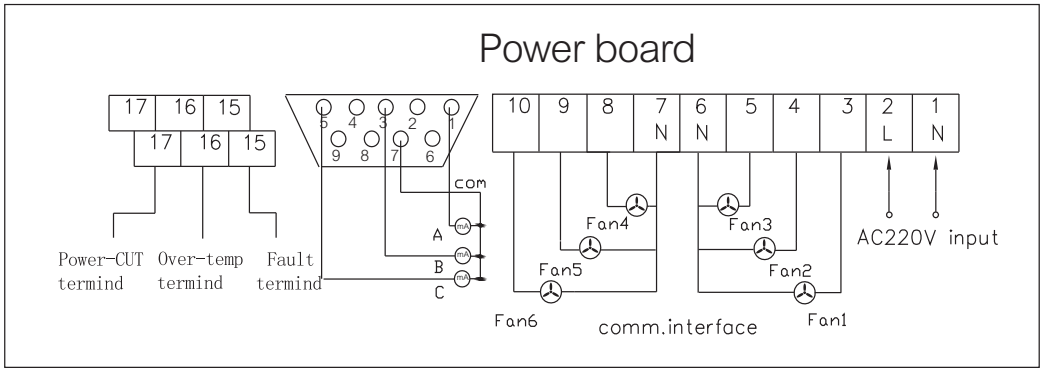
6.7. Press “function” again, the display F.=006 which means the number of fans in the system. Use “+” or “-“ key can set the value from 0-6 (0 is no fan connected in the system).

6.8. Press “function” again, the system will return to the state of circular temperature display.
NOTE: The system automatically ensures that the Power-cut temperature.>Over temp. alarm temperature >fan on temperature >fan off temperature, and the minimum step is 5ºC.

7. The description for BWDK-3208B/C

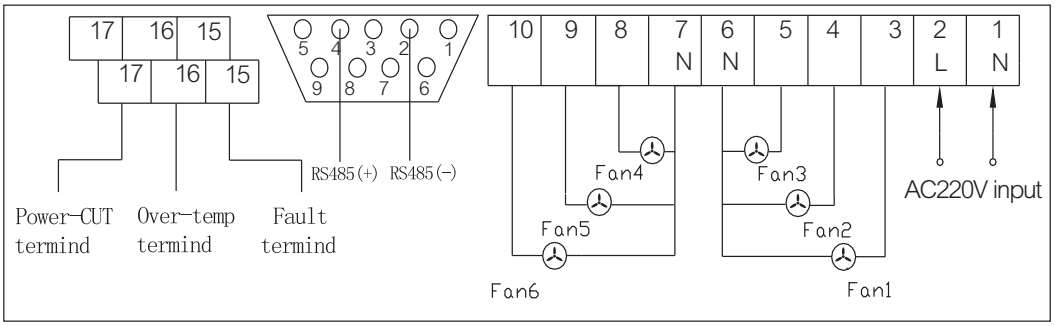
7.1. The model BWDK-3280B has three current outputs of 4-20mA.The 4-20mA signals are from 9-pin socket 7(Common), 1(Line A), 3(Line B) and 5(Line C) in the power board. The relation between current and temperature is 4-20mA to 0-200 ºC with 1 ºC to 0.08mA.

7.2. The model BWDK-3208C has three voltage outputs of 1-5V which have been



produced from the above model’s current outputs by connecting 250 ohm resistors in series. The relation between voltage and temperature is 1 ºC to 0.02V. The electrical connections can be found from the figure below:

8. The model BWDK-3208D/E



These models have communication interfaces RS232/RS485. The RS485 signals are from 9-pin socket 2(-) and 4(+) in the power board. The CD and communication protocol are provided.

6. Electrical Installation Description

1. **Sensor Connection**
   The sensor heads PT100 or PTC (optional) are put inside the transformer coils and the measured signals are transmitted into the instrument by 15 pin socket.

2. **Fan Connections**
   0-6 fans can be used in the system according to the real application. Output terminals 3-6 are used for one fan connection. Terminals 3, 4-6 are used for two fans. If three fans are needed, using terminals 3, 4, 5-6. When four fans are required, the terminals are 3, 4, 5-6 and 7-8. Terminals 3, 4, 5-6 and 8, 9-7 are used for five fans. If all six fans are installed, the connection terminals are 3, 4, 5-6 and 8, 9, 10-7.
   Note: if the fans were connected wrongly, the LEDs' indication will not be correct, and the alarming signals will be activated.

3. **The output connections for Power-cut, Over-Temp. and Fault**
   As shown in figure 2, terminals (15, 15), (16, 16) and (17, 17) inside the instrument are connected to the three relay contacts which are normally in open states. The outside connection of terminals (17, 17) is to the power source through a power-cut relay coil. The outside connection of terminals (16, 16) is to the power source through an alarming circuit. And the connection of terminals (15, 15) is to the power source through a fault indicator. When abnormal situation happens, the accordant relay contacts will be close to send the Power-cut, Over-temp Alarm, or Fault signals.

4. **The main power source**
   Terminals 1, 2 are used for the connection of main power source AC220V from power line.

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