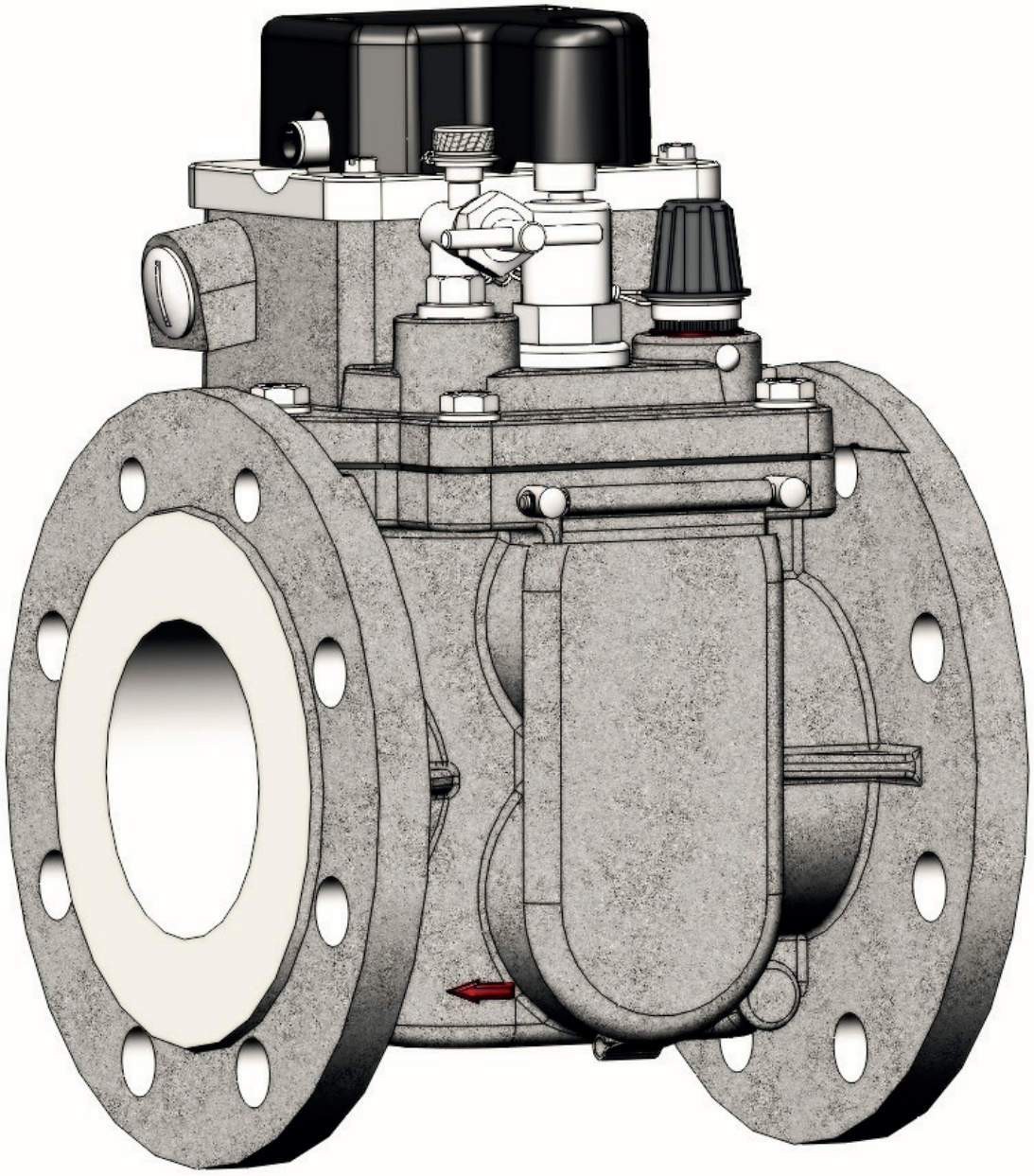
Elektromotoren und
Gerätebau Barleben GmbH



OPERATING INSTRUCTIONS
Transformer Protection Relay
NM Series (Buchholz principle)

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1 Safety instructions

Make sure that any persons installing, taking into operation and operating the Buchholz relay:

- are qualified and competent and
- fully comply with these operating instructions.

Improper operation or misuse might cause danger to

- life and limb,
- the relay and other property of the operator and
- the relay's proper function.

Opening of the device will void your warranty.

Safety instructions in this manual are presented in three different forms to emphasize important information:

NOTE

This symbol refers to important information on a specific subject.

CAUTION

This symbol indicates particular risks for the device or any other property of the operator. Danger to life and limb cannot be excluded.

WARNING

This symbol indicates serious danger to life and limb. Disregarding the warning can lead to serious or even fatal injury.

2 Installation

2.1 Installation in piping

The Buchholz relay (Figure 1/Number 1) is installed in the pipe (Fig. 1/ N° 2) between the tank (Fig. 1/ N° 3) of the device to be protected (transformer, reactor) and the conservator (Fig. 1/ N° 4). Make sure that the pipe and the Buchholz relay have the same nominal diameters.

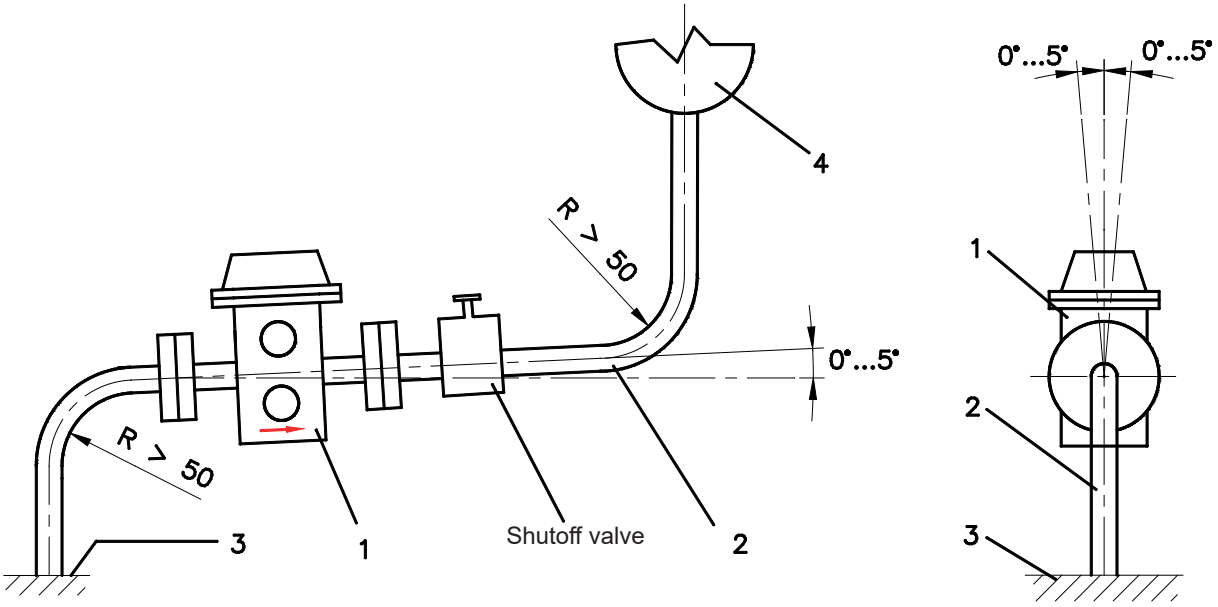


Figure 1 - Installation in piping

Make sure that

- gases produced in the insulating liquid can flow unimpeded to the Buchholz relay.
- the red arrow on the Buchholz relay points to the conservator.
- the flanges are stressed evenly when tightening the screws.
- the slope of the pipe to the conservator is between 0° and 5°.
- the position of the Buchholz relay in relation to the direction of flow does not deviate from the perpendicular by more than 5°.
- the pipe has no elbows, and bends are designed preferably with an inside pipe radius R > 50 mm.
- the free pipe length between the Buchholz relay and the nearest reference point does not exceed the following values:

Pipe diameter DN (mm)	25	50	80
Distance (m)	0.5	0.7	1.0

Should the distance exceed the above values, a support has to be provided in the immediate vicinity of the Buchholz relay.

CAUTION

- **Make sure during installation that no dirt, moisture or foreign matter get into the relay.**
- **The insulating liquid of the transformer/reactor may not contain conductive materials!**

2.2 Filling and bleeding of the Buchholz relay

Once the device to be protected is ready for operation and the conservator has been filled with insulating liquid, bleed the Buchholz relay completely.

Proceed as follows:

- Remove the small cap nut (Fig. 2/ N° 1) from the bleeding valve (Fig. 2/ N° 2)
- Open the bleeding valve (turn anticlockwise) and let the air escape from the Buchholz relay
- Close the bleeding valve as soon as insulating liquid comes out (clockwise rotation)
- Fit and tighten the small cap nut on the bleeding valve

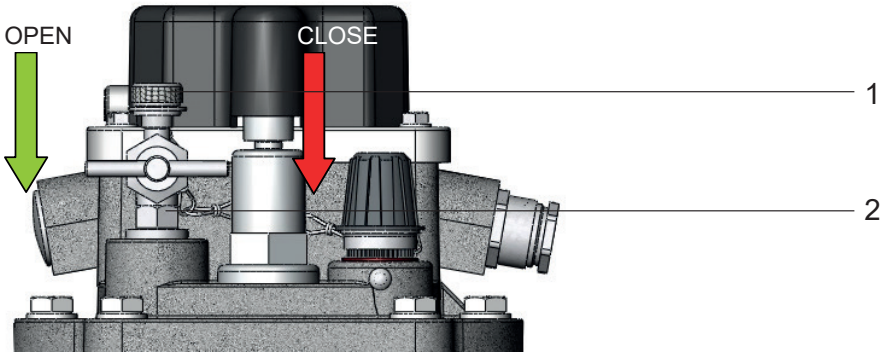


Figure 2 - Bleeding valve

2.3 Removal of transport lock

Proceed as follows:

- Remove the large cap nut (Fig. 3/ N° 1)
- Take the transport lock (Fig. 3/ N° 2) out of the large cap nut
- Fit and tighten the large cap nut **without** the transport lock

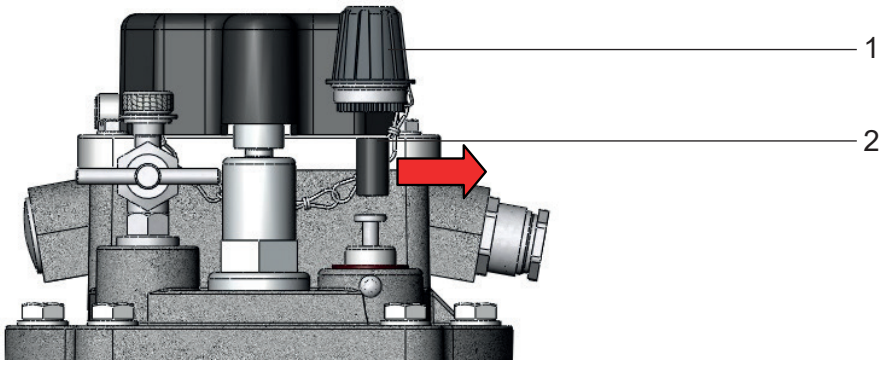


Figure 3 - Removal of transport lock

CAUTION

- **Remove the transport lock before taking the Buchholz relay into operation.**
- **If the Buchholz has to be transported again, reinstall the transport lock!**

2.4 Connection of signal lead

2.4.1 Upper and lower switching system

Multicore signal leads can be fitted in the Buchholz relay through cable glands. A conductor cross section of 1.5 mm^2 (copper) is recommended. The maximum cross section that can be clamped is 4.0 mm^2.

Proceed as follows:

- Remove 2 screws M5 (Fig. 4/ N° 1)
- Remove the dust hood (Fig. 4/ N° 2)
- Disconnect the sensor (Fig. 5/ N° 1) from the amplifier unit (Fig. 5/ N° 2) by pulling out the M8 line protection plug (LS plug) (Fig. 5/ N° 3).

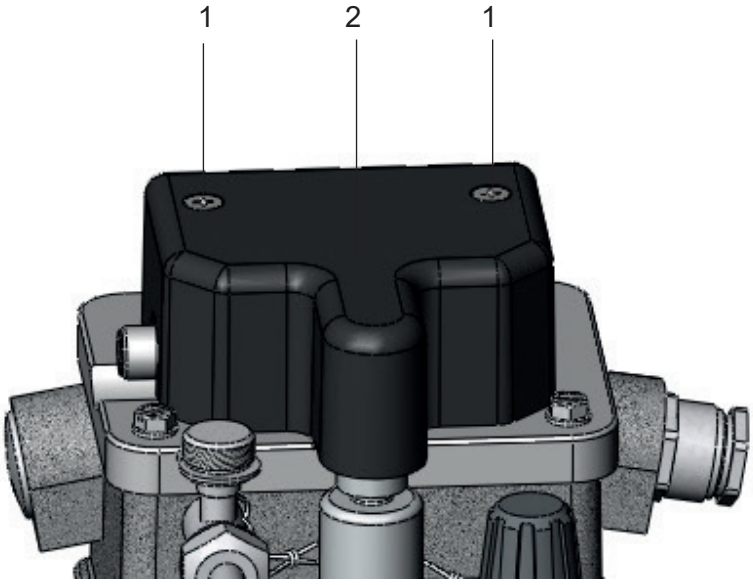


Figure 4 - Cover with dust hood

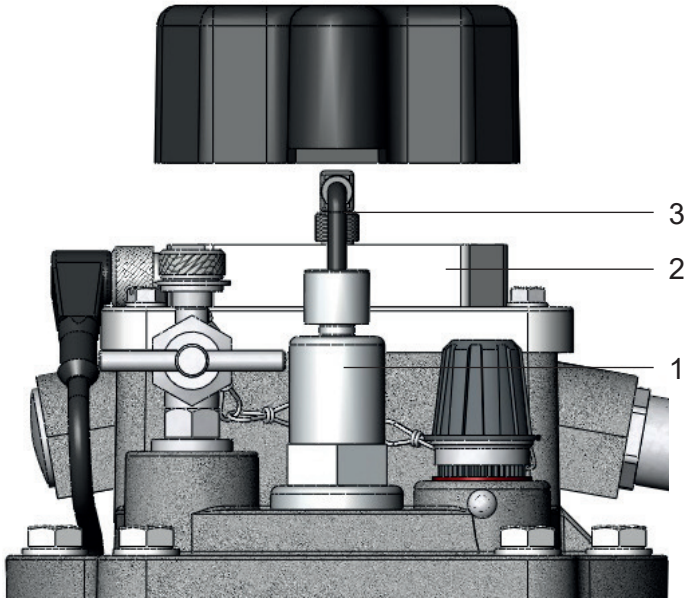


Figure 5 - Cover with dust hood removed

CAUTION

To release the LS plug hold them (Fig. 5/ N° 3) by the serrated handpiece and pull out without twisting. The plug may be damaged when twisting it.

- Remove 4 screws M5 (Fig. 6 & 7/ N° 4)
- Remove the cap (Fig. 6 & 7/ N° 5)
- Insert the lead through the cable gland (Fig. 6 & 7/ N° 6)
- Connect the lead to the terminal studs (Fig. 6 & 7/ N° 7):
  - Maximum torque 3 Nm for terminal studs with up to 8 bushings (Fig. 6)
  - Maximum torque 1.5 Nm for terminal studs with more than 8 bushings (Fig. 7)

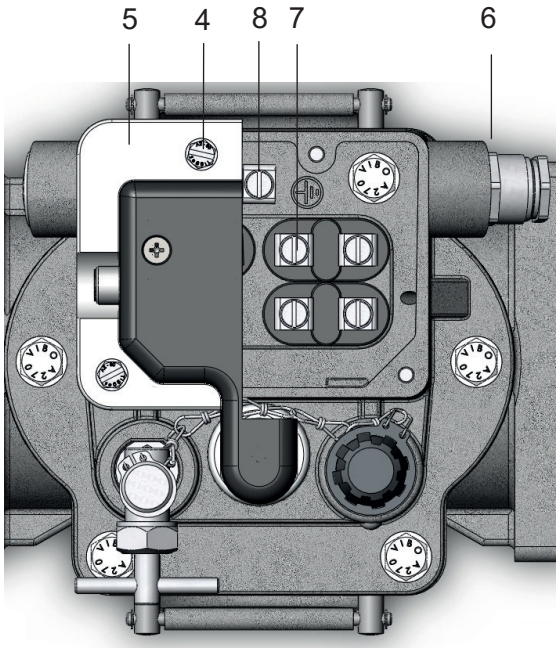


Figure 6 - Electrical connection for up to 8 bushings

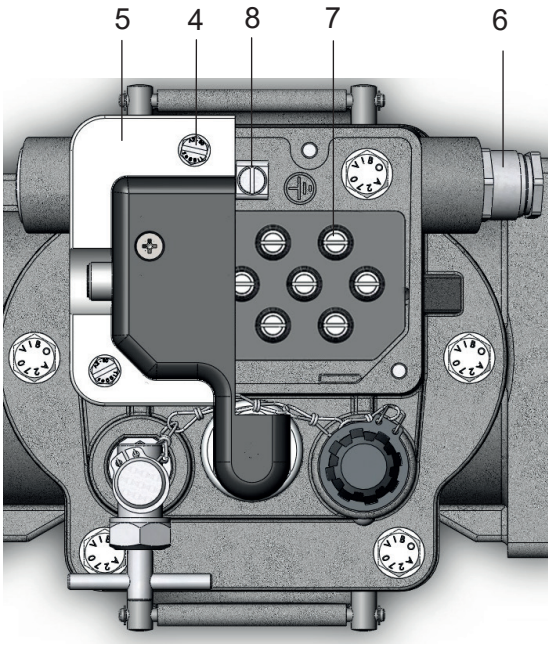


Figure 7 - Electrical connection for more than 8 bushings

Connected load of the switching systems:

Voltage:	AC 5 V - max. 250 V DC 5 V - max. 250 V	
Current:	AC 0.01 A - max. 6 A DC 0.01 A - max. 6 A	cos φ > 0,5 L/R < 40 ms
Switching capacity:	AC max. 1500 VA DC max. 1250 W	

NOTE

The inner side of the cap accommodates a plate with the graphic symbol and the connection diagram. The schemes show the switching systems in their neutral position. The neutral position is the operating condition when the Buchholz relay is filled with insulating liquid up the required level and the device to be protected operates without any fault.

WARNING

Connect the protective conductor (green-yellow insulation) to the earth terminal (Fig. 6 & 7/ N° 8) (maximum torque 3 Nm)

- Tighten the cable gland
- Fit the cap
- Tighten 4 screws M5 (maximum torque 3 Nm)
- Connect the sensor to the amplifier by fitting the LS-plug
- Fit the dust hood
- Tighten 2 screws M5

2.4.2 Functional test of the analogue monitoring unit

The sensor (Fig. 8/ N° 1) is installed in the cover of the Buchholz relay. The cap of the terminal box accommodates the electronic amplifier and evaluation unit (Fig. 8/ N° 2). In as-delivered state both parts are connected by the cable (Fig. 8/ N° 3) and the LS plug (Fig. 8/ N° 4). Operating voltage supply (DC 24 V) as well as signal transmission are through the amplifier output (Fig. 8/ N° 5).

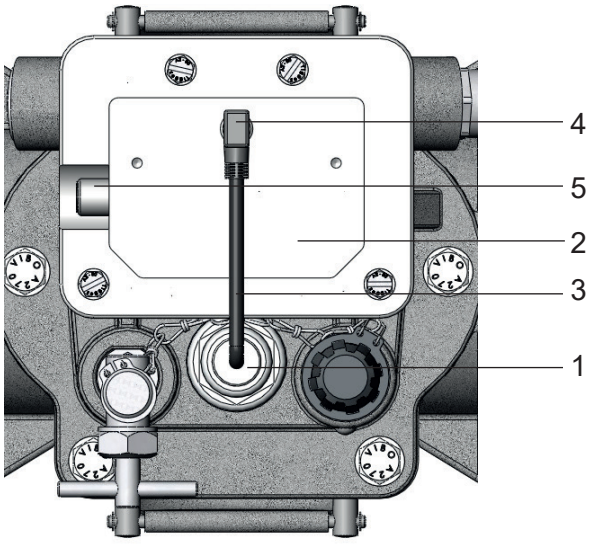


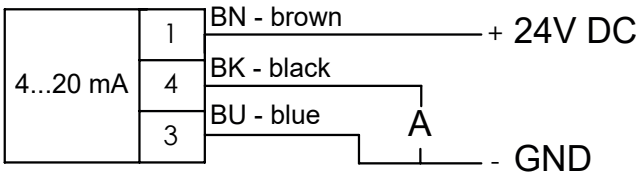
Figure 8 - Cap of the terminal box

Proceed as follows:

- Insert the four-core cable with integral M12 angle socket into the M12 plug connector of the amplifier output (Fig. 8/ N° 5).
  (It is recommended to use the four-core cable with integrated M12 angle socket of IP 67 degree of protection that is supplied together with the equipment!).
- Adapt the length of the four-core cable and connect the cable as specified
  (e.g. transformer control box, bus systems, separate power supply).

CAUTION

Before performing a dielectric strength test on the Buchholz relay disconnect the sensor from the amplifier and the amplifier from the voltage supply!



cable conductor	Colour	Description
1	BN - brown	DC 24 V +
2	WH - white	not used
3	BU - blue	DC 24 V - 4 - 20 mA signal
4	BK - black	

M12 plug connector for voltage and output

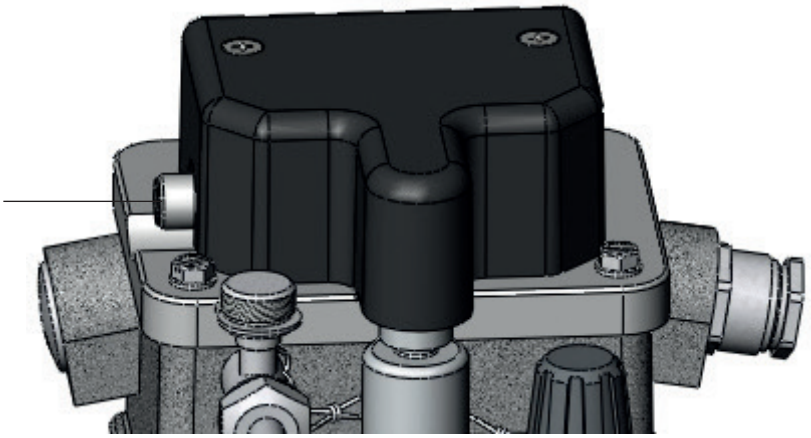


Figure 9 - Analogue monitoring unit

Connected load of analogue monitoring unit:

Voltage:	DC 24 V
Load current:	max. 50 mA

3 Functional test

The test can be performed with the help of a test key (mechanically) or a special test pump (pneumatically). Perform the test while the Buchholz relay is filled with insulating liquid up to the required level.

3.1 Functional test of the upper and lower switching systems

3.1.1 Testing by means of test key

Proceed as follows:

- Remove the large cap nut (Fig. 10/ N° 1)
- Press the test key (Fig. 10/ N° 2) half down and keep depressed (check of upper switching system - alarm)
- Obtain verification of correct function from the control room
- Press the test key down to stop position and keep depressed (check of lower switching system - disconnection)
- Obtain verification of correct function from the control room
- Release the test key
- Fit and tighten the large cap nut

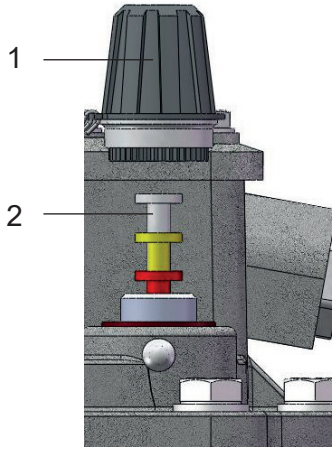


Figure 10 - Test key

3.1.2 Testing by means of test pump

Proceed as follows:

- Remove the small cap nut (Fig. 11/ N° 1) from the bleeding valve (Fig. 11/ N° 2)
- Fit the adapter (Fig. 11/ N° 3) of the hose (Fig. 11/ N°4) providing the connection to the test pump on the valve nozzle (Fig. 11/ N° 5)
- Open the bleeding valve (turn anticlockwise)
- Pump air into the Buchholz relay until falling of the **upper** float causes the magnet contact tube to operate
- Obtain verification of correct function from the control room
- Close the bleeding valve (turn clockwise)
- Remove the adapter from the valve nozzle
- Open the bleeding valve and let the air escape
- Close the bleeding valve as soon as insulating liquid comes out
- Fit and tighten the small cap nut on the bleeding valve

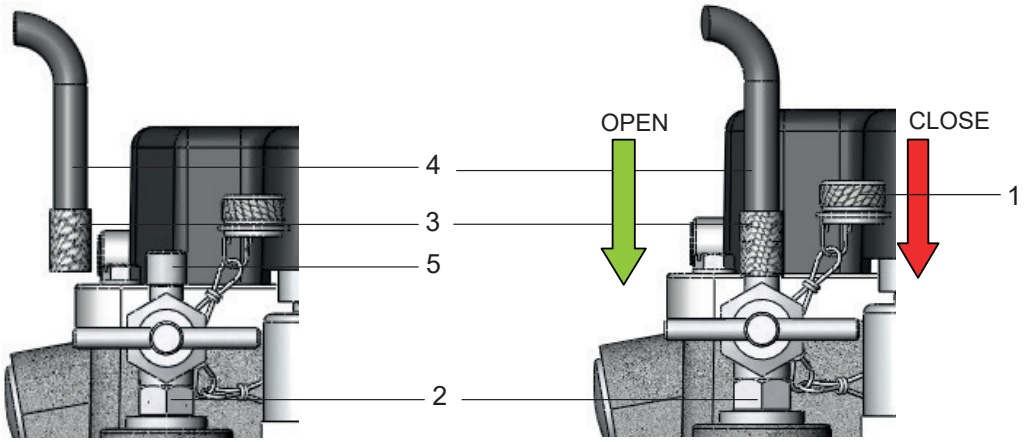


Figure 11 - Testing by means of test pump

NOTE

When the test is performed on the double-float Buchholz relay with the help of a test pump, for design reasons, only the upper switching system (alarm) is tested. Use only test pumps with suitable adapter (globe valve) supplied by EMB (ZG 5.1 or ZG 5.2).

3.2 Functional test of the analogue monitoring unit

The monitoring unit is checked for correct function by changing the insulating liquid level in the Buchholz relay and hence the output signal. The insulating liquid level in the Buchholz relay can be changed by pumping air in.

Proceed as follows (please, see figure 11):

- Remove the small cap nut (Fig. 11/ N° 1) from the bleeding valve (Fig. 11/ N° 2)
- Fit the adapter (Fig. 11/ N° 3) of the hose (Fig. 11/ N° 4) providing the connection to the test pump on the valve nozzle (Fig. 11/ N° 5)
- Open the bleeding valve (turn anticlockwise)
- Pump air into the Buchholz relay
- **The output signal of the monitoring unit becomes larger with increasing air volume and finally remains constant at max. 20 mA.**
- Close the bleeding valve (turn clockwise).
- Remove the adapter from the valve nozzle
- Open the bleeding valve and let the air escape
- **The output signal of the monitoring unit becomes smaller and finally remains constant.**
- Close the bleeding valve as soon as insulating liquid comes out
- Fit and tighten the small cap nut on the bleeding valve

NOTE

0 mA means error in the monitoring unit!

NOTE

Use only test pumps with suitable adapter (globe valve) supplied by EMB (ZG 5.1 or ZG 5.2).

4 Operation instructions in the case of gas accumulation

NOTE

According to IEC 60599:2015 as well as to DIN EN 60599:2016, after a Buchholz alarm, the gas must be taken out and analyzed as quick as possible.

After the gas warning has been triggered, a gas sample should be taken immediately:
In the Buchholz relay, the gas is in contact with the oil. The various failure gases will be absorbed by the oil at different speeds. As a result, the composition of the Buchholz gas changes and the typical failure gas patterns may no longer be detected.

For safe and contamination-free removal and transport of the gas, the Buchholz Gas Sampler BGS by EMB is recommended. With this, the accumulated gas can be removed on both the Buchholz relay and the additional device ZG 1.2., which is mounted on the device to be protected at man height and is connected via a pipe to the Buchholz relay.

After sampling the gas, the Buchholz relay must be bleeded.

An immediate on site analysis of the gas can be done by Buchholz Gas Tester (BGT):
The result can be included in the decision making on how to proceed with the transformer without further delays, to determine the cause of the failure and prevent a possible increase of a damage.

By Buchholz gas analysis can be distinguished if:
- the event is actually due to a fault in the transformer or
- due to accumulation of air.

Any kind of fault in the oil causes the formation of hydrogen. For the decision „Failure gas or air“ the measurement of the hydrogen concentration is sufficient (BGT 4.1).

With BGT 4.2, up to four other relevant failure gases can be measured directly on site in addition to hydrogen.

Therefore the following failure causes can be distinguished:

Cause of failure	Gases evolved (key gases))	Fault gas pattern Measurement by BGT 4.2				
		H_2	CO_2	CO	CH_4+	C_2H_2
Discharges of high energy (e.g. arcs, break downs, short circuits)	C_2H_2, H_2	**X**	-	-	-	**X**
Discharges of low energy (e.g. partial disch., sparking disch., corona discharges)	H_2, CH_4	**X**	-	-	**X**	-
Thermal faults	C_2H_4, CH_4, H_2, C_2H_6	**X**	-	-	**X**	-
Involvement of the solid (cellulosic) insulation	CO, also: CO_2	-	**(X)**	**X**	-	-
Air bubbles	none	-	-	-	-	-

It is generally difficult to distinguish between faults caused by discharges of low energy and thermal faults on the knowledge of the Buchholz gas composition only. Both faults cause the formation of the less soluble gases hydrogen and methane. On the other hand the very soluble key gases for thermal faults ethylene and ethane may not reach the gas collecting relay.
Also in Buchholz gases caused by air accumulation can be low fault gas concentrations.
These fault gases evaporated out of the oil into the gas bubbles during the bubble rise to the collecting relay.
In oil transformers do not exist faults which affect the solid insulation only.
However, the Buchholz gas analysis by BGT 4.2 allows a qualified first assessment of the cause and severity of the faults.

5 Maintenance

Buchholz relays are insensitive to ambient conditions, provided these conditions were considered when selecting the particular design of the Buchholz relay. Therefore, no special maintenance is required during operation.

Buchholz relays should be inspected and tested at specified intervals as described in the maintenance instructions of the plant operator. Make sure that the functional tests described are performed.

Unless otherwise specified by the operator, EMB recommends operating the test key once a year in the framework of the scheduled maintenance operations.

CAUTION

When removing the relay, make sure that there is no insulating liquid in the device. On customers request EMB GmbH will ensure proper disposal of old relays.

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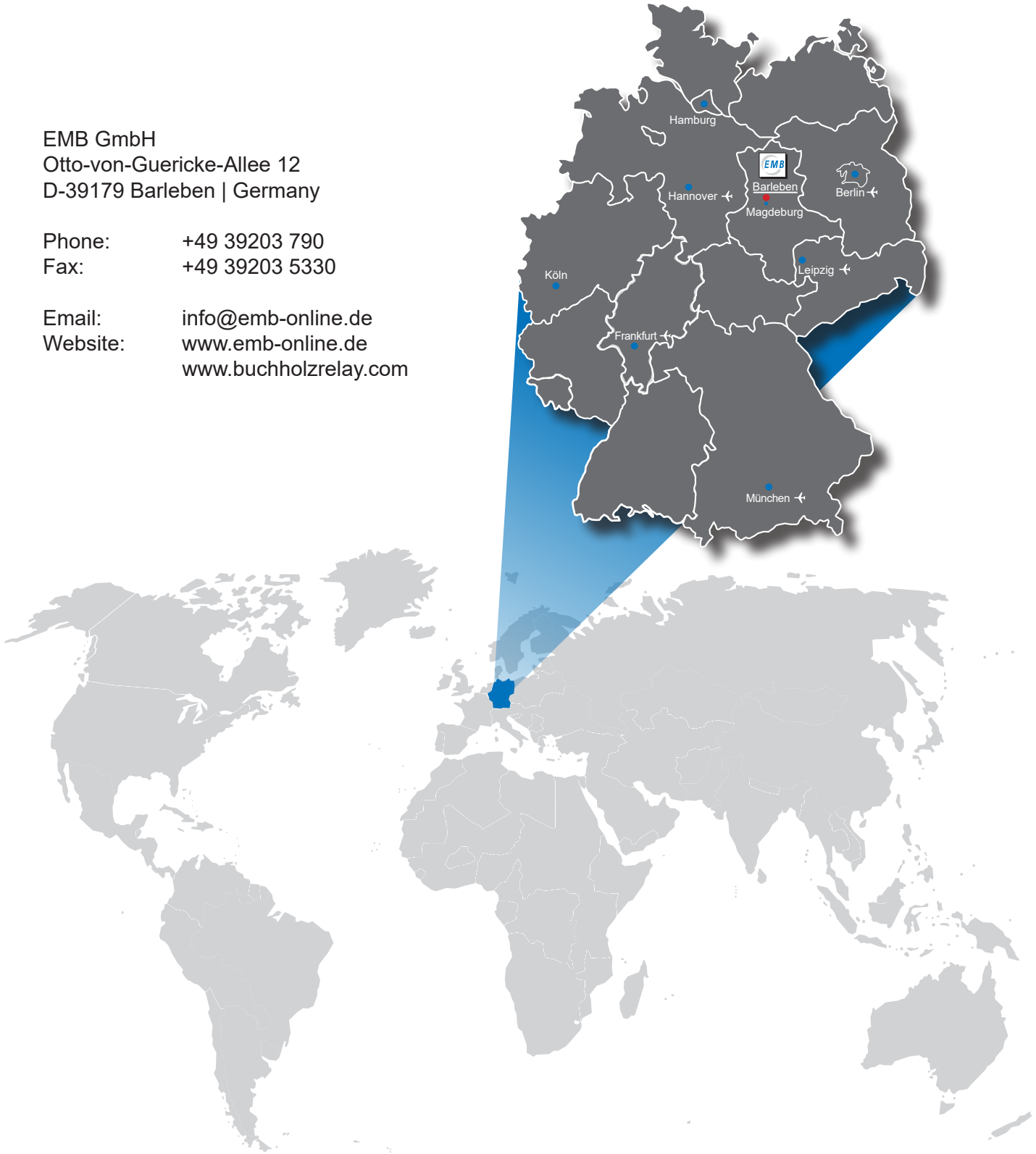

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