



ENERGOTEST

CONNECTION INTERLOCKING RELAY

type PB

Operating Manual



Gliwice, January 2007.

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1 MEANING OF OPERATING MANUAL

In case of doubts regarding to appropriate interpretation of manual content, please necessarily refer it to the manufacturer for explanations.

We will be strongly grateful to users for any suggestions, opinions and critical remarks. Please, pass it on to us verbally or in writing. It may help us to make a manual easier in use and to take into consideration users' requests and requirements.

Device, which the manual has been added on, includes impossible to eliminate, potential hazard for persons and material values. That's why every person, working at this device or performing any activities connected with operating and service of device, has to be previously trained and has to know potential hazard.

It requires careful reading, understanding and obeying of operating manual, particularly hints concerning safety.

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3 DECLARATION OF CONFORMITY

Device being the subject of this instruction was constructed and prepared and it is manufactured for the purpose of use in industrial environment.

At device constructing and manufacturing were complied with such norms which fulfilling is being ensure the realization of specific rules and precautions, provided that the user obeys the given guidelines of device installing and starting as well as its operation leading.

This device is compliance with EU directive resolutions:

- low voltage 73/23/EWG – Decree of Economy, Labour and Society Minister dated 12.03.2003 (Act Register no. 49 item 414) and
- electromagnetic compatibility 89/336/EWG – Decree of Infrastructure Minister dated 02.04.2003 (Act Register no. 90 item 848).

Conformity to directives was confirmed by tests performed in laboratory of Energotest as well as in independent from manufacturer measurement and research laboratories and develops centers in accordance with requirements of following standards:

Polish Standard consistent with directive 73/23/EWG

PN-EN 61010-1:2004 Safety requirements concerning the electric measurement apparatus, the automation and the laboratory devices. Part 1: General requirements.

Polish Standard consistent with directive 89/336/EWG

PN-EN 61000-6-2:2003 Electromagnetic compatibility (EMC) – Part 6-2: General Standards – Resistance in industrial environments.

PN-EN 61000-6-4:2002(U) Electromagnetic compatibility (EMC) – Part 6-4: General Standards – Requirements concerning the emission in industrial environment.

4 Application of unit

Relay of connection interlocking PB cooperates with reactive or resistive insulators. It can be used in any interior middle voltage switchgears to find out voltage appearance. The relay is adapted to cooperate with a coil, that interlocks closing the earthing switch, to prevent its from closing in case of voltage appearance on its contacts. Relay is equipped with internal LED voltage indicator.

Relay of connection interlocking PB equipped with additional executive module of supply switching-over automation cooperates with unit type APZmini. A set consist of a unit APZmini and suitable number of PB relays makes possible the realization of supply switching-over automation on the basis of signals concerning voltage appearance on supplying lines come from reactive or resistive insulators. A number of used PB relays is equal a number of supplying lines, between switchings are made.

5 Safety rules

Information included in this chapter is dedicated to teach the user the right installation, operating and service of unit. It is assumed that installing, activating and operating personnel of that device has got the proper qualifications and is aware of potential danger connected with working at electric devices.

The device fulfils all requirements of obligatory rules and standards in scope of safety. Its construction is particularly prepared because of user's security.

Installation of device



The installing of connection interlocking relay should be realized at lack of voltage on insulators. The device should be installed in place ensuring the right environmental conditions specified in technical data. It is not allowed to use high voltage indicators to cooperate with measurement insulators which have output currents more than 500 μA (point 5.4.5 of PN-EN 61958:2002 "The sets of prefabricated high voltage switchgears. Voltage presence indicators").

Unit should be properly fixed using enclosed fixing elements as well as protected from mechanical damage and from accidental access of unauthorized persons. Cross-sections and types of connection wires should be consistent with the guidelines given in following instruction.

An enclosure of relay is made of plastic and there's no need to be earthed.

Start up of device

During starting up of device there's needed to adjust its sensitivity to parameters of used reactive and resistive insulators as well as to rated voltage of power network. Selection method of the relay sensitivity is described in item 8.

Operating of device



The unit should operate in environmental conditions specified in technical data. Personnel operating the device should be authorized and acquainted with operating manual.

Removing the enclosure



Before starting of any activities connected with the necessity of removing the enclosure of unit there's definitely need to switch off all measurement voltages, switching off the voltage on insulator and disconnecting all plugs. Dangerous voltages may be still present on device elements for about 1 minute from the moment of disconnecting.

Applied components are very sensitive for electrostatic discharges, that's why opening the device without special anti-electrostatic equipment may cause its damage.

Maintenance

After installing the device does not require any additional service, except periodical check-up required by applicable regulations. In case of detection of any fault refer it to the manufacturer.

The manufacturer offers services in scope of activating, commissioning, warranty and post-warranty service. Warranty conditions are described in guarantee card.

All additional information concerning the maintenance is included in item 9.

Modifications and changes

Because of safety all modifications and changes of device function, which concerning this manual are not allowed. Modifications of device which were not certified in written document by manufacturer, cause loss of any claims by way of legal responsibility versus Energotest.



Replacement of any elements or components the device is consist of, coming from other manufacturers than originally applied, may cause danger for user and device malfunction.

Energotest does not take responsibility for damage caused by applying inappropriate elements or components.

Data plates, informing plates and labels

There's definitely need to obey the hints located on device as descriptions or informing plates and labels as well as it is necessary to keep them in good condition ensuring right legibility. Plates and labels, which become damaged or illegible, should be replaced with new ones.

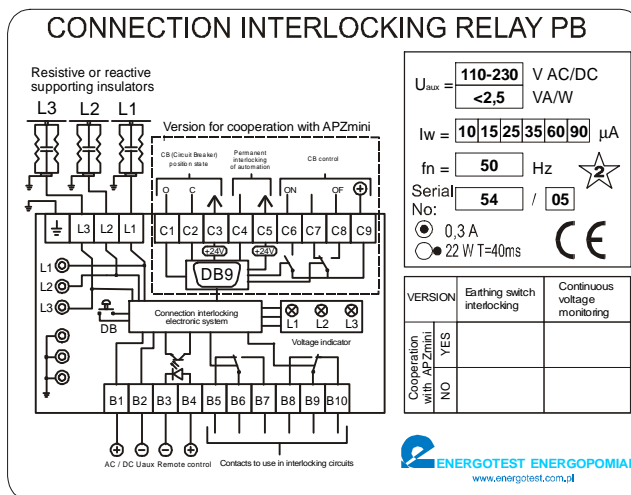


Fig. 1. Scheme of connections of connection interlocking relay type PB

Dangers impossible to eliminate



Dangers result from high on-load and measurement voltages. To avoid the electric shock during the operating it is strictly recommended not touching the connecting terminals.

6 Technical description of relay PB

6.1 General information

Modern switchgears and MV transformer stations are already equipped in stationary linear earthing switches in particular bays allowing for earthing the supplying cable. Closing the earthing switch is allowed only at non-voltage conditions on its steady contact (the movable contact is earthed). The operational use practice has shown until now, that to identify voltage appearance there used to be applied neon voltage indicators cooperating with resistive or reactive dividers built-in at supporting insulators. This solution does not ensure avoiding closing by mistake the living earthing switch. This particularly concerns the bays where the reverse voltage can occur (feeder, transformer, and coupler bays). Wrong closing the earthing switch is a serious hazard for human being and devices. Quite often it may be cause the death. Total elimination of closing the earthing switch by mistake can be achieved by applying electro-mechanical interlocking of its drive, cooperating with PB relay.

This relay is adapted to cooperate with reactive or resistance insulator having output currents from 20 up to 500 μA at nominal voltage of power network. It has got a built-in internal visual indicator, that shows voltage presence as well as an electronic circuit of connection interlocking, which is consist of executive elements like conditioning relays type DE1A. Optical elements signaling voltage presence in particular phases are three LED visible in front of relay. Depending on type of used insulator (value of its output current) and nominal voltage of power network there is need to match and adjust the threshold current value I_w of internal indicator showing voltage presence according with requirements of standard PN-EN 61958:2002 "The sets of prefabricated high voltage switchgears. Voltage presence indicators". That standard regarding threshold value of indicating voltage presence of set consisted of reactive (resistance) insulators and voltage indicator requires that in three-phase systems an indicating connected with signal "voltage presence":

- should appear if the real value of phase voltage is between 45% nominal voltage* and nominal voltage.
- shouldn't appear If the real value of phase voltage is less than 10% of nominal voltage*.

* nominal voltage – appropriate approximate value of voltage applied to network or device identification. Nominal voltage of three-phase system is a phase-to-phase voltage. Nominal voltage of single-phase system is a phase voltage (between phase and a neutral point).

Changes of current threshold value I_w of internal indicator showing voltage presence of PB relay can be done by rearrange the jumpers on the printed-circuit board. Access to those jumpers is available after opening the rear panel of relay and there's no need to take out the board of enclosure.

Output current value of insulator I_{in} at nominal voltage of power network can be calculated according to following equations:

$$I_{in} = U_n / (\sqrt{3} * X_i) \qquad X_i = 1 / (2\pi f C_i) \qquad \text{for reactive insulators}$$

$$I_{in} = U_n / (\sqrt{3} * R_i) \qquad \text{for resistive insulators}$$

where:

I_{in} – output current of insulator at nominal voltage of power network

U_n – nominal voltage of power network (phase-to-phase voltage)

X_i – reactance of insulator

R_i – resistance of insulator given by manufacturer

C_i – capacitance of reactive insulator given by manufacturer.

Right selection and adjusting of current I_w of PB relay ensure the fulfil of requirements of standard PN-EN 61958:2002 regarding threshold value of indicating the voltage presence of set consisted of reactive (resistive) insulators and voltage indicators.

On the front panel of PB relay there are sockets making possible connecting external mobile voltage indicator (for example WNf produced by Energotest), which can be also used to phasing.

Note: Voltages present in measurement sockets are the safety voltages, because maximum current flowing in case of short circuit to the earth doesn't exceed 0.5 mA r.m.s. (EN 61010-1:2001+AC: 2002).

Construction of PB relay makes possible use it as a connection interlocking relay, as a control relay of voltage presence on switchgear bus-bars or as a measuring executive element of supply switching-over automation based on the device APZmini. A way of configuration of the relay depending on applications is described in item 8.

6.2 Connection interlocking relay type PB

Executive elements of relay cooperate with a coil which interlocks closing the earthing switch, making impossible closing of earthing switch in case of voltage presence on its contacts. The schematic diagram of PB relay is shown on fig. 2.

There was established general rule that interlocking of earthing switch is active all the time, it means that closing the earthing switch is possible only after taking off the interlocking, so after supplying the unblocking coil with voltage.

On a front board of relay there were located: the LED voltage indicators, unblocking push-button „DB” and two signaling LED: („Permission”, „No permission”).

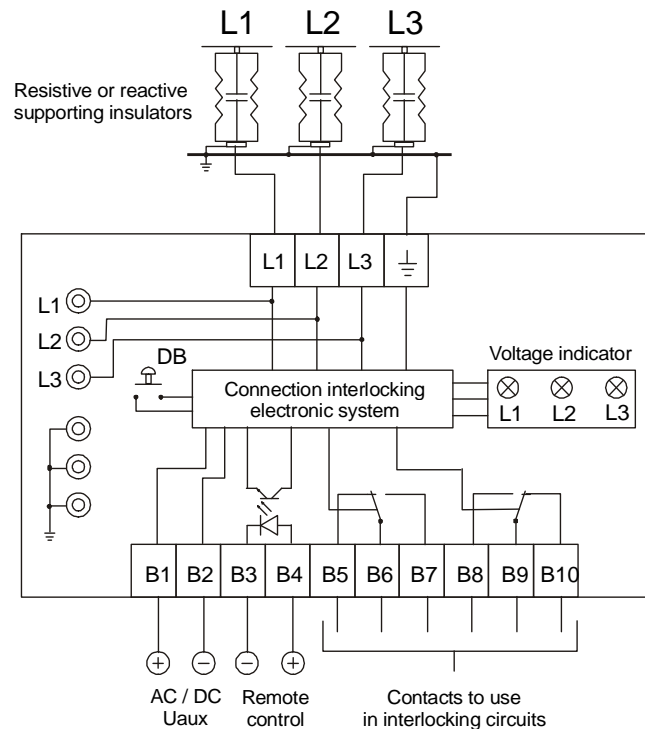


Fig. 2 Scheme of connections of connection interlocking relay type PB

A supplying with auxiliary voltage and a lack of measurement voltages is signaled by flashing LED "Permission". In case of occurred the measurement voltages the LED "Permission" goes out, and starts flashing LED "No permission". Pushing the pushbutton „DB” causes the activation of measuring system of voltage obtained from insulators. In the case of voltage presence affirmation, the LED "No permission" still flashes and there is no un-blocking the drive mechanism of earthing switch. In the case when after pushing the pushbutton „DB” the measuring system affirms no voltages got from reactive or resistive insulators, the LED "Permission" turns on constantly and the drive of earthing switch is unblocked (change over of contact states B6-B7, B8-B9) for some specific time (value set by producer) making possible closing the earthing switch by service personnel. After passing the set time (normally about 30 sec.) there occurs de-energizing of relay – LED "Permission" flashes again; and closing of earthing switch is not possible.

The PB relay additionally has got the contacts B3-B4, which may be used for remote starting the control system of voltage presence on steady contacts of earthing switch. Momentary supplying with voltage (normally value 220 V DC) is equal to push the „DB” pushbutton on a front board of relay.

The relay of connection interlocking of earthing switch is located in plastic enclosure used to install in front board (door) of switchgear. Dimensions of enclosure and installing hole are shown on fig. 1.

On the front panel of PB relay there are sockets making possible connecting external mobile voltage indicator, which can be also used to phasing.

6.3 Relay with constant voltage control

Relay of connection interlocking type PB can be adapted for continuous monitoring of voltage presence on switchgear bus-bars, installing a jumper on a board ET0157-4. After installing jumper a push-button “DB” is not active. Loss of voltage on switchgear bus bars is signaled by closing the contacts of executive relays connected to terminal B6-B7, B8-B9. More close description of proceeding with installing the jumper is described in item 8.

6.4 Connection interlocking relay type PB to cooperate with supply switching-over automation type APZmini

There is also possibility to use PB relays as a measuring-executive elements of supply switching-over automation made on device APZmini. In this case the relays need to be equipped with additional executive module (supply switching-over automation) cooperating with device type APZmini. PB relays fulfil the control function of voltage presence in power lines as well as they make possible controlling of CBs in those bays. Number of used PB relays is equal a number of feeder bays used in automation. A way of connecting of relay equipped in executive module is shown on fig. 3.

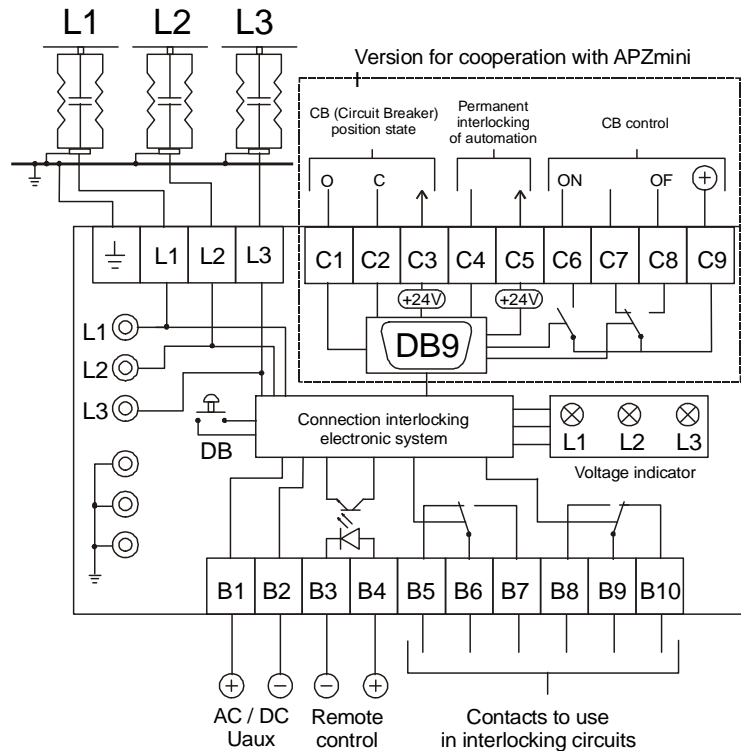


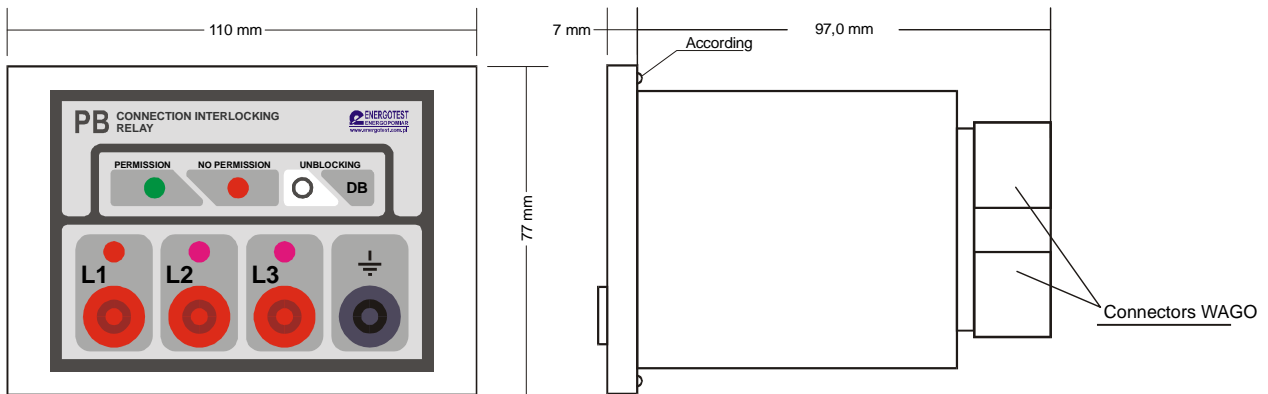
Fig. 3. Scheme of connections of connection interlocking relay type PB equipped in additional executive module of supply switching-over automation

More information about the ways of solutions of supply switching-over automation can be found in Operating Manual “System of supply switching-over automation based on a device APZmini and PB relays”.

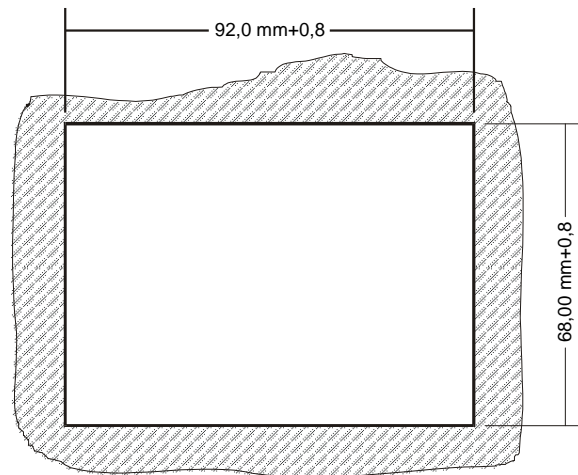
7 Technical data

Relay type	PB
Nominal supplying auxiliary voltage U_p	220/230 VDC/AC
Power consumption of PB relay from auxiliary voltage circuit	
- not activated status	<0,6 W/VA
- activated status	<2,5 W/VA
Relay cooperates with reactive and resistive insulators having an insulator output current I_{in} at nominal voltage of network	20...500 μ A
Nominal frequency	50 Hz
I_w threshold current value indicating voltage presence and no permission for closing the earthing switch	10...90 μ A \pm 10% in sub-ranges 10; 15; 25; 35; 60; 90 μ A
An additional deviation caused by change of ambient temperature	\pm 5%
Manufacturer's setting I_w	10 μ A (or according to custom-made order)
Response timing for a loss or appearing of measuring voltage	< 1s
Duration of un-blocking	30 \pm 5s
Electric strength of insulation	
- input circuits from supporting insulators	2 kV, 50 Hz; 1 min
- other circuits	2 kV, 50 Hz; 1 min
Insulation resistance	\geq 100 M Ω
Ambient temperature	
- operation	-10 ... + 55°C
- transport and storage	-25 ... +70°C
Output relays	DE1AL4,5 (10A, 250VAC)
Enclosure	Panel
- dimensions	according to fig.4
Interior protection	IP40 (IP54)*

* Relay is normally made with interior protection IP40, on custom request possible is realization in version IP54 (from front board of device using a seal according fig. 4)



Rys.4 Overall dimensions of PB relay



Rys.5 Hole dimensions for installing the PB relay

8 List of applied standards

During constructing and manufacturing of connection interlocking relay there were applied standards, which fulfilling ensures realization of assumed rules and precautions, provided that the user will follow the instructions and guidelines concerning installing and activating and maintenance.

The PB relay fulfils all principled requirements specified in directives: low-voltage (LVD) and electromagnetic compatibility (EMC), by conformity with following standards:

Polish standard consistent with low-voltage directive 73/23/EWG *)

- PN-EN 60255-5:2002(U)

Power-electric relays. Part 5: Coordination of insulation of measurement relays and protection devices. Requirements and research.

[replaces standard PN-88/E-88605 Power-electric relays. Electric insulation. Requirements and research.]

Polish standards consistent with directive 89/336/EWG **)

- PN-EN 50082-2:1997

Electromagnetic compatibility (EMC). Requirements concerning the resistance to disturbances. Industrial environment.

[replaced by standard PN-EN 61000-6-2:2002(U) Electromagnetic compatibility (EMC). Part 6-2: General standards. Requirements concerning the resistance in industrial environment].

- PN-EN 50263:2002(U)

Electromagnetic compatibility (EMC). Standard of product concerning the measurement relays and protection devices.

- PN-EN 55011:2001

Electromagnetic compatibility (EMC). Industrial, medical and scientific (IMS) devices of radio frequency. Characteristics of radio-electrical disturbances. Permissible limits and measurement methods.

Other applied standards

- PN-EN 61958:2002

The sets of prefabricated high voltage switchgears. Voltage presence indicators.

- PN-EN 60255-6:2000

Power-electric relays. The measurement relays and protection devices.

[replaces standard PN-93/E-88631 Power-electric relays. The measurement relays and protection devices]

- PN-EN 60255-21-1:1999
Power-electric relays. Research of resistance of measurement relays and protection devices to vibrations, single and multiplying strokes and seismic shocks. Research of resistance to vibrations (sinusoidal).
- PN-EN 60255-21-2:2000
Power-electric relays. Research of resistance of measurement relays and protection devices to vibrations, single and multiplying strokes and seismic shocks. Research of resistance to single and multiplying strokes
- PN-EN 60255-21-3:1999
Power-electric relays. Research of resistance of measurement relays and protection devices from vibrations, single and multiplying strokes and seismic shocks. Seismic research.
- PN-EN 60255-22-2:1999***)
Power-electric relays. Research of resistance of measurement relays and protection devices to electrical disturbances. Research of resistance to disturbances caused by electrostatic discharge.
- PN-EN 61000-4-2:1999***)
Electromagnetic compatibility (EMC). Methods of research and measurement. Research of resistance to electrostatic discharge. Primary publication EMC.
- PN-EN 60255-22-4:2003(U)***)
Power-electric relays. Part 22-4: Research of resistance to electrical disturbances of measurement relays and protection devices. Research of resistance to quick-change transient disturbances.
[replaces standard PN-IEC 255-22-4:1996 Power-electric relays. Research of resistance of measurement relays and protection devices to electric disturbances. Research of resistance to quick-change transient disturbances].
- PN-EN 61000-4-4:1999***)
Electromagnetic compatibility (EMC). Methods of research and measurement. Research of resistance to series of quick-change electrical transient disturbances. Primary publication EMC.
- PN-EN 60255-22-3:2002***)
Power-electric relays. Part 22-3: Research of resistance of measurement relays and protection devices to electric disturbances. Research of resistance to electromagnetic field disturbances.

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- PN-EN 61000-4-3:2003(U)^{***}
Electromagnetic compatibility (EMC). Part 4-3: Methods of research and measurement. Research of resistance to electromagnetic field at radio frequency.
 - ENV 50204:1995
Electromagnetic compatibility. Radiated immunity from digital radio telephones
 - PN-92/E-88608^{***}
Power-electric relays. Trials of resistance to electrical disturbances of measurement relays and protection devices. Trial with oscillation strokes at frequency 1 MHz [etc. IEC 255-22-1 (1988)].
 - PN-EN 61000-4-12:1999
Electromagnetic compatibility (EMC). Methods of research and measurement. Research of resistance to oscillation transients. Primary publication EMC.
 - PN-EN 61000-4-11:1997
Electromagnetic compatibility (EMC). Methods of research and measurement. Research of resistance to voltage decays, short breaks and changes of voltage. Primary publication EMC.
 - PN-IEC 255-11:1994^{***}
Power-electric relays. Decay and variable components of supplying auxiliary quantities of direct current measurement relays.
 - PN-EN 60529:2003
Interior protection ensured by enclosures (Code IP)

^{*)} according to List of consistent standards – Appendix no. 1 to Announcement of President of PKN dated 29.07.2003. (MP No. 46 dated 09.10.2003.)

^{**)} according to List of consistent standards – Appendix no. 5 to Announcement of President of PKN dated 29.07.2003. (MP No 46 dated 09.10.2003.)

^{***)} standard mentioned in PN-EN 50263:2002(U)

PKN – Polish Standard Committee

MP – Polish Publisher

9 Data of complete equipment

Equipment delivery includes:

- connection interlocking relay type PB,
- set of plug terminals into sockets,
- installing elements for attaching the relay in installing hole,
- operating manual,
- test report of product,
- guarantee certificate.

10 Installing

Before first supplying with voltage, the device should stay at least two hours in room; it is going to be installed, in order to equalize the level of temperatures and to avoid moisturizing. Because of construction reasons (enclosure made of plastic), the relay PB does not require protective earthing. However, for the sake of principle of operation the terminal marked by earthing symbol should be connected to the system earth. Recommended minimum cross-section of earthing wire equals 1.5 mm^2 . The others terminals marked L1, L2 and L3 should be connected to insulators with wires LY 1.5 mm^2 450/750 V led in separate installation pipe PCV. Length of wires should not exceed 5 m.

Device needs to be fixed in installing hole having dimensions shown on fig. 5, with the help of delivered fixing handles.

Scheme of connecting of the connection interlocking relay type PB depending on version is shown on fig. 2 and 3.

11 Activating

It is not allowed to do any manipulation in circuits connected with insulators with built-in voltage dividers, in case of voltage presence on its.

Before switching on the supplying voltage there's needed to check the correctness of relay connections to insulators.

The structure of device allows for correct work in range of insulator output current I_{in} changing from 20 to 500 μA at nominal voltage of network. In this connection, before activating there's need to check the received output current of used reactive (resistive) insulators at nominal voltage of network according to guidelines given in item 3.

Recommended settings of the relay in relationship to the results of an insulator's output current calculations are shown in the table below.

I_{in} [μA] AC current value of the applied insulator	Jumper position (sensitivity of the relay)
20...50	1 (10 μA)
50...80	2 (15 μA)
80...120	3 (25 μA)
120...200	4 (35 μA)
200...320	5 (60 μA)
320...500	6 (90 μA)

To make the changes in setting of relay current I_w there's need to:

- take all plugs out of the rear board of relay enclosure,

- unscrew the four screws fixing the rear board of relay enclosure,
- change the positions of jumpers – see the fig. 6,
- screw the rear board of relay enclosure using the screws,
- connect the plugs into right places.

To avoid necessity of changing the position of jumpers at the place of relay installing, there's need to describe at the order, what kind of insulators the relay will be cooperate with.

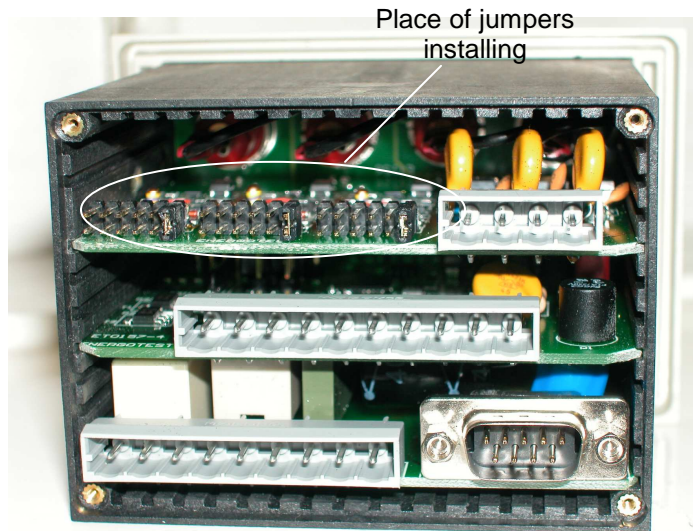


Fig.6 A view of jumpers after removing the rear board of PB relay

Switching off the un-blocking switch-button and continuous voltage measurement there's need to change the position of jumper on pcb ET0157-7. In that case, there's need to open the rear of enclosure according to description, as at sensitivity changing, take out the pcb ET0157-7 and to move the jumper J5 from position 2 to position 1. A view of pcb is shown on fig. 7.

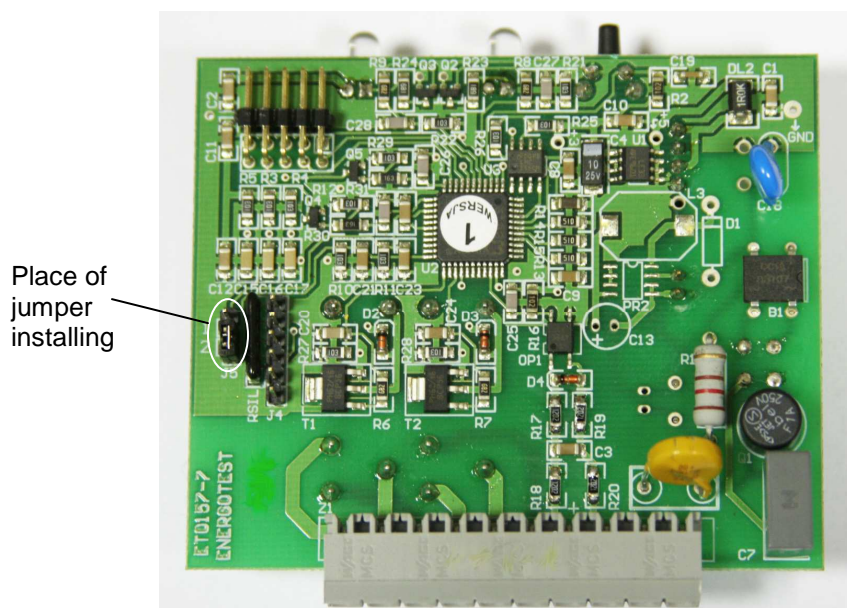


Fig.7. A view of pcb ET0157-7.

12 Operating

The devices made by Energotest are constructed in a way, there's no need to require any special operating activities from the user.

12.1 Routine tests

In principle, the relay does not require routine tests, because during switchgear operating it is continuously under the voltage and its indications are controlled by personnel staff instantly.

12.2 Detecting and removing the damage

In case of any doubts of correctness of relay operation, there is possibility of confirming the indications by plugging the external mobile indicator into measurement sockets accessible at the front of the relay.

It is not strongly recommended to do any repairs by the user without any previous agreement with producer.

13 Storing

Transport packing should have the same resistance degree for vibrations and strokes, as specified in standards PN-EN 60255-21-1:1999 and PN-EN 60255-21-2:2000 for sharpness class 1.

The device delivered by producer should be unpacked carefully, without using too much strength and inappropriate tools. After unpacking there's need to visually check if the device has no external damage.

The device should be stored in dry and clean place, where the storing temperature ranges from -25°C to $+70^{\circ}\text{C}$.

Relative humidity should be in such ranges, to not occur condensation or hoarfrost effect. Before supplying with voltage the device should be installed in operating place about 2 hours earlier, so that to even out the temperatures and to avoid condensation or hoarfrost effect.

14 Recycling

If as the result of damage or the operating life time finish there is necessary to disassemble (and if there's need to remove) the device, there's previously need to disconnect all the measuring units.

Disassembled device should be treated as an electronic scrap, which should be treated in accordance with the regulations concerning waste management.

15 Warranty and service

For the delivered device unit Energotest gives 12-month warranty counted from the date of purchasing (unless otherwise stated in the contract notations), according to principles specified in guarantee certificate.

The manufacturer ensures technical assistance at starting up of the device and provides warranty and post-warranty service on conditions specified in contract for that service.

Not obeying the rules mentioned in this instruction causes the loss of warranty.

16 Ordering

The orders including:

- auxiliary voltage value,
- interior protection (IP40, IP54),
- required setting of threshold current value I_w (type of insulator and rated voltage of power network to be applied to).

Need to refer to the manufacturer of device on the following address:

Energotest Ltd.

ul. Chorzowska 44B; 44-100 Gliwice, Poland

Phone 032-270 45 18, fax 032-270 45 17.

e-mail: handel@energotest.com.pl

www.energotest.com.pl